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POLICY BRIEF

Why the data gaps in Indian aquaculture need to be addressed to contribute to its efficient and sustainable development

Aquaculture is an important and growing sector in India. There are various aspects of Indian aquaculture that can be improved further to contribute towards its sustainable development. Before proceeding with various developmental strategies, it is essential to identify the specific data gaps that hinder its development. Furthermore, it is important to identify the appropriate ways to use the data to have a positive impact on the sector and the community.

HIGHLIGHTS

- Identification of the data gaps can help determine the appropriate methods to improve aquaculture farm operation, production and market access, as well as community capacity
- The data gaps can be addressed by creating a national aquaculture database in collaboration with various stakeholders including government bodies, research institutes, private entities, and aquaculture farmers
- The database should be standardized as per regulations and aid community-based monitoring
- Filling the data gaps will contribute to the achievement of most of the Sustainable Development Goals

DATA GAPS IN INDIAN AQUACULTURE AND POTENTIAL BENEFITS OF FILLING THE DATA GAPS

Improving aquaculture in India involves addressing various aspects, from sustainable practices to policy support, however, a key aspect that is often overlooked, but which can contribute significantly to the sustainable development of the sector, is addressing the specific data gaps that remain unfilled. There are several data gaps in Indian aquaculture, including but not limited to the following areas:

Farm Characteristics and Practices:

Information that is critical for the efficient operation of aquaculture farms, such as the number of farms, pond sizes, farming methods, and intensity of labour is not clearly available. Information about the types of seeds and feeds used by small-scale farmers, as well as their practices related to feeding, water management, and disease control, are currently limited, but can help optimize resource use and improve productivity (Dhande et al., 2023).

In contrast, lack of data about economic characteristics of a farm, such as production costs and income, creates barriers for designing targeted interventions.

With the use of improved data obtained by addressing these data gaps, farmers can optimize conditions for aquaculture and enhance the productivity to obtain higher growth rates and better yields. For example, farmers can optimize the use of resources, such as feed, water, and energy, based on accurate data, to make their operations more efficient, resulting in cost savings as well as reduced environmental impact (Parappurathu et al., 2023).

Production and Market Access Data:

There is a distinct lack of detailed data on the production of various species, especially in small-scale and inland aquaculture. There is also a gap in information on the quantities produced, growth rates, and market preferences for specific products, which is essential for farm planning and market access (Jaikumar et al., 2023). It should also be noted that market access is usually dependent on information about intermediary channels, processing facilities, and transportation networks, which is currently uncertain for Indian aquaculture.

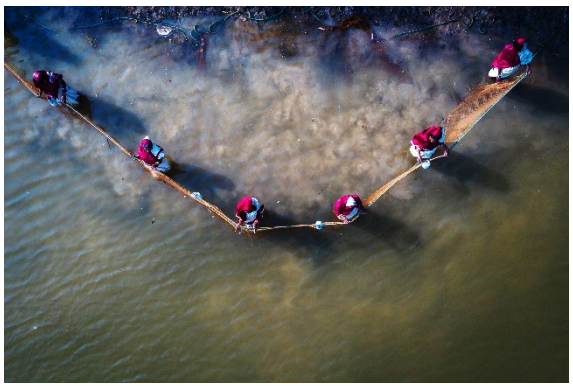
Addressing these data gaps will provide farmers with access to economic data related to markets, such as pricing information and consumer preferences, which will help farmers align their production with market demand. This will improve market access, reduce post-

harvest losses, and ensure fair prices for aquaculture products (Sahoo et al., 2023).

More importantly, availability of robust data will attract investments into the aquaculture sector (Kuntagod et al., 2021). Investors are more likely to support ventures with a solid foundation of information, contributing to the growth and modernization of the industry.

Community Characteristics:

Aquaculture in India is also hampered by the limited data on the societal characteristics of small-scale aquaculture communities, such as community capacity, gender roles, and social hierarchies. Lack of such information makes it difficult to design inclusive and sustainable policies for local aquaculture development (Shubin et al., 2023). Lack of information about community characteristics also acts as a barrier towards the development of capacity-building programs related to sustainable practices, technology adoption, and business skills.



Data related to the community characteristics can be used to tailor training programs and capacity-building initiatives according to the needs of the community identified through data (Duarah & Mall, 2020). In this way, data can be used to enhance the skills and knowledge of the farmers leading to a more empowered community.

