Article AR2126a

DOI: HTTPS://DOI.ORG/10.23910/1.2020.2126a

International Journal of Bio-resource and Stress Management

August 2020

Crossref

Print ISSN 0976-3988

Online ISSN 0976-4038

IJBSM 2020, 11(4):370-380

Review Article *Social Science*

Current Scenario of Fisheries and Aquaculture in India with Special Reference to Odisha: A Review on its Status, Issues and Prospects for Sustainable Development

Soibam Ngasotter[1*], Saumya Priyadarshini Panda[1], Upasana Mohanty[1], Sahina Akter[2], Susmita Mukherjee[3], David Waikhom[1], and Laishram Soniya Devi[2]

[1]College of Fisheries, Central Agricultural University (Imphal), Lembucherra, Tripura (799 210), India
[2]ICAR-Central Institute of Fisheries Education (CIFE), Mumbai (400 061), India
[3]Faculty of Fishery Sciences, West Bengal University of Animal and Fishery Sciences (WBUAFS), Kolkata (700 094), India

Corresponding Author

Soibam Ngasotter

e-mail: ngasotter@gmail.com

Citation: Ngasotter et al., 2020. Current Scenario of Fisheries and Aquaculture in India with Special Reference to Odisha: A Review on its Status, Issues and Prospects for Sustainable Development. International Journal of Bio-resource and Stress Management 2020, 11(4), 370-380. HTTPS://DOI.ORG/10.23910/1.2020.2126a.

Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The authors have declared that no conflict of interest exists.

Abstract

Fisheries is an important sector in India, providing employment to millions of people and contributes to the food security of the country. Presently, India ranks second in aquaculture and third in fisheries production, contributing 1.07% to the national GDP and 5.30% to the agriculture GDP. Odisha, an eastern Indian state on the coast of Bay of Bengal is one of the major fish producing maritime states and currently ranks 4th in total fish production after Andhra Pradesh, West Bengal and Gujarat. Odisha has an abundance of fisheries resources, both inland and marine, and is home to the largest brackish water lagoon (Chilika lake) in Asia and the second largest coastal lagoon in the world. The state has 0.683 million ha of freshwater resources, 0.418 million ha of brackish water resources and 480 Kms. of coastline and continental shelf area of 24,000 Km^2, which provides excellent scope for fisheries development. There has been a tremendous increase in fish production, from 0.386 million tonnes in 2010-11 to 0.758 million tonnes in 2018-19, with an export income generation around ₹ 31,000 million during 2017-18. Although the production has increased a lot in the last decade, there still seems to be an acute shortage in the supply of freshwater fish since the state continues to import freshwater fish from the neighbouring states. Understanding the various issues faced by farmers and improvising strategies to address them will contribute to augment production and productivity. This article highlights the present status of fisheries in Odisha, constraints and challenges faced by the farmers and fishers, and prospects and strategies for further improvement and development in the state.

Keywords: Chilika lake, fish production, fisheries, aquaculture, marine fisheries, Odisha fisheries

1. Introduction

Fisheries and aquaculture is one of the fastest-growing industries in the World (Tacon, 2020) and has been playing an important role in the economic development front on account of its contribution to food and nutritional security, national income, employment opportunities as well as generating livelihood options (Kumar and Shivani, 2014). It is the primary source of animal protein for billions of people Worldwide, where capture fishery and aquaculture serves the livelihoods of more than 10% of the global population (Anonymous, 2020b). Fisheries and

Article History

RECEIVED in 17th June 2020 RECEIVED in revised form 15th August 2020 ACCEPTED in final form 26th August 2020

aquaculture supplies not only dietary essentials for human consumption, but also provides excellent opportunities for employment and income generation, especially in the more economically backward rural areas (Jayasankar, 2018). Odisha (formerly Orissa) is an eastern Indian state on the coast of Bay of Bengal and is one of the important maritime states of India having excellent scope for fisheries development (Kumari and Patra, 2014). It has a coastline of 485 km (301 mi) along the Bay of Bengal (Coastal security, 2015). It is the 8th largest state by area and the 11th largest state by population. Odisha is located between the latitudes 17°49'N and 22°54'N and between longitudes 81°29'E and 87°29'E (Kumar and Shivani, 2014). The state covers a total area of 155,707 km^2, which is 4.87% of the total area of India (Anonymous, 2020c). Coastal plains are located in the eastern part of the state. It extends from the Subarnarekha river in the north to the Rushikulya river in the south and the lake Chilika is also a part of the coastal plains. The coastal plains are rich in fertile silt, which are deposited by the six major rivers flowing into the Bay of Bengal. These are Subarnarekha, Budhabalanga, Baitarani, Brahmani, Mahanadi and Rushikulya (Anonymous, 2015). The state is located in a tropical climatic zone characterized by high temperature and high humidity. It experiences a medium to high rainfall and short and mild winter (Mishra et al., 2016). The total surface water resource is estimated to be 85.59 billion m^3. The state depends mostly upon monsoon for its water resources. A higher percentage (78%) of the total annual rainfall occurs during the period from June to September and the balance 22% in the remaining period from October to May (Anonymous, 2020c). The state receives long-term average annual rainfall, which is of the order of 1452 mm, which corresponds to yearly precipitation of about 230.76 billion cubic meters (BCM) of water (State Water Policy, 2007).

India currently ranks 3rd in fisheries and 2nd in aquaculture production in the world, contributing 6.3% to the total global fish production (Anonymous, 2020a). Odisha is one of the major fish producing states and ranks 4th in total fish production in India after Andhra Pradesh, West Bengal and Gujarat. The total fish production of Odisha during 2017-18 is estimated to be 0.685 million tonnes (Handbook, 2019) and the export income generation is around ₹ 31,000 million during 2017-18 (Anonymous, 2018). Marine fish landing in 2018 was 0.0891 million tonnes, approximately 30% less than the previous year, which was 0.126 million tonnes in 2017 (Anonymous, 2019e). The fisheries development activities were first carried out by the Industries Department and were subsequently taken up by the Fisheries Department (Anonymous, 2012; Anonymous, 2013). Since then, the fisheries sector has developed a lot in the state and is currently one of the major fish producing states in the country. Various central research institutes along with the aid from the government of Odisha have been taking up activities to strengthen the aquaculture system in the state. ICAR-Central Inland Fisheries Research Institute (CIFRI) has installed 110 Galvanized iron (GI) cages and a circular cage in reservoirs of Odisha for the expansion of the cage polyculture system (Anonymous, 2019d). Being a maritime state, 0.114 million fishermen families reside near the coast whose primary livelihood is fishing. And to provide proper technology to the field, various training programs are organized by ICAR-CIFA for improving the livelihood of tribal families and provided knowledge on scientific fish farming (Anonymous, 2019c). The annual per capita fish consumption of the state is reported to be 15.38 kg during the 2018-19 (Anonymous, 2019a). Due to these high proportions of fish consumers, the state thus results in high demand for fish and fisheries products. Hence, it is necessary to enhance fish production by utilizing the rich resources that are present in the state. Dissemination of pen culture technology as a means of seed raising and fish production with an emphasis on species diversification for sustainability, conservation and profitability can be an excellent strategy for enhancing fisheries in the state (Sarkar et al., 2020b). This article highlights the present status of fisheries in Odisha, constraints and challenges faced by the farmers and fishers linked with the fisheries sector, and future prospects and strategies for further improvement and development in the state.

