INCATA PROJECT NOTE 10 JANUARY 2026

Does commercial small-scale aquaculture drive inclusive agricultural transformation in Odisha?

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Key Findings

This mixed methods analysis of the status of small-scale aquaculture in Odisha and its potential to induce inclusive agricultural transformation yields the following key findings:

- **Most of Odisha's population eat fish, but widely observed religious customs limit fish consumption to three days per week for most people.** This means that aggregate demand for fish is about 60 percent lower than it might be in a fish-eating state with a similar population and no dietary restrictions, resulting in low derived demand for aquaculture development to serve local markets.

- **Odisha faces a "second mover" disadvantage in farming fish.** Most of the farmed fish in Odisha's markets is 'imported' from neighboring Andhra Pradesh, which has a long-established, highly productive medium- and large-scale commercial freshwater aquaculture sector that can outcompete farms in Odisha on price, even after accounting for transport costs.

- **Aquaculture growth in Odisha is concentrated along the coast**, in capital-intensive shrimp farming clusters linked to global export markets. Intensive shrimp farming is difficult for small-scale producers to enter or participate in successfully and has been linked to a variety of exclusionary outcomes including soil salinization, and conflicts over land.

- **There is very little commercial small-scale freshwater aquaculture in Odisha.** We found no evidence of major spontaneous clusters of inland aquaculture farms comparable to those found in neighboring West Bengal and Andhra Pradesh, suggesting that aquaculture plays a limited role in driving agricultural transformation in Odisha at present.

- **Government schemes have doubled the number of community tanks and small private fishponds in some areas of Odisha over the past decade**, but the spatial pattern of development atomized, and fish farming is mainly oriented toward subsistence production. Only 0.5 percent of farm households in six surveyed districts had a fishpond.

- **Small-scale inland aquaculture in Odisha makes localized contributions to food and nutrition security.** Households in rural areas with more ponds are more likely to have eaten fish recently. This is valuable for those households who benefit directly.

- **Climate stress poses significant and growing challenges to aquaculture in Odisha's semi-arid and cyclone-prone environment.** These challenges are likely to intensify over time.

Introduction

The research project "*Tracking commercial small-scale producers for inclusive agricultural transformation*" (INCATA) studied the relationships between commercial small-scale producers (farmers) and micro, small and medium enterprises (MSMEs) in Odisha, India, to understand whether and how these relationships could contribute to inclusive agricultural transformation.

The value chains associated with aquaculture (fish and shrimp farming) and horticulture (vegetable cultivation) were initially selected for investigation. Odisha is ranked 5th among Indian states for aquaculture, with reported production totaling 839,000 t in 2022 (DOF, 2023). Preliminary enquiries made with key informants before the initiation of the project suggested that small-scale freshwater aquaculture (production of fish - particularly carp species - in inland areas) is growing rapidly.

Our initial field-based rapid reconnaissance research suggested that while intensive farming of high value vannamei shrimp in coastal ponds for export has boomed over the past decade or more, there are few, if any, substantial clusters of commercial freshwater fish farms producing a large surplus of fish for the local market. Most of the farmed freshwater fish sold in Odisha's markets is sourced from neighboring Andhra Pradesh, to the south where a highly dynamic largescale freshwater aquaculture sector has existed for several decades. In stark contrast, fish farming in Odisha appears limited mainly to low input subsistence oriented-production in small private ponds and collectively managed village tanks.

For these reasons, we chose to focus intensive survey-based research efforts on the vegetable value chain, in which commercial smallholder production is extremely widespread. We gathered information on the fish value chain by integrating relevant questions into market, farm, and community surveys field as part of the vegetable value chain survey and triangulated our field observations using geospatial analysis of the temporal expansion of ponds in Odisha. The remainder of this report summarizes key findings arising from these efforts.

Methods

This report draws on a mix of research methods and data sources. First, we conducted 41 interviews with actors in the aquaculture value chain four over rounds of exploratory rapid reconnaissance research, designed to evaluate the "lay of the land" in the aquaculture and horticulture value chains. The number interviews with fish value chain actors are summarized in Table 1, by value chain node.

