

Comprehensive Social-Ecological Assessment of the Shrimp Aquaculture Sector in Andhra Pradesh, India




dakshin

Sustainable Fisheries PARTNERSHIP

FARMED RESPONSIBLY asc CERTIFIED ASC-AQUA.ORG TM

Table of contents

Background

Aquaculture, particularly shrimp aquaculture, has been instrumental in India's growth as a leader in fisheries production. India has seen rapid growth in aquaculture over the years, with notable contributions from Andhra Pradesh. The coastal state led the fisheries and aquaculture production in 2022-23, with a 40.9% share in the output.

With the second-longest coastline in India (974 km), 33,227 sq. km of continental shelf, 8 lakh hectares of inland water bodies, and 2.12 lakh hectares under aquaculture, Andhra Pradesh is the leading state in aquaculture production.

Brackishwater shrimp farming started in Andhra Pradesh with the intervention of the Marine Products Export Development Authority (MPEDA) in the early 1980s. Initially, black tiger shrimp (*Penaeus monodon*) was the dominant species. Its culture boomed and remained the dominant shrimp species for two decades before a fall in the late 1990s due to the white spot syndrome virus (WSSV). Despite regulating the culture, the species continued to have disease issues, And the Pacific white shrimp gradually replaced it. The introduction of specific pathogen-free (SPF) Pacific white shrimp (*Litopenaeus vannamei*) in 2009 was a critical turning point for shrimp aquaculture in India. The sector saw more-or-less steep growth for a decade until a slump since the COVID-19 pandemic.

Challenges, scope and importance of enhancing sustainability in shrimp culture

With both central and state governments emphasising their ambition to strengthen aquaculture, especially the shrimp sector, to boost the economy and India's position in the global seafood market, enhancing sustainability and traceability is imperative.

However, the sector faces many challenges across its supply chain. The supply chain disruptions and market fluctuations during the COVID-19 pandemic revealed the vulnerability of the shrimp sector. While it did open venues in the domestic market, it is still in the nascent stages. In contrast, the export market still needs to gain more robustness, especially in the face of competition from countries like Ecuador. The recent investigative reports on poor working conditions in processing factories have drawn international eyes towards Andhra Pradesh and questioned the current capacity of regulatory mechanisms and the efficacy of their enforcement in India. The impact also caused uproar against Indian exporters for being unable to meet the required demands.

Under the ambit of the Blue Economy, shrimp aquaculture has gained substantial recognition from the government as a sector that needs to invest significantly. This opens up many opportunities to access and widen the market reach of Indian shrimp. In addition to boosting production, interventions must be brought in at multiple levels across the supply chain to improve the sustainability quotient on all the SDG fronts. Using a landscape approach, this assessment aimed to produce a detailed

understanding of the sector to highlight the avenues for sustained harvest and sustainable and equitable development of the shrimp aquaculture sector in India.

Objective of the study

1. Using a landscape approach, understand the evolution of shrimp farming and non-shrimp resource utilisation in Andhra Pradesh.

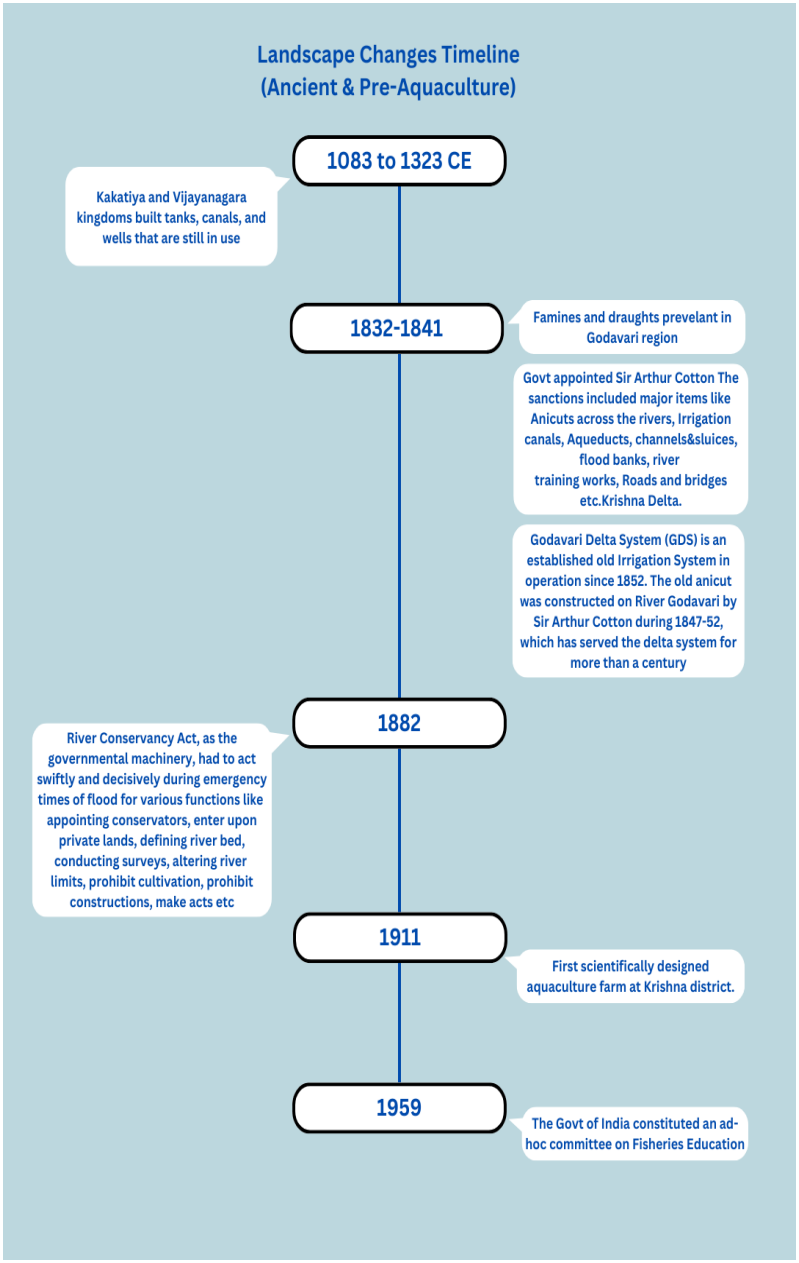
2. To map and understand the value chain and associated stakeholders in the shrimp aquaculture landscape and their role, especially for small-holder aqua farmers, women, and marginalised local communities.

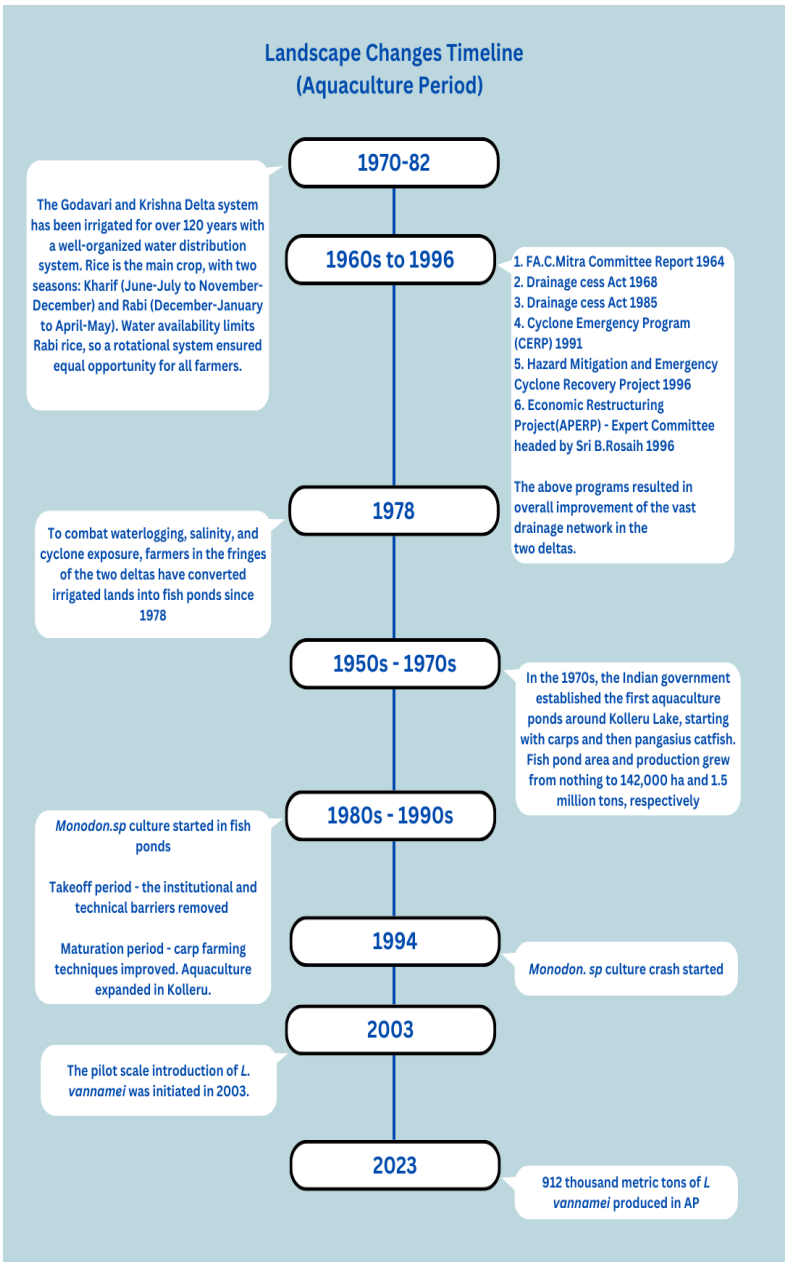
3. To map the social-ecological issues in shrimp aquaculture across the Godavari-Krishna landscape in Andhra Pradesh.