2. Fisheries Resources

India is blessed with an abundance of fisheries resources, both inland and marine. The country has a long coastline of 8,118 km and equally large areas under estuaries, backwaters, lagoons, etc., conducive for developing capture as well as culture fisheries. With the declaration of the Exclusive Economic Zone (EEZ) in 1977, an area of 2.02 million sq km, (comprising of 0.86 million sq. km on the west coast, 0.56 million sq. km on the east coast and 0.60 sq. km around the Andaman & Nicobar Islands) has come under our jurisdiction with the absolute right of exploring, exploiting and natural utilization of living resources falling within it (Handbook, 2014). The inland fishery resources include 1.96 lakh kms stretch of rivers and canals, 3.15 million ha reservoirs, 2.44 million ha ponds and tanks, 0.798 million ha of beels, derelict water bodies, 1.24 million hectare brackish water areas, and 0.29 million ha of estuaries (Datta, 2011; Anonymous, 2020a). India also has a vast floodplain wetland resource of 0.5 million ha that has massive potential for culture-based fisheries (Sarkar et al., 2020b).

Odisha, being a maritime state, has both inland and marine fisheries resources. The state has 0.683 million ha. of freshwater resources, 0.418 million ha of brackish water resources and 480 Kms. of coastline and continental shelf area of 24,000 Km^2 (Anonymous, 2019a) (Table 1). Along with this, Odisha has two ramsar sites, Bhitarkanika mangroves and Chilika lake with wetland area of 650 Km^2 and 1165 Km^2, respectively (Anonymous, 2019b). The state is drained by three major rivers, the Mahanadi, Brahmani and Baitarani along with several small rivers. Odisha also has 0.25 million ha of reservoir resources *viz*., three large reservoirs, six medium

Table 1: Freshwater, brackish water and marine resources available for fisheries in Odisha (Source: Anonymous, 2019a)

Freshwater resources	
Resources	Total area (in million Ha.)
Tanks/Ponds	0.133
Reservoirs	0.20
Lakes/swamps/bheels	0.180
Rivers/Canals	0.171
Total	0.683
Brackishwater resources	
Resources	Total area (in million Ha.)
Area suitable for brackish water tanks	0.033
Backwater	0.008
Chilika lake	0.079
Estuaries	0.298
Total	0.418
Marine resources	
Coastline	480 Kms.
Continental shelf area	24,000 Sq. Km. (approx)
District-wise coastal length (in Kms.)	
Balasore	80
Bhadrak	50
Kendrapada	68
Jagatsinghpur	67
Puri	155
Ganjam	60
Total coastal length	480

Table 2: Other fisheries resources for promoting and boosting fisheries in Odisha (Source: Anonymous, 2019a)

Freshwater fish seed hatchery	No.	Fry capacity (in millions)
Government (Research & Development)	05	60.00
Government hatchery	18	128.00
Government rearing farm	25	
OPDC	05	155.00
Private	86	700.00
Freshwater prawn seed hatchery	No.	Fry capacity (in millions)
Government	03	80
Private	07	125
Brackishwater shrimp seed hatchery	No.	Capacity (in millions)
Government	02	75.00
Private	12	292.50
Ice plant and cold storage	No.	Capacity (in MT)
Ice plant	57	613.50
Cold storage	12	67.00
Marine fish landing centre	No.	
1. Harbour	04	
2. Jetty	25	
3. Other landing centre	44	
Total	73	
4. Fish drying platform	10	3269
Crafts (marine)	No.	
A. Mechanized	1741	
B. Motorized	10085	
C. Country crafts (non-motorized)	9263	
Total	21089	

reservoirs and 1,433 small reservoirs (Sarkar et al., 2020a). With the availability of an abundance of aquatic resources, Odisha is having an excellent scope for fisheries development. It also offers enormous scope in generating employment and promoting trade and many other associated commercial activities. The food security and livelihood support from fisheries for the rural poor are one of the major benefits. Moreover, Odisha has additional resources for promoting and boosting fisheries such as fish and shrimp seed hatcheries, ice plants, cold storage, a large number of mechanized and motorized crafts, etc. (Table 2). In 2016, WorldFish partnered with the Fisheries and Animal Resources Development (F&ARD) Department of the Government of Odisha to increase the productivity of aquaculture through improvements in seed, technology and farming systems (WorldFish, 2020). Also, the partnership aimed at improving natural resource planning and management of sustainable aquaculture and fisheries in Odisha. The carp intensification program funded by WorldFish has helped fishers in Odisha to double production from 2.5 to 5 metric tons per hectare per year (WorldFish, 2020).

3. Fish Diversity

India has a rich freshwater fish diversity comprising of 1027 species in total (Gopi et al., 2017). Odisha water harbours about 186 species of fish, which represents approximately 18.11% of the total freshwater fish diversity in India (Mogalekar and Canciyal, 2018). These 186 species of freshwater fishes belong to 11 orders, 33 families and 96 genera from various freshwater bodies of Odisha. Of these, 105 species primarily belong to freshwater and the remaining

81 species are diadromous. The order Cypriniformes is the most dominant represented by three families, 37 genera and 95 species followed by Siluriformes (10 families, 25 genera and 41 species), and Perciformes (eight families, 15 genera and 25 species) (Mogalekar and Canciyal, 2018). Cyprinidae family has the most diverse fishes represented by 84 species and 33 genera followed by Bagridae (12 species and five genera), Sisoridae (8 species and five genera), and Ailiidae (7 species and five genera) (Mogalekar and Canciyal, 2018). The dominance of cyprinid species in natural water bodies is common all over South Asia and reported in several studies (Galib et al., 2009; Mohsin et al., 2009; Flowra et al., 2009). According to Mogalekar and Canciyal (2018), among the 186 fish species found in Odisha, 120 species are worth for capture (food) fishery, followed by ornamental fishery (101 spp.), aquaculture (37 spp.) and sport (25 spp). The abundance of such a diversified resource with many species being eligible to be a candidate species for aquaculture, there is an immediate need of attention for the collection of fishes from wild to develop the broodstock for captive breeding, seed production, experimental aquaculture and commercial culture of larger and fast-growing endemic fishes and colourful fishes for food and aquarium purposes, which could prove to be a potential source of income in the rural areas of Odisha.