Second, we triangulated our field observations of spatial patterns of aquaculture development using geospatial analysis techniques. To examine changes in the location of aquaculture ponds over time, decadal 30 m resolution maps of aquaculture presence and change (expansion) for the 1990s, 2000s, 2010s, and 2020s were derived from the 30 m Global Surface Water (GSW) monthly-water-occurrence product (Pekel et al., 2016). The GSW Version-4 monthly-water-occurrence maps for 1989-1991, 1999-2001, 2009-2011, and 2019-2021 were used. The maps were visually examined to exclude areas where the water detection reliability was clearly degraded by clouds or shadows and water bodies such as rivers, lakes and reservoirs were excluded. This approach allowed us to identify the location of ponds and track pond expansion at decadal intervals.

Table 1: Summary of fish value chain actors interviewed during the INCATA rapid reconnaissance in Odisha

Input supplier	Farmer	Wholesaler	Retailer	Government	NGO	Others	Total
6	5	7	13	5	2	3	41

Source: INCATA Odisha Fish Rapid Reconnaissance Survey, 2024-25

Third, we fielded surveys of 158 markets, of which 117 selling fish, 154 rural communities across 6 districts, and 3,089 farms growing vegetables and/or rice in the same districts. The market and community surveys were organized around structured focus group discussions. They included questions designed to elicit information, respectively, on numbers of fish traders and volumes of fish traded in surveyed markets in 2025 and 10 years prior (2015), and numbers of private and community ponds in surveyed villages. The farm survey included questions on whether households owned ponds, and whether the household had consumed fish within the 24 hours preceding the survey. The remainder of the report synthesizes key findings from these efforts.

Key insights from rapid reconnaissance

In this section of the report, we briefly summarize key findings from the rapid reconnaissance. First, in Odisha, widely observed religious customs limit fish consumption primarily to three days of the week: Wednesday, Friday and Sunday. These are the main market days when fish is sold. Some fish markets do not operate outside these days, while others remain open, but sell much lower quantities than during the three main ‘fish eating’ days. Although 95 percent of Odisha’s population are fish eaters (Padiyar et al. 2024), this custom substantially limits aggregate demand for fish relative to other states with large fish-eating populations and fewer dietary restrictions (e.g. West Bengal) and, thereby, limits derived demand for fish production and associated value chain development in Odisha.

Second, the vast majority of farmed fish in Odisha available in Odisha’s markets are ‘imported’ from neighboring Andhra Pradesh. Andhra Pradesh’s freshwater aquaculture predates Odisha’s by several decades. The value chain for fish from Andhra Pradesh extremely well developed. Trucks loaded with insulated Styrofoam boxes packed with fish (mainly rohu, a type of carp) and ice are dispatched daily by traders from Andhra Pradesh to supply markets all over Odisha, West Bengal, and far beyond. Fish produced in Andhra Pradesh originates from clusters of large- and medium-scale, highly commercial, intensively managed fish farms with high yields (Belton et al. 2017). These farms produce fish more cheaply than farms in Odisha due to their economies of scale and high productivity, even after accounting for transport costs. Competitive pressure from commoditized ‘Andhra fish’ makes it difficult for commercialization to take off in Odisha’s freshwater fish farms.

Third, numerous large clusters of commercial shrimp ponds exist throughout the coastal belt in Odisha, around Lake Chilika, India’s largest brackish water lagoon, and in low-lying deltaic areas at the mouth of the Mahanadi River and several other river systems that discharge into the sea in the state. These shrimp farm clusters are served by an ecosystem of specialized businesses, including shrimp hatcheries, feed and input supply businesses, traders, transporters, and processing factories. Shrimp farmers are dependent on input suppliers for formulated feeds, and chemicals for maintaining water quality and treating diseases. These inputs are often advanced by suppliers or traders to farms as in-kind credit. Some advances are output-tied, obliging farmers to sell their produce to the credit providers.

