

The Role of Fisheries in Rural Livelihoods in India

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Abstract

Fisheries are vital to India's rural economy because they provide millions of people with food, jobs, and income. India, one of the world's top fish-producing countries, has seen its fisheries industry evolve from traditional subsistence fishing to a contemporary, profitable business. This review examines the socioeconomic significance of fisheries, with a particular focus on their role in supporting rural livelihoods, national GDP, and nutritional security. Over 55% of the nation's fish production comes from inland and aquaculture fisheries, which have experienced impressive growth. Aquaculture promotes food security through sustainable production, while small-scale fisheries, in particular, give marginalized rural communities a means of subsistence. Because they give millions of people food, jobs, and income, fisheries are vital to India's rural economy. India, one of the world's top fish-producing countries, has seen its fisheries industry evolve from traditional subsistence fishing to a contemporary, profitable business. This review examines the socioeconomic significance of fisheries, with a particular focus on their role in supporting rural livelihoods, national GDP, and nutritional security. Over 55% of the nation's fish production comes from inland and aquaculture fisheries, which have experienced impressive growth. Aquaculture promotes food security through sustainable production, while small-scale fisheries, in particular, give marginalized rural communities a means of subsistence.

Keywords: Fisheries, Rural Livelihoods, Aquaculture, National GDP

1. Introduction

India was already one of the top nations in the world for fish production at the start of the decade. Each sub-sector made a substantial contribution to the sector, which was broadly divided into inland, marine, and aquaculture fisheries. India produced 9.6 million metric tonnes of fish in 2012, a considerable increase since the country's independence. With the help of the nation's extensive system of rivers, ponds, and reservoirs, inland fisheries have grown particularly rapidly and frequently outperformed marine fisheries in terms of output (Ayyappan, 2012). The fishing industry is vital to rural livelihoods, making a substantial contribution to economic growth, employment, and food security. India's fisheries, which employ over 16 million people directly and many more indirectly in the supply chain, have evolved from a subsistence activity to a crucial commercial enterprise thanks to their diverse range of resources (Ayyappan, 2012). Examining the development of the fishing industry, its effects on rural livelihoods, and the difficulties encountered are the objectives of this review.

1.1 Overview

The Indian fishing industry is vital to the nation's economy and social structure, making a substantial contribution to both individual and national development in various ways. The industry is essential for several key areas, including foreign exchange earnings, job creation, income generation, and food security (James, 2007). For many people, it also directly offers opportunities for a living. In addition to providing livelihoods, the industry plays a significant role in the national economy by serving as a major source of foreign exchange earnings. It generated Rs. 8,400 crore in revenue between 2009 and 2010, accounting for approximately 14% of agricultural exports (Ayyappan, 2012). The Indian fisheries industry has evolved from a small, traditional, subsistence-level endeavour to a sophisticated, contemporary industrial enterprise. Several factors have contributed to this evolution, including government programs and policies, scientific advancements, and support from businesses, the private sector, farmers, fishermen, non-governmental organizations, and self-help groups (James, 2007). With the third-highest global fish production and the second-highest inland fish production, India is a major player in the world's fisheries. Numerous water bodies, a wide variety of species, strong infrastructure, and highly qualified technical labour are among the nation's many resources, most of which have been fully utilized (James, 2007).

1.2 Importance of Rural Livelihoods

In many developing nations, fisheries are an essential component of the renewable natural resources (RNR) sector. This industry provides a vital economic foundation for rural communities, supporting the livelihoods of thousands of people (Neiland, 2004). It is well known that small-scale fishermen and their families catch and consume a significant percentage of the fish (Neiland, 2004). These people are particularly vulnerable to poverty because they are frequently regarded as some of the most impoverished members of society in developing countries. With a combined production of over 7.8 million tonnes of fish and shellfish from capture fisheries and aquaculture, India is recognized as the world's second-largest producer of fish and shellfish. With an annual yield of over 4.8 million tonnes, the nation's inland fisheries sector alone ranks second only to China in this area (Ayyappan, 2012). For people living in rural areas, particularly, this industry is a significant source of employment and income. The vast majority of these farmers and fishermen, who depend primarily

on fisheries for their livelihood, reside in more than 3,600 coastal villages, as well as in hamlets along significant river basins and reservoirs (Pillai, 2011). In addition to its economic benefits, the fishing industry is crucial to the food and nutritional security of a significant portion of the population, particularly in rural and coastal areas. In conclusion, the Indian fishing industry is a vital component of rural livelihoods, providing millions of people with work, income, and food security, strengthening the socioeconomic fabric of many communities (Pillai, 2011).

