COMMERCIAL SMALL SCALE VEGETABLE PRODUCERS AND INCLUSIVE AGRICULTURAL TRANSFORMATION IN ODISHA

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ABSTRACT

This report compiles findings from a research project titled “Tracking commercial small-scale producers for inclusive agricultural transformation” (INCATA), that studied the relationships between commercial small-scale producers (farmers) and micro, small, and medium enterprises (MSMEs) in vegetable value chains in Odisha, India. The goal was to understand whether and how these relationships could contribute to inclusive agricultural transformation. The research effort included rapid reconnaissance visits to 19 districts in the state, secondary data analysis and qualitative case studies, culminating in survey of 5640 value chain actors (farmers, inputs suppliers, wholesalers, commission agents and retailers). In addition, we documented the profile of 11,800 traders across 158 vegetable markets and 35,913 households in vegetable growing villages in 24 blocks and 6 districts as part of a listing exercise. This report comprises six standalone chapters, each focusing on a specific research question and authored by different teams, with the first chapter introducing the study and its methods.

Keywords: Vegetable value chains, MSMEs, commercialization, small scale producers, inclusive, India, gender, clusters

RESUMEN EJECUTIVO

Este informe compila los hallazgos de un proyecto de investigación titulado “Seguimiento de productores comerciales de pequeña escala para una transformación agrícola inclusiva” (INCATA), el cual estudió las relaciones entre los productores comerciales de pequeña escala (agricultores) y las micro, pequeñas y medianas empresas (MIPYMES) en las cadenas de valor de hortalizas en Odisha, India. El objetivo fue comprender si estas relaciones podrían contribuir a una transformación agrícola inclusiva y de qué manera. El esfuerzo de investigación incluyó visitas de reconocimiento rápido a 19 distritos del estado, análisis de datos secundarios y estudios de caso cualitativos, culminando en una encuesta a 5.640 actores de la cadena de valor (agricultores, proveedores de insumos, mayoristas, comisionistas y minoristas). Además, como parte de un ejercicio de empadronamiento, documentamos el perfil de 11.800 comerciantes en 158 mercados de hortalizas y 35.913 hogares en aldeas productoras de hortalizas en 24 bloques y 6 distritos. Este informe consta de seis capítulos independientes; cada uno se centra en una pregunta de investigación específica y ha sido elaborado por diferentes equipos, siendo el primer capítulo el encargado de introducir el estudio y sus métodos.

Palabras clave: Cadenas de valor de hortalizas, MIPYMES, comercialización, productores de pequeña escala, inclusivo, India, género, clústeres.

1. 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 horticulture value chains in Odisha, India. The goal was to understand whether and how these relationships could contribute to inclusive agricultural transformation.

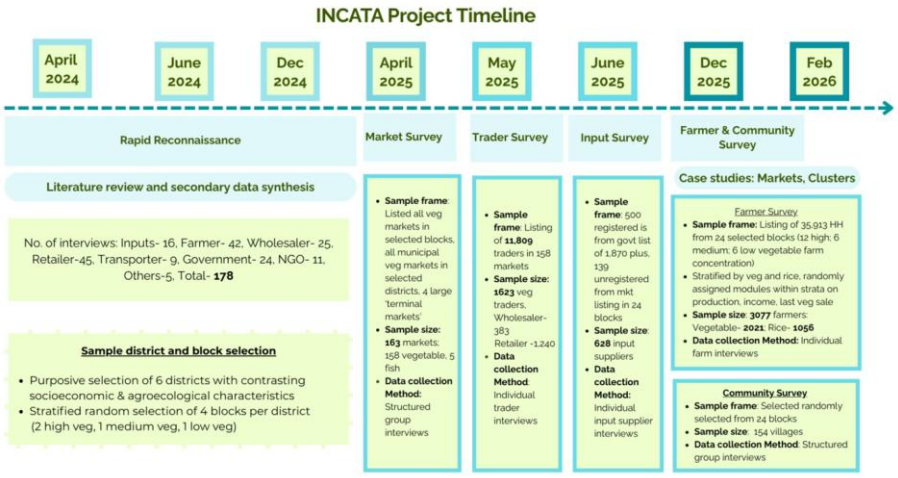
The project was designed to address several questions. This was based on the assumption that improved understanding of these dynamics will inform more effective policy design and implementation in support of inclusive agricultural transformation:

What factors kickstart agricultural commercialization? How do small-scale producers become commercial, how do MSMEs upstream and downstream of the farm get started, and how do these two sets of actors co-develop together?
To what degree does the co-development of commercial small-scale farms and supporting MSMEs translate into poverty reduction and women's economic empowerment? Who is included, and who is excluded, or gets stuck at low levels of inclusion, or slips backward? What are the economic opportunities available for youth in the transformation process?
What policies and investments have the potential to accelerate the symbiotic co-development of commercial small-scale producers and MSMEs, and the inclusive effects of their co-development?

To address these questions, INCATA focused on the value chain associated with commercial small-scale horticulture (vegetable cultivation) in Odisha. The vegetable value chain was selected because of the high level of participation and commercial orientation among small-scale vegetable producers, the high value of vegetable crops relative to staples, and the importance of vegetables for nutrition.

In the sections below, we set out in sequence the unique research methodology implemented in Odisha over the course of the project. The project timeline and research activities are illustrated in Figure 1.

Figure 1: Timeline of INCATA project activities in Odisha.



Formative research

The first year of the project was devoted to formative research that allowed for the formulation of precise research questions and a robust sampling strategy for subsequent surveys. This was comprised of two parts: (1) a literature review and synthesis of secondary data, and (2) rapid reconnaissance fieldwork.

Secondary data

The project team reviewed prior literature on horticulture and markets in Odisha, and India more broadly, to identify key themes that could be used as hypotheses to be tested empirically by quantitative surveys in the second half of the project. With the support from the Government of Odisha, the project team collated and synthesized large amounts of published and unpublished secondary data from Odisha. Datasets compiled included the following: time series district-wise horticultural production from the Directorate of Horticulture, district-wise land use statistics, information on quantities and prices of vegetables delivered to markets in Odisha, and a complete list of registered agricultural input suppliers. These data compilation and synthesis activities supported subsequent sampling strategies and sample frame development.

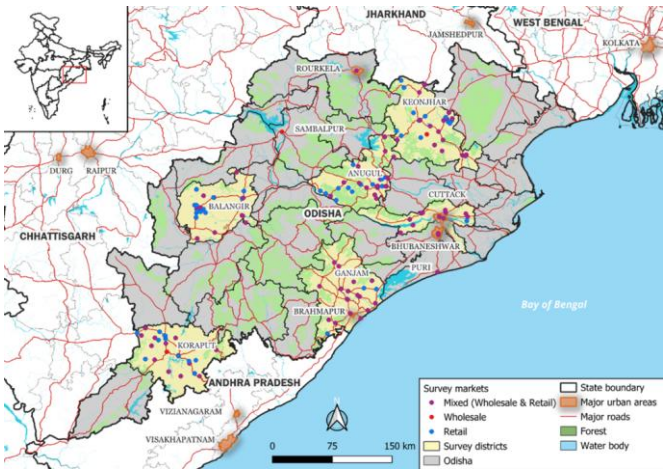
2. METHODS
Rapid Reconnaissance

Rapid reconnaissance is a technique for systematically understanding the 'lay of the land' in a value chain in a specific region. It is based on in depth, semi-structured field interviews with actors in the value chain of interest. This approach allows for triangulation of data collection and information across actors from multiple locations, value chain segments, and scales of operation on the nature of their day-to-day business operations, and longer-run changes occurring in the sector.

The information collected during rapid reconnaissance is synthesized qualitatively to: (1) arrive at a basic understanding of local conditions and how actors in the value chain operate, (2) inform decisions on sampling strategy, (3) refine research questions to reflect dynamics observed in the field. Information acquired and hypotheses developed during rapid reconnaissance thus provide the foundation for the design of all subsequent quantitative research activities, as well as the detailed contextual knowledge needed to correctly interpret their results.

The locations visited during rapid reconnaissance fieldwork are presented in Figure 2. The fieldwork covered three large circuits, each focused on a distinct geography: the coastal plain (the most prosperous part of the state), the southern uplands (the least economically developed and most hilly part of the state, with a high concentration of tribal communities), and the northern uplands (an intermediate area in terms of socioeconomic conditions).

Figure 2: Map of Odisha showing the location of markets and traders selected for inclusion in INCATA surveys



Source: Authors

We visited 19 of Odisha's 30 districts, and 35 markets during the rapid reconnaissance, spending around 120 person days in the field in total. Interview respondents were selected opportunistically but purposively, based on a mix of introductions made via personal contacts of the project team, and ad hoc interviews. We conducted 178 interviews with actors associated with Odisha's vegetable value chains (Table 1).

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

Input supplier	Farmer	Wholesaler	Retailer	Transporter	Government	NGO	Others	Total
16	42	25	45	9	24	11	5	178

Source: INCATA Odisha Rapid Reconnaissance, 2024-25.

The interviews followed semi-structured guidelines containing open-ended questions about the microeconomic conduct of each type of actor interviewed, organized with reference to (1) business assets owned or accessed by the respondent (2) input acquisition behavior; (3) value addition, (4) disposal of outputs, (5) access to services and amenities, and changes in numbers of value chain actors over time.

After reflecting on findings from the rapid reconnaissance, we developed a refined set of core research questions that reflected our observations of how vegetable value chains in Odisha were developing. These questions are set out in Box 1. They cover issues related to transformations in value chain structure, changes in the conduct of small-scale vegetable producers, inclusion, smallholder commercialization, symbiosis, clustering, and market formation. These questions informed our design of all subsequent research (questionnaire and sample design).

We attempt to answer each question in the chapters in this series, drawing on results of our research activities across all value chain nodes. These research activities are elaborated in the following sections.

***Box 1**: Research questions arising from the rapid reconnaissance*

- How are vegetable markets transforming?
- Who grows vegetables?
- How are the production practices of vegetable farmers transforming?
- Does commercial small-scale vegetable farming production enhance farmer welfare?
- Are the relationships between actors in Odisha's vegetable value chains parasitic or symbiotic?
- Who is included in the vegetable value chain, and on what terms?
- How do spontaneous vegetable production clusters form, and how inclusive are they?
- How do "organized" vegetable clusters impact women's voice and agency?

Study area and district and block selection

Six districts—Cuttack, Ganjam, Angul, Keonjhar, Balangir, and Koraput—were purposively selected from Odisha's 30 districts, to ensure agroclimatic, socio-economic, and institutional diversity in the areas studied (Figure 2).

Selection criteria included representation of varied agroclimatic zones, inclusion of tribal and non-tribal regions, and heterogeneity in vegetable cultivation intensity and recent trends. Vegetable cultivation intensity was measured using a district-level vegetable concentration index that we constructed based on district level data on vegetable production over a 10-year period.

Districts with and without exposure to the state's Agricultural Production Cluster (APC) program - designed to accelerate the expansion of commercial vegetable cultivation in economically deprived areas of Odisha - were selected to reflect the state's efforts to support vegetable production. Together, the selected districts account for approximately 30 percent of Odisha's reported vegetable cultivation area and production and 29 percent of its population.

Within each district, all blocks (sub-districts) were stratified by vegetable production concentration (high, medium, low) in consultation with the Department of Horticulture. From each district, four blocks were selected randomly—two high-concentration blocks, one medium, and one low—yielding 24 blocks in total. This stratification permitted comparison across production intensities and between APC and non-APC blocks.

Market identification

A comprehensive effort to list all vegetable markets1 in the six selected districts was undertaken. A list of markets was obtained from the Government of Odisha and validated in the field. We selected all rural markets in the 24 selected blocks and all urban markets in the 6 selected districts. In addition, four 'terminal markets' (major wholesale markets receiving deliveries from out of state) located outside our sample districts were included in the sample because of their importance as regional aggregation and distribution hubs for horticultural produce.

Initially, 154 vegetable markets were identified across the six districts. Markets with fewer than 20 retailers were excluded from the final sample due to their small size, irregular operation, and limited relevance for studying value chain dynamics. During survey implementation, we identified additional markets selling vegetables within our study area, bringing the number of markets in the sample to 158.
We conducted a survey in all 158 markets based on structured Focus Group Discussions (FGDs) to collect quantitative information on market origin, evolution, infrastructure, management and

[1] We did not adopt a specific definition of market to ensure that we did not exclude those that the communities in the study area deemed to be markets.

governance, the volumes of vegetables traded in high and low season, and the numbers of traders and ancillary businesses present in the market at the time of the survey and ten years prior.

Sampling of traders and input suppliers

Our surveys of off-farm vegetable value chain segments covered three categories of market actors: retailers (including farmer-retailers - farmers visiting markets to sell their own produce), wholesalers (including commission agents – wholesalers earning a fee for coordinating transaction among buyers and sellers), and agricultural input suppliers.

In each market, we conducted a census of all actors engaged in selling vegetables and/or agricultural inputs (seeds, fertilizers, or agrochemicals). These included all those operating within 50 meters of the "core" market area. In all cases, we considered the market to be the area defined by those who operated there. Traders specializing exclusively in sales of potatoes, onion, ginger, and garlic were considered out of scope for the survey and were excluded. We listed 11,809 sellers in all, representing the universe of traders operating in selected markets on the day of the listing. We drew on this list to select respondents for inclusion in the survey.

A stratified random sampling approach was used, with each of the markets serving as a stratum. Within each market, nine retailers were randomly selected from a complete market census list, resulting in a planned sample of 1,206 respondents. Sample size calculations assumed a prevalence of 0.5, a design effect of 2, a 5 percent margin of error, and a 70 percent response rate. The final achieved sample comprised 1,240 retailers.

For wholesalers, a census approach was adopted, reflecting their relatively small numbers and central role in aggregation. All wholesalers operating in surveyed markets were targeted, including unlisted actors identified during the survey. In total, 383 wholesalers/commission agents were interviewed. Around five percent of wholesalers who were approached declined to participate in the survey. Input suppliers were sampled using a mixed strategy. All input suppliers operating within the selected markets were surveyed (n = 139). To capture off-market input suppliers, a random sample of 500 registered input dealers was drawn from a government-provided list of 1,870 registered suppliers across the six districts. About three-quarters of licensed input suppliers selected from the list for inclusion in the survey were reached, and the rest were confirmed to have exited the business. The final sample included 628 input suppliers (Figure 3).

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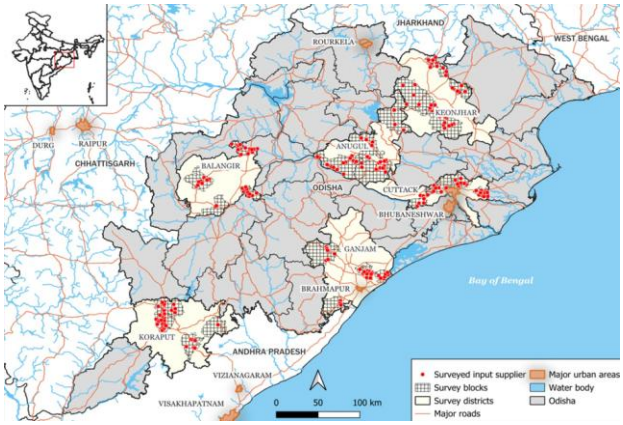
Figure 3: Map of Odisha showing the location of input suppliers selected for inclusion in the INCATA input supplier survey

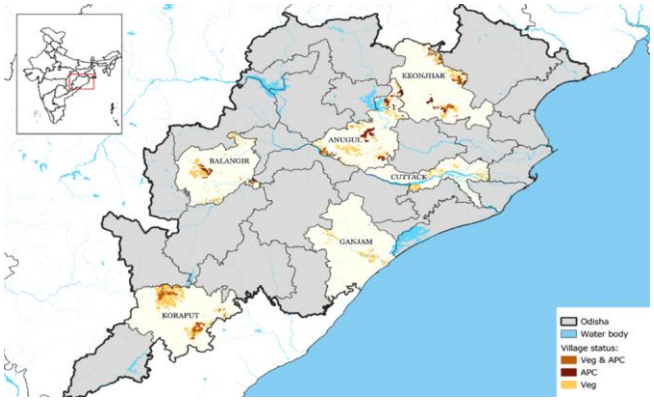


Source: Authors

Sampling of communities and farmers

Within each of the 24 sampled blocks, all villages cultivating vegetables were identified in consultation with local horticulture officials. From these lists, six villages per block were randomly selected, yielding 144 villages. In addition, 10 villages with active APC-supported producer groups were randomly selected from APC blocks, identified through consultation with NGOs implementing the APC program, for a total of 154 villages (Figure 4).

Figure 4: Map of Odisha showing the location of villages selected for inclusion in the INCATA farm survey



Source: Authors

Villages with fewer than 30 households in total were dropped and replaced randomly from the list of villages within the block. Three villages were replaced in this way. In one block, one village was selected purposively to replace a village where there was deemed to be a security risk. A census of households was conducted in each selected village, to identify vegetable-growing households and paddy-growing households without vegetables that had cultivated within the previous 12 months. We listed 35,913 households.

From this frame, we targeted a minimum of 15 vegetable growers and six non-vegetable (paddy-only) farmers for random selection per village. In practice, it was not always possible to reach the number of respondents targeted per village, particularly in smaller villages and in some areas with low concentrations of vegetable farms. In these cases, sample numbers were adjusted by randomly selecting replacement farmers from other villages in the same block. This resulted in a final sample of 2,021 vegetable farmers and 1,056 non-vegetable farmers, bringing the total farmer sample to 3,077 households (an average of 515 per district).

In each of the 154 selected villages, we fielded a community survey through structured focus group discussions with knowledgeable residents. The survey covered information on the population of the village, its locality, access to information, services, infrastructure, institutions and government programs, irrigation, and numbers of farmers of different crops and other actors in the vegetable value chain present in the village —at the time of the survey, and 10 years prior.

Achieved sample

Table 2 summarizes the entire achieved sample across the six quantitative surveys implemented under the INCATA project in Odisha, totaling 5,640. We interviewed 1,623 vegetable traders (of which 1,240 were retailers and 383 were wholesalers), 628 agricultural input suppliers, and 3,077 farmers (2,021 growing vegetables, and 1,056 growing rice but no vegetables, for comparison with vegetable producers). Of all 3,077 farmers, 249 were located in villages where the Government of Odisha had implemented the Agricultural Production Cluster (APC) program. Of these, 99 self-identified as belonging to an APC for either vegetables or livestock. We also conducted structured quantitative focus group interviews in all 158 sampled vegetable markets and 154 sampled villages.

Table 2: Complete summary of achieve survey simples

Survey node	Sample size
Vegetable market	158
Vegetable trader	1,623
Wholesaler	383
Retailer	1,240
Input supplier	628
Farmer	3,077
Vegetable	2021

Rice	1056
Community	154
Total	**5,640**

Ethics approval and informed consent

The INCATA Odisha study received ethical approval from the Institutional Review Boards (IRBs) of the International Food Policy Research Institute (IFPRI) (DSG-25-0511, IRB #00007490, approved May 1, 2025) and an approved modification (DSG-25-0511M, IRB #00007490, approved September 29, 2025), Global AgriSystem Pvt. Ltd. (GAPL/IRB/2025/001, approved May 1, 2025), and AMS (AMS/IRB/2025-26/02, approved December 1, 2025).

Informed consent was obtained from all participants prior to participation. Consent was obtained verbally, as approved by the IRBs, and was documented by the study team at the time of data collection. Participation was voluntary, participants could decline to answer any question or stop at any time, and all data were handled confidentially and analyzed in de-identified form.

CHAPTER 1. HOW ARE VEGETABLE MARKETS IN ODISHA TRANSFORMING?

Background

As with much of the rest of India, Odisha's marketing context for vegetables is a complex mosaic of actors and spaces. Until the 1950s, much of Odisha's vegetable trade occurred in local village level markets or *haats* that predate India's Independence in 1947 even if the produce moved long distances. Trade operated largely in the private realm with virtually no state regulation. Unlike other crops favored by the colonial government, vegetables received minimal government involvement in market development.

This changed with the implementation of the Agriculture Produce Market Committee Act in 1956, that aimed to regulate the first point of sale between the farmer and the buyer. Market yards (mandis) established under the APMC were governed by Regulated Market Committees (henceforth RMCs) where farmers sold to licensed traders and the mandi collected a transaction fee.

These RMCs, comprising principal yards and sub-yards, were thus grafted on to a preexisting network of spot markets. The APMC notified the list of commodities that would come under its purview. Traders could only operate in the mandi if they secured a license. However, unlike many other states, the APMC in Odisha permitted wholesalers but did not recognize commission agents as a distinct category i.e. those who mediated a transfer without taking possession of the goods.