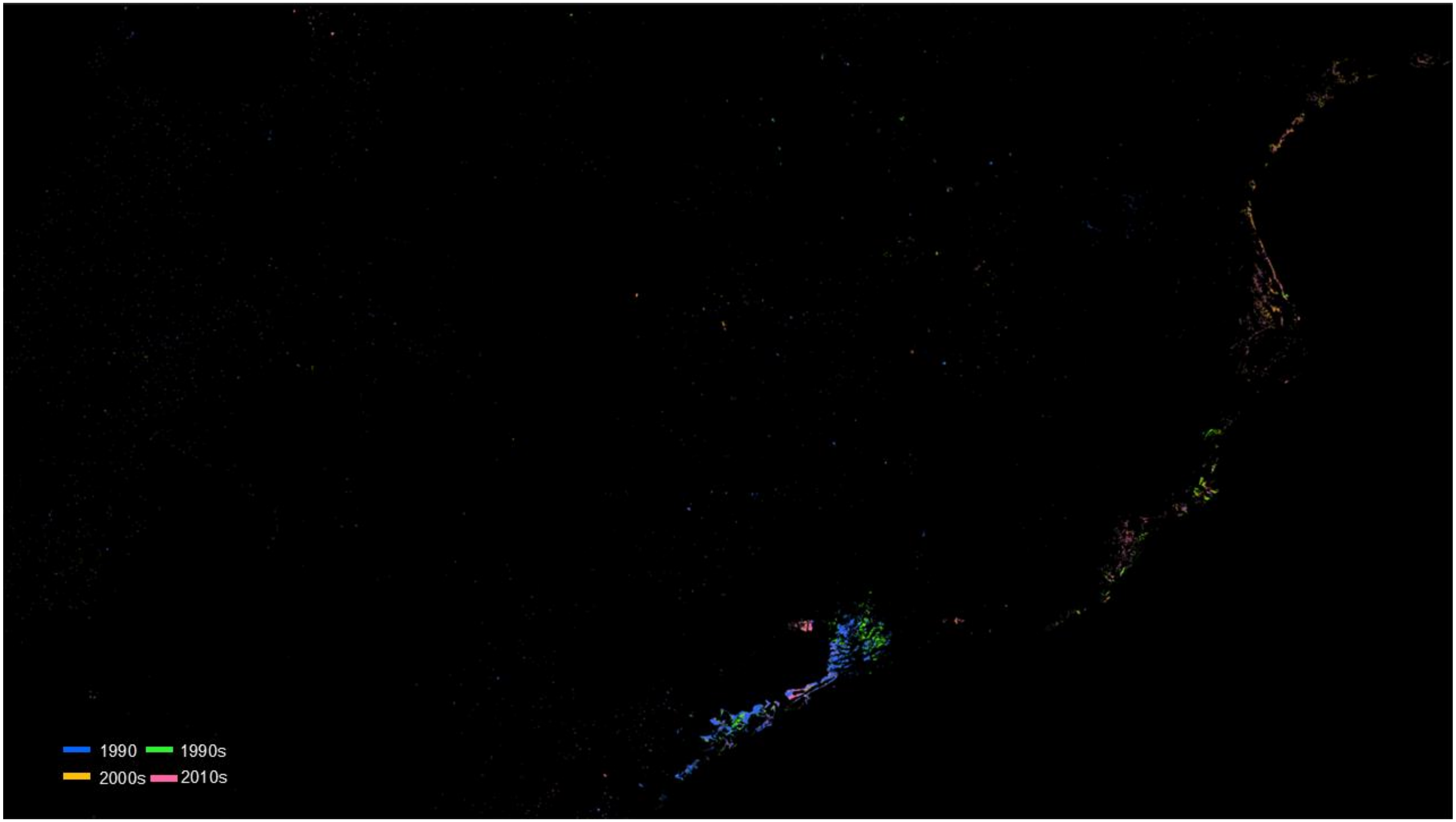
The apparently widespread extent of interlocking markets in the ‘modern’ shrimp value chain reflects high production high costs, which can run to tens of thousands of dollars per hectare on intensive farms, and the inherently risky nature of shrimp production, as shrimp is both highly disease prone and exposed to price movements in the volatile global shrimp market. This makes shrimp production risky, with losses common, making many farmers dependent on borrowing to cover operating costs, although it is also potentially highly lucrative if high prices coincide with good yields. Although many shrimp farms are quite small, they are highly capital-intensive. Moreover, shrimp farming in Odisha has been linked to a range of exclusionary impacts including land grabbing and salinization of agricultural land (e.g. Chhotray, 2022). These factors place shrimp farming out of scope for INCATA.

Fourth, unlike in neighboring Andhra Pradesh and West Bengal, where spontaneous clusters of commercial freshwater fish farms are found in numerous districts, we were unable to identify any major cluster of inland fish farms and linked MSMEs. Away from the coast, aquaculture in Odisha follows an atomized pattern of spatial development, scattered across numerous widely distributed multipurpose community tanks that are also used for bathing, irrigation, and watering cattle and other functions besides fish culture, and in small privately owned ponds.

