TATA–CORNELL INSTITUTE FOR AGRICULTURE AND NUTRITION

ANNUAL REPORT 2025–26

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TCI 2025–26 Annual Report Contents

A Note from Our Director
2

By the Numbers
3

Our Work
4

Cultivating Carbon-Neutral, Highly Productive Food Systems
6

Supporting Climate-Resilient and Nutrition-Sensitive Food Systems
8

Staff Spotlight: Leslie Verteramo Chiu
9

Promoting Agricultural Development with FPOs
10

Tackling Wasted Potential
14

Maximizing Anti-Anemia Policies
15

Accounting for Food Subsidy Leakage
16

Improving Agricultural Extension Services
17

Fostering Sustainable Value Chains for Nutritious Foods
18

Scholar Spotlight: Kiera Crowley
19

Cash Transfers Reshape Rural Work
20

Alumni Spotlight: Rohil Sahai Bhatnagar
21

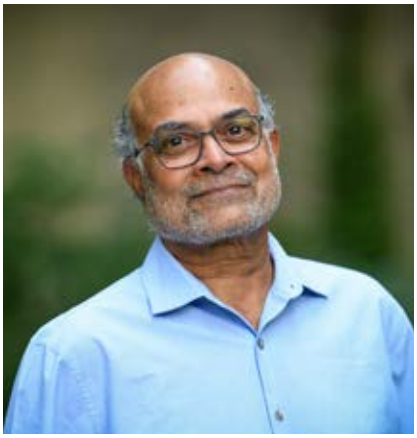
Promoting Crop Diversification
22

Improving Nutrition Programs for Children and Pregnant Women
23

Personnel and Partners
24

Photos: Front cover and pages 2-3 by Raghav Puri/TCI

A Note from Our Director



The 2025–26 academic year was auspicious for the Tata–Cornell Institute for Agriculture and Nutrition (TCI). Several of our research projects bore fruit in the form of reports and policy briefs, while field-based research began for our latest project, which focuses on value chains. TCI has become a well-recognized research entity in India, with a commensurate impact of food systems discussions across the country.

In the past year, our researchers published six studies in peer-reviewed academic journals on topics ranging from crop management to nutrition and public health programs. These studies demonstrate not only the wide breadth of research produced by TCI, but also its real-world relevance to rural communities and ongoing policy debates.

For the past several years, TCI has engaged in an ongoing research effort on farmer producer organizations (FPOs), which India has made a cornerstone of its agricultural development strategy. In early 2026, we released a milestone report on FPOs in India, providing a wide-ranging assessment of the overall FPO landscape in the country. We also unveiled an update to our FPO Platform for India, a comprehensive database of Indian FPOs. The platform now includes a networking tool that empowers FPOs to market themselves and interact with potential business partners. We reached an agreement with the Indian Ministry of Agriculture and Farmers' Welfare to take over operation of the platform, ensuring that it will live on in perpetuity.

In the past year, TCI held a series of workshops and policy dialogues to highlight the importance of climate-smart agriculture in the face of a changing climate. TCI researchers presented policy briefs on our research in Bihar, which demonstrates the potential of community-based agrivoltaics, advanced artificial insemination for livestock, and advanced management systems for rice production to reduce greenhouse gas emissions while improving agricultural productivity.

In addition to those policy events, TCI also began field-based work on another project that emphasizes the relationship between food production and the environment—"Promoting Value Chains for Climate Resilience and Nutritious Diets." Researchers traveled across India to assess the value chains for several nutritious, climate-resilient crops, and in the future, they will make recommendation to strengthen these value chains.

We proudly saw two of our TCI scholars earn advanced degrees this year. Bharath Chandran C received a Master of Professional Studies (MPS) in Global Development and Sumedha Minocha received her PhD in Applied Economics and Management. We are especially happy that both of these talented researchers have joined TCI as staff members and will continue to contribute to our work.

The research detailed in this report is made possible by the generous support of our funders, including grants from the Walmart Foundation and the Novo Nordisk Foundation, as well as the founding endowment given to Cornell University by the Tata Education and Development Trust.

I hope that you enjoy reading about our work. Thank you for supporting TCI.

Prabhu Pingali
Founding Director, TCI

Photo by Heather Ainsworth

TCI by the Numbers

11 Researchers

5 TCI Scholars

4 Faculty Fellows

38 Alumni

23 PhDs Earned

10 Master's Degrees Earned

16 Academic Disciplines

8 Reports

5 Books

63 Journal Articles

15 Book Chapters

36 Policy Briefs

3 Fact Sheets

2 Training Manuals

Photo by Raghav Puri/TCI

Our Work

The Tata-Cornell Institute is a long-term, multidisciplinary research initiative focused on creating and assessing innovative, food systems-based approaches to improving nutrition and livelihoods in India and other developing countries.

TCI Assistant Director Mathew Abraham speaks at a policy dialogue on climate-resilient agriculture organized by TCI in New Delhi. (Photo by TCI)

Agriculture Transformation, Food Systems & Nutrition Transition

India's ongoing transformation from low-productivity agriculture to an advanced economy has profound implications for nutrition in the country. TCI research explores the impact of these changes to help India's food systems adapt and adequately provide for the shifting needs of its people.

Climate Change & Sustainable Agriculture

As climate change continues, India's agricultural sector must grapple with its effects and adopt more resource-conscious, sustainable practices. TCI's research focuses on building resilient food systems capable of weathering climate change while meeting the nutritional needs of growing populations.

