

TATA-CORNELL INSTITUTE 2016 ANNUAL REPORT



TATA-CORNELL INSTITUTE FOR
AGRICULTURE AND NUTRITION (TCI)

College of Agriculture and Life Sciences
Cornell University



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LETTER FROM THE DIRECTORS



We are delighted with the progress that TCI has made over the past four years in promoting a nutrition-sensitive food system in India. We are poised to make significant analytical and methodological contributions towards our understanding of the multi-dimensional nature of the nutrition problem in South Asia's largest country. TCI Scholars are showing that there is no trade-off between action-oriented research that addresses real problems and academic excellence. Our first Ph.D. graduate, Soumya Gupta, was recognized with the Paula Kantor Award for Excellence in Field Research, a wonderful testament to the high quality of academic life and scholarship that TCI provides even as we focus sharply on solving the problems of chronic malnutrition in India.

The TCI academic program has grown significantly over the past year. We now have 13 Ph.D. students from several departments across Cornell University. Our students and the program benefit enormously from the enthusiastic and dedicated support provided by our TCI Faculty Fellows. Our growing list of Faculty Fellows includes professors from Applied Economics, Soil Science, Plant Science, Animal Science, and other departments. We look forward to further expanding our reach across the campus,

especially with disciplines that have not traditionally focused on rural poverty and malnutrition.

We are also pleased with the expanding group of partners in India, which include both academic and non-governmental organizations. The Tata Institute of Social Sciences (TISS) continues to be the bulwark of support for all our field-based activities. TCI's success depends on maintaining its strong collaborative partnership with TISS. We plan to further enhance this partnership in the coming year by remotely linking TISS students to Cornell to participate in a semester-long course: "The Global Food, Energy, and Water Nexus – Engaging Students from the US, China, and India for a Sustainable Future" (Fall of 2017).

Late last year, TCI received a \$13.4 million grant from the Bill & Melinda Gates Foundation to provide "Technical Assistance and Research for Indian Nutrition and Agriculture" (TARINA). This grant enables TCI to scale up the promotion of a nutrition-sensitive food system across the lagging states of Bihar, Odisha, and Eastern Uttar Pradesh. Over the past year we set up an office for TARINA and a "Center of Excellence (CoE)" in New Delhi, recruited the Director of TARINA and the head of the CoE as well as other operational staff. The TARINA consortium has established action research and scaled up activities for promoting food system diversity through increased production as well as enhanced consumer demand for more nutritious food. We are excited about the contributions that TCI, working with the partners of the TARINA Consortium, can make towards establishing a more nutritious food system in India.

Let us end by thanking TCI and TARINA staff members in Ithaca, Mumbai, and New Delhi. We are fortunate to have such an outstanding and committed team of professionals working towards our common vision of a food- and nutrition-secure India.

Dr. Prabhu Pingali, Director
Dr. Bhaskar Mittra, Associate Director



TATA-CORNELL INSTITUTE RESEARCH TEAM

From left to right: Jessica Ames, Amit Anshumali, Jocelyn Boiteau, Prankur Gupta, Tanvi Rao, Anaka Aiyar, Rohil Bhatnagar, Anthony Wenndt, Prabhu Pingali, Katy Merckel, Naveen Sunder, Payal Seth, Vidya Bharathi Rajkumar, Megan Witwer, Andaleeb Rahman. Not pictured due to graduation: Phil Frost. Not pictured due to field work: Mathew Abraham, Soumya Gupta, Shiuli Vanaja, Maureen Valentine, Vidya Vemireddy.



OVERVIEW

OVERVIEW

The Tata-Cornell Institute for Agriculture and Nutrition (TCI) is a long-term research initiative based at Cornell University in Ithaca, NY and in our offices in Mumbai and New Delhi, India. With a multidisciplinary team consisting of applied economists; nutritionists; food, plant, soil and animal scientists; engineers; sociologists and more, we are working to create, test, and scale up sustainable and effective solutions to reduce poverty and improve malnutrition and livelihoods in rural India.

We uniquely combine field-based projects, academic research, and policy analysis to generate and share knowledge relevant to Indian policymakers, research institutions, and development agencies. Our institutional partners have deep field experience and extensive knowledge of the local context; by working together, we share our strengths, mutually build our capacity, and refine the quality of our joint projects. Founded in 2013 thanks to a generous gift from the Tata Trusts, we are well on our way to making meaningful discoveries and developing innovative technologies and policy solutions to address the agriculture–nutrition nexus in India.

Linking agriculture and nutrition: Pathways and solutions

While it is well understood that positive maternal and child health outcomes can be achieved through multiple pathways, TCI believes the pathways *linking* agriculture and nutrition can create the most profound and lasting impacts for health. Therefore, we have identified and oriented our applied research along four such pathways:

1. The **income pathway**, where gains in household income can translate to better food affordability and other positive impacts
2. The **food access pathway**, including a household's

access to sufficient, diverse, and quality food year-round

3. The **positive nutrition–behavior pathway**, where interventions attempt to equalize food allocation among individuals within a common household and optimize early childhood care practices
4. Nutrient absorption through improvements in the **health–environment pathway**, which links access to clean water and improved sanitation and hygiene practices to better nutritional health

TCI's research and projects in India consider the factors that influence both a *household's ability to access food*—such as income, employment and the ability to afford safe, high-quality, and diverse foods in sufficient quantities—and *an individual's ability to absorb and utilize* his or her share of the household's total nutrient/food basket, which could differ depending on the individual's age, gender, level of empowerment, household dynamics, cultural practices, or even physiological life stage (e.g., pregnancy and infancy require unique diets and care practices).

The income pathway and the food access pathway have the most direct connections to agriculture, given the dependency of the poor on these activities for income as well as their ability to influence the quality, quantity, and diversity of the overall food supply. Many TCI projects fall on these pathways and are featured in this year's annual report.

