

TCI AT 10

A DECADE OF TRANSFORMING FOOD SYSTEMS FOR THE FUTURE



**Tata-Cornell
Institute**

A Decade of Transforming
Food Systems for the Future

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DIRECTOR'S NOTE

Reflections on a decade of transforming food systems

In 2013, I had the privilege to join Cornell University in creating the Tata–Cornell Institute for Agriculture and Nutrition (TCI)—a long-term research institute focused on addressing the seemingly intractable issues of malnutrition and rural poverty in India and other developing countries around the world.

A decade later, I can proudly say that we have built an impressive institution with a reputation for producing innovative, impact-oriented research and delivering a rigorous education to graduate students engaged with all aspects of food systems.

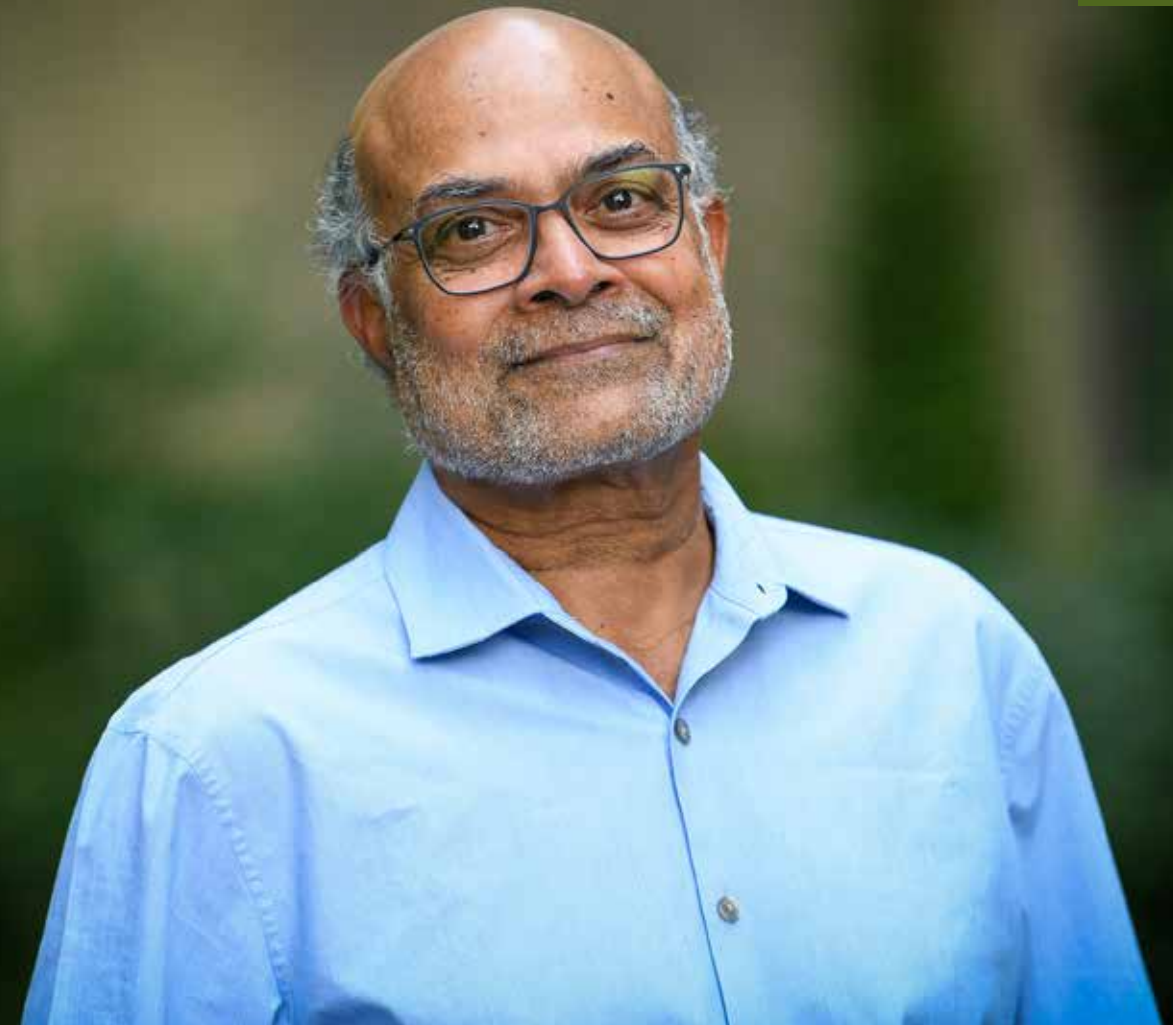
The education delivered by TCI is rooted in field-based research that emphasizes the importance of local contexts and practical impact. Through the TCI Scholars Program, TCI has helped more than a dozen graduate students obtain advanced degrees in a wide variety of fields. These bright young minds now work at universities, think tanks, development organizations, and private industries around the world.

In addition to training students, TCI's team of professional research staff have undertaken several innovative projects. The largest of these was Technical Assistance and Research for Indian Nutrition and Agriculture, or TARINA, which leveraged the expertise of academics and development practitioners to create evidence-based pathways to make India's agricultural systems more nutrition-sensitive. Along with other TCI projects, TARINA has made a measurable impact on people's lives, and many of its components have since been incorporated into government policy.

Two of TCI's projects are unique among the others for their emphasis on making important data available to researchers and other stakeholders in India's food system. As a complement to our work on farmer producer organizations (FPOs), we have built a platform with comprehensive data on India's FPO ecosystem.

In partnership with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), we updated and strengthened their District-Level Database for Indian Agriculture and

Photo by Heather Alnsworth



Allied Sectors, an invaluable resource for researchers interested in Indian food systems.