2. Fisheries in India

Since independence, India's fishing industry has undergone a significant transformation, evolving from a subsistence pursuit to a vital commercial enterprise. Government programs, advances in science, and the enthusiastic involvement of numerous stakeholders have all contributed to this development. In the past, the Indian fishing industry has evolved into a more advanced and contemporary industrial enterprise, transforming from a small, traditional, and subsistence-level activity (James, 2007). Numerous elements, including government programs and policies, scientific advancements, private sector support, businesses, farmers, fishermen, non-governmental organizations, and self-help groups, have significantly contributed to this change (James, 2007). India's fishing industry, which included both inland and marine fisheries, was primarily artisanal prior to the end of World War II (Sudarsan, 1987). This suggests that fishing was done on a traditional, small-scale basis at that time. Both the federal and state governments made major efforts to develop India's abundant fisheries resources after World War II. The late 1940s saw the start of significant advancements in marine fisheries (Sudarsan, 1987).

In the past, the Indian fishing industry has evolved into a more advanced and contemporary industrial enterprise, transforming from a small, traditional, and subsistence-level activity. Numerous elements, such as government programs and policies, scientific advancements, private sector support, businesses, farmers, fishermen, non-governmental organizations, and self-help groups, have contributed significantly to this change (James, 2007). Over the past 50 years, the Indian fisheries industry has experienced significant growth, with finfish and shellfish production increasing tenfold from 0.75 million tonnes in 1950–1951 to 7.8 million tonnes in 2010–2011. This significant rise highlights the industry's growing importance as the nation's second-largest fish producer globally and its increasing contribution to nutritional security (Ayyappan, 2012).

With its share rising from 29% in 1950–1951 to over 55% today, the inland fishing industry has experienced impressive growth. With an annual yield of over 4.8 million tonnes, India's inland fisheries sector is a significant global player, ranking second only to China in this regard. Approximately 77% of the production in inland fisheries originates from aquaculture, making it the primary contributor (Ayyappan, 2012). Particularly in the inland fisheries industry, where it accounts for 77% of production, aquaculture has been a major growth engine (Ayyappan, 2012). The production of finfish and shellfish has increased from 0.75 million tonnes to 7.8 million tonnes over the past 50 years, clearly demonstrating the potential and success of aquaculture, in addition to capture fisheries. The significance of this growth for future production enhancement is highlighted by Ayyappan (2012).

To improve productivity, sustainability, and the standard of living for communities that rely on the fishing industry, government support is crucial. Several programs and policies, including the Fish Farmers Development Agency and the National Fisheries Development Board (NFDB), play a crucial role in supporting sustainable practices and providing financial assistance. The main source of assistance is government-initiated development projects (Rao, 1980). Credit distribution to fishermen is a function of the Fisheries Cooperative Societies. Several focused programs are implemented, including the Development of Integrated Rural Areas, the Development Agency for Small Farmers, and the Development Agency for Fish Farmers (Rao, 1980). In addition to governmental organizations, other financial institutions support the sector by offering credit and loan facilities. These include numerous financial institutions, Development Banks for Agriculture, and Commercial banks (Rao, 1980).

3. Socioeconomic Importance of Fisheries

Fisheries have a multifaceted socioeconomic impact on employment, income generation, and food security in different regions. Many people rely on fishing for their livelihoods, especially in developing nations, and it makes a substantial contribution to local economies. In addition to meeting dietary needs, this industry fosters auxiliary sectors that contribute to overall economic growth. Globally, recreational fisheries are of great socioeconomic significance, supporting many facets of economic activity and human well-being. This significance goes beyond simple leisure and includes the production of food, revenue, and social goods (Arlinghaus & Cooke, 2009).

3.1 Employment generation in rural areas

The industry is essential for creating jobs and revenue, which in turn boosts a number of subsidiary businesses. Most importantly, a significant portion of the economically disadvantaged population relies on fisheries for their livelihood (Biradar & Ayyappan, 2006). Through commercial ventures that rely on fishing expenditures, like tackle stores, recreational fishing generates revenue at the local, state, and federal levels (Arlinghaus & Cooke, 2009). Fishing is a multifaceted strategy that can significantly boost local economies, enhance food security, and reduce poverty in rural areas by generating employment opportunities. There have been encouraging outcomes when fisheries and aquaculture are incorporated into rural development plans (Béné, 2008). In remote rural areas, particularly in developing nations, small-

scale fisheries are crucial to household livelihoods and play a significant role in generating jobs and revenue. Even for those who farm, fishing is the primary source of cash income for many households. Compared to households that do not fish, fishing households frequently report higher incomes (Béné, 2008). This is especially true for the lowest quartile households, who depend more on fishing for their cash income—nearly 90% of their income comes from fishing (Béné, 2008).