4. To understand the existing governance systems and issues with shared commons associated with shrimp aquaculture.

5. To chart recommendations for enhancing the sustainability of shrimp produced in Andhra Pradesh.

The history and evolution of the aquaculture landscape in Andhra Pradesh



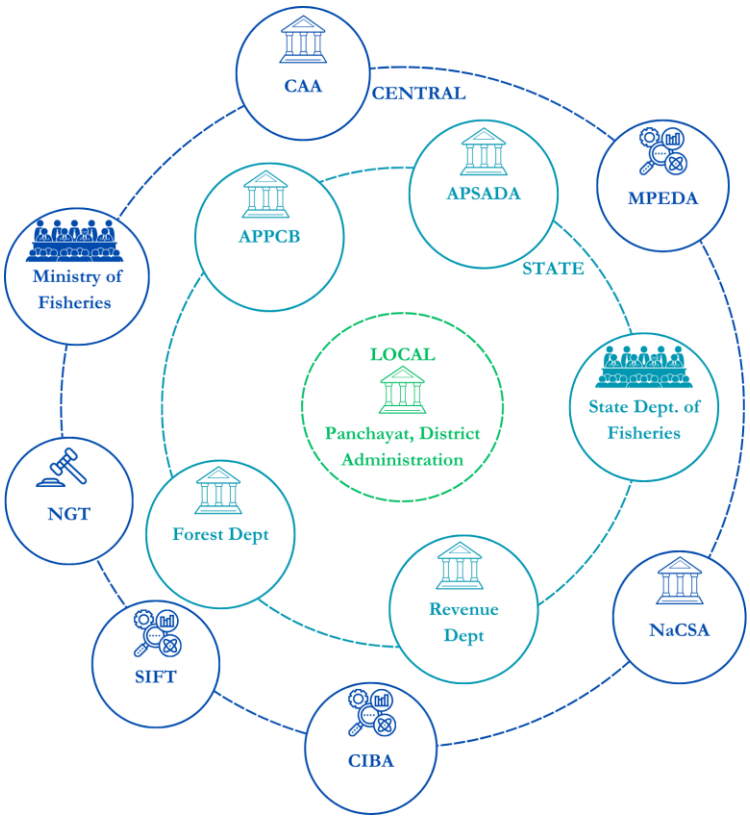


A summary of the timeline of the changes that happened in Andhra Pradesh Landscape

The Interconnected Issues and Key Entry Points in the Shrimp Aquaculture Sector

Annexure II presents a visual map and detailed table outlining the key challenges and recommendations for achieving sustainability across the shrimp aquaculture sector. It presents a broad value chain, starting from the input resources for aquaculture, from hatcheries and feed to retail, highlighting critical issues related to feed sourcing, land governance, farming techniques, and water pollution. The map also identifies cross-cutting concerns such as weak regulatory enforcement, environmental degradation, human rights violations and market traceability.
Using our rapid survey's PESTLE approach, the issues in the map are categorised into political, economic, social, technological, environmental and legal dimensions, providing a comprehensive foundation for targetted interventions and viable growth in the sector.

The Federal and Local Governance Institutions and Their Roles in Regulating the Aquaculture Landscape in Andhra Pradesh



The infographic depicting the existing federal system of governance dividing responsibilities to the central government, state government and local bodies, governing the aquaculture sector in Andhra Pradesh

Detailed descriptions of the federal system and responsibilities are as follows:

1. **Central government**

Regulatory body	Key Responsibilities
Ministry of Fisheries, Animal Husbandry and Dairying	- Develop infrastructure to promote sustainable practices and manage resources. Also, set up a Fisheries and Aquaculture Infrastructure Development Fund (FIDF) to support fisheries and aquaculture.
State Institute of Fisheries Technology (SIFT)	- Primarily functions as a training and knowledge dissemination centre for the fisheries sector, providing hands-on education to students and fishermen on sustainable aquaculture practices, modern fishing techniques, and conservation methods.
Coastal Aquaculture Authority (CAA)	- To regulate the activities related to coastal aquaculture in India and ensure no harm to the coastal ecosystem and ecology. - Register coastal aquaculture farms, make regulations for the construction and operation of aquaculture farms in coastal areas, as well as to monitor such farms to determine their adherence to environmental impact guidelines, comply with registration as per Rules, take action for discontinuation of coastal aquaculture farms that are not by guidelines laid down by the CAA.
Marine Products Export Development Authority (MPEDA)	- Promotion of aquaculture for augmenting export production through hatchery development, new farm development, diversification of species and gradation of technology - Impart training for aquaculture farmers and conducting R&D for aquaculture of aquatic species having export potential through Rajiv Gandhi Centre for Aquaculture (RGCA).
National Centre for Sustainable Aquaculture (NaCSA)	- Established by MPEDA in 2007, an outreach organisation for uplifting the livelihood of small-scale shrimp farmers. - The objective is to promote, guide, and assist farmers in adopting sustainable and eco-friendly farming practices for exporting quality seafood.
Central Institute of Brackish Aquaculture (CIBA)	- Indian Council of Agricultural Research (ICAR) established CIBA in 1997 to develop brackishwater aquaculture in India under the Ministry of Agriculture and Farmers Welfare

National Green Tribunal (NGT)	- Established in 2010, NGT is the judicial body that adjudicates environmental cases in India involving legislations, including:
	  - The Water (Prevention and Control of Pollution) Act, 1974;
	  - The Water (Prevention and Control of Pollution) Cess Act, 1977;
	  - The Forest (Conservation) Act, 1980;
	  - The Air (Prevention and Control of Pollution) Act, 1981;
	  - The Environment (Protection) Act, 1986;
	  - The Public Liability Insurance Act, 1991;
	  - The Biological Diversity Act, 2002.

	- In aquaculture, NGT plays a crucial role by acting as a judicial body that oversees and regulates the environmental impacts of aquaculture practices and takes action against stakeholders that violate regulations. Through legal interventions and monitoring, NGT effectively promotes responsible aquaculture practices.