Researchers associated with TCI have written more than 40 articles that have been published in peer-reviewed journals in the last 10 years, in addition to 3 books and over a dozen book chapters. The Institute has also produced a series of its own reports and policy briefs, helping to steer the conversation about food systems in India toward crop diversification and sustainable practices.

As I reflect on TCI's first decade, I am excited for what comes next. Part of TCI's next chapter is a focus on food systems as they relate to the environment and climate change.

One of our newest projects, Zero-Hunger, Zero-Carbon Food Systems, reflects this new focus. Through it, we seek to reduce Indian agriculture's greenhouse gas contributions while maintaining or improving agricultural productivity.

Though the necessities of climate change will take part of our focus, TCI's core mission remains the improvement of nutrition outcomes and rural livelihoods in India and the developing world. In our first decade, our research helped to build a foundation for food systems reforms to make progress on those twin goals. In the next decade, we will build upon that foundation.

I hope that you will enjoy reading the following reflections on TCI, as we celebrate our 10th anniversary, and I thank you for your interest in our work.

Sincerely,

A handwritten signature in black ink, which appears to read 'Prabhu Pingali'.

Prabhu Pingali
Founding Director, TCI

SOWING THE SEEDS OF FOOD SYSTEMS REFORM

For 10 years, TCI has produced a foundation of research aimed at transforming India's food system to better serve consumers and producers alike

The story of hunger in India is in some ways one of success. With the advent of the Green Revolution in the 1960s, the Indian government used improved varieties of staple grains and chemical fertilizers to boost productivity and rescue millions from hunger. That success was only partial, however. Undernutrition is still an issue in India, as is micronutrient deficiency, and increasingly, obesity. Though production has increased, the incomes of the country's smallholder farmers remain poor. These interrelated issues are intractable, causing untold misery for many of India's 1.4 billion people and throttling the country's potential economic development.

Tackling this complex problem was the charge given to the Tata-Cornell Institute for Agriculture

and Nutrition (TCI) a decade ago. For the past 10 years, TCI has undertaken research aimed at transforming India's food system into one that is nutrition-sensitive, sustainable, and provides satisfactory livelihoods.

Founded in 2013, TCI was established with a \$25 million endowment given to Cornell University by the Tata Education and Development Trust, a philanthropic branch of the Tata Group. The endowment was made possible by the vision of Ratan Tata, former Tata Group chairman and Cornell alumnus of the Class of 1962, in order to bring Cornell's world-renowned expertise to bear on India's troubles with agriculture and nutrition.

"While India has experienced remarkable growth, it is still stuck with unacceptably high levels of

malnutrition and poverty," TCI Director Dr. Prabhu Pingali said. "TCI was created to address these issues, and in the past 10 years, we have made great strides with our research. It has been a remarkable journey, and I look forward to continuing this most important work in the years ahead."

Pingali began his tenure with TCI by traveling across India with Associate Director Bhaskar Mittra. The pair sought to understand the country's different regions and communities, along with the challenges these areas faced, to decide what issues TCI should prioritize in those early years.

"Based on those early trips, we decided on a starting point for TCI's fieldwork and began to develop

the Institute's research framework," said Mittra. "Over the last decade, TCI's fieldwork has had a direct impact in nine states, and its research has had an influence across all of India."

In 2013, TCI was only a team of three. In the following decade, the Institute grew rapidly, with dozens of staff, researchers, and students located in the United States and across India. With that growth, TCI has taken on an ambitious research agenda, which has made significant impacts on people's lives, in food systems literature, and in the wider discussion of nutrition and agriculture in India and elsewhere.

In a mere 10 years, TCI completed several large-scale, impactful research projects. The biggest of



TCI RESEARCH AREAS

- **AGRICULTURE TRANSFORMATION, FOOD SYSTEMS & NUTRITION TRANSITION**
- **CLIMATE CHANGE & SUSTAINABLE AGRICULTURE**
- **FOOD & AG-SCIENCE INNOVATIONS**
- **FOOD SAFETY, WATER & SANITATION**
- **GENDER & NUTRITION**
- **INFORMATION COMMUNICATION TECHNOLOGIES, DATA SYSTEMS & AG-TECH**
- **MARKETS & VALUE CHAINS**

“Over the last decade, TCI’s fieldwork has had a direct impact in nine states, and its research has had an influence across all of India.”

these was Technical Assistance and Research for Indian Nutrition and Agriculture, or TARI-NA—a project supported by the Bill & Melinda Gates Foundation. The TARINA project established a consortium of nongovernmental institutions (NGOs) and academic researchers to design and implement data-driven programs to improve the rural poor’s year-round access to affordable, diverse, and high-quality foods.

With projects in Bihar, Odisha, and Uttar Pradesh, TARINA greatly increased TCI’s footprint in India and strengthened the Institute’s partnerships with NGOs and development organizations. Several of the interventions piloted by TARINA have been adopted by state and local governments. The TCI Center of Excellence in Delhi, established under TARINA, continues to support nutrition-sensitive agriculture in India through evidence-building, capacity development, and advocacy.

Other notable projects include Safe Drinking Water Systems, which constructed solar-powered water pumps in rural villages, and the Sustainable Flour Fortification Initiative, or Sfurti, which addressed micronutrient deficiency with an easy-to-use, home-based method for flour fortification. TCI’s project on Optimizing Soil Health, which is still operational, has improved infrastructure for comprehensive soil health testing in Bihar.

TCI has also contributed an impressive number of publications to the overall food systems literature, including dozens of journal articles and book chapters, in addition to books, reports, and pol-

icy briefs. Among the most notable publications are the Institute’s 2019 book, *Transforming Food Systems for a Rising India*, and its 2020 report on *Food, Agriculture, and Nutrition in India*, both of which have helped to shape policy discussions around Indian agriculture and food systems.