Food & Ag Science Innovations

Building food systems that prioritize nutrition requires leveraging the latest scientific advancements in areas like soil health and fortification. TCI researchers are bridging the gaps between research and implementation through building of awareness, technology, and knowledge transfer.

Food Safety, Water & Sanitation

Nutrient absorption is significantly impacted by interrelated factors involving food contamination, access to safe water, and hygiene. TCI research in these areas aims to inform effective interventions that ensure that families and individuals can enjoy the full nutritional benefits of the foods they eat.

Gender & Nutrition

In India, 80 percent of economically active women are employed in the agricultural sector, with many performing unpaid household labor. TCI seeks to improve nutrition outcomes by understanding how women's empowerment at the community and household levels helps to bolster positive nutritional behaviors and improved intrahousehold access to food.

ICTs, Data Systems & Ag Tech

Information and communication technologies (ICTs) and other technological inventions can boost agricultural productivity and improve livelihoods, while strong, comprehensive data systems help ensure that policies and strategies are built on a foundation of solid evidence. TCI explores how new technologies can enhance food systems while working to build and improve databases and platforms.

Markets & Value Chains

Rising demand for diverse agricultural products presents an opportunity for smallholder farmers to improve their livelihoods. TCI research aims to empower small farmers by identifying and addressing barriers that limit their access to value chains and markets.

Want to learn more about our work in one of these research areas? Check for color-coded tags at the top of each story throughout this report.

Photo by TCI

Cultivating Carbon-Neutral, Highly Productive Food Systems

Climate Change & Sustainable Agriculture

ICTs, Data Systems & Ag-Tech

Two of the thorniest challenges facing India today are climate change and persistent hunger and malnutrition. The shift to a green economy could hamper efforts to grow more food, while boosting production threatens to increase greenhouse gas emissions. Similarly, failing to curb climate change and adapt to shifting weather patterns puts agricultural production at risk.

Livestock are one of the leading agricultural sources of greenhouse gas emissions. (Photo by TCI)

TCI's project on "Zero-Hunger, Zero-Carbon Food Systems" aims to identify, study, and promote synergistic solutions that reduce emissions while improving agricultural productivity and increasing the resiliency of India's food systems in the face of climate change. TCI researchers, working with partner organizations on the ground, have identified several potential pathways to build a climate-smart agricultural sector.

Shining a Light on Agrivoltaics

In the summer of 2025, TCI and Preservation and Proliferation of Rural Resources and Nature (PRAN), along with Jain Irrigation Systems, completed construction of a pilot agrivoltaics installation in Bihar's Gaya Ji district. Agrivoltaics combines agriculture and solar power generation to prevent the competition of food and energy production for land. Although traditional agrivoltaics emphasizes large-scale power generation for the electrical grid, TCI's test site was engineered with smallholder needs and capacities as its focus. In TCI's community-based model, six farmers jointly own and manage a 20-kilowatt solar array, which produces electricity for micro-irrigation systems and a grain mill.

Access to reliable and affordable irrigation allowed the farmers to begin growing crops during dry seasons. The farmers also decided to grow a more diverse sets of crops, including a relay cropping system (mung bean–okra–banana) on the same field. The drip and sprinkler systems also reduced the amount of water needed for cultivation and improved soil conditions. Yields and crop income increased as a result.

The farmers can also generate income by charging for grain mill services. Additional uses for excess energy generated, such as food preparation appliances and refrigeration, are also possible.

Efficient Livestock Production

Livestock production is one of the largest sources of agricultural emissions in India. TCI research shows that increasing the proportion of productive female animals in herds, through the use of enhanced artificial insemination with sex-sorted semen, can lower the emissions associated with livestock production in Bihar by as much as 6.7 metric tons by 2050, while also generating an estimated 207.5 million rupees in additional income for farmers.

However, widespread adoption of advanced artificial insemination in India has been stymied by high costs and low awareness. In Bihar, TCI partnered with BAIF Development Research Foundation to administer a campaign to raise awareness of advanced artificial insemination and assess how it affected farmers' willingness to

adopt and pay for the service. The researchers found that willingness to adopt the service increased by about 27 percent after the campaign, while willingness to pay increased by about 7 percent.

> *TCI researchers, working with partner organizations on the ground, have identified several potential pathways to build a climate-smart agricultural sector.*

Improving Rice Productivity

As part of the project, TCI supported Faculty Fellow Andrew McDonald's research, which focuses on boosting productivity by tailoring crop management approaches to local environments.

Excessive use of nitrogen fertilizer, which is subsidized by the Indian government, contributes to high nitrous oxide emissions from rice farming. McDonald's research shows that about 50 percent of Bihar farmers could decrease fertilizer usage without sacrificing yields, while some in northern Bihar could increase yields by using more fertilizer. Such precision nitrogen fertilizer recommendations, in tandem with interventions to improve irrigation, could significantly boost productivity and profitability while reducing emissions.

In addition to nitrous oxide, rice production also contributes to climate change through methane emissions caused by soil flooding practices. Many presume that most rice production in Bihar relies on continuous flooding, but emerging research shows a more complicated hydrologic picture, which affects both emissions estimates and potential mitigation interventions. McDonald's research suggests that mitigation efforts should focus on identifying Bihar's "emissions hotspots" and matching them with the technologies best suited to local conditions. One such technology is alternate wetting and drying, which uses controlled irrigation to reduce water consumption.