3.2 Contribution to GDP and rural income

Given their growth potential and substantial contribution to India's socioeconomic development, fisheries are acknowledged as a "sunrise sector" of the economy (Biradar & Ayyappan, 2006). Fisheries play a crucial role in ensuring nutritional security and contribute significantly to the nation's food supply. They generate substantial and consistent foreign exchange profits. Fisheries play a crucial role in ensuring nutritional security and contribute significantly to the nation's food supply. They generate substantial and consistent foreign exchange profits. The industry is essential for creating jobs and revenue, which in turn boosts a number of subsidiary businesses. Most importantly, a sizable section of the economically disadvantaged population depends on fisheries for their livelihood (Biradar & Ayyappan, 2006).

3.3 Gender roles in fisheries-related activities

Although roles are frequently gender-specific, both male and female household members participate in fishing and farming activities. While women frequently fish in groups using customary techniques, such as "écopage," men typically fish alone with passive gear. Men are in charge of gathering wood and maintaining the camp, while women are primarily responsible for processing fish (such as smoking and salting) and other domestic tasks. Children also participate; boys help their fathers fish in the main river channel, while girls frequently engage in "écopage" (Béné, 2008). Since women comprise approximately half of the world's population, they are recognized as a vital and integral part of society. Women comprise a sizable share of the workforce in agriculture and related industries, such as fishing, in India, particularly in rural areas. India had 2.42 million fisherwomen in 2000, demonstrating their significant presence in the industry (Nune, 2008).

3.4 Subsistence vs commercial fishing practices

The differences between commercial and subsistence fishing are significant because they serve distinct economic and community needs. Whereas commercial fishing focuses on generating profits and meeting market demand, subsistence fishing primarily aims to fulfill the nutritional and livelihood needs of the local population. For community welfare and sustainable management, it is essential to comprehend how they interact (de Almeida et al., 2011). Although they vary significantly in scope, techniques, and objectives, both commercial and subsistence fishing are crucial to the economy and way of life of coastal communities in India. Small-scale, traditional fishing communities mostly engage in subsistence fishing to supply local consumption and their immediate food needs. Usually, the catch is not meant for mass market sale (Freeman, 1993).

Maintaining the primary goal of fishing is to produce food for the fisherman's family and the local community; any surplus is occasionally sold in local markets. Usually, it entails small-scale operations with conventional boats (such as catamarans, canoes, or small wooden boats) and basic equipment like traps, handlines, and small nets (such as cast nets or gillnets). Nearshore operations are common. For coastal communities, fishing is frequently a component of a diversified livelihood strategy that also includes daily wage labour, farming, aquaculture, and other pursuits. This type of fishing is typically less harmful to the environment due to its small-scale and conventional techniques (de Almeida et al., 2011).

Commercial Fishing Profit-driven, with the goal of catching many fish to sell in both domestic and foreign markets, frequently focusing on high-value species. The primary objective of commercial fishing, which is conducted on a larger scale, is to generate revenue by selling fish and marine products on both domestic and international markets (Freeman, 1993). It involves larger ships equipped with sophisticated navigation systems, advanced fish-finding technology, and mechanized equipment, such as trawlers, purse seiners, and longliners. International and deep-sea waters may be used for operations (de Almeida et al., 2011). Because it requires a substantial capital investment in boats, equipment, and processing facilities, it is often the primary occupation for those involved. Overfishing, bycatch, and habitat destruction are just a few of the adverse effects it can have on the environment, especially when combined with unsustainable methods like bottom trawling. A significant economic contributor to India, generating revenue from exports and supporting a substantial processing and distribution sector (de Almeida et al., 2011).

4. Fisheries and Food Security

Fish is an essential part of the global diet because it provides essential nutrients that greatly contribute to food security. High-quality protein and vital micronutrients, including calcium, iron, zinc, vitamin A, and vitamin B12, are abundant in it and are essential for human growth and well-being. Consuming fish is particularly crucial in regions such as Bangladesh and sub-Saharan Africa, where malnutrition and micronutrient deficiencies are prevalent. Fish nutritional value varies greatly among species, with non-farmed fish typically having a higher micronutrient content than farmed fish (Muringai et al., n.d.). Fish sales boost household spending power, giving families access to a wider range of foods and improving their overall diets. This economic empowerment indirectly increases nutritional security (Kawarazuka et al., 2010).

4.1 Nutritional value of fish

Due to its high content of vital nutrients, fish is a crucial component of household nutritional security, particularly in developing nations. There are several dietary advantages to eating fish directly. Vital micronutrients can be found in abundance in fish. They are especially high in zinc, calcium, iron, and vitamin A (Kawarazuka et al., 2010). These nutrients are essential for growth, development, and general health, particularly in populations where deficiencies are prevalent. Eating some of the fish that they catch or raise can directly increase the nutritional intakes of households engaged in small-scale aquaculture or fisheries. The nutritional status of family members has improved, and dietary gaps have been filled thanks to easy access to nutrient-dense food (Kawarazuka et al., 2010).