2. State government

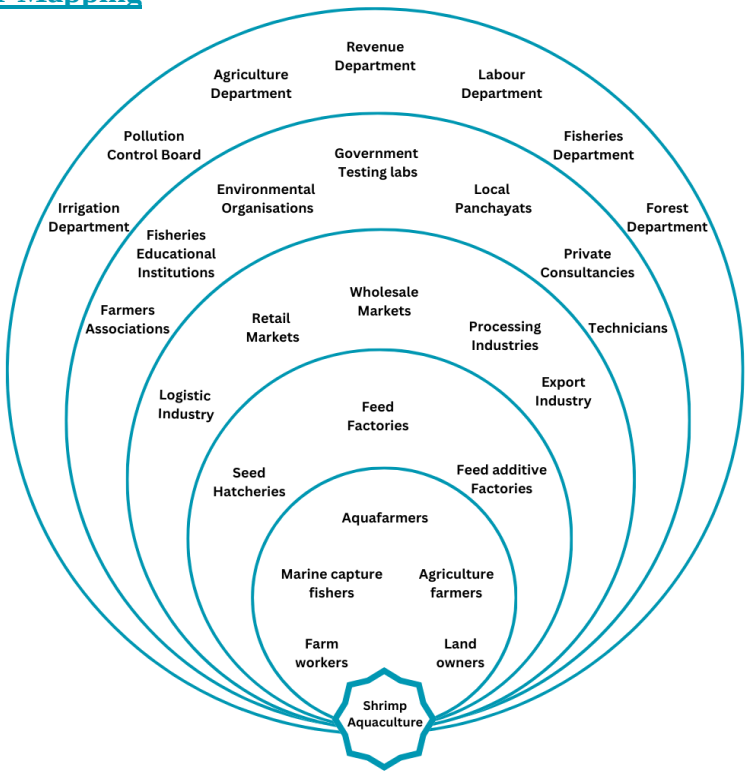
Regulatory body	Key Responsibilities
Andhra Pradesh State Aquaculture Development Authority (APSADA)	- To develop aquaculture in Andhra Pradesh to increase production, productivity, sustainability and profitability. - Promote innovative aquaculture technologies such as pond/cage/mariculture, etc. - To certify and promote all aquaculture inputs, such as seed, feed, feed ingredients, feed supplements, aqua chemicals, aqua products, medicines, etc.
Andhra Pradesh Pollution Control Board (APPCB)	- The APPCB is a statutory authority entrusted with implementing environmental laws and rules in Andhra Pradesh, India.
Forest Department	- Identifies and takes action against unauthorized aquaculture ponds established within protected forest areas, particularly in wetland ecosystems like the Kolleru Lake, Ramsar Convention site - Monitor compliance with CRZ regulations regarding aquaculture development in the coastal areas, ensuring activities are carried out within designated zones.
Revenue Department	- Handles disputes related to land ownership, encroachment, and lease violations in aquaculture zones. - Andhra's Department of Fisheries must engage with the Revenue Department and other agencies to ensure that the village ponds and tanks are productively used for fisheries and aquaculture. - Grants land conversion permissions for using agricultural land for aquaculture under the Andhra Pradesh Agricultural Land (Conversion for Non-Agricultural Purposes) Act, 2006.

3. Local Bodies of governance

Regulatory body	Key Responsibilities
District-Level Administration	- District collectors notify the "Aquaculture Zone" to register and renew existing unregistered aquaculture farms and hatcheries and to regularise existing unregistered farms.
Village councils (Panchayats)	- Plays an essential role in resolving conflicts, in addition to regulating and allocating resource use, ensuring equitable access to resources, and providing some form of social insurance at the grassroots level. - Involved in regulating the use of village common land, water bodies, & ponds for aquaculture and monitoring illegal land conversion from agriculture to aquaculture.

Other Key Results

1. Stakeholder Mapping



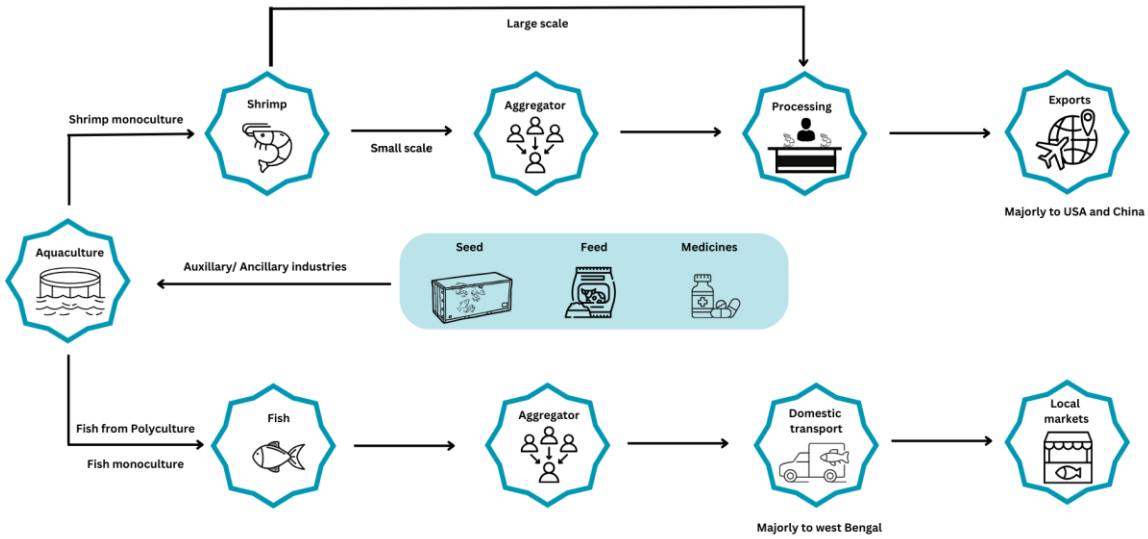
An onion peel diagram showing different stakeholders and their relative positions based on their roles and involvement

2. Stakeholder influence matrix

Using Mendelow's Power-Interest Matrix, we categorized stakeholders based on their level of power/influence, interest, and involvement in the Andhra Pradesh aquaculture sector. The table below summarizes the stakeholder dynamics.

Stakeholder	Power/Influence	Interest	Involvement
Central institutions: Fisheries dept	High	High	Key player
Coastal Aquaculture Authority (CAA)	High	High	Key player
Andhra Pradesh Pollution Control Board (APPCB)	High	Medium to high	Key regulator
Large-scale farmers	High	High	Key player
Small-scale farmers	Low to medium	High	Important supporter
Processors and Exporters	High	High	Key player
Shrimp hatcheries and feed suppliers	Medium	High	Importer supporter
District administration & local panchayat	High	Medium to high	Influencer
Workers: women working in processing plants	Low	Medium to high	Important supporter
Environmental NGOs, research institutions	Low to medium	High	Important supporter
Banks and microfinance agencies	Medium	Medium	Influencer
Market technocrats	Medium	High	Important supporter
Retailers and domestic market players	Low to medium	Medium	Low-priority stakeholder
Certification schemes (ASC, BAP, MPEDA)	Medium	High	Important supporter

3. Broad Supply Chain:



Supply chain diagram of aquaculture sector in Andhra Pradesh representing inflows and outflows of product

4. Case study: Sustaining Small-Scale Aquaculture in Mogalthur: A Low-Intensity, High-Resilience Approach

Mogalthur, situated in the West Godavari district of Andhra Pradesh, is a village known for its low-input, small-scale aquaculture farming, both shrimp and fish farming. Historically, when Indian shrimp (monodon) was prominently farmed in India, most farms were small-scale land use. However, with the shift towards Vannamei, many farmers transformed their land into high-intensive farming, aiming for higher returns. However, this was achieved with the rising risks of disease endemics, which countered productivity and forced them to reconsider this approach. Since 1993, the White Spot Syndrome Virus (WSSV) has caused significant damage to the ecosystem and aquaculture-based economy.

Mr. Gubbala Narayana Murthy, head of the small-scale aquaculture farmers' society, discussed the importance of creating a Society for small farmers. "*The main purpose was the disease control*". Their focus on small-scale, less intensive aqua farming is based on the **3C principle: Capacity of the creek, capacity of the farmer and capacity of the farm.** In 2002, MPEDA, along with the Network of Aquaculture Centres in Asia-Pacific (NACA), initiated a disease control program to study Best Management Practices (BMP).

This initiative gave rise to their *Sri Subrahmanyeshwara Aquaclub,* comprising over 50 farmers managing over 200 acres of ponds. The program emphasised cooperative approaches to implement BMPs, enhancing productivity and sustainability in shrimp farming.



