



National Action Plan for Sustainable and Resilient Fisheries & Aquaculture System in Pakistan



Authors

Dr. Nazia Sher

Ms. Safia Noor & Ms. Aimen Ali

National Institute of Maritime Affairs
at Bahria University, Sector E-8, Islamabad

 www.nimapak.org  [/nimaisb](https://www.facebook.com/nimaisb)  dnima@bahria.edu.pk  [nima_pakistan](https://www.instagram.com/nima_pakistan)  [/nimaisb](https://twitter.com/nimaisb)

Chapter 1

Introduction: Background & Rationale

Fisheries and aquaculture are increasingly important for food security, nutrition, and economic development. Globally, fish provides nearly 20 percent of the average per capita intake of animal protein for about 3.5 billion people. This makes the fisheries sector a critical contributor to global nutrition, particularly in developing countries where alternative protein sources may be limited¹. The country has approximately 39,000 registered fishers, and fisheries contribute around 0.4 percent to the national GDP and about 1 percent to agricultural GDP. Beyond direct employment, the sector supports millions of people indirectly through processing, marketing, transportation, export trade, and other value chain activities².

Although Pakistan has a rich resource base over 1,000-km coastline along the Arabian Sea, a comprehensive system of rivers and reservoirs and high-altitude freshwater ecosystems in Gilgit- Baltistan and Khyber Pakhtunkhwa, its fisheries sector has not been fully developed. The marine resources are being strained by overfishing, illegal fishing gears, and pollution, whereas inland aquaculture is hampered by poor investment and infrastructure and less advance technologies³.

Meanwhile, there is increased need for fish and seafood consumption owing to population growth, urbanization, and the continuously shifting dieting habits. This is a solid argument in favor of the reforms and the development of fisheries and aquaculture industries in Pakistan to fulfill national food security requirements and become parts of the global markets.

1.1 Importance of Fisheries & Aquaculture

The world is facing food insecurity where fish is one of the affordable sources of animal protein relative to red meat and poultry respectively and thus it is important in the provision of food security in Pakistan. Economic Growth Fish and sea food exports earned the country US\$ 489.2 million⁴ in 2025 with great potential that could be realized through value addition and conformity to international standards. Fisheries create income earning activities among the rural and coastal communities with women playing an important role in processing and small-scale aquaculture⁵. Aquaculture provides an opportunity to create pathways of adaptation toward sustainable food production in a changing climate with water-scarce conditions and in flooding scenarios.

¹ FAO. (2024). *The State of World Fisheries and Aquaculture 2024*. Rome: Food and Agriculture Organization of the United Nations. <https://www.fao.org/newsroom/detail/fao-report-global-fisheries-and-aquaculture-production-reaches-a-new-record-high/>

² ICSF. (2023). *Pakistan tapping trade potential of fisheries*. International Collective in Support of Fishworkers. <https://www.icsf.net/newss/pakistan-tapping-trade-potential-of-fisheries/>

³ Dawn. (2024, July 28). Climate change, fuel costs push Pakistan's fishing industry towards collapse. Dawn News. <https://www.dawn.com/news/1849648>

⁴ Pakistan Today, July 7, 2025

⁵ Profit by Pakistan Today. (2025, July 9). *Pakistan unveils 10-year policy to harness blue economy and modernize fisheries sector*. Pakistan Today. <https://profit.pakistantoday.com.pk/2025/07/09/pakistan-unveils-10-year-policy-to-harness-blue-economy-and-modernize-fisheries-sector/>

1.2 Problem Statement

Despite rich aquatic resources and a strategic location, Pakistan's fisheries and aquaculture sectors remain underdeveloped due to fragmented policies, outdated farming practices, poor infrastructure, and weak governance. Productivity lags behind regional peers like Bangladesh and India, with high post-harvest losses (30–35%)⁶, poor seed and feed quality, and limited R&D⁷. Environmental pressures overfishing, pollution, mangrove loss, and climate change further threaten ecosystems and fish health. Institutional gaps, weak law enforcement, and lack of disease monitoring systems unlock the sector's potential, Pakistan urgently needs a unified, climate-resilient National Action Plan that ensures sustainability, competitiveness, and social equity in line with SDGs.

1.3 Research Objectives

The primary objective of this research is to develop a comprehensive and evidence-based National Action Plan (NAP) that aims to transform Pakistan's fisheries and aquaculture sectors into sustainable, resilient, inclusive, and economically viable components of the national economy. This study aims to develop a strategic framework that can guide policymakers, institutions, stakeholders, and investors toward coordinated sectoral development and sustainable resource management, while addressing key environmental, economic, and social challenges.[

1.4 Research Questions

Main research questions of the study are:

- a. What are ecological, technical, socio-economic and policy-related barriers of the fisheries and aquaculture sector in Pakistan?
- b. What are the ways to make climate resilience, biodiversity conservation, and sustainability part of fisheries policy?
- c. How can aquaculture be modernized (using technology e.g. RAS, IoT, blockchain)?
- d. What are the ways of using financial mechanisms, PPPs, to increase investment in aquaculture?
- e. What is needed to facilitate gender inclusion and social equity within the industry?

6 INP WealthPK. (2023, October 12). *Pakistan's fisheries sector awaits modernization*. Independent News Pakistan. <https://www.inp.net.pk/ur/news-detail/inp-wealthpk/pakistans-fisheries-sector-awaits-modernization>

7 Aaj News. (2025, July 9). *Govt unveils 10-year National Fisheries Aquaculture Policy to revive blue economy*. Aaj English TV. <https://english.aaj.tv/news/330423467/govt-unveils-10-year-national-fisheries-aquaculture-policy-to-revive-blue-economy>

1.5 Scope

This research aims to develop a National Aquaculture Plan for Pakistan by addressing key challenges and opportunities in the sector. It will focus on policy and governance, identifying regulatory gaps and proposing frameworks for licensing, compliance, and investment incentives. The study will assess infrastructure and technology, evaluating hatcheries, feed mills, and processing units while exploring modern techniques like Biofloc, RAS, and IMTA. A market and economic analysis will examine production costs, supply chains, and export potential, identifying funding mechanisms such as microfinance and public-private partnerships. The research will also assess environmental and climate resilience, studying the impact of climate change on aquaculture and proposing sustainable practices to mitigate risks. Additionally, it will analyze socioeconomic impacts, emphasizing community engagement, employment generation, and the role of women and small-scale fish farmers. The study will further strengthen research and development, focusing on disease control, selective breeding, and feed optimization. Finally, an implementation and monitoring framework will be developed, including key performance indicators (KPIs) and a feedback mechanism for continuous policy improvement. By integrating scientific research, economic feasibility, and stakeholder collaboration, this research will provide a comprehensive and actionable National Aquaculture Plan to ensure sustainability, economic growth, and food security in Pakistan.

1.6 Research Methodology

This research paper adopts a mixed-methods approach qualitative[MR6.1][B6.2], exploratory and policy-focused approach to come up with the National Action Plan of the Sustainable and Resilient Fisheries & Aquaculture System in Pakistan. The methodology is developed that allows combining policy analysis, institutional evaluation, and evidence-based studies to develop practical recommendations on governance change, sustainability, and resilience building.

1.6.1 Research Design & Approach

The work incorporates a qualitative and analytical research design taking a constructivist approach to interpret complex formulations of governance, environmental and socio-economic factors in the fisheries and aquaculture sector environment in Pakistan.

It is policy driven, guided by:

- a. FAO Code of conduct on responsible Fisheries
- b. UN Sustainable Development Goals (SDGs), especially SDG 14 (Life Below Water) and SDG 2 (Zero Hunger)
- c. Pakistan vision 2025 and their national development priorities

d. The theory covered in the research framework uses Adaptive Governance and Resilience Theory, the focus of which is institutional capacity, ecological sustainability and inclusive resource management.

1.6.2 Data Sources & Collection Method

Secondary data of the study is as under:

- a. Government publications and policy papers Ministry of National Food Security & Research, Marine Fisheries Department and Provincial Fisheries Departments.
- b. Quantitative data of Pakistan Bureau of statistics, FAOSTAT and provincial yearbooks.
- c. International reports of FAO, World Bank, ADB, WWF and USAID.
- d. Articles published in peer-reviewed journals and obtained in Scopus, Science Direct, and JSTOR.

1.6.3 Supplementary Data

Besides literature, specifically selected discussions and interactions with experts are used to confirm findings and contextual relevancy.

1.6.4 Scope & Sampling of Literature Review

The literature was reviewed with a purposive sampling strategy to cover all areas of:

- a. The geographic scope of the study covers both marine and inland fisheries and aquaculture across the provinces of Khyber Pakhtunkhwa, Sindh, and Balochistan, as well as the territory of Gilgit-Baltistan.
- b. The scope of governance levels, i.e. federal, provincial and community levels.
- c. Thematic ambit - policy transformation, climatic resilience, advancing aquaculture techs, chains, and socio-economic aspect covers gender.
- d. This approach ensured the integration of international best practices with local contextual realities.

1.6.5 Analytical Framework

Thematic content analysis was done, supported by policy instruments:

- a. SWOT Analysis- to determine weaknesses, strengths, opportunities and threats in the systems of fish and aquaculture in Pakistan.
- b. Policy Coherence Analysis - to examine how the fisheries policy can be integrated in other areas (climate, trade, agriculture, water management).
- c. Stakeholder & Institutional Mapping -to assess how the institution roles and interactions, using the Power-Interest Grid.
- d. These levels of analysis enabled establishment of that which was missing in governance, overlapping in sectors and priority areas of intervention.

1.6.6 Validation & Reliability

Findings were reinforced by using comments from other contributors.

- a. Triangulation of numerous sources of data (policy materials, facts and figures, and articles).
- b. Peer review of fisheries scholars and practitioners to make sure that it is technically accurate and relevant to policy.

1.6.7 Ethical Consideration

The research is conducted on the grounds of published and publicly available information. We did not conduct any direct fieldwork or engagements at the community level and therefore no formal ethical clearance was necessary. Ethical standards were not violated, and proper acknowledgements were made on sources.

Chapter 2

Current Status of Fisheries & Aquaculture in Pakistan

2.1 Introduction

Aquaculture refers to the farming of fish, crustaceans, and aquatic plants, and has emerged as one of the fastest-growing food production sectors worldwide in recent years. It is estimated that the amount of fish aquaculture currently surpasses the amount of number caught every year and surpassed it in 2022⁸. In the case of Pakistan, aquaculture is especially promising as the country possesses great natural resources with a long coastline on the Arabian Sea of 1,001 kilometers, and inland water ways like rivers, reservoirs, lakes, and brackish-water areas.

A small contribution compared to its natural resources, the fisheries and aquaculture sector currently makes only 0.31% of the national GDP and 1.3% of agricultural GDP with approximately one million people employed⁹. This sector is underdeveloped, the reason being overexploitation of marine capture fisheries, weak governance, poor infrastructure and limited value addition. At least 60-90 percent of the Pakistani marine fish stocks are overfished according to the Fisheries Resources Appraisal of Pakistan¹⁰.

In this regard, aquaculture has proved to be the best and most sustainable alternative. It alleviates pressure on shrinking marine resources and investors can exploit opportunities to export and develop rural livelihoods as well as food security. The significant increase in recent years in both private and government-led projects, including shrimp cluster farming in Punjab and Sindh, AquaHatch International hatcheries projects and Dhabeji Aqua Foods intensive shrimp culture, evidence the new impetus in aquaculture in Pakistan¹¹.

⁸ Food and Agriculture Organization of the United Nations (FAO). *The State of World Fisheries and Aquaculture* 2022. FAO. <https://openknowledge.fao.org/items/11a4abd8-4e09-4bef-9c12-900fb4605a02>

⁹ Pakistan Business Council. *Policy Brief: Sustainable Fisheries and Aquaculture for Pakistan*. 2025. <https://www.pbc.org.pk/wp-content/uploads/Seafood-Policy-Brief.pdf>

¹⁰ Fisheries Resources Appraisal of Pakistan (FRAP). (2015). *Marine Fisheries Stock Assessment Report*. Marine Fisheries Department & FAO, Government of Pakistan

¹¹ Government of Pakistan. *Pakistan Economic Survey 2023-24*. Ministry of Finance, 2024.

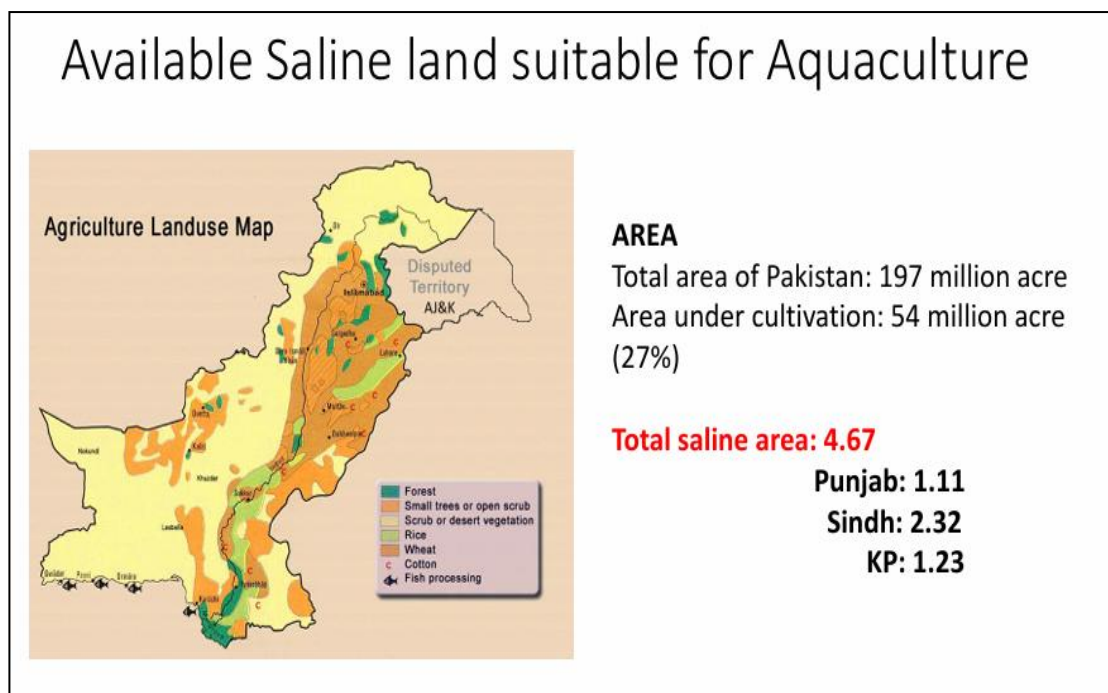


Figure 1: Map of Pakistan's Fisheries and Aquaculture (ACIAR. (2024). WAC-2020-179 final report.)

Table 1: Inventory of Pakistan's Aquatic Resources by Province (2025)

Aquatic Resource	Sindh	Punjab	Balochistan	Khyber Pakhtunkhwa	Total
Rivers / Streams	160,000	2,940,000	—	2,408	—
Canals & Drains	321,340	65,800	6,070	3,102,408	—
Lakes	97,000	30,000	—	34,803	—
Dams / Reservoirs	3,000,000	195,670	—	31,600	—
Waterlogged Areas	700,000*	—	—	—	—
Deltaic Area	1,000,000	—	—	—	—
Flood Water Area	49,170	60,230	—	—	—
Fish Farms	49,170	10,500	240	560	60,500
Territorial Marine Waters	352 km × 12 NM	1,481 km × 12 NM	—	—	—

2.2 Historical Development of Aquaculture in Pakistan

Aquaculture development in Pakistan has been slow and not very steady. Aquaculture during the 1970s was a traditional carp culture that occurred and was limited to the provinces of Punjab and Sindh. Farmers evoked simple earth ponds to cultivate the indigenous species of carp's species i.e. rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*). The efficiency of these systems was low because there was still no enhanced production of seed, feed and cultivation methods.

In the 1980s, freshwater fish output was enhanced by the introduction of Chinese carps including grass carp and silver carp. Nonetheless, such growth was limited to a few Punjab and Sindh districts.

The 1990s involved an effort to create brackish water aquaculture in the coastal areas of Sindh, especially shrimp farming. Unluckily, majority of such projects failed because of their lack of hatcheries and limited technical knowhow as well as lack of disease management facilities. Cold-water trout farming in Gilgit-Baltistan succeeded during this period which was fueled by the existence of natural streams and tourism activities.

By the 2000s, aquaculture began diversifying. Production of tilapia (*Oreochromis niloticus*) and pangasius (*Pangasius hypophthalmus*), which came to Punjab, made it more commercially profitable. In Sindh and Balochistan there was also the beginning of experimentation of shrimp aquaculture by the proprietary investors.

In the 2010s and 2020s, aquaculture received renewed attention. The opening of AquaHatch International, which would produce shrimp seed that was adapted to the country, decreased the spending on imported shrimp seed. Meanwhile, Dhabeji Aqua Foods in Karachi developed one of the largest intensive shrimp farms in the country with an area of 400 acres that combined high-density pond system and in-site processing facilities. Furthermore, pilot shrimp cluster farms in Muzaffargarh and Bahawalpur in the Punjab, had also shown that it is not only possible, but also economically viable, to convert salty lands into lucrative shrimp ponds, and in this way, provide huge economic returns to the rural population¹².