Various government programs including the erstwhile Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), and PMMSY (the Prime Minister’s Fishery Wealth Scheme) have either constructed or subsidized the construction of both community and private ponds in recent years, while fish culture in community tanks and among private pond owners has been promoted by government and NGOs, often by working with women’s self-help groups (WSHGs). Based on our observations at numerous rural and urban markets across Odisha, locally produced farmed fish from village tanks and backyard aquaculture ponds enters markets in very limited quantities. This observation suggests that smallholder freshwater fish farming in Odisha at present is mainly for subsistence and/or extremely localized commercial consumption (i.e. sold within the same village where it is produced).

Fifth, Odisha’s climate is semi-arid and thus not ideal for aquaculture. We observed multiple instances in the field of climate stress negatively impacting aquaculture during rapid reconnaissance. Examples include hatcheries unable to produce fish seed because the delayed onset of rains had left nursery ponds devoid of water, a major fish kill at a rare commercially oriented fish farm, brought about by overfeeding, low water levels, and high water temperatures resulting in a crash in dissolved oxygen, and accounts of shrimp farmers of making losses with increasing regularity on account of erratic rainfall and temperature fluctuations that result in high mortality.

Figure 1: Image of Odisha, showing decadal expansion of aquaculture ponds, and clustering of shrimp ponds on the coastline



Source: Own geospatial analysis

Figure 2: Close up inset of central Odisha showing decadal expansion of ponds, and atomized pattern of spatial distribution

Source: Own geospatial analysis

Geospatial analysis

Figures 1 and 2 above confirm the pattern of geographical distribution of aquaculture ponds observed during rapid reconnaissance. In Figure 1, the location of dense clusters of shrimp ponds along large swathes of Odisha's coastline is immediately apparent, forming a boundary between land and sea. The earliest of these farms were already in place in 1990 around the shores of Lake Chilika. Most shrimp pond expansion during the 1990s was also close to Chilika, but it has extended north up the coastline over the past 2 decades into new frontier zones in response to demand from global shrimp markets and as land in the original cradle around Chilika became fully occupied by ponds or legally protected.

A loose constellation ponds occupying small areas of land spread across swathes of inland districts can also be seen in Figure 1. Figure 2 is a zoomed-in inset from Figure 1, showing this pattern in more detail. Hillier areas with few ponds appear dark. Individual ponds of different ages are spread widely and apparently haphazardly across space, with no clustering evident. This pattern of distribution appears consistent with many villages having low numbers of ponds, with little spatial concentration, and confirms the absence of any major inland aquaculture clusters in Odisha.

Markets

In this section we report results on fish from our market survey. Of 158 markets surveyed, 117 sold some fish. Most fish markets (75%) are retail-only markets. Twenty-four percent combine wholesale and retail functions, and only a single market functions exclusively as a wholesale market (Table 2).

Table 2: Number and share of surveyed markets selling fish, by type of market

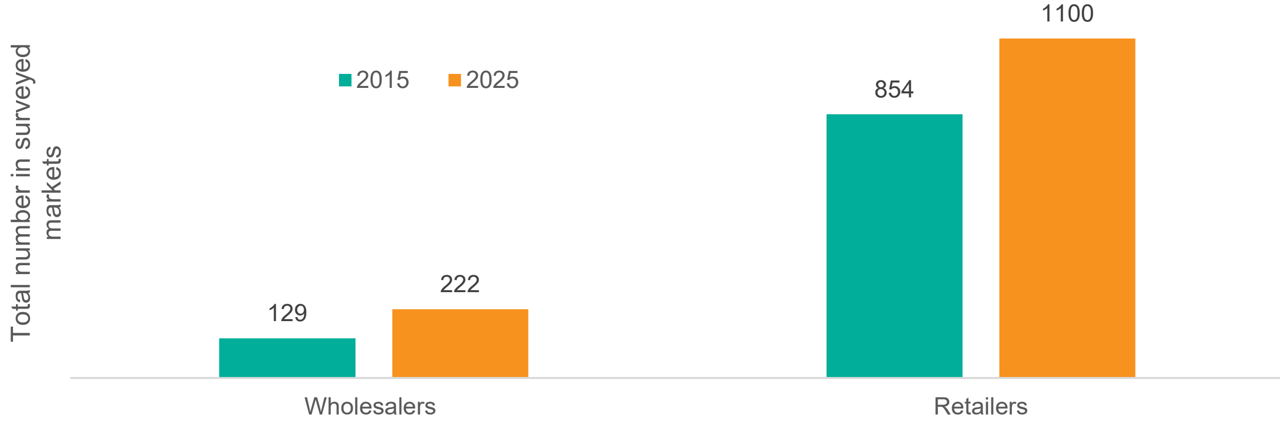
This section of the report summarizes Category	Number	%
All markets selling fish	117	100
Wholesale + retail	28	24
Retail only	88	75
Wholesale only	1	1