Promoting Climate-Smart Farm Practices

Using its research, TCI is promoting agrivoltaics, advanced artificial insemination, and improved rice management systems in Bihar and throughout India. In fall 2025, TCI co-organized a roundtable discussion in Patna, Bihar, during which researchers presented their findings to government officials, private sector actors, and other researchers. In early 2026, TCI held a policy dialogue in Delhi to present its research and discuss ways to implement its findings into government policies.

Taken together, the research conducted under this project highlights clear steps India can take to ensure that its future food systems meet the country's nutritional needs without contributing to climate change.

Crops grow amid solar panels at the agrivoltaics installation TCI built in Bihar. (Photo by TCI)

Supporting Climate-Resilient and Nutrition-Sensitive Food Systems

Agriculture Transformation, Food Systems & Nutrition Transition

Climate Change & Sustainable Agriculture

The heavy dependence on paddy cultivation in India's rice bowl state, Chhattisgarh, highlights several environmental and nutritional concerns. Reliance on a water-intensive crop like paddy contributes to groundwater depletion, methane emissions, soil health degradation, and susceptibility to climate shocks, especially in rainfed regions. A rice-heavy diet increases the risk of malnutrition and noncommunicable diseases, compared to traditional crops like millets and pulses, which are richer in iron, fiber, and protein.

To mitigate these interlinked environmental and nutritional challenges, TCI is assessing different pathways that can potentially facilitate the transition to a more diversified cropping system. In coordination with Professional Assistance for Development Action (PRADAN), TCI implemented a field trial to assess three climate-smart interventions: knowledge sharing, market support, and irrigation enhancement.

> ***TCI is assessing different pathways that can potentially facilitate the transition to a more diversified cropping system.***

The first intervention pathway consisted of a series of workshops that provided farmers with information about climate change, including its origins, impacts, and broad mitigation efforts. Training on cultivation techniques and strategies for crops like paddy, millets, oilseeds, and pulses, with an emphasis on climate-resilient processes and scientific methods, was also provided.

The second intervention was designed to evaluate whether facilitating access to agricultural inputs and strengthening market linkages can support the adoption of non-paddy crops. Farmers received crop input kits containing seeds, organic manures, and crop medicines at a nominal cost. Further provisions for postharvest value addition were made through the installation of village-level pulse and oilseed processing units.

The third intervention was aimed at understanding whether improving irrigation access would enable farmers to diversify into alternative crops. TCI and PRADAN built solar lift irrigation infrastructure and farm ponds, in addition to establishing community-based water user groups.

TCI researchers are monitoring the impact of these interventions to gain actionable insights on transitions in the agricultural system. The findings from this research can help to inform policies supporting a shift to a more nutrition-sensitive, climate-conscious food system.

TCI and PRADAN built solar-powered lift irrigation systems for farmers in Chhattisgarh to promote crop diversification. (Photo by TCI)

Staff Spotlight: Leslie Verteramo Chiu

While TCI's work is focused on India, its research—especially on farmer producer organizations (FPOs)—often holds relevance in other countries around the world. Research economist Leslie Verteramo Chiu is an integral part of that work, bringing regional expertise on Latin America to the Institute's study of FPOs.

As an economist, Verteramo Chiu is interested in finding ways to improve market access and reduce risk for agricultural producers, especially smallholders. "By understanding the enabling factors of FPO creation and successful operation, and the corresponding benefits that FPOs generate for their members and regions, I hope to contribute to the public debate on improving smallholder farmer welfare and provide evidence for better public policy," he says.

He has contributed to two TCI reports on FPOs: *The State of Farmer Producer Organizations in India: Performance, Trends, and the Role of Gender* and *Aggregation Models and Small Farm Commercialization: An Annotated Bibliography of Relevant Literature*.

Verteramo Chiu has also spearheaded the Institute's research on FPOs outside of India, including a visit to Mexico in 2025, during which TCI researchers met with the Secretary of Agriculture and Rural Development and visited with FPO representatives from the states of Tlaxcala, Puebla, and Morelos. In late 2024, he helped to organize a hemispheric workshop on agrifood system policies, bringing together policymakers, researchers, and private sector actors from Latin America and the Caribbean to strengthen regional cooperation and develop a collaborative roadmap toward policies addressing food system challenges in the region.

Verteramo Chiu was drawn to TCI by its institutional capacity and reputation for high quality research, as well as the opportunity to collaborate with experts across Cornell and with public and private institutions in India and Latin America.

"The research conducted at TCI has contributed to improving the public debate that is necessary to develop policies, backed by evidence, that impact the lives of millions of people," he says.

Photo by Lukasz Rawa/Unsplash

Promoting Agricultural Development with FPOs

ICTs, Data Systems & Ag Tech

Markets & Value Chains

In India, the average farm is only 1.15 hectares, and 86 percent of farmers hold less than 2 hectares of land. These smallholders are disadvantaged with respect to accessing markets, credit, and agricultural inputs like seeds, preventing them from reaching their full potential productivity and income. To address this challenge, India has promoted the formation of farmer producer organizations (FPOs). By joining FPOs, farmers can collectively reduce costs and improve market access, helping to drive higher agricultural productivity, enhanced food security, and livelihood development.

TCI's project on "FPO-Led Small Farm Market Access Models" aims to support the promotion of FPOs by studying the challenges that they face and identifying successful strategies for making FPOs economically sustainable to boost agricultural growth.