(Left to right): worker casting the net to harvest the catch; the community documentation of the feed quantity used in each pond per day; the catch harvested from the pond

What is working out for them? The following are the technical aspects:

1. *Polyculture approach*: In Mogalthur, there are two cropping seasons: February to July, with only Vannamei farming, followed by July to December, when polyculture is undertaken.
2. *Low stocking density:* Vannamei is stocked at a minimum of 15-25 per sq. m, while polyculture is maintained at 1 per sq. m
3. *Economic viability and livelihood diversification:* Although the profit margins in small-scale farming are generally lower than those in high-intensive aquaculture farming, Mogalthur farmers sustain themselves by diversifying their livelihoods with an integrated coconut-aquaculture farming approach. This also helps farmers depend less on the aquaculture produce, reinforcing the 3C principle in action.

While this approach does not eliminate shrimp disease outbreaks, Mogalthur's ponds demonstrate significantly higher productivity and superior shrimp and fish quality compared to high-input-intensive aquaculture regions. To read more, visit the link.

Key Recommendations

The aquaculture sector in Andhra Pradesh involves multiple actors, regulatory agencies, civil society actors, and community institutions. Over the last few decades, as the industry grew, individual stakeholder groups have come together to form collectives in the form of associations or societies (hatchery associations, farmer associations, feed producer associations and so on). However, each stakeholder group operate in their respective silos. There is a glaring lack of communication and coordination amongst these various groups, leading to poor coordination on the ground and various issues ranging from ecological to social and economic. Our interactions with these different actor groups indicate that each of these stakeholder groups is interested and committed to moving towards sustainability. However, the lack of coordination amongst these actors severely hampers any initiatives to move the sector towards sustainability. Any further regulations (be it market-driven or government regulations) will further add to the chaos on the ground. We recommend a two-tiered approach to facilitate communication, information flow, trust building amongst the various actors, improved coordination and accountability and encouraging compliance.

1. **Recognize the intermeshed nature of farmers' well-being and environmental health and establish a mesoscale multi-actor platform.**

   We strongly propose the creation of a meso-level (from farmer groups to processors and exporters). The group should be established to implement ASC standards and ensure that Andhra's shrimps can compete in the global sustainability market. Broadly, such a platform should involve key actors across the value chain (farmers, civil society, corporations, entrepreneurs, and government agencies). The platform should come together with a clear mandate to work towards the sustainability targets laid out by the ASC and the government.

   The platform should be facilitated by a third party that is neutral, not embedded within the ecosystem or the landscape and has the necessary skills to operate such large multi-actor platforms. Initiatives like Common Ground have specifically such expertise and can be the lead in running such platforms. Based on our past experiences of running such multi-actor platforms in India, we recommend that the platform be co-created with the key stakeholders with sufficient time and resources allocated towards the process of co-creation. This will be crucial to ensure stakeholder buy-in into the process and to ensure long-term sustainability.

   Such an empowered, democratic formal body should be the front end and liaison point for all formal engagements and partnerships with key regulatory agencies (like MPEDA and CAA), research institutions, international regulatory agencies and so on. We have conducted a detailed stakeholder mapping to identify key actors, institutions, and agencies that could potentially participate in such a platform.

2. Strengthen grassroots governance

The formal and informal village governance institutions in India are critical to her development. Many development and market-based initiatives tend to overlook the role of such institutions, particularly informal institutions, in ensuring equity and sustainability. Andhra Pradesh, in particular, has active village management committees (or simply village committees) in the majority of villages that play a strong role in village governance and elicit more compliance than many formal regulatory agencies.

We suggest a landscape-level analysis to identify major aquaculture clusters across the Krishna-Godavari basin. These clusters could be delineated based on shared resources, cultures, administrative boundaries, biogeography, and so on. Each cluster could federate the gram panchayats (formal village governance institutions) and village committees (informal institutions) to form cluster-level platforms. Working closely with the meso-level platform, these cluster-level platforms could form the bridge between the meso-level platform and the grassroots. The main roles of the cluster platforms can be to assist in implementing, monitoring, and reporting on the interventions and decisions taken at the meso-level. Allocating resources towards platform coordinators and trained field monitoring teams could help streamline and coordinate sustainability actions on the ground.

Common Ground, with decades of prior experience implementing such multistakeholder platforms at various levels (from the grassroots to the international level) and at scale across various biogeographies and landscapes of India, would be ideally placed to lead such initiatives.

Discussions with community members highlighting key socio-economic issues they face in their villages

While the recommendations mentioned above are critical for building coordinated, long-term, systemic changes in the aquaculture sector in Andhra Pradesh, multiple issues came up in our field surveys that are of high severity and demand immediate attention. We have selected some of the major issues that were prevalent at the landscape level or have intense impacts on local ecologies and

communities below. Along with the issues, we have provided some recommendations and suggestions. We have also provided a detailed table outlining all the major issues that were encountered as part of the field surveys (see Annexure II)

1. **Reducing risks and perverse incentives by promoting poly-culture models of aquaculture over intense mono-cultures:**
   Historically, India's native black tiger shrimp (*Penaeus monodon*) dominated aquaculture. However, following WSSV outbreaks in the 1990s, the industry transitioned to Pacific white shrimp (*Litopenaeus vannamei*), with its specific pathogen-free (SPF) variant introduced in 2009, marking a significant shift in shrimp farming. However, despite this transition, there have been tremendous losses in the aquaculture-based economy due to disease endemics. The ground reports indicate that aquaculture, despite high production levels and prevalence across the landscape, is a highly risky business. Most farmers seem to invest in high-risk, high-intensity monoculture shrimp farming instead of opting for safer options like poly-culture. The surveys indicate that farmers involved in poly-culture are capable of breaking even despite their shrimp harvests suffering significant losses as the fish cultured in the same ponds enable them to retrieve their investments. While such options exist, the lack of market incentives in undertaking poly-culture pushes farmers towards high-intensity, single-species farming, placing them at tremendous risk. This creates a downward spiral, pushing farmers, particularly the small farmers who form the majority, to invest in more unsustainable farming practices. ASC should try incentivising low-risk, more resilient and improved sustainable farming practices such as polyculture.
   The spread of disease endemics in aquaculture ponds has far-reaching implications for the ecosystem and the rise of antimicrobial resistance (AMR). To mitigate these risks and enhance farm productivity, farmers should adopt low stocking densities and rational feeding to reduce disease outbreaks. Encouraging species diversity by incorporating native seeds and avoiding monocropping of Vannamei shrimp can further strengthen ecosystem resilience.

(Left to right): Vannamei is harvested at the farm to be sold to the processing plants, and aquaponds are dried and ploughed for the next season.

2. **Addressing issues of pollution and drinking water contamination**

Contamination and pollution of drinking water is an overarching problem that persists across the landscape and affects even community members not involved in aquaculture. The Jal Mitra initiative of the Department of Drinking Water and Sanitation helps monitor the water management issue at the village level. The Jal Mitra scheme involves training local village residents to manage water supply systems in villages and has been a successful initiative in many parts of India. A tie-up with the Department of Drinking Water and Sanitation to achieve targets of ensuring safe drinking water for the people in these landscapes can help design interventions that can make a difference at a large scale. The Jal Mitras can be provided with specific training to monitor and report on the scale and impact of pollution, contamination levels, seasonality in water quality parameters, distinguishing the impacts of aquaculture on water quality from other sources, and so on. This information will be critical in designing contextual interventions. The Jal Mitras could also be key in implementing interventions that aim to create awareness and mitigate these issues on the ground.

(Left to right): Untreated water from the aqua pond being discharged directly into the canal; the visible difference between the water purchased by the community members vs the water extracted from their house taps (yellow tint) connected to the canal

3. **Feeding the future by closing the gap between the wild-capture fisheries and the aquafeed sector**

Nearly one-fifth of the world's annual wild capture fisheries is diverted to produce fishmeal and fish oil (FMFO), which is further used to produce aquafeeds. Much of these wild-caught fish come from massive, unsustainable, large-scale fisheries, including bottom trawling.

These fisheries have been well-documented for their ecological and socio-economic impacts worldwide. Over time, the unchecked exploitation of wild fisheries threatens both aquaculture and wild-capture fisheries, calling for an urgent need for collaboration. Organisations like Dakshin have been working towards building a coalition of key aquaculture-relevant industrial leaders and fish meal and fish oil (FMFO) manufacturers to help bridge this disconnect, albeit with limited success. Collaborations between Dakshin Foundation and ASC to work towards contextual and inclusive solutions through certification schemes are a certain possibility. Strengthening this link can be a cornerstone in establishing traceability, sustainability and long-term viability in the aquafeed supply chain.