Access to comprehensive and accurate data will allow stakeholders, including farmers, policymakers, and researchers, to make informed decisions (Rossignoli et al., 2023). Comprehensive data on the socio-economic aspects of aquaculture can guide community development initiatives such as promotion of inclusive practices, improvement of livelihoods, and equitable distribution of aquaculture benefits (Pragathi et al., 2023).

Finally, regulatory bodies – community managed or government driven – can use data to monitor and enforce compliance with aquaculture regulations. This will ensure that environmental and health standards are met, contributing to the sustainable and responsible growth of the sector (Lakra & Gopalakrishnan, 2021).

Environmental and Health Aspects:

Information on the environmental practices of small-scale aquaculture operations, including waste management and water conservation efforts, is critical for assessing and improving the sector's sustainability (Nair & Nayak, 2023). However, it is difficult for the local farmers to obtain such information currently due to a lack of access to such information. Likewise, information about the health aspects, which helps the aquaculture farms

produce safe and nutritional food products, is also hard to access with ease (Rao et al., 2021). Both these types of information are necessary for aquaculture farms for maintaining regulatory compliance in line with the environmental and health standards.

Environment related data such as weather conditions, water quality, disease outbreaks, and other risk factors can help in the early detection and mitigation of risks. This can lead to more resilient aquaculture operations and reduced losses due to unforeseen challenges (Chattopadhyay & Chandras, 2008).

Similarly, data on climate patterns and their impact on aquaculture can help farmers and policymakers develop strategies to adapt to and mitigate the effects of climate change. This will contribute to the long-term resilience of the sector (Tharanath et al., 2021).

Finally, data on environmental practices, compliance with environmental regulations, and the adoption of sustainable farming methods will contribute to the overall sustainability of the aquaculture sector by improving their environmental performance as well as enhancing efficiency of the operations.

Technology Adoption:

Data on the adoption of modern technologies, such as aeration systems, water quality monitoring devices, and digital farm management tools, can contribute towards more efficient aquaculture farms (Kar & Tripathy, 2020). However, information about technology adoption or the barriers facing it in Indian aquaculture is currently limited.

Addressing this data gap will help farmers to improve their production practices, for instance, by using data on technology adoption to modernize their operations and enhance efficiency.

In addition to the above benefits, addressing the aquaculture data gaps can contribute to the achievement of various SDGs as tabulated in APPENDIX I.

POLICY INSIGHTS

To address data gaps in Indian aquaculture, the following policy recommendations should be considered:

Aquaculture Database

Create a comprehensive national aquaculture database that includes key information on important factors such as production, water quality, disease prevalence, and socio-economic aspects.

The importance of collecting aquaculture data and creating databases has been highlighted in recent studies from

the North Atlantic region (Froehlich et al., 2022; Mikkelsen et al., 2021).

It is vital that the databases be populated by accurate and latest data. Development of monitoring systems and real-time data collection tools can enhance the data accuracy and timeliness related to the environmental conditions and production practices.

Also, standardized reporting practices should be established and farmers should be incentivized to report key data points accurately and regularly. More importantly, this database should be regularly updated and accessible to relevant stakeholders.

Capacity Building

Develop training programs for aquaculture farmers and extension officers on effective data collection methods.

The capacity building programs can also support the farmers with technology adoption by providing small-scale farmers with access to modern and advanced data collection tools, record-keeping methods, and reporting practices.

In addition to data collection, the programs should also train the stakeholders in data analysis and interpretation, so that they are equipped with the skills to derive meaningful insights from collected data.

Additionally, extension officers can also facilitate knowledge dissemination locally and provide on-the-ground support for effective data collection and other capacity-building activities related to aquaculture development.

Community-Based Monitoring

Implement community-based monitoring programs, involving local communities in data collection efforts.

In addition to improving data accuracy, this method will also create a sense of ownership and participation among farmers.

Community based monitoring of aquaculture has been already tried successfully in various countries. In Spain, Vietnam, and Cambodia, monitoring and surveillance was included as one of the main activities of the community-based cooperatives managing their fisheries and aquaculture (García-Lorenzo et al., 2021). In the Pacific islands specialized toolkits were developed and provided to the community to aid monitoring activities (Johnson et al., 2020). Community based monitoring was also successful in Africa as demonstrated in Kenya where monitoring of mariculture projects was shown to be effective in poverty alleviation (Odhiambo et al., 2020).

Additionally, the community can also act as an important stakeholder in organizing public awareness campaigns to highlight the importance and various

benefits of data collection, including its environmental and economic benefits, as well as its use in improved decision-making for aquaculture practices.