Polyunsaturated fatty acids (PUFAs) and essential amino acids (EAA) are both abundant in fish. Numerous physiological processes depend on these nutrients (Maulu et al., n.d.). Even in rural areas, fish is a reasonably priced and easily accessible source of animal protein that greatly enhances food security. Given its abundant availability and rich nutritional profile, fish can be a powerful tool in combating malnutrition and food insecurity (Maulu et al., n.d.). A significant source of animal protein is fish. *Hyporhamphus dussumieri* had the lowest total protein content (10.51%), while *Thunnus albacares* (tuna) had the highest at 13.69% of dry weight. Each species had a different amount of carbohydrates; *Lutjanus gibbus* had the lowest amount (2.97%), and *Parupeneus bifasciatus* had the highest (6.12%) (Dhaneesh et al., 2012). Fish lipid content can vary greatly depending on species, diet, age, season, and place of origin. *Hyporhamphus dussumieri*, which was categorized as lean or semi-fatty in the Lakshadweep study, had the highest lipid content (6.97%). *Epinephelus tauvina* had the lowest ash content (1.05%), which indicates the presence of minerals, while *Lutjanus bohar* had the highest (1.65%) (Dhaneesh et al., 2012).

4.2 Availability and affordability in rural diets

Fish's accessibility and affordability in rural diets are essential for addressing protein deficiencies, especially in developing nations. A major contributor to food security, fish is a vital source of high-quality protein and essential nutrients. Access to these resources is hindered by issues such as habitat degradation, overfishing, and financial constraints. The diets of Bangladesh's rural poor heavily rely on small indigenous fish species (SIS) (Thilsted et al., 1997). These fish are an essential food source that makes a substantial contribution to daily dietary intake. The nutritional value of SIS is increased because, unlike larger fish, they are frequently eaten whole, including their organs and bones. Because they are widely accessible and reasonably priced, small fish species play a significant role in the diets of rural populations, particularly in developing nations where poverty is a major concern (Kawarazuka & Béné, 2011).

Role in addressing protein deficiency

Due to their high protein content and ability to enhance the nutritional value of plant-based diets, fish—especially small species—are highly effective in preventing protein deficiencies. Fish protein is about 5–15% more digestible than plant protein (Kawarazuka & Béné, 2011). Additionally, fish protein facilitates the absorption of plant-based proteins. Animal sources, such as fish, have a more balanced concentration of essential amino acids, with exceptionally high levels of lysine, in contrast to staple foods like rice or maize, which are limited by their low lysine content (Kawarazuka & Béné, 2011). In low-income food-deficient (LIFD) countries, the addition of fish to a plant-based diet increases total protein intake and improves the overall quality of the diet, as its lysine content compensates for the lack of lysine in plant-based components. Since fish accounts for a significant portion of total protein intake, it is crucial to develop strategies aimed at reducing micronutrient deficiencies in developing nations (Kawarazuka & Béné, 2011). Fish is essential for the quality of protein and other nutrients in many LIFD countries, even though plant-based foods make up the majority of protein intake (Kawarazuka & Béné, 2011).

5. Fisheries-Based Livelihood Systems

A variety of techniques for obtaining aquatic organisms are incorporated into livelihood systems based on fishing, which are primarily divided into two categories: capture fisheries and aquaculture (also known as culture fisheries). Globally, these systems are crucial for supplying food, generating revenue, and creating jobs.

5.1 Capture fisheries

The harvesting of wild aquatic animals from their natural habitats is known as capture fishing. Catching fish, shellfish, and other freshwater or marine organisms that have developed and procreated without direct human interference in their life cycle is the foundation of this traditional approach. The pursuit and capture of existing wild stocks define it (Ottolenghi et al., 2004). It depends on the ecosystems' inherent productivity, and if not managed sustainably, they are frequently vulnerable to environmental changes and stock depletion. This includes both contemporary industrial fishing and traditional methods (Lovatelli & Holthus, 2008).

Fish and shellfish are harvested from lakes, rivers, and oceans as part of capture fisheries. The majority of marine fish production in India originates from wild catches rather than aquaculture, as capture fisheries account for the largest share of the marine sector. The text does not provide a detailed breakdown for capture fisheries alone, despite the combined production from aquaculture and capture fisheries exceeding 7.8 million tonnes (Ayyappan, 2012).