Source: INCATA Odisha Market Survey, 2025

Figures 3 and 4 present, respectively, the total numbers of fish wholesalers and retailers present in 117 surveyed fish markets, and the average number of male and female wholesalers (Figure 4a) and male and female retailers in each market (Figure 4b). Figure 5a presents the average quantity of fish traded in each market on 'normal' market days (Wednesday, Friday and Sunday), in tons, in 2015 and 2025. Figure 5b presents the share of fish traded in each market reported as originating from out of state in 2015 and 2025. Several points stand out.

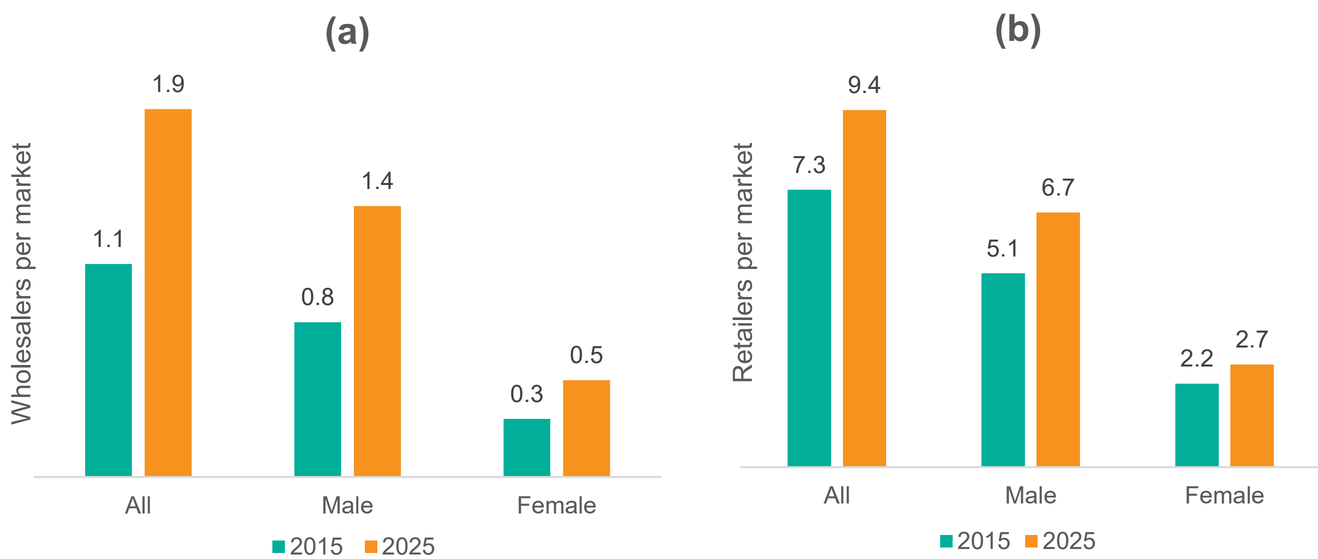
First, the number of fish wholesalers increased at a higher rate than number of fish retailers from 2015 to 2025 (by 72 percent vs 29 percent), but from a low base. Most markets had no fish wholesaler. Second, women accounted for 26 percent of fish wholesalers and 29 percent of fish retailers in 2025, marginally down from their share of the total in 2015.