Collaborations

Encourage collaboration among government agencies, research institutions, and industry associations to streamline data collection efforts.

The collaborations can be local, national, regional, and global, and have access to best practices and shared data. The collaborations would also allow farmers to be part of research initiatives and help broaden their understanding of aquaculture challenges and solutions globally.

The collaborations should also explore the benefits provided by public-private initiatives as is becoming increasingly common (Jena & Tyagi, 2016; Silas, 2016). This includes partnering with some of the myriad Indian digital technology companies and exploiting and harnessing ICT, IoT, Cloud-edge computing, AI, machine learning, immersive technologies and blockchain for aquaculture data acquisition, management, analyses, and dissemination (Rowan, 2023).

The collaborations will be more effective if they are supported by coordinating bodies which oversee data-related initiatives and ensure cross-sectoral cooperation, such as the Department of Fisheries under the Ministry of Fisheries, Animal Husbandry & Dairying of India. These specialized bodies can also conduct regular audits of data collection processes to ensure accuracy, completeness, and reliability of the data collected.

Regulatory Framework

Update aquaculture framework to include specific requirements for data reporting and adherence to sustainable practices.

The regulatory framework should be dynamic and be able to evolve as per the industry needs and scientific understanding.

The framework should also include a policy feedback mechanism whereby the stakeholders have an outlet to provide input on data collection policies and practices. This will ensure the policies and practices remain relevant and evolve as per the needs of the aquaculture sector. It is also highly important that the framework is overseen by the national Department of Fisheries to monitor and maintain the necessary standards nationally.

Implementing these policy recommendations can contribute to filling the data gaps, thereby enhancing the resilience of Indian aquaculture, and fostering a sustainable and innovative sector. Continuous evaluation and adaptation of policies based on feedback and emerging challenges will be crucial for the success of these initiatives.

Effective implementation of these recommendations will make a significant contribution towards the success of the ‘Blue Revolution’ or the ‘Neel Kranti Mission’ launched by the Indian government to develop the fisheries sector and bring prosperity to the fishers

(Ngasotter et al., 2020). Moreover, this will also be in line with the National Data Sharing and Accessibility Policy (NDSAP), which is otherwise known as the open data policy of the Government of India.

REFERENCES

Chattopadhyay, N., & Chandras, S. (2008). Agro-Meteorological Advisory Services for Informed Decision Making in India. In C. Sivaperuman, A. Velmurugan, A. K. Singh, & I. Jaisankar (Eds.), *Biodiversity and Climate Change Adaptation in Tropical Islands* (pp. 763–783). Academic Press. https://doi.org/10.1016/B978-0-12-813064-3.00028-4

Dhande, K. K., Sharma, R., Ananthan, P. S., & Vinay, A. (2023). Profitability and resource use efficiency of polyculture system in Andhra Pradesh. *Aquaculture International*, *31*(5), 2905–2918. https://doi.org/10.1007/S10499-023-01115-6/METRICS

Duarah, J. P., & Mall, M. (2020). Diversified fish farming for sustainable livelihood: A case-based study on small and marginal fish farmers in Cachar district of Assam, India. *Aquaculture*, *529*, 735569. https://doi.org/10.1016/J.AQUACULTURE.2020.735569

Froehlich, H. E., Gentry, R. R., Lester, S. E., Rennick, M., Lemoine, H. R., Tapia-Lewin, S., & Gardner, L. (2022). Piecing together the data of the U.S. marine aquaculture puzzle. *Journal of Environmental Management*, *308*, 114623. https://doi.org/10.1016/J.JENVMAN.2022.114623

García-Lorenzo, I., Ahsan, D., & Varela-Lafuente, M. (2021). Community-based fisheries organisations and sustainable development: Lessons learned from a comparison between European and Asian countries. *Marine Policy*, *132*, 104672. https://doi.org/10.1016/J.MARPOL.2021.104672

Jaikumar, M., Ramadoss, D., Sreekanth, G. B., Smrithi, K., & Parihar, R. D. (2023). Regional impacts of COVID-19 pandemic on aquaculture and small-scale fisheries: Insights and recovery strategies in India. *Aquaculture*, *570*, 739403. https://doi.org/10.1016/J.AQUACULTURE.2023.739403

Jena, J. K., & Tyagi, L. K. (2016). Public-Private Partnership in Fisheries and Aquaculture in India. In V. Sinha, K. Perar, A. Sharma, & B. Mohanty (Eds.), *Public private partnerships in aquaculture* (1st ed., pp. 105–118). Narendra Publishing House.