5.2 Culture fisheries (aquaculture)

Aquaculture, or culture fisheries, is the more popular term for the farming of aquatic organisms in controlled or semi-controlled environments. The goal of this practice is to increase production above and beyond what is possible with natural systems. Aquaculture can encompass both intensive systems with high levels of management and large-scale systems with minimal intervention. In particular, the paper "Capture-based aquaculture: the fattening of eels, groupers, tunas, and yellowtails" describes and examines methods that are similar to those used in capture fisheries and aquaculture. Eels, groupers, tunas, and yellowtails are among the species that depend on wild-caught 'seed' (juveniles) that are subsequently raised in a controlled environment for their continued growth or fattening (Ottolenghi et al., 2004). With a notable 77% production share in the inland fisheries sector, this industry has played a significant role in the expansion of India's fisheries. Aquaculture played a significant role in the notable increase in total fish and shellfish production, rising from 0.75 million tonnes in 1950–1951 to 7.8 million tonnes in 2010–2011. India is second only to China in this area, producing over 4.8 million tonnes a year from its inland fisheries sector, which is primarily driven by aquaculture (Ayyappan, 2012).

5.3 Integrated farming systems

Fish-rice models and other integrated farming systems (IFSs) are essential for increasing the seasonal diversification of livelihoods in Indian fisheries. For smallholder farmers navigating uncertain economic times, IFS's integration of multiple agricultural components not only boosts productivity but also ensures a steady income throughout the year. This approach utilizes water and land resources throughout the year, resulting in a significant increase in farm income and productivity (Sinhababu & Das, 2007). In rainfed lowland ecologies, the rice-fish farming method is recognized as a feasible means of increasing farm income and productivity. By offering a variety of revenue streams and reliable food production throughout the seasons, its implementation can significantly enhance the standard of living for farmers in areas such as eastern India (Sinhababu & Das, 2007). Fish play a significant role in the rice ecosystem, an agroecosystem that complements rice by utilizing various ecological niches and cooperating with it. System components, ecological interactions, and overall sustainability have all suffered as a result of ecosystem changes, especially with regard to fish populations (Baruah & Borah, 2006).

5.4 Seasonal livelihood diversification

The primary activity during the rainy season is growing rice alongside aquatic plants. This system combines the cultivation of rice with freshwater prawns and carp. The land is used for other crops following the dry-season rice harvest. Farmers cultivate a diverse range of crops, including vegetables, oilseeds, pulses, and watermelons. A steady supply of produce is ensured by the year-round production of fruit and vegetable crops in the dyke areas surrounding the fields (Sinhababu & Das, 2007). Fish trapping is a large-scale, unregulated method of producing fish in Assam's seasonal floodplains, which span 2.6 million hectares and have historically been used for rice cultivation (Baruah & Borah, 2006). Due to modern farming technologies and developmental activities, fish populations in the rice ecosystem, which was once a major source of fish for rural farmers, have sharply declined, resulting in a chronic fish shortage and ecological degradation (Baruah & Borah, 2006).

6. Institutional and Policy Framework

State and federal fisheries departments play a critical role in determining the sustainability and governance of fisheries in different nations. These departments are responsible for implementing policies that address economic development, ecological balance, and the livelihoods of fishermen.

6.1 Role of central and state fisheries departments

In India, the management and development of the fisheries sector, which is essential for employment, economic growth, and food security, are largely the responsibility of the federal and state fisheries departments. These divisions are responsible for creating policies, enforcing regulations, and promoting sustainable fishing practices. To address issues such as overfishing and protect the livelihoods of millions of fishermen nationwide, their combined efforts are crucial (Joseph, 1987). Important insights were gained from a case study on Kerala's fishery credit delivery system, which should help with the creation of suitable policies. These regulations are designed to benefit all parties involved and promote the sector's economic growth (CMFRI, 2012). The central and state governments of India share responsibility for the management and development of fisheries, with each playing unique but complementary roles to guarantee resource conservation and sustainable growth. National policies, guidelines, and strategies for fisheries development are developed by the central government, principally through the Ministry of Fisheries, Animal Husbandry, and Dairy. It also helps different states and Union Territories coordinate their efforts (Joseph, 1987).

6.2 Key schemes before 2012 (e.g., RKVY, MPEDA, NFDB initiatives)

India's fisheries industry has seen several significant initiatives aimed at enhancing socioeconomic development, sustainability, and production. These programs have been crucial in improving living standards and ensuring food security.

6.2.1 Rashtriya Krishi Vikas Yojana (RKVY)

To ensure the comprehensive development of agriculture and related sectors, the RKVY scheme was launched in 2007. Since its inception, the program has undergone significant advancements and has been implemented during the eleventh and twelfth plan periods. The program encourages states to boost public spending on agriculture and related fields. It supported the development of fisheries and aquaculture by lending money to various projects. The plan placed a strong emphasis on infrastructure development and sustainable fishing methods.