With the formation of the Odisha State Agricultural Marketing Board (OSAMB) in 1984, a dedicated body began to oversee market development and regulation. Since the early 2000s Odisha has progressively removed elements in the APMC Act that imposed various restrictions, first allowing contract farming and the establishment of private markets in 2006, then exempting most vegetables from the purview of the APMC Act 1956 and most recently removing mandi fees of 1% in order to attract more vegetable trade into the mandis. Simultaneously, the Government of Odisha has been investing in Krushak Bazaars (Farmers' Markets), establishing physical spaces to allow farmer-to-consumer transactions.

Currently, Odisha's vegetables can be sold at village haats, Krushak Bazaars, Regulated Market Committee (RMC) yards and private markets. Direct purchases via contract farming are also permitted implying that there are currently few restrictions on where trade can occur. In part because of the considerable diversity in the marketing context, there has been little systematic study of the nature and transformation of markets and marketplaces, although studies of specific markets and commodities exist (Chatterjee et al. 2020; Tiwari and Sahu, 2024). The INCATA study is an effort to fill this gap.

This chapter draws on the INCATA Odisha Market Survey, 2025, documenting 158 markets in six districts in Odisha, including four terminal markets that lie outside these districts –

Bhubaneshwar, Puri, Rourkela, Sambalpur. The market survey was conducted via Focus Group Discussion (FGD) in each market with a group of diverse participants including wholesalers, retailers, and, where available, with members who manage these markets. The goal of this exercise was to document the origin, features and facilities of the market and trace its evolution over the past decade.

Our survey covered a wide range of topics related to the establishment, infrastructure, operations and management of the market. For this note, however, we focus on two aspects: we characterizing the markets in the sample and documenting the nature of their transformation over the past 10 years, i.e. the period between 2015 and 2025. We supplement this with data from the INCATA Odisha Community Survey in 154 villages across 24 blocks in the six study districts, to map the transformation of the marketing context in the production zones.

Characterizing the markets

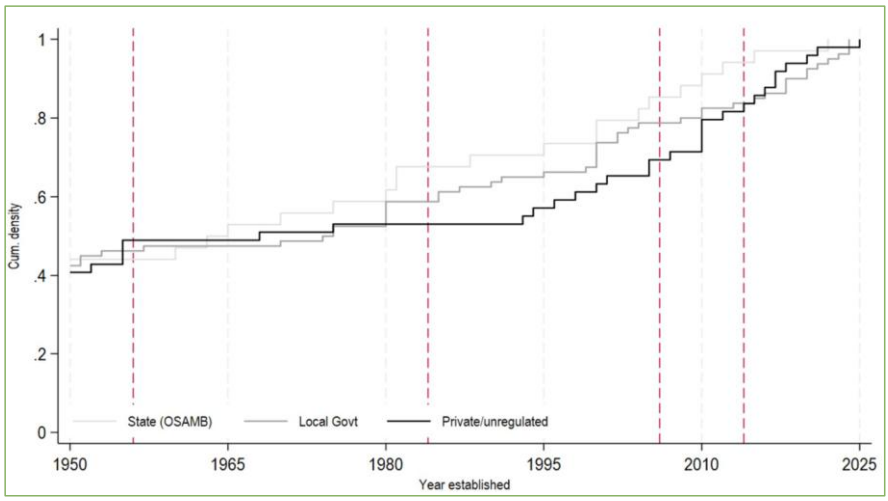
Our survey suggests that a significant proportion of the sample markets (40%) have been functioning for longer than the respondents can recall (In 2025, the 158 vegetable markets received 2.25 million tonnes of vegetables over the year; 90% of these vegetable deliveries arrive in markets not regulated by OSAMB. Terminal markets handle 1.5 times the volume of all the other 154 markets combined indicating the vast difference in the scales of operations. Over the course of the market survey, our listing process counted 11805 traders of all types, retailers (who may be farmers themselves), wholesalers and commission agents. This is about 1.9 traders per 1000 people (552 people per trader), 1 trader for 8.39 operational holdings ~ 12 traders/100 vegetable holdings. Our estimates from the market surveys which suggest a total of 23894 traders in high season, puts this ratio at 3.9 traders per 1000 people (or 258 people per trader) and 4.1 holdings per trader or 24 traders/ 100 vegetable operational holdings. There are an estimated 18 retailers per wholesaler.

How did these marketplaces transform over the decade?

More (private) markets and perennialization of markets

Figure 6 shows a timeline for the proportion of present-day market that existed in a given year (x-axis). Whereas a bulk of the public and other markets under local governments were established in the 1980s, a significant share of the private markets appear to have been established after the mid-1990s, dominated the growth of the former types of market. While the recent spurt has been gradual and does not specifically coincide with a key policy change, it is evident that private markets grew in the era of a more liberal regulatory regime.

Figure 6: When were the markets established?



Source: INCATA Odisha Market Survey, 2025

A key marker of agricultural commercialization is the "perennialization" of markets, i.e., that periodic markets become more permanent and regular. In the case of our sample markets in Odisha, the past decade has seen multiple markers of commercialization (Table 4). First, there has been a proliferation of markets; furthermore, of the 154 markets surveyed they have transformed into daily markets from being weekly markets a decade earlier. In 2025 sample markets on average were reported to work more days per week and more hours per day than they did a decade earlier. This expansion in work hours is suggestive of either an expansion to accommodate production or consumption or greater pass-through of produce, both, each of which may necessitate extended working hours. The proportion and number of permanent stalls (or stalls that are pucca i.e., with permanent structure with roof and walls) increased as well (Table 4).

Table 4: Market transformation, 2015 and 2025

	Now	10 years ago	% change
Number of markets	158	154	2.5
Share of markets that operate daily	42	36	13
Days per week market is operational for all markets	576	475	21
Mean days per week is operational	4	3	33
Hours per week that the market is operational- mean (std deviation)	43 (42.2)	36 (37.0)	19
Share of markets with pucca stalls	49	31	57
Total number of pucca stalls	2322	1163	100
Average no. of stalls per market	30	16	88
Number of the following in the sample block in which the survey market is located			
Daily vegetable markets in the block	290	216	34
Weekly *haats* in the block	660	530	25
Transport logistics hub in the block	97	53	83

Hirschman-Herfindahl index for deliveries	0.23	0.30	
Hirschman-Herfindahl index for traded volumes	0.26	0.42	

). Among the markets with a known date of inception, the average age of markets is 32.37 years; half of the markets were established in the past 25 years. These markets were established in diverse ways – some splitting from older markets, some established by groups of traders or by farmers in the village and some others growing organically around demand centers. However, about 74% were established by a government, state or local body. Several private markets too may operate on government land.

Table 3: Sample markets at a glance, 2025

Characteristic	
Age (years) for those established in 1950 or after	32.37
Proportion of markets (that are):	
Older than the respondents can recall	0.40
In a Gram Panchayat (Rural haat)	0.49
Established by the government (GP/municipal or state government)	0.74
Operate on government land	0.87
Part of a larger bazaar	0.31
Non-food items are sold in the market	0.85
Vegetable vendors and traders also operate outside the main market	0.51
Wholesalers operate in the market	0.63
Regulated by any government/government-related body	0.72
Regulated by OSAMB	0.29
Market has self-organized traders association or union	0.24

Source: INCATA Odisha Market Survey, 2025

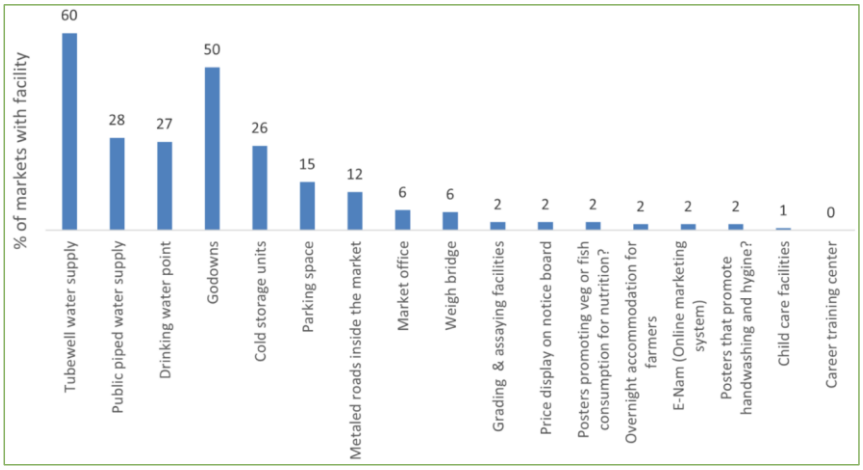
As for regulation, as per our survey, just 29% of the markets were reportedly regulated under the APMC and fall under the purview of OSAMB. Thus, contrary to the popular notion that vegetable trade across India is heavily controlled by the state via the APMCs, Odisha's situation suggests that this is not the case.2 A bulk of the rest are governed by local bodies, and the remaining are self-regulated or unregulated. Among those that are regulated by any government body, it seemed that the running of the markets was tendered out to private players annually for a fee, for rights to collect market user fees while taking on the responsibility of maintaining and operating the market. This arrangement seemed common in both urban and rural centers.

[2] This echoes earlier studies by Sahoo (2015) and Sharma (2012) that a bulk of agricultural trade in Odisha occurs outside the RMCs.

What do these markets look like? Almost half of all markets are in rural areas and are essentially village marketplaces or haats (Table 3). Virtually all are located on or near an all-weather road. Although our survey was of marketplaces, more than half of the markets surveyed (51%) had vendors spilling beyond the recognizable boundaries of the marketplace. An overwhelming proportion of the markets are not specialized vegetable markets; most of the markets had vendors selling non-food items, for example. A third were part of a larger bazaar. These vegetable markets were invariably more than just places to buy and sell vegetables. They serve as hubs for different trades and related enterprises. Wholesalers operated in 63% of the sample markets; the others were exclusively retail markets. Close to a quarter have a self-organized traders' association, although their roles varied significantly across markets.

Figure 5 reveals that vegetable markets in the study area have widely varying levels of infrastructure development. Basic water and sanitation facilities are most common, with tubewell water supply present in 60% of markets and public piped water supply in 28% of markets. Drinking water points are available in only 27% of markets, suggesting a notable gap in basic amenities.

Figure 5: Market infrastructure, 2025



Source: INCATA Odisha Market Survey, 2025

Beyond water, the next tier of facilities shows moderate provision: godowns (storage facilities) are present in half the markets (50%), while cold storage units exist in only 26%. Parking space, essential for the movement of produce and vehicles, is available in just 15% of markets.

More specialized facilities show limited presence. Only 12% of markets have metaled (paved) roads inside the market premises, and facilities like market offices (6%), weigh bridges (6%), and various display, grading, and quality control facilities each appear in 2% or fewer markets. Notably, no markets in the sample have career training centers, and only 1% have childcare facilities.

In 2025, the 158 vegetable markets received 2.25 million tonnes of vegetables over the year; 90% of these vegetable deliveries arrive in markets not regulated by OSAMB. Terminal markets handle 1.5 times the volume of all the other 154 markets combined indicating the vast difference in the scales of operations. Over the course of the market survey, our listing process counted 11805 traders of all types, retailers (who may be farmers themselves), wholesalers and commission agents. This is about 1.9 traders per 1000 people (552 people per trader), 1 trader for 8.39 operational holdings ~ 12 traders/100 vegetable holdings.3 Our estimates from the market surveys which suggest a total of 23894 traders in high season, puts this ratio at 3.9 traders per 1000 people (or 258 people per trader) and 4.1 holdings per trader or 24 traders/ 100 vegetable operational holdings. There are an estimated 18 retailers per wholesaler.

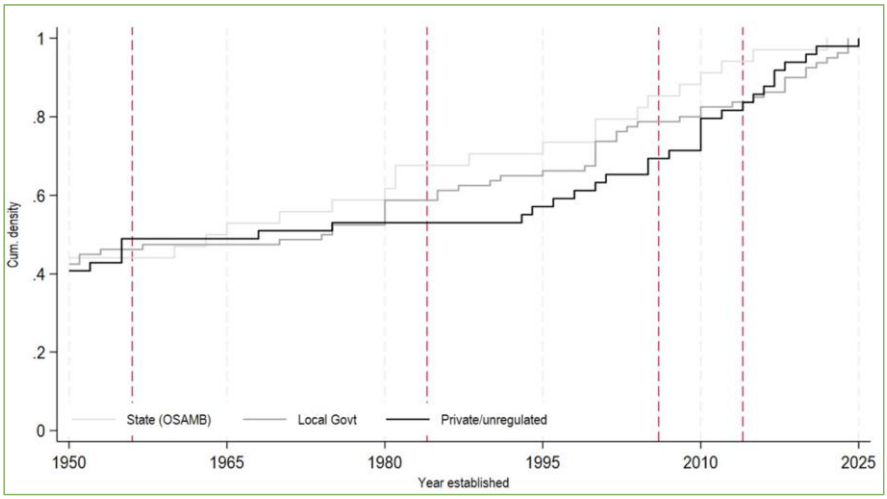
[3] We assume that the population of the 24 sample blocks and the four cities where the terminal markets are located total 6.16 million people as of 2025. For operational holdings we assume, based on the INCATA Odisha Houselisting 2025, that 25% of the 3.958 lakh operational holdings estimated in the Agricultural Census 2015-16 grow vegetables.

How did these marketplaces transform over the decade?

More (private) markets and perennialization of markets

Figure 6 shows a timeline for the proportion of present-day market that existed in a given year (x-axis).[4] Whereas a bulk of the public and other markets under local governments were established in the 1980s, a significant share of the private markets appear to have been established after the mid-1990s, dominated the growth of the former types of market. While the recent spurt has been gradual and does not specifically coincide with a key policy change, it is evident that private markets grew in the era of a more liberal regulatory regime.

Figure 6: When were the markets established?



Source: INCATA Odisha Market Survey, 2025

A key marker of agricultural commercialization is the "perennialization" of markets, i.e., that periodic markets become more permanent and regular. In the case of our sample markets in Odisha, the past decade has seen multiple markers of commercialization (Table 4). First, there has been a proliferation of markets; furthermore, of the 154 markets surveyed they have transformed into daily markets from being weekly markets a decade earlier. In 2025 sample markets on average were reported to work more days per week and more hours per day than they did a decade earlier. This expansion in work hours is suggestive of either an expansion to accommodate production or consumption or greater pass-through of produce, both, each of which may necessitate extended

[4] Note that there may be markets that don't exist any longer.

working hours. The proportion and number of permanent stalls (or stalls that are pucca i.e., with permanent structure with roof and walls) increased as well (Table 4).

Table 4: Market transformation, 2015 and 2025

	Now	10 years ago	% change
Number of markets	158	154	2.5
Share of markets that operate daily	42	36	13
Days per week market is operational for all markets	576	475	21
Mean days per week is operational	4	3	33
Hours per week that the market is operational- mean (std deviation)	43 (42.2)	36 (37.0)	19
Share of markets with pucca stalls	49	31	57
Total number of pucca stalls	2322	1163	100
Average no. of stalls per market	30	16	88
Number of the following in the sample block in which the survey market is located			
Daily vegetable markets in the block	290	216	34
Weekly *haats* in the block	660	530	25
Transport logistics hub in the block	97	53	83
Hirschman-Herfindahl index for deliveries	0.23	0.30	
Hirschman-Herfindahl index for traded volumes	0.26	0.42	

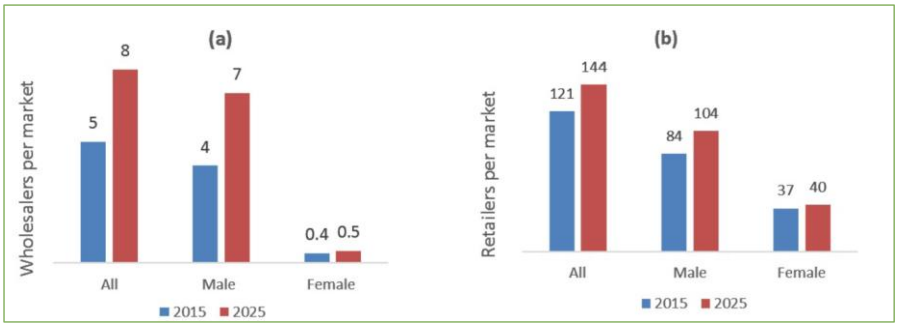
As part of the market survey, we asked respondents to discuss the trends in the block overall of different types of markets. Notwithstanding the differences in responses across respondents in different markets within the block, we report the response that had the maximum value. 5 Daily markets for vegetables in the sample blocks increased at a faster rate (a decadal growth of 49%) than the weekly haats in the block (39%) – confirming the findings from the sample markets, but also suggesting new weekly haats are mushrooming as part of the transformation. Noteworthy is that transportation hubs (i.e. spaces where trucks transporting vegetables assemble to aggregate or distribute to traders and other transporters) increased by 87%, likely reflecting the growing connectedness of production and consumption zones both within and outside Odisha.

Expanding traders and volumes, diffused growth and densification of ancillary enterprises

As one would expect, with the proliferation and expansion of markets, there has been a significant increase (88%) in the average number of stalls per market (Table 4). There has been a significant increase in the number of wholesalers (66%) and retailers (19%) in surveyed markets in 10 years (Figure 7), driven primarily by growth in the number of male traders (26% increase in total number of male wholesalers and retailers per market, in contrast to just 7% increase in total women traders).

[5] On the one hand it is possible that those who report lower figures were not aware of all the markets; second, choosing the higher figure from a decade ago may ensure that we have a conservative estimate of the growth in the numbers of these markets.

Figure 7: Average number of (a) wholesalers and (b) retailers operating per market during high season, 2015 and 2025



Source: INCATA Odisha Trader Surveys 2025

The total volume of vegetables traded in surveyed markets increased 53% in 10 years. Low season volumes increased slightly faster than high season (58% versus 51%, Figure 8), suggesting likely growth in off-season production. Our data suggests growth in volumes of vegetables traded occurred more at the intensive margin so that traders were operating on a larger scale on average in 2025 than in 2015, and both segments became relatively less gender inclusive over time. Growth in volume of vegetables traded per trader (Figure 9) is comparable to the growth rate at the market level in vegetable deliveries. Faster growth in retailer trade volumes than wholesaler, may indicate increase in sales of own/locally sourced produce.

Figure 8: Average quantity of vegetables delivered per market: (a) t/year; (b) t/day, in high and low season (2015 and 2025)

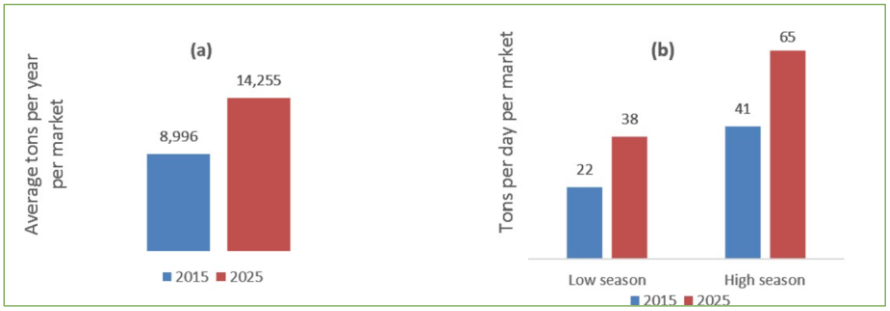
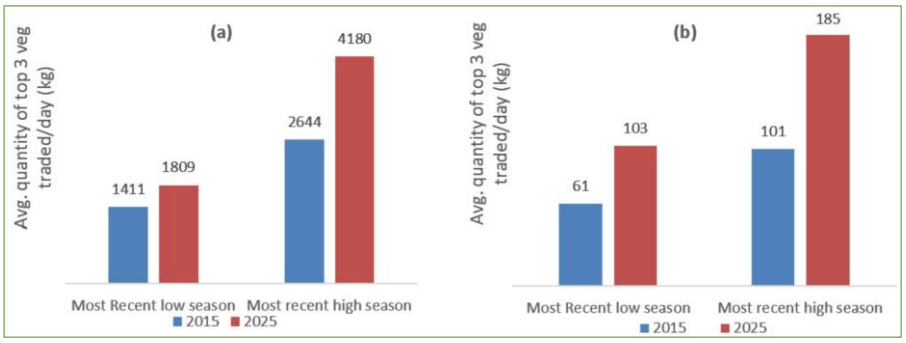


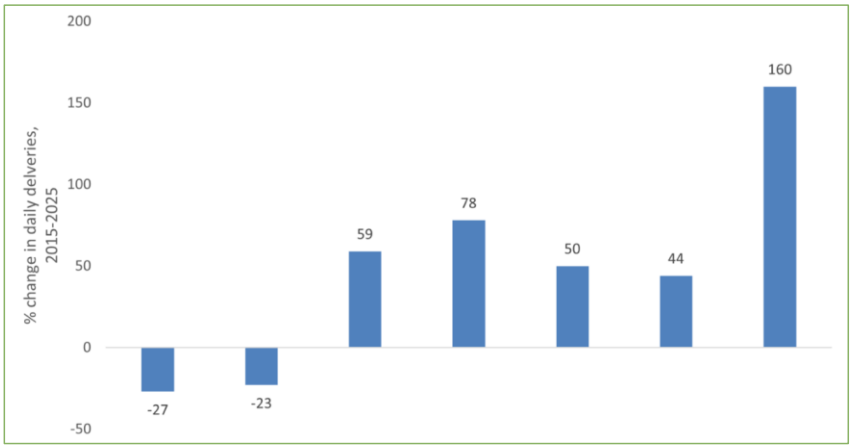
Figure 9: Average quantity of the top three vegetables traded by (a) wholesalers and (b) retailers during high and low season, 2015 and 2025 (kg/day)



Source: INCATA Odisha Trader Surveys 2025

Reflecting the overall rapid changes in transport and mobility, there is a marked shift in the modes of transporting produce (Figure 10). Deliveries by pedestrians and bicycles have given way to deliveries on motorbikes and in autos (which have larger capacity, are faster and convenient). It was not uncommon for farmers to share an auto to bring produce to the market for retail sales or for sale to traders. The increase in deliveries by larger vehicles, especially largest (20-ton truck deliveries up 144%). Together these trends suggest simultaneous increases in local and out-of-state vegetables supplies.