Table 2: Timeline of Aquaculture Development in Pakistan

Period	Key Developments
1970s	Traditional carp farming in Punjab & Sindh
1980s	Introduction of Chinese carps (grass, silver)
1990s	Shrimp farming pilots in Sindh; Trout farming in GB
2000s	Tilapia and Pangasius introduced in Punjab
2010s	Expansion of shrimp clusters; private investments
2020s	AquaHatch International Hatchery, Dhabeji Aqua Foods

2.3 Current Production Trend

Total fish production stands at 0.79 million metric tons (MMT) as given in the Pakistan Economic Survey (2023-24) . According to the survey 0.51 MMT is marine capture and 0.28 MMT is inland fisheries and aquaculture.

The production under marine capture fisheries has plateaued or decreased whereas that under aquaculture has continued to grow, now amounting to 43 per cent of the total fish production in 2024¹³ . The fishing industry in Pakistan is gradually transitioning from primarily marine capture to a more balanced combination of inland aquaculture and marine fisheries.

¹² Pakistan Business Council (PBC). (2025, June). *Saving Our Seas, Farming Our Future: Sustainable Fisheries and Aquaculture for Pakistan. Policy Brief. The Pakistan Business Council.* <https://www.pbc.org.pk/wp-content/uploads/Seafood-Policy-Brief.pdf>

Table 3: Fish Production Trends in Pakistan (2000–2025)

Year	Marine Production (000 MT)	Inland & Aquaculture (000 MT)	Total (000 MT)	Source
2000	360	260	720	FAO Fisheries Statistics; GoP (Historical Data)
2010	370	280	770	FAO Fisheries Statistics; GoP (Historical Data)
2020	400	320	880	FAO (2022) <i>State of World Fisheries</i> ; GoP Fisheries Wing
2023	420	340	940	Pakistan Economic Survey 2022–23 (MoF)
2024	410.9	310.0	720.9	Pakistan Economic Survey 2023–24; Dawn, 2024
2025	590.5	208.0	798.5	ICSF, 2025 (Provisional, Jul–Mar FY25)

Table 3 shows the long-term trend to develop fish production in Pakistan between 2000 and 2025. In the first half of 2000s the overall production was approximately 720,000 metric tons, the greater part of which came due to marine harvest. The growth in production was modest throughout the next 20 years, with production reaching 940,000 MT in 2023, majorly because the growth in production was slow due to the stagnation of marine resources, and hardly any expansion of aquaculture. Only in 2024 was noticeable change observed as 720,900 MT (410,900 MT marine and ~310,000 MT inland) got officially recorded, which puts pressure on the marine stocks and dictates dependence on the inland aquaculture. Nevertheless, according to the forecasts for 2025, this number may jump to 798,480 MT with marine production increasing to 590, 480 MT with inland production dropping to 208, 000 MT. These changes are indicative of better capture reporting as well as changes in the dynamics of aquaculture growth.

2.4 Species & Farming Practices

In Pakistan, aquaculture varies according to the ecology of the specific regions of the country, with there being regional specializations in terms of species that are most adaptive to those regions and their environments.

2.4.1 Freshwater fish farming (Punjab and Sindh)

The culture with carp species is prevalent, and the main species are rohu, catla, mrigal. Tilapia and pangasius became crucial commercial species during the past 20 years.

2.4.2 Salty Water Aquaculture (Sindh, Balochistan)

Whiteleg shrimp (*Litopenaeus vannamei*) and black tiger shrimp (*Penaeus monodon*) are growing in popularity due to cluster-based development of shrimp.

2.4.3 Cold-Water Aquaculture (Khyber Pakhtunkhwa and Gilgit-Baltistan)

Rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) are farmed in rivers and streams and serve as a niche market and tourism market.

Table 4: Major Aquaculture Species in Pakistan (FDP-2024)¹⁴

Region	Main Species	Notes
Punjab	Carp, tilapia, pangasius	Largest hub of freshwater aquaculture
Sindh	Carp, tilapia, shrimp	Coastal and inland brackish water farming
Balochistan	Shrimp, cage culture (nascent)	High potential, limited infrastructure
KP & GB	Trout	Niche farming, tourism-driven

Table 5: Regional Distribution of Aquaculture in Pakistan – Area, Farm Count, Production, and Species

Region	Area (Acres)	Number of Farms	Production (Tons)	Cultured Species	Culture Systems
Punjab	44,000	7,800	78,140	Carps; Tilapia; Shrimp; Pangasius	Polyculture; Semi-intensive; Extensive
Sindh	124,412	3,218	67,798	Carps; Tilapia; Shrimp; Pangasius	Polyculture; Extensive
Khyber Pakhtunkhwa	2,746	349	412	Carps; Trout	Polyculture; Extensive; Intensive
Balochistan	1,000	100	1,000	Carps; Trout	Polyculture; Extensive; Intensive

2.5 Shrimp Farming Potential

Shrimp culture will provide one of the best opportunities to develop the coast. The salinity of land in Pakistan can be used to produce high valued shrimp farming, which will earn millions of exports revenue.

Table 6: Shrimp Farming Potential from Saline Land in Pakistan¹⁵

Saline Land Utilization (%)	Area (Million Acres)	Estimated Output (Tons)	Potential Export Value (USD Billion)
2.5%	0.12	200,000	1.70
5%	0.23	400,000	3.00
11%	0.50	950,000	3.75
25%	1.10	2,100,000	15.70
100%	4.67	8,900,000	66.70

¹⁴ Australian Centre for International Agricultural Research. (2024). Development of inland aquaculture in Pakistan: Final report (WAC-2020-179). ACIAR. <https://www.aciar.gov.au/sites/default/files/2024-05/wac-2020-179-final-report.pdf>

¹⁵ Australian Centre for International Agricultural Research. (2024). Development of inland aquaculture in Pakistan: Final report (WAC-2020-179). ACIAR. <https://www.aciar.gov.au/sites/default/files/2024-05/wac-2020-179-final-report.pdf>

2.6 Economic Contribution

The aquaculture and fisheries sector contributes in numerous ways to the Pakistani economy and the population.

Economically, it is the source of 0.31% of the national GDP and 1.3 percent of agricultural GDP¹⁶. It sustains approximately a million livelihoods including small-scale fishers to transporters, processors, and exporters.

Seafood exports generated USD 496 million in FY2022-23 which is a record high. The export was at the level of approximately 214,000 MT, and its major items were seafood, shrimp, frozen fish, and cuttlefish. The targeted markets include China, UAE, Thailand, Saudi Arabia and Malaysia. The level of foreign exchange earnings has been low because the Pakistani exports are in raw or less processed goods.

On the domestic front, fish consumption is very low at just 2 kg per capita per year as compared to the world average of 20.5 kg/year¹⁷ (FAO, 2022). This is repeated by both culture dietary preferences and bad distribution systems.

Table 7: Export Performance of Pakistan's Seafood Sector (PBS-2024)

Year	Export Volume (000 MT)	Export Value (USD million)
2010	131	226
2020	200	450
2022–23	214	496
2023–24	200	410

2.7 Case Studies of Aquaculture Development

2.7.1 Shrimp Cluster (Muzaffargarh)

The viability of aquaculture has been proven with respect to piloting shrimp farming on the saline land in Muzaffargarh. An acre of land produces PKR 1.2 to 3 million a year. The model enables farmers to cultivate two crop cycles annually, thereby allowing those with previously low-productivity land to generate higher income.¹⁸

2.7.2 Aqua Hatch International

A partnership-based initiative of producing locally cultivated shrimp seeds at different levels of salinity. It helps in the reduction in mortality rates and increasing farm productivity due to Pakistan historic relation with imported shrimp seed.

¹⁶ Pakistan Bureau of Statistics, Pakistan Bureau of Statistics (Islamabad: Government of Pakistan), <https://www.pbs.gov.pk>

¹⁷ Food and Agriculture Organization of the United Nations, The State of World Fisheries and Aquaculture 2022: Towards Blue Transformation (Rome: FAO, 2022), <https://doi.org/10.4060/cc0461en>

¹⁸ Pakistan Bureau of Statistics. (2025). Pakistan fisheries statistics 2025. Government of Pakistan. <https://www.pbs.gov.pk>

2.7.3 Dhabeji Aqua Foods (Karachi)

The 400-acre intensive shrimp farm adopted high-density ponds, use of paddle aerators and a processing facility on the farm. It is one of the biggest commercial shrimp ventures in Pakistan and is supposed to be an important factor of export.

2.7.4 Trout Farming in GB

The target market of trout farms is the domestic urban population along with tourists. They are also useful in matters concerning rural livelihood development in high altitude areas.

2.8 Challenges Facing Aquaculture

Aquaculture has a lot of challenges despite its growth:

- a. **Marine Resource Depletion:** FRAP (2015) says that 60-90 percent of the fish stocks are overexploited.
- b. **Weak Enforcement:** The existence of illegal nets, trawling, and informal cross-border trade are anti-sustainable.
- c. **Infrastructure issues:** Hatcheries, feeding mills, testing equipment, and cold chains have not developed properly.
- d. Barriers to Pakistan lost its access to the EU market in 2007 because of the sanitary compliance issues.
- e. **Environmental Strain:** There is pollution in coastal water, mangrove deforestation, and the coastal aquaculture is afflicted with intrusion of salty water.
- f. **Climate Change:** Sea temperature increases, and uncertain rainfall are a risk to production systems.

Table 8: Key Challenges in Pakistan's Aquaculture Sector (Source: Compiled from Fisheries Development Board (2025) and FAO (2024))

S No.	Domain	Details
1	Natural Potential	1.2 million hectares suitable for aquaculture
2	Infrastructure	Lack of breeding centers, cold storage, and feed mills
3	Productivity Capacity	Low productivity; reliance on traditional methods
4	Species Diversity	80% carp production; minimal tilapia and trout farming
5	Institutional Weaknesses	Weak governance; limited extension services

S No.	Domain	Details
6	Human Resource Deficit	Shortage of skilled technical and management staff
7	Financial Support Deficiency	Absence of loan and insurance schemes for farmers
8	Legal Gaps	Weak zoning regulations and insufficient legal frameworks
9	Environmental Issues	Disease outbreaks, pollution, and salinity intrusion
10	Private Sector Engagement	Low levels of private investment and industry participation

2.9 Opportunities and Potential Growth

The biggest potential in Pakistan is inland shrimp farming, in Sindh and Balochistan. Cluster-based shrimp production can turn salty and unproductive land into high-yielding fishery areas. By bringing technology and management practices up to date, farmers would make USD 8,000 per acre up to USD 30,000 per acre annually (PBC, 2025). Other opportunities are:

- Tilapia growth in the national market.
- Value added in processing (peeled shrimp, frozen fillets, ready to eat meals).
- Export diversification of China to EU and US markets.
- Public-private alliances in hatcheries, feed, feeding as well as disease control.

2.10 Benchmarking with Regional Competitors

Pakistan has an insignificant seafood export in comparison to the neighbors.

- During 2023-24, India also exported more than 7.3 billion dollars' worth of seafood, which was mainly concentrated on vannamei shrimp.
- Vietnam and Ecuador have developed shrimp aquaculture businesses that are globally competitive with a total worth of billions of dollars.
- Saudi Arabia and Iran have been able to transfer coastal fishing communities to fish farming.

This comparison reveals that Pakistan has an uncompromising need to invest in the aquaculture infrastructure, hatcheries and compliance frameworks in order to compete at the international level.

2.11 Policy Recommendations and Way Forward

To take full advantage of aquaculture, there must be a coordinated approach in Pakistan:

- a. Formulate a National Aquaculture Roadmap with definite targets.
- b. Purchase hatcheries, animal feed factories and biosecurity testing facilities.
- c. Enforce cold chain infrastructure and processing plants.
- d. Guarantee match to EU sanitary and traceability.
- e. Encourage campaigns to help people eat more fish produced nationally and less fish imported.
- f. Support the development of public-private partnership in the form of cluster-based shrimp aquaculture.

2.12 Conclusion

In Pakistan aquaculture is at a crossroad. As marine capture fisheries are reduced, an alternative means through which food, income, and exports are secured is by adopting aquaculture as a sustainable means. Pakistan can change the aquaculture industry into one of the key components of its Blue Economy with the passage of favorable natural conditions and growing interest in the sector among the private sector individuals.

Pakistan can learn and experiment based on international best practices, and invest in infrastructure, governance and compliance to repeat success stories of their competitors in the region like India and Ecuador. When adequately supported, aquaculture can provide both export income and improve the lives of rural people and enhance ecologically sustainable prospects.

Chapter 3

Literature Review

3.1 Previous Studies

The sources of data used in the current study include the most popular academic databases such as Web of Science, Google Scholar, and Research Gate. A systematic review technique was used to find literature that relates to fisheries and aquaculture governance. The articles that were chosen to conduct the research contain a clear indication and repetition of core issues related to governance. Emphasis was given to research that discussed policy formulation, institutional arrangements, sustainability and community involvement in fishing and farms. This ensured that such findings were supported by honest, peer reviewed materials. This CLR Methodology solely employs literature in conducting analysis only. This research does not involve humans or animals. The authors manually review the literature, and the results are driven by the following method.

Table 9: Reviewed Various National Fisheries Governance Articles

S No.	Title of the Paper	Name of the Journal	Year Published	Volume	Issue	Reiteration of Governance Principle
1.	Assessment of Fishery Resources in Inland Waters of Pakistan: A Case Study of Indus River	Journal of Fisheries and Aquatic Sciences	2015	10	2	Ecosystem-Based Approach
2.	Analysis of Fish Consumption Patterns in Urban and Rural Areas of Pakistan	Journal of Agriculture and Rural Development in the Tropics and Subtropics	2016	117	2	Cooperation
3.	Impact of Policy Reforms on Fisheries Management in Pakistan: A Case Study of Sindh Province	Pakistan Development Review	2016	55	4	Science-Policy Integration
4.	Economic Analysis of Aquaculture Development in Pakistan: Opportunities and Challenges	Aquaculture Economics & Management	2016	20	3	Cooperation
5.	Role of Community-Based Fisheries Management in Pakistan: Lessons Learned and Future Directions	Ocean & Coastal Management	2016	134		
6.	Impact of Urbanization on Inland Fisheries in Pakistan: A Case Study of Rawal Lake	Journal of Environmental Planning and Management	2016	59	12	Science-Policy Integration
7.	Analysis of Policy Reforms in Pakistan's Fisheries Sector: A Case	Journal of Applied Ichthyology	2016	32	4	Cooperation

S No.	Title of the Paper	Name of the Journal	Year Published	Volume	Issue	Reiteration of Governance Principle
	Study of Khyber Pakhtunkhwa Province					
8.	Analysis of Policy Reforms in Pakistan's Fisheries Sector: A Case Study of Gilgit-Baltistan	Journal of Applied Aquaculture	2016	28	4	
9.	Impact of Climate Change on Pakistan's Fisheries Sector: A Review	Journal of Fisheries and Aquatic Science	2017	12	4	Precautionary Measures
10.	Improving Governance in Pakistan's Fisheries Sector: Lessons from International Best Practices	Journal of Sustainable Development	2017	10	5	Ecosystem-Based Approach
11.	Sustainable Fisheries Development in Pakistan: Policy Priorities and Pathways	Journal of Environmental Management	2017	203, Part 1		Cooperation
12.	Impact of Pollution on Fishery Resources in Pakistan: A Case Study of the Indus River	Environmental Science and Pollution Research	2017	24	4	
13.	Role of Women in Inland Fisheries in Pakistan: A Gender Analysis	Gender, Technology and Development	2017	21	2	Cooperation
14.	Economic Analysis of Shrimp Farming in Pakistan: A Case Study of Balochistan Province	Aquaculture Economics & Management	2017	21	5	Cooperation
15.	Economic Analysis of Inland Fisheries Development in Pakistan: Opportunities and Challenges	Journal of Inland Fisheries Society of India	2017	49	1	Cooperation
16.	Economic Analysis of Freshwater Fisheries Development in Pakistan: Opportunities and Challenges	Journal of Inland Fisheries Society of Pakistan	2017	22	1	Cooperation
17.	Role of Women in Small-Scale Fisheries in Coastal Areas of Pakistan	Asian Fisheries Science	2018	31	1	Cooperation
18.	Legal Framework for Fisheries Management in Pakistan: A Comparative Analysis	Pakistan Journal of Legal Studies	2018	19	3	
19.	Impact of Climate Change on Pakistan's Inland Fisheries: Adaptation Strategies and Policy Implications	Journal of Aquatic Ecosystem Stress and Recovery	2018	25	4	
20.	Impact of Infrastructure Development on Fisheries in Pakistan: A	Journal of Coastal Conservation	2018	22	4	Precautionary Measures

S No.	Title of the Paper	Name of the Journal	Year Published	Volume	Issue	Reiteration of Governance Principle
	Case Study of Gwadar Port					
21.	Aquaculture Development and Its Impacts on Ecosystem Services: A Case Study of Fish Farming in Punjab, Pakistan	Aquaculture Reports	2018	10		Ecosystem-Based Approach
22.	Fishery Co-Management in Pakistan: Lessons Learned and Future Directions	Ocean & Coastal Management	2018	157		Cooperation
23.	Assessment of Fishery Resources in Pakistan's Coastal Waters: A Case Study of Gwadar Port	Pakistan Journal of Marine Sciences	2018	27	2	Cooperation
24.	Role of Women in Artisanal Fisheries: A Case Study of Coastal Communities in Balochistan, Pakistan	Ocean & Coastal Management	2018	156		Cooperation
25.	Impact of Infrastructure Development on Inland Fisheries in Pakistan: A Case Study of Mangla Dam	Environmental Science and Pollution Research	2018	25	30	
26.	Role of Women in Artisanal Fisheries: A Case Study of Coastal Communities in Sindh, Pakistan	Ocean & Coastal Management	2018	162		
27.	Impact of Infrastructure Development on Inland Fisheries in Pakistan: A Case Study of Tarbela Dam	Journal of Applied Ichthyology	2018	34	5	
28.	Assessment of Fisheries Management in Pakistan: Challenges and Opportunities	Pakistan Journal of Marine Sciences	2019	28	1	Ecosystem-Based Approach
29.	Effects of Industrial Pollution on Fish Health in Karachi Coast, Pakistan	Environmental Monitoring and Assessment	2019	191	9	
30.	Assessment of Fishery Resources in Pakistan's Exclusive Economic Zone: A Case Study of Karachi Coast	Journal of Oceanography and Marine Science	2019	10	3	Ecosystem-Based Approach