4. **Addressing ecological and socio-legal aspects of Shrimp aquaculture:**

Illegal aquaculture practices, powered by political backing and weak governance mechanisms, emerged as a key concern in this assessment. Empowering local grassroots institutions (refer to point 2 above) and supporting them in utilising legal channels to combat illegal aquaculture presents a viable solution. The demolition of illegal ponds and sand mining in Andhra highlights the impacts of community collectivization in addressing issues. Strengthening land ownership transparency, certification renewals, and audit enforcement will further reinforce accountability.

Additionally, investing in rewilding projects, post-demolition will enhance community resilience and restore land productivity, ensuring a more sustainable future for aquaculture. Such efforts need to focus particularly on the coastal ecosystems, given the intensity of the impacts. The conservation and restoration of mangroves, sand dunes, eco-sensitive zones such as bird sanctuaries, biodiversity-rich areas and other key coastal ecosystems affected by aquaculture need to be identified and given special attention. There are agencies like the MSSRF that are already involved in such initiatives in coastal areas and could become key partners in implementing such initiatives.

(Left to right): Illegal aquaculture being demolished in Gogunamattam village post judgement by NGT and efforts of communities collectivisation; Coconut cultivation in Antarvedi area failed due to water-logging

5. Building technological platforms for transparency, sustainability and accountability

While technology has a huge role to play in the aquaculture sector, in Andhra Pradesh, the use of technology is limited to the hatchery, feed, and processing sectors. At the production end, the use of technology is limited to the use of aerators and, to some extent, surveillance. Mobile-based technologies, in particular, due to their accessibility and prevalence, can play a huge role in capturing data at large scales, bringing in accountability and traceability, building investor confidence and ensuring sustainability targets are achieved. A range of technologies can be embedded at the production end that can help capture issues at the production end, can help map and track commodity flow across the value chain and ensure sustainability is embedded at every link. New start-ups like AquaExchange have developed customised technologies to achieve this at the production end (end to end). While this is a welcome development, such critical information remains within a corporate actor and is not made available to the general public. We recommend working with partners like AquaExhange to ensure data transparency.

Further, many of the interventions mentioned above, such as the inclusion of Jal Mitras for monitoring and surveillance at the grassroots, could use mobile-based technologies to generate critical data at the landscape level.

Understanding quality control and monitoring mechanisms at AquaExchange

6. Documenting local adaptations for contextual solutions.

The health of the ecosystem and the productivity of the aquaculture sector are intrinsically connected and must be assessed in tandem. However, much of the work remains fragmented. Policies and regulations must be informed by the on-ground insights and challenges the farmers and local communities face, which depend on shared resources.

Farmers often come up with their own solutions to many of the issues they face. Often, these solutions are contextual and successful. These adaptations that the communities come up with should be documented and this could perform their own hits and trials that serve as scientific data and must be, wherever possible, incorporated into policy reforms as innovative farmer-led solutions. Therefore, existing success stories and initiatives should be documented, reviewed and disseminated rather than innovated in every aspect.

Acknowledgements

We are very grateful to all the informants for their valuable insights and contribution to the study. We sincerely thank Dr Sumalatha, Dr Kiran Rao from the State Institute of Fisheries Technology (SIFT), Mr Rama Sankar Naik, IAS (Retired), Commissioner of Fisheries, Dr C. Suvarna, IFS PCCF (HoFF), Mr Gopi, DFO Tallarevu, Ms Karri Padmasri and Mr Karri Narayan Rao for their support. We extend our gratitude to Mr Arjili Dasu and his team from the District Fishermen Youth Welfare Association, Mr D. Pal, Chinta Srinivas and their team from the Democratic Traditional Fishers and Workers Forum for their valuable time and support. We also thank Mr Venkatesh Salagrama, Mr Siddharth Chakravarthy, Mr Rafi Sheik, Dr Raja Bhushanam from Media Institute, Dr Srinivasu Nookarapu from the University of Hyderabad, Dr Shiv Sankara Rao and Mr Pranav SriChakra from East Coast Conservation Team for their invaluable contribution to our understanding of the sector.

We would also like to thank AquaExchange, an MSSRF organisation, for enriching our understanding of the market and landscape of aquaculture in Andhra. This study would have been incomplete without valuable contacts provided by Mr Patanjali Shashtri, Mr Venkata Krishna, Mr Tataji and Ms Himaja. We would also like to thank all our participants, including farmers, shrimp hatchery owners and workers, processors, and export companies across the landscape who shared their insights and helped us snowball further contacts. We are grateful to Mr Sudhakar, Mr Siva and Mr Venkat Rao, who supported us throughout with logistics.

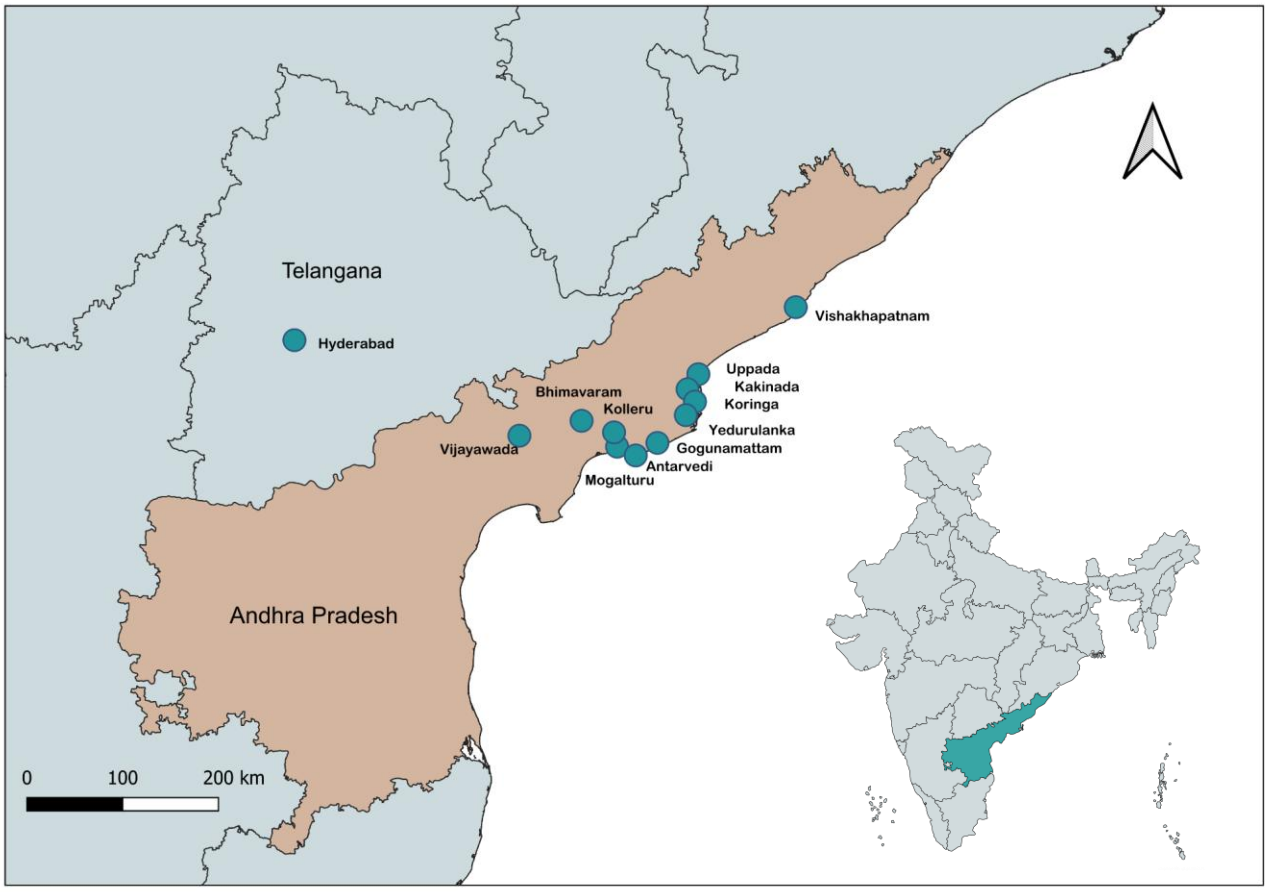
Last but not least, we would like to extend our gratitude to Mr Jim Cannon and Mr Paul Bulcock from SFP, Mr Chris Nennis, Ms Jill Swasey and Mr Marcos Moya from ASC, Mr Jagdeesh Puppala and Sisir Pradhan from Living Landscapes and Mr Mohan and Mr Ravi from Seafood Solutions team for enriching our experience and sharing their knowledge with us.