Figure 10: Percentage change in mean number of vegetable deliveries per market per day in high season 2015 and 2025, by mode of transport



Source: INCATA Odisha Trader Surveys 2025

It is worth noting that the increase in the number of traders and volumes far outstrip Odisha's decadal population growth (an estimated 12%) so that more vegetables is traded per capita than a decade ago.

To better understand the nature of transformation, we computed the Hirschmann-Herfindahl Index (HHI), a measure of concentration, i.e. the weighted average share of each market, where the weights are their shares themselves. The resulting metric lies between 0 and 1 where 1 implies complete concentration (with one market conducting all trade) and a number closer to 0 indicating that all the markets are responsible for a small share of the trade each. We find a marked decrease in the HHI both for volumes traded and volumes delivered, suggesting that the growth has been even and come with diffusion across markets (Table 4). Our data suggests that as many as 89% of the sample markets grew.

Borewell digging business, cold storage units and farmer producer company (FPC) presence in the marketplaces have increased dramatically, primarily on account of the very low base – suggesting that the recency of these enterprises and facilities (Table 5). Although the numbers of godowns and cold storage units, especially in public markets, those in active use tend to be few and far between. Interestingly, clusters of enterprises around markets providing ancillary services grew more quickly than the number of markets, suggesting cluster densification took place (Table 5).

Table 5: Total and mean number of ancillary enterprises and services in the vicinity of surveyed vegetable markets, 2015 and 2025

Number of...	2015	2025	% change (2025/2015)	Avg. number/ market (2015)	Avg. number/ market (2025)
Markets	154	158	2.5	-	-
Agricultural input shops	232	340	47	1.5	2.2
Agricultural machinery shops	58	98	69	0.4	0.6
Borewell drilling businesses	6	24	300	0.04	0.2
Farmer producer companies (FPOs)	13	41	215	0.08	0.3
Private cold storage businesses	4	13	225	0.03	0.1
Trucking logistics companies	107	160	50	0.7	1.0
Bag sellers	978	1415	45	6.4	9.0
Bank branches	78	125	60	0.5	0.8
ATMs	51	111	118	0.3	0.7

Source: INCATA Odisha Market Survey 2025

How did the marketing context in the villages change?

Thus far we have been focusing on the transformation of marketplaces. Yet these are not the only points of first-sale of vegetables. To examine how these other channels transformed, we draw on the Community Survey of 154 sample villages (Table 6), where we ask respondents about the types of traders who operate in the village and how the mix of marketing options has changed over the period 2015 to 2025. Four features stand out. First, vegetable farmers who retail their own produce have been common and maintain continue to be with 58 and 67% of the villages having at least one farmer who retails his/her own produce. Second, in 2015, just 8 and 12% of the villages had transporters (from within the village and outside respectively) collecting and moving produce for sale outside. By 2025, 38% of the villages had these transporters, even though there are not many serving each village. Third, there has been a noticeable growth in local village retailers who procure from farmers and sell to consumers. Many of them are itinerant vendors who go door to door. Fourth, a significant share of the villages is well served by market intermediaries, even if on average they are not numerous.

Table 6: How did the marketing context transform in the villages? (154 villages)

Type of market actor	Total	Mean number/village455	Proportion of villages with type of actor	Total	Mean	Proportion	Decadal growth in total number actions(%)
	2025			2015			
Village traders -sell to outside traders	288*	1.9	0.38	137*	0.9	0.25	110
Village retailers – sell to local consumers	436	2.8	0.49	251	1.6	0.35	74
Outside traders collect from farmers	241	1.5	0.48	142	0.9	0.31	70
Village transporters – outside	131	0.8	0.38	21	0.1	0.08	524
Outside transporters collect from farmers	135	0.9	0.38	36	0.2	0.12	275
Vegetable farmers retail vegetables	3,029	19.42	0.67	2,038	13.06	0.58	49

Source: INCATA Community Survey, 2025. Notes: * Some of the traders are common across several villages. We counted them in all the villages since our aim was to ascertain if the village was served by a trader.

Concluding remarks

This chapter distills a small set of key results from the INCATA Market and Community Surveys to characterize vegetable markets in the study area and map their transformation between 2015 and 2025. An important insight is that over 90% of the estimated 2.25 million tons of vegetables that are delivered go to unregulated markets, contrary to the popular notion that government markets dominate agricultural trade across India. These markets show markers of early stages of commercialization with the perennialization of markets. Even as new periodic markets develop, markets are becoming more permanent, operating longer hours and hosting more traders. Our survey suggests that wholesalers have grown more than retailers, both have grown more than overall population and volumes transacted per trader have grown.

There is evidence that this growth has been diffused with the concentration of trade and deliveries reducing over the decade. There is also a marked change in how produce arrives in the market, increasingly by motorized vehicles and larger trucks with transporters proliferating from a low base as market intermediaries in the production zones. In the production zones, a significant proportion of the villages are well served by a multiplicity of marketing channels.

Our preliminary analysis points to a few areas that would benefit from policy attention. First, several marketplaces continue to have limited if not poor infrastructure. Upgrading infrastructure in “real” trade occurs would go a long way in ensuring safe and comfortable spaces for traders and for produce to move safely and efficiently via these spaces. Second, the current practice of tendering the operations and maintenance of markets appears to compromise the quality of infrastructure. The present results are preliminary, and more research is ongoing to understand some of these aspects in greater depth.

CHAPTER 2. WHO GROWS VEGETABLES?

To what extent is vegetable cultivation a pathway to agricultural commercialization in Odisha, and can such a process be inclusive of smallholders? This chapter draws on an extensive house listing exercise (INCATA Odisha House listing) that covered 35,913 households in 154 villages across 24 blocks and six districts in Odisha, India, to ascertain the extent to which farmers participate in vegetable farming. We ask: How many rural households grow vegetables? Who and where are they? Why do others not grow vegetables? We supplement our analysis with insights from a community survey (INCATA Odisha Community Survey) conducted concurrently with the house listing exercise.

Both the house listing exercise and the community survey were undertaken as part of a larger research effort under a project called INCATA in Odisha India, as part of the house listing, we documented some key characteristics to be able to establish the scale of vegetable cultivation. The community surveys conducted in each of the 154 villages documented a range of characteristics of the sample village, including socio-demographic characteristics, infrastructure, government programs, and shocks, etc. and to map the transformation within the village between 2015 and 2025 across various spheres of economic life, especially within agriculture.

How many households farm vegetables?

As part of the house listing process, we counted 35,913 households in the study area. Of these, we were able to speak with 78% of the households during our survey window; the others were unavailable due to various reasons (**¡Error! No se encuentra el origen de la referencia.** 7); 97% of those we contacted agreed to listing, totaling 27,189 households. Of those listed, 69% farmed in the past year, of whom virtually all (i.e. 95%) grew paddy. About 22% of these households who engaged in cultivation in the past year grew vegetables. This proportion is significantly higher than national surveys estimate for Odisha overall, likely because we focused on vegetable growing regions.

Table 7: A profile of the households in the study área

Details	Number	Proportion	Proportion of all listed households
Found household	27,905	0.78	
Agreed to listing	27,189	0.97	
Engaged in cultivation the past year	18,876	0.69	
Of which: Grew paddy the past year	18,002	0.95	0.66
Grew vegetables the past year	4,196	0.22	0.15
Grew vegetables in kitchen garden the past year	9,299	0.34	0.34
Ever grew vegetables on farm or kitchen garden (among households who did not farm or did not grow vegetables this past year)	584	0.07	0.02

Has worked on vegetable fields of others (all listed households)	12,115	0.45	0.45

We asked both those who farmed and those who did not (i.e. for all 27,189 we listed successfully) if they had a kitchen garden where they grew vegetables. More households (34% of all listed) had a kitchen garden relative to those who farmed vegetables. Only 14% of those with a kitchen garden also sell from the kitchen garden. In general, it does not seem to be the case that kitchen gardens are a first step towards commercialization.

Among those who declared that they currently had neither kitchen gardens nor were active in agriculture, only 7% had ever grown vegetables either on farms or as part of kitchen gardens. We will discuss the reasons later and focus now on employment.

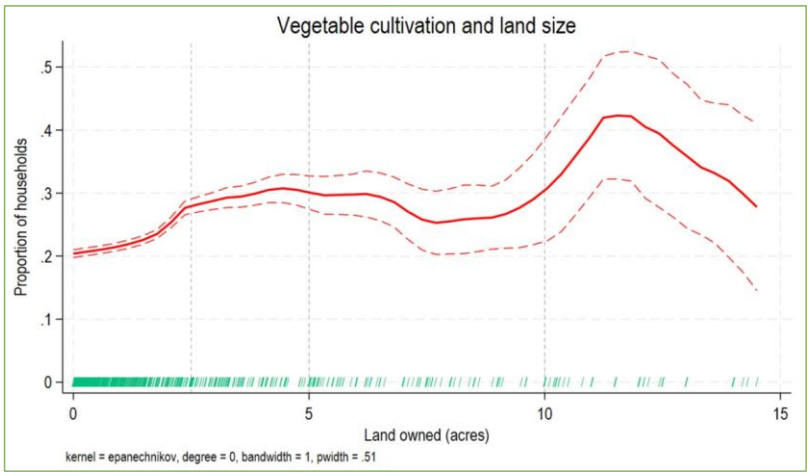
Interestingly, overall, 45% of all those listed had worked on others' vegetable fields. This therefore suggests that although only 15% of all those listed grew vegetables themselves, thrice as many had worked on others' vegetable fields, underscoring the potential positive implications for employment when vegetables are the pathway to agricultural commercialization. About 3% of all those engaged in cultivation were members of producer groups of any type.

Who grows vegetables?

¡Error! No se encuentra el origen de la referencia. represents a local polynomial regression of the share of households who farm and also grow vegetables against reported land owned. The relationship between the likelihood of farming vegetables has a non-linear relationship with land owned. Those with land sizes between 2 and 5 acres (i.e. small farmers, according to official definitions in India) are the most likely to grow vegetables; farms that are smaller i.e. marginal farmers, are much less likely to grow vegetables.

Medium-sized farmers with 10-12 acres also seem likely to grow vegetables, though as farms get larger, the proportion of households growing vegetables declines again. These data suggest that vegetable farming can be inclusive of small farmers, while at the same time also accommodating larger scale commercialization.

Figure 11: How is land size correlated with vegetable cultivation?



Source: INCATA Odisha House listing, 2025. Notes: the rug plot shows the distribution of the sample across different landholding sizes. The vertical lines represent different cutoff for classifying farmers into marginal (<2.5 acres), small (2.5 to 5 acres), semi-medium (5 to 10 acres).

As part of the house listing, we recorded whether households grow paddy. We find that 74.7% grow paddy but no vegetables, 20.7% grow both, and just 1.5% grow vegetables but no paddy, with the rest (3.1%) growing neither. Virtually everyone grows paddy, not only because it is a staple that farmers may use for their own consumption, but also because of a robust public procurement system. We compare some of the characteristics between vegetable growers and non-vegetable growers. The choice of what to grow is imbricated with irrigation access.

- Farmers without access to irrigation are more likely to grow only paddy, but no vegetables. Those with irrigation are disproportionately likely to grow both vegetables and paddy.
- A greater proportion of non-vegetable growers have kitchen gardens for self-consumption relative to vegetable growers (37% versus 21%), and more of them have kitchen gardens whose produce is for sale (7% versus 2.4%), emphasizing that kitchen gardens may expose paddy farmers to vegetable markets even if this is not a significantly large number.

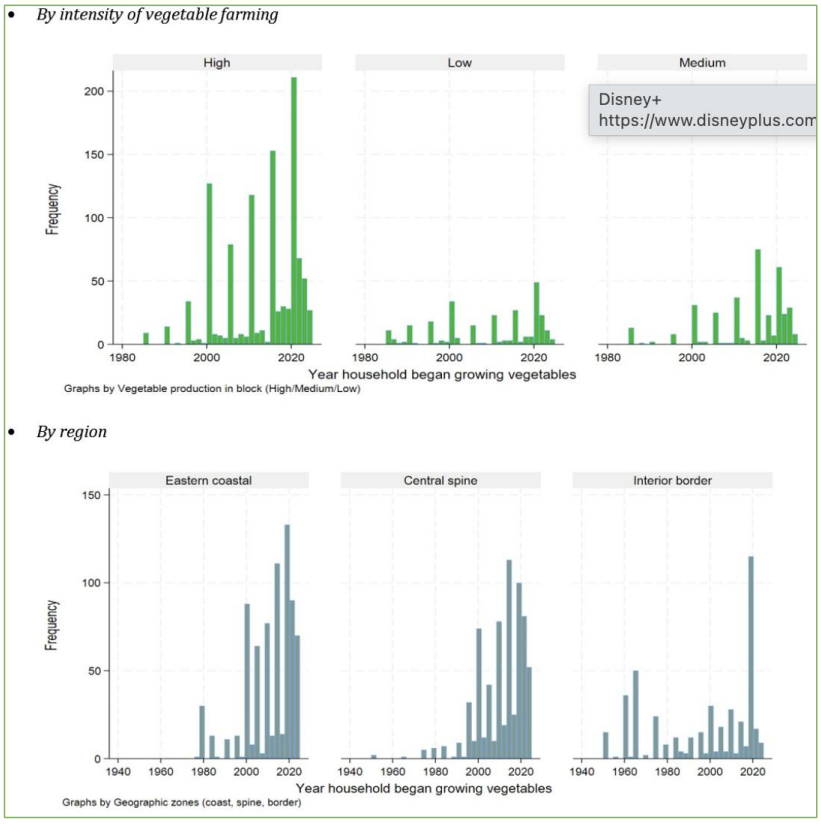
Patterns of growth

A majority of vegetable growers (55%) stated that their family or household had been growing vegetables for longer than they can recall. Among the others, close to a quarter began vegetable growing after 2015, with several taking to vegetables after 2020. Over 85% of those who began

growing vegetables after 1950, commenced the sale of vegetables the same year, underlining the commercial orientation of vegetable cultivation.

Spatially, there are interesting patterns (Figure 12). First, growth of vegetable farming households has been disproportionately higher in high intensity blocks suggesting a clustering effect. Second, there appears to be evidence of sub-state specialization. We group our sample districts into three regions: Eastern Coastal (Ganjam, Cuttack), interior border (Balangir) and Central Spine (Koraput, Anugul, Keonjhar). There has been a pronounced spurt in new vegetable growers in the Eastern coastal as well as the Central Spine. Our hypothesis is that while the former is home to teeming and growing cities representing a strong demand pull, the central spine is emerging as a hub for vegetable production.

Figure 12: Entry into vegetable farming



Source: INCATA Odisha House listing, 2025

The community survey suggests that across the villages, while the number of households growing vegetables has increased, as have those growing rice and cotton, those growing sugarcane and maize have declined, the former dramatically. To the extent that farmers choose from among several cash crops, this seems to suggest that the ascendance of vegetables may coincide with the shrinking of sugarcane, in particular.

According to the respondents in of the INCATA Odisha Community Survey, in villages where the number of vegetable growers increased, the key reasons were increase in the prices of vegetables, expanded access to irrigation, and better transport and connectivity. As Figure 13 shows, there has been an increase by several fold in the ownership of vehicles increasingly used to transport vegetables and the time taken to travel to market by the most common mode has declined by 36%. The INCATA Odisha Farmer Survey too reveals motivations for starting vegetable cultivation were high vegetable prices (38%) and to provide for their own consumption (83%) (Figure 14). It is apparent that vegetable cultivation is driven both by the motivation to sell and to consume, for the sample farmers overall, suggesting diverse motivations across farmers.

Figure 13: Some changes in the village

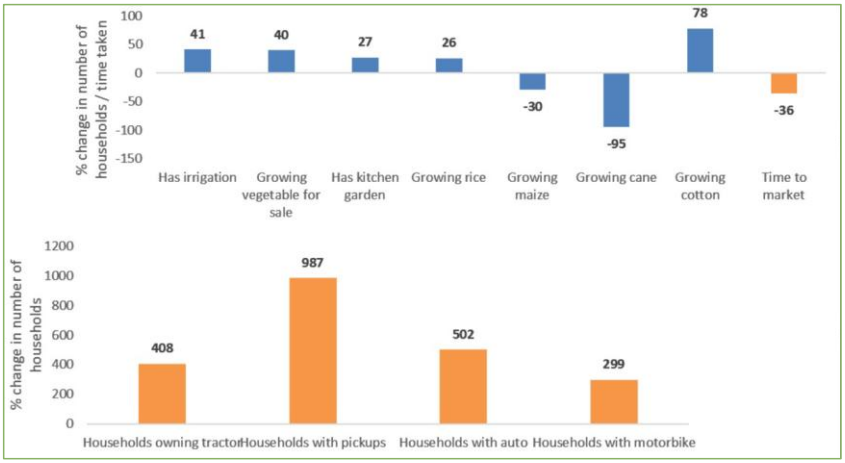
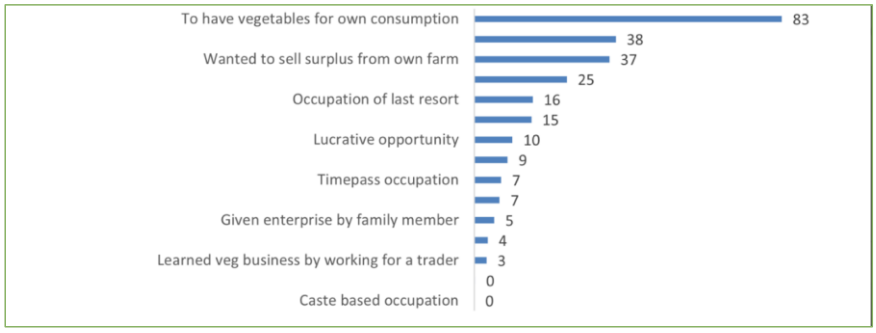
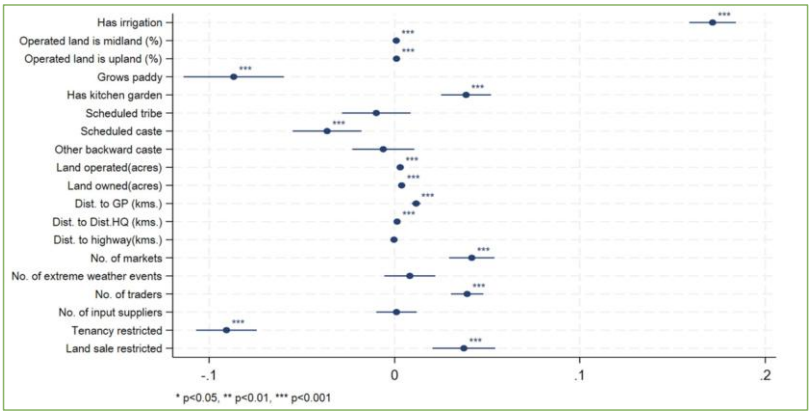


Figure 14: Motivations for taking up vegetable farming



To more systematically uncover the strength of the correlates of vegetable farming, we combined data from the house listing exercise with village characteristics compiled from the INCATA Odisha Community Survey. We then estimated a linear probability model (LPM) regressing the variable indicating whether or not a household undertakes vegetable farming or not as a function of a set of household characteristics (for example, social group, irrigation access, land owned and operated, etc.) and village characteristics (the proportion of operated area in the village that is upland, its distance to highways, village and district headquarters, the number of traders, input dealers and markets that households in the village have access to and land tenancy and sale restrictions. The results are presented in Figure 15. Irrigation access is by far the most important predictor of vegetable farming. While having a kitchen garden is positively associated, growing paddy is somewhat negatively associated with vegetable farming; villages with land tenancy restrictions are likely to have fewer vegetable farmers whereas those with restrictions on sale are more likely to have more vegetable farmers, likely reflecting the prevalence of vegetable farming in tribal areas. The number of input suppliers and traders that households in the village use/access also has a bearing on the uptake of vegetable farming. While the results from the regressions show associations, these reveal interesting patterns.