Income pathway & food access pathway

TCI Scholar Tanvi Rao completed an empirical analysis of the determinants of maternal nutrition and found that income had a greater effect on combating malnutrition in women relative than even increased home production of nutritious foods. With higher income, these women increased purchases of

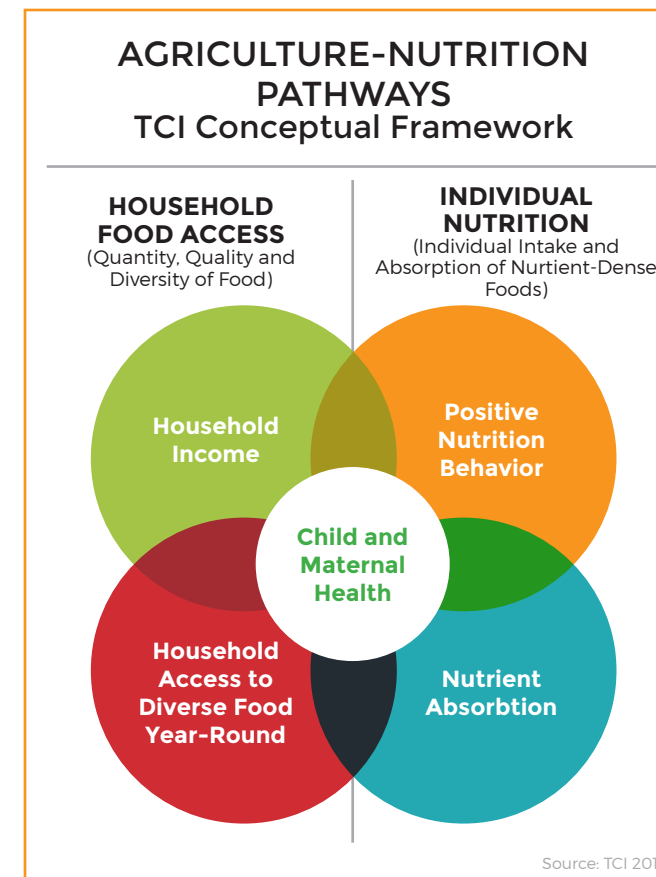


Figure 1: TCI Conceptual Framework

food, especially of protein and micronutrient-rich pulses.

We believe that greater availability of nutrient-rich foods such as lentils, split peas, and beans will be critical to improving nutrition outcomes. Demand is already rising for pulses, and TCI Postdoctoral Associate Mathew Abraham is analyzing what can be done to expand the supply. By addressing market failures and transactions costs along the pulse value

chain, producers can improve their incomes and rural and urban households will be better able to afford pulses. Encouraging the public policy transition away from staple grain fundamentalism and toward a more diversified food system will reduce micronutrient malnutrition as well as food and nutrition insecurity.

Livelihoods and nutrition will also improve when small producers can increase production efficiency. One strategy promoted among policy circles and non-governmental organizations (NGOs) is to invest in livestock programs, for example raising and tending small ruminants. To better inform this policy debate, TCI Scholar Maureen Valentine has spent 2016 investigating goat feeding systems in the tribal, forest areas in the state of Odisha. She is testing the idea that shifting from an extensive, open-grazing system to a semi-intensive system could increase animal feed efficiency and improve net income for farmers as animals grow more quickly and produce more milk, which will better support the health and development of offspring while also providing animal source foods for the family. While Maureen's survey data will not be analyzed until 2017, her first-hand interactions with farmers reveal that changing feeding practices and altering perceptions about what's healthy for a goat and for the common lands in a resource-limited environment is by no means easy and may reflect substantive challenges that lie ahead in the effort to achieve the sustainability of small ruminant programs.

Another area of research that explores trends that may impact the income and food access pathways is Dr. Asha Sharma's work on climate variability and agriculture production. According to her analysis, a delayed onset of the monsoon does not necessarily mean less agricultural production, but shortening the rainy season could reduce crop yields. Models also suggest that the worst effects of climate change will be on crops important to nutrition, such as coarse cereals, legumes, and oilseeds. Regardless of the climate model

considered, the effects will be negative for most crops, including rice, wheat, and maize.

In 2016, the TCI has also initiated a major project in Gujarat. The Sustainable Flour Fortification Initiative is designed to provide households with year-round access to micronutrients (the food supply pathway). Focusing on tribal communities and tapping into the social marketing potential of women's self-help groups (SHGs), the TCI along with partners BAIF, MS University of Baroda, and DSM have successfully piloted a program designed to be sustainable over the long term by empowering SHG members to sell sachets



of multiple-micronutrient powder and by generating consumer demand for such sachets. Beyond its role on the food supply pathway, this program exemplifies the TCI's positive nutrition-behavior pathway, as behavior change communication strategies have been essential to raising awareness and creating demand for this important solution to nutrient deficiency.

Positive nutrition-behavior pathway

The TCI has long recognized SHGs as an important vehicle for implementing social change, and we believe they can effectively nudge communities towards adopting positive nutrition behaviors. However, despite the vast number of SHGs across India, there is not a clear understanding of what makes one SHG more successful than another. As such, our research has endeavored to define the potential for "success" by creating a SHG Index. We are also analyzing the transformation process which occurs at the level of the individual (e.g., in terms of empowerment) for those community members choosing to participate in a SHG and the potential spillover effects of this transformation in the broader community.

We are also continuing our work on measuring women's empowerment, dietary diversity, and food choice through ongoing research. For example, TCI Postdoctoral Associate Soumya Gupta's dissertation research—for which she was awarded the inaugural Paula Kantor Award for Excellence in Field Research—examined the extent to which women's empowerment in rural communities of central India is influenced by agricultural management practices and how these practices, in turn, influence the quality of women's diets and their vulnerability to iron deficiency. This year, TCI Scholar Vidya Vemireddy returned to the same rural communities to continue TCI's data collection effort for the Women's Empowerment in Agriculture Index, and to focus on a new research question: How do women's time-allocation patterns in agriculture affect time-saving

food choices and nutrition outcomes? In partnership with ICRISAT, we have also continued our work with the Minimum Nutrition Dataset for Agriculture (MNDA) and Market-level Dietary Diversity (MLDD) methodologies (described in previous TCI Annual Reports), pairing that approach with an intensive 24-hour dietary recall to assess whether gender or adolescence is associated with differences in food allocation relative to the rest of the household.