Annexure I: Approach and Methodology

Methodology

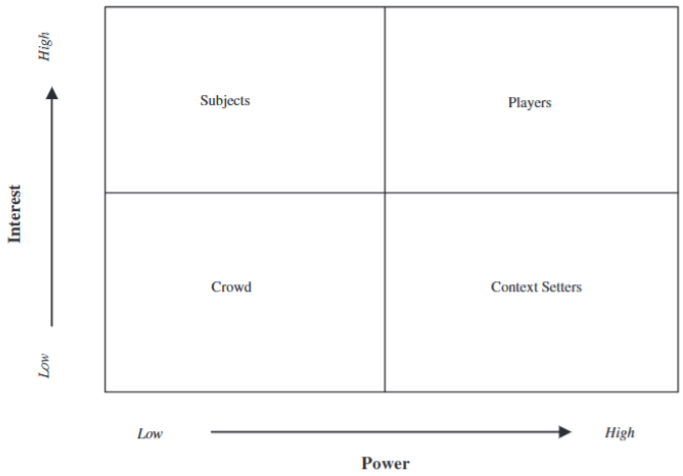
We utilised a landscape approach to assess the Andhra aquaculture sector's ecological and socio-economic implications. This holistic framework helps integrate social, ecological, and economic drivers while recognising the crucial role of multi-stakeholders across a geographical scale of Andhra Pradesh. The following are the key steps followed to produce this comprehensive report:

1. **Zoning and site prioritization:** The coastal brackishwater aquaculture sector is operational in the following districts: East Godavari, Krishna, West Godavari, Srikakulam, Guntur, Nellore, and Prakasam. Based on the key informants' support and the extent of aquaculture operations, we prioritised West Godavari and East Godavari for this assessment.



Map highlighting the sites prioritised for this assessment. Made using QGIS.

2. **Stakeholder groups mapping:**
   Using a purposive sampling approach, we identified stakeholders holding a direct or indirect relationship with the aquaculture sector of the prioritised region.
   We then developed a stakeholder-influence matrix to assess the power dynamics and influence in decision-making processes.



Power-interest matrix. Source: Bryson, J. M. (2004). What to do when stakeholders matter: Stakeholder identification and analysis techniques. *Public Management Review, 6*(1), 21–53

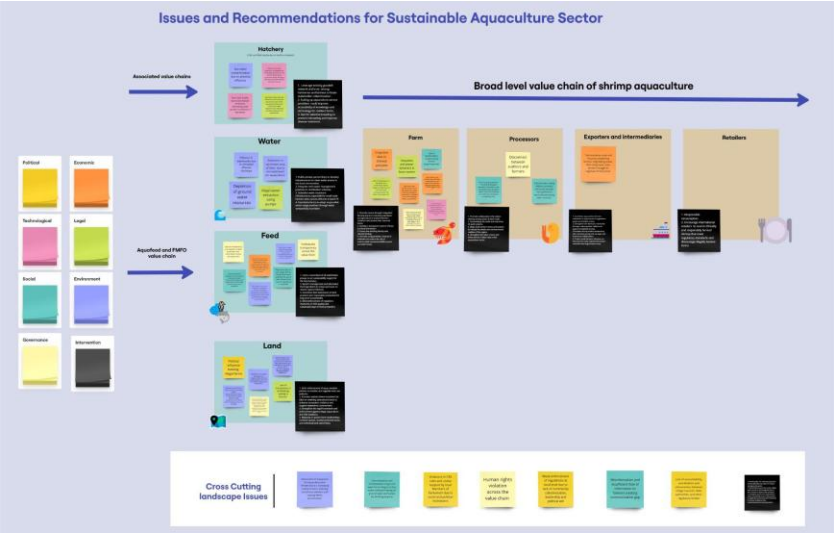
3. **Ecological and socio-ecological issue mapping**

   To understand the landscape's ecological and critical social and economic issues, we identified and conducted semi-structured interviews and group discussions with farmers, hatcheries, intermediaries, processors, conservationists, local communities, grassroots organisations, and different regulatory and statutory bodies regulating the sector. The questionnaires focused on gaining insights into water issues, habitat degradation, farm-vele issues, land tenure issues, labour rights violations, gendered roles, community resilience and market and regulatory aspects.

   Interviews were conducted in Telugu (regional language). We ensured adherence to ethical guidelines in all interviews. Informed and ongoing consent was obtained before conducting and recording the interviews. To protect participants' confidentiality, we anonymised the data during summarisation.
   Miro board was utilised to visualise the issues and key entry points for further analysis.

4. **Formulating holistic recommendations and interventions**
   The fieldwork was followed by consolidating information, transcribing interviews from Telugu to English, and developing key recommendations to facilitate a roadmap for sustainable and responsible aquaculture development in Andhra Pradesh.

Annexure II: Issues and respective recommendations/interventions



We mapped the key issues and entry points on the Miro board. The table below is its elaborated version.

Category	Topic	Issues	Opportunities/ potential interventions
Inputs	**Seeds**	1. Poor quality of seed, leading to crop loss. 2. The inability to do early detection of diseases like WSSV, White Feces Syndrome (WFS), and Running Mortality Syndrome (RMS) leads to significant loss.	Many farmers purchase seed from the same trusted hatchery (Validated by both the hatchery owner and aquafarmer). This trust and good connections can be a leverage point for collectivization among different stakeholder groups. Services providers like AquaExchange conduct regular health screenings for seeds and farmed shrimps, which helps reduce risks. Facilitating the establishment of more screening companies in the landscape could make such services accessible and available and reduce risks.
	Feed	1. Wild-caught fish form the primary ingredient of shrimp feed, leading to massive unsustainable transitions in marine capture fisheries. Demand for protein from the sea has led to indiscriminate fishing and large-scale habitat losses, affecting	1. Multiple organisations, like Dakshin Foundation, are working on the issue of fishmeal and fish oil (FMFO) and its impacts. Along with fishmeal producers, feed companies, and other key industrial actors, a small consortium can be formed at a national level to formulate sustainability targets for the

		the ecology of our oceans and the livelihoods of small-scale fishers. 2. High protein, nitrogen, and phosphorus content in shrimp feed leads to eutrophication and pollution of water bodies, particularly along the coastline. 3. Adding antibiotics 'Antibiotic-free' feed leads to antibiotic resistance, not just in the farms but in the waterbodies outside. This can impact the exportability of the farmed shrimps but also poses a serious health hazard for local communities. 4. The presence of heavy metals in the feeds damages the fish present in the nearby ecosystems. This is found in areas such as Tallarevu and coastal Kakinada, where they discharge effluents directly into the canals without adequate treatment.	fishmeal sector. Dakshin would be happy to take the lead on this. 2. Agencies like MPEDA and the APSADA Act (Andhra Pradesh State Aquaculture Development Authority) should undertake periodic and regular testing of the feed produced by various brands and strictly enforce existing regulatory measures and ASC compliance.
	Certifications	1. There is a massive disconnect between the certification agencies and farmers regarding sustainable practices of undertaking aquaculture. 2. In India, processors are The standards are often 'too technical' for the farmers, leaving room for misinterpretations and non-compliance	1. Simplify certification guidelines and provide training programs tailored to small-scale farmers. 2. Improve communication between certification agencies, farmer groups and processors to bridge the knowledge gap. 3. Reimagine certification strategies and develop participatory certification models that involve farmers in the standard-setting process. 4. Recognition for the unique aspects of India's landscape needs to be incorporated into the certifications.
	Technology	1. In recent years, disproportionate stress on cultivating a single species—Pacific white shrimp (L. *vannamei*)—has led to a higher risk of crop losses and lower profits. 2. *"If we plan to do shrimp monoculture, we*	1. For seed, use diverse species, including native seeds 2. Avoid monocropping of *vannamei* and view it as a multi-species fishery by adopting polyculture and combining shrimp with fish species.