Many of the publications produced by TCI were authored by TCI alumni, who cut their teeth by performing field research in rural India, a core tenet of the TCI Scholars Program. The program has produced more than a dozen successful doctoral and other advanced degree candidates, representing 10 academic disciplines. This new generation of researchers is now at work in academic institutions, development organizations, and private industries around the world.

The latter half of TCI’s first decade was indelibly marked by the COVID-19 pandemic. Although field research plans were put on hold, the Institute’s research staff swiftly pivoted to study the pandemic’s impact on India’s food systems and nutrition outcomes. In reports and journal articles, researchers charted an uneven rise in non-staple food prices that threatened nutrition security and demonstrated that national lockdowns caused women’s nutrition, in particular, to suffer.

Entering its second decade, TCI has developed a reputation for innovative, rigorous research and has achieved a solid record of success to build upon as it continues its mission to transform food systems for the future.

Photo by Maureen Valentine/TCI



TRAINING THE NEXT GENERATION

TCI provides cutting-edge education for future food systems researchers and practitioners

Hunger and malnutrition are not problems that will be solved overnight. A core part of TCI's work is to imbue young food systems scholars with the skills and experience necessary to tackle these difficult challenges. Through the TCI Scholars Program, summer internships, and postdoctoral appointments, TCI is molding a new generation of researchers and practitioners.

The TCI Scholars Program provides support to PhD and Master's level graduate students at Cornell University whose research aligns with TCI's commitment to improving nutrition outcomes and livelihoods in India and other developing countries.

TCI funding empowers scholars to devote themselves to their research and tackle ambitious projects, while the Institute's experienced research

staff provides them with mentorship and guidance.

"The education and training I received at TCI were excellent," said alumna Tanvi Rao, who earned her PhD in applied economics and management and is now a senior economist at the American Institutes for Research. "It was a unique opportunity for graduate students to work with a group of multidisciplinary, applied researchers pursuing common goals around understanding and improving agricultural and nutritional security in India."

Scholars are also included in the TCI Research Group, a multidisciplinary collection of students and researchers who meet weekly to present their research and receive feedback from the group. The diverse background of the group members exposes scholars to insights from different fields.



"TCI offered me the opportunity to craft my own research questions and the flexibility to explore those answers through interdisciplinary studies," said alumnus Rohil Sahai Bhatnagar, who earned his doctorate in food science and technology. "In my current role as a senior scientist at PepsiCo, this kind of holistic training has similarly 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."

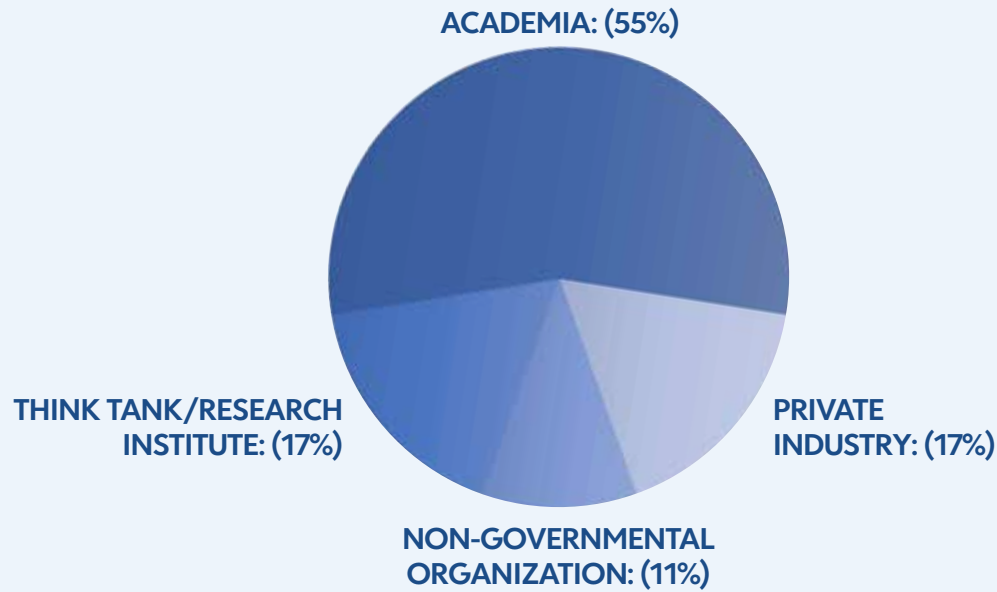
TCI also helps to train young researchers through its Summer Internship Program and participation in the Cornell University College of Agriculture and Life Sciences (CALS) Global Fellows Program, which provides undergraduate students with in-

ternship opportunities. Interns in both programs spend eight weeks in India performing research with TCI or one of its partners, obtaining an introduction to field-based research.

Several interns have gone on to continue their research as TCI scholars. Kiera Crowley completed an internship in India before joining TCI as a research support specialist and, eventually, as a scholar.

"The time I spent in India for the internship was exhilarating; it was kind of like a mini-PhD—coming up with research questions, developing the research instruments, conducting the research, analyzing it, and writing a report all within the space of six weeks," Crowley said. "Before this trip I

WHERE DO TCI ALUMNI WORK?



wasn't really thinking about pursuing a PhD, but I came home ready to apply. I was lured by the prospect of getting to develop and chase my own research questions, and the valuable experience that would come with that."

Global Fellow Axel Letondot spent his internship working with the research institution WorldFish to incorporate fish into school meals in Odisha.