Health-environment pathway

The TCI's work at the AguaClara water treatment plants in Jharkhand continues. On average, the AguaClara piped water system is supplying water to 60 households in each of the four treatment villages. Currently, TCI Scholar Shiuli Vanaja is completing her year of fieldwork to evaluate the potential time savings for women in these rural areas and to consider how their time might be alternatively allocated (e.g., to income-generating activities, improved child care practices) once piped water is introduced to a household.

Our work on food safety issues also falls on the health-environment pathway, as contaminated foods certainly harm nutritional health. Accordingly, we are analyzing the policy environment related to food safety regulations and the government agencies providing oversight and enforcement. We are also raising awareness and improving the knowledge base with regards to mycotoxin risk in the Indian food supply. Based on field research conducted by TCI Scholar Anthony Wenndt, the TCI has confirmed that there is substantial risk for village-level mycotoxin contamination across several agroecological and cultural contexts in India. We have found that such contamination, typically associated with maize and groundnuts, is also affecting sorghum, rice, and pulses. This evidence must lead to a shift in thinking about where food safety threats might exist and confirms the need to tailor mitigation approaches to specific food system contexts.

New initiatives

Finally, we are truly excited about our flagship project TARINA (Technical Assistance and Research for Indian Nutrition and Agriculture). Made possible by a generous grant from the Bill & Melinda Gates Foundation, the TCI is leading a consortium of partners to promote a food systems approach and scale up nutrition-sensitive agriculture interventions in Bihar, Odisha, and Uttar Pradesh. The four-year grant uniquely combines the research capacities of the TCI, Cornell University, Emory University, the International Food Policy Research Institute (IFPRI), and the Tata Institute of Social Sciences (TISS) with the technical capacities of leading NGOs and development partners—BAIF Development Research Foundation, CARE India, Grameen Development Services (GDS), and Tata Trusts. Together, we are translating our extensive research and deep field knowledge into an actionable policy agenda to tackle the complex problem of malnutrition in India.

We have also begun our analysis of the third pillar of the triple burden of malnutrition: the rising trend in the incidence of overweight and obesity across the Indian population. While stunting, wasting, and micronutrient deficiencies remain core priorities, we—like all policymakers, researchers, and development practitioners in countries undergoing this nutrition transition—must dedicate more of our thinking to how we can tackle the obesogenic environment in cities, associated changes in the food system, and shifts in individual consumer preferences (e.g., for convenience foods and eating out), which are likely driving the rise in diabetes, cardiovascular disease, and other non-communicable diseases. Addressing the triple burden of malnutrition should be part of India's strategy as it strives for zero hunger and the end to malnutrition in all its forms, and we believe implementing reforms across the food system will be decisive in eliminating the food and nutrition insecurity that affects nearly half of all Indians.



**2016
RESEARCH
HIGHLIGHTS**

DETERMINANTS OF MATERNAL NUTRITION OUTCOMES IN INDIA: EMPIRICAL EVIDENCE ON THE ROLE OF AGRICULTURE

An alleged relationship between agricultural production and nutritional improvements of household members is often used to motivate investments in agricultural productivity. Yet, we have little rigorous evidence, especially in the Indian context, to confirm that this link indeed exists at the level of the household. The problem stems in part from the lack of suitable data. India's National Family & Health Survey (NFHS), which collects anthropometric data, last released complete unit data in 2005 and does not collect income or agriculture data. Unfortunately, the lack of geographic identifiers in the 2005 NFHS makes it impossible to

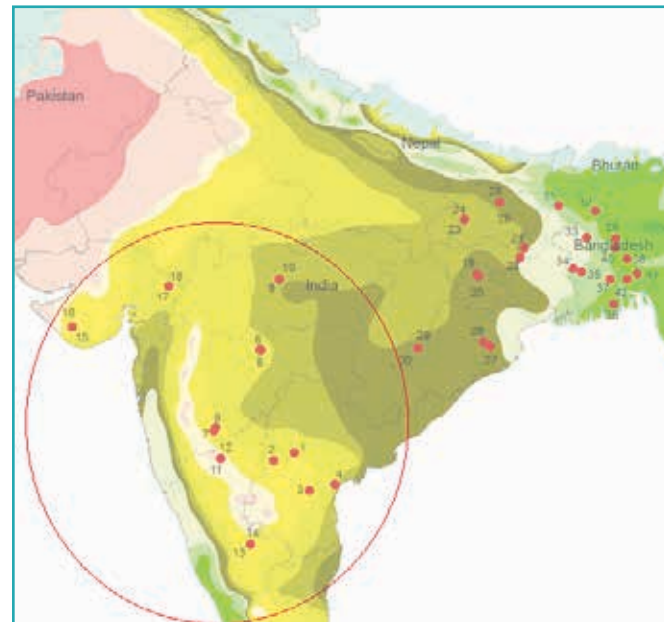


Figure 2: Source: ICRISAT

conduct an analysis aggregated at a higher level, for instance at the district level, for India. As a result, anthropometric data cannot be linked to district-level data on agricultural production.

In 2015-2016, TCI decided to address this gap. As there are no nationally representative data available, to explore the agricultural production-nutrition link we turned to another rich but underutilized dataset—ICRISAT's household panel data,¹ collected as part of its Village Dynamics in South Asia (VDSA) program. While traditionally a dataset focused on agriculture, in 2010 the VDSA also began yearly collection of anthropometric data on all household members. Therefore, the data represent a unique source of agriculture, income, consumption, and anthropometric data that follow the same smallholder farming households year after year.

We investigate whether or not increases in agricultural production at the household level are associated with improvements in the Body Mass Index (BMI) of women of child-bearing age (15-49 years) in the household. This work, currently under peer review, is titled “*Determinants of maternal nutrition outcomes in India: Empirical evidence on the role of agriculture.*” We use five years of household- and individual-level panel data collected between 2009 and 2013. The data are drawn from 18 villages across five Indian states: Andhra Pradesh/Telangana, Gujarat, Karnataka, Maharashtra, and Madhya Pradesh. (As noted in Figure 2, our analysis is based on data from the 18 encircled village locations. We do not use data from east India or Bangladesh in this paper because of the limited availability of anthropometrics in these data. The total number of individuals with valid BMI data in the sample varies from year to year, ranging between 791 and 992 individuals. We also overlay our sample villages with rainfall data, which we obtain from the University of Delaware Air Temperature and Precipitation database.