4. Fish Species Cultured

In India, carp culture forms the backbone to freshwater aquaculture mainly dominated by Indian major carps, namely catla (*Catla catla*), rohu (*Labeo rohita*), and mrigal (*Cirrhinus mrigala*) which contribute a majority of the total Indian aquaculture production (Anonymous, 2020b). With the introduction of carp polyculture system in the 1970s, three exotic carps, namely, silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idellus*) and common carp (*Cyprinus carpio*) now form the second important group. Even though the country also possesses several other minor carp species which show high regional demand, including, *Labeo calbasu, L. fimbriatus, L. gonius, L. bata, L. ariza, Puntius sarana, Hypselobarbus pulchellus, H. kolus* and *Amblypharyngodon mola*, as well as several others, commercial farming of these species has yet to take off (Ayyappan and Jena, 2003). Among the catfishes, magur (*Clarias batrachus*) and singhi (*Heteropneustes fossilis*) are of prime importance (Anonymous, 2020b). In recent years, tremendous progress has been made in the culture of fishes like *Pangasius pangasius, Pangasius sutchi, Oreochromis niloticus, Ompok pabda,* etc. The other finfish species of importance include climbing perch (*Anabas testudineus*), murrels (*Channa striata* and *C. marulius*), etc. Giant river prawn (*Macrobrachium rosenbergii*), is the most important freshwater species followed by the monsoon river prawn, *M. malcolmsonii* (Anonymous, 2020b). Giant tiger prawn (*Penaeus monodon*) and whiteleg shrimp (*Litopenaeus vannamei*) from the brackish water aquaculture sector, contribute to the bulk of the shrimp production. As of marine resources, the dominant farmed species are the green mussel (*Perna viridis*), Indian brown mussel (*Perna indica*), Indian backwater oyster (*Crassostrea madrasensis*), Japanese pearl oyster (*Pinctada fucata*) and seaweed species like *Gracilaria edulis* (Anonymous, 2020b).

Fish species cultured in Odisha includes Indian major carps viz. catla, rohu and mrigal and exotic carps like common carp, silver carp and grass carp. Although the majority of fish farmers are culturing carps, the current production volume is only 50,000 tonnes of carp species, compelling the state to import carps from neighbouring states to fulfill the local demand (FishSite, 2020). Other fish species currently being cultured in small scale includes *Clarias batracus, Channa striatus, Puntius sarana, Pangasius pangasius, Labeo fimbriatus,* etc. The state is presently promoting the use of circular cages to intensify and increase carp production (FishSite, 2020). Other high valued fish species are being explored as a new candidate for culture. Mud crabs *Scylla serrata* and *Scylla tranquebarica* are being cultured in some of the existing brackishwater ponds with suitable modification at a very small scale. Asian seabass (*Lates calcarifer*), mullet (*Mugil cephalus*), pearl spot (*Etroplus suratensis*), and milkfish (*Chanos chanos*) are also being cultured in departmental fish farms at a very limited scale, as presently there is no hatchery produced seed of these species is available.

5. Fish Production

Fisheries and aquaculture is an important sector of food production in India, providing nutritional security, livelihood and employment to millions of people. India currently ranks 3rd in fisheries and 2nd in aquaculture production in the world, contributing 6.3% to the total global fish production. The total fish production of India during 2017-18 is estimated to be 12.60 million metric tonnes, of which nearly 65% is from the inland sector, and about 50% of the total production is from culture fisheries (Anonymous, 2020a). The marine landing from the coast of Odisha during 2018-2019 is estimated at 0.0891 million tonnes (Anonymous, 2019e). Fish is the chief source of protein for human nutrition and also a foreign exchange earner, the fisheries sector has an essential role in the socio-economic development of the country especially as a source of livelihood for a large section of the economically backward population of the country (Kumar and Shivani, 2014).

Odisha is one of the major fish producing state and ranks 4th in total fish production in India after Andhra Pradesh, West Bengal and Gujarat. The total fish production of Odisha during 2018-19 is estimated to be 0.758 million tonnes (Handbook, 2019). The trends of inland and marine fish production in Odisha may be analyzed from 2010-11 up to 2018-19, covering a long eight years period (Figure 1). The total fish production from both inland and marine was 0.386 million tonnes in 2010-11, and this was raised to 0.758 million tonnes in

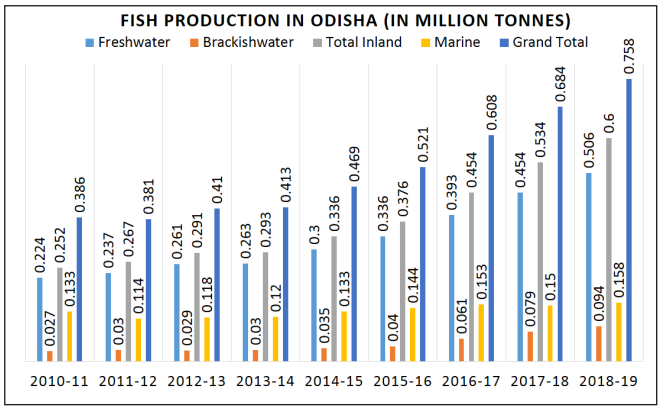

Figure 1: Fish production of Odisha (from 2010-11 to 2018-19) (Source: Anonymous, 2019a)

2018-19 (Figure 1). Although the total inland production has increased significantly from 0.252 million tonnes in 2010-11 to 0.6 million tonnes in 2018-19, the production from the marine sector remains almost constant over the past eight years, with the production being 0.133 million tonnes in 2010-11 to 0.158 million tonnes in 2018-19 (Figure 1). This may be primarily due to the depletion of fishery resources in the marine sector and the speedy expansion of culture fishery in the inland sector. The growth of production differences is likely to be further widened in favour of inland fisheries in the coming years. The production data and figures of both inland and marine in Odisha from 2010-11 to 2018-19 are as shown in figure 1.