With each state creating its own District and State Agriculture Plans, RKVY functions as a state plan scheme. A state must maintain or increase its state plan expenditure on agriculture in order to be eligible for RKVY funding. By encouraging decentralized planning, the program ensures that agricultural strategies consider local priorities, needs, and crops. States have discretion over how to use 70% of RKVY-RAFTAAR's yearly budget that is set aside for routine operations, such as value-added and infrastructure projects. By providing funding and mentorship to creative agricultural startups, the program encourages young people to pursue careers in agriculture (Agriwelfare, n.d).

6.3 Role of cooperatives and self-help groups

In India's fisheries industry, cooperatives and self-help groups (SHGs) play a crucial role in enhancing the socioeconomic conditions of fishing communities. These groups empower members via skill development and group efforts in addition to offering financial assistance (Beg & Mishra, 2011). In India, fishing communities have long struggled to manage their traditional sources of income, particularly in areas such as Madhya Pradesh's Tikamgarh and Chattarpur districts. They frequently lost access to ponds to contractors and landlords. These communities banded together by creating village co-ops in order to recover these resources and defend their rights (Beg & Mishra, 2011). These co-ops' and their federation's concerted efforts were crucial in promoting legislative changes. In 2008, their campaign was successful in getting the state government to change its fisheries policy. Following this revision, a new law was introduced with provisions aimed at improving livelihoods in areas affected by drought and safeguarding the rights of traditional fishing communities (Beg & Mishra, 2011).

Small-scale fishermen and aquaculture farmers frequently depend on cooperatives and self-help groups (SHGs) to provide them with access to vital resources like credit, high-quality inputs (feed, seeds), and contemporary fishing gear that would otherwise be out of their price range or unavailable on their own (Ayyappan & Diwan, 2007). By assisting members in collectively marketing their produce, these organizations reduce the exploitation of intermediaries and ensure higher prices for their catch. They can enhance the value of their products by facilitating direct sales to customers or processing facilities (Ayyappan & Diwan, 2007).

6.4 Market access and cold-chain infrastructure

In India's fishing industry, market accessibility and cold-chain infrastructure are crucial for reducing post-harvest losses and enhancing export potential. The effectiveness of the supply chain for perishable goods, such as fish, is hindered by the current infrastructure, which is insufficient and has a significant gap in cold storage and transportation facilities. Over the past ten years, India's cold chain capacity has more than doubled (Yahia, 2010). The expansion of the retail industry in tandem with the rise of the middle class, adherence to international quality and safety standards, and a greater reliance on cold chains to meet the growing trade and consumption of perishable foods are all factors contributing to this growth (Yahia, 2010). Most businesses in developing nations, including India, still find it extremely costly to build and own cold chain facilities.

Additionally, a few specialized firms rent out cold chain spaces and equipment, forcing companies to either build their own facilities or purchase them (Yahia, 2010). A lack of infrastructure severely constrains India's domestic fish marketing. This deficiency primarily restricts fish consumption to regions near landing centers. Due to inadequate infrastructure, consumers' access to high-quality food items is limited by low per capita income, despite being quality-conscious (Hassan et al., 2012). This implies that a market environment where high-quality products are not widely available or reasonably priced for a larger population is influenced by infrastructure problems (Hassan et al., 2012).

7. Challenges Faced by Rural Fisherfolk

The problems faced by India's rural fishermen are complex and intricately linked, particularly in relation to resource depletion and climate variability. Resource depletion, overfishing, climate variability, and disaster vulnerability are significant issues facing India's rural fishermen, which are often exacerbated by their socioeconomic circumstances and limited adaptive capacities (Sannadurgappa et al., 2011). The sustainability of marine ecosystems, as well as the livelihoods of fishing communities, is threatened by these issues. India's inland fisheries face numerous challenges, particularly in the context of climate change and its associated impacts, which have a direct impact on the vast rural population that relies on these resources for its livelihood (Das & Srivastava, n.d.). In India, a sizable portion of the rural population—roughly 700 million people—directly depend on climate-sensitive industries like fishing for their livelihoods and subsistence. They are therefore extremely susceptible to climatic fluctuations and possible calamities. A significant environmental issue that is negatively affecting many facets of fisheries and raising their susceptibility to climate-related disasters is climate change (Das & Srivastava, n.d.). Global fisheries frequently face resource depletion and overfishing, which are exacerbated by climate change. This climate change can alter fish habitats, migration patterns, and reproductive cycles,

thereby placing additional strain on surviving stocks. Although not specifically addressed in the excerpt, these issues are often associated with the sector's broader environmental challenges(Das & Srivastava, n.d.).