S No.	Title of the Paper	Name of the Journal	Year Published	Volume	Issue	Reiteration of Governance Principle
31.	Evaluation of Fishery Management Practices in Pakistan: A Comparative Study of Public and Private Sector Initiatives	Journal of Fisheries and Aquaculture	2019	11	2	Cooperation
32.	Analysis of Governance Challenges in Pakistan's Fisheries Sector: A Case Study of Sindh Province	Governance	2019	32	4	
33.	Legal Frameworks for Sustainable Aquaculture Development in Pakistan: A Comparative Analysis	Aquaculture Law & Policy	2019	23	2	Ecosystem-Based Approach
34.	Impact of Industrial Pollution on Fish Health in Karachi Coast, Pakistan: A Case Study	Environmental Monitoring and Assessment	2019	191	7	
35.	Legal Frameworks for Sustainable Shrimp Farming in Pakistan: A Comparative Analysis	Journal of Aquaculture Law & Policy	2019	26	2	Ecosystem-Based Approach
36.	Impact of Marine Pollution on Fish Health in Coastal Areas of Pakistan: A Case Study	Journal of Marine Biology	2019	2019		
37.	Legal Frameworks for Sustainable Aquaculture Development in Pakistan: A Case Study of Punjab Province	Aquaculture Law & Policy	2019	28	1	Ecosystem-Based Approach
38.	Socio-Economic Impacts of Overfishing on Coastal Communities in Pakistan	Pakistan Journal of Agricultural Sciences	2020	57	3	
39.	Role of Women in the Value Chain of Fishery Products: Case Study from Coastal Communities of Pakistan	Journal of Gender, Agriculture and Food Security	2020	5	1	Cooperation
40.	Assessment of Fishery Extension Services in Pakistan: Challenges and Opportunities	International Journal of Fisheries and Aquatic Studies	2020	8	3	Ecosystem-Based Approach
41.	Assessment of Fishery Extension Services in Coastal Areas of Pakistan: Challenges and Opportunities	Journal of Agricultural Extension and Rural Development	2020	12	1	Ecosystem-Based Approach

S No.	Title of the Paper	Name of the Journal	Year Published	Volume	Issue	Reiteration of Governance Principle
42.	The Impacts of Climate Change on Pakistan's Marine Fisheries: Vulnerabilities and Adaptation Strategies	Journal of Marine Science and Engineering	2020	8	6	Precautionary Measures
43.	The Effects of Climate Variability on Pakistan's Inland Fisheries: Implications for Management and Policy	Journal of Freshwater Ecology	2020	35	1	
44.	Evaluation of Fishery Extension Services in Coastal Areas of Pakistan: A Case Study of Karachi	Pakistan Journal of Zoology	2020	52	6	Cooperation
45.	Assessment of Fishery Extension Services in Coastal Areas of Pakistan: A Case Study of Sindh Province	Pakistan Journal of Agricultural Research	2020	33	3	Ecosystem-Based Approach
46.	The Impacts of Climate Change on Inland Fisheries in Pakistan: Adaptation Strategies and Policy Implications	Journal of Environmental Science and Engineering	2020	9	2	Precautionary Measures
47.	Evaluation of Fishery Extension Services in Coastal Areas of Pakistan: A Case Study of Balochistan	Pakistan Journal of Zoology	2020	52	5	Cooperation
48.	Socioeconomic Impacts of COVID-19 on Coastal Communities Dependent on Fisheries: A Case Study of Karachi, Pakistan	Ocean & Coastal Management	2021	204		Science-Policy Integration
49.	Socioeconomic Impacts of COVID-19 on Fisheries Sector in Pakistan: Challenges and Coping Strategies	Journal of Coastal Conservation	2021	25	3	Precautionary Measures
50.	Socioeconomic Impacts of COVID-19 on Fisheries Sector in Pakistan: Challenges and Coping Strategies	Journal of Fisheries and Aquatic Science	2021	16	3	

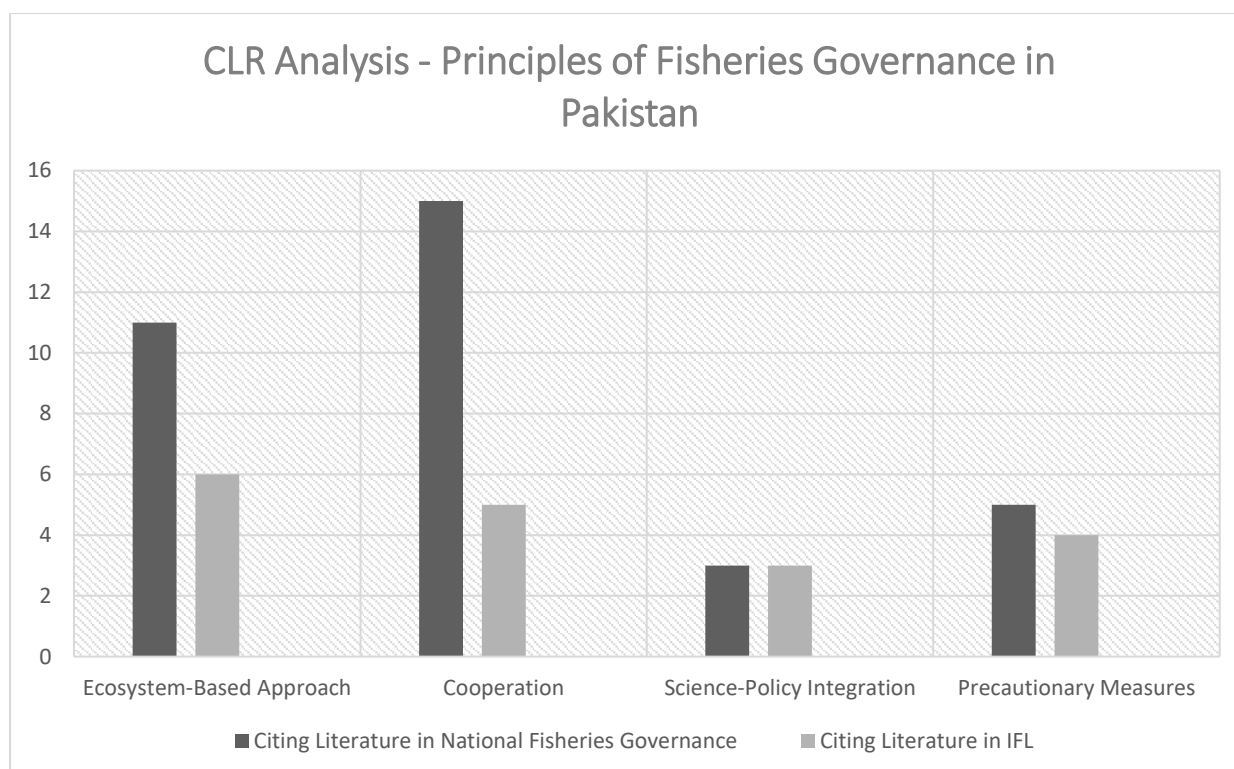


Figure 2: Comparison of Literature on Pakistan with Governance Principles Impact

3.2 Key Findings of the National Fisheries and Aquaculture Policy 2007 in Pakistan (FAO-TCP)

Pakistan started its first comprehensive process of formulating a national policy on fisheries and aquaculture in 2005-2007 using a participatory multi-stakeholder process. The policy was designed to overcome poor coordination in governance and open up the industry to economic growth, poverty alleviation and food security. It also came up with strategic pillars like institutional reform, development of aquaculture, sustainable capture fisheries and improvements of post-harvest. Although there was observable improvement by 2006-07, there were still major setbacks in the aspects of infrastructure, legal coherence, green sustainability and human capital. These loopholes point to the necessity of policy reforms in line with the international guidelines such as WTO-AFS, SDGs, and the FAO Code of Conduct.

Table 10: Fisheries & Aquaculture Policies of Pakistan

S No	Policy / Plan	Year	Main Objectives	Identified Gaps	Reference
a.	National Aquaculture Development Plan (NADP)	2002	Promote aquaculture, enhance inland fish production, introduce new farming techniques.	Weak implementation, lack of funding, poor R&D support, limited technology adoption.	FAO (2009), ¹⁹ Government of Pakistan (2002).

¹⁹ Food and Agriculture Organization of the United Nations (FAO). (2009). *The state of world fisheries and aquaculture 2008*. Rome: FAO.

S No	Policy / Plan	Year	Main Objectives	Identified Gaps	Reference
b.	National Environmental Policy	2005	Ensure sustainable development, protect ecosystems, integrate environment into all economic sectors including fisheries.	Weak enforcement, no specific aquaculture strategies, overlapping mandates.	GoP, Ministry of Environment (2005).
c.	National Aquaculture Policy	2010	Expansion of aquaculture, improve livelihoods, strengthen institutional frameworks.	Absence of monitoring mechanisms, weak stakeholder participation, lack of private sector incentives.	FAO & GoP (2010) ²⁰ .
d.	National Climate Change Policy	2012	Adaptation and resilience of natural resources including fisheries.	Limited sectoral integration, fisheries not prioritized, lack of adaptive infrastructure.	GoP, Ministry of Climate Change (2012) ²¹ .
e.	National Food Security Policy	2018	Improve food security through fisheries and aquaculture contribution.	Fisheries sector underrepresented, aquaculture role not fully integrated in food value chain.	GoP, Ministry of National Food Security (2018).
f.	Fisheries Management & Conservation Strategy	2016	Ensure sustainable fisheries, regulate exploitation, conserve biodiversity.	Weak compliance with international standards, illegal fishing persists, monitoring gaps.	Marine Fisheries Department (2016).
g.	Balochistan Sustainable Fisheries & Aquaculture Policy (BSFAP)	2024–2034	Sustainable fisheries, aquaculture development, fisherfolk welfare, blue economy growth.	Implementation capacity yet untested, funding gaps, need for cross-provincial alignment.	Government of Balochistan ²² (2024).
h.	Deep Sea Fishing Policy	2018	Regulate deep-sea fishing, promote sustainable offshore resource exploitation.	Enforcement issues, conflict between provincial and federal jurisdiction, IUU fishing persists.	GoP, Ministry of Maritime Affairs (2018) ²³ .
i.	Pakistan Vision 2025	2014	Promote Blue Economy, integrate fisheries into national growth strategy.	Fisheries sector overlooked in practical terms, limited investment in aquaculture infrastructure.	Planning Commission of Pakistan (2014) ²⁴ .

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21 Food and Agriculture Organization of the United Nations (FAO). (2009). The state of world fisheries and aquaculture 2008. Rome: FAO

22 Government of Balochistan. (2024). Balochistan sustainable fisheries and aquaculture policy (2024–2034). Quetta: Government of Balochistan

23 Food and Agriculture Organization of the United Nations (FAO) & Government of Pakistan. (2010). National aquaculture policy. Islamabad: FAO & Ministry of Food, Agriculture and Livestock.

24 Planning Commission of Pakistan. (2014). Pakistan vision 2025. Islamabad: Ministry of Planning, Development & Reform.

3.3 Global practices

3.1.1. U.S. Coastal State Aquaculture Plans (2014–2022)

Seven U.S. states (Alaska, Florida, Maine, Michigan, New Jersey, North Carolina and Oregon) created and enacted coastal aquaculture plans between 2014 and 2022. Such plans were widely different in length, 8 pages to 177 pages, and they took between 1 and 3 years to develop. Although differing greatly, all the plans had one thing in common, which was to develop the aquaculture industry of each of the states.

Analysis of state characteristics showed that there was no significant correlation between the probability of having an aquaculture plan and conditions such as prior history of planning (1979-1997), geographic type (oceanic vs. Output (as measured by Great Lakes sales, aquaculture sales, or the number of farms) or enabling policy scores. This implies that it is internal motivation that has contributed more to planning development and not structural factors.

The backing of these plans split among mandated and non-mandated sources of institutional support. Four states, Alaska (through Governor Administrative Order 280), Florida (2011 Aquaculture Policy Act), New Jersey (1998 Act) and North Carolina had legislatively required plans. The other three -Oregon, Maine and Michigan - established their strategies because of mutual interactions among academia, industry and government. Enter technicians that provided a positive contribution, although there is no regulatory control.

Planning in each of the seven states was multi-stakeholder in nature and included the input of academia, state and federal agencies, the aquaculture industry, and tribal groups. Four states conducted stakeholder surveys and engagements with a segment of the population. The percentage of contributors goes down to 1 percent in Oregon and reaches 60 in North Carolina. The typical forms of leadership that were present in common practice were steering committees, advisory boards, and even specialized task forces.

Concerning the expansion of aquaculture, four of the states cultivated marine environments (although they did not exclude freshwater), two worked both in the marine systems and in freshwater, and one (Michigan) only in the freshwater systems. In more marine states, molluscs were the most likely to be targeted. Salmon were given highest priorities in Maine, Michigan, Oregon, and Florida, whilst crustaceans and algae were also equally common. There were unique targets such as echinoderms (Alaska and Oregon), and reptiles (Florida only). An interesting note is that Alaska still had a regulatory ban on finfish farming in state waters.

The strongest reasons, most mentioned by the seven states, to develop these aquaculture plans were economic development, creation of employment opportunities, reduction in trade deficits, creating resilient sectors and food security assurance. Selected priorities were the expansion of the North Carolina Fish Farmer Program and Alaska with its capitalization of \$100 million of

industry, Michigan and its ambition to reach a value of one billion dollars in its aquatic farming, and the use of aquaculture as a climate adaptation strategy in Maine.

Regarding the structure, all plans except Florida plan had an executive summary, vision of aquaculture, synthesis on current state, and a list of strategic recommendations and development targets. Targets were quantitative and qualitative including the Alaska projection of \$100 million and the Michigan target of 22,000 new jobs; Florida aimed at rising farm-gate income and Maine at an overhaul of licensing.

Best management practices (BMPs), marine spatial planning (MSP), climate change, underserved communities, habitat restoration, and a connection with commercial fisheries and endangered species were also frequent shared topics among the plans. Although BMPs were referred to in all the plans, only New Jersey presented elaborate guidelines. In plans with a spatial framework, where all plans had a spatial structure implemented, SPF was four %45 envisaged in 4 plans. Five plans had some mention of climate change although Maine reflected this with specifically detailed mentioning. Drawing special attention to underserved communities was specifically addressed in Alaska, Maine, and Michigan plans and restoration benefits discussed in five plans.

Recommendations tended to be thematic, in six of the seven states, with Oregon having a narrative-style plan containing 20 conclusions, some of which were sprinkled with suggestions. The most popular themes in regulation suggestions were regulative streamlining, commercial promotion, labor force, research investment, and informing the population.

Examples

Few examples pertaining to this scenario are:

- a. **Alaska:** A focus on mariculture promotion and involvement of the tribal community, and investment in aquaculture research²⁵.
- b. **Florida²⁶:** It is concentrated on species diversification, food safety, and aquaculture education.
- c. **Maine²⁷:** Believed in balanced licensing mechanisms, branding and sustainability.
- d. **Michigan:** Highlighted nurtured and built trust, sustainability and better-developed financing mechanisms.

25 Alaska Department of Fish & Game. (2018). Alaska Mariculture Development Plan. Juneau, AK: Alaska Department of Fish & Game

26 Florida Department of Agriculture & Consumer Services. (2024). Florida Aquaculture Plan 2025. Tallahassee, FL: Division of Aquaculture, FDACS

27 Sadusky, H., Brayden, C., Zydlewski, G., & Belle, S. (2022). Maine Aquaculture Roadmap, 2022-2032. Orono, ME: Maine Sea Grant / Maine Aquaculture Hub.

- e. **New Jersey²⁸:** Notes on workforce development, permitting reform and hatchery assistance.
- f. **North Carolina:** Shellfish support, water quality protection and efficiency in regulations.
- g. **Oregon:** Provided general recommendations that were not organised by theme but presented more as a story.

²⁸ New Jersey Department of Agriculture. (2021). New Jersey Aquaculture Development Plan Update, 2021-2026. Trenton, NJ: NJDA

Chapter 4

Incorporating Climate Resilience into Pakistan's Aquaculture and Fisheries Sector Planning

4.1 Introduction

Climate change is increasingly becoming a threat to the fisheries and aquaculture sector of Pakistan. Fisheries only contribute less than 1% to the Pakistan GDP yet it is a source of livelihood and food to millions of Pakistanis, especially along its coastline in Sindh and Balochistan. Pakistan is regarded as one of the most vulnerable nations of the globe to the impacts of climatic change in relation to fisheries and aquaculture²⁹. Increasing temperature, changing monsoons and weather patterns, rise in sea level and weather extremes are already disturbing fish habitats and productivity. These problems augment pre-existing problems of overfishing, pollution and poor infrastructure, which weaken the sustainability and growth of the sector^{30 31}. The report entails a complete analysis of the climate change vulnerability of inland and marine fisheries, adaptive technologies and nature-based solutions and financing to mainstream climate resiliency and disaster risk management (DRM) policies throughout the country and provinces. It will aim to contribute to an informed climate resilient national policy on aquaculture and fisheries that would protect livelihoods and food security in Pakistan Blue Economy.