6. Production of Spawn and Fry (Fish Seeds)

Production of good quality fish seeds is an important asset for increasing fish production in any country. India has been able to stand second in fish production next to China because of the successful implementation of 'induced fish breeding,' which supplies quality fish seeds to the farmers for culture across the country. India has established over 1,500 hatcheries in the country, producing over 32 billion carp fry (Marx et al., 2020). In Odisha, the government is giving much attention to the development and supply of quality fish seeds to the fish farmers to achieve the target of doubling the fish supply in the state. During the year 2018-19, 3887.63 million spawn and 896.242 million fry have been produced in Odisha (Figures 2 and 3) (Anonymous, 2019a). The state Fisheries Department has 28 breeding farms and 25 rearing farms besides 86 fish seeds farms in the private sector, which contributes in supplying quality seeds to the farmers. Tanks developed under Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) and captive nurseries developed at reservoir sites are also used to produce fish seeds to address the requirement of the state. Under the central assisted scheme "Blue Revolution: Integrated Development and Management of Fisheries," twelve hatcheries have been established in the last two years with a production capacity of 10 million fry each, which is meant for integrated development of fisheries, including post-harvest operations and other infrastructure (Anonymous, 2019a). Sector-wise spawn and fry production in Odisha is given in Figure 2 and Figure 3, respectively.

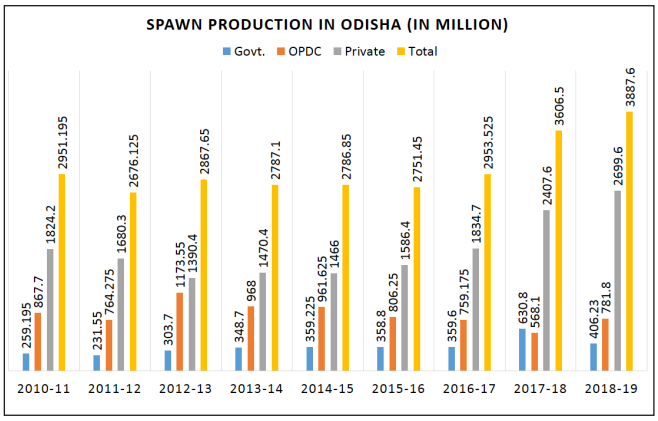

Figure 2: Spawn production in Odisha in millions (from 2010-11 to 2018-19) (Source: Anonymous, 2019a)

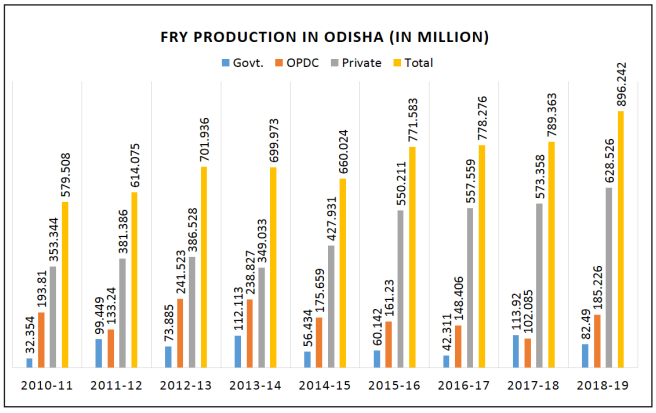

Figure 3: Fry production in Odisha in millions (from 2010-11 to 2018-19) (Source: Anonymous, 2019a)

7. Fish Consumption

Fish, being an excellent source of protein and many other essential fatty acids and micronutrients, plays a particular role in human nutrition by providing a valuable and nutritious contribution to a diversified and healthy diet. With the ongoing changes in dietary trends, which continue to increase towards a greater variety in food choice along with improved health, nutrition, and diet concerns. The overall demand of fish for consumption is expected to be increased, with more and more people shifting their food habits towards protein-rich diets. In India, 56% of the Indian population are fish eaters, and the per capita availability of fish is 9.85 Kg (Saha and Paul, 2020).

In Odisha, with the increase in fish production, fish consumption has also increased in the state over the last ten years. Per capita fish consumption grew significantly from 10.86 kg in 2009-10 to 15.38 kg in 2018-19. The lowest per capita fish consumption was 9.13 kg in 2012-13 and the highest being 15.38 in 2018-19 (Figure 4). The increase in

consumption has been driven not only by the increase in production but also by a combination of many factors such as technological developments in fish processing, cold chain, shipping and distribution; rising incomes of people in the state, which strongly correlate with increased demand for fish and fishery products; reduction in loss and waste; and increased awareness of the health benefits of fish among consumers (Anonymous, 2020b).

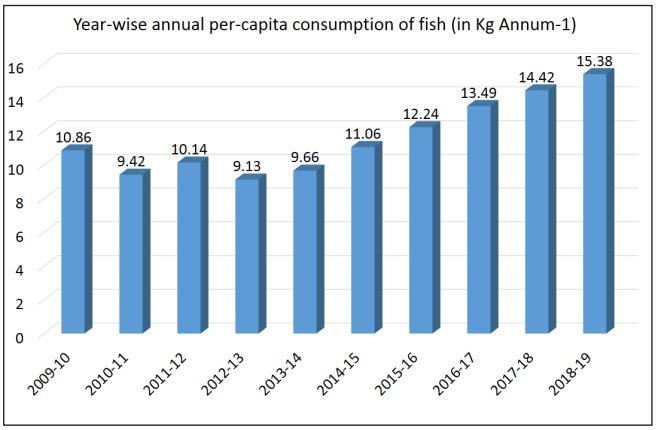

Figure 4: Year-wise annual per-capita consumption of fish in Odisha (In kg annum^{-1}) (Source: Anonymous, 2019a)

8. Trade of Fish

Fish has always been widely popular and sought after food commodity not only in Odisha but also all over the country and abroad. Delicious dishes of fish have always become customary for guest entertainment, social functions and festivals. The volume of fish produced in Odisha from marine, freshwater and brackish water sources has been of the order of 0.75 million tonnes, which needs trading to meet not only the consumption requirements of the people of Odisha but also the people of the states and nations.