Figure 3: Total number of fish wholesalers and retailers in surveyed markets, 2015 and 2025



Source: INCATA Odisha Market Survey, 2025

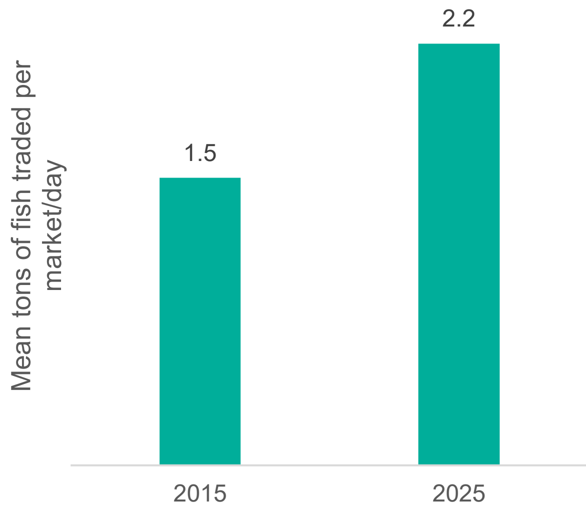
Figure 4: Average number of (a) wholesalers and (b) retailers operating per market during high season, 2015 and 2025

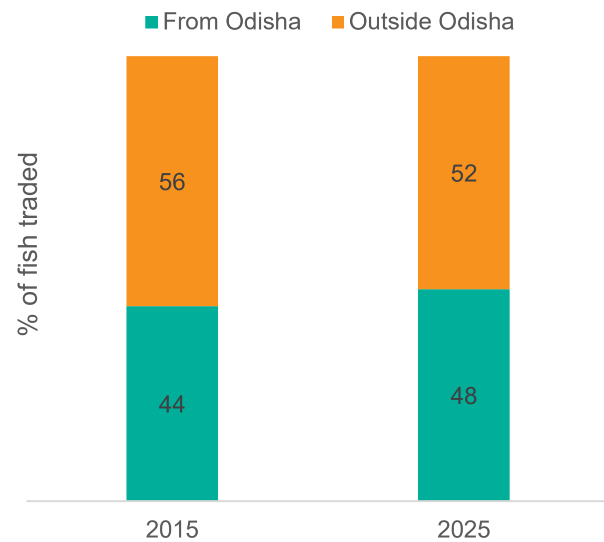


Source: INCATA Odisha Market Survey, 2025

Third, the number of fish wholesalers and retailers in each market is much lower than the number of vegetable wholesalers and retailers, reflecting the much lower volumes of fish traded compared to vegetables. However, women account for a larger share of fish wholesalers (26 percent) than they do in the vegetable value chain (1 percent), but participate in fish and vegetable retailing at similar rates (29 percent and 28 percent, respectively). This finding could be indicative of a caste-based element to fish trading, which is often practiced by members of scheduled fishing castes, intersecting with gender, rather than signifying that the wholesale segment of the fish value chain is necessarily more inclusive than that of the vegetable value chain.

Figure 5a: Average quantity of fish traded per market on market days (t), 2015 and 2025; **Figure 5b:** Percentage of fish traded originating from inside and outside Odisha, 2015 and 2025.





Source: INCATA Odisha Market Survey, 2025

Fourth, the average quantity of fish traded each day is much lower than the quantity of vegetables traded per market: 1.5 t of fish per day, as compared with 38 t vegetables per day in low season, and 65 t in high, partly reflecting that higher proportion of retail only fish markets compared to vegetables.

Fifth, the share of fish traded that reported was as originating from outside Odisha was greater than 50 percent in 2015 and 2025, but fell 4 percentage points between the two years, possibly suggesting an increase in local supply over this period. However, based on our observations during rapid reconnaissance, per our own field observations, most of the fish available in markets that originate from Odisha is harvested from marine and, to a lesser extent, freshwater, capture fisheries. Moreover, the out-of-state share of fish delivered to markets in Odisha may be underreported if respondents consider fish produced outside Odisha (primarily Andhra Pradesh), but sold to them by wholesalers based in Odisha, to have been delivered 'from Odisha'.

Numbers of businesses present in and around surveyed markets that support the fish value chain are reported for 2015 and 2025 in Table 3. The total number of markets selling fish increased by only 11% over this period. Numbers of private cold storage businesses increased substantially, but from a very low base, from 2 to 8. Based on our observations in markets, we hypothesize that these businesses are used primarily for storing fish rather than vegetables. Ice factories are critical to the functioning of fish value chains as ice is an essential input for facilitating long distance fish trade in the absence of a cold chain. Their numbers approximately doubled in a decade, to 13. Insulated Styrofoam boxes packed with ice are critical for preserving fish quality during transit or prior to sale. The number of markets where at least one enterprise selling foam boxes also increased sharply, from 5 to 25.