"It was a very positive experience and really important for me, at a young age, to not only have an international experience, but one that was fully immersive and hands-on," he said.

In addition to TCI scholars and interns, the Institute also provides opportunities for postdoctoral students to work as research staff. After receiving mentorship from TCI, many postdoctoral researchers have gone on to secure faculty positions at universities around the world.

TCI funding empowers scholars to devote themselves to their research and tackle ambitious projects, while the Institute's experienced research staff provides them with mentorship and guidance.

Alumna Anaka Aiyar said that the support she received from TCI staff allowed her to focus on her research and publish several papers in top academic journals while a postdoctoral researcher. Now an assistant professor of economics at the University of Nevada, Reno, Aiyar said that her time at TCI also allowed her to hone her presentation skills, making her a better teacher.



After completing her doctorate in human population and evolutionary genetics, Srilakshmi Raj spent three years as a research associate at TCI examining the genetic and environmental causes of childhood stunting. She is continuing that research as an assistant professor at the Albert Einstein College of Medicine in New York.

"The field-based research and qualitative survey knowledge I gained from TCI is helping me design these studies," she said.

To date, TCI has produced 22 alumni: 14 with PhDs, four with Master's degrees, and four postdoctoral researchers.

TCI-trained researchers and practitioners are making a difference across the world at top uni-

versities like Azim Premji University in India, at international development organizations like ACDI/VOCA, at major research institutes like the International Center for Agricultural Research in the Dry Areas (ICARDA), and in private industries like PepsiCo.

"TCI taught me to see science not only through the lens of a microscope but also through the lens of the lived experiences of the communities we serve," said Anthony Wenndt, a TCI alumnus who works as a program lead for social protection and technical officer for reaching the very poor at the Global Alliance for Improved Nutrition (GAIN). "This perspective is something that I apply to my work at GAIN and that I know I will apply throughout my lifetime."

AN INTEGRATIVE APPROACH

An academically diverse research group creates synergies to tackle the challenges of complex food systems

To tackle issues as complex as malnutrition and rural poverty, TCI has made interdisciplinary research a key feature of its program. Over the past 10 years, TCI has supported researchers from at least 15 different fields, leveraging different skill sets to address different aspects of India's food system, from crop production to household gender dynamics, and beyond.

TCI scholars have earned their PhDs pursuing a truly diverse set of projects. Vidya Vemireddy surveyed female farmers in Maharashtra and standardized 502 local recipes to discern the impact of time spent farming on nutrient intake. Rohil Sahai Bhatnagar organized focus groups and conducted a market assessment while developing a process to fortify wheat flour using iron derived from a microalgae used in biofuel. Kavya Krishnan analyzed soil samples from long-term

agricultural trials in Bihar to learn how different land management techniques impact soil health and productivity. Jocelyn Boiteau surveyed tomato farmers, wholesale buyers, and retailers in Andhra Pradesh and Telangana to understand the extent of food loss and waste across perishable vegetable supply chains. And Bindvi Arora used supercritical fluid extrusion technology to develop protein-rich puffed snacks suitable for weaning infants.

"Malnutrition is not an issue that is solely the realm of nutritionists, and poverty is not a problem that can be solved by economics alone," TCI Director Prabhu Pingali said. "TCI has deliberately brought together researchers and experts from a diverse array of fields, so that we can address these complicated issues together from all angles."



The interdisciplinary nature of TCI's work is clear from its diverse contributions to the academic literature. Researchers representing the Institute have published studies on topics such as mycotoxin mitigation, soil management, animal nutrition and diets, food extrusion technology, and farm aggregation strategies.

By adopting such a multifaceted approach to India's malnutrition-poverty dilemma, TCI has positioned itself to offer comprehensive solutions that more effectively confront these issues.

"TCI offers a great platform for doing interdisciplinary research that is heavily rooted in understanding the local context to inform the design of research programs and policies," said Soumya Gupta, a TCI alumna who continues to work at the

Institute as a research economist. "This is reflected in the intensive fieldwork that underpins all of TCI's work and in the empirical evidence that has been generated on how food systems can be leveraged for better nutritional outcomes in India."

TCI's interdisciplinary approach extends to its weekly research group meetings, during which researchers—typically, doctoral students—present their findings and comment on each other's research.

"TCI provides an amazing and unique platform for researchers from disciplines as diverse as economics, plant science, soil sciences, and nutrition to come together and critically discuss various approaches to strengthening food systems in India and across the world," said TCI alumnus Naveen

TCI RESEARCHERS HAVE HAD EXPERTISE IN AT LEAST 15 ACADEMIC FIELDS

- Animal science
- Applied economics and management
- Biological and environmental engineering
- Demography
- Development sociology
- Food science and technology
- Global development
- Human population genetics
- Information sciences
- International nutrition
- Operations management
- Plant pathology and plant-microbe biology
- Public administration
- Regional science
- Soil and crop sciences

Sunder, who earned his doctorate in economics. “This allows young researchers like me to develop a holistic understanding of food systems, and fosters dialogue and cooperation between academics from different domains.”

Bringing a diverse group of scholars together in one room creates important synergies that improve their research.

For example, while attending presentations given by students in the research group studying international nutrition, Vemireddy, who earned her PhD in applied economics and management in 2019, learned about different nutritional indicators, which proved useful in her study on the impact of women’s workloads on nutritional outcomes.

“It’s a multidisciplinary group, where scholars from different backgrounds come together for a common objective, which is broadly addressing

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agricultural and nutritional linkages,” Vemireddy said.

Alumnus Anshuman Gupta, who now works for the think tank Intellectcap Advisory Services, said that the interdisciplinary nature of TCI’s work was help-



ful as an introduction to development research.