4.2 Climate Hazards and Sector Vulnerabilities

Pakistan's fisheries and aquaculture face multiple climate risks, including rising air and water temperatures that reduce oxygen levels, and adversely affect fish health, and heighten disease vulnerability, particularly in cold-water species like trout, which have suffered mass mortalities during recent heat waves. Coastal ecosystems are threatened by sea-level rise, saltwater intrusion into the Indus Delta, and mangrove loss, while erosion and land subsidence endanger landing sites and aquaculture ponds. Extreme weather events such as the 2010 and 2022 floods devastated inland aquaculture wiping out trout farms in Swat while cyclones, storms, droughts, and heat waves increasingly damage fishing communities and reduce inland catches. Variability in river flows and reservoirs, driven by erratic monsoon patterns and glacier melt, further disrupts spawning, shrinks habitats, and intensifies water competition with agriculture, affecting carp polyculture in Punjab and Sindh. In the marine sector, warming Arabian Sea waters are shifting valuable species like tuna, mackerel, and shrimp to deeper zones, while acidification and coral degradation erode nursery grounds. Periodic harmful algal blooms and hypoxic "dead zones" along the coast, linked

²⁹Maqsood R and Abbas K. *Climate Change and Fisheries: A Global Perspective*. *Pro Aqua Farm Marine Biol* 2024, 4(1): 180033

³⁰Climate change, fuel costs push Pakistan's fishing industry into more choppy waters <https://www.aa.com.tr/en/asia-pacific/climate-change-fuel-costs-push-pakistan-s-fishing-industry-into-more-choppy-waters/3293622>

³¹Pakistan: Climate change, rising global temperature affect fisheries – ICSF <https://icsf.net/newss/pakistan-climate-change-rising-global-temperature-affect-fisheries/>

to warming and stratification, have also led to fish die-offs underscoring the urgent need for climate-resilient policies in Pakistan's fisheries sector.

4.3 Summary of Climate Change Impacts

The table below explains some of the most important factors of climate change and how it affects aquaculture and the marine fisheries in Pakistan:

Table 11. Key climate change factors and their impacts on Pakistan's inland and coastal fisheries.

Climate Change Factor	Impacts on Inland Aquaculture & Fisheries	Impacts on Marine/Coastal Fisheries
Rising Temperature	Elevated pond/river temperatures reduce dissolved oxygen and stress fish; cold-water trout farming in northern Pakistan is collapsing as glacial water warms ³² . Higher disease incidence in aquaculture (due to warmer water favoring pathogens) ³³ .	Warmer seas alter fish distributions (many species moving to cooler deeper waters) and timing of spawning ³⁴ . Coral reef damages and bleaching; heat stress on mangroves. Potential increase in fisheries post-harvest losses without adequate cold chain.
Sea-Level Rise	N/A (inland areas not directly affected by sea level, though coastal river deltas see intrusion)	Saline water intrusion in the Indus Delta damages mangroves and coastal farms. Coastal erosion and submergence of fish landing sites and villages ³⁵ . Loss of brackish-water habitats (e.g. lagoons) impacting shrimp/fish nurseries.
Extreme Weather (Floods, Storms)	Floods destroy fish ponds and hatcheries, as seen in 2022 when ~375 trout farms were ruined, causing PKR 2.58 billion in losses ³⁶ . Infrastructure (pond bunds, cages) damage and widespread fish escape/mortality. Droughts dry up water bodies, causing fish kills and reduced aquaculture yields.	Storm surges and cyclones damage boats, gear, and coastal cage farms. Heavy rain can flood coastal ponds or estuaries, changing salinity abruptly and causing mortality. Extreme floods flush nutrients into the sea initially boost productivity but also carry pollutants harming coastal fisheries. Overall increased variability adds risk and uncertainty for fisherfolk livelihoods.

³²Climatic Change Pushes Pakistan's Trout Fish Farming Towards Collapse — Global Issues <https://www.globalissues.org/news/2025/02/11/39055>

³³Maqsood R and Abbas K. Climate Change and Fisheries: A Global Perspective. *Pro Aqua Farm Marine Biol* 2024, 4(1): 180033

³⁴Climate change, fuel costs push Pakistan's fishing industry into more choppy waters <https://www.aa.com.tr/en/asia-pacific/climate-change-fuel-costs-push-pakistan-s-fishing-industry-into-more-choppy-waters/3293622>

³⁵Mongabay (2024). Pakistan bucks global trend with 30-year mangrove expansion <https://news.mongabay.com/2024/02/pakistan-bucks-global-trend-with-30-year-mangrove-expansion/>

³⁶Climatic Change Pushes Pakistan's Trout Fish Farming Towards Collapse — Global Issues <https://www.globalissues.org/news/2025/02/11/39055>

Water Variability (Drought Hydrology) &	More frequent droughts lower river and reservoir levels, shrinking inland fish habitats and concentrating pollutants. Erratic rainfall and flow disrupt spawning of riverine fish (e.g. Indus carp), leading to recruitment failures. Water shortages for pond aquaculture in dry seasons; farmers face choosing between irrigation vs. fish.	Changes in Indus River outflow alter coastal nutrient balance and estuarine conditions. Reduced freshwater flow in dry years increases salinity along the coast, stressing brackish-water fisheries (e.g. palla fish in Indus delta). Conversely, intense monsoon outflows can alter coastal turbidity and nutrient loads, shifting marine productivity patterns.
Ocean Chemistry Changes	N/A (does not apply to inland directly, except increased evaporation in lakes can raise salinity in some inland lakes).	Ocean acidification (from CO ₂ uptake) harms calcifying organisms (shellfish, corals) and could affect fish food chains. Coastal hypoxia (low oxygen) events may increase with warming, driving fish away or causing die-offs.

4.4 Socio-Economic Impacts and Existing Adaptation Gaps

Climatic changes not only impact ecosystems, but they also work against social-economic vulnerability in fishing and agricultural societies. Reduced catches of fish inland and marine fisheries have been observed partly due to climate factors. Industry experts observe that there is a decrease in the capture fisheries in Pakistan and this is attributed to: climate change due to increased temperatures, overfishing and pollution³⁷. A recent report has cautioned that the global fish catch will drop by 25-30 percent in the past years by 2024, attributable to not only changes in marine conditions caused by climate change but also to other factors³⁸. Such drops have direct effects of reducing fisherfolks incomes and aggravate poverty levels among the coastal communities³⁹. The shrinking average size of fishes is causing many small-scale fishers to take their poles further offshore or move to other occupations when inland waters become less fertile or inaccessible. In the Indus Delta, mangroves/freshwater loss has already sent some fishing families on migration⁴⁰.

Inland, an obvious example of livelihood collapse caused by climate is the devastation of trout farms by floods. The floods left hundreds of the workers in fish farming jobless and some families in the community had to go overseas to

³⁷Business Recorder (2023). *Climate change, rising global temperature affect fisheries: expert (Peshawar). (Reports capture fisheries decline due to climate warming affecting marine, brackish, and freshwater ecosystems)*

³⁸Climate change, fuel costs push Pakistan's fishing industry into more choppy waters <https://www.aa.com.tr/en/asia-pacific/climate-change-fuel-costs-push-pakistan-s-fishing-industry-into-more-choppy-waters/3293622>

³⁹Pakistan: Climate change, rising global temperature affect fisheries – ICSF <https://icsf.net/newss/pakistan-climate-change-rising-global-temperature-affect-fisheries/>

⁴⁰Mongabay (2024). *Pakistan bucks global trend with 30-year mangrove expansion*

work. In the absence of insurance, or adequate government intervention, then the likelihood of the affected societies recovering is low. Climate change is therefore compounding pre-existing issues of rural poverty, and gender disparities may become worse as women (who are frequently engaged in processing or feeding aquaculture fish) have less means to adapt⁴¹.

Climate adaptation and disaster risk reduction efforts have not been fully incorporated into fisheries policies and planning processes in Pakistan despite these clear risks. Risks posed by climate and environment are just a reminder in most provincial fisheries plans. Early warning mechanisms against floods or storms to fishing communities are at early stages and the prevailing infrastructure in the aquaculture farms is not yet climate resilient. Currently, climate risk assessment and contingency financing mechanisms that have been put in place explicitly relating to fisheries/ aquaculture sector do not exist. Such gap puts the sector in darkness of imminent threats and lacking specific resources in times of disasters. Reducing climate vulnerability will entail taking up adaptation initiatives proactively to overcome these vulnerabilities⁴².

4.5 Adaptive Technologies and Nature-Based Solutions

Pakistan can implement various adaptive technologies and nature-based solutions that have the potential to build a resilience at inland as well as coastal levels. This section discusses a few of the potentially fruitful methods of innovative farming systems to the restoration of the ecosystem that is especially applicable in Pakistan. It is focused on solutions that have been effective in similar settings, or pilot projects in the country, with the potential to be brought to scale by enabling policy⁴³.

4.6 Integrated Agriculture-Aquaculture Systems (IAA)

Integrated agriculture-aquaculture (IAA) systems involve a fish farm with a crop or livestock system in a mutually supportive way. Rice fish culture where fish are produced in rice paddy fields or the combination of fishpond and livestock and horticulture are examples. Various benefits of climate resilience arise in such systems they supplement farmers earnings (so in case a crop fails because of climate stress, fish might still make some profits) and resource use. IAA also minimizes food waste and chemical fertilizer use by reusing farm by-products such as fishpond fertilizers/aten/feeds (e.g. livestock manure or crop residues)⁴⁴. It also makes water use more efficient, that which produces crops

41Climatic Change Pushes Pakistan's Trout Fish Farming Towards Collapse — Global Issues <https://www.globalissues.org/news/2025/02/11/39055>

42Mohsin, M., Yin, H., & Mehak, A. (2024). Sustainable solutions: exploring risks and strategies in Pakistan's seafood trade for marine conservation. *Frontiers in Marine Science*, 11, 1420755.

43Mekonen, S., Taddese, F., & Mingist, M. (2025). Nature-based solutions to freshwater fisheries: challenges and opportunities for their application in Ethiopian fisheries management. *Fisheries and Aquatic Sciences*, 28(3), 135-151.

44Climate-Smart Land Use Insight Brief No. 1- Integrated Agriculture-Aquaculture (IAA) Systems for Climate Change Adaptation, Mitigation and Livelihoods - weADAPT <https://weadapt.org/knowledge-base/climate-food-security-and-agriculture/integrated-agriculture-aquaculture-iaa-systems-for-climate-change-adaptation-mitigation-and-livelihoods/>

and fish is one of the ways that it is an important advantage in a water-scarce area or during a drought season.

IAA has been marked as a climate smart practice in South Asia and Pakistan. Research by the WorldFish Center observes that IAA can assist coastal farm families and fishermen in the challenges of climate change: coastal farmers whose fields become too salty to cultivate plants may switch to fish farming in waters of shallower salinity along with salt-tolerant crops, and fishers may switch to integrated farming to provide alternative income in years of poor catches. In arid interior regions, IAA enhances water management and productivity such as utilization of irrigation canals or ditches to conduct fish farming during the rainy season and then applying nutrient-enriched mud or water to cultivated land in the dry season⁴⁵. In addition to sustaining production despite climate variability, these practices enhance food security (by growing protein and vegetables/grains in combination).

4.7 Mangrove Restoration and Conservation

Ecosystem-based adaptation will be essential along Pakistan 1,100 km coastline, where mangrove restoration is an exemplary nature-based solution. Mangrove forests serve as natural defense lines against climate-induced change: they protect coasts against storm surges and waves as well as act as barriers against shoreline erosion and combat sea-level rise by holding sediments. Mangroves are yet another form of blue carbon ecosystems that help in climate mitigation by sequestering huge quantities of carbon (almost four times that done by tropical rainforests per hectare)⁴⁶. Of particular significance to fisheries, mangroves act as nurseries to some of the world's most commercially popular fish, crabs, and shrimp healthier mangroves equal more robust fish populations to support fishing communities.

Pakistan is a success story in restoring mangrove. Whilst mangroves declined in most of the world, Pakistan experienced a near 3-fold increase in mangrove cover between 1986 (~48,000 ha) and 2020 (~144,000 ha). This was done by conducting huge planting programs and community participation especially in the Indus delta (Sindh) as well as in Balochistan coast. A collaboration between Government and NGOs was aimed at restoring mangroves in degraded sites and some programs (e.g. the Ten Billion Tree Tsunami program since 2018) had the expansion of mangroves as a priority item. Consequently, there has been a reverse of the global tendency in the loss of mangrove in Pakistan. Such growth is already paying resilience dividends: local fishers around the world have seen increasing fish harvests in mangrove-regrowth regions due to mating habitat improvements, and communities are finding their villages battered less by monsoon storms.

Pakistan can tap the full potential of this nature-based solution by incorporating mangrove conservation as a central component of climate resilience in its

45digitalarchive.worldfishcenter.org(<https://digitalarchive.worldfishcenter.org/bitstreams/ff5731ae-3320-45cd-8857-3e48cc109bb6/download>)

46Harnessing the power of mangroves <https://afpak.boell.org/en/2024/12/10/harnessing-power-mangroves>

fisheries policy. This specifies avoiding deforestation of mangroves (such as due to fuelwood harvesting or construction along the coast) and carrying on with major rehabilitation initiatives of degraded mangrove forests. Locally run mangrove stewardship initiatives (such as local women taking charge of mangrove propagation nurseries) have shown results and must be replicated. Creative financing, such as blue carbon credits, can be used to finance mangrove efforts indeed, Sindh province Indus Delta blue carbon project is already earning cash by selling blue carbon credits based on natural restoration of mangroves whilst it has bettered the livelihoods of 42,000 residents. Directly acknowledging the importance of mangroves in fisheries productivity and coastal protection has meant that policies can put in place inter-departmental cooperation (fisheries, forestry, climate change ministries and so on) and ensure long term funding of such initiatives⁴⁷.

4.8 Seaweed Farming and Mariculture

Seaweed culture is a nascent prospect in the coastal regions of Pakistan that goes in line with climate resilience and livelihood diversification. Seaweeds (macroalgae) can be raised in the ocean on ropes or other supports, and they offer a variety of uses. First, seaweed cultivation is a climate-smart occupation seaweeds grow rapidly and can be harvested throughout the year, meaning that seaweed can also be used as income when other fishery harvests are poor. Second, seaweed plays role in climate change mitigation and adaptation: they can sequester carbon dioxide (CO₂) and mitigate the acidification of the ocean locally, increasing the surrounding waters pH and benefiting shellfish and some corals⁴⁸. Large facilities of seaweed farming also decrease wave energy which can help safeguard coastlines against storm surges (just like artificial reefs or mangroves do in dissipating waves)⁴⁹.

Seaweed farming can also be part of an integrated multi-trophic aquaculture where the seaweed can be farmed with seafood such as fish or shrimp, and through the ravenous consumption of nutrients (waste) produced by the fish, the seaweed prevents eutrophication. Regenerative ocean farming is a trending sustainability practice of this kind. Pakistani coast is home to a diverse seaweed (more than 170 genera of seaweeds are documented in Pakistani waters)⁵⁰. With proper management seaweed farming in such areas as the Karachi coastline, Indus Delta creeks or the sheltered bays along Balochistan coast would not only provide raw materials to a variety of industries (food, animal feed, fertilizers, cosmetics and even biofuel) but it could also become a potential source of employment to the coastal communities including women (who can often tend to seaweed nurseries and processing).

47Pakistan bucks global trend with 30-year mangrove expansion
<https://news.mongabay.com/2024/02/pakistan-bucks-global-trend-with-30-year-mangrove-expansion/>

48Seaweed farming for food and nutritional security, climate change
<https://www.sciencedirect.com/science/article/pii/S2468550X22001460>

49Seaweed farming – Riphah Information Portal <https://iportal.riphah.edu.pk/newspaper/seaweed-farming/>

50(PDF) COSMETIC SEaweeds OF PAKISTAN – ResearchGate
https://www.researchgate.net/publication/236158504_COSMETIC_SEaweeds_OF_PAKISTAN

Seaweed cultivation is not currently popular in Pakistan, but studies have suggested that there is huge potential when majority of the coastline is used in regenerative ocean farming along the Arabian Sea⁵¹. The government may come up with pilot projects in partnership with the marine research institutes to see what kind of seaweed consisting of the most suitable types (examples of such types are *Ulva*, *Gracilaria*, *Kappaphycus* or other high-value types) should be used and also which farming methods used in other Asian countries could be transferred (such as off-bottom farming or floating raft culture). Seaweed farming can be the ideal nature-based adaptation: it can improve ecosystem health of the ocean, offers an alternative source of income to fishing during off seasons, and even lead to improved fish/bivalve production using secondary cultivation (e.g. growing clams with seaweed). Including support of mariculture (sea farming) of seaweed and shellfish as policy through training, subsidies or public-private partnerships would mark a move into climate-smart blue growth in Pakistan.