Assessing India's FPO Ecosystem

In 2026, TCI published *The State of Farmer Producer Organizations in India: Performance, Trends, and the Role of Gender*, a comprehensive assessment of the government's push to promote FPOs. The report provided critical information about the FPO ecosystem in India, including national, state, and district-level FPO promotion and survival rates, as well as governance and financial performance based on a range of metrics, such as gender leadership, size, and crops produced.

The report revealed that the overall financial outlook for FPOs is mixed. Larger organizations with more shareholders, which have the financial resources to invest in value addition, market infrastructure, and professional management, outperform smaller ones, which often struggle with basic operational expenses. Lower FPO profitability is likely due to limited market access, smaller operational scales, and infrastructure challenges. The report also shows low debt utilization among most FPOs, a likely reflection of limited access to formal credit rather than conservative financial management.

The report also took a close look at the impact of gender on FPO performance, revealing that women-led FPOs outperform those with mixed or predominantly male leadership. Female-led FPOs exhibit higher survival rates and outperform their male-led counterparts by most financial metrics. FPOs with female or mixed leadership survive past their government support period at rates 4–13 percent higher

TCI research support specialist Dieter Bouma speaks during the launch event for The State of Farmer Producer Organizations in India. *(Photo by TCI)*

To access the FPO Platform for India, visit fpo.tci.cornell.edu

than those led by men. Women-led FPOs are also more profitable, more effectively utilize debt, exhibit improved liquidity management, and have more efficient operations.

Despite the higher performance of women-led FPOs, the report showed that they are not promoted equally across India. For example, one in three FPOs in Jharkhand are women-led, while in Haryana, only one in 20 are led by women.

> ***The report … took a close look at the impact of gender on FPO performance, revealing that women-led FPOs outperform those with mixed or predominantly male leadership.***

Additionally, the report presented case studies of six women-led FPOs that emerged from self-help groups—collectives of women who pool resources to access business loans, provide mutual support, and foster economic development. The case studies showed that women-led FPOs that emerged from self-help groups drew considerable lessons from their experience, such as fostering group cohesion, financial literacy, and democratic governance.

Collecting Data on FPOs

The report was prepared using data from TCI's FPO Platform for India, a data platform with comprehensive information on more than 260,000 FPOs, including crops produced, services provided, supporting organizations, and financial information.

TCI launched an enhanced version of the platform in 2025, introducing new data and features, most notably "FPOConnect"—a networking tool that allows FPOs to market themselves and interact with potential business partners. Through this tool, FPOs can claim their pages and create personalized business profiles on the platform. The profiles are accessible through search engines, providing FPOs with a valuable web presence for marketing. Businesses, FPO promoters, service providers, and others can also join FPOConnect to follow and message FPOs directly.

Under an agreement between TCI and the Indian Ministry of Agriculture and Farmers' Welfare signed in early 2026, the platform will be transferred to the Ministry, which will host the platform going forward. TCI and the Ministry will work as knowledge partners, with TCI researchers consulting on new features, which could be added to the platform in the future.

The agreement ensures that the FPO Platform will continue to be an essential tool for researchers and policymakers, as well as businesses and FPOs, helping to strengthen India's FPO ecosystem.

TCI Director Prabhu Pingali and Ministry of Agriculture and Farmers' Welfare Joint Secretary Chinmay Gotmare signed a memorandum of understanding transferring the FPO Platform for India to the ministry on February 18, 2026. (Photo by TCI)

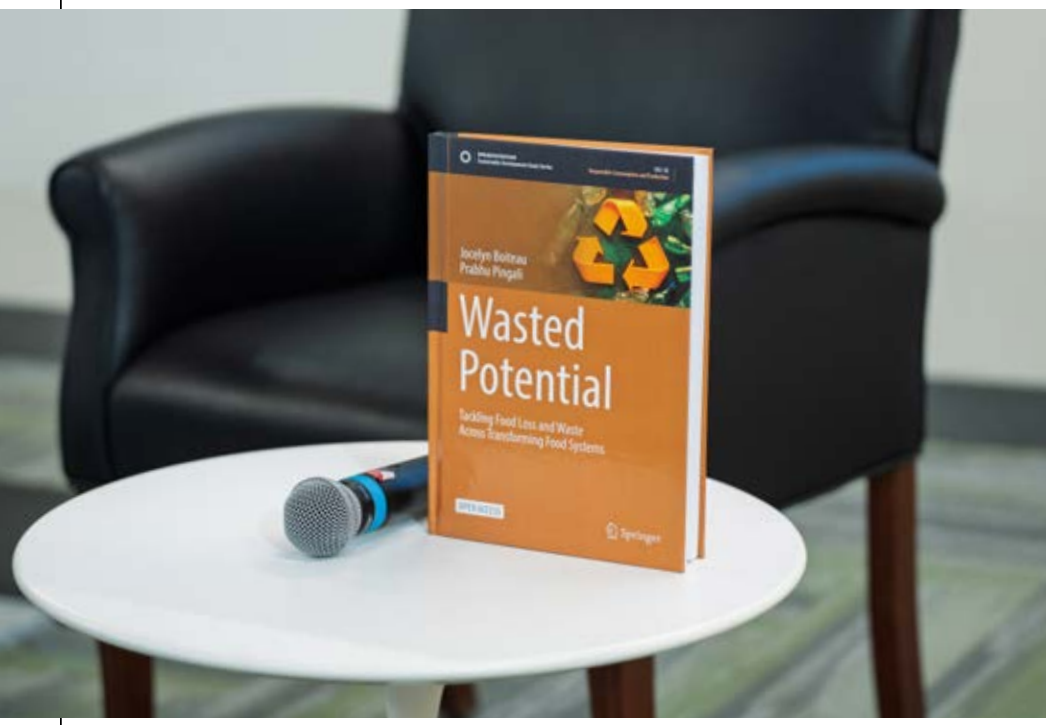
Photo by TCI

Tackling Wasted Potential

Food Safety, Water & Sanitation

Markets & Value Chains

Each year, about 32 percent of the food produced across the world is lost or wasted. Tackling food loss and waste has been on the global agenda for decades, with policymakers citing it as a contributing factor to issues like food insecurity and environmental degradation. Despite this attention, food loss and waste remains a challenge across the world.