“Being a scholar at TCI was a great opportunity to interact with students and professors pursuing systematic research on various topics related to agriculture and nutrition in India,” he said.

Alumna Kathryn Merckel, associate director for nutrition and food systems at the international development nonprofit ACDI/VOCA, said that her experience as a TCI scholar empowered her to think about complex problems from different angles and develop holistic and contextually appropriate solutions.

“On any given day, I work with agriculturalists, economists, gender and youth inclusion experts,

and more,” Merckel said. “The cross-cutting and diverse knowledge of these many subjects has allowed me to work effectively and productively within these many fields and communicate how each can be leveraged to improve nutrition and food security.”



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FROM THE CLASSROOM TO THE FIELD

Field-based studies are a pillar of TCI's research program

Sweating in hot and humid weather. Commuting daily over muddy roads in the hinterland of India. Fieldwork is no easy task, but the lessons learned from interactions with local communities and the first-hand experience of policy challenges are invaluable.

That's why field-based research forms a central pillar of the TCI Scholars Program. From summers of exploratory research to years spent designing and implementing large-scale research projects, fieldwork helps transform doctoral students into professionals and ensures that their research is grounded and impactful in people's lives.

Early in their time as TCI scholars, PhD students spend their summers doing exploratory research in the field, with the goal of identifying and fine-tuning the research questions that they will seek to elucidate in their dissertations. For many,

this is their first experience in the field and proves to be formative for their future research and careers.

For TCI alumna Vidya Vemireddy, exploratory fieldwork helped her to discover a meaningful research topic—women's time use—that she has carried into her career as a faculty member at the Indian Institute of Management, Ahmedabad.

"When I did my formative fieldwork, I visited villages, and as I was talking to people, I realized that time was a constraint," she said. "I started looking up the literature and found that there was a serious research gap in understanding how time constraints impact women's nutritional outcomes, and I decided to take it up as my research topic."

TCI gave Scholar Amrutha Pampackal, a PhD candidate in development sociology, the freedom to



explore different locations for her research without having to worry about funding and other resources.

"After a month of exploratory work, I chose Kalahandi (in Odisha) for my research," she said. "Kalahandi has a large population traditionally dependent on the forest for food, but over years as access to the forest and the quality of the forest changed, the pathways through which people access food also changed—this triggered my interest to deep-dive into the area."

Later in their studies, scholars often return to the field to complete full-fledged research projects based on what they learned during their exploratory work.

For her field project assessing the impact of farm work on women's nutrition outcomes, Vemireddy produced an index of hundreds of local recipes to measure nutrient intake and estimate the time women spent cooking. This experience sharpened her research skills. "I got to know how people think and could understand their routine and daily challenges, which allowed me to ask a lot of very valid, field-based questions and learn skills in project and people management," she said.

Fieldwork provides scholars with the skills and insights needed to produce rigorous research with the capacity for having of real-world impact. Shilpi Vanaja, a TCI alumna and now assistant professor of economics at the Azim Premji University in India, took advantage of an existing TCI project

THE PATH OF A TCI SCHOLAR – FROM CLASS TO FIELD

CLASSROOM STUDY

EXPLORATORY FIELD RESEARCH

DESIGN RESEARCH PROJECT

FIELDWORK

ANALYZE DATA AND WRITE THESIS

providing safe, piped drinking water to communities in rural Jharkhand to examine how access to clean water at home improved women's productivity and use of time. She values the fieldwork experience that TCI afforded to her, emphasizing that it made her understand the nuances of real-world research.

"I could not have received a better training and learning experience than what I received at TCI to succeed as an empirical economist," Vanaja said. "My experiences in the field helped me fine-tune the research question to fit the sociocultural context in rural India and do meaningful research; later, it also helped me land in a top institution as an assistant professor."

Fieldwork gave TCI alumna Kathryn Merckel, now associate director for nutrition and food systems for the development organization ACDI/VOCA, important hands-on experience organizing proj-

From summers of exploratory research to years spent designing and implementing large-scale research projects, fieldwork helps transform doctoral students into professionals and ensures that their research is grounded and impactful in people's lives.

ects in the developing world. As a TCI scholar, she designed and implemented randomized control trials in northern India to determine if agricultural promotion alone was sufficient to build knowledge of and demand for vitamin A-rich, orange-fleshed sweet potatoes, or if nutritional education was required as well.



"My dissertation fieldwork was a great introduction to designing, implementing, and evaluating nutrition-sensitive interventions at the ground level," she said.

Through fieldwork, TCI also encourages scholars to pursue research that will be impactful for communities in developing countries. TCI alumnus Anthony Wenndt utilized a participatory approach to his research of mycotoxin contamination in village-level food systems, empowering farmers to help find durable solutions.

"TCI encouraged me to think outside the box about the way I approached science," Wenndt said. "TCI was nurturing and supportive of the idea of embedding science within a community

and making sure that the learnings and methods that were leveraged in my research were those that were in support of real issues that farmers faced on the ground."

TCI alumna and research economist Soumya Gupta described the fieldwork experience, though difficult, as a crucial part of learning to perform impactful food systems research.

"For graduate students, TCI offers a great degree of freedom in the design and implementation of field activities," she said. "Although that can seem overwhelming at the beginning, it is a tremendous learning opportunity in the long run."

STEERING THE CONVERSATION

TCI research has helped drive India's food systems dialogue toward diversification and sustainability

TCI has had a marked influence on the academic literature on agriculture and food systems since its inception in 2013. In the process, it has helped to drive debate over Indian food systems reforms toward diversification and sustainable development.