8.1. Export of fish and fish products

India is one of the major exporters with more than 50 different types of fish and shellfish products being exported to 75 countries around the world. Fish and fish products have presently emerged as the largest group in agricultural exports from India, with 1.377 million tonnes in terms of quantity and ₹ 451.06 billion in value. This accounts for around 10% of the total exports and nearly 20% of the agricultural exports, and contribute to about 1.07% of the national GDP and 5.30% to the agriculture GDP (Anonymous, 2020a).

Quality fish and shrimp from marine and inland sources of Odisha are exported to foreign countries. Exports of aquatic products have become one of the most lucrative sources of foreign exchange earnings. The export of fish and fish products from Odisha to foreign countries has increased significantly over the last decade which is evident due to the increase in fish production in the state. The export figure of aquatic products of both fish and fish products was 14,588 tonnes, with foreign exchange earning of ₹ 4210.6 Million during 2009-10. However, the figure reached 53,344 tonnes with a foreign exchange earning of ₹ 31,000 Million (Figure 5). The majority of items exported are frozen shrimp and frozen fish. Other items, such as frozen cuttlefish, squids, etc. are also exported (Anonymous, 2018).

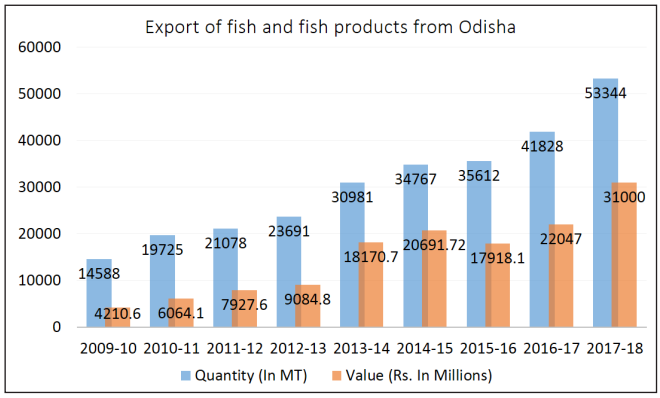

Figure 5: Export of fish and fishery products from Odisha to foreign countries (Source: Anonymous, 2018)

8.2. Import of freshwater fish from neighbouring states

Odisha also imports quite a substantial amount of freshwater fish from the neighbouring states particularly from Andhra Pradesh to meet the demand of the people in the state. The state imported 0.092 million tonnes of freshwater fish in 2009-10 which reduced to 0.049 million tonnes in 2018-19, representing a decrease in dependency from the neighbouring states to meet the local demand of freshwater fish (Figure 6). This is mostly due to a significant increase in fish production over the last decade. However, it seems that there is still an acute shortage in the supply of freshwater fish inside the state since the import of fish has not stopped completely. Fish not being a popular diet with the people in Andhra Pradesh finds a good market in Odisha.

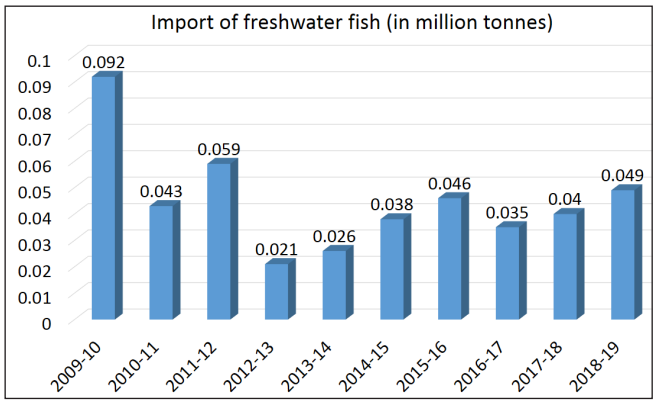

Figure 6: Import of freshwater fish from neighboring states (Quantity in million tonnes) (Source: Anonymous, 2019a)

9. Odisha Fisheries Policy, 2015

To double the inland fish production and increase the present export value to ₹ 200,000 million, the Government

of Odisha came up with 'Odisha Fisheries Policy, 2015' during September 2015. The Fisheries Department of Odisha has taken up the horizontal expansion as well as the vertical expansion of culture areas to reach average productivity to the level of 5.00 tonnes ha^{-1}. The Policy aims to be a pioneer in aquaculture development and fisheries extension for ensuring food security, livelihood, the welfare of fishers, and employment generation in the state. The Policy intents to address sustainable utilization of fisheries resources, livelihood security of fisher community, protection/ promotion of nutritional security, gaps in the legal and regulatory framework and their enforcement, breaches in the administrative structure and processes, technology and extension support, financing mechanisms including subsidies, etc. as well as social and environmental implications (Odisha Fisheries Policy, 2015).

10. Ongoing Government Schemes for Fisheries Development

The Government of India has launched central and state sponsored schemes for the development of fisheries in the state. The "Blue Revolution" or the "Neel Kranti Mission" was launched in the year 2016 by the Hon'ble Prime Minister of India with a vision to achieve economic prosperity of the country and the fishers and fish farmers as well as contribute towards food and nutritional security through full potential utilization of water resources for fisheries development in a sustainable manner, keeping in view the bio-security and environmental concerns (Blue Revolution, 2019). It focuses mainly on increasing fisheries production and productivity from aquaculture and fisheries resources, both inland and marine. The key goal of the scheme would be to increase the share of Indian fisheries in the export sector significantly. It will ensure doubling the income of the fishers and fish farmers with inclusive participation of the socio-economically weaker sections and ensure sustainability with environment and bio-security. The scheme was restructured by the Ministry of Agriculture and Farmers Welfare, Department of Animal Husbandry, Dairying & Fisheries by merging all the ongoing central assisted schemes under an umbrella of Blue Revolution. The restructured scheme provides focused development and management of fisheries, covering inland fisheries, aquaculture, and marine fisheries, including deep sea fishing, mariculture, and all activities undertaken by the National Fisheries Development Board (NFDB). The restructured scheme on "Blue Revolution: Integrated Development and Management of Fisheries" has been approved at a total central outlay of Rs. 3000 crore for implementation during five years (2015-16 to 2019-20) to develop and boost fisheries and fisheries activities (Blue Revolution, 2019).

In Odisha, Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) provide financial support of ₹ 1.625 to 1.995 lakh to the beneficiaries for excavation of 0.50 acre of multipurpose ponds which provide 100 days employment to families with utilizing farm pond for multipurpose uses like water conservation, protective irrigation, horticulture plantation and Pisciculture, etc. The ponds are constructed in the land of small and marginal farmers to enhance their livelihood (Anonymous, 2019a). Along with this, other ongoing schemes and programs in the state are MPY- Matsya Pokhari Yojana, MUY- Matsyjibi Unayana Yojana, RIDF- Rural Infrastructure Development Fund, Development of Inland Fisheries under Fisheries Policy, Popularization of Fisheries Machineries/Equipment, Organization of Skill Upgradation Training, Livelihood Support to Marine Fisherman during Fishing Ban Period, Reactivation of Fisheries Cooperative Societies and RKVY- Rashtriya Krishi Vikas Yojana (Anonymous, 2019a).