Figure 15: Correlates of vegetable farming



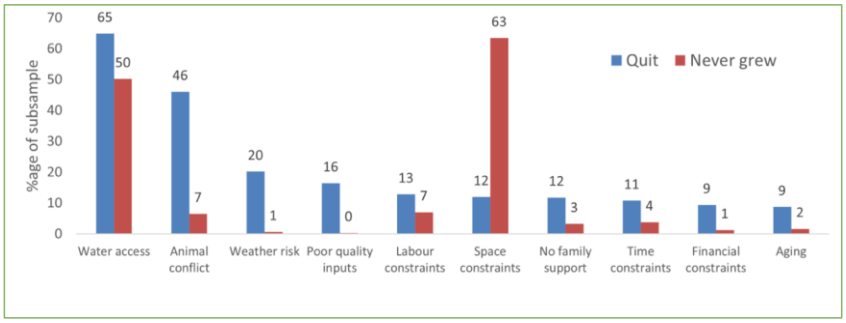
Source: Based on the INCATA-Odisha House listing and Community Survey, 2025. Only select variables are plotted. The regression controls for districts and does not cluster standard errors.

Constraints

The reasons for quitting vegetables and never having grown them are somewhat different, despite the large overlaps . Water constraints and access to irrigation are common constraints. Popular perception in the context of India is that marketing challenges for vegetables are the main deterrent for farmers. Here we have a somewhat different story. Farmers who quite cite animal conflict as the second most important reason. Our field visits also revealed that monkeys, wild boar/bisons, and elephants, depending on the area, make it very challenging to grow vegetables. Poor quality inputs also emerge as a factor for giving up vegetable cultivation. Financial constraints and market access, popularly viewed as the binding constraints for diversification, are barely mentioned by the farmers themselves.

As for those who do not take to vegetable growing, apart from access to irrigation, space constraints, and land availability are the second most frequently expressed constraint. The INCATA Odisha Community Survey (whose respondents are members of the community) are mostly consistent with these individual level responses. In general, low-lying lands that are prone to waterlogging are allocated to rice (unless expensive investments render them more suitable for cultivation) and upland and midlands are more suited to vegetables. Land markets too are key. In many parts of Odisha, land leasing and tenancy are restricted, a constraint where the transfer of land from marginal to more advantaged communities is forbidden to protect the former. Extreme weather events also render vegetable cultivation risky and 65% of the villages noted that they had experienced at least one extreme weather event in the past decade (Figure 16).

Figure 16: Reasons for not growing vegetables or quitting



Source: INCATA Odisha House listing, 2025. Notes: These were administered to two distinct subsamples. Those who said they grew vegetable but quit and those who had never grown vegetables either on farm or kitchen garden.

Concluding Remarks

This note contributes to some key debates around why diversification into high-value crops, such as vegetables, is not happening more rapidly in India. The INCATA study in Odisha finds that vegetable growing in the state is widespread and has a long history. Further, vegetable farming has been conducted both for commercial purposes and for self-consumption. Commercial vegetable farming appears to be inclusive. Even amongst marginal farmers, vegetable farming is prevalent and rises as land sizes become larger within the smallholder category. There does not appear to be a higher proportion of vegetable farmers among the larger landowners, though there is some evidence that vegetables offer scope for medium farmers as well. Irrigation is by far the most important correlate of vegetable farming. In contrast to the popular notion that market access is a critical constraint that deters vegetable cultivation, water constraints, land availability, and animal conflict emerge as key barriers, with varying significance, depending on whether we examine disadoption or non-adoption of vegetables. There is a distinct spatial pattern for uptake, with suggestive evidence that existing vegetable clusters may be seeing greater uptake, as are regions with large urban centers and access to markets.

CHAPTER 3. HOW ARE THE PRODUCTION PRACTICES OF VEGETABLE FARMERS IN ODISHA TRANSFORMING?

Entry into vegetable farming

Table 8 presents information on the history of entry into vegetable farming by surveyed households. Although vegetable farmers' average age is 48, the average age at which farmers first started cultivating vegetables is 24, indicating that most vegetable farmers have been practiced in the activity for more than two decades. Only 19 percent of respondents are first generation vegetable farmers, originating from households in which no parent had ever cultivated vegetables. Close to half are second generation, indicating that vegetable cultivation was initiated by their parents and 27 percent are from families that have farmed vegetables for longer than the respondent can recall. This pattern suggests that vegetable cultivation has been present in Odisha for a long time but started to expand 20-30 years ago as commercialization increased

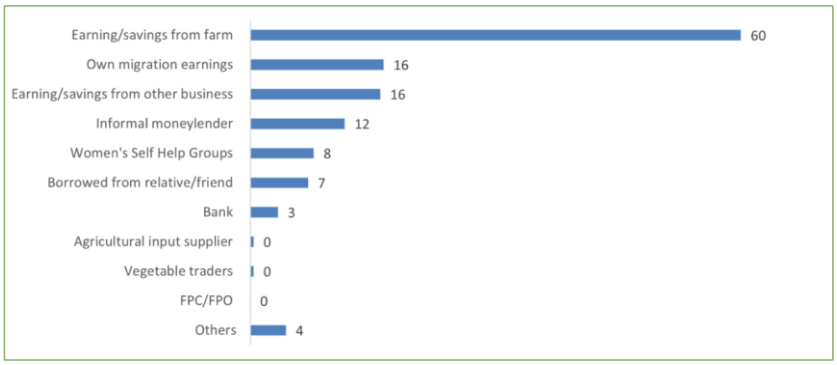
Table 8: Characteristics of entry into vegetable cultivation (percentage of vegetable farming households reporting)

Item	Vegetable farmers
Respondent's age at first entry into veg farming (years)	24.2
First generation vegetable farmer (%)	18.9
Second generation vegetable farmer (%)	45.9
Third generation vegetable farmer (%)	8.7
Family has farmed vegetables longer than respondent can remember (%)	26.6
Required any capital to begin vegetable farming (%)	81.2
Value of startup capital for vegetable farming (INR, constant 2025 prices)	24,129
Received any assistance to begin vegetable farming (%)	3.5
Area of vegetable land cultivated expanded in the past 10 years (%)	44.3
Area of vegetable land cultivated remained the same in the past 10 years (%)	36.2
Area of vegetable land cultivated contracted in the past 10 years (%)	19.5

Source: INCATA Odisha Farmer Survey 2025

Entry into vegetable cultivation required a capital investment for 81 percent of respondents, averaging ₹24,129 ($277) at constant 2025 prices. The main source of investment for entry into vegetable cultivation is earnings or savings from own farm, underlining diversification of existing agricultural activities as the main pathway into commercial vegetable production. Notably, earnings from own migration, and earnings from non-farm business each funded entry into vegetable farming for 16 percent of respondents, highlighting important linkages between off-farm employment and agricultural commercialization. Informal money lenders and women's self help groups (WSHG) were a source of funds for 12 percent and 8 percent of respondents respectively, the latter suggesting that credit from WSHGs can play a catalytic role in agricultural diversification. Banks supplied funds used in only 3 percent of cases, and farmer producer organizations or companies (FPOs and FPCs) none. Agricultural input suppliers and vegetable traders also play a negligible role in financing entry into vegetable farming (less than 1 percent each) (Figure 17).

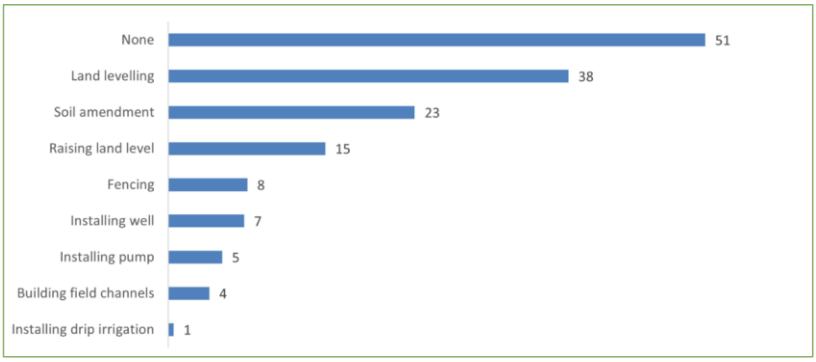
Figure 17: Sources of capital used to fund in entry into vegetable farming (percentage of households reporting)



Source: INCATA Odisha Farmer Survey 2025

Half of respondents made no changes to their land when initiating vegetable cultivation, but 38 percent leveled land and 15 percent raised the level of their land, likely requiring significant investment of time and/or resources, while 23 percent practiced soil amendment. Investments related to irrigation are also common, with 7, 5, 4 and 1 percent of respondents, respectively, digging wells, installing pumps, and digging field channels, and installing drip irrigation, reflecting the importance of irrigation for enabling commercial vegetable production (Figure 18).

Figure 18: Changes made to agricultural land operated to initiate vegetable farming (percentage of households reporting)



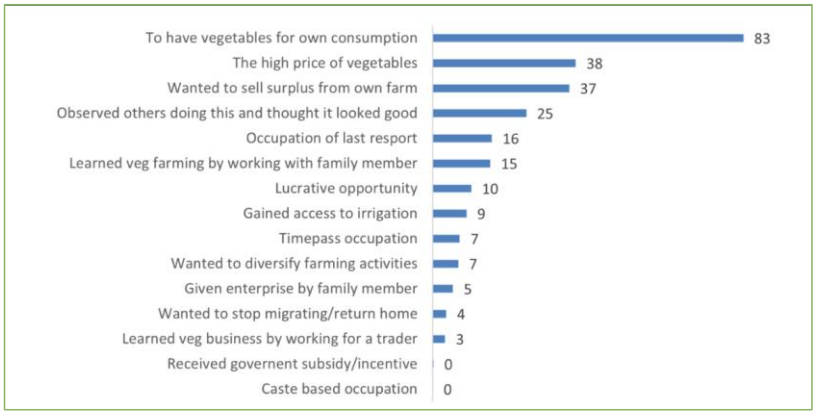
Source: INCATA Odisha Farmer Survey 2025

Only 4% of households reported receiving external assistance to initiate vegetable farming, primarily from WSHGs, or producer groups under the Government of Odisha's Agricultural Production Cluster (APC) program (each mentioned by about one third of respondents, conditional on receiving assistance). Smaller numbers of respondents (17% each, conditional on receiving assistance) reported receiving assistance from government subsidy programs and agricultural extension officers. These figures suggest that while programs such as these can play an important role in assisting some farmers, spontaneous entry into vegetable farming without any external source of directed assistance is the norm.

Forty-four percent of respondents who had farmed vegetables for at least 10 years had expanded the areas under vegetable cultivation within the past ten years, while 36 percent had made no change, and 20 percent had contracted, indicating a tendency for entrants into vegetable farming to subsequently increase the scale of production, suggesting that vegetable cultivation is often a rewarding activity.

Figure 19 presents the motivations of vegetable farmers for initiating production. By far the most common stated motivation was to produce vegetables for own consumption, suggesting that a progression from subsistence to more commercially oriented production occurred over time (as 99 percent of respondents sold at least some of the vegetables they produced in the year prior to the survey). At the same time several responses reveal commercial motivations, indicating that subsistence and income objectives are not mutually exclusive. Thirty-eight percent of respondents referred to the high price of vegetables, 37 percent mentioned wanting to produce a surplus for sale, 10 percent perceived vegetable farming as a lucrative opportunity, and 7 percent wanted to diversify farming activities.

Figure 19: Motivations for entry into vegetable cultivation (percentage of households reporting)



Source: INCATA Odisha Farmer Survey 2025

Observing others farming vegetables successfully motivated 25 percent of respondents to begin doing so themselves, highlighting the importance of the demonstration effect produced by other farmers, while 15 percent were motivated by learning from a family member and 5 percent by being handed the activity by a family members, indicating the importance of within family

transmission of farming practices. Nine percent citied gaining access to irrigation as a motivation, underlining its role as a catalyst for vegetable farming. Sixteen percent and seven percent of respondents, respectively, reported entering vegetable farming as an occupation of last resort or a 'timepass' occupation, perhaps suggesting that some underemployed educated rural youth may take up vegetable farming because of a lack of non-farm work options. No respondents reported vegetable farming as being a caste-based occupation, suggesting a degree of inclusivity, and none was motivated to start by receipt of a government subsidy or incentive.

Sequence of vegetable cultivation commercialization

Table 9 presents the evolution of vegetable farming characteristics over time, by season, share of production sold (marketed surplus) and share of household vegetable consumption originating from own production. We restrict the sample to households that have produced vegetables for more than 10 years to produce a quasi-panel, for the first year of vegetable cultivation (which varies by household), 2015 and 2025. The post-monsoon cool season is peak season for vegetable production. The share of vegetable farming households growing vegetables in cool season increased slightly from first year of vegetable production (79 percent) to 2025 (83 percent), possibly indicative of improving irrigation access, as growing vegetables in cool season often requires irrigation. The share of households growing vegetables in rainy season increased marginally from first year of cultivation (59 percent) to 2015 (61 percent), but fell slightly in 2025 (56 percent). The pre-monsoon hot season is least favorable for vegetable cultivation and most dependent on irrigation access, and follows a similar pattern to rainy season cultivation, rising from 21 percent in first year of cultivation to 24 percent in 2015, but dropping slightly in 2025 to 23 percent.

Table 9: Seasonal vegetable farming characteristics and disposal of vegetables produced, by year

Item	First year of vegetable cultivation	2015	2025
Growing vegetables in cool season (%)	78.9	82.0	83.2
Growing vegetables in rainy season (%)	58.5	60.9	55.9
Growing vegetables in hot season (%)	21.0	23.6	22.7
Grew vegetables in one season	56.9	50.7	53.2
Grew vegetables in two seasons	27.9	32.1	31.8
Grew vegetables in three seasons	15.3	17.1	14.1
Marketed surplus of vegetables (%)	62.2	65.3	70.6
Vegetables consumed by the household that were purchased (%)	46.6	44.9	45.9

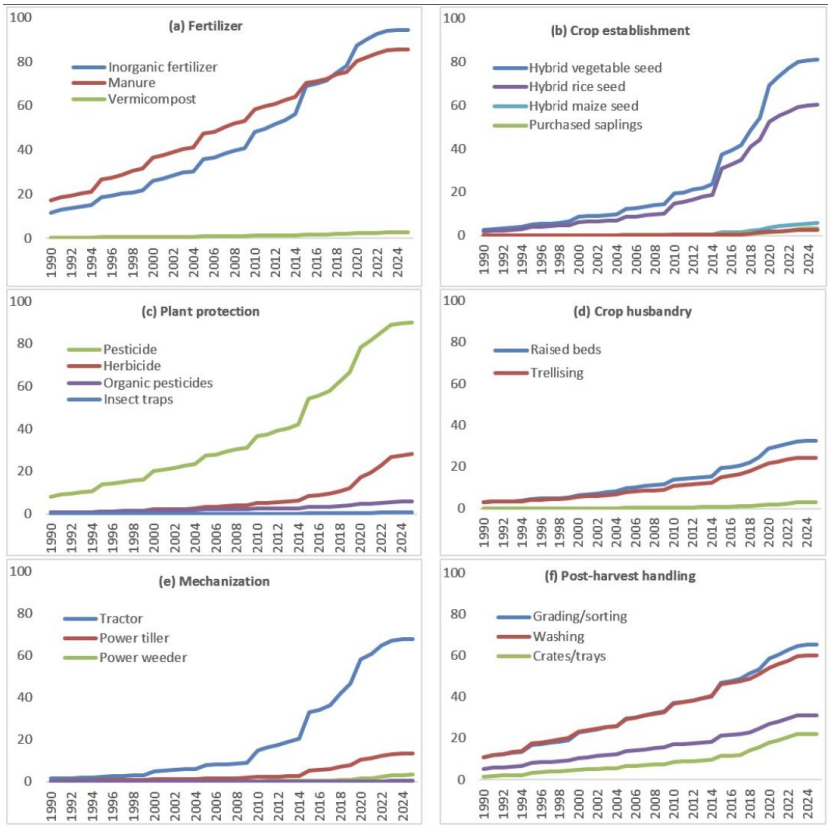
Source: INCATA Odisha Farmer Survey 2025. Note: sample is restricted to households that started growing vegetables before 2015

The share of households farming vegetables in 1, 2, or 3 seasons follows a similar trend. Fifty-seven percent of households grew vegetables in only one season when starting, falling slightly to 51 percent in 2015, before rising slightly to 53 percent in 2025. Conversely, the shares of households growing vegetables in 2 and 3 seasons increased slightly from year of first production to 2015 but decreased marginally by 2025.

The overall pattern evident is one of limited overall change in the number of growing seasons, indicating that vegetable farming has grown at the extensive margin (by bringing land not previously used to produce vegetables under cultivation), rather than at the intensive margin (by increasing the number of annual cycles of vegetable production). However, although variation between years in the number of growing seasons is small and must be interpreted with caution, the direction of the trends consistently points to a slight decline in off-season vegetable cultivation post 2015. We interpret them to suggest that rainy season and hot season vegetable cultivation may have faced increasing challenges due to climate stress over the past decade. This impression is consistent with observations during fieldwork, during which respondents in several areas reported that vegetable cultivation had declined locally due to water shortages, weather extremes, or the deterioration of irrigation systems.

Farms' marketed surplus of vegetables increased gradually over time, from 62 percent in the first year of vegetable production to 71 percent in 2025. This finding has several implications. First, by inference, the share of vegetables that households consumed from their own production was significant (around 30-40% in all years), suggesting that commercial vegetable cultivation does not occur at the expense of self-provisioning, reflecting the high importance ascribed to production for own consumption. Second, the skills of vegetable producers may have increased with experience, leading to higher output. Third, vegetable yields may have increased with the application of production enhancing technologies, leading to larger marketed surpluses (see Figure 21). Fourth, some vegetable producers may have expanded the area under cultivation, leading to higher surpluses.

Figure 21: Sequence of adoption of vegetable production technologies (percentage of vegetable farms reporting year of first use, by year) 1990-2025



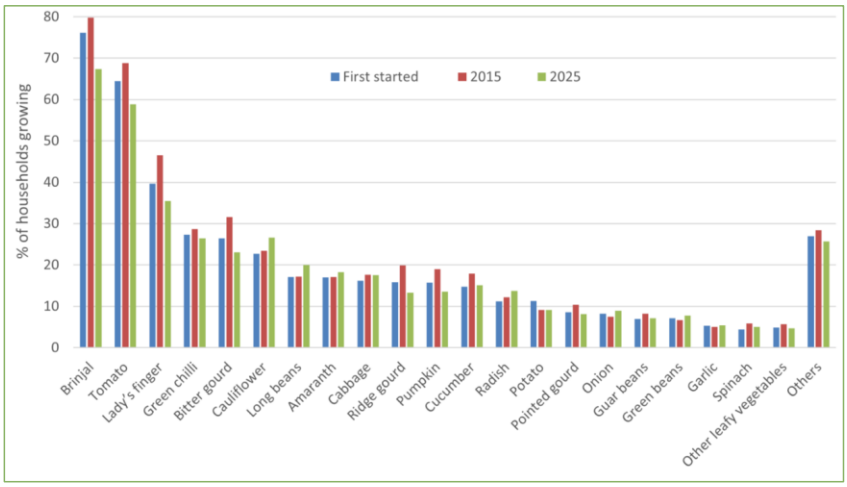
Source: INCATA Odisha Farmer Survey 2025

The share of vegetables consumed by households that were purchased from the market remained stable over time, at around 45 percent. This is likely to imply that households purchase types of vegetables they do not produce or buy during seasons when they do not grow vegetables.