We chose maternal BMI as the central indicator of nutrition at the household level because Indian women are at particular risk of being underweight. Here, underweight is defined as having BMI less than 18.5. This risk is particularly heightened for younger women (15-25 years old), among whom fertility in the country is largely concentrated. In our sample, 33% of all women between 15 and 49 years old are underweight (Figure 3). This number is worryingly high. Moreover, the incidence of underweight for younger women is more than 13% higher. Maternal undernutrition contributes to fetal growth restriction, which increases the risk of neonatal death and, for surviving children, stunting (the condition in which a child is too short for his/her age).

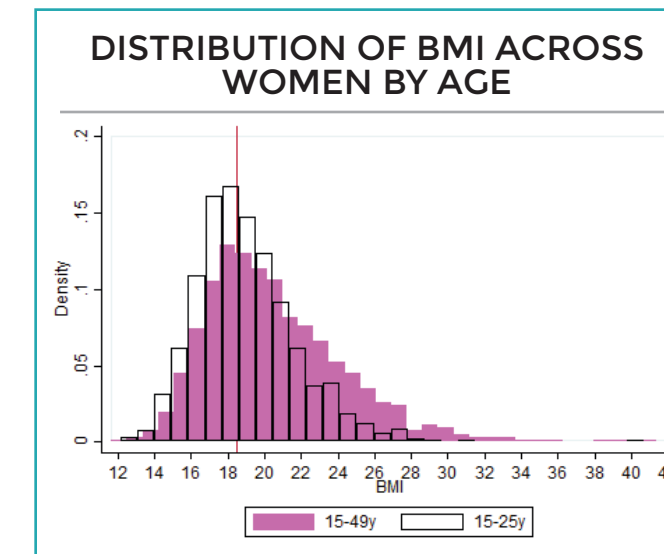


Figure 3

Therefore, these figures are not only troubling for the current generation but also disconcerting because they imply strong inter-generational effects.

We have two main reasons to believe that income from agriculture might be particularly pertinent to the nutritional status of women. First, income from farming

is the single largest source of income in our sample and, on average, accounts for around a third of all income earned by Indian households. Second, agriculture is an important source of income for women. While a majority of both non-agricultural and agricultural income accrues to men, the proportion of income accruing to women is nearly two times as great in farming as it is in non-agricultural sectors.

PUBLICATION ALERT



Prabhu Pingali and Tanvi Rao.
“Understanding the multi-dimensional nature of the malnutrition problem in India.” Chapter in *Agriculture and Rural Development in a Globalizing World*, edited by Prabhu Pingali and Gershon Feder. (Routledge Press, 2017). (In Press)

Empirically, we test for the effect of agricultural production, measured as Gross Value of Output per Acre (GVO/acre), on maternal BMI, in an “individual fixed effects” model. This econometric model accounts for time-invariant or “fixed” differences between individuals, exploiting only variation that exists for a given individual over time. Therefore, factors that do not change with time, e.g., individuals’ “castes,” are not potential confounders for our estimates. We might be worried, of course, that other factors that co-move with agricultural production on a year-to-year basis might confound our estimates. To mitigate such concerns, we control for a host of time-varying variables in our model, including income from other sources as well as village-level rainfall. Village-level rainfall undoubtedly affects agricultural productivity and also likely affects nutrition outcomes via altering the individual’s disease environment, and is therefore an important control. We estimate both a short-term specification and a

SCHOLAR SPOTLIGHT

Tanvi Rao, TCI Scholar and Ph.D. candidate, Applied Economics and Management



I am an applied microeconomist interested in researching institutions and interventions that help individuals better invest in their human capital. Currently, my work spans two areas of human capital research—post-secondary education access as well as health and nutrition—with

a geographic focus on India. My dissertation research as a TCI Scholar involved collecting primary survey and experimental data from high-school students in Jharkhand to understand the extent to which biased beliefs about post-secondary returns and costs might be barriers to students' college-going decisions. In my work on nutrition in India, I use detailed panel data, collected by ICRISAT, to investigate agriculture and nutrition linkages at the household level. Some of my other work involves developing a narrative synthesis of the existing malnutrition literature in India, focusing on papers that measure effects on an anthropometric scale and a quasi-experimental evaluation of India's flagship community health-worker program, the Accredited Social Health Activist or ASHA worker program.



long-term specification of our model. The short-term specification measures the extent to which, on a year-to-year basis, changes in maternal BMI are associated with changes in agricultural output. However, if from one year to another, agricultural output first increases and then decreases over a period of two or three years, the net effect of agricultural output on BMI might be zero. Therefore, the long-term specification smooths year-to-year fluctuations and shows how the growth rates of the two variables are associated with each other over the full period of the sample.

Over the longer term, and for the group of households that regularly farm, we find a 10 percentage point rise in agriculture income to be statistically associated with a 0.15 percentage point rise in BMI. Consistent with findings reported in the literature, this effect is economically modest but important considering that we do not find a corresponding effect for growth in non-agricultural income.

In additional analysis, we also present evidence to suggest that the own-production of food is not as important a pathway for nutritional improvements as the income effect. We find that increases in agricultural income stem primarily from increased purchase of food, specifically of protein-rich pulses. Finally, we show exceptionally stronger effects of increases in agricultural production for younger women. All in all, our results provide strong affirmation of the utility of pursuing an agricultural growth strategy to address malnutrition in women.