		need to be ready to take risks as it is highly susceptible to disease outbreak." - small-scale farmer.	3. *"We do polyculture here (shrimp and fish grown in the same pond). The fish we produce is enough to compensate for the input costs; whatever we earn from shrimp is additional income."* 4. Address the inbreeding of shrimp in local hatcheries and opt for selective breeding and passing disease resistance (similar to the Ecuador model)
Operations	**Stocking**	1. To reduce crop losses, farmers often indulge in overstocking and feeding, which results in stagnation in growth, reduced productivity, higher natural mortality, and greater risks of disease endemics. 2. "Due to high stocking densities, the growth stagnates and our farmers are harvesting at sizes of 100-80 count and are not going up to 30-40 count. Lower is the count higher is the revenue for them" - SIFT officials	1. Ensure low stocking density and rational feeding.
	Disease	1. Despite investing in biosecurity, farmers experience losses due to disease endemics. If there are two crops in a season, the aquafarmers presume one would be at a loss due to the diseases. This has led many aquafarm owners to lease their lands to other farmers. 2. *"The farms are so susceptible to White-gut disease, and even the medicine for it is too high (5k-6k per Kg)."* - Small-scale farm holder. 3. Due to the high lease amount, farmers cannot afford to sundry the aquafarm between crop seasons. They usually restock the pond without drying it, making it more prone to disease pathogens.	
	Labour and human rights	1. A report by Corporate Accountability Lab (CAL) highlights the poor working	1. Strengthen the enforcement of labour laws in the aquaculture sector, especially in processing units.

		conditions for women workers, including a lack of proper sanitation, ventilation and resting facilities. Having to work for long hours at a stretch, these workers often develop frostbite and skin inflammation from handling chemicals and brine. 2. A high proportion of informal labour is hired without contracts, and they have low social security, prompting them to continue working without raising any concerns.	2. Work with processors to adopt ethical labour certification schemes, like Fair Trade. 3. Understand the challenges behind the workers' unionisation and work with them to strengthen existing systems and grievance redressal mechanisms.
	Biosecurity measures	1. Corporate farmers can maintain well-established biosecurity measures. However, the majority, being small-scale farms, cannot afford it. 2. *"Now nobody is interested because regardless of whether you install biosecurity or not, farmers lose crops."* - Laboratory scientist, Kakinada	
Market level	**Middlemen**	1. Intermediaries tend to unite and fix prices, resulting in poor negotiating power for farmers. Therefore, amidst increasing input costs, farmers are unable to negotiate shrimp prices. 2. This has led to reduced profit margins. Farmers are coping with this by overstocking shrimp seeds by at least 50% in the ponds to resist the change.	1. Incentivise the collectivization of farmers, similar to the producer groups present in the agricultural sector, which empowers them with better market access and price negotiation power. 2. Strengthen the domestic market for shrimps, reducing their reliance on exports and global pricing. 3. Improve transparency in the shrimp trade by making real-time pricing information more accessible to farmers by collaborating with market technocrats. 4. Collaborate with technocrats such as 'AquaBrahma' who work on bridging this gap and improving farmers' access to trade-related information. 5. Given that large farmers get access to trade-related information through their well-established channels, it is imperative to protect the interests of small farmers, who often don't have access to such networks.

	Lack of regulatory mechanisms	1. The use of antibiotics in the past has come under scrutiny, and shipments have been rejected in the EU due to poor hygiene and antibiotic residues. 2. The CAA mandates the establishment of Effluent Treatment Plants (ETP) for aquafarms with an area of 5 hectares or more within the CRZ, which means small-scale shrimp farms have no regulatory obligation to treat the water before discharging. Legally, small farms are obliged to be set up in proximity and have a common ETP, which is not present on the ground.	
Landscape and system level	**Land-use changes (loss of productivity and etc.)**	1. The land used for shrimp farming was historically used for paddy cultivation. Many factors, such as reduced paddy yields and government support for aquaculture, caused the farmers to transition from paddy cultivation to aquaculture. 2. Once converted, the soil becomes hypersaline and unfit for agriculture, causing land abandonment. Besides, the lime used in ponds to treat the soil can modify its physiochemical properties, exacerbating the issue.	1. The fisheries department proposed aquazones to combat such issues. The land-use zonation policy needs to be implemented more strictly. 2. More R&D focus is to be incorporewilding projects for abandoned lands and improve the resilience of the ecosystem and the communities dependent on it.rated to invest in
	Antibiotic resistance	1. Due to intensive shrimp farming, antibiotics are significantly used to prevent diseases, which has the potential to lead to environmental AMR (antimicrobial resistance). 2. Once discharged from the aquaculture ponds into nearby water bodies, the resistant bacteria can have profound health implications for the nearby communities. 3. While exporting antimicrobial residues have been reported from the Indian shrimp being exported to the USA, EU and Japan, leading to	1. Farmers are becoming more aware of antibiotic usage. Therefore, encourage partnership platforms between processors and farmers to understand the long-term impacts of antibiotic resistance through a landscape approach. 2. The certification agencies can play a vital role in supporting farmers in transitioning to probiotic use while reducing the vilification of farmers in antibiotic-related cases. 3. Stricter enforcement of antibiotic regulations by MPEDA and CAA.

		the rejection of the consignments.	
	Pollution	1. The effluents from aquaculture ponds and hatcheries along with booming industries ecosystem including pharmaceutical industries are leading to serious drinking water issues for the villages and communities residing around shrimp farms. 2. The over-extraction of groundwater has led to saltwater intrusion, and many villages are forced to buy water instead of relying on groundwater or canal water.	1. Collaborate with buyers and certification agencies to encourage farmers to adopt sustainable water practices. 2. Collaborate with different industrial players to support initiatives that implement pollution control measures. 3. Enforce stricter effluent treatment requirements, especially for smaller farms.
	Biodiversity loss	1. Habitat loss in the coastal landscape due to mangrove destruction due to the expansion of shrimp farming and infrastructural development. 2. The decline in mangrove habitat has also impacted the bird population, including near-threatened species. 3. Decreased native fish population due to water pollution and disease endemics. 4. Introduction of non-native shrimp species that can have severe impacts on local ecosystems. 5. The invasion by species like *Prosopis juliflora* into the mangrove habitat has severely destroyed the pristine ecosystem.	1. Develop market-driven incentives for farms and processors to adopt biodiversity conservation measures, such as habitat restoration. These can be similar to PES models (Payment for Ecosystem Services) wherein farmers and relevant stakeholders are encouraged to be local stewards to maintain the quality of the ecosystem through financial incentivisation. 2. Encourage companies to invest in conservation programs like mangrove reforestation in brackish and estuarine areas. key shrimp-producing areas. 3. Integrating coconut cultivation with shrimp farming, especially in inland areas with more clayey soil, will promote livelihood diversification. This will help improve farmers' resilience and prevent their seasonal losses. 4. Incorporate biodiversity-friendly practices during certification processes. 5. Promote awareness among consumers to choose sustainably farmed shrimp, pushing the market toward biodiversity-conscious production. 6. Develop market and R&D for native shrimp species i.e., *monodon,* to reduce ecological disruption. 7. Address illegal aquaculture and

			infrastructural development violating CRZ rules.
	Climate change	1. The incessant destruction of mangroves to favour infrastructure development has increased coastal erosion, reduced shoreline protection, and debris deposition in mangrove habitats. NGT has taken suo-moto in a recent case to investigate the extent of ecological damage caused by developments, including the Vishakhapatnam port area, which was once mangrove-rich.	1. Many organisations like MSSRF, EcoNiche are working with communities to undertake mangrove restoration work. Incentives, such as Ecosystem Service Payments, can directly support these initiatives, ensuring sustainability in shrimp farming and long-term assured supply.
	Corruption	1. Violations in CRZ rules and undue support by local Members of Parliament due to inclinations to certain castes and classes. 2. One of the major reasons behind illegal aquaculture was found to be open political backing, causing further disputes and resistance at the village level. 3. Lack of transparency in leasing and licensing of land for aquaculture, particularly of commons and government land	1. Encourage farmers (both small-scale and large-scale) to collectivise and utilise the unions as watchdogs to report unfair practices. This will also ensure the decentralisation of power and work with village-level councils. 2. Industry players collaborate with the government to create a transparent platform to ensure fair land leasing and licensing. This will allow international buyers to source shrimp from farms that meet ethical and regulatory standards and discourage illegally backed farms. 3. Offer premium pricing, product differentiation for produce, or certification benefits to farms that strictly adhere to ethical and regulatory norms.
	Water management (ground and surface)		1. Encourage public-private partnerships to develop infrastructure for clean water access in the local communities. 2. Integrate strict water management practices in certification schemes and auditing, ensuring farmers abide by the water sustainability measures. 3. Processors are given credits for subsidising water treatment infrastructure, especially for small-scale farmers who cannot afford to install ETP. 4. Work with market players and financial incentives for farms that adopt eco-friendly water usage practices - in the form of water