Crop choice

Figure 20 presents the share of households growing vegetables of different types by year, using the same quasi-panel of households who had been growing vegetables for more than a decade. Brinjal (eggplant) and tomato are by far the most widely grown vegetables, produced by 67 percent and 59 percent of households, respectively, in 2025. Ladies finger (okra) was produced by 36 percent of households and green chili, bitter gourd and cauliflower by more than 20 percent. A leafy vegetable, amaranth, was grown by 20 percent, and cabbage, ridge gourd, cucumber and radish (mooli) grown by more than 10 percent. A total of 39 vegetables, including several root crops, were reported to be grown. Thus, there is a high concentration of production in several key 'commodity vegetables', but with a high number of diverse 'niche vegetables' also grown by smaller numbers of households.

Figure 20: Percentage of households growing horticultural crops, by year



Source: INCATA Odisha Farmer Survey 2025. Note: Sample is restricted to households that started growing vegetables before 2015.

The temporal trend in the share of households producing vegetables of each type follows a similar pattern to the number of seasons in which vegetables were grown, as discussed above, increasing between the year when households first initiated vegetable farming and 2015, and declining in 2025 to levels below those in the first year of vegetable farming. For example, 76 percent of households grew tomato in their first year of production. This level increased to 80 percent in 2015, before falling to 67 percent in 2025, a decline of 13 percentage points. Among the 25 vegetables produced by 5 percent or more households, the share of households growing increased for 15 vegetables and declined for 2 between first year of growing and 2015, but increased for 5 vegetables and declined for 13 from 2015 to 2025. The only vegetables for which share of households growing increased between first year of vegetable farming and 2025, were cauliflower, long beans, amaranth, cabbage, and radish. The average number of vegetables produced per household in first year of growing vegetables was 4.5. This number rose to 4.9 in 2015, then fell to 4.3 in 2025.

We suggest two possible explanations for this pattern. First, increasing climate stress over the past decade may have pushed some households to stop growing certain vegetables in the hot season and rainy, consistent with the trends in Table 9. Second, inflows of vegetables from out of state may have eroded, or lessened incentives for, the production of certain vegetables. However, the increase in the share of households producing of a small subset of vegetables (e.g. cauliflower, cabbage) may suggest progression along the product cycle toward local cultivation on some kinds of commodity vegetables that were previously sourced from out of state.

Technology adoption

Table 10 presents information on the share of vegetable farmers currently using a variety of technologies. Except for hybrid rice seed and hybrid maize seed, use of these technologies is reported in relation to their role in vegetable cultivation. We find the following.

Table 10: Percentage of vegetable farming households currently using agricultural technologies (whole sample, high and low vegetable farm concentration blocks, first and third operated land terciles) and tests of statistical significance.

Respondents currently using...	All vegetable farms (%)	Low concentration block (%)	High concentration block (%)	P-value	Land Tercile 1 (%)	Land Tercile 3 (%)	P-value
Hybrid vegetable seed	80.8	79.8	80.3	0.845	75.3	82.4	0.001***
Hybrid rice seed	59.9	52.4	60.2	0.004***	47.2	70.3	0.000***
Hybrid maize seed	5.3	4.0	6.4	0.068*	3.4	8.7	0.000***
Seed trays	2.6	2.1	2.6	0.563	2.0	3.4	0.125
Purchased vegetable seedlings	2.6	1.7	2.9	0.167	2.3	3.8	0.114
Inorganic fertilizers	94.2	89.4	96.4	0.000***	92.8	95.2	0.065*
Manure	85.3	85.8	83.1	0.183	81.7	89.8	0.000***
Vermicompost	2.7	1.3	2.5	0.118	1.5	3.9	0.007***
Raised bed planting	31.9	29.1	34.6	0.034**	32.8	33.1	0.917
Trellising	23.9	26.3	25.7	0.804	21.6	24.5	0.214
Plastic mulching	2.9	1.1	4.4	0.001***	2.1	3.6	0.104
Pesticide	89.5	80.7	92.7	0.060*	84.4	92.0	0.178
Organic pesticide	5.0	2.8	6.6	0.000***	3.8	6.3	0.001***
Insect traps	0.6	0.0	0.7	0.000***	0.3	0.9	0.000***
Herbicide	27.6	15.9	34.5	0.002***	23.8	32.1	0.043**
Tractor	67.7	57.3	72.9	0.000***	64.1	68.1	0.126
Power tiller	13.1	13.4	13.6	0.921	14.3	14.9	0.754
Power weeder	3.3	1.1	4.8	0.000***	2.0	5.1	0.002***
Drone	0.4	0.0	0.1	0.507	0.5	0.4	0.95
Grading/sorting vegetables	65.0	62.6	64.7	0.429	60.0	70.4	0.000***
Washing vegetables	59.7	57.7	61.1	0.218	52.3	66.9	0.000***
Crates/trays	21.8	20.2	20.1	0.979	13.2	30.2	0.000***
Plastic bags/bagging	31.0	20.0	30.7	0.000***	23.8	39.1	0.000***

Source: INCATA Odisha Farmer Survey 2025. Note: *** p<0.01, ** p<0.05, * p<0.10

First, adoption of hybrid vegetable seed is extremely widespread, reported by about 81 percent of vegetable farming households. Rates of hybrid vegetable seed use are almost identical in blocks with low and high concentrations of vegetable farms (about 80 percent in both groups), reflecting the very widespread diffusion of this technology. However, adoption is significantly higher among farms in the largest operated landholding tercile (land tercile 3, 82 percent) than among those in the smallest tercile (tercile 1, 75 percent).

Second, use of hybrid rice seed is widespread, reported by about 60 percent of vegetable farms overall. Adoption is significantly more common in high vegetable concentration blocks (60 percent) than in low concentration blocks (52 percent). The largest tercile of farms adopts hybrid rice seed at substantially higher rates (70 percent) than the smallest tercile (47 percent). A similar pattern is observed for hybrid maize seed, though adoption rates are much lower overall (5 percent), reflecting the more limited role of maize relative to rice in these farming systems.

Third, use of seed trays and purchased vegetable seedlings is very limited, adopted by about 3 percent of households each. This reflects the predominance of traditional practices of establishing seedlings in soil and the limited availability of commercial nurseries. There are no statistically significant differences in adoption rates between high and low vegetable concentration blocks, nor between farms in land tercile 1 and tercile 3.

Fourth, rates of adoption of inorganic fertilizers (DAP, urea, etc.) are high but not universal, reported by 94 percent of vegetable farms. Adoption is significantly higher ($p<0.01$) in high vegetable concentration blocks than in low concentration blocks (96 versus 89 percent). Differences by landholding tercile are small and only weakly statistically significant, suggesting that access to inorganic fertilizers is broadly scale neutral.

Fifth, use of manure as a fertilizer is also extremely common, though somewhat lower than that of inorganic fertilizers, reported by 85 percent of farms overall. There is no statistically significant difference in manure use between high and low vegetable concentration blocks, indicating similar geographic access. However, the largest third of farms are significantly more likely to use manure (90 percent) than the smallest third (82 percent).

Sixth, use of vermicompost - often promoted by NGOs and government agencies as an alternative to inorganic fertilizers - remains limited, reported by about 3 percent of farms. Adoption does not differ significantly between high and low vegetable concentration blocks but is significantly higher among farms in land tercile 3 than among those in land tercile 1.

Seventh, raised bed planting and trellising are agronomic practices that can increase the productivity and quality of gourds and other vines by raising them off the ground and exposing them to the light. About 32 percent of farms report using raised bed planting, while 24 percent use trellising, often in tandem, suggesting widespread uptake among households who grow gourds and other climbing plants (these account for 39 percent of vegetable farms). Raised bed planting is significantly more common in high vegetable concentration blocks than low, but with no significant difference by farm size. Trellising does not differ significantly across vegetable concentration blocks or landholding terciles.

Eighth, plastic mulching, used primarily for weed control and moisture retention, is adopted by only about 3 percent of vegetable farms. Use is significantly more common in high vegetable concentration blocks than in low concentration blocks but does not vary significantly by landholding tercile.

Ninth, pesticide use is extremely widespread, practiced by nearly 90 percent of vegetable farmers. Adoption rates are higher in high vegetable concentration blocks than in low concentration blocks, though this difference is only weakly statistically significant. Differences by landholding tercile are not statistically significant. The widespread use of pesticides reflects the vulnerability of vegetable crops to pest attack but has potentially important implications for human and environmental health.

Tenth, organic pesticides such as neem oil, promoted as alternatives to highly toxic synthetic pesticides, are used by about 5 percent of vegetable farmers. Adoption is significantly higher in high vegetable concentration blocks and among larger farms. Insect traps - an alternative pest management strategy - are used by fewer than 1 percent of farms. Their use is concentrated in high vegetable concentration blocks and among larger farms, indicating extremely limited diffusion overall.

Eleventh, herbicide use is less common than pesticide use, reported by about 28 percent of vegetable farms, reflecting the sensitivity of many vegetable crops to herbicide damage. Herbicide use is significantly more common in high vegetable concentration blocks than in low concentration blocks, and among farms in land tercile 3 relative to those in tercile 1. Higher adoption among larger farms likely reflects the labor-saving properties of herbicides.

Twelfth, mechanized land preparation is widespread. Sixty-eight percent of farms use four-wheel tractors, while smaller shares use power tillers (13 percent) and power weeders (3 percent). Interestingly, although tractor use is significantly more common in high vegetable concentration blocks than low (73 vs 57 percent), it does not differ significantly by landholding tercile. Power tiller use does not vary significantly across geographies or farm size classes, whereas power weeder adoption is significantly higher in high concentration blocks and among larger farms. While it may seem counterintuitive that large machines – tractors – should be scale neutral, while the smallest machines – power weeders – are not, we posit that this finding reflects the characteristics of machinery rental service markets, where tractors and power tillers are widely available for hire as outsourced services, whereas power weeders are usually owner-operated and rarely hired out.

Thirteenth, a few farmers (0.4 percent) have begun to use agricultural drones, likely to spray pesticides and/or liquid fertilizers. These farmers are all located in Cuttack district. Although agricultural drone adoption in Odisha is nascent, this confirmation of its existence suggests potential for future growth.

Fourteenth, practices that support product upgrading or value addition (grading and sorting, and washing) are widespread, practiced by 65 and 60 percent of farmers, respectively. Packing vegetables in crates or trays and bagging vegetables are also quite common, practiced by 22 and 31 percent of farmers. All these practices are used significantly more by large farms (land tercile 3), consistent with obtaining high volumes of production.

The sequence of vegetable technology adoption

Figure 21 presents the sequence of adoption of technologies presented in Table 10, represented by the percentage of vegetable farmers in the sample reporting the first year in which the technology was used. The following broad patterns are apparent:

First, manure and inorganic fertilizers are the earliest widely adopted technologies. With 19 and 12 percent of the vegetable farmers surveyed in 2025, respectively, were already using in 1990. Adoption of both forms of fertilizer increased at a similar rate until around 2014, prior to which the share of farmers using manure was higher than the share using inorganic fertilizers. After 2014, the share of farmers using inorganic fertilizers for vegetable cultivation for the first time accelerated rapidly, overtaking the share using manure for the first time around 2019.

Second, first use of hybrid vegetable seed and hybrid rice seed by vegetable farmers increased slowly and at a similar rate from 1990 to 2014, after which time both increased rapidly, with rates of first use of hybrid vegetable seed outstripping hybrid rice seed particularly after 2019. First use of seed trays and purchased vegetable saplings began to grow slightly from a very low base from around 2018.

Third, pesticides were the earliest widely adopted input after manure and inorganic fertilizer. Year of first use follows a similar pattern to inorganic fertilizer, increasing at a steady rate until 2014 and accelerating rapidly thereafter. First use of herbicides in vegetable farming began around 2010 and increased slowly to 2019, accelerating thereafter.

Fourth, raised beds and trellising have a long history, with first use increasing incrementally until 2014 and growing at a slightly higher rate thereafter, with adoption of raised bed planting increasing more quickly thereafter.

Fifth, first use of tractors began somewhat later on average than adoption of inorganic fertilizers, pesticides and hybrid seed, with only 1 percent of current farmers having used them for vegetable cultivation, but followed a similar temporal pattern thereafter, beginning to accelerate after 2010, and accelerating further from 2014. First use of power tillers (two-wheel tractors) began around 2014, and power weeders, which are smaller than power tillers, from around 2020. Drones were first used in 2023. Interestingly, this sequence of miniaturization of agricultural machinery runs in the opposite direction to that found in many other locations (e.g. Southeast Asia) were small machines (power tillers) have been widely adopted before larger tractors.

Sixth, grading/sorting and washing were adopted early. Twelve percent of current farmers already used each practice in 1990. Rates of first use of both practices increased steadily and in step, suggesting that they may be adopted jointly. First use of crates, trays and bags also grew at a steady though slower rate, and from a lower base, with rate of respondents reporting first use increasing slightly after 2014.

Irrigation

What accounts for the pattern of accelerating adoption of a bundle of complementary productivity enhancing vegetable cultivation technologies from around 2010 onwards? Analysis of the history of adoption of irrigation supplies part of the answer. Table 11 presents the share of irrigated parcels

of land operated by surveyed farm households (including vegetable farmers, and non-vegetable farmers growing mainly rice), by type of irrigation used and the type of irrigation provider (government, private or community), and well as rates of growth irrigation adoption over different time periods. The following points stand out.

Table 11: Percentage of irrigated parcels and rate of growth in parcels irrigated, by irrigation type and provider.

Type of irrigation	Irrigation provider: Government (%)	Irrigation provider: Private (%)	Irrigation provider: Community (%)	% of all irrigated parcels (%)	Growth, 1980-2025 (%)
Irrigation canal (%)	95	2	4	26	47
Open well (%)	7	85	8	23	58
Tubewell/borewell (%)	38	58	4	18	304
Lift irrigation (%)	83	17	0	15	133
Rainwater harvesting (%)	23	51	26	11	49
Reservoir/dam (%)	85	5	10	8	17
Stream/waterfall (%)	0	0	100	0.1	16
Total (%)	55	38	7	100	65
Growth, 1980-2010 (%)	19	29	7	20	-
Growth, 2010-2025 (%)	35	67	14	43	-
Growth, 1980-2025 (%)	65	114	22	74	-

Source: INCATA Odisha Farmer Survey 2025

First, irrigation is supplied by a mix of surface and groundwater sources. Canal irrigation is the most common type of irrigation (26 percent of irrigated parcels), followed by open wells (23 percent), tubewell/borewells (18 percent), lift irrigation (15 percent), rainwater harvesting (11 percent), and reservoirs or dams (8 percent).

Second, irrigation provided by government is most common, accounting for 55 percent of the total, followed by private sources (38 percent) and communities (7 percent).

Third, canal, lift, and dam irrigation are provided mainly by government, while open wells are mainly private. More than half of parcels receiving tubewell and rainwater harvesting irrigation are served by private irrigation, but these types of irrigation are also supplied by government (particularly borewells) and by communities (particularly rainwater harvesting).

Fourth, the number of parcels receiving irrigation for the first time has increased by 65 percent since 1980. The number of parcels receiving borewell irrigation increased fastest, growing by over 300 percent, followed by lift irrigation (133 percent). The number of parcels receiving open well irrigation and rainwater harvesting irrigation also increased substantially since 1980 (by 58 percent and 49 percent, respectively).

Fifth, expansion of irrigation access accelerated sharply after 2010, coinciding with a sharp uptick in adoption of productivity enhancing technologies in vegetable cultivation. From 1980 to 2010 the rate of change in the number of parcels receiving irrigation from any source was slow, growing only 20 percent in 30 years. The number of privately irrigated parcels of land grew slightly faster, but from a lower base, than the number where irrigation was provided by government (29 percent vs 19 percent). In the 15 years from 2010 to 2025, the number of parcels receiving irrigation for the first time from any source increased by more than double the rate that it had in the preceding 30 years. Growth in the number of privately irrigated parcels from 2010-2025 (67 percent) outstripped that of government (35 percent) or community (14 percent) irrigated parcels.

Table 12 further disaggregates the type and source of irrigation used on parcels of land used to grow vegetables, and parcels used to grow rice. Open wells and borewells are the two most common types of irrigation in vegetable farming, used to irrigate 29 percent and 19 percent of parcels of irrigated vegetable land, respectively. Canals and lift irrigation are the two forms of irrigation most commonly used to grow rice, used to supply water to 33 percent and 16 percent of irrigated rice parcels, respectively. Notably, open wells and borewells are mainly privately owned, while canals and lift irrigation are primarily provided by government. Thus, although growers of vegetables and rice use a mixture of types of irrigation from a variety of sources for both crops, government irrigation schemes are predominantly targeted at, and used for, rice farming, whereas vegetable cultivation is heavily dependent on private irrigation.

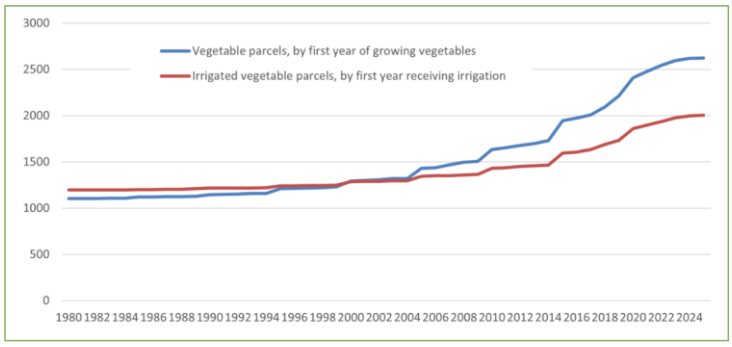
Table 12: Percentage of irrigated parcels used for vegetable farming and rice farming, by type and source of irrigation

Crop	Tubewell/ borehole	Open well	Lift irrigation	Canal	Reservoir/ dam	Rainwater harvesting	Stream/ waterfall
Vegetables (%)	19	29	11	12	6	12	11
Private (%)	62	85	21	3	7	53	0
Government (%)	33	7	79	97	89	21	0
Community (%)	5	8	1	4	4	25	100
Rice (%)	11	12	16	33	9	7	13
Private (%)	50	85	11	1	4	45	0
Government (%)	48	11	89	95	84	32	0
Community (%)	3	5	0	4	13	23	100

Source: INCATA Odisha Farmer Survey 2025

Figure 22 illustrates the importance of irrigation access as a catalyst for vegetable cultivation, showing the cumulative number of parcels of land under vegetable cultivation by first year brought under vegetable cultivation, and the cumulative number of vegetable parcels by first year of receiving irrigation. A substantial number of respondents were unable to say in which year one or both these events took place. 'Don't know' responses were dropped' and 'always' responses were assumed to refer to before 1980. Despite these recall limitations a clear association can be seen between date of irrigation acquisition and entry into vegetable farming. The cumulative numbers of parcels receiving irrigation and under vegetable cultivation both grew very gradually from 1980 to 2000. The rates of growth of both increased slightly from 2000 to 2015 and accelerated thereafter, both tracing a similar trajectory, but with number of parcels brought under vegetable cultivation outstripping number of vegetable parcels newly receiving irrigation for the first time.

Figure 22: Cumulative count of parcels of land brought under vegetable cultivation, and irrigated vegetable parcels, by year of first receiving irrigation, 1980-2025



Source: INCATA Odisha Farmer Survey 2025 Note: Assumed pre-1980 as start date for parcels brought under vegetable cultivation of irrigation where respondent reported 'always' as date.

CHAPTER 4. DOES COMMERCIAL SMALL-SCALE VEGETABLE FARMING PRODUCTION ENHANCE FARMER WELFARE?

A key hypothesis of the INCATA project is that agricultural commercialization may improve small-scale agricultural producer welfare by, for instance, raising farm incomes or improving diets.

To explore the relationship between commercial small-scale vegetable cultivation and household welfare we surveyed farm households who produce vegetables and sell their crop (*"vegetable farmers"*) and farm households who grow rice but do not produce vegetables for sale (*"non-vegetable farmers"*).

Most vegetable farmers (90 percent) grow rice, reflecting its status as the main staple crop in Odisha. Almost all rice growing households produce monsoon rice, but only 6 percent grow an irrigated dry season rice crop. Twenty-one percent of households selected into the non-vegetable farmer sample were found to have produced some vegetables during the preceding year, but planted an extremely low average area of vegetables (0.04 ha) and generated a limited marketed surplus (17 percent), indicating that they operated kitchen gardens primarily for subsistence use.

Vegetable production in Odisha is strongly commercially oriented. The vegetable farmers in our sample sold an average of 74 percent of their production. That is a much higher rate of commercialization than found in rice cultivation: non-vegetable farmers sold 47 percent of their rice crop, vegetable farmers sold 35 percent, and 34 percent of households sold no rice at all. Thus, comparing these two groups provides an entry point for exploring the relationship between smallholder commercialization and welfare.