Jocelyn Boiteau and Prabhu Pingali presented Wasted Potential *at several book launch events around the United States. (Photo by IFPRI)*

A 2025 book written by TCI researchers provides an evidence-based framework for addressing food loss and waste as a means to improving access to healthy diets. In *Wasted Potential: Tackling Food Loss and Waste Across Transforming Food Systems*, TCI alumna Jocelyn Boiteau and Director Prabhu Pingali set forth a policy agenda that builds demand for diverse, nutritious foods in order to incentivize reduction of food loss and waste while mitigating trade-offs between food security, environmental sustainability, and socioeconomic welfare. In addition to stimulating demand for safe and nutritious foods, Boiteau and Pingali called for investments in value-adding innovations like processing, packaging, and cold chain infrastructure, as well as public infrastructure and financial services that improve market access.

Although most previous works on food loss and waste have focused on loss at the retail and consumer levels, Boiteau and Pingali utilized a food systems approach that encompasses the full set of activities along food supply chains. This comprehensive approach enabled them to identify potential trade-offs and synergies with other goals. For example, food packaging can help to reduce the loss of perishable foods and make them more accessible to consumers, but also has a negative environmental impact.

Wasted Potential also highlights important issues with the data used to monitor food loss and waste. In particular, the lack of a single, agreed-upon definition for food loss and waste makes it difficult to compare data on both the extent of the issue and the effectiveness of reduction strategies. Boiteau and Pingali also highlighted the need for more robust data collection and the alignment of data collection and estimation approaches with sustainable food systems objectives.

Boiteau and Pingali shared key findings from *Wasted Potential* at a series of book launch events at Cornell University; the Agriculture, Nutrition & Health Academy; and the International Food Policy Research Institute.

Tata-Cornell Institute

Visit to tci.cornell.edu/wasted-potential or use the QR code above to to download a copy of Wasted Potential.

Maximizing Anti-Anemia Policies

Food Safety, Water & Sanitation

Gender & Nutrition

Anemia—characterized by insufficient healthy red blood cells or hemoglobin—causes impaired cognitive and developmental outcomes, costing the Indian economy roughly 1.3 percent of gross domestic product (GDP) each year.

> ***According to the study, children who received benefits from both programs had higher blood hemoglobin levels than those who received only one.***

In 2020, an estimated 67 percent of Indian children under 5 years were anemic.

Anemia has several causes, including iron or vitamin deficiencies, resulting from poor diets or infections from fecal contamination. TCI research shows that deliberately targeting these pathways through policy can amplify the impact of government efforts. In a study published in the journal *Applied Economic Perspectives and Policy*, TCI researchers assessed the impact of two government interventions, the nutrition program *Anemia Mukt Bharat* (Anemia-Free India) and *Swachh Bharat Mission* (Clean India Mission), a sanitation program intended to eliminate open defecation. According to the study, children who received benefits from both programs had higher blood hemoglobin levels than those who received only one.

The researchers used data from India's National Family Health Survey (NFHS) to analyze the effects of each program on the hemoglobin levels of children under 3 years. Children who received at least one intervention under *Anemia Mukt Bharat* had 0.06 g/dl higher hemoglobin levels. Among children who received improved sanitation facilities under the *Swachh Bharat Mission* and whose communities' open defecation rates fell below 40 percent, hemoglobin levels were 0.12 g/dl higher than those who were not reached by the intervention. In contrast, hemoglobin levels were 0.08–0.23 g/dl higher in children receiving interventions from both programs.

Hemoglobin levels below 11 g/dL are considered anemic. The researchers estimate that 2,100–6,700 children are 0.08–0.23 g/dL below the 11 g/dL threshold and could be raised out of anemia by receiving interventions from both programs.

This research underscores the importance of how programs are implemented, demonstrating that public health efforts can have the biggest impact if they address health determinants comprehensively, with coordination between all the government ministries involved.

Gupta, S., Seth, P., and Pingali, P. 2025. "Multisectoral Convergence of Food, Nutrition and Sanitation Programs for Child Health: Evidence From Country-Level Programs in India." *Applied Economic Perspectives and Policy* 48(2), May, 424–34.

Doctors weigh children at a school in West Bengal, India. (Photo by SOMNATH MAHATA/ Shutterstock)

Accounting for Food Subsidy Leakage

Markets & Value Chains

India's massive food program, the Public Distribution System (PDS), provides subsidized grain to more than 800 million people each year, but not all of it reaches consumers. In 2011–12, about 42 percent of the 51.4 million metric tons of grain distributed through the PDS was lost. Some of this "leakage" occurs during transportation, storage, and distribution, while some is stolen.