Johnson, J. E., Hooper, E., & Welch, D. J. (2020). Community Marine Monitoring Toolkit: A tool developed in the Pacific to inform community-based marine resource management. *Marine Pollution Bulletin*, *159*, 111498. https://doi.org/10.1016/J.MARPOLBUL.2020.111498

Kar, B., & Tripathy, S. (2020). Aquaculture Industry in Odisha: A Review. *Space and Culture, India*, *8*(2), 183–193. https://doi.org/10.20896/saci.v8i2.690

Kuntagod, N., Podder, S., Rote, R. E., Abbabathula, S. S., Mishra, N., & Chopra, A. (2021). Ecosystem approach to sustainable aquaculture for smallholder farmers. *2021 11th IEEE Global Humanitarian Technology Conference, GHTC 2021*, 138–141. https://doi.org/10.1109/GHTC53159.2021.9612446

Lakra, W. S., & Gopalakrishnan, A. (2021). Blue revolution in India: Status and future perspectives. In *Indian Journal of Fisheries* (Vol. 68, Issue 1, pp. 137–150). Indian Council of Agricultural Research. https://doi.org/10.21077/ijf.2021.68.1.109283-19

Mikkelsen, E., Fanning, L., Kreiss, C., Billing, S. L., Dennis, J., Filgueira, R., Grant, J., Krause, G., Lipton, D., Miller, M., Perez, J., Stead, S., & Villasante, S. (2021). Availability and usefulness of economic data on the effects of aquaculture: a North Atlantic comparative assessment. *Reviews in Aquaculture*, *13*(1), 601–618. https://doi.org/10.1111/RAQ.12488

Nair, N. V., & Nayak, P. K. (2023). Uncovering water quality and evaluating vulnerabilities of small-scale fisheries in Chilika Lagoon, India. *Frontiers in Marine Science*, *10*, 1087296. https://doi.org/10.3389/FMARS.2023.1087296/BIBTEX

Ngasotter, S., Panda, S. P., Mohanty, U., Akter, S., Mukherjee, S., Waikhom, D., & Devi, L. S. (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*, *11*(4), 370–380. https://doi.org/10.23910/1.2020.2126A

Odhiambo, J. O., Wakibia, J., & Sakwa, M. M. (2020). Effects of monitoring and evaluation planning on implementation of poverty alleviation mariculture projects in the coast of Kenya. *Marine Policy*, *119*, 104050. https://doi.org/10.1016/J.MARPOL.2020.104050

Parappurathu, S., Menon, M., Jeeva, C., Belevendran, J., Anirudhan, A., Lekshmi, P. S. S., Ramachandran, C., Padua, S., Aswathy, N., Ghosh, S., Damodaran, D., Megarajan, S., Rajamanickam, G., Vinuja, S. V., Ignatius, B., Raghavan, S. V., Narayanakumar, R., Gopalakrishnan, A., & Chand, P. (2023). Sustainable intensification of small-scale mariculture systems: Farm-level insights from the coastal regions of India. *Frontiers in Sustainable Food Systems*, *7*, 1078314. https://doi.org/10.3389/FSUFS.2023.1078314/BIBTEX

Pragathi, M. S., Anitha, M., Sreenivasulu, G., & Jayaraju, N. (2023). Sustainable Aquaculture and Economic Development in Coastal Areas: The Case of Andhra Pradesh, India. In N. Jayaraju, G. Sreenivasulu, M. Madakka, & M. Manjulatha (Eds.), *Coasts, Estuaries and Lakes: Implications for Sustainable Development* (1st ed., pp. 393–404). Springer International Publishing. https://doi.org/10.1007/978-3-031-21644-2_24/COVER

Rao, D. N., Rao, T. B., & Machiraju, P. V. S. (2021). Chemical and Pathogen Impacts on Human Health near Aquaculture Areas in West Godavari District of Andhra Pradesh, India. *Nature Environment and Pollution Technology*, *20*(3), 1285–1293. https://doi.org/10.46488/NEPT.2021.v20i03.040

Rossignoli, C. M., Manyise, T., Shikuku, K. M., Nasr-Allah, A. M., Dompreh, E. B., Henriksson, P. J. G., Lam, R. D., Lozano Lazo, D., Tran, N., Roem, A., Badr, A., Sbaay, A. S., Moruzzo, R., Tilley, A., Charo-Karisa, H., & Gasparatos, A. (2023). Tilapia aquaculture systems in Egypt: Characteristics, sustainability outcomes and entry points for sustainable aquatic food systems. *Aquaculture*, *577*, 739952. https://doi.org/10.1016/J.AQUACULTURE.2023.739952