4.9 Recirculating Aquaculture Systems (RAS) and Controlled Environment Farming

The adoption of contemporary Recirculating Aquaculture Systems (RAS) can significantly increase the climate resilience of Pakistan aquaculture, particularly in arid or harsh climatic conditions. RAS are types of fish farms that continuously circulate and recycle water and typically keep their fish inside tanks in optimum conditions throughout the year. The major contribution of RAS is the water savings that they can achieve up to 90% or more savings in water as compared to open ponds, which is an important consideration as the water becomes more erratic. RAS also enables one to regulate temperature, oxygen and waste, isolating fish to external weather changes (heat waves or cold spells) and losses due to floods or pollution. They also provide immunity to diseases and parasites that could flourish in warmer waters as water quality is well controlled in a closed loop⁵². With RAS, fish production is separated from natural water systems which means aquaculture is less susceptible to droughts, floods or pollution incidents.

In Pakistan, RAS technology is in its early years, but the interest is rising. A recent pilot project in the South Punjab introduced the use of so-called bio floc technology, a form of recirculating system where the good bacterium in the water breaks down fish wastes and recaptures it in form of feed eliminating the need to frequently change pond water. According to this pilot (PR 20 million in cost), this was a revolutionary idea to save water and cut down the pollution of fish farming⁵³. The fact that such initiatives are being considered by the policymakers of Pakistan shows that aquacultural solutions are required in Pakistan that are stronger, and climate friendly. In the future, national policy

51Unlocking the Potential - Pakistan Today <https://www.pakistantoday.com.pk/2023/07/23/unlocking-the-potential/>

52 Gupta, S., Makridis, P., Henry, I., Velle-George, M., Ribicic, D., Bhatnagar, A., ... & Netzer, R. (2024). Recent developments in recirculating aquaculture systems: a review. *Aquaculture Research*, 2024(1), 6096671.

53 Pakistan: Pilot project launched to promote fisheries - ICSF <https://icsf.net/newss/pakistan-pilot-project-launched-to-promote-fisheries/>

makers should make concerted efforts to encourage RAS and other controlled environment aquaculture (i.e. aquaponics, biofloc culture) via practices such as low-interest loans, technical training, and the waiver of tax on equipment purchases (e.g. pumps, filters, sensors).

RAS may be especially valuable in cities or peri-urban regions (such as Karachi, Lahore, Islamabad) where it can produce high-dollar fish at the edge of the markets with little land and water footprint. They also provide all-year production that is not affected by changes in climate according to seasons which may stabilize supply and prices. It is capital-intensive and costs are decreasing over time; however, there can be the development of model RAS farms under the public-private partnerships. Long-term investment in capacity building RAS can enable Pakistan to jump ahead to more climate-resilient aquaculture systems with water efficiency, biosecurity, and increased production [48]. This will moderately protect the sector against future climate pressure and make the sector more sustainable⁵⁴.

4.10 Climate-Resilient Species and Strain Selection

Another adaptation mechanism is shifting towards climate resistant fishing species and better breeds in fish farming and stocking. Not every fish species responds equally to climatic misery; some can withstand higher temperatures, changing salinity levels, or low oxygen in a fish habitat. In the case of captive aquaculture, Pakistan can shift away to sturdy species that will hybridize in normal and more fluctuating environments. As another illustration, the importation of Nile tilapia (*Oreochromis niloticus*) in Pakistan has now given a fast-growing, heat-resistant fish that can be cultured in ponds. Tilapia prefers warmer water (up to ~30 °C) and is more tolerant of low oxygen levels - which may prove valuable as pond temperatures rise and eutrophication threatens. Certain strains of carp or catfish (including the African catfish, *Clarias gariepinus*) are also more resistant to elevated temperatures and poor water conditions and may be encouraged in appropriately locations. However, it is worth controlling the risks of invasions and avoiding the negative impact of the introduced species on native biodiversity⁵⁵.

4.11 Strategies to Mainstream Climate Resilience into Policy

Pakistan needs to mainstream climate resilience and DRM into the national and provincial policies to protect fisheries and aquaculture against climate risks. This translates into transitioning out of ad-hoc projects and into systematically implementing adaptation steps in planning, governance and investment in the

54 Gupta, S., Makridis, P., Henry, I., Velle-George, M., Ribicic, D., Bhatnagar, A., ... & Netzer, R. (2024). Recent developments in recirculating aquaculture systems: a review. *Aquaculture Research*, 2024(1), 6096671

55 Divu, D. N., Mojjada, S. K., Anil, M. K., Gopidas, A. P., Sundaram, S. L. P., Mahalingam, A., ... & Gopalakrishnan, A. (2024). Thermal tolerance and environment adaptability of Indian pompano: Discovery of a resilient candidate species for sustainable mariculture production in a climate change scenario. *Aquaculture*, 584, 740665.

sector. The following are some of the major strategic guidelines for realizing this integration⁵⁶:

Table 12: Major Strategic Guidelines for Climate Resilience into Policy

Section	Focus Area	Key Measures/ Actions	Institutional Linkages	Expected Outcomes
Integrate Climate Risk Assessment & Adaptation Planning	Climate risk assessment and adaptation in policy	• Develop periodic climate risk inventories (sea-level rise, storm surges, flooding, drought, temperature variability) • Establish measurable adaptation targets (e.g., 50% cut in climate losses, mangrove restoration) • Climate risk screening for new harbors/hatcheries • Update codes for flood-proof aquaculture facilities • Include climate scenarios in stock management	Align with National Climate Change Policy, NAP, SDG 13, Paris Agreement	• Policies proactively reduce climate impacts • Climate risks mainstreamed in fishery planning • Resilient aquaculture and infrastructure
Strengthening Institutional Coordination & Capacity	Governance & institutional collaboration	• Establish a climate-resilient fisheries task force • Coordination among Ministry of Food Security, Provincial Fisheries, MOCC, NDMA • Seasonal advisories based on PMD projections • Capacity building for officers in climate-smart aquaculture and DRM	Climate & disaster agencies, FAO, academia	• Improved coherence in fisheries governance • Enhanced adaptive capacity of officials • Local fishers guided with climate-smart practices
Invest in Climate-Resilient Infrastructure & Disaster Preparedness	Infrastructure & disaster risk management	• Climate-proof fishing ports, landing sites, markets • Seawalls, breakwaters, improved drainage • Backup power/cooling for processing & storage • Resilient aquaculture ponds & aeration	NDMA, Provincial Fisheries, Insurance sector	• Reduced damage from floods/storms • Faster disaster recovery for fishers • Livelihood security in coastal/inland aquaculture

56 Yadav, N. K., Patel, A. B., Singh, S. K., Mehta, N. K., Anand, V., Lal, J., ... & Devi, N. C. (2024). Climate change effects on aquaculture production and its sustainable management through climate-resilient adaptation strategies: a review. *Environmental Science and Pollution Research*, 31(22), 31731-31751.

Section	Focus Area	Key Measures/ Actions	Institutional Linkages	Expected Outcomes
		- Coastal cyclone/tsunami shelters - SMS/radio-based early warning systems - Post-disaster protocols & emergency funds		
Promote Research, Data & Knowledge	Climate-smart R&D and monitoring	- Research on monsoon impacts, migration changes - Partnerships with universities, FAO, UNESCO, WorldFish - Expand coastal observation networks - Develop best practices for climate-smart fishing & farming - Promote innovations: solar boats, sensors, low-cost cold storage	Universities, international agencies, PPPs	- Data-driven fisheries policy - Innovation adoption (low-emission technologies) - Adaptive management through real-time monitoring
Inclusive & Community-Centered Adaptation	Community empowerment & inclusion	- Empower cooperatives for mangrove restoration, reef/fish monitoring - Vulnerability mapping with communities - Target vulnerable groups (women, small-scale fishers) - Awareness against maladaptive practices (dynamite fishing, groundwater overuse) - Establish local consultation forums	Local communities, NGOs, farmer/fisher groups	- Stronger local ownership of resilience measures - Social inclusion & livelihood security - Behavior change for sustainable practices

4.12 Conclusion

This unprecedented threat to Pakistan aquaculture and fisheries can also be turned around through careful planning and innovation and driven to a sound climate-resilient future. In this report the effects rising temperatures, sea-level rise, extreme weather and the variability of water are already having on fisheries in the Indus Delta which have seen sea levels rising as well as in the flooded trout farms of Swat. It looked at adaptive solutions crafted to suit the Pakistani context: integrated agriculture-aquaculture which diversified agricultural and saves water, mangroves and seaweeds to access the protective and productive services nature may offer, advanced farming technologies such as RAS as a buffer against climatic extremes, and a shift in species and strains to harder ones. These interventions informed by recent history examples and data over the last 5 years should hold sway because it is evident that resilience can be

achieved, indeed is being tested out in Pakistan and other parts of the world with positive results.

It is not enough to engage in a single project. What is advocated in the recommendations is the integration of climate resilience into policy and institutions. Implications are that national and provincial policies in fisheries need to consider climate adaptation and DRM as strategic objectives and backed by inter-agency collaboration, research and community interaction. Pakistan could now implement strategies and regulations to help prevent worst-case losses such as implementing climate risk assessment, enhancing disaster preparedness, and investing in ecosystem restoration thus finding opportunity with adaptation to change (such as new climate friendly aquaculture industries). Mainstreaming such concepts will put the Pakistan fisheries sector in touch with global best practices, and in line with its own commitments through frameworks such as the SDGs, Paris Agreement, and Sendai Framework for Disaster Risk Reduction.

To sum up, the necessity to introduce climate resilience into the fisheries and aquaculture planning should not be regarded as an environmental decision but is an economic and social issue requiring attention in Pakistan. A climate resilient fisheries sector will provide the livelihood of close to half a million-fisher people and fish farmers, safeguard the food security of Pakistan and protect aquatics that are the basis of the blue economy. Available evidence indicates that Pakistan possesses the knowledge and resources necessary to advance these reforms. The way forward is to take strong action to reinforce policies, muster resources, and empower communities to make sure fisheries and aquaculture survive and even prosper under the impact of climate change, not to become its latest victims. Through collaborative action and dedication to sustainable management, Pakistan can develop a resilient, flexible fisheries sector which will continue feeding the country and contributing to its growth in the climate of uncertainty that is the future.

Chapter 5

Promote Sustainable Practices and Environmental Stewardship

5.1 Introduction

The fisheries and aquaculture sector are very crucial in livelihoods and food security in Pakistan although its output to the economy is not large. The sector now represents 1% of national GDP⁵⁷ and per capita fish consumption is only about 2 kg of fish (much below the world average of approximately 17 kg). These figures bring out a very big unamplified potential for growth. Exploitation of major fisheries stocks has stagnated or decreased with overfishing and unsustainable operations, but aquaculture is becoming a major source of fish production. Total production of seafood in the country is estimated at about 0.79 million metric tons annually with 0.51 million tons produced in marine capture and 0.28 million tons produced in inland waters including fish farms⁵⁸. The percentage of aquaculture contribution has been on the rise, especially inland in the past two decades with stagnation in wild catches. The Government of Pakistan recently established its first intricate National Fisheries and Aquaculture Policy (2025-2035) and this government policy also focuses on sustainability, environmental protection and climate resilience to consider when building the blue economy^{59 60}. Aligned with Sustainable Development Goal 14 (life below water), there is an increasing awareness that sustainable and environmental stewardship practices are vital to drive fisheries improvement, expand aquaculture and preserve natural diversity. This report is an in-depth analysis of recommended measures towards sustainable fisheries management and aquaculture in Pakistan including catch limits, gear restrictions, closed seasons, biosecurity, feed and waste management and an ecosystem-based approach that places production and conservation on a similar plane of importance. The analysis is based on the recent research and statistics (arranged within the past 5 years) to outline the issues and avenues to guide the process of incorporating sustainability into Pakistan national policy on aquaculture/fisheries.

5.2 Sustainable Fisheries Management Practices

Sustainable management of wild fisheries requires science-based regulations and conservation measures. Key practices include implementing catch limits, regulating destructive fishing gear, enforcing seasonal closures, and expanding marine protected areas. Table 13 summarizes these measures and their intended outcomes in Pakistan's context^{61 62}.

57PID https://pid.gov.pk/site/press_detail/29635

58pbc.org.pk <https://www.pbc.org.pk/wp-content/uploads/Seafood-Policy-Brief.pdf>

59PID https://pid.gov.pk/site/press_detail/29635

60pbc.org.pk <https://www.pbc.org.pk/wp-content/uploads/Seafood-Policy-Brief.pdf>

61 Ahmed, R. (2024). *Fostering Sustainable Growth through the Blue Economy: Balancing Prosperity and Marine Conservation*.

62 Mohsin, M., Yin, H., & Mehak, A. (2024). Sustainable solutions: exploring risks and strategies in Pakistan's seafood trade for marine conservation. *Frontiers in Marine Science*, 11, 1420755.

Table 13: Key Sustainable Fisheries Management Measures and Benefits

Measure	Purpose / Outcome
Science-Based Catch Limits	Set allowable catch quotas by species based on stock assessments and Maximum Sustainable Yield (MSY) to end overfishing. This allows depleted fish populations to recover, leading to higher long-term yields and economic returns. Improved catch reporting (landings data, logbooks) is needed to monitor quotas, since past studies suggest only ~30–40% of actual catch was recorded in official statistics ⁶³ (implying significant illegal/unreported fishing).
Gear Restrictions (Selective & Non-Destructive Fishing)	Ban the use of fine-mesh nets and other destructive gear that catch juvenile fish and non-target species. For example, <i>Bullo</i> , <i>Gujjo</i> and <i>Katro</i> nets – small-mesh nets banned under law – have still been used in Sindh’s Indus delta, catching huge numbers of juveniles and contributing to a decline in inland catches (from ~258,000 tons in 2010 to ~228,000 tons in 2019) ⁶⁴ . Enforce minimum mesh sizes and require bycatch reduction devices. In shrimp trawling, requiring Turtle Excluder Devices (TEDs) is critical: the absence of TEDs led the United States to ban wild shrimp imports from Pakistan in 2017 because endangered sea turtles were being caught and killed. Mandating TEDs and inspecting nets (as Pakistan is now doing) will protect turtles and could reopen lucrative export markets ⁶⁵ . Additionally, <i>zoning</i> rules like the 12-nautical-mile coastal exclusion zone (no large trawlers nearshore) help reduce habitat damage in nursery areas and protect artisanal fisherfolk’s grounds.
Seasonal Fishing Closures	Impose closed seasons during critical breeding/spawning periods to allow fish stocks to reproduce. Pakistan has traditionally announced ad-hoc bans (e.g. a two-month monsoon ban on shrimp fishing in June–July in Sindh), but enforcement has been inconsistent. The new policy aims to institutionalize science-based seasonal closures across provinces. For example, a summer ban on shrimp and certain fish is vital – shrimp stocks in Sindh have declined sharply (27,000 tons in 2020 to 17,400 tons in 2024) in part due to shortening the ban. Expanding the closure to 3 months (May–July), as experts recommend, and providing compensation or alternative livelihood support to fishermen during the off-season would yield larger catches after the reopening. Coordinated federal-provincial enforcement of seasonal bans will enhance their effectiveness in stock recovery ⁶⁶ .

⁶³seararoundus.org <https://www.seararoundus.org/doc/publications/wp/2014/Hornby-et-al-Pakistan.pdf>

⁶⁴Fishing communities of Sindh forced into destructive practices - Pakistan - DAWN.COM <https://www.dawn.com/news/1579822>

⁶⁵US team’s visit sparks action on shrimp export ban - Business - DAWN.COM <https://www.dawn.com/news/1782514>

⁶⁶Sindh lifts ban on fishing before time <https://tribune.com.pk/story/2553883/sindh-lifts-ban-on-fishing-before-time>

Marine Protected Areas (MPAs)

Designate no-take zones or restricted fishing areas to protect critical habitats and nurseries, enabling ecosystems to rebound and “spill over” into fishing zones. Pakistan lagged in MPA coverage but has recently taken steps: Astola Island was declared the country’s first MPA in 2017 and Churna Island the second in 2024⁶⁷. In July 2025, the coastal lagoon Miani Hor (Balochistan) – home to Pakistan’s only three mangrove species – was declared the third MPA⁶⁸. These protected areas are biodiversity hotspots (coral reefs, turtle nesting sites, mangrove nurseries) and serve as sanctuaries for marine life to breed and grow. Currently, MPAs cover <0.2% of Pakistan’s marine area⁶⁹. The government has committed to expand protected waters to 30% by 2030 in line with the global “30x30” target. Achieving this will require identifying further sites (e.g. Indus delta creeks, offshore banks) and, importantly, implementing management plans for existing MPAs (controlling illegal fishing, monitoring ecological health). When well-managed, MPAs not only conserve endangered species and habitats, but also enhance fisheries outside their boundaries through the spillover of adult fish and larvae, as evidenced in other countries⁷⁰.