Overfishing, habitat loss, pollution, invasive species, water abstraction, and damming have already placed significant strain on India's fisheries production systems. These elements add to the sector's overall susceptibility to the effects of climate change(Sannadurgappa et al., 2011). In India's fisheries and related industries, there is a recognized need for human resources with the knowledge and expertise to develop standardized goods and services. Currently, the majority of the workforce's skill development is accomplished through on-the-job training offered by businesses and farms engaged in fisheries-related operations(Yasin, 2010). To equip people with employable skills, the Indian government has proposed the Modular Employable Skill (MES) development program, which aims to replace the current system of vocational education and training(Yasin, 2010).

Excessive fishing can decrease fish populations' capacity to "buffer" against underperforming year classes, making them more vulnerable to short-term natural climate variability. Fishery-induced stock structure impoverishment (smaller and smaller sizes, lower ages) makes fish stocks more vulnerable to climate change(Sannadurgappa et al., 2011).To equip people with marketable skills, the Indian government has proposed the Modular Employable Skill (MES) development program, which aims to replace the current system of vocational education and training. To supply competent human resources for inland, marine, and fish processing areas, the fisheries sector's MES program was created. Fish breeding, mussel culture, fish feed preparation, fish processing, and fish boat building are among the suggested modules for curriculum development (Yasin, 2010).

Predator-prey relationships are impacted by fishing, which has a major impact on the species composition and size structure of fish assemblages. Small fish species may benefit from the eradication of larger predatory fish due to the interaction with global warming and the general increase in body size with latitude. It is currently challenging to forecast how ecosystems will react to fishing pressure and climate change(Sannadurgappa et al., 2011). One major obstacle to the adoption of technology, especially for the impoverished, is credit constraints. The study examines this problem within the context of a small-scale fishery in South India, with a particular focus on the spread of boats made from plastic-reinforced fibre in a Tamil Nadu fishing village. This implies that for people to purchase new technologies that can enhance their quality of life, they must have access to financial resources, such as credit(Gine &Klonner, 2005).

The biggest danger to fish production in the future is fishing. Its effects are intricately linked to climate change and cannot be handled as distinct problems. Fish communities and marine ecosystems are impacted by fishing because it alters fish distribution, demography, and stock structure(Sannadurgappa et al., 2011).Due to the anticipated warming, the significance of fisheries to their economies and diets, and the limited ability of society to adapt, states such as Karnataka, Tamil Nadu, Andhra Pradesh, Kerala, and Maharashtra are particularly vulnerable to the effects of climate change on capture fisheries. Fish is a major source of protein in these vulnerable states, which are frequently among the poorest(Sannadurgappa et al., 2011).

The 1980s saw a swift, temperature-driven change in the North Sea ecosystem, underscoring the effects of hydro-climatic forcing. Because of the planet's commitment to continued warming, adaptation is crucial. Because ecosystems are dynamic and governed by interactions among species, the environment, and external factors such as climate, marine ecosystems worldwide are undergoing rapid changes (Sannadurgappa et al., 2011).

Most people agree that implementing new technology is essential to progress. The advantages of implementing new technologies, however, may not be shared equally, particularly if markets are not functioning correctly(Gine &Klonner, 2005). By combining macroeconomic research on the effects of globalization on inequality with microeconomic research on technology adoption, the study examines the dynamics of income inequality during the diffusion of technology. This suggests that credit limitations can exacerbate existing disparities by preventing some groups of people from accessing beneficial technologies(Gine &Klonner, 2005).Fish stocks are impacted by climate change both directly and indirectly. Physiology, behaviour, growth, development, reproduction, mortality, and distribution are all impacted by direct effects. The productivity, composition, and structure of the ecosystems that fish rely on for food and shelter are all changed by indirect effects (Sannadurgappa et al., 2011).

The distributions of fish and plankton are already rapidly shifting poleward due to rising temperatures. Some modifications may have a beneficial effect on fish production, but others decrease the ability to reproduce, leaving stocks susceptible to once-sustainable fishing levels. Particularly for freshwater and diadromous species, local extinctions are happening(Sannadurgappa et al., 2011).The fishing industries in India's central and northern states are expected to be the most economically affected by climate change. The ability of local economies to adjust through labour and capital mobility determines indirect economic impacts. Despite being crucial for fisheries, South Indian states are especially at risk. Largely populated West Coast states depend on upwelling fisheries, the landings of which are influenced by erratic fluctuations in atmospheric and oceanic climate. In certain states, fish account for nearly two-thirds of the daily animal protein intake, making them a crucial source of protein. There is already overfishing in many of these fisheries(Sannadurgappa et al., 2011).