Rowan, N. J. (2023). The role of digital technologies in supporting and improving fishery and aquaculture across the supply chain – Quo Vadis? *Aquaculture and Fisheries*, *8*(4), 365–374. https://doi.org/10.1016/J.AAF.2022.06.003

Sahoo, C. K., Raulo, S., Singh, S., Srichandan, S., Baliarsingh, S. K., Acharyya, T., & Barik, K. K. (2023). Environmental–Economical Aspects of Protonibea diacanthus: A Heavily Priced Marine Fish of India. *Proceedings of the National Academy of Sciences India Section B - Biological Sciences*, *93*(2), 291–300. https://doi.org/10.1007/S40011-022-01426-3/METRICS

Shubin, S., Andrews, W., & Sowgat, T. (2023). Rhizomatic poverty in aquaculture communities of rural India & Bangladesh. *Social & Cultural Geography*, *24*(8), 1285–1304. https://doi.org/10.1080/14649365.2022.2055776

Silas, E. G. (2016). Role of Public-Private Partnership in Fine Tuning Research and Development in Fisheries and Aquaculture. In V. Sinha, K. Perar, A. Sharma, & B. Mohanty (Eds.), *Public private partnerships in aquaculture* (1st ed., pp. 77–86). Narendra Publishing House.

Tharanath, G. M., Kothalil, J., Kaippilly, D., & Zonno, V. (2021). Consequences of climate change in aquaculture and mitigation measures – lessons from Kerala, India. *The Round Table*, *110*(5), 597–605. https://doi.org/10.1080/00358533.2021.1985273

AUTHORS

Institute for Global Environmental Strategies (IGES)
2108-11 Kamiyamaguchi, Hayama, Kanagawa, Japan 240-0115.

Rohit Ramachandran
Policy Researcher
ramachandran@iges.or.jp

Osamu Saito
Principal Policy Researcher
o-saito@iges.or.jp

WorldFish
W Jalan Batu Maung, Batu Maung, 11960 Bayan Lepas, Penang, Malaysia.

Rodolfo Dam Lam
Scientist
R.DamLam@cgiar.org

Cristiano Rossignoli
Research Leader
C.Rossignoli@cgiar.org

APPENDIX I: Contribution to SDGs by filling aquaculture data gaps

SDG	Description	Contribution to SDG
2	Zero hunger	Improved data leading to sustainable and increased aquaculture production can deliver a reliable source of nutritious food.
3	Good health and well-being	Improved data on disease management and water quality can lead to improved health and well-being.
4	Quality education	Training programs and capacity-building initiatives, supported by comprehensive data, can contribute to quality education for farmers.
5	Gender equality	Data focusing on the role of women in aquaculture, their contributions, and the challenges they face can guide targeted to promote gender equality within the aquaculture sector.
6	Clean water and sanitation	Data can be used to monitor the water quality for sustainable water use and pollution management in aquaculture operations.
8	Decent work and economic growth	Improved economic data can contribute to sustainable economic growth in the aquaculture sector, including increased employment opportunities.
9	Industry, innovation and infrastructure	Data on technology adoption, innovation, and infrastructure development in aquaculture can enhance the efficiency.
10	Reduced inequalities	Comprehensive data can highlight disparities and inequalities within the aquaculture sector and can be used to design targeted interventions to reduce inequalities among small-scale farmers and ensure equal share of the benefits.
11	Sustainable cities and communities	Sustainable and responsible aquaculture practices, guided by comprehensive data, can contribute to creating sustainable communities, self-sufficient in terms of food and economy, among others.
12	Responsible consumption and production	Comprehensive data on aquaculture production, supply chains, and consumption patterns will support waste reduction and improve efficiency, thereby contributing to responsible production and consumption practices.
13	Climate action	Data on climate patterns, adaptation strategies, and the environmental impacts of aquaculture can contribute to climate action and help mitigate climate-related risks.
14	Life below water	Sustainable and responsible aquaculture practices, informed by comprehensive data, can aid in the conservation and sustainable use of marine and freshwater ecosystems.
15	Life on land	Comprehensive data on land use in aquaculture can contribute to the conservation of biodiversity and terrestrial ecosystems by enhancing sustainable aquaculture practices which reduce pressure on terrestrial ecosystems for food production.
17	Partnerships for the goals	Filling data gaps requires collaboration between agencies, research institutions, private entities, and local communities, by exchange of knowledge and resources.