5.3 Promoting Sustainable Aquaculture Practices

Expanding aquaculture is a major opportunity for Pakistan to increase fish supply without further pressuring wild stocks but it must be done sustainably. Pakistani aquaculture (mostly carp polyculture in ponds) has grown steadily, now contributing roughly one-third of national fish production⁷¹. However, many farms still use traditional methods with low inputs (e.g. fertilizing ponds and supplemental feeding with agricultural by-products)⁷². To ensure aquaculture’s growth does not come at the expense of the environment or fish health, best practices are needed in several areas: biosecurity and disease management, feed efficiency and nutrition, waste reduction and environmental protection, and

67With coral-rich Churna Island now an MPA, Pakistan takes baby steps on ocean protection <https://news.mongabay.com/2025/07/with-coral-rich-churna-island-now-an-mpa-pakistan-takes-baby-steps-on-ocean-protection/>

68Miani Hor Declared Third Marine Protected Area in Pakistan | WWF <https://www.wwfpak.org/?392737/Miani-Hor-Declared-Third-Marine-Protected-Area-in-Pakistan>

69With coral-rich Churna Island now an MPA, Pakistan takes baby steps on ocean protection <https://news.mongabay.com/2025/07/with-coral-rich-churna-island-now-an-mpa-pakistan-takes-baby-steps-on-ocean-protection/>

70Miani Hor Declared Third Marine Protected Area in Pakistan | WWF <https://www.wwfpak.org/?392737/Miani-Hor-Declared-Third-Marine-Protected-Area-in-Pakistan>

71pbc.org.pk <https://www.pbc.org.pk/wp-content/uploads/Seafood-Policy-Brief.pdf>

72Fisheries: Potential in Pakistan <https://tdap.gov.pk/wp-content/uploads/2022/03/Fisheries-Potential-of-Pakistan-Salma-Nusrat.pdf>

ecosystem-based farm siting and community integration. Table 14 outlines sustainable aquaculture practices and their benefits^{73 74}.

Table 14: Sustainable Aquaculture Practices and Outcomes

Practice	Purpose / Outcome
Biosecurity & Disease Control	Prevent and manage disease outbreaks through measures such as using disease-free seed stock (e.g. hatchery-certified SPF fry/shrimp post-larvae), controlling water quality and entry (screens, water treatment), limiting farm access, and having contingency plans (quarantine ponds). Cluster-based farming models propose on-site diagnostic labs for rapid disease testing and response ⁷⁵ , which would enable early detection of pathogens like White Spot Virus (which devastated shrimp farms in the past) and quick containment. Strong biosecurity reduces losses and the need for antibiotics.
Feed Efficiency & Nutrition	Improve feed conversion and fish growth by using formulated, nutritionally balanced feeds (e.g. pelleted floating feed) and modern feeding techniques. Traditional low-protein feeds yield poor growth and cause more waste. Introduction of advanced systems like the In-Pond Raceway System (IPRS) has shown dramatic gains – trials in Pakistan since 2019 achieved feed conversion ratios of ~1.1–1.4:1 (feed:gain), nearly 2× more efficient than conventional ponds, and up to 6–8× higher fish production per unit area ⁷⁶ . Floating feeds also allow farmers to see and avoid overfeeding, reducing waste. Emphasize using locally available plant proteins (soybean meal, etc.) to minimize reliance on fishmeal, thereby easing pressure on wild fish. Pakistan’s first extruded feed mill was established in 2013 with U.S. support, enabling domestic production of high-protein floating feeds ⁷⁷ . Better feed and nutrition not only accelerate growth and yields, but also improve fish health and quality (which in turn supports disease resistance and market value).
Waste Management & Eco-Friendly Design	Minimize environmental impacts of farming. Waste reduction involves capturing and reusing nutrients: for instance, periodically remove organic sludge from pond bottoms and use it as fertilizer on crops, instead of letting it foul water bodies. High-efficiency systems like IPRS can collect ~40–70% of

73 Garlock, T. M., Asche, F., Anderson, J. L., Eggert, H., Anderson, T. M., Che, B., ... & Tveteras, R. (2024). Environmental, economic, and social sustainability in aquaculture: the aquaculture performance indicators. *Nature Communications*, 15(1), 5274.

74 Alghamdi, M., & Haraz, Y. G. (2025). Smart Biofloc Systems: Leveraging Artificial Intelligence (AI) and Internet of Things (IoT) for Sustainable Aquaculture Practices. *Processes*, 13(7), 2204.

75pbc.org.pk <https://www.pbc.org.pk/wp-content/uploads/Seafood-Policy-Brief.pdf>

76Pakistan Aquaculture Industry Shows Great Potential to Support Country’s Food Security - U.S. Soybean Export Council <https://ussec.org/news/pakistan-aquaculture-industry-shows-great-potential-support-countrys-food-security/>

77Tilapia from ‘farm to plate’ using US soy - All About Feed <https://www.allaboutfeed.net/animal-feed/feed-additives/tilapia-from-farm-to-plate-using-us-soy-2/>

	waste for reuse⁷⁸. Avoid water pollution by limiting water exchange and treating effluents (settlement ponds, biofilters) if discharged. Curb prophylactic use of antibiotics – rely on probiotics and good husbandry to maintain water quality and health, to prevent antimicrobial resistance. Farm siting should avoid ecologically sensitive areas: Pakistan’s coastline still has about 130,000 hectares of mangroves⁷⁹ which serve as vital fish nurseries and storm buffers – these must not be cleared for ponds. Instead, new aquaculture (e.g. shrimp ponds) is being targeted on inland saline wastelands in Sindh/Punjab⁸⁰, turning waterlogged or salt-affected soils (unsuitable for crops) into productive farms without encroaching on natural habitats. Aquaculture design should also account for climate resilience: the extreme floods of 2022, for example, destroyed hundreds of fish farms in Khyber Pakhtunkhwa and swept away stocks. Thus, ponds and raceways need higher dikes and drainage systems to withstand flooding, and insurance or disaster assistance mechanisms are needed for farmers. By adopting these measures, aquaculture operations can prevent pollution of rivers/coasts and be better prepared for climate extremes⁸¹.
Ecosystem Approach & Livelihood Integration	Apply an ecosystem-based approach to aquaculture that considers interactions with the broader environment and communities. This includes diversifying cultured species and using integrated systems – for instance, polyculture of compatible species (as done with carp of different feeding niches) maximizes resource use, and potential integrated multi-trophic aquaculture (IMTA) (e.g. farming shrimp or fish alongside seaweed or shellfish that absorb waste nutrients) could be explored to enhance sustainability. Moreover, integrating aquaculture with local livelihoods can reduce pressure on wild fisheries. Pakistan is piloting cluster-based shrimp farming in coastal communities: multiple families are each allocated ponds in a large cluster, with shared infrastructure (canals, hatcheries, feed supply) and support services (training, veterinary care). This model (inspired by successes in countries like Saudi Arabia and Iran) allows traditional fishers to become fish/shrimp farmers, providing them a stable income and an incentive to comply with fishing restrictions as their livelihood diversifies⁸². Similarly, promoting small-scale aquaculture in inland rural areas (e.g. homestead ponds for nutrient-rich small fish) can improve nutrition and take

⁷⁸Pakistan Aquaculture Industry Shows Great Potential to Support Country's Food Security - U.S. Soybean Export Council <https://ussec.org/news/pakistan-aquaculture-industry-shows-great-potential-support-countrys-food-security/>

⁷⁹Karachi's defensive mangrove barrier faces triple threat <https://phys.org/news/2015-01-karachi-defensive-mangrove-barrier-triple.html>

⁸⁰pb.org.pk <https://www.pbc.org.pk/wp-content/uploads/Seafood-Policy-Brief.pdf>

⁸¹Climatic Change Pushes Pakistan's Trout Fish Farming Towards Collapse — Global Issues <https://www.globalissues.org/news/2025/02/11/39055>

⁸² pb.org.pk <https://www.pbc.org.pk/wp-content/uploads/Seafood-Policy-Brief.pdf>

	pressure off wild stocks. In northern Pakistan, expanding trout farming (while ensuring sustainable water use) offers high-value production that creates jobs and food without affecting ocean fisheries. An ecosystem approach also means conducting Environmental Impact Assessments (EIA) for new farms to mitigate any local ecological impact and ensure farms do not compete for water or land with other needs. Overall, aligning aquaculture development with ecosystem health – “farming with the environment” – will lead to more resilient and socially beneficial outcomes ⁸³ .
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5.4 Conclusion

Pakistan’s fisheries can no longer follow “business as usual.” By adopting sustainable practices, science-based catch limits, seasonal closures, eco-friendly aquaculture, and ecosystem-based management the country can restore wild fish stocks and expand aquaculture without harming nature. The **National Fisheries and Aquaculture Policy 2025–2035** signals commitment, but real progress depends on strong enforcement, research, and stakeholder participation. Done right, this transition can boost exports, generate jobs, ensure food security, and protect ecosystems—a win-win for people and the planet.

⁸³ Banini, P. K., Anyan, K. F., Zornu, J., Ackah, M., Batsa, D. N., Issifu, K., ... & Cudjoe, K. S. (2024). Rethinking freshwater cage aquaculture: A case in Ghana. *Water*, 16(21), 3054.

Chapter 6

Strategies induced for Institutional Strengthening and Capacity Building

In Pakistan the sector of fisheries and aquaculture are of mere importance and their sustainability and resilience can be achieved in efficient manner only through establishing robust institutional frameworks, by clearly defining structure of governance and by means of empowering human resources. The inclusive strategies are required to achieve this particular vision that specifically involves participation from both type of stakeholders either public or private. This chapter expresses the over view of strategic reforms intended for institutional strengthening and capacity development holistically across sector at various levels⁸⁴.

6.1 Clarity of Institutional and Governance Reforms

The overlapping and underlying complex directives of federal and provincial bodies cause hinderance in effective fisheries governance in Pakistan. So, for this purpose the clarity of roles and improved coordination is vital for implementation of coherent policy and sustainability in long terms⁸⁵.

6.2 Clarification of Federal and Provincial Mandates

- a. **Legal Correspondence:** The extensive review of laws and policies related to fisheries should be conducted to integrate both federal and provincial frameworks in line with the 18th Constitutional Amendment⁸⁶.
- b. **Functional illustration:** Coherent and explicit responsibilities for marine, inland, and aquaculture sectors to be defined across tiers of government to avoid duplication and regulatory conflicts.
- c. **Coordination Body for National Fisheries:** Establishment of a National Fisheries Coordination Council (NFCC) comprising federal, provincial, and technical representatives is necessary to oversee national policy alignment, research collaboration, and inter-provincial resource management⁸⁷.

⁸⁴ Nasr Ullah, Ambreen Asghar, and Muhammad Ali Khan. "Empowering Agriculture for Food Security and Economic Growth: Implementation Strategies in Pakistan." *Policy* 3, no. 1 (2022): 33-50.

⁸⁵ Lina, Liu, and Muhammad Murad Zaib Butt. "Analysing Pakistan's fisheries legislation and institutional framework: integrating Sustainable Development Goal 14 within the scope of International Fisheries Law." *Frontiers in Marine Science* 12 (2025): 1503748

⁸⁶ Pradhan, Sisir Kanta, Tara S. Nair, and Prateep Kumar Nayak. "Making Sense of the Legal Policy Frameworks Governing Small-Scale Fisheries in India." In *Implementation of the Small-Scale Fisheries Guidelines: A Legal and Policy Scan*, pp. 279-298. Cham: Springer Nature Switzerland, 2024.

⁸⁷ Kausar, Rehana. "Cross-learning for Addressing Emergent Challenges of Aquaculture and Fisheries in Pakistan." *Cross-learning for Addressing Emergent Challenges of Aquaculture and Fisheries in South Asia* (2021): 87.

Table 15: Clarification of Mandates on Fisheries on Federal and Provincial Level

Governance Aspect	Federal Responsibility	Provincial Responsibility
Marine Fisheries	Policy, deep sea fishing beyond 12 NM	Fishing within 12 NM, coastal regulation
Inland Fisheries and Aquaculture	Technical guidance, national strategies	Licensing, management, extension services
Data and Research	National surveys, standard setting	Localized data collection and monitoring
Coordination Mechanism	Establish NFCC	Representation in NFCC
Post Legislation 18th Amendment	Harmonization with provinces	Align local laws with national policy

6.3 Strengthening Coordination of Inter-organizational and governmental Sectors

a. **Platforms for Governance Integration:** Creation of multi-sectorial coordination platforms is essential, comprising representatives from various sectors such as agriculture, climate change, trade, water and coastal development organizations⁸⁸.

d. **Consolidated Licensing and Compliance Mechanism:** Development of a centralized monitoring and digital licensing system for consistent surveillance and data sharing in real time across jurisdictions.

6.4 Institutional Improvement

a. **Organizational Reforms:** Restructuring the fisheries departments to demonstrate the progressive roles in resource management, innovation, extension and regulation⁸⁹.

b. **Performance Based Governance:** Introducing the performance metrics and mechanisms of accountability and responsibility for institutions at every level to improve transparency and delivery of services.

6.5 Programs for Capacity Development

Strengthening of the human as well as organizational capacity is crucial to unlock the potential aspects of Pakistan's fisheries and aquaculture systems. The allocated programs are required for government institutions, aquaculture practitioners, fisher folk communities, and women-led enterprises⁹⁰.

⁸⁹ Kaczan, David J., and Pawan G. Patil. "Potential development contribution of fisheries reform: evidence from Pakistan." *The Journal of Environment & Development* 29, no. 3 (2020): 275-305.

⁹⁰ Zohra, Fatema Tuz, Shahroz Mahean Haque, Shonia Sheheli, and Md Masud Rana. "Capacity strengthening of fish farmers for improving their livelihood in Mymensingh district of Bangladesh." *Archives of Agriculture and Environmental Science* 7, no. 2 (2022): 156-165.

Table 16: Stakeholder Group Requirements for Capacity Building

Stakeholder Group	Key Capacity Building Needs	Intervention Tools
Fisheries Departments	Technical training, digital systems and frameworks designed for monitoring and evaluation.	Institutional training, Information Technology upgrades
Aquaculture Farmers	Hatchery management, climate adaptable aquaculture, access to easy funds	Farmer Field business Schools, credit schemes
Women Entrepreneurs	Business skills, value addition and access to markets.	Toolkits, cooperatives and leadership training
Fisher Communities	Safety at sea, sustainable gear, livelihood diversity	Community based training, programs for youth

6.6 Fisheries Departments

- Technical Training:** Providing the training on ecosystem-based fisheries management, aquaculture biosecurity, data collection techniques, traceability, and digital technologies⁹¹.
- Enhancing Institutional Capacity:** Investing in infrastructure like labs, hatcheries, and field offices. Permitting the departments with access to data management systems and ICT tools.
- Development Plans for Human Resource:** Undertaking the capacity assessments and implementing tailored training and plans for recruitment purpose based on identified gaps.

Table 17: Identified Gaps in Institutional Capacity in Provincial Department of Fisheries

Province	Staff Shortage (%)	Budget Utilization (%)	ICT Infrastructure (1–5 scale)
Sindh	38%	62%	2.0
Balochistan	45%	58%	1.5
Punjab	25%	70%	3.5
Khyber Pakhtunkhwa	33%	65%	2.5

6.7 Aquaculture Farmers

- Farmer Field Schools:** Promoting collaborative learning and technical training of basic skills like hatchery management, preparation of ponds, methods of feeding, and climate resilient aquaculture⁹².

⁹¹ HUSSAIN, Syed MAKHDOOM, Zainab AKRAM, Shafaqat ALI, Ebru YILMAZ, Khadija AKRAM, Adan NAEEM, Eman NAEEM, and Muhammad AMJAD. "CHAPTER I TECHNOLOGICAL ADVANCEMENT IN AQUACULTURE." *Developments in Aquaculture: Trends, Challenges, and Applications–1st Edition*– (2025): 7.

⁹² Qurani, I. Z., N. I. Fawzi, R. Fadilah, and W. Kismorodati. "Empowering fish-farmer through coastal field school: Towards sustainable aquaculture practice." In IOP Conference Series: Earth and Environmental Science, vol. 750, no. 1, p. 012054. IOP Publishing, 2021.

- b. **Access to Technology and Finance:** Training the farmers on certain concepts such as, input use efficiency, business planning, and moreover linking them to the credit facilities, platform for technical advisory and insurance programs⁹³.

Table 18: National Aquaculture Production (2018–2023)

Year	Aquaculture Production (Metric Tons)	% Growth from Previous Year
2018	180,000	4.3%
2019	190,000	5.6%
2020	210,000	10.5%
2021	230,000	9.5%
2022	250,000	8.7%
2023	265,000 (estimated)	6.0%

6.8 Women Entrepreneurs

- a. **Programs for Entrepreneurship and Leadership:** Conducting selective training programs for the women in services of value addition that consists of processes like drying, packaging, processing and marketing with some business skills⁹⁴.
- b. **Cooperatives and Supporting Networks:** Facilitating formation of women headed fisheries businesses and then linking them to service markets and the providers.
- c. **Easy Access to Funds and Technology:** Ensuring the participation of women in certain operations that include credit schemes, programs of the innovation support and also the input distribution tasks⁹⁵.

Table 19: Female Labor Force Participation and Literacy Rates (Rural vs Urban)

Area	Female Labor Force Participation (%)	Female Literacy Rate (%)
Urban Pakistan	24	67
Rural Pakistan	19	38
National Avg	23	51

6.9 Fisher Communities

- a. **Training Setup for Community Empowerment:** Involves the training on techniques of sustainable fishing, safety measures at sea, selectivity

⁹³ Kausar, Rehana. "Cross-learning for Addressing Emergent Challenges of Aquaculture and Fisheries in Pakistan." Cross-learning for Addressing Emergent Challenges of Aquaculture and Fisheries in South Asia (2021): 87.

⁹⁴ Rahaman, Md Saidur, Leo Paul Dana, and Nishath Anjum. "Empowering Women in Building a Sustainable Blue Economy." In Handbook of Sustainable Blue Economy, pp. 1-20. Cham: Springer Nature Switzerland, 2024.