Since its founding, TCI researchers have published dozens of scholarly articles and book chapters, advancing the overall food systems literature in innovative ways. The Institute's research has appeared in the top journals of a variety of fields, such as *Food Policy*, *World Development*, *Agricultural Economics*, and *The Proceedings of the National Academy of Sciences*. TCI has also published books and reports that spurred discussions on important topics in Indian policymaking circles, such as agricultural diversification.

Altogether, TCI researchers have authored three books, 14 book chapters, and 43 journal articles since 2013. In that time, the Institute also self-published six reports, two training manuals, and 21 policy briefs.*

"After only a decade in existence, I am enormously proud not only of the number of publications that TCI researchers have produced, but of our impact on food systems policy discussions across India," TCI Director Prabhu Pingali said. "Our work has helped to put crop diversification and environmental sustainability firmly on the agenda."

TCI's 2019 book, *Transforming Food Systems for a Rising India*, used the latest data and scientific evidence to explore various challenges to and opportunities for achieving a nutrition-secure future through diversified production systems, an

improved health and hygiene environment, and greater individual capability to access a balanced diet, contributing to an increase in overall productivity. The book made a splash among researchers and policymakers engaged in India's national conversation about food and has been downloaded more than 150,000 times.

The Institute's ongoing series of reports on *Food, Agriculture, and Nutrition in India* (FAN) have had a similar impact on India's food systems dialogue. The initial report, published in 2020, mapped the country's major cropping systems and suggested changes that could diversify food production and increase farmer incomes. A subsequent report focused on addressing hunger and nutrition in Bihar.

More entries in the FAN series will be published in the future.

Apart from academic publications, TCI has also sought to bring its research directly to the policymaking community through a mix of panel discussions and consultations, with the publication of policy briefs, and op-eds and news stories published in leading Indian newspapers, such as *The Indian Express*, *The Economic Times*, and *The Times of India*.

To view and access TCI publications, visit tci.cornell.edu/publications.

*As of March 2023



MAKING A DIFFERENCE

TCI projects have directly impacted thousands of people in rural communities across India

TCI is, first and foremost, a research institute. However, with its focus on impactful, field-based studies, several of TCI's projects have directly helped communities in rural India. From installing safe drinking water systems to training women's self-help groups, TCI projects have had lasting impacts long after the research has concluded.

The project with the largest footprint is undoubtedly Technical Assistance and Research for Indian Nutrition and Agriculture (TARINA), which reached more than 18,000 households in Uttar Pradesh, Bihar, and Odisha. From 2015 to 2021, TARINA embarked upon numerous activities to promote nutrition-sensitive agriculture. It facilitated timely seed supply, strengthened market linkages, and addressed local constraints that affect efforts to diversify production.

As a result of TARINA activities, the number of households producing nonstaples, like pulses and oilseeds, increased from 30 percent to 68 percent in intervention districts, and the adoption of homestead vegetables increased from 11 percent to 40 percent. The average three-month yield of a kitchen garden rose from 7 kg per household in 2016 to 22.5 kg per household in 2019. In the 148 villages where TARINA was engaged, there was a 20 percent increase in households adopting goat or poultry rearing or dairy production, which helped to boost their incomes. A 2019 survey revealed increases in the household-level availability and consumption of milk, eggs, or meat.

Seeing women's empowerment as a potent tool for the successful mitigation of malnutrition and for strengthening a nutrition-sensitive food sys-

tem, TARINA created or strengthened 448 women's self-help groups in its intervention districts, with an almost twofold increase in women's association with self-help groups. Increased involvement in self-help groups translated into increased participation in decision-making with regard to farming activities.

TARINA also mobilized hundreds of smallholder farmers and their families in Uttar Pradesh, as part of a farmer research network known as KISSAAN (*Kisan Sahyog Samoohik Anusandhan* Network), to develop and implement locally meaningful solutions to mycotoxin contamination. After the field implementation phase of the project, KISSAAN transitioned into a digital community space, in which farmers across several villages could

share insights and continue to build a community around their collective interests.

The on-the-ground success of TARINA's projects translated into policy changes at the state level. TARINA's practices for intensifying the production of pulses were adopted by 44 *Krishi Vigyan Kendras* (agricultural extension centers) in Bihar, while models of crop-specific women's collectivization, piloted under TARINA, were integrated into the Uttar Pradesh State Rural Livelihood Mission. TARINA's kitchen garden model is now used in 1,594 tribal residential schools in Odisha.

"TARINA brought about significant changes in people's behavior and practices around agricultural production, distribution, and consumption,"

Photo by Maureen Valentine/TCI



said Shubh Swain, who served as TARINA’s assistant director. “Those changes impacted entire communities, motivating state agencies to adopt and scale up several TARINA activities, ensuring that the program’s impact lives on.”

TCI also leveraged Cornell University’s engineering expertise to help build vital infrastructure in eastern India. In an effort to curb waterborne diseases that prevent proper nutrient absorption, the Institute partnered with AguaClara Reach, a nonprofit founded at Cornell, to build and install safe drinking water systems in villages in Jharkhand and Odisha. AguaClara’s sustainable filtration–disinfection systems have delivered piped, in-home drinking water to 2,500 people in villages in Jharkhand and Odisha at a cost of only \$1–2 per household per month.

AguaClara Reach continues to work in India today. “With TCI’s support of AguaClara Reach,

“While our long-term hope is that our research can bring about systemic improvements to food systems in India and throughout the developing world, we can have more immediate impacts in communities through our fieldwork.”

we have established a new partnership in India, which is leading to new innovations in sustainable water treatment,” AguaClara Reach Technical Director Monroe Weber-Shirk said.

Another TCI project, the Sustainable Flour Fortification Initiative (Sfurti), aimed to address micronutrient malnutrition and iron deficiency anemia

in India. The project provided an easy-to-use, home-based method of fortification for households that milled their own grain. TCI partnered with women’s collectives to sell Sfurti powder sachets—containing iron, folic acid, and vitamins A and B12—in Gujarat.