AGUACLARA CLEAN DRINKING WATER SYSTEMS IN JHARKHAND

Jharkhand, an eastern state of India, suffers from inadequate access to good quality drinking water,

especially in rural areas. According to the Jharkhand state government, about 30% of households have some facilities for accessing drinking water, but not all have drinking water. In the absence of on-premises access to household water, family members must travel some distance to fetch water for household purposes. The time spent collecting water by household members (typically women) is time not spent pursuing other market and home production labor activities. Therefore, TCI is analyzing the effect that access to AguaClara piped water systems has on time spent by women collecting water to understand how they use the time saved.

In 2014, with the support of TCI and NGO-partner Professional Assistance for Development Action (PRADAN), AguaClara started treatment-based piped water schemes in four Jharkhand villages. By December 2015, the chemical doser-based piped water systems had completed two years of operation in two villages of Koderma district, Jhoklakarma and Durguniya. By the same time, in the Khunti district, the villages of Rohne and Gufu were celebrating one year of operation of an AguaClara piped water system that includes filters along with chemical dosers. Details on the AguaClara work in Jharkhand can be found in TCI Annual Reports from 2014 and 2015.

On average, AguaClara piped water systems supply water to 60 households in each of these villages. Each household pays 60 rupees (or less than \$1) a month for access to piped water at home.

To evaluate the impact of this project, survey data are being collected from three treatment villages and three control villages in Jharkhand. The treatment villages are the abovementioned Gufu in Khunti district and Jhoklakarma and Durguniya in Koderma district. (A set of three villages of similar socio-economic structures to these AguaClara villages were chosen in nearby regions to serve as control villages.)

In each of these villages, TCI is conducting a census survey (covering all households that were in each village at the time of the survey). Led by TCI Scholar Shiuli Vanaja, our team is interviewing female household members between 15 and 45 years of age as household representatives and gathering 24-hour recall reports on their use of time. We are also collecting data on water usage and community-level infrastructure in the sample villages.



We began surveying AguaClara villages and their control villages in January 2016. The first round of surveys was finished by May 2016 and the second round of data collection is underway. The objective behind collecting data over multiple seasons is to control for the effect of seasonality in terms of both water source availability and women's labor time-use patterns.

The potential time savings brought by piped water offers women many alternative activities to pursue, such as household chores, caring for children, market-based labor work, agricultural work on their own farms, and community work. Significant time savings for these women reflects the potential of piped water to change the lives of women in rural areas in innumerable ways by providing more income, more leisure time, and/or more autonomy inside the home.

SUSTAINABLE FLOUR FORTIFICATION INITIATIVE IN GUJARAT: SFURTI FOR A HEALTHIER LIFE

Although Gujarat has been among the best-performing states in India economically, it has struggled regarding social development parameters such as the health and nutrition status of women and children. A periodic study conducted by the Government of India, National Family Health Survey-3, found that in Gujarat anemia was prevalent among 55% of women and 80% of children under 3, while 45% of children under 5 were underweight. Vitamin A deficiency has been high in the Indian population in general, while vitamin B12 deficiency is high among the vegetarian-eating population. This was the backdrop for the launch of the Sustainable Flour Fortification Initiative (SFurtI).

The objective of SFurtI is to improve the nutritional status of tribal communities through a sustainably managed program run by the women's collectives themselves. This initiative has been launched in 15 tribal villages in the Songadh block of Tapi district, covering about 5,500 households. Four vital micronutrients—iron, folic acid, vitamin A, and vitamin B12—are served in powder form in packets weighing 1.25 gm (adequate for 5 kg of wheat/rice/millet flour) and is being sold at Rs.3, a price determined by the community. This program is being implemented through the Women's Federation with technical assistance from TCI, BAIF Development Research Foundation, Maharaja Sayajirao (MS) University of Baroda, and DSM.

The inhabitants of project villages belong mostly to such tribal groups as the Gamit, Kotwaliya, Chaudhary, Kokni, and Kathod, and therefore have their own socio-economic and cultural practices. To better understand project villages and their communities,

a rapid situational survey was conducted to capture socioeconomic, dietary, and basic anthropometric data from select villages. The study identified several important issues pertaining to culture and food habits that were then taken into consideration while designing the project.

Once the team had gained a fair understanding of the various communities under study it initiated dialogues with government departments and key stakeholders from the villages. Insofar as nutrition is not a felt need in these communities, multiple dialogue sessions were required to convince key stakeholders of the benefits of the program. Field level workers who were designated by the communities themselves were provided with classroom and field-level training on their roles and responsibilities, including stakeholder coordination, awareness generation, household visits, sales pitches, record-keeping, accounts-keeping, etc. Village-level government actors such as ASHA workers,



Anganwadi workers, and teachers were also brought in for awareness generation in the villages and were immensely helpful in building credibility for the project.

The community interacted with Paperboat, a well-known consulting firm, in developing campaign strategies and designing the awareness material. This material was pre-tested in the project villages to ensure the context specificity, relevance, and recall value of the campaign. A total of twelve awareness materials were designed in local languages and used during the campaign. Materials were also handed over to village-level workers to use during house-to-house sales pitches.

The product and the awareness campaign were formally launched on June 17, 2016. During the first phase of the campaign, which ended on July 6, 2016, the team travelled to each project village and conducted mass meetings to discuss the project, the product and its benefits, points of sale in the village, etc. Mixing and

cooking demonstrations were also organized to provide a better understanding of the use of the product. Subsequently, a second awareness campaign was also carried out to reach out to far-flung hamlets beyond the villages and to connect with households that had been left out. A Management Information System developed specifically for the purpose is helping the project team keep track of sales numbers, consumers, new consumers, repeat consumers, etc. A team from MS University is tracking biochemical and clinical parameters to document the health benefits of this program.

A felicitation event was organized on October 7, 2016 in one of the project villages under the guidance of the Collector of Tapi district, with representation from district health and education departments, partner organizations, and village-level stakeholders. Almost 900 women members and consumers of SFurtI from project villages attended the event. The highlight was the recognition of key village-level stakeholders who are helping to build awareness of the product among consumers. The event also served to inform government officials on the status of work and progress so far as well as to encourage women, who are the most important stakeholders in the program.