Finally, fish cutters are market workers who process freshly purchased fish for customers for a fee, by gutting, descaling, and cutting it into ready to cook pieces. Their numbers have grown in recent years, anecdotally, because consumers are increasingly time constrained or have less paid domestic help than previously, have little time to process fish at home, and find it convenient to use the services of fish cutters for a fee. Their numbers grew by 52 percent over the decade, to reach an average of 2.4 per market.

Table 3: Total numbers of ancillary businesses per fish market, percentage change 2015 to 2025, and average numbers of businesses per market

Category	2015	2025	% change (2025/2015)	Number per market (2015)	Number per market (2025)
Markets selling fish	105	117	11	-	-
Private cold storage businesses	2	8	300	0.02	0.07
Ice factories	6	13	117	0.06	0.11
Insulated foam box sellers	5	26	420	0.05	0.22
Fish cutters	183	278	52	1.74	2.38

Source: INCATA Odisha Market Survey, 2025

Ponds

In this section of the report, we review the characteristics of ponds in rural areas. Table 4, based on our community survey, reports the share of 154 surveyed villages with a community or private pond, the average and total numbers of each, and change in these numbers from 2015 to 2025. About two-thirds of surveyed villages had a community pond in 2025, up 6 percentage points from 2015, but the total number of community ponds increased at a much faster rate over the same period (78 percent) to reach 437; an average of 2.8 per village. This suggests that programs such as NREGA have contributed substantially to increasing numbers of community ponds, particularly in villages that already had them. However, as noted above, although community ponds may be used for aquaculture this is not always the case in practice and we do not know how many were used for this purpose.

The share of villages with at least one private pond is slightly lower than that of community ponds (54 percent) but grew sharply from 2015 to reach a similar number to that of community ponds (454, or 2.9 per community on average). These figures indicate that substantial construction of private ponds has taken place over the past decade, albeit starting from a very low base (Table 4).

Table 5 breaks down community survey results further, by district, and incorporates data on the average area of private ponds in these districts, as reported in our farm survey. The average number of private and community ponds per village varies substantially by district. It is lowest in Balangir, a district bordering Chhattisgarh State, (averaging 0.8 and 1.3 private and community ponds per village surveyed, respectively). The highest pond densities (7.8 private and 6.0 community ponds per villages) are found in Keonjhar in northern Odisha, which has a large tribal population. Other districts have intermediate numbers of ponds. Geographical variations in pond densities may reflect differences in soil type, depth of water tables, and topography, as well as cultural factors that might influence fish consumption preferences. Ponds are small in size, averaging 0.3 ha, but size also varies among districts, being lowest in Keonjhar (0.08 ha) and highest in Ganjam (0.57 ha), closely followed by Anugul (0.56).

Table 4: Share of villages with private pond and community ponds, total numbers of ponds in surveyed villages, and average numbers of ponds per village in 2015 and 2025

Category	2015	2025	change (2025/2015)
Villages with a community pond (%)	59	65	6 percentage points
Total number of community ponds	245	437	78%
Average number of community ponds per village	1.6	2.8	1.2
Villages with a private pond (%)	29	54	25 percentage points
Total number of private ponds	127	454	275%
Average number. of private ponds per village	0.8	2.9	2.1

Source: INCATA Odisha Community Survey, 2025

Table 5: Average number of private ponds and community ponds per village, by surveyed district, 2025

Category	Average number of private ponds per village	Average number of community ponds per village	Average area of private ponds (ha)
Cuttack	1.9	2.3	0.19
Ganjam	1.1	2.3	0.57
Balangir	0.8	1.3	n/a
Anugul	3.4	2.6	0.56
Keonjhar	7.8	6.0	0.08
Koraput	1.8	1.9	n/a
Total	2.9	2.8	0.30

Source: **Source:** INCATA Odisha Community and Farmer Survey, 2025

Table 6, drawn from our farm survey, compares the share of households operating a pond and the share of households reporting fish consumption within the past 24 hours, by various household characteristics. It is rare for farm households in Odisha to possess a pond. Only 0.5 percent of households surveyed have one. Interestingly, pond ownership is highest among scheduled castes and lowest for non-scheduled caste households, possibly reflecting prescriptions against certain upper caste groups participating in activities linked to fish. A higher share of vegetable farming households (0.6 percent) has a pond than households farming only rice (0.3 percent). The reasons for this are not known, but it is possible that ponds are used as a source of irrigation water for surrounding vegetable plots. As expected, larger farms are more likely to have a pond. The share of households in land tercile 1 (the third of farms with the smallest operated holdings) is 0.1 percent, rising to 1.1 percent in land tercile 3. As observed in Table 6, ponds are not evenly distributed among districts. None of the households surveyed in Balangir or Koraput had a pond, while 1 percent and 1.4 percent of those in Cuttack and Keonjhar, respectively, did.