In the remainder of this note we compare the household, landownership, and asset ownership characteristics of vegetable and non-vegetable farming households. We then compare indicators of household welfare and use regression analysis to further parse out the associations between household characteristics, agricultural commercialization through vegetable cultivation, and key welfare outcomes (income and diet diversity).

Household characteristics

The household characteristics of vegetable and non-vegetable farmers (Table 13) are broadly similar, but the overall socioeconomic status of vegetable farmers is slightly higher than that of non-vegetable farmers. Ninety-nine percent of vegetable farmers are Hindu, compared to 96 percent of non-vegetable farmers. The share of scheduled caste households is very similar for both types of farmers (19 percent), but the share of scheduled tribe households engaged in vegetable farming is lower than that in non-vegetable farming (24 percent vs 33 percent). Conversely, a larger share of vegetable farmers (57 percent) belong to non-scheduled castes than non-vegetable farmers (47 percent).

Table 13: Household characteristics of vegetable producing and non-vegetable producing farm households.

Characteristic	Non-vegetable farmers	Vegetable farmers	P-value & significance
Hindu	95.5	99.2	<0.000***
Scheduled tribe	32.7	23.8	<0.000***
Scheduled caste	19.7	19.1	<0.715
Other castes	47.3	56.9	<0.000***
Household head has no primary education	12.7	9.6	<0.010***
Household head started or completed secondary education (%)	42.7	47.7	<0.008***
Household's main occupation is agriculture	63.1	73.8	<0.000***
Household's main income source is casual labor	25.3	15.9	<0.000***
Household currently has a migrant	17.8	17.1	<0.635

Source: INCATA Odisha Farmer Survey, 2025

Vegetable farmers are better educated on average than non-vegetable farmers: 48 percent and 43 percent, respectively, have some secondary education. Vegetable farmers are also more likely than non-vegetable farmers to report that agriculture is their main occupation (74 percent vs 63 percent) and, conversely, less likely to report that their main source of income is casual labor (16 percent vs 25 percent). This suggests that vegetable farmers may have greater agricultural assets and earnings than non-vegetable farmers, making them less dependent on casual non-farm employment to supplement farm income. Similar shares of households of both types (around 17 percent) have a current migrant.

Landholdings

Table 14 presents the landholding characteristics of both sets of farmers. We define landowning households in the strict sense, as those where one or more household members possess a land title in their name. Many farmers in Odisha work land belonging to parents or siblings, that has not been formally divided or inherited. We include this in the category 'operated land', along with land leased, borrowed, shared, or mortgaged in.

Table 14: Land ownership and operation characteristics of vegetable producing and non-vegetable producing farm households

Characteristic	Non-vegetable farmers	Vegetable farmers	P-value & significance
Household owns land (%)	80.1	76.0	<0.010***
Household leases in land (%)	23.4	29.1	<0.001***
Area of land operated (ha)	0.69	0.89	<0.000***
Number of segments of land operated by household	2.2	2.6	<0.000***
Number of individual plots of land operated by household	7	8	<0.000***
Number of operated segments under vegetables	0.2	1.2	<0.000***
Number of operated segments under rice	1.8	1.7	<0.016**
Number of operated segments under other crops	0.4	0.5	<0.090*
Number of lowland segments of land per household	0.6	0.6	<0.909
Number of midland segments of land per household	0.9	1.2	<0.000***

Number of upland segments of land per household	0.6	0.7	<0.077*
Household has irrigated land (%)	41.6	78.8	<0.000***
Number of irrigated segments operated by household	0.7	1.3	<0.000***
Share of segments operated by household that are irrigated (%)	30.0	54.5	<0.087*
Simpson index of agricultural production	0.20	0.46	<0.001***

Source: INCATA Odisha Farmer Survey, 2025

Agricultural landholdings in Odisha are highly fragmented, making it time consuming to collect detailed information on the individual plots operated by a household. To facilitate respondent recall, we recorded detailed information about landholdings at 'segment' level. A segment is a piece of land with a distinct identity (e.g. a name), often originally a single large holding that has been subdivided into smaller plots over time. The plots of land in a segment usually have common characteristics (e.g. the same elevation and soil type). A household can operate more than one plot of land on a given segment.

Vegetable farmers are slightly less likely to own land than non-vegetable farmers. Seventy-six percent and 80 percent respectively possess land to which they have title. This could imply that vegetable farmers are more likely to be part of extended households where multiple siblings work land with a shared title deed. Conversely, slightly more vegetable farmers (29 percent) lease in land than non-vegetable farmers (23 percent). This could imply that commercial vegetable cultivation is associated with thickening land markets, as households lease in land to initiate or expand a potentially lucrative form of cultivation, but may also be related to the lower share of vegetable farmers reporting that they own land.

The average area of land operated by vegetable farmers (0.9 ha) is 29 percent larger than that operated by non-vegetable farmers (0.7 ha), but small in relative terms: the average area of land operated by vegetable farms in land tercile 3 (i.e. the largest third) is 1.8 ha: less than 2 ha, the international definition of a smallholder. Vegetable farming households operate slightly more segments of land than non-vegetable farming households (2.6 vs 2.2) and slightly more plots within those segments (8 vs 7).

Vegetable farmers devote one more segment of land to vegetable cultivation than non-vegetable farmers (1.2 vs 0.2) but operate similar numbers of segments under rice (1.7 vs 1.8) and other crops - pulses, oilseeds, maize, millet, fibers, flowers, and tree crops - (0.5 vs 0.4). This pattern suggests that vegetable farmers use their land more intensively than non-vegetable farmers by devoting some plots to vegetable cultivation outside the main monsoon rice cultivation period.
Lowland (flat, low-lying land that accumulates water) is well suited to rice cultivation, while midland and upland (elevated, sloping, well-drained land) is usually better suited to vegetable cultivation, pulses and oilseeds, and cereals such as maize or millet. Vegetable and non-vegetable farming households operate similar numbers of lowland segments (0.6) and upland segments (0.6), but vegetable farmers operate significantly more midland segments than non-vegetable farmers (1.2 vs 0.9). This seems to imply that having access to midland increases the likelihood of households entering vegetable cultivation, but could also suggest that some vegetable growing households deliberately expand their midland holdings to enable expanded vegetable cultivation.

Irrigation is an important factor for enabling vegetable cultivation, particularly during the cooler post-monsoon months which are the peak season for vegetable production. Vegetable farming households are much more likely than non-vegetable farming households to have irrigated land

(79 percent vs 42 percent). They also have more irrigated segments per household (1.3 vs 0.7) and a higher share of segments that are irrigated (55 percent vs 30 percent). These numbers underline the importance of irrigation access as a catalyst for vegetable cultivation and may also suggest that vegetable cultivators invest in irrigation to facilitate production.

The above factors result in a much higher level of agricultural diversification by vegetable farmers than non-vegetable farmers. The value of the Simpson index (a measure of diversity) of agricultural production based on the number of crops grown and area allocated to each, is more than double for vegetable farmers (0.46) than non-vegetable farmers (0.2).

Assets

Table 15 compares the credit use and asset ownership characteristics of vegetable and non-vegetable farming households and their receipt of government transfers, to explore whether these differ among the two categories of household. Vegetable farmers were slightly more likely to have borrowed for use in agriculture in the past year than non-vegetable farmers, and among households that had not borrowed, were slightly less likely to report difficulties accessing agricultural credit. The first point could suggest that the operating costs associated with vegetable farming create more demand for agricultural credit than rice cultivation alone, while together these points may suggest that vegetable farming households have slightly better access to agricultural credit.

Table 15: Borrowing, transfers, and asset characteristics of vegetable producing and non-vegetable producing farm households

Characteristic	Non-vegetable farmers	Vegetable farmers	P-value & significance
Borrowed to fund agriculture in 2024 (%)	46.1	50.4	0.025**
Unable to access agricultural loan in past year (conditional on not borrowing) (%)	7.6	4.6	0.025**
Received Kalia transfer in past 12 months (%)	57.4	60.6	0.252
Ever leased in land (%)	20.5	28.2	<0.000***
Ever purchased land (%)	4.1	8.7	<0.000***
Owns irrigation equipment (%)	20.2	46.4	<0.000***
Owns agricultural machinery (%)	2.7	5.8	<0.000***
Owns motorbike (%)	58.8	63.2	0.016**
Owns mobile phone (%)	97.0	96.8	0.836
Number of types of asset owned by household	4.1	4.7	<0.000***

Source: INCATA Odisha Farmer Survey, 2025

The Government of Odisha's KALIA (Krushak Assistance for Livelihood and Income Augmentation) Scheme provides financial transfers to farmers and vulnerable households to support their agricultural activities. The share of households receiving funds from KALIA within the past 12 months is similar among groups of farmers (around 58 percent), suggesting that neither group has privileged access to public resources, but perhaps also that receiving KALIA payments is not sufficient to stimulate adoption of vegetable cultivation.

Vegetable cultivation appears to offer a pathway to expanded reproduction or accumulation for some farm households. More vegetable farmers report having ever leased in or purchased land than non-vegetable farmers (28 vs 21 percent and 9 vs 4 percent, respectively. Although we did not collect information on the timing of land leases and purchases, it seems plausible that vegetable farmers expanded their holdings by leasing, or accumulated land by purchasing, at a higher rate than non-vegetable farmers, either to enable initiation or expansion of vegetable cultivation, or through reinvestment of profits earned from vegetable farming activities.

Vegetable farming households own more agricultural assets than non-vegetable farmers on average. The shares of vegetable farmers owning irrigation equipment (e.g. pumps) and agricultural machinery are more than double those of non-vegetable farmers (46 vs 20 percent and 5.8 vs 2.7 percent, respectively). This reflects in part the higher irrigated area operated by vegetable producers and suggests that irrigation equipment may be a threshold investment for entry into vegetable production. Higher rates of agricultural machinery ownership among vegetable farmers could be related to the labor demands of vegetable farming, or to high returns relative to non-vegetable farming which may be reinvested in productive assets.

Motorbike ownership is slightly higher among vegetable farming households than among non-vegetable farmers (63 vs 59 percent), but rates of mobile phone ownership are identical. Vegetable farming households own a greater number of types of asset on average than non-vegetable farmers (4.7 vs 4.1), but the difference, though significant, is not large and is accounted for mainly by differences in agricultural asset ownership.

Welfare

Table 16 presents variables for vegetable and non-vegetable farming households that are indicators of several dimensions of welfare.

Table 16: Welfare characteristics of vegetable producing and non-vegetable producing farm households.

Characteristic	Non-vegetable farmers	Vegetable farmers	P-value & significance
Household consumed vitamin A-rich vegetables within past 24 hours (%)	40.8	48.5	0.007***
Household consumed dark green leafy vegetables within past 24 hours (%)	67.5	73.2	0.027**
Household consumed other vegetables within past 24 hours (%)	86.7	95.8	<0.000***
Household Diet Diversity Score	8.2	8.8	<0.000***
Annual agricultural income (INR)	37,282	46,188	0.011**
Annual household income (excluding government transfers) (INR)	90,817	90,415	0.953
Gini co-efficient of agricultural income	0.52	0.52	n/a
Gini co-efficient of household income	0.43	0.45	n/a

Source: INCATA Odisha Farmer Survey, 2025

Vegetable farmers consume significantly more vegetables of all types more frequently than non-vegetable farmers and have significantly more diverse diets overall, suggesting positive nutrition benefits. Between 8 and 19 percent more vegetable farmers consumed vitamin A-rich vegetables, dark green leafy vegetables, and other types of vegetable within the past 24 hours than non-vegetable farmers. Vegetable farmers average household diet diversity score, based on a total 16 food groups, is 8.8, compared to 8.2 for non-vegetable farmers.

Vegetable farmers have significantly higher agricultural incomes than non-vegetable farmers. The average annual agricultural income earned by vegetable farming households is ₹46,188 ($530) - 24 percent higher than that earned by non-vegetable farmers. This result suggests that vegetable cultivation has an important role to play in contributing of the Government of India's policy objective of doubling farmers' income. However, the average household incomes of rice and vegetable farmers, excluding income from government transfers, are not significantly different, suggesting that non-vegetable farming households may specialize more in non-farm employment, while the labor-intensive nature of vegetable cultivation may limit opportunities to engage in such kinds of work.

The Gini coefficient is a measure of inequality within a population. A value of 0 signifies total equality and 1 signifies total inequality. We calculated the Gini coefficient of agricultural income for vegetable farming and non-vegetable farming households. If vegetable farming results in some vegetable growing households increasing their agricultural earnings at a faster rate than others, we might expect to see higher income inequality among this group than among non-vegetable farmers, but the Gini coefficient of agricultural and household income is very similar (0.52) for both vegetable farming and non-vegetable farming households, suggesting that vegetable farming does raise income inequality among adopters.

However, it is possible that within-group inequality does not widen while inequality across the whole population of agricultural households rises. To test this, we compare the Gini coefficient of agricultural income across all surveyed households in blocks with low, medium and high concentrations of vegetable farms. Inequality is highest in high vegetable cultivation concentration blocks (0.53), lowest in medium concentration blocks (0.50) and intermediate in low concentration blocks (0.51). However, these differences are small, and caution must be exercised in interpreting them as our sampling strategy is not designed to statistically represent the population of each block.

Regression analysis

In this section (Table 17) we analyze associations between key descriptive variables reviewed in preceding sections and five outcome variables indicative of household welfare, namely annual income per capita (gross revenue minus paid out costs, divided by number of household members) from: (1) vegetables, (2) rice, (3) total crops; (4) total household income (including farm and non-farm sources); (5) the household diet diversity score (HHDDS), based on 16 food groups). The following results stand out.

Table 17: Ordinary least square regressions on associations between characteristics of vegetable producing and non-vegetable producing farm households, incomes and diet diversity.

Variables	(1) Annual vegetable income/capita from (INR)	(2) Annual rice income/capita (INR)	(3) Annual crop income/capita (INR)	(4) Annual household Income/ capita (INR)[a]	(5) Household diet diversity score (0-16 scale)
Scheduled Tribe (Ref: OBC)	1412.822	-1344.172	479.442	-4083.902	0.251
	(959.26)	(1328.14)	(1730.07)	(2572.03)	(0.20)
Scheduled caste (Ref: OBC)	869.017	-1736.563	-567.086	-1720.573	0.229
	(811.46)	(1094.66)	(1577.34)	(2887.60)	(0.20)
General caste (Ref: OBC)	3390.265***	191.016	3490.356**	129.059	0.368**
	(1177.16)	(1006.56)	(1552.08)	(2782.71)	(0.18)
Below primary (Ref: Completed primary)	83.628	-348.936	-702.210	-4628.408**	0.266
	(1524.09)	(1573.97)	(2249.47)	(2158.87)	(0.22)
Secondary or Tertiary (Ref: Completed primary)	-611.850	686.271	461.080	3403.514**	0.255*
	(844.57)	(854.71)	(1378.40)	(1690.88)	(0.14)
Household has a current migrant (0/1)	-2718.747***	-1632.518**	-4838.953***	3303.926	-0.095
	(806.39)	(720.18)	(1169.53)	(2128.71)	(0.17)
Number of HH members	-952.506***	-1761.201***	-3166.448***	-3490.923***	0.040
	(208.70)	(236.38)	(413.92)	(519.66)	(0.03)
Area of land operated by the household (ha)	1891.563**	11047.183***	16050.890***	8234.431***	0.001
	(735.43)	(1457.55)	(2846.60)	(2005.57)	(0.08)
HH ever leased in or purchased land (0/1)	3772.617**	-217.609	3532.575*	4100.085*	-0.046
	(1662.07)	(964.19)	(2104.56)	(2443.84)	(0.15)
Share of operated segments that are upland (%)	20.115**	0.388	21.384	32.613*	0.004**
	(9.40)	(10.48)	(15.33)	(19.47)	(0.00)
Share of operated segments that are lowland (%)	1.131	41.049**	45.207**	84.753**	-0.003
	(10.03)	(17.03)	(21.19)	(33.03)	(0.00)
Borrowed for farming in past 12 months (0/1)	-406.834	-1241.441	-2316.504*	-8095.072***	-0.258*
	(715.61)	(925.02)	(1384.16)	(1696.84)	(0.13)
Household owns irrigation equipment (0/1)	2015.291**	789.417	1912.269	1531.793	0.629***
	(831.12)	(944.72)	(1664.43)	(1888.51)	(0.14)
Simpson index of area of agricultural production	12869.228***	-5712.263***	13389.795***	2876.359	0.339
	(1338.50)	(1428.44)	(2861.80)	(3393.09)	(0.24)
Household received KALIA transfer in past year (0/1)	665.333	-755.999	380.116	-1373.583	-0.304**
	(1246.38)	(881.99)	(1591.66)	(1866.12)	(0.13)
Household received cash transfer from other government scheme in past year (0/1)	51.645	-3559.844*	-3108.550	-3167.833	-0.479**
	(1324.48)	(1954.87)	(2392.56)	(3842.80)	(0.24)
Household received transfer from public distribution system in past year (0/1)	-1679.930	136.460	-1037.077	920.632	0.289*
	(1649.14)	(1089.26)	(2099.63)	(3001.02)	(0.17)
Medium vegetable farming concentration block (Ref: High concentration)	-1315.243	-2805.821**	-3336.904*	-228.145	-0.199
	(1125.31)	(1192.36)	(1943.45)	(1926.57)	(0.16)
Low vegetable farming concentration block (Ref: High concentration)	-2141.577***	-546.832	-2897.951**	202.199	-0.091
	(800.56)	(1176.12)	(1427.02)	(1976.12)	(0.16)
Constant	978.635	16649.353***	16608.557***	33711.243***	9.326***
	(1957.26)	(2534.53)	(3773.72)	(5863.47)	(0.39)
District level fixed effect	YES	YES	YES	YES	YES

Observations	1205	1205	1205	1205	1205
R-squared	0.133	0.306	0.277	0.178	0.189

Source: INCATA Odisha Farmer Survey, 2025Note: ᵃAnnual household income excludes government transfers. Standard errors in parentheses. Significance: * p<0.1, ** p<0.05, *** p<0.01.

First, we compare the association between caste and welfare indicators for (1) scheduled tribe, (2) scheduled caste, and (3) general caste households, in relation to other backwards caste (OBC) households. There is no significant difference between OBC, scheduled tribe, and scheduled caste households for each category of income. General caste households have significantly higher vegetable income, overall crop income and HHDDS) relative to OBC households. This result suggests that general caste households derive a higher relative level of benefit from vegetable cultivation than other groups, possibly reflecting unobserved factors such as social capital embedded in caste networks.

Second, we compare the association between education and welfare for households where the household head's level of education is (1) below primary level, (2) secondary level or above, taking completion of primary education as the reference value. The association between primary level education and household income is negative ($p<0.05$), while the association with secondary level education is positively associated ($p<0.05$), but there is no significant association between education level and vegetable, rice, or all total crop income, suggesting that education is an important factor in determining off-farm income, but not agricultural income. Secondary level education and above is weakly positively correlated with HHDDS, suggesting an income effect of education on diet quality.

Third, having a migrant is strongly negatively correlated ($p<0.01$) with income derived from vegetables, rice, and all crops, and positive but insignificant for total household income. Migration is not associated with any significant change in HHDDS. These results suggest that reduced household labor supply associated with migration may negatively impact agricultural production, but may be offset financially by remittance earnings, and/or that receipt of remittance earnings may incentivize households to devote less effort to farming.

Fourth, household size (the number of members present in the household) is strongly negatively correlated with all 4 per capita income variables but not significantly correlated with HHDDS. We interpret this to mean that in larger households, earnings are split between more members resulting in lower incomes per capita.

Fifth, the area of agricultural land operated by the household is positively associated with all 4 types of per capita income, but the effect is slightly weaker for vegetable income ($p<0.05$) than rice income ($p<0.01$). This result implies that, as expected, the more land households have at their disposal for agriculture the higher their agricultural incomes, but that the relationship is stronger for rice than for vegetables, which can produce high yields from small cropped areas.

Sixth, having purchased or leased in land is positively associated with vegetable income ($p<0.05$) and weakly associated with total crop income and household income, but not significantly associated with rice income. This finding suggests that some households are able to increase their earnings from vegetable cultivation by expanding their landholdings, with leasing being the most common means of doing so (see Table 15). For rice farmers, leasing in land may be associated with having inadequate holdings to support subsistence needs, and hence less likely to result in improvements in income than acquiring land for higher value vegetable cultivation.