Sfurti resulted in an adoption rate of 70 percent in the 5,540 households in which the project was implemented. Participants reported reduced fatigue and increased energy after using the sachets, while researchers found a significant improvement in blood markers used to diagnose iron deficiency anemia.

“While our long-term hope is that our research can bring about systemic improvements to food

systems in India and throughout the developing world, we can have more immediate impacts in communities through our fieldwork,” TCI Director Prabhu Pingali said. “I am particularly proud that TCI projects, like TARINA and our partnership with AguaClara Reach, have made real, positive differences in many people’s lives.”

Photo courtesy of Shuli Varma/TCI



EXPANDING ACCESS TO DATA

TCI builds innovative data platforms to inform high-quality research and effective policymaking

High-quality research and effective policymaking both require access to robust, reliable data. This is especially true with regard to food systems. TCI has been leading the push for making such data accessible through two ongoing projects: the District-Level Database for Indian Agriculture and Allied Sectors and the Farmer Producer Organization (FPO) Platform for India.

A joint project between TCI and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the District-Level Database for Indian Agriculture features socioeconomic, environmental, nutrition, and health-related data for 571 districts in 20 Indian states from 1966–2017. The data are apportioned to account for changes in district boundaries, allowing researchers to look at the diversity in growth patterns across India

from a historical perspective. Altogether, the database includes 74 data sets, 1,030 variables, and more than 11 million data points.

The database has proven to be exceptionally useful for TCI researchers. Its data have been used for many of the Institute's publications, including its series of reports on *Food, Agriculture, and Nutrition in India*, which featured a map of India's cropping systems created using the District-Level Database.

TCI and ICRISAT researchers continue to work together to improve the District-Level Database by expanding data sets and exploring the use of innovative data-collection techniques, such as the use of remote sensing and high-resolution satellite imagery.



Photo by Dan Verderosa/TCI • Digital composite by DiggyFish Studio

While the District-Level Database presents comprehensive data on India's agricultural system, TCI's FPO Platform for India offers users a one-stop shop for information on India's FPO ecosystem. Created with the support of the Walmart Foundation, as part of the FPO Hub within TCI's Center of Excellence, the FPO Platform is the only centralized source of data on Indian FPOs currently available.

Through the interactive, web-based dashboard, researchers and other stakeholders can access a wealth of data on FPOs, such as crops produced, founding years, and sponsoring agencies. The flexible dashboard allows users to take a wide view of FPOs across states or dig deep into the attributes of individual FPOs.

Efforts are now underway to establish a data-sharing pipeline with major FPO stakeholders in India to ensure that all data on the platform are as current and comprehensive as possible. A new portal feature empowers FPOs to validate and update their own data, and can facilitate connections between FPOs, businesses, and other stakeholders.

“Access to high quality data is the lifeblood of rigorous research and evidence-based policymaking,” TCI Director Prabhu Pingali said. “Collecting data and making it widely available to all stakeholders, from academic researchers to policymakers, is key to both appraising food systems and setting priorities for research and investments to improve them.”

LOOKING AHEAD

TCI's second decade brings a focus on climate change and sustainable agriculture

In its first 10 years, TCI has built a solid footing for addressing malnutrition in India and beyond. TCI research has helped guide the conversation about malnutrition in India toward food systems-oriented solutions; its on-the-ground projects have built a foundational capacity for promoting nutrition-sensitive food systems; and its alumni are advancing this work in academia, private industry, and development organizations around the world. In the next decade, TCI will continue to build upon these successes through impactful, results-oriented research focused on the nexus between food, agriculture, and the environment.

The environment is an increasingly important part of food systems, especially in the developing world. As agricultural sectors are called upon to provide for growing populations, their carbon

footprints will expand at the same time that the world confronts the realities of a changing climate. Rising temperatures and more frequent extreme weather events, such as droughts, will put enormous stress on agricultural production.

With this reality in mind, TCI is poised to make climate change and sustainable agriculture a major focus of its research agenda.

"Climate change impacts virtually every area of study," TCI Director Prabhu Pingali said. "As researchers interested in improving nutrition outcomes and livelihoods in the developing world, we must account for the effects of a changing climate and do our part to help stop the rise in temperatures."

Already, new research projects are putting sustainability at the forefront of the Institute's work.



The most ambitious of these projects is Zero-Hunger, Zero-Carbon Food Systems, which aims to create a menu of policy options for reducing net agricultural greenhouse gas emissions in Bihar while improving productivity.

In addition to the focus on the environment, in the next decade, TCI hopes to grow the capacity for needed food systems transformations, not only in India but throughout the world. Similarly to how the Institute helped to build capacity for nutrition-sensitive agriculture in India through its TARINA program, TCI is now helping to build the capacity of national plant breeding programs across the globe as it leads the institutional capacity team of the USAID-funded Feed the Future Innovation Lab for Crop Improvement.

Centered at an elite academic institution, educating researchers and practitioners remains at the core of the Institute's mission. Each TCI alumnus who joins the academy in India or elsewhere contributes to a growing capacity for food systems innovation in a changing world. In the coming years, TCI's global network of alumni will amplify the Institute's impact and grow such capacity even further.

"From hunger and malnutrition to pollution and climate change, the world is facing a number of serious, seemingly intractable, long-term issues," Pingali said. "But we are making progress, and as TCI begins a second decade of work, I am confident that we will continue to move the needle in a positive direction."