8. Case Studies / Regional Examples

8.1 Inland Fisheries in Assam: A Case Study

Assam, located in northeastern India, has a subtropical climate that allows for the cultivation of freshwater fish in various aquatic environments. With a total area of 78,438 km², the state comprises approximately 30% of India's northeastern region. The Brahmaputra and Barak river systems distinguish it, with a large number of floodplain wetlands (Beels) and swamps (112,000 ha), and numerous tributaries that span 4,820 km. Assam struggles to produce enough fish to meet the demands of its expanding population, despite having abundant aquatic resources. At 6.55%, the state makes up a small portion of India's total inland fish production (Das, 2006). Aquaculture is viewed as a viable alternative to increase the supply of fish, as natural fish production is declining. For 95% of Assamese people, who view fish and rice as staple foods, fish is an essential source of protein. Assam currently produces approximately 159,000 tons of fish annually, compared to an estimated demand of 250,000 tons, which is expected to increase to 320,000 tons soon. Due to this shortfall, a substantial quantity of fish must be imported daily from other states (Das, 2006).

In 1998, the Assam Rural Infrastructure and Agriculture Service Project (ARIASP) launched a pilot project in three villages in the Amsoi region of Nagaon district. The project's objectives were to establish a farmer-based extension system and develop suitable technologies for the region. A total of 31 ponds from 29 households with small to medium-sized ponds were chosen. Many of these ponds were seasonal, and the majority of these households were below the poverty line. Through training programs covering fish culture, livestock farming, integrated farming, fish breeding, hatchery management, and microcredit, the project aimed to increase farmers' knowledge and proficiency. Farmers received training on how to cultivate fish in their ponds using locally accessible resources (Das, 2006).

8.2 Marine fisheries in Kerala

Kerala's marine fisheries, renowned for their high output and significant financial contributions, play a crucial role in India's overall fish production and economy. Kerala is India's leading producer of marine fish, accounting for about a quarter of the country's yearly total. An average of 5.75 lakh tonnes of marine fish are produced annually in the state. Kerala exports marine products, which bring in a significant amount of foreign exchange for the country each year—roughly Rs. 1100 crores. Kerala has led the way in implementing new and innovative technologies in fishing methods, resulting in a complex marine fishery structure. With large production volumes, substantial export revenue, and a proactive approach to technology and policy, Kerala's marine fisheries industry is a vital component of the Indian economy (Pillai et al., 2007).

9. Future Directions and Recommendations

Adopting sustainable fishing practices that ensure resource regeneration and ecological balance is essential, given the mounting strain on both inland and marine resources. The adoption of environmentally friendly aquaculture technologies, habitat preservation, and ethical fishing practices should all be promoted through policy. Long-term productivity and biodiversity preservation will be aided by the enforcement of fishing laws and the strengthening of community-based management systems. In the post-harvest handling, processing, and marketing of fish, women play a crucial yet often overlooked role. Enhancing women's involvement in every link in the fisheries value chain should be the goal of future initiatives. In addition to increasing household income, granting access to microcredit, training, and leadership positions will advance social inclusion and gender equality in fishing communities. Modernizing the fishing industry requires education and skill development. Priority should be given to training programs that emphasize value addition, entrepreneurship, fish health management, and sustainable aquaculture. Cooperation among local communities, government agencies, and research institutions can enhance technology transfer and knowledge exchange, thereby raising living standards and productivity.

10. Conclusion

In India, fishing is a vital component of rural livelihoods, playing a major role in economic growth, job creation, and food security. Thanks to government programs, scientific discoveries, and community involvement, the industry has evolved from a traditional occupation to a thriving commercial enterprise. Aquaculture and inland fisheries have become significant growth drivers, providing millions of people with opportunities to diversify their income sources and ensure nutritional sufficiency. The social cohesion of fishing communities has been strengthened by women's involvement in post-harvest handling and marketing; however, increased financial resources and empowerment remain crucial. Notwithstanding these successes, several issues persist, including resource overuse, climate change, inadequate market infrastructure, and technological deficiencies. Ensuring sustainability requires strengthening institutional frameworks, enhancing cold-chain infrastructure, and promoting environmentally friendly aquaculture practices. Fishermen's resilience and capacity can be further increased through cooperative movements, education, and training. To guarantee social and economic equity, future strategies should prioritize gender-inclusive policies, community-led management, and fair resource distribution. Productivity will be maximized and climate impacts will be lessened with the combination of innovative technology and sustainable practices. Essentially, fisheries are a source of income and a means of achieving inclusive rural development. India can establish its fisheries industry as a resilient model that promotes both ecological

integrity and socioeconomic well-being by fostering sustainability, empowering women, and investing in capacity building.

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