11. Issues and Challenges Faced by the Fisheries Sector in Odisha

The important issues that are currently faced by the fisheries sector in Odisha inter-alia include (Odisha Fisheries Policy, 2015; Jayashankar et al., 2014; Das et al., 2020):

i. Resource depletion aggravated by the use of destructive fishing gears and methods

ii. Inadequate information on the fisheries resources and the state of the aquatic environment to guide management decisions

iii. Inappropriate regulatory framework and inappropriate mechanisms for controlling access to fisheries resources

iv. Inadequate monitoring, extension and enforcement mechanisms

v. Insufficient mobilization and involvement of the communities in the development and management of fisheries resources

vi. Inadequacy of extension services critically hindering capture fisheries and aquaculture development;

vii. Inadequate fisheries infrastructure

viii. A difficulty in imposing any limitation or stringent action on over-fishing, as fishing is a livelihood option for the majority of poor people;

ix. Low levels of literacy and relatively high levels of debt

x. Siltation of the fishery harbors and fish landing centres because of the natural littoral drift, and human pressures making most of them non-operational

xi. Lack of modern fishing facilities and equipment in the majority of small fishing boats

xii. Clandestine import and introduction of disease-infected fish/shrimp seed in culture systems

xiii. Introduction of exotic/alien fish species in aquaculture systems

xiv. Natural calamities such as unprecedented rain, cyclones and floods, leading to the destruction of coastal structures, fish/aquaculture ponds and systems

xv. Climate change and poor management policies to mitigate climate change for sustainable fishery in the future.

12. Constraints and Issues Faced by the Farmers and Fishers in Odisha

12.1. Technical constraints

Although technology has developed a lot, it hasn't reached most of the farmers yet. So lack of technical knowledge like what are the best fish culture methods, which species of fish/shellfish should be cultured, lack of input knowledge (seed, feed and fertilizers), inconsistent supply of fish, lack of natural feed, disease outbreaks, lack of quality seeds, etc., are some of the technical constraints faced by the farmers (Rahaman et al., 2013; Elfitasari and Albert, 2017; Srinivas et al., 2019). Since the majority of the rural population constitute the farming group, they are a little reluctant to accept modern technology. So informal education, group discussions, proper guidance along with field demonstration technology can be effective to cast away this shadow of ignorance. Intermittent electricity and power supply are also one of the major limitations. A study in the Paribasudeipur village of Khurda district of Odisha revealed that high cost of feed, non-availability of quality seeds, and biological hazards such as predatory fishes in the pond environment to be the main technical problems faced by the farmers (Jayashankar et al., 2014).

12.2. Financial constraints

At the national level, many funding agencies are there which provides financial support like subsidies, loans, etc. to the farmers. In Odisha, there are many funding agencies. Still, lack of awareness and knowledge about it among the fish farmers, and lack of government support both technically and financially constitute a significant constraint (Rahaman et al., 2013). Even though the government has been paying proper attention towards fisheries, still some ground-level clarity in the system is necessary to disburse all the financial aid to the farmer's accounts directly. Jayashankar et al. (2014) revealed that very less amount of credit given to farmers for aquaculture activities to be one of the financial constraints faced by the farmers and suggested micro-financing organizations to extend financial assistance to the farmers.

12.3. Social constraints

Most of the fish farms are located in village areas and the markets are located far away from these villages. There exist a lot of transportation problems due to poor infrastructure and road connectivity. Poor extension services, lack of awareness, competition and encouragement; low levels of literacy and relatively high levels of debt; poisoning and poaching, theft and pilferages, poor governing policies, administration and legal policies are some of the social constraints (Rahaman et al., 2013; Kumar and Shivani, 2014; Srinivas et al., 2019). Multi-ownership of ponds and tanks marks a hindrance in the proper fish production from it (Jayashankar et al., 2014). Another hurdle is third party rights for Gram Panchayat tanks. Legal provisions should be made to transfer the multi-ownership of waterbodies to interested parties. It is recommended that the Panchayat tanks be leased out to fish farmers for the development of aquaculture and thereby to improve the economically weaker section of the society (Jayashankar et al., 2014).

12.4. Infrastructural constraints

For the dissipation of scientific knowledge from lab to land, a proper chain of system is necessary to link the scientific rooms to the ground level. Not enough field level scientific extension centres are available to the fisherman, which lags their knowledge in the world level fish farming system. The fisheries extension service requires to be strengthened by way of additional workforce suitably trained in scientific fish culture technology (Kumaran et al., 2012). The absence of an organized market and lack of refrigeration/preservation facilities at the village level also adds up to some of the infrastructural constraints faced by the farmers (Rahaman et al., 2013; Jayashankar et al., 2014).

12.5. Environmental problems and other issues

In Odisha, fisheries provide nutritional security, besides livelihood support and gainful employment to many people, it may be in the form of food, or it may be in the form of income generation and other social benefits, such as reduced vulnerability to poverty. Odisha is prone to natural calamities such as unprecedented rain, cyclones and floods (Das, 2016; Arora and Birwal, 2017), leading to the destruction of coastal structures, fish/aquaculture ponds and systems. Therefore, fish farmers are among those who are severely affected due to heavy rain and floods across the state, from the loss of fish stocks to the destruction of cages, farmers are ruing a repeat of losses. A study conducted by Das et al. (2020) on the impact of climate change on marine fisheries production in the states of West Bengal and Odisha concluded that climate change had an adverse effect on the marine fisheries resulting in a reduced catch of fishes which ultimately affected the low-income coastal populations of both the state. Other issues are urbanization and other anthropogenic activities, inbreeding depression, pollution and habitat loss, over-exploitation, uncheck entry of exotic species and an invasion threatening the local species. Indiscriminate fishing methods (fish poisons, dynamites, electrocution, etc.) are also playing a significant role in this (Acharjee and Barat, 2010).