TCI research, which assessed leakage from the PDS, showed that it reached a record low in 2023–24, but also exposed discrepancies, indicating that the available data may not be completely reliable. Using household consumption and expenditure data, the researchers found that leakage declined from 41.7 percent in 2011–12 to 24.1 percent in 2022–23. In 2023–24, it fell further to 8.8 percent.

The researchers credited the decline to reforms implemented under the National Food Security Act (NFSA) of 2013, which improved the identification of beneficiaries and emphasized the end-to-end computerization of the PDS supply chain. The steep drop between 2022–23 and 2023–24 was likely caused by the expiration of COVID-era provisions, which had increased the amount of grain provided to recipients.

Although the researchers found that leakage declined, they also found reason to doubt the accuracy of the available data. They found that five states—Assam, Bihar, Jharkhand, Rajasthan, and Uttar Pradesh—had negative leakage, meaning that more PDS grain was consumed than was distributed to beneficiaries—clearly, an impossibility.

> ***"[T]he researchers found that leakage declined from 41.7 percent in 2011–12 to 24.1 percent in 2022–23. In 2023–24, it fell further to 8.8 percent."***

The problem was likely caused by an overestimation of grain consumption. Because the 2021 census was delayed, the researchers found it necessary to use population projections based on migration data from 2011 to estimate consumption. This could have led to misestimation of state-level populations, especially given the increase in migration over the past decade.

Given these concerns, the researchers stated that the actual PDS leakage is likely between 10 and 20 percent. Although greater than their 8.8 percent estimate for 2023–24, it would still mark a substantial decline from earlier years.

In addition to quantifying recent progress in reducing leakage, this research highlights the need for improved data collection, with which further improvements to the PDS can be made.

PDS grain is distributed from a truck in Chandigarh during the COVID-19 pandemic. (Photo by Raghav Puri/TCI)

Improving Agricultural Extension Services

ICTs, Data Systems & Ag Tech

The expansion of mobile phone networks in rural parts of India and other developing countries has enabled the expansion of digital agricultural extension services like the Kisan Call Centres, providing farmers with information and advice on topics like weather, input utilization, pest management, and market price fluctuations.

> ***Pramanik found that a 1 percent increase in queries related to weather was associated with a 0.3 percent increase in average paddy yields.***

In a TCI-supported study, published in *Agricultural Economics*, TCI alumnus Chanchal Pramanik demonstrated the potential benefits of Kisan Call Centres, as well as their limitations. According to the study, an increase in calls related to weather was tied to an increase in paddy yields, while increased pest attacks (as measured by pest-related queries) corresponded with a drop in yields, suggesting that targeted enhancements, such as localized weather forecasts and region-specific pest alerts, could augment the impact of the call centers.

As part of the study, Pramanik analyzed more than 17 million queries to call centers in 10 states over a period of 10 years. He also used data on weather and crop yields, in addition to various characteristics of farm households.

Weather and pests were the most frequent concerns of farmers who phoned the call centers. Pramanik found that a 1 percent increase in queries related to weather was associated with a 0.3 percent increase in average paddy yields. The link between weather queries and yield suggests that weather forecasts can enhance farmers' preparedness and decision-making.

With regard to pest-related queries, Pramanik found that a 1 percent increase in calls was tied to a 1.1 percent decrease in paddy yields. This is likely because such calls were made only after pests had begun to damage crops.

By demonstrating the benefits and limits of digital agricultural extension, Pramanik's study provides policymakers with information to strengthen these services, helping farmers to increase their yields and improve their livelihoods.

C. Pramanik. 2026. "Access to Digital Extension Services and Crop Yield: Evidence From Paddy Cultivation in India." *Agricultural Economics* 57(2), March, e70099.

A wheat farmer talks on a mobile phone while examining his crops. (Photo by Master of Stocks/ Shutterstock)

Fostering Sustainable Value Chains for Nutritious Foods

Agriculture Transformation, Food Systems & Nutrition Transition | Climate Change & Sustainable Agriculture | Markets & Value Chains

From the agricultural inputs shop, where the farmer decides what seeds, fertilizers, and pesticides to buy, to the consumers' plate, which determines demand for different products, agricultural value chains shape how food is produced, processed, distributed, and consumed. They influence not only the efficiency and equity of market outcomes, but also the nutritional quality of diets, environmental sustainability of production systems, and the livelihoods of actors involved at each stage.

TCI's latest project, "Promoting Value Chains for Climate Resilience and Nutritious Diets," aims to examine the value chains for five major food groups in India: cereals, pulses, oilseeds, fruits, and vegetables. The main objective of this project is to promote efficient value chains that are economically viable, environmentally sustainable, and nutrition-sensitive. By identifying key bottlenecks, trade-offs, and opportunities across different stages of the value chain, TCI seeks to inform policies and interventions that can enhance value addition, reduce losses, improve market linkages, and support the production and consumption of diverse, nutritious foods.

In the first stage of the project, researchers mapped trends in the production, consumption, and trade of crops across these five major food groups, situating them within broader structural shifts in India's food system. The researchers also synthesized the existing literature to assess the value chains of the most widely produced crops, with a focus on their economic, environmental, and nutritional performance.