The initial results of the SFurtI program have kept the team motivated. The project is now focusing on retaining the current consumer base while expanding its reach among those who have been most difficult to connect with so far. Communications strategies are being reviewed and village-level outreach is being strengthened to expand the consumer base. The project team hopes that this pilot will go a long way toward improving the nutritional status of the rural poor in a self-sustainable manner.

EFFECT OF CLIMATE VARIABILITY AND CHANGE ON AGRICULTURE

The challenges India faces in tackling malnutrition are complicated further by the vulnerability of its agriculture to climate variability and change. By improving our understanding of how the climate affects agriculture, we can better address maternal and child nutrition in India. Dr. Asha Sharma's research as a TCI postdoctoral associate sought to shed light on these climate-agriculture-nutrition pathways. Her research shows that, while the climate does not affect agriculture in some of the ways we assume it does, we are not paying enough attention to other ways in which climate change can negatively affect agriculture.

A delayed rainy season does not necessarily mean less agricultural production

The onset of the monsoon captures the Indian imagination every summer, with extensive news coverage given to the progression of the monsoon. It is widely assumed that a delayed start to the rainy season results in poor crop yields, yet no studies confirm this. Using production data for ten crops as well as rainfall and temperature data from the 1970s into the 2000s, we tested this assumption using statistical models. We found that it was the length of the rainy season, rather than its onset, that was important to crop yields. Thus a rainy season that is a few days late is not much cause for worry, but a much greater delay in onset that is likely to shorten the rainy season could reduce crop yields. We also found that rice and cotton farmers in districts with lower levels of irrigation (who are therefore more likely to be poorer) were likely to experience a decline in yields due to a shortened rainy season (Figure 4).

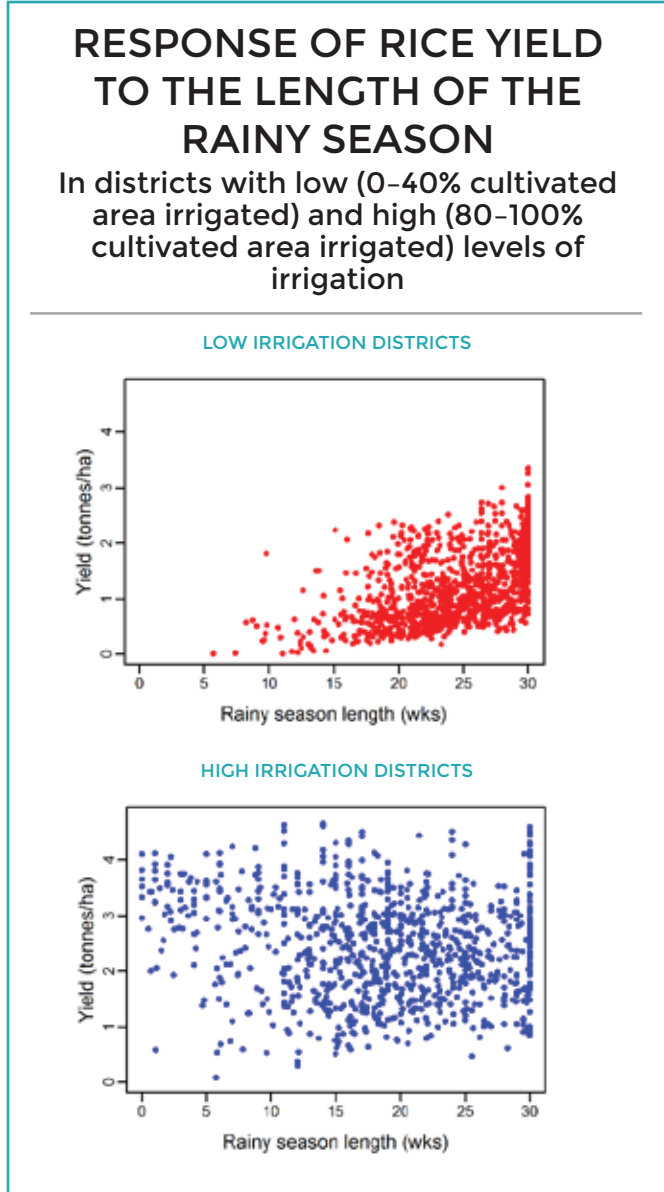


Figure 4

However, farmers in districts with greater access to irrigation and inputs were better able to smooth production.

Some of the worst effects of climate change will be on crops important to nutrition

Rice and wheat account for half the calories consumed by Indians. The dominance of these crops in Indian diets is also reflected in their dominance in climate change impact studies. Unfortunately, this means that other crops, which together account for a large proportion of calories consumed as well as important nutrients and micronutrients, are largely ignored in climate change assessments. This should be all the more alarming because many of these crops, such as the coarse cereals sorghum and millets, are important to the diets of poorer Indians.

Using statistical models, we studied the projected impacts for the year 2050 in seventeen climate models on the seventeen major Indian crops for which there are long-term data. We found that under both moderate (Representative Concentration Pathway, or RCP 4.5) and high (RCP 8.5) greenhouse gas emissions scenarios, rice and wheat are relatively less severely affected than many other crops that are important for nutrition. The crops expected to be affected most severely by climate change included coarse cereals, legumes, and oilseeds (Figure 5). Some of these crops are promoted as being more tolerant of harsher climates, so what is going on?

The source of the vulnerability is that the crops affected most severely are not necessarily the most sensitive to climate, but are grown in climatically marginal regions. Climate change only worsens the already hot and dry conditions in these regions. Combined with the fact that no part of India will experience an improved growing climate in the future, this implies that even if the crops

FUTURE CHANGES IN YIELDS (YEAR 2050, "MODERATE" RCP OF 4.5)	
Large Decrease	Maize, high irrigation; Safflower*
Moderate Decrease	Rice, high irrigation; Pearl millet; Cotton, high irrigation; Wheat, low irrigation; Wheat, high irrigation; Barley, high irrigation; Sorghum*; Rapeseed/mustard, high irrigation; Maize, low irrigation*; Sesame*; Barley, low irrigation*; Chickpea*
Little Change	Cotton, low irrigation; Finger millet*; Soybean*
Moderate Increase	Rice, low irrigation; Castor; Pigeon pea*; Groundnut*; Linseed*; Rapeseed/mustard, low irrigation*
Large Increase	-

* Low statistical confidence

Figure 5

currently grown in these regions are shifted elsewhere, there will be less climatically attractive land with which to feed more people. Moreover, alternative sources of livelihood will need to be found for those living on these marginal lands.