⁹⁵ Amandaria, Riri, Rahim Darma, Nixia Tenriawaru, Letty Fudjaja, Untari, and Rida Akzar. "Gender, empowerment, and rural sustainable development: A case study of crab business integration." *Open Agriculture* 10, no. 1 (2025): 20250416.

of equipment, adjustment to climate resilience, and including services of social protection⁹⁶.

b. **Alternative Programs for Livelihood sustenance:** Providing skills to communities for supporting their additional livelihoods through ecotourism, aquaculture and the maintenance of boat to minimize constraint on wild stocks⁹⁷.

c. **Education and Youth Participation Programs:** Introducing technical training related to fisheries and initiating programs of entrepreneurship in inland fishing harbor as well as coastal regions.

6.10 Public-Private Partnerships (PPPs) and Community Oriented Resource Management (CBRM)

Utilizing innovations in private sector and awareness of local knowledge is utmost need for development of adaptable and market-based fisheries sector⁹⁸.

6.11 Public and Private Partnerships (PPPs)

a. **PPP Policy Framework:** Developing tailored guidelines on national and provincial PPP levels for fisheries and aquaculture development in order to attract investment in terms of infrastructure, hatcheries and cold chains⁹⁹.

b. **Private Sector Participation:** Facilitating the partnerships with stakeholders by involving active participation from the input suppliers, exporters, manufacturers, and also from the financial institutions for better access to services and markets.

c. **Technology Transfer Centers:** Creating the innovation centers that are PPP driven for piloting and scaling up modern technologies used in aquaculture, providing solutions for disease management, and their utilization in manufacturing sustainable feeds.

⁹⁶ Hasan, Mohammad R., Pedro B. Bueno, and Richard A. Corner. "Strengthening, empowering and sustaining small-scale aquaculture farmers' associations." *FAO Fisheries and Aquaculture Technical Paper* 655 (2020): 1-181.

⁹⁷ Ali, Mazalina, and Achmad Zamroni. "Enhancing fisheries community resilience for sustainable livelihood and coastal resources management." *Fish for the People* 19, no. 2 (2021): 16-20.

⁹⁸ Rej, Nilanjan, Shyam Sundar Dana, Abdul Hannan Mondal, Moumita Ray Sarkar, Dipam Ray, Arif Ahammed, and Ritika Karjee. "Aquaculture Practices and Knowledge Level of Fish Farmers in Purulia District of West Bengal." *Indian Journal of Extension Education* 61, no. 3 (2025): 7-13.

⁹⁹ Shah, Syed Babar Hussain, Yongtong Mu, Muhammad Mohsin Aslam Jarwar, Zulfiqar Ali, Muhammad Talib Kalhoro Larak, Muhammad Noman, and Maqsood Ahmed Soomro. "Role of Public Sector Trainings for Promoting Aquaculture Development in Pakistan: Current Status and Future Prospects." *J. Sci. Tech* (2016): 174-184.

Table 20: Opportunities for Public-Private Cooperation in Fisheries Sector

Area of Partnership	Private Sector Role	Public Sector Support
Infrastructure	Invest in hatcheries, cold chains, logistics	Policy incentives, land access
Technology Innovation	R&D in feed, disease control, equipment	Subsidy, pilot programs, regulatory facilitation
Market Access & Exports	Direct sourcing, value chain development	Trade facilitation, export policy
Training and Advisory	Industry-led training modules	Curriculum validation, accreditation

6.12 Community Based Resource Management (CBRM)

- a. **Community Fisheries Management Committees (CFMCs):** Empowerment of local fishing communities in legalized manner, enabling them to participate in the compliance and surveillance process as well as resource management¹⁰⁰.
- b. **Agreements for Collaborative Management:** Establishing the co-management arrangements in a formalized way that facilitates governmental sector and communities by the means of shared governance of rivers and the coastal areas¹⁰¹.
- c. **Benefit Sharing and Incentives:** Developing equitable benefit sharing mechanisms for ecotourism, the resource use, and motivating stewardship concept by conservation efforts.
- d. **Participatory Monitoring and Evaluation:** Training of community members in primary skills of monitoring and collection of data to ensure sustainability and build ownership.

6.13 Conclusion

In country like Pakistan, two major things can play a crucial role in resilient fisheries and aquaculture considering one as the Institutional reforms and the other is capacity building. Comprehensive governance reforms, institutional restructuring, greater community participation, and sustained investment in human capital are fundamental to achieving long-term sustainability and climate resilience within the sector. These policies need to be enforced through involvement of multi stakeholders, with strong monitoring and accountability frameworks rooted at every level.

¹⁰⁰ Ali, Mazalina, and Achmad Zamroni. "Enhancing fisheries community resilience for sustainable livelihood and coastal resources management." *Fish for the People* 19, no. 2 (2021): 16-20.

¹⁰¹ Hafsaridewi, Rani, Dewayany Sutrisno, Sonny Koeshendrajana, and Tikkyrino Kurniawan. "Fishermen's resilience-based management policy on small islands." In *BIO Web of Conferences*, vol. 171, p. 04014. EDP Sciences, 2025.

Chapter 7

Support Gender Inclusion and Social Equity

In the fisheries and aquaculture sectors of Pakistan sustainable development needs to be overall equitable and socially unbiased. Although women and marginalized communities contribute substantially to fisheries and aquaculture activities, they remain underrepresented in governance structures and policy forums. Their work is frequently informal and poorly documented, limiting their access to credit, capacity-building programs, and market opportunities. This chapter critically examines these disparities and recommends deliberate interventions to strengthen gender-responsive and socially inclusive sectoral development¹⁰².

7.1 Fisheries and Aquaculture

Women and certain groups of ethnic minorities that include fisher folk working on small scale and the laborers without owning a piece of land are actively working across the fisheries value chain, still remain generally intangible in aspects of policy formulation and remain unknown in official statistical data^{103 104}.

7.2 Roles of Women

- a. **Post Harvesting and Processing:** Women to the large extent are involved in procedures of fish drying, cleaning, grading, value addition, and informal trade, often without legal or financial recognition.
- b. **Aquaculture and Hatchery Work:** Women considerably contribute in seed collection, maintenance of ponds, caring and feeding for hatchlings, especially in rural areas and the coastal community.
- c. **Livelihood Diversification:** On small scale in micro-enterprises many of the women work in fish vending and collection of shellfish to earn their household incomes.

¹⁰² Adam, Rahma, Cynthia McDougall, Kate Bevitt, Sarah Freed, Chelcia Gomese, Abigail Johnson, Jacqueline Lau et al. "Four pathways to achieve gender equality and women's empowerment in small-scale fisheries and aquaculture: Insights from FISH research." (2022).

¹⁰³ Xu, Zhao, Maria Qayum, Jamil Afzal, and Muhammad Aslam. "Availability and access to Livelihood capital assets for development of sustainable Livelihood strategies of fishermen: A case study of Manchar Lake Pakistan." *Heliyon* 9, no. 12 (2023).

¹⁰⁴ Ali, Muhammad Ramzan. "Small-scale fisheries in Pakistan." *Small-scale fisheries in South Asia* 81 (2018).

Table 21: Gender Roles in the Fisheries Value Chain

Value Chain Stage	Common Women's Roles	Barriers Faced
Post-Harvest	Drying, grading, sorting, selling	No legal recognition, limited income
Aquaculture Activities	Feeding, pond management, seed collection	Limited training, technology access
Processing & Value Addition	Cleaning, packaging, smoking, ornamental fish	Exclusion from decision-making and cooperatives
Market Access	Street vending, informal selling	No licenses, mobility restrictions

7.3 Roles of Marginalized Communities

- a. **Small-Scale and Sustenance Fishers:** Most of the underprivileged populations enormously depend on (rivers, coastal fisheries and inland water bodies) for their sustenance, they face issue of restricted access to resources and consumers markets¹⁰⁵.
- b. **Landless Workers:** These people often work in minor boat operations, fish handling without any social assistance and net repairing.

7.4 Barriers to Participation

- a. Lack of access to training, infringement of rights to property, funding issues and no permanent employment opportunities.
- b. Women from backward areas face many cultural restrictions along with hinderance in their mobility process.
- c. Issues regarding underrepresentation in structures of fisheries governance.
- d. Institutional data systems are not strong enough to express gender stratification and social indicators.

Table 22: Employment in Pakistan's Fisheries Sector by Gender

Category	Male (%)	Female (%)
Capture Fisheries (Harvesting)	95	5
Post-Harvest Processing	30	70
Aquaculture & Hatcheries	60	40
Fish Marketing & Retail	80	20
Informal/Unrecognized Labor	35	65

¹⁰⁵ Kusakabe, K., & Thongprasert, S. (2022). *Women and men in Small-scale Fisheries and Aquaculture in Asia: barriers, constraints and opportunities towards equality and secure livelihoods*. Food & Agriculture Organization.

7.5 Efforts to Uplift Women's Participation and Empowerment

A reframing approach is required to make sure that women and the sidelined communities not only just work as participants rather they should also be given a fair chance to hold a certain position in development of a robust aquaculture system and the resilient fisheries^{106 107}.

7.6 Skill Development and Capacity Building

a. **Skill Focused Training Programs:** Women friendly training modules to be designed for better fish farming practices, management of hatchery, fish processing and packaging methods including other beneficial entrepreneurship programs¹⁰⁸.

b. **Community Oriented Mobile Learning:** Establishing community-based learning centers and deployment of the training units for reaching out to unprivileged groups, especially women in remote areas considering (coastal and inland) villages¹⁰⁹.

7.7 Access to Profitable Resources and Funding

a. **Gender based Credit Schemes:** Promoting the microfinance banking system that offers loans on low interest rate and affordable funding schemes for women entrepreneurs and producers working on small scale¹¹⁰.

b. **Grant Programs and Toolkits:** Providing assistance in start-up for women led businesses inform of toolkits through contribution in solar dryers, aquaculture inputs and the ice boxes along with the supply of grants.

7.8 Market Linkages and Enterprise Support

a. **Women's Cooperatives and Collectives:** Strengthening the cooperatives that are headed by women in order to improve their bargaining

¹⁰⁶ Gonzalez Parrao, C., Shisler, S., Moratti, M., Yavuz, C., Acharya, A., Eysers, J., & Snilstveit, B. (2021). Aquaculture for improving productivity, income, nutrition and women's empowerment in low-and middle-income countries: A systematic review and meta-analysis. *Campbell Systematic Reviews*, 17(4), e1195.

¹⁰⁷ Adam, Rahma, Cynthia McDougall, Kate Bevitt, Sarah Freed, Chelcia Gomese, Abigail Johnson, Jacqueline Lau et al. "Four pathways to achieve gender equality and women's empowerment in small-scale fisheries and aquaculture: Insights from FISH research." (2022).

¹⁰⁸ Kais, Shaikh Mohammad. "Climate change and resilience in industrial aquaculture: a study of community capitals in the shrimp-farming zone in Bangladesh." PhD diss., 2018.

¹⁰⁹ Khan, Shaheen Rafi, and Shahrux Rafi Khan. "Reversing unsustainable policies and practices in the fisheries sector: A chronology of collective action by the Pakistan fisheries forum." In *Social Capital and Collective Action in Pakistani Rural Development*, pp. 187-222. Cham: Springer International Publishing, 2021.

¹¹⁰ Kaczan, David J., and Pawan G. Patil. "Potential development contribution of fisheries reform: evidence from Pakistan." *The Journal of Environment & Development* 29, no. 3 (2020): 275-305.

power, giving them easy access to direct market and improving the procurement input¹¹¹.

b. **Support for Value Addition Enterprises:** Facilitating the participation of women in valuable sections such as ornamental and smoked fish including the packaging of processed seafood¹¹².

7.9 Involvement in Process of Decision Making

a. **Representation in Governance Bodies:** Ensuring that marginalized voices and women are properly engaged in policy dialogues and their participation is highly considered important at local and as well as on national levels in fisheries committees and the collaborative management framework¹¹³.

b. **Leadership Development:** In the fisheries sector the mentorship and the leadership programs for the women are necessary to build up their confidence and enhance their basic knowledge in advocacy.

7.10 Promoting Gender Responsive and Socially Inclusive Policy Frameworks

Institutionalizing the gender equality by considering the policies and governance mechanisms that must be oriented on basis of equity and justice¹¹⁴.

7.11 Policy Integration

a. **Mainstreaming of Genders in Fisheries Policies:** Reviewing of the existing framework and policies to effectively incorporate the gender equality overall as a key objective in sectors of fisheries, coastal development and aquaculture.

b. **Inclusion of Policies in National and Provincial Action Plans:** To Ensure that national strategies made for fisheries and aquaculture are clearly addressing the needs and the respective roles of women and other deprived communities in society¹¹⁵.

¹¹¹ Gopal, Nikita, Holly M. Hapke, Kyoko Kusakabe, Surendran Rajaratnam, and Meryl J. Williams. "Expanding the horizons for women in fisheries and aquaculture." *Gender, Technology and Development* 24, no. 1 (2020): 1-9.

¹¹² Shaffril, Hayrol Azril Mohamed, Asnarulkhadi Abu Samah, and Raidah Mazuki. "A systematic literature review on the adaptation of women in fisheries-based families on climate change impacts." *Journal of Environmental Studies and Sciences* (2024): 1-18.

¹¹³ Mehak, Ana, Yongtong Mu, Muhammad Mohsin, and Xing-Can Zhang. "MCDM-based ranking and prioritization of fisheries' risks: a case study of Sindh, Pakistan." *Sustainability* 15, no. 11 (2023): 8519.

¹¹⁴ Adam, Rahma, Anamika Amani, Rob Kuijpers, Katrine Danielsen, Esther Smits, Froukje Kruijsen, Nicole Moran et al. "Climate-resilient aquatic food systems require transformative change to address gender and intersectional inequalities." *PLOS Climate* 3, no. 7 (2024): e0000309.

¹¹⁵ Kaczan, David J., and Pawan G. Patil. "Potential development contribution of fisheries reform: evidence from Pakistan." *The Journal of Environment & Development* 29, no. 3 (2020): 275-305.

Table 23: Policy Recommendations based on Gender Responsiveness

Policy Area	Gender-Responsive Recommendations
Training	Mobile training units, female trainers, community learning hubs
Finance	Collateral-free credit schemes for women
Data & Monitoring	Collect sex-disaggregated data at all operational levels
Governance & Leadership	Reserved seats in fisheries committees, leadership mentoring
Legal Frameworks	Recognize women's informal labor under labor laws

7.12 Data and Evidence Systems

a. **Gender and Socially Disarticulated Data:** The specific systems to be established for data collection that work by making use of the available disaggregated data for monitoring the progress, to direct planning, and to identify gaps in policy¹¹⁶.

b. **Social Impact Assessments:** The social involvement and equity assessments to be considered mandatory for planning aquaculture development and significantly extensive projects on fisheries.

7.13 Legal and Institutional Reforms

a. **Legal Recognition of Women Workers:** Women must be given the social security, rights to labor protection and official recognition of their roles in fisheries.

b. **Inclusive Institutions:** Developing indicators for performance and keeping in view the guidelines in context to the gender inclusive planning within relevant departments of fisheries¹¹⁷.

7.14 Awareness and Cultural Change

a. **Behavior Change Communication:** Launching awareness campaigns on the grassroot level to break societal stereotypes regarding role of women and vulnerable groups in community by promoting the concept of shared responsibilities¹¹⁸.

¹¹⁶ Mohsin, Muhammad, Yin Hengbin, Zhang Luyao, Li Rui, Qian Chong, and Ana Mehak. "An application of multiple-criteria decision analysis for risk prioritization and management: A case study of the fisheries sector in Pakistan." *Sustainability* 14, no. 14 (2022): 8831.

¹¹⁷ Lina, Liu, and Muhammad Murad Zaib Butt. "Analysing Pakistan's fisheries legislation and institutional framework: integrating Sustainable Development Goal 14 within the scope of International Fisheries Law." *Frontiers in Marine Science* 12 (2025): 1503748.

¹¹⁸ Khan, Shaheen Rafi, and Shahrukh Rafi Khan. "Reversing unsustainable policies and practices in the fisheries sector: A chronology of collective action by the Pakistan fisheries forum." In *Social Capital and Collective Action in Pakistani Rural Development*, pp. 187-222. Cham: Springer International Publishing, 2021.

- b. **Community Dialogues:** Facilitating the social dialogue on community level so as to strengthen social participation and minimize intransigence to initiatives developed for gender equity¹¹⁹.

7.15 Conclusion and Recommendations

The long-term resilience and productivity of Pakistan's fisheries and aquaculture systems depend directly on sustainable management, effective regulation and inclusive development. Empowering women and marginalized groups is not only a matter of social justice but also a strategic economic priority, as it unlocks untapped human capital and strengthens resource governance. To translate this into action, the National Action Plan should introduce reserved representation for women in fisheries committees, establish leadership mentoring and capacity-building programs, expand access to finance and extension services, and ensure legal recognition of women's economic contributions within the sector. Gender equity and social inclusion must be embedded as non-negotiable pillars of sustainable fisheries development, supported by measurable targets and clear accountability mechanisms.

¹¹⁹ Arshad, Sana, Saba Arshad, Sumaira Afzal, and Faisal Tasleem. "Environmental Impact and Sustainable Practices in Aquaculture: A Comprehensive Review." *Haya Saudi J Life Sci* 9, no. 11 (2024): 447-454.

Chapter 8

Proposed National Action Plan

Fisheries/aquaculture plays a crucial role in Pakistan in agriculture and economy, food security, incomes of the people and state resources. With huge potential, the fisheries sector in the country experiences several systemic problems including obsolete infrastructure, poor governance as well as environmental vulnerability especially in relation to climate change. To realize all this potential, one must implement a National Action Plan that comprises short term and long-term measures.