Building on these insights, in the second stage of the project, TCI identified one relatively understudied crop from each food group for in-depth, context-specific qualitative analysis. In spring 2026, researchers completed primary data collection across five diverse locations in India—each representing a distinct value chain: maize in Purnea, Bihar; black gram in Chhatarpur, Madhya Pradesh; soybean in Latur, Maharashtra; orange in Nagpur, Maharashtra; and eggplant in Nadia, West Bengal. These case studies traced the functioning of value chains from input provision and production practices to aggregation, processing, and retail, capturing the perspectives of farmers, traders, and other value chain actors.

By combining these grounded insights with broader value chain assessments, the project aims to identify bottlenecks, coordination failures, and points of value loss that shape outcomes for producers and consumers alike. The findings will generate actionable evidence on where and how interventions can improve efficiency, enhance resilience, and support a transition toward more sustainable and nutrition-sensitive food systems.

Markets are just one stop along the value chain, which brings crops from the farm to consumers. (Photo by Raghav Puri/TCI)

Scholar Spotlight: Kiera Crowley

Tata-Cornell Institute Scholar Kiera Crowley may be a member of TCI's latest cohort of doctoral students, but she has been with the Institute for far longer than most. After taking a class with TCI Director Prabhu Pingali, Crowley completed a summer internship in India in 2018. From there, she worked for TCI as a research support specialist before starting her doctoral studies in 2020.

As a TCI scholar and PhD student in Soil and Crop Science, Crowley studies the diversification of cropping systems in Bihar, India. "I am motivated by a desire to help policies and development programs better support lasting, large-scale transitions toward agricultural systems that improve both environmental sustainability and rural livelihoods," she says.

Prior to beginning her doctoral work, Crowley's experience with TCI taught her that the issues she cares about, like reversing soil degradation and improving rural livelihoods, require both biophysical and social understanding. That need led her to the Soil and Crop Sciences Section of the School of Integrative Plant Sciences at Cornell University, where she works with advisor and TCI Faculty Fellow Andy McDonald.

Crowley notes that TCI's support has allowed her the time and flexibility needed to undertake her research project in Bihar, while giving her the opportunity to develop an interdisciplinary skill set. TCI also provided important logistical support for her field-based studies, and the Institute's interdisciplinary learning environment has been a boon to her research.

"Academically, input from Director Prabhu Pingali and various TCI colleagues has strengthened my research, from the design through the analysis stage," she says.

After completing her degree, Crowley hopes to transition from international agricultural

development toward more local work in New York. While grateful for her experiences in India, she would like to work within communities and landscapes that she can more deeply understand over the long-term.

"I hope to use my training in both quantitative and qualitative research to help farmers in New York address challenges related to environmental pollution, soil and water management, and climate resilience," she says.

Photo by Michele Blackwell/Unsplash

Cash Transfers Reshape Rural Work

Agriculture Transformation, Food Systems & Nutrition Transition

Gender & Nutrition

In India, national and state-level safety net programs provide assistance to impoverished households through cash transfers. Development economists have long asked whether cash transfers cause people to work less, with studies from India and a range of other countries showing no effect. However, an equally important question has gone largely unanswered: does it matter who in the household receives the money? In rural India, women often shoulder the most physically demanding and least remunerative work, relying on public employment programs as a last resort. Cash transfers to women could empower them to choose how much work they do and what jobs they are willing to accept.

TCI Scholar Kasim Saiyyad is addressing this issue by studying how the provision of cash transfers to different gendered members of households affect their decisions around work and other household issues. In a study of 800 households in Maharashtra, Saiyyad compared the impact of two male-targeted cash transfer programs, the PM–KISAN and the *NaMo Shetkari Mahasanman Nidhi Yojana*, with that of the *Ladki Bahin Yojana*, which provides cash to eligible women. Saiyyad's research encompassed three rounds of surveys, in addition to administrative records from the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), which provides public employment to impoverished men and women.

Saiyyad found that when cash is given to men, there is no change in employment. Both men and women in the study continued pursuing work through the MGNREGS. However, when money was given to women, MGNREGS work days for women fell. The decline was concentrated in the period from July to October, when private farmwork is plentiful, indicating that women were not quitting work; they were stepping back from safety-net jobs that they no longer needed.

> ***[W]hen money was given to women, MGNREGS work days for women fell. The decline was concentrated in the period from July to October, when private farm work is plentiful, indicating that women were not quitting work; they were stepping back from a safety-net jobs that they no longer needed.***

In addition to employment decisions, Saiyyad's research also explores what else changes when cash transfers are directed toward women, such as dietary diversity, household migration decisions, and the intrahousehold balance of financial autonomy. This research holds the potential to show how cash transfers, long judged neutral on whether people work, may quietly reshape rural lives in different ways, depending on which member of the household receives the money.

Laborers work on an MGNREGS project in Maharashtra, India. (Photo by Kasim Saiyyad/ TCI)

Alumni Spotlight: Rohil Sahai Bhatnagar

TCI alumni shine in many different fields, including academics and development research. One recent alumnus is making a mark in private industry as a food scientist, combining his acumen for science, technology, and business.

Rohil Sahai Bhatnagar, who received his PhD in Food Science and Technology from Cornell University in 2020, is now a senior research scientist at PepsiCo. Bhatnagar is developing a novel encapsulation technology to deliver a controlled release of caffeine to the small intestine through a beverage.

The encapsulation technology is a natural extension of his doctoral studies with TCI, during which he created an innovative method of flour fortification with iron from defatted microalgae used in biofuel production. Bhatnagar encapsulated the microalgae in emulsions in order to mask its off-putting taste and color.