Table 6: Percentage of farm household with private ponds and percentage of farm households consuming fish within past 24 hours, by households characteritics and district, 2025

Category	% of households with a pond	% of households consuming fish in past 24 hours
Whole sample	0.5	15.9
Scheduled tribe	0.5	17.1
Scheduled caste	0.8	15.4
Non-scheduled caste	0.4	15.5
Vegetable farming households	0.6	17.3
Non-vegetable farming households	0.3	14.2
Land tercile 1	0.1	18.1
Land tercile 2	0.5	12.0
Land tercile 3	1.1	17.1
Anugul	0.7	13.4
Balangir	0.0	9.6
Cuttack	1.4	21.8
Ganjam	0.4	12.4
Keonjhar	1.0	28.5
Koraput	0.0	16.1
N	**3,065**	**1,218**

Source: INCATA Odisha Farmer Survey 2025.

There appears to be some correspondence between levels of pond ownership and levels of fish consumption. A subset of survey respondents was asked whether their household had consumed fish within the past 24 hours. Although 95 percent of Odisha's population consumes fish on occasion (Padiyar et al. 2024), only 16 percent had done so within the preceding 24 hours. This low level of consumption in part reflects the effect of widely followed religious restrictions on fish eating four days per week. Some interesting patterns are evident.

First, there are not large caste-based differences in propensity to consume fish. Almost the same share of scheduled and non-scheduled caste households and a marginally higher share of members of scheduled tribes (around 15.5 and 17 percent, respectively), consumed fish within the past 24 hours. Second, a slightly higher share of vegetable farming households than non-vegetable farming households (17 percent and 14 percent) had consumed fish within the past 24 hours, possibly reflecting the higher levels of pond ownership observed among vegetable farmers. Third, interestingly, although pond ownership increases sharply with landholding, fish consumption does not. For unknown reasons, land tercile 1 households have the highest rates of fish consumption (18 percent) and land tercile 2 the lowest (12 percent).

Finally, there are large variations in fish consumption by district that appear to correspond with variations in the share of households owning ponds. Fish consumption within the past 24 hours was lowest in Balangir where no surveyed households owned a pond and only 10 percent consumed fish, and highest in Keonjhar and Cuttack, where are least 1 percent of households have ponds and 29 and 22 percent of households respectively had consumed fish. It is not clear from the result whether households in districts with a higher preexisting propensity for fish consumption were more likely to construct ponds, or whether the existence of ponds raises the likelihood of fish consumption, but it is probable that this relationship runs in both directions. These results suggest tentatively that production of fish in small rural ponds, though not highly commercially oriented can create consumption spillovers for other nearby households, contributing to food and nutrition security, despite a lack of commoditization.

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ACKNOWLEDGMENTS

The INCATA project was implemented under a Memorandum of Understanding between the International Food Policy Research Institute and the Government of Odisha. We gratefully acknowledge the guidance and strategic direction provided by Dr. Arabinda Kumar Padhee (IAS), Additional Chief Secretary to the Government, Department of Agriculture & Farmers' Empowerment (DA&FE), Government of Odisha. We also extend our sincere appreciation to Sri. Pawan Kalyan (IAS), Director of Horticulture, Government of Odisha, Smt. Dharitree Mishra, Managing Director, Odisha State Agricultural Marketing Board (OSAMB), Sri Shubhranshu Mishra (OAS), Additional Secretary to the Government, DA&FE, Government of Odisha, Dr. Sangram Kesari Pattanaik, Joint Director of Agriculture, DA&FE, Sri Nagendra Kumar Mallik, Dy. Director of Agriculture, DA&FE and other officials and staff of the Government of Odisha for their valuable advice, inputs, and support in facilitating field-level activities.

This work was supported, in whole or in part, by the Gates Foundation GRANT INV-066950. Any opinions expressed here belong to the authors and are not necessarily representative of or endorsed by IFPRI or CGIAR. The conclusions and opinions expressed in this work are those of the authors alone and shall not be attributed to the Foundation. This work is a contribution to the CGIAR Science Program on Policy

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