Regardless of the climate model considered, the effects will be negative for most crops. At the same time, the extent to which crops will be affected varies more widely depending on the climate models chosen than due to emissions scenarios.

This is sobering news because we do not know which climate models best represent the future climate for our regions of interest. However, it also means that policymakers can start planning climate adaptation strategies now without being overly concerned about wasted resources should the world go down a lower emissions pathway.

Implications

These studies together show that historical data can be very useful in helping us plan for future climate challenges. The maintenance and improvement of agricultural and climate data collection leads to long-term benefits that dwarf the costs. Researchers, extension workers, and policymakers must not ignore crops that are important to the nutrition of rural Indians, especially since it appears many of these crops may be among the most severely affected by climate change. Finally, we see hardly any benefit to Indian agriculture from climate change. While some crops may experience slight benefits, it seems clear that the majority will not. Thus, rather than bolstering merely rice and wheat, investments that increase the climate resilience of all crops ultimately will generate better returns for Indian livelihoods and nutrition.

RESEARCHER SPOTLIGHT

Dr. Mathew Abraham, Postdoctoral Associate

I joined the TCI team in August 2015 after earning my Ph.D. from the Department of International Economics and Management, Copenhagen Business School. My background is in public policy research with a focus on agriculture and development, and my research interests are in agricultural markets and value chains, institutional innovations for rural development, and social entrepreneurship.



At TCI, I was part of the TARINA Food Systems Diagnostic Survey team visiting Bihar, Odisha, and

eastern Uttar Pradesh to identify and design food system interventions. The issue of supply constraints in pulses and the food security implications of this shortage in a country where affordable proteins is crucial inspired me to look at the issue of pulse production in India from the supply perspective.

In my work, I seek to identify various transaction costs and market failures in the marketing of pulses to identify the major price factors that may disincentivize their cultivation. Having mapped both the regional and international value chain for pulses, I am now assessing a range of interventions along the pulse value chain that can streamline marketing—an effort I am currently undertaking in the field from November 2016 through early 2017.

On the whole, my work at TCI brings together scholarship, project intervention, and dissemination of research to inform and influence policy. This experience has been invaluable to me professionally and also in motivating me to seek solutions to pressing food security concerns from the holistic perspective of food systems.

IMPROVING THE PULSES SUPPLY TO ADDRESS MICRONUTRIENT MALNUTRITION

In India pulses such as pigeon peas, chickpeas, green gram, red gram, and lentils are the most important sources of dietary protein, fiber, amino acids, and vitamins. As an inexpensive, non-animal source of protein and micronutrients, pulses figure prominently in Indian diets, and therefore India is currently the largest producer, consumer, and importer of pulses in the world. Demand for pulses in India has grown due to the rising population and increases in per capita income. However, since the 1960s there has been only a marginal increase in the yields of various pulses and the acreage under pulse cultivation has marginally decreased. This supply constraint in pulses has increased price volatility and reduced availability from 60-66 grams per capita per day to 31 grams in 2005. Since 2006, India has been looking at imports to tackle the shortage of pulses in the country. Imports improved the per capita availability of pulses to 47 grams per capita per day in 2014, but have had limited impact on reining in prices in domestic markets.

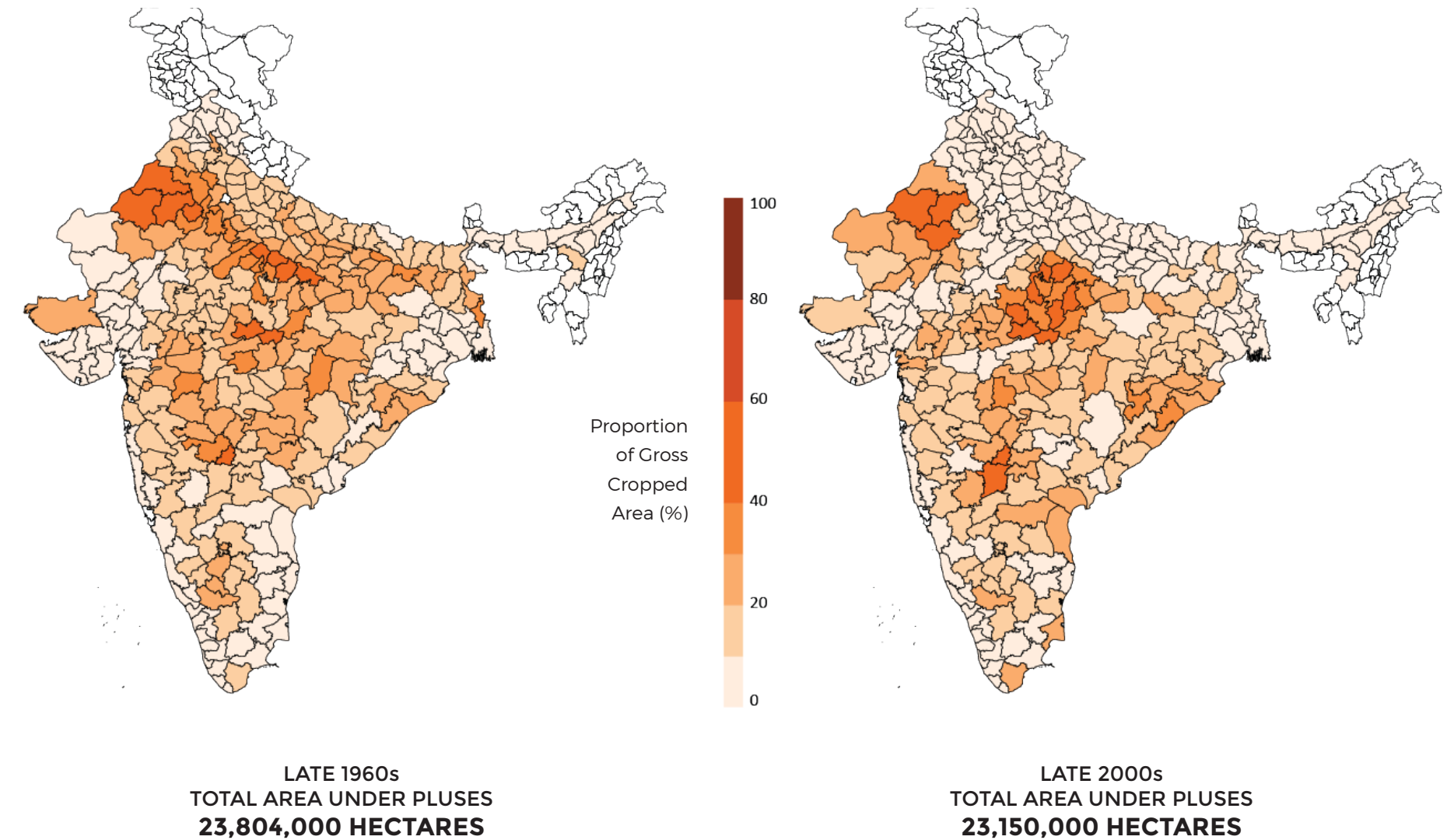
A mixture of price and non-price factors that have disincentivized the growing of pulses are mainly responsible for poor supply response. Policy and institutional support for cereals has had a major influence on the patterns of pulse cultivation in India. The inelastic supply of land and the limited availability of irrigation facilities have lowered the priority of pulses and more productive lands have been utilized to grow cereals. The absence of research and development (R&D) for seed development as well as poor technical support for pulses in comparison with cereals have also reduced their prominence. These non-price factors have determined farm-level incentives to grow pulses but,