Seventh, the share of upland segments of land operated per household is positively associated with vegetable income ($p<0.05$), household income ($p<0.01$) and HHDDS ($p<0.05$), whereas the share of lowland segments operated per household is positively associated with rice income, crop income and household income, but uncorrelated with HHDDS. These results underline how the portfolio of types of land that a household possesses influences its ability to engage in production of crops of different types and further illustrates the positive link between vegetable production and HHDDS.

Eight, borrowing to support agricultural production is negatively associated with total crop income ($p<0.1$), household income ($p<0.01$) and HHDDS ($p<0.1$), but is not significantly associated with vegetable or rice income. This suggests that households with fewer financial resources are more likely to borrow to fund agriculture.

Ninth, ownership of irrigation equipment is positively associated with vegetable income ($p<0.05$) and HHDDS ($p<0.01$), but is not significantly associated with rice income, total crop income, and total household income. This demonstrates the importance of private irrigation for vegetable cultivation, possibly constituting a threshold investment in some cases, and underlines again the positive relationship between vegetable cultivation and HHDDS. This result might also suggest that rice cultivators are better served than vegetable farmers by public irrigation works such as canals.

Tenth, the Simpson index of agricultural production is strongly positively associated with vegetable income, total crop income and HHDDS ($p<0.01$) and positively but insignificantly associated with total household income and HHDDS. Although endogenous, this result confirms the link between vegetable cultivation and agricultural diversification, and agricultural diversification and diet diversity.

Eleventh, receipt of a KALIA transfer, a welfare payment for farmers designed to support agricultural production, is not significantly correlated with any of the 4 income variables, but is negatively associated with HHDDS ($p<0.05$). A similar set of relationships holds for receipt of other government cash transfers. Receipt of rice and other foods from the public distribution system (PDS) is also uncorrelated with any income variables, but is positively associated with HHDDS ($p<0.1$).

We interpret these results to suggest that KALIA and other government transfers are targeted toward lower income households. Positive effects of the KALIA transfer on agricultural incomes may be obscured by the lower base agricultural income of the recipients. It is also possible that some KALIA payments are utilized in whole or in part for consumption rather than agricultural investments. Receipt of PDS food does not appear to be a disincentive to agricultural production. Nor do PDS food transfers appear associated with substitution of rice cultivation for vegetable production, as might be anticipated receipt of PDS grains were to substantially relax the imperative to produce rice for subsistence. The positive association between receipt of PDS transfers and HHDDS may suggest that by relieving the burden of household expenditure on staple foods, PDS transfers allow households to increase their purchases of non-staples.

Twelfth, we address associations between the clustering of vegetable production at the block level (predefined as part of our sampling strategy, which categorized all blocks in surveyed districts as having a high, medium, or low concentration of vegetable farms) and the 5 welfare variables, using high concentration blocks as the reference category. Being located in a medium vegetable farming concentration block is negatively associated with vegetable income, relative to high concentration blocks, but the coefficient is insignificant. However, being in a low vegetable concentration block

is strongly negatively associated ($p<0.01$) with vegetable income. Being in a medium concentration block is negatively associated with rice income ($p<0.05$). In low concentration blocks the association with rice income is negative but not significant. The coefficient of all crop income is negative and significant in medium and low concentration blocks, but stronger in low (<0.01 vs 0.05). Finally, there is no significant association between vegetable farm concentration at the block level and household income or HHDDS.

In sum, the general tendency apparent in this pair of results is for agricultural incomes from all sources to be higher in blocks with high concentrations of vegetable cultivation activities. We hypothesize that this reflects a confluence of factors that could include irrigation access, infrastructure provision, market access, the density of micro, small and medium enterprises (MSMEs) in off-farm segments of the agricultural value chain, and access to information (e.g., knowledge spillovers among farmers and from MSMEs). These results may be cautiously interpreted as supporting the inference that spontaneous clusters of vegetable farms form in areas with suitable initial conditions, and that the densification of commercializing farms and supporting MSMEs in these areas creates conditions that can raise agricultural incomes in these locales, with complementarities between vegetable cultivation and other types of farming, including rice.

CHAPTER 5. ARE THE RELATIONSHIPS BETWEEN ACTORS IN ODISHA'S VEGETABLE VALUE CHAINS PARASITIC OR SYMBIOTIC?

Introduction

In this note, we address a key hypothesis of the INCATA project: that the relationships and interactions between MSMEs and commercial small-scale farms in vegetable value chains are more symbiotic than parasitic. This hypothesis runs counter to the common view that agricultural traders and input suppliers often lock farmers into exploitative relationships and extract excessive surpluses from them using tied credit.

We hypothesized that recent improvements in transport, communications, mobility, access to non-farm employment, credit, and information, and increased competition among growing numbers of traders input suppliers, have led to thicker rural markets, reducing the ability of marketing intermediaries to create dependencies among farmers. We further hypothesized that the spatial clustering of commercial small-scale producers and MSMEs may improve access to information and services, lowering barriers to entry and creating competition, inducing MSMEs to provide services to farmers to differentiate themselves and attract customers, with outcomes that are more symbiotic than exploitative.

In this note, we explore these two dimensions of symbiosis. First, the extent and terms of credit linkages between actors along the vegetable value chain. Second, the nature of service provision between actors at different nodes in the chain.

Credit relations in vegetable value chains

Table 18 presents details of credit provision by agricultural input suppliers, vegetable wholesalers and retailers to their suppliers and customers during the preceding 12 months. Most enterprises provided no credit (either cash or in-kind) to suppliers or buyers during the past year. Ninety-five percent of retailers, 92 percent of input suppliers, and 81 percent of wholesalers did not extend loans of any kind.

Table 18: Credit provision to suppliers and buyers by input suppliers, wholesalers and retailers

Item	Input suppliers	Wholesalers	Retailers
No loans (%)	91.7	81.2	95.0
Cash loans (%)	3.8	0.8	0.5
In-kind loans (%)	4.3	17.8	4.2
Respondent gave a loan to a supplier that obligated the supplier to sell only to the respondent (%)	0.5	0.5	0.5
Respondent gave a loan to a buyer that obligated them to buy only from the respondent (%)	0.5	1.3	1.0

Source: INCATA Odisha Trader and Input Supplier Surveys, 2025

Among enterprises that provided loans, only 3.8 percent of input suppliers and less than 1 percent of wholesalers and retailers lent cash. In-kind loans were somewhat more common, given by 4.3 percent of input suppliers and retailers, and 17.8 percent of wholesalers. This pattern is consistent with wholesalers providing short-term trade credit to buyers in the form of vegetables, allowing them to sell produce before paying for it. Between 0.5 and 1.3 percent of enterprises reported that credit they provided obligated recipients to buy from or sell to them exclusively, indicating that rigid tied credit obligations are rare.

Table 19 provides more granular information than the annual recall reported in Table 18, presenting details of advance payments and credit given and received by vegetable wholesalers and retailers during their most recent purchase and sale, and by agricultural input suppliers and vegetable farmers during their most recent sale.

Table 19: Characteristics of trading relationships and credit during the most recent purchase and sale completed by input suppliers, wholesalers and retailers.

Item	Input suppliers	Vegetable farmers	Wholesalers	Retailers
Most recent supplier is a regular supplier (%)	n/a	n/a	72.8	59.5
Most recent supplier is an occasional supplier (%)	n/a	n/a	26.3	31.7
Duration of trading relationship with most recent supplier (years)	n/a	n/a	9.0	6.9
Respondent has an outstanding loan to most recent supplier (%)	n/a	n/a	14.4	8.8
Respondent was obliged to buy only from most recent supplier (conditional on having outstanding loan) (%)	n/a	n/a	6.2	18.5
Most recent sale was to a regular customer (%)	51.4	38.8	58.2	32.2
Most recent sale was to an occasional customer (%)	36.5	26.7	34.5	36.9
Duration of trading relationship with most recent customer (years)	4.3	8.4	6.6	4.5
Buyer advanced money to secure most recent sale (%)	2.5	3.4	6.5	5.5
Buyer paid in full at time of most recent sale (%)	93.9	87.3	54.6	92.3
Buyer will pay for some or all of most recent sale with a delay (%)	3.0	4.5	38.9	2.1
Number of days delay in payment (conditional on delay)	32.7	4.4	6.0	4.5

Source: INCATA Odisha Trader and Input Supplier Surveys, 2025

Pure 'spot' transactions made with no prior relation are rare. Most vegetable wholesalers and retailers have longstanding business relationships with their suppliers and transact with them regularly. About seventy-three percent of wholesalers and fifty-nine percent of retailers bought from regular suppliers during their most recent transaction, and 26.3 percent and 31.7 percent, respectively, purchased from occasional suppliers. The average duration of the trading relationship between wholesalers and retailers and their most recent supplier was 9.0 and 6.9 years, respectively, suggesting that long-term business relationships built on trust are an important feature of buyer-supplier interactions.

About 14.4 percent of wholesalers and 8.8 percent of retailers had loans outstanding to their most recent supplier. Based on our field observations, we interpret this to mean that it is common for traders to receive in-kind advances (vegetables) from their suppliers that are repaid after the goods are sold. Among respondents receiving loans from suppliers, 6.2 percent of wholesalers and 18.5 percent of retailers reported that they were obligated to buy exclusively from the supplier to whom they were indebted. This equates to less than 1 percent of wholesalers and 2 percent of retailers

being debt-tied to a single supplier, confirming the low incidence of tied credit seen in Table 18.

Similar to their relationship with suppliers, a high proportion of vegetable value chain enterprises have longstanding relationships with buyers. More than half the most recent sales made by input suppliers (51.4 percent) and wholesalers (58.2 percent) were made to regular customers, as were 32.2 percent of sales by retailers and 38.8 percent by farmers. About a third of sales by each type of off-farm enterprise and a quarter by farms were to occasional customers. The average duration of trading relationships with buyers ranged from 4.3 years (input suppliers) to 8.4 years (farmers). These findings again underscore the personalized nature of business transacted in the vegetable value chain, and the importance of repeat interactions in establishing exchange relationships.

Few buyers paid an advance to guarantee access to a product. Payment for the most recent sale was received in full at the time of sale by 93.9 percent of input suppliers and 92.3 percent of retailers. Moreover, few sellers extended any in-kind credit: only 3 percent of input suppliers allowed customers to pay for all or part of the most recent sale with a delay. These very low levels of in-kind credit provision may reflect the risky nature of lending to households. These figures are confirmed by our farm survey: only 2.4 percent of farmers reported that the seed or seedlings used to produce their main vegetable crop were received partially or wholly on credit, and 3.1 percent received fertilizers, pesticides or other agricultural inputs partly or fully on credit.

Only 2.1 percent of retailers allowed payment for their most recent sale with a delay, indicating a low incidence of selling vegetables to consumers on credit. In contrast, 38.9 percent of wholesalers allowed the customer in their most recent sales transaction to pay for all or part of the goods with a delay, averaging 6 days. This finding is consistent with wholesalers providing revolving trade credit to some regular buyers, where goods are obtained partially or fully on credit and the outstanding balance is repaid when the buyer procures more goods. This arrangement can be understood as a mutually beneficial service provided by wholesalers to their customers, enabling trade credit recipients to operate with limited working capital while credit providers benefit from the regular custom. Few farmers (five percent) received payment with a delay for part or all of their goods, with an average delay of 4 days, conditional on payment being delayed, while 87.3 percent received payment in full on the day of the sale.

Table 20 presents characteristics of credit use by vegetable farmers. Half of vegetable farmers borrowed within the past 12 months to support their farming activities. Farmers who did not borrow generally chose not to do so, reporting that they had sufficient funds (67 percent, conditional on not borrowing) or did not want to take on debt (28 percent). Just 5 percent of vegetable farmers who did not borrow indicated that they had wished to but been unable to do so, suggesting that access to credit is not a major constraint for most farmers.

Table 20: Characteristics of credit use by vegetable farmers

Item	Vegetable farmers
Borrowed for farming during past 12 months (%)	50.4
Wanted agricultural loan but unable to access (conditional on not borrowing) (%)	4.6
Most recent agricultural loan was from input supplier or vegetable trader (%)	1.4
Most recent agricultural loan was from friend/relative (%)	53.0
Most recent agricultural loan was from bank (%)	5.9
Most recent agricultural loan was from self-help group or microfinance institution (%)	35.3
Most recent agricultural loan was from informal moneylender (%)	12.7
Value of most recent agricultural loan (conditional on taking loan) (%)	22,605

Source: INCATA Odisha Farmer Survey 2025

Among farmers who borrowed to support their agricultural activities, only 1.4 percent took loans from off-farm enterprises in the vegetable value chain, corresponding with the low rates of credit provision reported by enterprises in Table 18. Family and friends are by far the most common source of agricultural loans, accounting for 53 percent. Self-help groups are the second largest source of agricultural credit (35 percent of all loans taken), suggesting that they play an important role in facilitating smallholder commercialization. Informal money lenders account for 12.7 percent of loans, and banks only 5.9 percent. The average value of loans taken by farmers (₹22,600 or $260) is substantial, and in a similar size to the average annual expenditure on vegetable production by surveyed farmers. Together these numbers paint a picture of farmers who are not heavily credit constrained and are thus not driven to accept loans with exploitative conditions in large numbers.

Provision of services by actors in vegetable value chains

Off-farm enterprises in the vegetable value chain may provide a variety of services to suppliers or clients that exceed the basic business functions of selling products and purchasing goods. In this section of the chapter we examine the types of services provided and received by actors at each value chain node. We focus first on services provided by input suppliers to farmers (Table 21).

Table 21: Services provided to vegetable farmers by input suppliers

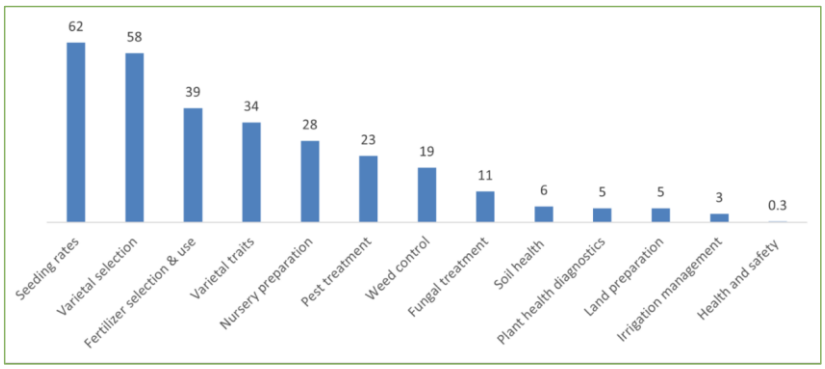
Services	Input suppliers
Was asked for advice by customer during most recent sale (%)	47.9
Offered advice to customer during most recent sale (%)	52.4
Charged a fee for providing advice (%)	0.8
Ever provided equipment-related services, for a fee, conditional on selling equipment (%)	22.7
Ever given referrals to other service providers, conditional on selling equipment (%)	4.5
Ever participated in a farmer fair in 2024 (%)	36.9
Ever used retail customer as distributor (%)	6.1

Source: INCATA Odisha Input Supplier Survey, 2025

Provision of advisory services by input suppliers is extremely common, with advice frequently both solicited and offered. Just under half (47.9 percent) of input suppliers reported that customers sought advice from them during this most recent sale, while just over half (52.4 percent) reported giving advice. These advisory services are free. Less than 1% of respondents charged a fee for giving advice.

Figure 23 presents the types of advice and information that input suppliers gave to customers during their most recent sale. Topics relating to seed selection and use are particularly common. More than half of input suppliers gave information on seeding rates and/or varietal selection. Around one-third provided information on varietal traits, and about one-quarter on nursery preparation. Advice on fertilizer selection and use was also common (provided in 39 percent of cases), followed by advice on plant protection - treatment of pests, weeds and fungi. This distribution of topics roughly tracks the composition of products sold by input suppliers: vegetable seed and paddy seed are each sold in about one-third of transactions, fertilizer in a further third, and plant protection products in about 10 percent.

Figure 23: Type of information provided by input suppliers to customers during most recent transaction (percentage of suppliers who gave advice on subject, conditional on giving advice).



Source: INCATA Odisha Input Supplier Survey, 2025

Few input suppliers (seven percent) sell any farm equipment. Sprayers are by far the most common item of equipment sold. Only a handful of input suppliers sell other items such as plastic mulch, tubing for drip irrigation, greenhouses, irrigation pumps, solar panels, or electrical fences. This observation suggests that these are sold by specialized stores, and that few input suppliers serve as 'one-stop-shops' for all items, reflecting the small average scale of operations. Around a quarter of input suppliers that sold equipment helped customers to set up items such as sprayers and plastic mulch.

Equipment-selling input suppliers were asked whether they provided outsource services to farmers for a fee (e.g. borewell installation, laser land levelling, agricultural machinery hiring, soil testing, crop marketing). Only a handful (between 1 and 3) reported doing so in each case. Supplying vegetable seedlings to order, providing crop spraying services and land preparation services, and linking farmers traders were the main services offered. Only one respondent reported referring customers to another enterprise when unable to supply vegetable seedlings, suggesting limited cooperation among different types of input supply and service provision enterprises.

Table 22 presents information on wholesaler and retailer actions when procuring and selling vegetables. These actions may be considered as services to suppliers (farmers, wholesalers) and buyers (wholesalers, retailers). Corresponding information on the services received by farmers from their buyers (wholesalers and retailers) is presented for triangulation. All responses refer to respondents' most recent linked sale and procurement transactions.

Table 22: Services provided by wholesalers and retailers to suppliers and buyers

Item	Wholesalers	Retailers	Vegetable farmers
Who organized transport when procuring most recently sold lot of vegetables?			***Who organized transport when selling most recent lot of vegetables?***
Self (%)	46.5	52.8	44.1
Seller (%)	41.0	38.9	n/a
Buyer (%)	n/a	n/a	36.7
Broker (%)	6.0	0.2	1.1
Transporter (%)	3.9	0.4	0.4
Who owned vehicle used to procure the most recently sold lot of vegetables?			***Who owned vehicle used to sell the most recently sold lot of vegetables?***
Self (%)	17.9	31.9	38.3
Seller (%)	25.7	37.9	n/a
Buyer (%)	n/a	n/a	43.4
Broker (%)	1.1	1.3	1.2
Transport rental business (%)	31.9	21.9	15.9
What quality upgrading or value addition activities were performed before selling the vegetables?			
Did nothing (%)	78.6	81.3	32.1
Hold in storage (%)	2.1	1.4	7.7
Trimming/removing leaves (%)	0.8	1.0	5.4
Remove damaged items (%)	15.7	10.6	29.5
Cutting/deseeding/husking (%)	0.3	0.1	0.0
Grade (%)	0.0	0.1	45.3
Repack (%)	1.0	0.0	8.9
Wash (%)	4.2	7.3	28.1
What type of logistical support was provided to the buyer without an explicit fee?			***What type of free logistical support was received from the buyer?***
None (%)	76.0	95.5	87.0
Loading (%)	3.9	0.3	5.9
Transporting (%)	0.8	0.1	4.9
Packing (%)	19.1	4.0	4.6
Returnable crates (%)	1.0	0.0	0.0

Source: INCATA Odisha Farmer and Trader Surveys, 2025

Wholesalers and retailers arranged the transport used to procure vegetables from suppliers during roughly half of transactions. The cost of transport provided to suppliers is often explicitly costed into the price offered. Although not free, this form of transport provision can be considered as a service. For example, based on our field observations, many farmers choose to sell vegetables to traders at the farmgate despite receiving a lower price than they would if selling at a market, because doing so is convenient and saves time needed for vegetable cultivation activities. Conversely, in roughly 40 percent of procurement transactions, sellers provided transport. This can be considered a service to the buyer, for similar reasons. Brokers or transporters organized the transport used in about 10 percent of the most recent purchases by wholesalers, constituting a form of outsourced delivery service. Farmers arranged transport of vegetables to the buyer during 44 percent of their most recent sales while buyers organized transport in 37 percent of cases, which may be interpreted as a form of service to farmers.

Third-party logistics providers play important roles in enabling trade in vegetables. Although wholesalers organized the transport used to procure vegetables in 47 percent of their most recent purchases, they owned the transport used in only 18 percent of these transactions. Vehicles used

by wholesalers for product procurement in thirty-two percent of transactions were rented from third parties (e.g. truck rental businesses, tuk-tuks). Retailers relied on transport rental services to procure vegetables, in 22 percent, while farmers used them in 18 percent of most recent sales.

Most wholesalers and retailers (78.6 and 81.3 percent) do not engage in any form of value addition or product quality upgrading after receiving vegetables from their suppliers. The most common action taken is removal of damaged items, practiced by 15.7 percent and 10.6 percent of wholesalers and retailers, respectively. Washing vegetables is the second most common action, practiced by 4.2 percent of wholesalers and 7.3 percent of retailers, usually for root vegetables. Very few wholesalers (2 percent) and retailers (1 percent) hold vegetables in storage prior to sale, reflecting the high turnover of product, which is sold out quickly to avoid quality deterioration. Very few traders grade, repack or process the vegetables received.