PERSONNEL AND PARTNERS

STAFF

Dr. Prabhu Pingali, Director
Dr. Bhaskar Mittra, Associate Director
Dr. Mathew Abraham, Assistant Director
Ms. Brenda Daniels-Tibke, Administrator
Ms. Mary-Catherine French, Administrative Assistant (retired)
Mr. Manoj Kumar, Administrative Assistant
Ms. Terry Mingle, Administrative Assistant
Ms. Maya Nair, Administrative Assistant
Ms. Rajalakshmi Nirmal, Communications Specialist
Mr. Milorad Plavsic, Manager for Strategic Initiatives
Ms. Surekha Thakkar, Finance Assistant
Mr. Daniel Verderosa, Communications and Outreach Manager (Ithaca)

RESEARCH STAFF

Dr. Jocelyn Boiteau, Postdoctoral Associate
Mr. Bharath Chandran C., Consultant

Ms. Sage Grasso-Monroe, Research Support Specialist
Dr. Soumya Gupta, Research Economist
Mr. Ali Ilahi, Research Support Specialist
Mr. Naveen Sridhar Kottayil, Assistant Program Officer
Dr. Raghav Puri, Postdoctoral Associate
Dr. Andaleeb Rahman, Research Associate
Ms. Pallavi Rajkhowa, Postdoctoral Research Fellow
Ms. Payal Seth, Consultant
Dr. Greg Traxler, Research Fellow
Dr. Leslie Verteramo Chiu, Research Associate

TCI SCHOLARS

Mr. Whitman Barrett, PhD student, Soil and Crop Sciences
Ms. Shivranjani Baruah, PhD student, Plant Pathology and Plant Microbe Biology
Ms. Apurva Borar, PhD student, Applied Economics and Management
Mr. Tanuj Chawla, MPS student, Information Sciences
Ms. Kiera Crowley, PhD student, Soil and Crop Sciences
Ms. Shubhangi Gupta, PhD student,

Applied Economics and Management
Ms. Natasha Jha, PhD candidate, Applied Economics and Management
Ms. Ekta Joshi, PhD student, Applied Economics and Management
Ms. Annie Gurmeher Kaur, Applied Economics and Management
Ms. Sumedha Minocha, PhD student, Applied Economics and Management
Ms. Amrutha Jose Pampackal, PhD candidate, Development Sociology
Mr. Chanchal Pramanik, PhD student, Regional Science
Ms. Shree Saha, PhD student, Applied Economics and Management
Mr. Kasim Saiyyad, PhD student, Applied Economics and Management
Ms. Vanisha Sharma, PhD candidate, Applied Economics and Management
Ms. Anna David Thottappilly, PhD candidate, Applied Economics and Management

FACULTY FELLOWS

Dr. Mark Conostas, Charles H. Dyson School of Applied Economics and Management
Dr. Nagesh Gavirneni, Samuel Curtis Johnson Graduate School of Management
Dr. Andrew McDonald, School of Integrative Plant Science

Dr. Rebecca Nelson, School of Integrative Plant Science
Dr. Anil Netravali, College of Human Ecology
Dr. Harold van Es, School of Integrative Plant Science

ALUMNI

Dr. Anaka Aiyar, Postdoctoral Associate, Economics
Dr. Amit Anshumali, PhD, Development Sociology
Dr. Bindvi Arora, PhD, Food Science and Technology
Dr. Rohil Sahai Bhatnagar, PhD, Food Science and Technology
Dr. Jocelyn Boiteau, PhD, International Nutrition
Dr. Sunaina Dhingra, Postdoctoral Associate, Economics
Mr. Phil Frost, MS, Soil and Crop Sciences
Dr. Soumya Gupta, PhD, Applied Economics and Management
Mr. Anshuman Gupta, MPA, International Development Studies
Dr. Kavya Krishnan, PhD, Soil and Crop Sciences
Dr. Kathryn Merckel, PhD, International Nutrition
Dr. Sri Raj, Research Associate, Genetics

Dr. Vidya Bharathi Rajkumar, PhD, Applied Economics and Management
Dr. Tanvi Rao, PhD, Applied Economics and Management
Dr. Fatma Rekik, PhD, Soil and Crop Sciences
Ms. Karuna Salve, MPS, International Development
Dr. Asha Sharma, Postdoctoral Associate, Economics
Dr. Naveen Sunder, PhD, Economics
Dr. Shubh Swain, Research Associate, Demography
Dr. Maureen Valentine, PhD, Animal Science
Dr. Shiuli Vanaja, PhD, Applied Economics and Management
Dr. Vidya Vemireddy, PhD, Applied Economics and Management
Dr. Anthony Wenndt, PhD, Plant Pathology and Plant-Microbe Biology
Ms. Sonali Uppal, MPA, International Development

PARTNERS

AguaClara LLC
BAIF Development Research Foundation
CARE India
Delhi School of Economics

Grameen Development Services (GDS)
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
International Food Policy Research Institute (IFPRI)
Maharaja Sayajirao University of Baroda
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SERVICES

Managing Editor: Daniel Verderosa
Copy Editor: Patti Mason
Design: Bill Akunevicz Jr
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www.dragonfish.design

**TCI Headquarters**

375 Warren Hall
Department of Global Development
College of Agriculture and Life Sciences
Cornell University
Ithaca, NY 14853-7801

Phone: 607-255-4416
Email: tcj.cals@cornell.edu
Website: tcj.cornell.edu
Twitter: @tatacornell
Facebook: @tatacornellinstitute
Instagram: @tatacornellinstitute
LinkedIn: [linkedin.com/company/tata-cornell-institute](https://www.linkedin.com/company/tata-cornell-institute)

TCI Center of Excellence

E-5, Qutab Hotel Campus
Shaheed Jeet Singh Marg
New Delhi, India 110016