1.1 Short-Term Plan (1-3 Years)

The strategic plan is focused on long-term goals and seeks to meet the immediate and underlying issues in the fisheries and aquaculture in Pakistan. It is centered on governance, infrastructural development, capacity building and implementation of climate-resilient practices that can provide a base to deeper reformatations.

1.1.1 Strengthening Governance and Institutional Framework

- a. **Institutionalization of the National Fisheries Authority (NFA):** It will function as a central governing body that will facilitate coordinated monitoring, policy formulation and regulatory structure of the fisheries sector. The NFA will collaborate with the provincial fisheries departments and will strive to create uniformity in the rules as well as synchronize efforts nationally. This will rationalize resource deployment and enhance performance in the sector.
- b. **Capacity Building and Institutional Strengthening:** The key departments in each province related to fisheries like Sindh, Balochistan, and Punjab will be subjected to capacity building programs. Training workshops will be conducted with the aim of increasing awareness in the new fisheries management practices, enforcement of policies, data collection and resource monitoring. This will help local authorities to better manage the aquatic ecosystems of Pakistan that vary in their diversity.
- c. **Coordinated drafting of Provincial Action Plans:** The respective legislative mandates of the federal and provincial governments in specific domains should be clearly defined. Tailored provincial and local action plans should then be developed based on the unique needs, challenges, and resource capacities of each region. While these plans must remain aligned with national priorities, they should also retain sufficient flexibility to address local concerns, such as flood management in the Indus River basin and coastal protection in Sindh.

1.1.2 Infrastructure and Market Access Improvement

- a. **Cold Storage Transportation Infrastructure:** The development of cold store facilities and enhancement of refrigerated

transport is likely to counteract post-harvest losses that are often as high as 25-30% due to lack of facilities¹²⁰. Development of the cold chains will focus on the coastal and inland regions of Pakistan (Karachi, Gwadar, Sukkur and Multan).

b. Improvement of Fish Landing Sites: Key landing sites should be developed in strategic fishing towns and hubs with important infrastructure such as harbors, landing jetties and processing centers. This comprises security enhancements, improved safety practices and capacity building of fishers, and processors on safe handling of fish that limit wastage.

c. Enhancing Market Connection: Introducing an online network system that connects fish farmers, processors, and retailers will aid in improving market access to the local fish farmers as the producers will be able to enter wider markets of a larger region and the entire country. The platform will equally offer market pricing information to enable the fishers to make improved sales decisions.

1.1.3 Promoting Climate-Resilient Aquaculture

a. Pilot Projects Climate-Resilient Aquaculture: Pilot projects will aim at the integration of climate-resilient aquaculture, including recirculating systems (RAS), integrated multi-trophic aquaculture (IMTA), and production of drought-tolerant fish species. Those projects will occur in regions including Punjab and Sindh where inland aquaculture is dominant.

b. Training on Sustainable practices: The sustainable practices will be trained on the use of feed, water quality management, disease control, and biosecurity through training programs that will be carried out to aquaculture farms to increase productivity and heighten environmentally sustainable practices. There would also be emphasis on decreasing the need for wild-caught fish as food.

c. Natural Resources Integration: Aquaculture systems should be configured in a way that makes better use of natural resources, e.g. agricultural runoff and wastewater used to foster fish farming thus lessening the environmental impact of aquaculture.

1.1.4 Research and Development (R&D)

a. Establishment of Research Centers on Aquaculture: There is the need to establish research centers in collaboration with universities and international organizations to facilitate development of local aquaculture species, refinement of the feed formulations and management of aquaculture diseases. Arguable areas that will be given

¹²⁰ Melba, R. (2005). *Post-harvest fisheries losses in developing countries: Issues and challenges*. Rome: FAO.

special attention include species such as Rohu and Nile tilapia, and shrimp farming-tech.

b. **Public-Private Partnerships on R&D:** Partnering arrangements between the government, commercial industries and the world research institutions will be promoted to further spur developments in aquaculture practices. Alliances with agencies such as the FAO and World Bank will play an important role of introducing global experience in Pakistan.

1.1.5 Gender and Social Inclusion

a. **Empowering Women in Fisheries/ Aquaculture:** Female-friendly programs will then be established to provide women with knowledge of fish processing, marketing and management, so that they can tap opportunities in the field. Special training will be undertaken to sensitize the fishers on the rights and duties of women in fishery management with an aim of encouraging more women to become members of the cooperatives and serving in leadership roles.

b. **Engaging the Youth in Aquaculture:** Engaging young people through vocational training, internships, and entrepreneurship programs in aquaculture will help develop a new generation of skilled professionals familiar with modern technologies and sustainable practices. The proposal also includes the provision of scholarships for students pursuing higher education in fisheries management and aquaculture technologies, with the aim of strengthening technical expertise and building long-term human capital within the sector.

1.2 Long-Term Plan (4-10 Years)

The long-term strategy aims at scaling up the positive activities that occurred during the short-term phase and institutionalizing sustainable practices in fisheries and aquaculture in Pakistan. It is geared towards national wide transformation, increased economic integration and resilience against such things as climate change and other systemic pressures.

8.2.1 Comprehensive Fisheries and Aquaculture Governance

a. **Operational autonomy of the National Fisheries Authority (NFA):** The NFA will be empowered to take a leading role in fisheries governance, establishing catch limits, enforcing aquatic ecosystem-based management of fishing and sustainable fishing practices. It will also be tasked with instituting and controlling quotas, reduction of overfishing and access with equal access to resources.

b. **National Fisheries Policy Framework:** This will involve coming up with a proper policy on fishing which revolves around the sustainable management of marine, freshwater, and brackish waters.

This policy will entail resource conservation policies, fisheries, and environmental protection policies. Some international agreements, including the Sustainable Development Goals (SDGs) and the FAO Code of Conduct for Responsible Fisheries will also be aligned with the policy.

8.2.2 Sustainable and Resilient Infrastructure

a. **Creation of Modern Aquaculture Parks:** Modern aquaculture parks will be developed that would be large scale and integrated in a sustainable manner linking the hatchery, processing facilities, and transport links. The parks will be fitted with new-fangled technologies in water cleansing, recirculating and waste reception guaranteeing negligible ecological consequences culling maximum production.

b. **Port and Coastal Infrastructure Overhaul:** The overhaul and expansion of coastal infrastructure in major fishing ports, i.e., Karachi and Gwadar, will also assist in improving the handling, processing, and export of seafood. The infrastructure development will consist of the latest fishing vessels, cold storage, processing and packaging units and the seafood would be of international standards.

8.2.3 Research, Innovation, and Technology Adoption

a. **National Aquaculture Innovation Hub:** A specialized aquaculture innovation center will also be developed to help in the advancement of the production of new technologies, breeding programs of new species, disease management, and environmentally friendly approach. The hub will also be based on AI and big data analytics at various levels to access fish health and production outcomes and optimize resource use.

b. **Real-Time Monitoring and Sensors: Data collection systems:** The systems will monitor and record high-frequency data, which will be collected on water quality, fish health, feed conversion rates, and the environment, and advance monitoring systems installed in all aquaculture farms and fisheries. The information should be used to enhance productivity, monitor trends, and inform both the local and national policy making.

8.2.4 Climate Change Adaptation and Environmental Protection

a. **Nationwide Restoration Programs:** There will be large scale restorations of some important coastal ecosystems including mangroves, reefs, and seagrass meadows. Such ecosystems offer important fish breeding areas as well as natural shock absorbers to storms and mounting sea tides.

b. **Implement Climate-Smart Aquaculture:** Climate-ready fish farming practices like salt-tolerant species and climate-controlled

systems will be used in production systems to respond to increased temperatures in waters, saltwater intrusion, among other effects of the changing climate.

8.2.5 Export Market Expansion and Diversification

a. **Secure International Certifications:** The fisheries and aquaculture products in Pakistan shall seek international certifications such as HACCP, Global GAP and ISO and will be compliant with international safety and quality standards.

b. **Seeking out New Export Markets:** It will also be sought to diversify export markets with newer areas like Southeast Asia, North America, and Africa being one of the key areas of focus where the efforts will be made in diversification of the value chain between the farm and the table along with adding more value and exporting processed seafood products.

8.2.6 Long-Term Social and Economic Development

a. **Sustainable Livelihoods and Social Security:** Integrated support system will be introduced to the fishing communities that would improve their living conditions with special emphasis on health, education, social security and retirement. This will imply that fishers and aquaculture workers receive safety nets in the event there is a fluctuation in the market and environmental related challenges.

b. **Private Sector Investment and Participation:** The private sector will be encouraged to invest in fisheries and aquaculture by way of tax incentives, grants on research and development and the use of public-private partnerships (PPP). This will foster innovation, boost productivity, and the export of the fisheries products of Pakistan.

8.2.7 Education and Capacity Building

a. **Curriculum Integration and Vocational Training:** The process of curricular integration will be included into the academic framework of universities to train a new cadre of professionals with new skills in fishing management in sustainable fisheries and aquaculture technologies. The vocational training centers will also be established to train fish farmers, processors and managers where practical hands-on training is imparted.

b. **International Collaboration in Education and Research:** Pakistan will seek to join hands with international universities, research and development groups in human advancement to improve local programs in fisheries and aquaculture research.

1.3 Conclusion

Pakistan's fisheries and aquaculture sectors hold substantial untapped potential, especially for rural and coastal communities reliant on them for livelihoods. The country's vast inland waters and Arabian Sea coastline offer opportunities for growth, yet the sector faces major constraints such as weak infrastructure, outdated practices, low productivity, environmental risks, and inadequate policies.

A National Action Plan for Sustainable and Resilient Fisheries and Aquaculture is essential to modernize governance, build climate resilience, and enhance global competitiveness. Addressing climate change impacts rising sea levels, shifting monsoons, ocean warming and acidification alongside overfishing, mangrove loss, poor post-harvest practices, and limited innovation is critical for sustainability.

The way forward requires coordinated action by government, private sector, institutions, and communities. Key priorities include investment in R&D, infrastructure, education, and governance reforms, while ensuring social inclusion, food security, and livelihood enhancement to support poverty reduction and national development.

8.4 Recommendations

8.4.1 Strengthen Governance and Institutional Coordination

a. **Establishment of a National Fisheries Authority (NFA):** To ease and facilitate governance, it is proposed that Pakistan should established a National Fisheries Authority (NFA) that will be the main coordinating body at the federal level of fisheries and aquaculture management. The NFA is supposed to collaborate closely with the provincial fisheries departments to standardize policies, regulation, and enforcement procedures in the country. The NFA can also play the role of ensuring that the national vision on sustainable fisheries and aquaculture is realized in the government at all levels without having tethered governance and overlapping mandates.

b. **Strengthening of the local/ provincial Fisheries Departments:** To realize the successful implementation of national policies, more authority, resources and technical support should be made available to the local/ provincial fisheries departments. Such decentralization in responsibilities will be effective especially in directing issues that need to be handled locally e.g. the handling of resources in the region and specific species conservation concerns.

c. **Improved Inter-Departmental Cooperation:** A multi-stakeholder focusses on the level of interaction between several departments-i.e., the department of National Food Security, the department of Climate Change, and the department of Maritime Affairs-should be developed. This partnership will make it easier to control interventions and ultimately create more integrated, comprehensive, and long-term solutions to the fishery and aquaculture industries.

8.4.2 Enhance Research and Development (R&D)

- a. **Development of Aquaculture Research Centers:** Aquaculture research centers should be developed to work on species-specific breeding programs, disease management, non-waste production of feed, sustainable water quality management, and improvements of the genetic make-up of farmed fish. These centers ought to cooperate with foreign research institutions to be aware of the recent technological improvements and exchange of information.
- b. **Publicity of Public-Private Partnerships in R&D:** To enable fast innovation as well as research output, the government should encourage public-private partnership (PPP) with the private sector investors, universities, and research institutions locally. This will facilitate the formation of innovative technologies and solutions that will be relevant in the individual environmental conditions in Pakistan. Government investment through grants and incentives of R&D activities will play a pivotal role in influencing the private sector to invest in sustainable solutions for aquaculture and fisheries.
- c. **Technology Transfer and Knowledge Sharing:** Pakistan is currently not participating enough in the global fisheries and aquaculture organizations including FAO and World Bank and should step up their presence to share knowledge and learn about best practices. In this partnership, the exchange of superior technologies in aquaculture will be possible like recirculating aquaculture systems (RAS) which comes with a lot of advantages in the case of water conservation, diseases prevention, and utilization of spaces.

8.4.3 Invest in Climate-Resilient Practices

- a. **Introducing Climate-Smart Aquaculture Systems:** As the fisheries and aquaculture industry become more susceptible to climate change, we must promote the transition of using climate-smart aquaculture. These activities ought to comprise sustainable and low-carbon technologies like those of solar-powered water pumping systems, biosecurity to prevent incidences of diseases, and use of rainwater harvesting systems to control water within aquaculture units. The creation of climate-resistant species and systems, whether it be saltwater tolerant fish species or integrated multi-trophic aquaculture (IMTA) systems, will help to make aquaculture more resistant to the environmental impact of the same and make it more sustainable.
- b. **Climate-Resilient Fisheries Management:** Fisheries management ought to integrate the adaptation mechanisms to climate changes e.g. determining protection marine areas to conserve the breeding and migration herds and the establishment of fish habitats to protect threatened fish species, the so-called fish refuge. Given the uncertainty of the weather pattern, it is important that the government invests in climate forecasting tools and early warning systems and

disaster management systems to enable fishing communities to respond to environmental threats more readily.

c. **Incentivizing Climate Adaptation:** State governments should reward climate adaptation by giving financial incentives or subsidies to fish farmers who change their activities to use practices that become sustainable and resilient to climate change. Special attention should be given to the citizens that are marginalized and thus become particularly vulnerable in times of climate-related shocks making sure that those populations have the capacity and the resources to adapt to evolving environmental circumstances.

8.4.4 Improve Infrastructure and Market Access

a. **Cold Storage/ Refrigeration infrastructure:** Post-harvest losses in Pakistan are also a major impediment to the profitability of the fisheries sector. The government can respond fast by investing in establishing cold storage facilities and cooled transportation system in major fishing points in Karachi, Gwadar and Thatta. These investments will not only minimize the levels of spoilage and wastage, but it will also prolong the shelf life of seafoods which will make both local and international markets accessible.

b. **Modernization of fish processing units:** To add value to the fisheries sector, fish processing plants need to be modernized to achieve international levels of hygiene and produce high quality products to export products. Investment in automated processing technologies, along with targeted training programs for local processors, will improve productivity, ensure compliance with export standards and strengthen overall product competitiveness .

b. **Enhanced Access to Export Markets:** The Pakistan seafood export is badly hit by the barriers to export markets in relation to compliance to the international sanitary and phytosanitary (SPS) standards. In addressing this, government ought to concentrate on the enhancement of certification systems whereby the sea food products can conform to the standards of international importers especially in Europe, the UAE and China. The creation of the body that will solely focus on facilitating exports of seafood in the Ministry of Commerce, would help in enhancing the Pakistani seafood industry in the international market and the ability to handle the trade negotiation processes.

8.4.5 Promote Sustainability in the Fisheries Sector

a. **Sustainable Management Practices in Fisheries:** Sound policies on fisheries management need to be formulated as per scientific

information to ensure sustainable fish streams stop overfishing. One major step is to have catch limits, designating marine protected areas, seasonal closures and encourage eco-labeling of sustainably caught fish products.

b. **Better Resource Surveillance:** As an integrated resource surveillance mechanism using the modern technology of satellite tracking and data logs shall be established, it would help to keep a check on the fishes, analyze the health of the ecosystem and be able to enforce the fishing law to enable tight management of resources. Constant stock analyses are needed to advise decision-making to avoid overfishing of the major fish species.

c. **Encouraging Sustainable Aquaculture:** The government should encourage sustainable aquaculture practices such as those that lessen the risk of environmental degradation like decreasing of the source of feed, wild fish, and creation of efficient systems to manage water. Through incentivizing, aquaculture businesses must also be encouraged to adapt to best management practices (BMPs) including water reuse technologies, disease control, proper waste disposal systems, etc.

8.4.6 Focus on Social Inclusion and Livelihoods

a. **Empowerment of Women and Youth in Fisheries and Aquaculture:** The National Action Plan should have the specific strategies of enabling inclusion of women and youth in the fisheries and aquaculture industries. This may include provision of specific vocational training to women in fish processing and aquaculture management, and development of financial inclusion programs to women and female-led aquaculture enterprises. Also, it would help to make the young engage in the aquaculture field of career through mentorship programs and targeting the young through education.

b. **Social Protection to Fishing Communities:** There should also be some form of social protection net towards the fishing community, who stand in constant danger of economic deprivation because of unstable market rates, environmental disasters, and fluctuations in fish supply. Health insurance policies, disability payments and pension schemes are good ways through which the small-scale fishers can be given stability during such hard moments.

8.4.7 Long-Term Monitoring and Evaluation

a. **The Guidelines of Monitoring and Evaluation Framework:** A powerful monitoring and evaluation (M&E) framework is vital to make sure the plan to implement the National Action Plan. This framework must contain key performance indicators (KPIs) that would assist in the measurement of the economic, environmental, and social impacts of

interventions. Reviews and appraisals should be done regularly to monitor progress and find bottlenecks to implement changes to the policies where need be.

b. **Regular Impact Assessments:** Long-term impact assessment should be used in gauging the success of the various strategies and programs. Such intelligence ought to inform policy-making and subsequent updating of the national action plan, to make it relevant and evolve to new challenges and opportunities.

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