			stewardship incentives.
	Governance and regulatory systems	1. Weak enforcement of existing regulatory measures at the local level. 2. There is a visible lack of coordination and cohesiveness between village councils, state authorities, the forest department, the revenue department, and other regulatory bodies. 3. Weak enforcement of laws regulating effluent discharge and waste management.	1. Strengthen village councils' roles in resolving land disputes and monitoring and enforcing regulations pertaining to aquaculture. 2. Implement community-led monitoring initiatives to ensure compliance with environmental and social standards.

N.B.: There are a few thematic areas where further probing is needed. Due to the sensitivity of issues such as access to capital, loans, and debts, further investigation is needed to map them in detail.

Annexure III: Actor Mapping

Stakeholder category	Important actor groups	Type of agency and their role
Aquaculture farmers	Small farmers, medium farmers and large farmers	Primary producers involved in shrimp/fish farming
Landowners	Customarily owned landowners, Government allocated land, private landowners	Influence expansion and compliance with regulations.
Farm workers	Locals and seasonal migrants, including women	Involved in farm operations and women working shrimp processing plants - often lack labour law protection
Agriculture farmers	Farmers practising integrated coconut-aquaculture and paddy farming	Diversifying livelihoods and utilising traditional and innovative methods to combine agriculture and aquaculture
Capture fishers	Marine capture fishers, freshwater and estuarine fishers	Impacted by habitat loss and water quality degradation due to effluents discharged by aquafarms and industries
Feed factories	Feed manufacturers selling feed to both domestic and/or international market	Private companies and corporations producing feed for shrimp and polyculture - have a crucial stake in responsible feed production
Feed additive factories	Companies producing probiotics, medicines, etc.	Provide nutritional supplements to ensure crop productivity
Seed hatcheries	CAA-registered seed hatcheries	Produce shrimp and fish seed (PL: Post Larvae and fingerlings stage) to the farmers.
Processors and Export Industries	Seafood exporters (including frozen and processed shrimp exporters)	Involved in international trade and engage closely with certification schemes (BAP, ASC)
Wholesale markets	Shrimp and fish wholesale traders	Control bulk distribution of seafood in the domestic market
Retail Markets	Local and regional seafood vendors	Provide direct access to customers through supermarkets and online platforms
Intermediaries	Transport and cold-chain service	Involved in the supply chain by

(logistics)	providers	managing transportation, storage, and export logistics
Farmers Associations	District Fishermen Youth Welfare Association (recently aquaculture farmers also being added)	Producers collectives - advocate for farmers' rights, access to subsidies, etc.
Fisheries Educational Institutions	State Institute for Fisheries Technology (SIFT), National centre for sustainable aquaculture (NaCSA)	Govt. institutions providing capacity development and extension services support
Environmental Organizations & other NGOs	Examples: Democratic Traditional Fishworkers Forum, Dakshin Foundation, MSSRF	Monitor environmental impacts and social injustices. Promote community-based conservation and livelihood enhancement & policy advocacy
Government Testing Labs	State-accredited labs	Conduct disease diagnostics, residue testing and water quality assessments
Local Panchayats	Village and district-level government bodies	Formal governance institutions- Regulate land and water use. Resolve disputes and oversee rural village development
Private consultancies	Example: Seafood Solutions	Provides technical expertise and technical support for farmers, including certifications and environmental compliance assessments
Technicians	Disease and water quality experts.	Support day-to-day farm activities, troubleshooting and farmers' training
Forest Department	Government regulatory body	Oversees illegal encroachments, mangrove restoration and habitat protection, especially in coastal aquaculture zones
Fisheries Department	Coastal Aquaculture Authority (CAA), Marine Products Exports Development Authority (MPEDA)	Regulates aquaculture, licensing, trading and policy implementation
Labour Department	State and national labour agencies	Ensuring human rights and labour welfare along with fair wages.
Revenue	Land and property governance	Managing land tenure, leasing

Department	authority	regulations, tax policies and disputes over land used for aquaculture purposes
Andhra Pradesh Pollution Control Board (APPCB)	Environmental regulatory agency	In charge of developing and implementing environmental safeguards, particularly pollution and effluent discharge
Irrigation Department	State water resource management authorities	Manages water supply, irrigation canals, and resource allocation for aquaculture farms

Annexure IV: Social Survey and Appraisal of Good Practices

Following best practices to conduct social surveys can facilitate generating reliable, inclusive, and policy-relevant insights applicable to any region globally. Our improvised methodology helped us navigate the real-time challenges we faced during this assessment. This section elaborates on some of those learnings inspired by our experiences. These may not be exhaustive, but we kept it replicable and relatable so that any group could initiate similar surveys anywhere in the world.

1. **Understand the landscape and the objectives before starting the assessment.**
    a. Defining the survey's aim is crucial to smoothening the rest of the process. Before heading to the field, meet all the relevant stakeholders involved in designing the survey's objectives and ensure everyone is on the same page.
    b. To better understand the entire landscape, select study sites based on the intensity of aquaculture, the history of conflicts and ecological concerns, and the diversity of stakeholders. Given limited resources, this will help gain more insights with less effort.
    c. Select a mix of qualitative and quantitative methods. Our assessment couldn't include many quantitative perspectives, and we see a scope for improvement. The numbers speak for themselves and can further weigh the narratives gathered from the communities.

2. **Ethics first: No fishy business!**
    a. Obtaining free and ongoing consent from the participants, key informants, and other relevant stakeholders must be uncompromised. This includes explaining to them the purpose, confidentiality, and voluntary participation in the survey. This will ensure the participants' safety and allow them to share more reliable and unbiased information for the survey, as they will be more comfortable participating.
    b. Ensure the anonymity of the participants and data protection.
    c. Adapting the survey strategy to accommodate the region's culture and local context is crucial. Having locals or persons who understand local language, social hierarchies, and traditional norms on the survey team reduces second-guessing the team's decisions and overall approach.

3. **In the case of short-term surveys, stakeholder mapping and data collection processes should be inclusive and in phases.**
    a. With limited resources and time, capturing every voice and narrative may not be feasible. In such cases, having representative stakeholders from each group can help identify key areas for deeper engagement. The survey team should internally discuss and prioritise follow-ups with specific stakeholders to avoid overly broad recommendations.
    b. Furthermore, what worked for our team was conducting the assessment in two phases. The first phase was the pilot survey, which helped narrow the areas with

more focus for a comprehensive report. The second phase was more intuitive and hands-on, and accuracy was assured through data triangulation.

c. Making short-term surveys participatory in the true sense is complex, and rapport-building remains uncertain. However, adopting clear communication and a sensitive approach helped our team overcome some of these challenges and helped gain the trust of the participants. Acknowledging participants' time and providing them with the generated output, which in this case is the reports, can also strengthen long-term partnerships and credibility.

4. Fieldwork 101: navigating logistics and other challenges

a. Considering stakeholders's availability beforehand helps plan the fieldwork. We aligned our survey timings with the stakeholders' harvest days and other personal engagements.

b. Despite the planning, there were instances where participants requested postponing discussions due to unforeseen cultural events, festivals, etc. Staying flexible helps reduce stress within the survey team. Expecting the unexpected helps design contingency plans and replan the fieldwork.

c. We planned many of our visits alongside the local grassroots organisation. This facilitated smooth access to the stakeholder groups.

d. Last but not least, considering traffic, remote site access, and weather conditions significantly contribute to efficient planning and time management.