In contrast, many farmers engaged proactively in upgrading and value addition activities prior to their most recent sale. Forty-five percent practiced grading, 29.5 percent removed damaged items, 28.1 percent washed vegetables, 8.9 percent repacked them and 5.4 percent removed trimmings. These actions can be interpreted as efforts by farmers to maximize value capture from their product, but also benefit buyers as they reduce the amount of effort required to prepare products for sale.

Wholesalers (76 percent) and retailers (95.5 percent) provided limited logistical support to customers during their most recent purchase for which they did not charge an explicit fee. The most common free service provided was packing, offered by 19.1 percent of wholesalers, and 4 percent of retailers, followed by loading (4 percent of wholesalers) and supplying returnable crates (reported by 1 percent of wholesalers). Correspondingly, 87 percent of farmers reported receiving no free logistical support from buyers, while roughly 5 percent reported receiving free support for each of packing, loading, and transporting.

CHAPTER 6. WHO IS INCLUDED IN ODISHA'S VEGETABLE VALUE CHAINS, AND ON WHAT TERMS?

Table 23 summarizes the gender and caste characteristics of participants in the farm, input supply, wholesale, and retail segments of Odisha's vegetable value chain. The terms "scheduled caste" and "scheduled tribe" refer to communities recognized in the Indian constitution as having experienced historical marginalization and social and economic disadvantage. We use "non-scheduled caste" to refer to individuals not covered by either designation.

Table 23: Gender and caste composition of Odisha population and INCATA survey sample populations.

Category	Odisha population (%)*	Vegetable farmers (%)≠	Input suppliers (%)≠	Vegetable wholesalers (%)≠	Vegetable retailers (%)≠
Female	49	42.2†	2.7	1.0	27.5
Scheduled tribe	23	23.8	0.8	0.5	10.1
Scheduled caste	17	19.1	5.3	3.9	15.0
Non-scheduled caste	60	56.9	94.0	95.6	74.9
N	-	**2021‡**	**628**	**384**	**1,239**

Source: *Population census (2011), ≠INCATA Odisha Surveys 2025. ‡The total survey N for vegetable farmers is 2021, but households were assigned to subsamples who were administered with different combinations of modules so in subsequent tables the N for vegetable farmers may differ by variable. † Estimated as women's share of family labor days devoted to farming the household's main vegetable crop.

Using the 2011 census as a benchmark, 23% of Odisha's population belong to a scheduled tribe and 17% to a scheduled caste, with the remaining 60% non-scheduled caste. Women comprise 49% of the population. We compare these population shares with the composition of participants in each node of the vegetable value chain (Table 23).

Overall, the two most remunerative off-farm segments, input supply and wholesaling, are dominated almost entirely by non-scheduled caste men. Retailing is the most accessible off-farm node, but women and members of scheduled tribes remain underrepresented. Farming is the most inclusive node in terms of direct participation, with a gender and caste composition closer to that of the population than any other segment.

Women are largely excluded from input supply and wholesaling: only 2.7% of input suppliers and 1.0% of wholesalers are women-run enterprises. Women's participation is higher in retailing (27.5%), but still far below their population share.
Members of scheduled tribes show similarly low inclusion in off-farm nodes. They constitute less than 1% of input suppliers and wholesalers and 10.1% of retailers, around half their share in the wider population.

Members of scheduled castes are modestly better represented than women and scheduled tribes in input supply and wholesaling (5.3% and 3.9%, respectively), yet remain heavily underrepresented relative to the state population. Their participation in retailing (15%) is closer to their population share.

Participation in vegetable farming is more closely aligned with Odisha's population composition, though women remain somewhat underrepresented. Women engage in vegetable cultivation in 81% of vegetable farming households and account for 42.2% of total labor hours (family + hired) used in cultivation. The caste composition of vegetable farmers is broadly similar to the population distribution, with scheduled castes marginally overrepresented, scheduled tribes close to parity, and non-scheduled castes slightly underrepresented. These comparisons should be treated cautiously because the sample is not statistically representative of Odisha's entire population.

Terms of incorporation into vegetable value chains

Table 24 compares participants in vegetable farming, input supply, wholesaling, and retailing across human capital, assets, business scale, and practices. Several patterns stand out.

Table 24: Human capital, assets, enterprise scale, and business practices, of vegetable farmers, agricultural input suppliers, wholesalers and retailers

Category	Vegetable farmers	Input suppliers	Wholesalers	Retailers
Age of respondent (years)	47.6	45.2	44.7	47.0
Age of enterprise (years)	23.3*	14.0	20.6	17.0
No formal education (%)	9.6	0.6	11.5	22.9
Secondary education (%)	47.7	68.8	27.9	9.3
Sole occupation (%)	49.7	61.6	88.5	65.5
Prior occupation was agriculture (%)	n/a	27.7	13.5	37.6
Owns agricultural land (%)	78.8	67.0	28.4	61.2
Area of land owned (ha)	0.89†	1.78	0.89	0.85
Owns own stall (%)	n/a	53.7	34.5	8.6
Enterprise startup capital at 2025 prices (INR)	24,128	191,869	289,233	7,782
Enterprise asset value at 2025 prices (INR)	n/a	783,293	549,619	33,751
Member of traders' association (%)	n/a	4.9	20.1	5.2
Has any type of business license (%)	n/a	94.4	40.6	8.1
Hired any labor in 2024 (%)	38.5‡	14.8	47.4	2.6
Borrowed for enterprise in 2024 (%)	50.4	14.3	17.0	10.6
Owns mobile phone (%)	96.8	83.4	72.4	50.2
Made digital payment for most recent purchase (%)	n/a	n/a	28.4	5.5
Received digital payment (UPI) for most recent sale (%)	1.4	n/a	14.3	1.9
Most recent customer was female (%)	4.0	4.6	7.6	18.0
Respondent set price of most recent sale (%)	17.2	n/a	45.3	49.9
Value of most recent sale (INR)	5,697*	1,742	1,970	115
Median annual vegetable enterprise income (INR)	17,386	n/a	70,800	43,830
Expects to expand enterprise in next 5 years (%)	57.2	82.5	72.4	77.6

Source: INCATA Odisha Surveys, 2025, n/a = information not available. *Most recent sale of the main vegetable produced by the household. *Number of years since the respondent participated in vegetable farming for the first time. †Area of land operated used for farms here instead of land owned, due to stricter definition of 'ownership' in farm questionnaire than other surveys. ‡Share of vegetable farms hiring labor for production of main vegetable crop

Age and experience. Participants across all segments are, on average, in their mid- to late-40s, and over 90% are aged 30 or above, indicating limited youth participation. Enterprises and farms are long established (around 15–20 years on average). This may reflect both survivor bias and meaningful stability among those who remain active.

Education and barriers to entry. Input suppliers are comparatively educated: 68.8% have secondary education or above, including 36% with graduate education. Retailers are at the opposite end of the spectrum, with 22.9% having no formal education and only 9.3% reaching secondary education. This aligns with the more regulated and skill-intensive nature of input supply. New pesticide license applicants are required to possess science-related degrees or diplomas, or to employ someone who does, though compliance is not universal. Wholesalers sit between these extremes (27.9% with secondary education or above). Farmers, notably, are better educated on average than wholesalers and retailers: the share with no formal education is similar to wholesalers (about 10%), but 47.7% have secondary education or above, suggesting vegetable cultivation draws from a wide socioeconomic base.

Livelihood diversification and land. Retailing and input supply often serve as pathways into off-farm livelihoods. Many retailers (37.6%) and input suppliers (27.7%) practiced agriculture before starting their enterprise, and 67% of input suppliers and 61.2% of retailers belong to landowning households. Input suppliers own more land on average than retailers (1.8 ha vs 0.9 ha), consistent with higher pre-entry socioeconomic status. Wholesalers are less connected to agriculture: only 13.5% practiced agriculture prior to wholesaling and 28% come from landowning households, likely because most (77%) are urban. Occupational specialization is high: over 60% of input suppliers and retailers and nearly 90% of wholesalers report no other occupation. Half of vegetable farmers report being entirely dependent on agriculture, underscoring limited off-farm diversification in rural Odisha and highlighting retailing as an important diversification strategy.

Capital requirements and assets. Entry costs differ sharply across nodes. Retailers' startup capital (2025 prices) averages ₹7,800 ($89), while wholesalers' and input suppliers' startup capital is far higher, at ₹289,000 ($3,325) and ₹192,000 ($2,205), respectively, representing major barriers to entry. Business assets show a similar pattern and exceed startup capital by roughly two to four times, indicating accumulation over time. Startup costs for vegetable farming are moderate (₹24,128 or $277), around 60% above average annual vegetable production costs.

Formality and collective organization. Retailing is the least formal: only 5% hold any business license. Input supply is largely formal (94% licensed) due to regulatory requirements. Wholesaling is intermediate (41% licensed), implying substantial informality, potentially linked to the share operating outside regulated markets (including private or unregulated markets). Trader association membership is generally low across non-farm nodes, but higher among wholesalers (20%) than retailers or input suppliers (both 5%), suggesting associations govern only a subset of markets.

Labor and gendered employment. Hiring is rare among retailers (2.6%), reflecting small scale and limited job creation beyond self-employment. Few input suppliers hire labor (14.8%), while nearly half of wholesalers do (47.4%), slightly more than vegetable farms (38.5%). Wholesalers and input suppliers mainly employ salaried men (e.g., book-keeping), with very limited employment of women. In contrast, vegetable cultivation relies largely on casual daily wage labor when hired, and among households that hire, 72% employ women (and 75% employ men), with women contributing close to 54% of hired labor days. Even so, hired labor accounts for only 14% of total cultivation labor hours, concentrated mainly in harvesting.

Finance. Business borrowing is low among non-farm enterprises: 11–17% borrowed for enterprise use in the past year (wholesalers highest, retailers lowest), suggesting many operate through cyclical reinvestment. Farming is different: 50% of farming households borrowed to support agricultural operations in the past 12 months, reflecting seasonality and cashflow risks. Conditional on borrowing, most loans are informal (54% from family/friends) or from self-help

groups (35%). Very few (1%) borrowed from value chain actors, indicating tied lending is uncommon in this context.

Phones and payments. Mobile phones matter for coordination and information, but reported phone ownership is lower among non-farm respondents (50% retailers, 72% wholesalers, 83% input suppliers) than farm households, likely due to question wording (individual vs household ownership). Smartphones dominate among owners. Despite widespread access and the reach of UPI digital payments, use of UPI is limited for receiving payments: 1.9% of retailers and 1.3% of farmers received payment by UPI for their most recent sale (input supplier data not available), versus 14% of wholesalers. Wholesalers and retailers use UPI more for making payments than receiving them, consistent with trade credit and remote settlement practices.

Business scale and earnings. The most recent retail sale averages ₹115 ($1.30), about 17 times smaller than wholesalers' most recent sale (₹1,970 or $22.60) and 15 times smaller than input suppliers' (₹1,742 or $20.00). Farmers' most recent sale of their main vegetable averages ₹5,984 ($69), consistent with sizable quantities sold. Median annual incomes are ₹17,386 ($200) for farmers, ₹43,830 ($500) for retailers, and ₹70,800 ($810) for wholesalers (input supplier income unavailable). The relatively modest ratio of wholesaler to retailer and farmer incomes likely reflects concentration within wholesaling, also visible in a much higher mean wholesaler income (₹680,436 or $7,821).
Outlook. Business sentiment is generally positive. Between 72% (wholesalers) and 83.5% (input suppliers) expect their business to expand over the next five years. Farmers are less optimistic about expanding vegetable area (57%), but this still exceeds the share anticipating contraction (17%).

Who is included in vegetable retailing, and on what terms?

Retailing is the most inclusive off-farm node because barriers to entry are lower than in wholesaling and input supply, which require larger investments and higher levels of human and social capital. To understand how inclusion and outcomes differ within retailing, we examine variation by gender, caste, and community (Table 25).

Table 25: Human capital, assets, enterprise scale, and business practices, of vegetable retailers, by gender and caste

Category	Male retailers	Female retailers	Non-scheduled caste retailers	Scheduled caste retailers	Scheduled tribe retailers
Retailer is female	0.0	100	20.4	49.5	48.0
Age of respondent (years)	46.9	47.4	46.9	46.3	49.3
No formal education (%)	12.8	65.1	18.4	53.8	52.8
Secondary education (%)	12.6	0.9	10.9	6.5	2.4
Sole occupation (%)	65.1	66.6	65.9	76.3	46.6
Prior occupation was agriculture (%)	37.5	37.8	37.5	28.0	52.8
Owns agricultural land (%)	63.0	56.3	63.0	41.4	76.8
Area of land owned (ha)	0.89	0.73	0.85	0.69	1.05
Owns own stall (%)	11.5	0.9	10.4	3.8	1.6
Enterprise startup capital at 2025 prices (INR)	8,354	6,275	8,279	6,791	5,609
Enterprise asset value at 2025 prices (INR)	39,324	19,076	36,986	22,953	25,802
Member of traders' association (%)	12.6	0.9	11.3	5.9	0.0
Has trading license (%)	9.8	3.5	9.7	3.8	2.4
Hired any labor in 2024 (%)	3.3	0.6	3.2	1.1	0.0

Borrowed for enterprise in 2024 (%)	10.5	9.4	11.6	7.5	3.2
Owns mobile phone (%)	61.1	21.4	55.3	40.3	27.2
Made digital payment for most recent purchase (%)	6.7	1.8	6.5	2.5	2.6
Received digital payment for most recent sale (%)	2.4	0.6	2.4	1.1	0.0
Most recent customer was female (%)	11.7	34.6	14.2	29.0	29.6
Respondent set the price of most recent sale (%)	52.6	42.8	55.1	28.0	44.0
Value of most recent sale (INR)	137.8	56.4	128.0	61.0	102.6
Annual vegetable income (INR)	235,587	145,443	240,718	155,218	74,744
Expects to expand enterprise in next 5 years (%)	74.1	86.8	73.3	93.0	86.4

Source: INCATA Odisha Surveys 2025.

Intersection of gender and caste. Gender and caste jointly shape who becomes a retailer. Nearly half of scheduled caste and scheduled tribe retailers are women, compared with only 20% among non-scheduled caste retailers. This may reflect greater mobility among tribal women due to different gender norms, but it may also indicate that retailing functions as a "last resort" occupation for some women facing constrained options.

Education gradients. Education levels are very low across all retailer groups, but sharply differentiated. Only 12.6% of male retailers have completed secondary education, versus 0.9% of female retailers and 2.4% of scheduled tribe retailers. Conversely, 65.1% of women retailers and over half of scheduled tribe and scheduled caste retailers have no formal education, compared with 12.8% of male retailers. These patterns likely reflect both socioeconomic disadvantage and cohort effects, given retailers' relatively high average age and historical gaps in schooling access.

Occupations and land. Vegetable retailing is the sole occupation for about two-thirds of men, women, and non-scheduled caste retailers, and for an even higher share of scheduled caste retailers (76.3%), suggesting stronger dependence. Scheduled tribe retailers are less specialized (46.6% retail-only) and more likely to have previously worked in agriculture (52.8%), implying retailing can be a pathway to diversification for them. Landownership aligns with this: scheduled tribe retailers own the most land (1.05 ha), scheduled caste retailers the least (0.69 ha). Women retailers come from households with slightly less land than men (0.73 vs 0.89 ha).

Capital and assets. Financial disparities are pronounced. Male retailers' startup capital averages ₹8,354 ($96), about one-third higher than women's (₹6,275 or $72). Male retailers' business assets (₹39,324 or $452) are roughly double women's (₹19,076 or $219), suggesting faster asset accumulation among men or differential constraints on reinvestment. Scheduled caste and scheduled tribe retailers enter with lower startup capital and hold fewer assets than non-scheduled caste retailers, and these gaps appear to persist or widen over the business lifecycle.

Formality and social capital. Men and non-scheduled caste retailers have higher rates of trader association membership and business licensing than women, scheduled castes, and scheduled tribes, implying higher average levels of social capital, formality, and scale. Even among men, however, levels are low (12.6% association membership; 9.8% licensed).

Borrowing. Borrowing to fund retail operating costs in the past year is low overall and similar for men and women (about 10%). It is lower among scheduled tribe (3.2%) and scheduled caste retailers (7.5%) than among non-scheduled caste retailers (11.6%), potentially reflecting constrained credit access and/or smaller business scale. Similar borrowing rates for men and

women may reflect the role of women's self-help groups as a source of micro loans.

Digital divides. Mobile phone ownership differs dramatically: only 21.4% of female retailers own a phone, compared with 61% of male retailers. Ownership is also lower for scheduled tribe (27.2%) and scheduled caste retailers (40.3%) than for non-scheduled caste retailers (55.3%). While non-ownership does not imply zero access (many may use household phones), these gaps likely translate into disadvantages in information discovery, coordination, and remote transactions, and may be compounded by very low literacy.

Digital payments. UPI use among retailers is minimal and mirrors mobile access disparities. No scheduled tribe retailer and only 0.6% of scheduled caste retailers received UPI payment in their most recent sale, versus 2.4% of male and non-scheduled caste retailers. UPI use for making payments is slightly higher (1.8% among women up to 6.7% among men), consistent with UPI being more useful for settling supplier payments (especially where credit and remote settlement are common) than for customer payments.

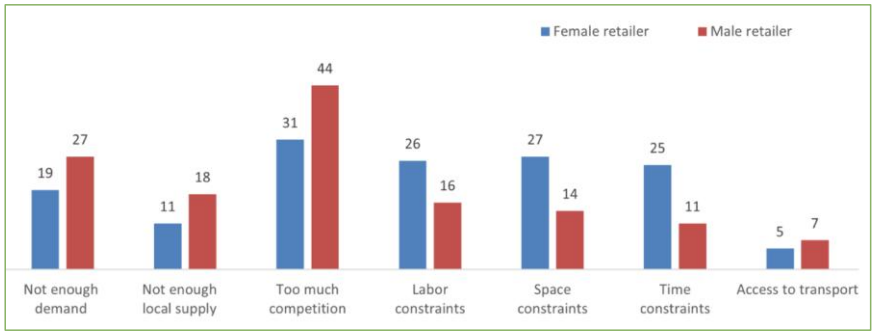
Women customers and market inclusion. Female retailers were three times more likely than male retailers to have served a female customer in their most recent sale (34.6% vs 11.7%). Scheduled caste and scheduled tribe retailers were about twice as likely as non-scheduled caste retailers to serve female customers (29% vs 14.2%). This may reflect female shoppers' preferences, and it highlights an inclusion channel for women consumers. It may also reflect identity matching between retailers and customers, though this cannot be confirmed with available data.

Pricing agency and scale. Women report less ability to set prices unilaterally than men (42.8% vs 52.6%). Scheduled caste retailers report substantially less unilateral price-setting than non-scheduled caste retailers (28% vs 55%), suggesting lower bargaining power and agency. Consistent with scale differences, the average value of the most recent sale by male retailers is about 2.5 times women's (₹138 or $1.60 vs ₹56 or $0.65). Non-scheduled caste retailers also have higher sale values than scheduled caste and scheduled tribe retailers. Annual incomes follow similar patterns: higher for men than women, and higher for non-scheduled caste retailers than for scheduled caste and scheduled tribe retailers.

Business sentiment and constraints. Despite these disadvantages, women and retailers from scheduled castes and tribes report more optimistic expectations of business expansion over the next five years than men and non-scheduled caste retailers. This may reflect smaller baseline scale (and thus perceived room to grow) or a greater reliance on the enterprise and stronger growth aspirations. Overall optimism across retailer groups indicates meaningful perceived potential for growth in this node.

Finally, respondents reported the challenges they face in expanding their vegetable retail businesses (Figure 24). Men more often cite broad market conditions (competition, weak demand, inadequate local supply). Women more often emphasize day-to-day operational constraints (labor, time, space, and to a lesser extent transport). These differences are consistent with gendered constraints on time and mobility, differential access to household resources, and marginalization in marketplace locations.

Figure 24: Perceived challenges to business expansion (% of respondents)



Source: INCATA Odisha Surveys, 2025

DATA AND SOFTWARE AVAILABILITY

Extended data

Data supporting the findings of this study are currently being cleaned and anonymized and will be deposited in RIMISP's Harvard Dataverse repository as soon as they are ready for public release. Until deposition is complete, the datasets are not yet available. The authors will update the preprint with the persistent repository link and citation upon release.

Competing interests

'No competing interests were disclosed'.

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