13. Prospects and Strategies for Further Improvement and Development

The state Odisha has a lot of potential resources for fisheries, but they are still underutilized. If the resources can be utilized at its full capacity, the state can make more profit from the fisheries sector. The extension services in the state are not proper due to which technology doesn't reach most of the fish farmers. If it can reach them, they will adopt the new and advanced technologies, so that the production can be increased (Kumaran et al., 2012). Vertical expansion, and species and system diversification can also be adopted by young and advanced farmers to double up their production

(Cai et al., 2016; Metian et al., 2020). Breeding and culture technologies of diversified groups of freshwater species which have already been standardized like Indian major carps (IMCs), minor carps, barbs, catfish, pabda, freshwater prawn (genetically improved), climbing perch and murrels can be taken up to increase production by folds. Strategies like intercropping minor carps in conventional major carp culture (Das et al., 2019), monoculture of catfish and prawns, or their polyculture with major carps and mono sex tilapia culture can be effective as well (Ibrahim and Naggar, 2010). Adoption of multiple stocking and multiple harvesting, implementation of wastewater aquaculture system (Chatla et al., 2020), utilization of shallow/rain-fed ponds for producing stunted fingerlings, adoption of integrated, intensive and semi-intensive farming systems can be applied for increasing fish production and productivity (Katiha et al., 2005). Most of the fish farms are still being operated with traditional fish farming techniques. Therefore, more fish farms must be brought under scientific farming. There are lots of schemes like Rashtriya Krishi Vikas Yojana (RKVY) for giving financial support to the fish farmers but they are not aware of it. Making the fish farmers aware of these schemes can make fish culture become full-fledged entrepreneurship. Integrated farming like the culture of fish with paddy, piggery, poultry, horticulture, apiculture, etc. should be encouraged to enhance the production. Sewage fed pond culture can be established by which we can reuse the wastewater and also produce more from fewer resources.

14. Conclusion

Odisha has established itself as a major fish producing state in the country. However, more emphasis is required to reach its full potential. To further increase fish production, the various underutilized water bodies need to be explored and utilized sustainably. Understanding the socio-economic problems of the farmers, promotion and adoption of a robust and modern aquaculture system, upgraded infrastructure facilities and improved management policies are required for sustainable development of aquaculture in the state.

15. References

Acharjee, M.L., Barat, S., 2010. Impact of fishing methods on conservation of ichthyofauna of river Relli in Darjeeling Himalaya of West Bengal. Journal of Environmental Biology 31(4), 431−434.

Anonymous, 2012. Annual Activities Report 2011-12. Fisheries & Animal Resources Development Department (F&ARD), Government of Odisha, Odisha, India.

Anonymous, 2013. Government of Odisha. Available from www.odisha.gov.in/fisheries&ard/index.htm. Accessed in May 2020.

Anonymous, 2015. Geography of Odisha. Know India, Government of India. Available from https://web.archive.org/web/20150204220248/http://www.archive.india.gov.in/knowindia/state_uts.php?id=81. Accessed in May 2020.

Anonymous, 2018. The Marine Products Exports Development Authority (MPEDA). Available from https://mpeda.gov.in/MPEDA/marine_products_exports.php. Accessed in May 2020.

Anonymous, 2019a. Annual Activities Report 2018-19. Fisheries & Animal Resources Development Department (F&ARD), Government of Odisha, Odisha, India, 66.

Anonymous, 2019b. Annual Report 2018-19. Ministry of Environment, Forest and Climate Change, New Delhi, 276.

Anonymous, 2019c. Annual Report 2018-19. ICAR-Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar, India, 148.

Anonymous, 2019d. Annual Report 2018-19. ICAR-Central Inland Fisheries Research Institute (CIFRI), Kolkata, India, 332.

Anonymous, 2019e. Annual Report 2018-19. ICAR-Central Marine Fisheries Research Institute (CMFRI), Kochi, India, 320.

Anonymous, 2020a. National Fisheries Development Board (NFDB), Department of Fisheries, Ministry of Fisheries, Animal Husbandry & Dairying, Government of India. Available from http://nfdb.gov.in/about-indian-fisheries.htm. Accessed in June 2020.

Anonymous, 2020b. The State of World Fisheries and Aquaculture 2020. Sustainability in action. FAO, Rome, Italy, 244. https://doi.org/10.4060/ca9229en

Anonymous, 2020c. Topography. Government of Odisha. Available from https://www.odisha.gov.in/content/topography. Accessed in June 2020.

Arora, A., Birwal, D., 2017. Natural calamities, crop losses and coping strategies: an economic analysis from Odisha. Indian Journal of Agricultural Economics 72(3), 385−395.

Ayyappan, S., Jena, J.K., 2003. Grow-out production of carps in India. Journal of Applied Aquaculture 13(3-4), 251-282. https://doi.org/10.1300/J028v13n03_04

Blue Revolution, 2020. Guidelines on Centrally Sponsored Scheme (CSS) on Blue Revolution: Integrated Development and Management of Fisheries. Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture and Farmers Welfare, Government of India, Krishi Bhavan, New Delhi, 60.

Cai, J., Yan, X., Zhou, X., 2016. Species diversification in aquaculture: a global assessment.

Chatla, D., Padmavathi, P., Srinu, G., 2020. Wastewater Treatment Techniques for Sustainable Aquaculture. In Waste Management as Economic Industry Towards Circular Economy. Springer, Singapore, 159-166. https://doi.org/10.1007/978-981-15-1620-7_17

Coastal security, 2015. Odisha Police, Government of Odisha. Available from https://web.archive.org/web/20150206043803/http://odishapolice.gov.

in/?q=node%2F163. Accessed in May 2020.

Das, I., Lauria, V., Kay, S., Cazcarro, I., Arto, I., Fernandes, J.A., Hazra, S., 2020. Effects of climate change and management policies on marine fisheries productivity in the north-east coast of India. Science of The Total Environment, 138082. https://doi.org/10.1016/j.scitotenv.2020.138082

Das, M.M.P., 2016. Climatic vulnerability & its impact on the Villagers Living in the Coastal Regions of Ganjam District of Odisha. International Journal for Research in Business, Management and Accounting 2(10), 1–9.

Das, P.C., Kamble, S.P., Velmurugan, P., Pradhan, D., 2019. Evaluation of minor carps intercropping in carp polyculture vis-à-vis other grow-out cropping patterns of carp farming. Aquaculture Research 50(6), 1574–1584. https://doi.org/10.1111/are.14034

Datta, S., 2011. Inland Fisheries Resources of India. CIFE, Kolkata Centre, Article in Inland Water Biology.