In addition to research, Bhatnagar works with PepsiCo's external partners for technology scale-up and commercialization. He also advises on collaborative projects with top universities in the US, Europe, and China.

Bhatnagar says that his experience at TCI has shaped his career in food science research and is a driving factor behind his professional success.

"TCI offered me the opportunity to craft my own research questions and the flexibility to explore those answers through interdisciplinary studies," he explains. "In my current role as a senior scientist at PepsiCo, this kind of holistic training has allowed me to search for solutions in disciplines other than my background and enabled me to refine and implement those learnings in the stage gate process."

Approaching food science from a food systems perspective is another important lesson from

Bhatnagar's days at TCI.

"One of the most valuable components of my TCI experience has been the training to look at food science from a food systems standpoint and the opportunity to look at laboratory-scale technology development from a viability standpoint and consider commercial economic feasibility while designing lab-scale experiments," he says. "This ability has been crucial for me in interacting with stakeholders and promptly coming up with troubleshooting solutions."

Photo by Ries Bosch/Unsplash

Promoting Crop Diversification

Agriculture Transformation, Food Systems & Nutrition Transition

Crop diversification, or cropping system redesign, is widely promoted as a pathway to improve farmer incomes, strengthen resilience to climate change, increase access to nutritious foods, and provide ecosystem services. However, attempts to promote diversification often have limited success and can also lead to unintended consequences.

TCI Scholar Kiera Crowley is conducting research in Bihar, India, to better understand the drivers and consequences of cropping system transitions. Using survey data and interviews with farmers, Crowley's research focuses on three issues: the relationship between cropping patterns and socioeconomic factors, how farmer perceptions of field water characteristics influence diversification, and the implications of diversification on groundwater in Bihar.

Crowley interviewed 80 farmers and other agricultural stakeholders about the winter-season transition from wheat to maize in eastern Bihar, using National Sample Survey data to characterize cropping patterns in the state. Quantitative analysis suggests that cropping patterns are shaped more by district-scale factors than by household-level characteristics, while the interviews reveal that market and biophysical factors created a strong enabling environment for maize uptake. However, adoption also depends on the availability and affordability of irrigation and labor, in addition to access to market infrastructure.

Additional interviews with 96 farmers documented perceptions of waterlogging in individual fields and how those perceptions influence crop choice. Preliminary results suggest that farmers with similar waterlogging conditions often make different crop choices, indicating unrealized potential for diversification in some rice-dominant areas. However, socioeconomic constraints continue to limit many farmers' willingness to diversify.

> ***Crowley's research offers essential insights into how and why farmers decide to diversify, as well as the potential environmental impact of changing cropping patterns.***

Crowley used crop modeling and crop area statistics to estimate the water consumption of winter maize systems and compare future groundwater demand under different maize expansion scenarios. Her results suggest that maize uses substantially more water than wheat and that continued rapid expansion could push groundwater extraction beyond officially defined "safe" levels.

Given the importance of crop diversification to food system reforms aimed at promoting climate resiliency and improving nutrition outcomes, Crowley's research offers essential insights into how and why farmers decide to diversify, as well as the potential environmental impact of changing cropping patterns.

Kiera Crowley interviewed dozens of farmers during her field-based research in Bihar. (Photo provided by Kiera Crowley)

Improving Nutrition Programs for Children and Pregnant Women

Gender & Nutrition

The first 1,000 days of life is a critical window for nutrition. Despite rising living standards, undernutrition during pregnancy remains widespread, particularly in low-income settings. Food transfers are important policy instruments for addressing these gaps. In India, nutrition support is delivered during pregnancy through the Integrated Child Development Services (ICDS), one of the world's largest public nutrition programs, making it a promising platform for generating large-scale health impacts through existing government infrastructure.

> ***[I]ntegrating daily cooked meals into existing large-scale nutrition programs can substantially improve maternal dietary intake and pregnancy-related health outcomes.***

As part of her doctoral research, TCI alumna and postdoctoral associate Sumedha Minocha assessed different ICDS delivery models. The first model provides ready-to-cook dry rations distributed once every two months, averaging about 430 calories and 14 grams of protein per day. The second combines these rations with daily cooked meals served through village community or *Anganwadi* centers, providing an additional 910 calories and 30 grams of protein per day. The meals also include a more diverse range of foods, such as eggs.

Minocha surveyed approximately 930 pregnant women receiving ICDS services. She found that women receiving the bundled program consumed an additional 264 calories and 8 grams of protein per day, and gained an additional 2.03 kg of weight between the first and third trimesters, relative to those receiving only dry rations. These results show that integrating daily cooked meals into existing large-scale nutrition programs can substantially improve maternal dietary intake and pregnancy-related health outcomes.

Minocha also studied how the different delivery models affect social interactions between members of different castes. Caste-based social segregation remains a persistent feature of Indian society, shaping access to services and opportunities. Because the cooked-meal program requires daily visits to *Anganwadi* centers, it generates repeated opportunities for interactions between beneficiaries.

Based on around 2,000 observations from the surveyed women, she found that women from different caste groups are 14 percent less likely to interact with each other and 11 percent less likely to report friendships, compared with women from the same caste. However, the cooked-meal program reduces these gaps, increasing cross-caste interactions and friendships by 10 and 12 percent, respectively. This suggests that routine contact through public welfare programs can meaningfully reduce social segregation and reshape community-level networks.

A mother and child enjoy a meal outside of an Anganwadi center. (Photo by Samrat35/ Dreamstime.com)

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