Elfitasari, T., Albert, A., 2017. Challenges encountered by small scale fish farmers in assuring fish product sustainability. Omni-Akuatika 13(2), 128–136. http://dx.doi.org/10.20884/1.oa.2017.13.2.256

FishSite, 2020. Odisha seeks major carp cage culture increase. Available from https://thefishsite.com/articles/odisha-drives-carp-cage-culture-initiatives. Accessed in July 2020.

Galib, S.M., Samad, M.A., Mohsin, A.B.M., Flowra, F.A., Alam, M.T., 2009. Present status of fishes in the Chalan Beel-the largest beel (wetland) of Bangladesh. International Journal of Animal and Fisheries Science 2(3), 214–218.

Gopi, K.C., Mishra, S.S., Kosygin, L., 2017. Pisces. Chapter 33. In: Chandra, K., Gopi, K.C., Rao, D.V., Valarmathi. K., Alfred, J.R.B. (Ed.), Current Status of Freshwater Faunal Diversity in India. Director, Zoological Survey of India, Kolkata, India, 527–570.

Handbook, F.S., 2014. Handbook on Fisheries Statistics 2014. Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Government of India, New Delhi, 1–166.

Handbook, F.S., 2019. Handbook on Fisheries Statistics 2018. Department of Fisheries, Ministry of Fisheries, Animal Husbandry & Dairying, Government of India, New Delhi, 1–190.

Ibrahim, N., Naggar, G.E., 2010. Water quality, fish production and economics of Nile tilapia, *Oreochromis niloticus*, and African catfish, *Clarias gariepinus*, monoculture and polycultures. Journal of the World Aquaculture Society 41(4), 574-582. https://doi.org/10.1111/j.1749-7345.2010.00397.x

Jayasankar, P., 2018. Present status of freshwater aquaculture in India-A review. Indian Journal of Fisheries 65(4), 157–165.

Jayasankar, P., Sahu, B.B., De, H.K., Rajesh, N., Panda, N., Mohanty, U.L., Rath, D.P., Behera, S., Dash, A.K., Sahoo, P.R., 2014. Problems in aquaculture development in Odisha: a participatory assessment. Journal of Aquaculture 22, 1–6.

Katiha, P.K., Jena, J.K., Pillai, N.G.K., Chakraborty, C., Dey, M.M., 2005. Inland aquaculture in India: past trend, present status and future prospects. Aquaculture Economics & Management 9(1-2), 237–264. https://doi.org/10.1080/13657300590961573.

Kumar, S.T., Shivani, P., 2014. Marine fisheries; its current status, sustainable management and socio-economic status of the marine fishers of Odisha, through Indian Marine Policy: A case study. Research Journal of Animal, Veterinary and Fishery Sciences 2(7), 10–19.

Kumaran, M., Vimala, D.D., Chandrasekaran, V.S., Alagappan, M., Raja, S., 2012. Extension approach for an effective fisheries and aquaculture extension service in India. The Journal of Agricultural Education and Extension 18(3), 247–267. https://doi.org/10.1080/1389224X.2012.670442.

Kumari, M.K., Patra, S., 2014. Growth and Performance of Fishery in Odisha. Asian Journal of Research in Business Economics and Management 4(6), 100–110.

Marx, K.K., Sundaray, J.K., Rathipriya, A., Abishag, M.M., 2020. Broodstock Management and Fish Seed Production. CRC Press.

Metian, M., Troell, M., Christensen, V., Steenbeek, J., Pouil, S., 2020. Mapping diversity of species in global aquaculture. Reviews in Aquaculture 12(2), 1090–1100. https://doi.org/10.1111/raq.12374.

Mishra, D., Sahu, N.C., Sahoo, D., 2016. Impact of climate change on agricultural production of Odisha (India): a Ricardian analysis. Regional environmental change 16(2), 575–584. https://doi.org/10.1007/s10113-015-0774-5

Mogalekar, H.S., Canciyal, J., 2018. Freshwater fishes of Orissa, India. Journal of Fisheries 6(1), 587–598.

Mohsin, A.B.M., Hasan, M.M., Galib, S.M., 2009. Fish diversity of community based fisheries managed oxbow lake (Bookbhara Baor) in Jessore. Bangladesh Journal of Science Foundation 7(1), 121–125.

Odisha Fisheries Policy, 2015. Government of Odisha. Available from https://investodisha.gov.in/download/Odisha_Fisheries_Policy_2015.pdf. Accessed in June 2020.

Rahaman, S.M., Bera, B.K., Ananth, G.S., 2013. A study on problems and constraints in production and marketing of fish in West Bengal. Journal of Crop and Weed 9(1), 110–113.

Saha, C., Paul, B.N., 2020. Flowthrough system for industrial aquaculture in India. Aquaculture Asia 5(4), 24–26.

Sarkar, U.K., Lianthuamluaia, L., Panda, D., Kumari, S., Parida, P.K., Karnatak, G., Mishal, P., 2020a. Evaluation and impact assessment of culture-based fisheries to enhance fish yield in small reservoirs in Odisha State, India. Fisheries Management and Ecology 00, 1–9.

https://doi.org/10.1111/fme.12429

Sarkar, U.K., Mishal, P., Borah, S., Karnatak, G., Chandra, G., Kumari, S., Meena, D.K., Debnath, D., Yengkokpam, S., Das, P., DebRoy, P., 2020b. Status, Potential, Prospects, and Issues of Floodplain Wetland Fisheries in India: Synthesis and Review for Sustainable Management. Reviews in Fisheries Science & Aquaculture 1-32. https://doi.org/10.1080/23308249.2020.1779650

Srinivas, D., Venkatrayulu, C., Swapna, B., Swathi, A.V., Venkateswarlu, V., 2019. Studies on socio-economic profile, problems and constraints of shrimp farmers in nellore district of Andhra Pradesh, India. Asian Journal of Science and Technology 10(06), 9731−9735.

State Water Policy, 2007. Resolution State Water Policy, Department of Water Resources, Government Of Odisha. Available from http://www.dowrodisha.gov.in/SWP2007/SWP%202007.pdf. Accessed in May 2020.

Tacon, A.G., 2020. Trends in global aquaculture and aquafeed production: 2000–2017. Reviews in Fisheries Science & Aquaculture 28(1), 43-56. https://doi.org/10.1080/23308249.2019.1649634

WorldFish, 2020. Carp intensification doubles production and increases profits for Indian farmers. Available from http://blog.worldfishcenter.org/2019/06/carp-intensification-doubles-production-increases-profits/. Accessed in June 2020.