despite increasing prices, they have not led to increased adoption. At the market level, high transaction costs due to low marketable surplus, fragmented market structure, poor information about price and quality, and the oligopsonistic power of large traders have led to poor price realization for small producers.

In recent years, imports have become an important source of increased availability of pulses in the country. India produced 17 million tons of pulses while importing 5.1 million tons in 2015-16, the highest volume of imported pulses to date. However, over the long run, increasing domestic production remains crucial to improving the availability of pulses in India.

TCI has therefore made the study of pulses a top priority on its agenda. Mathew Abraham, a postdoctoral associate at the Institute, has been focusing his research on the pulses value chain. In early 2016, he traced the journey of pulses from farm to retailer by visiting small farms, traveling with aggregators to markets, and conducting key-informant interviews with millers and retailers. With this active research in the field combined with desk analysis and review of the literature, the study assessed the major challenges in the marketing of pulses. We have identified the various forms of transaction costs and market failures that have led to poor price realization in the markets. Addressing market failures and transaction costs in the pulse value chain is important for incentivizing pulse cultivation. We are now considering potential interventions, such as aggregation models (e.g., producer groups) and vertically coordinated private value chains to tackle issues such as low marketable surplus, weak bargaining power, and price realization and information problems. Dr. Abraham returned to India in November 2016 for three months of field work to observe interventions such as producer organizations and private sector participation and their influence on price factors and improving incentives in pulse adoption.

CHANGING AGRICULTURAL LANDSCAPES IN INDIA Pulses cultivation decreases over the last 40 years



Data source: Govt of India - Agricultural Statistics;
1970 district boundaries



We believe more broadly that it is critical, at the policy level, to depart from a cereal-based focus to promote R&D in pulses, improve rural infrastructure (especially access to irrigation), and provide technical support for better agronomic practices to respond to non-price factors affecting pulse cultivation. Through TCI's work in the TARINA project, in collaboration with partners such as International Food Policy Research Institute (IFPRI), we aim to recommend implementable solutions to policymakers that can potentially diminish supply constraints affecting pulses. We believe working in this area is timely and relevant to designing interventions that address the issue of micronutrient malnutrition. Increasing the supply response of pulses to meet growing demand is central to ensuring food and nutrition security in India.

SUSTAINABLE LIVESTOCK FEEDING SYSTEMS IN THE FACE OF INTENSIFYING GOAT PRODUCTION

India's goat sector is constrained by feed shortages because of limited fodder cultivation, insufficient crop residues, and dependence on common property resources that are small in size and increasingly degraded in terms of vegetative and soil quality. Increasing human and livestock populations amplify land pressure, which result in decreased availability and productivity of grazing land.

Experts and policymakers generally consider intensifying goat production as a solution to issues caused by open grazing. TCI anticipates environmental benefits and higher farmer incomes by replacing large populations of openly grazed, under-producing goats with fewer, more productive, stall-fed animals. Unfortunately, few studies have been conducted on farms to quantify the effects that feeding system changes would have on smallholder farmers.

This research addresses degradation of common property resources by experimenting with a recommendation by policymakers and animal agricultural groups to support a transition to more intensive goat production systems. TCI's effort in this area is led by TCI Scholar Maureen Valentine. Supporting farmers' shift from an extensive open grazing system to a semi-intensive system could relieve pressure on common lands and provide ecosystem service benefits. We expect that intensification will increase animal feed efficiency and improve net income for farmers as animals grow more quickly and produce more milk, which will better support the health and development of their offspring while also providing animal source foods.

Our main objective in this effort has been to develop a richer understanding of how rural farmers could convert to a more tightly confined feeding system that depends less on open grazing of forest resources. We view this project as a pilot that could validate software that originated at Cornell, the Small Ruminant

Nutrition System, for predicting dry matter intake of local, tropical goats in India, and a proof-of-concept that could validate a methodology for data collection from grazing goats.

To meet these goals, we have been collecting data that will estimate the dry matter intake of goats in various feeding groups, evaluating goat health within these groups, and tracking farmers' characteristics and opinions of the project throughout.

Field work began in May 2016 in Kandhamal District, Odisha. We selected two tribal villages in the Tikabali Block in which to initiate the goat feeding study. Sixteen farmer households were randomly selected, and half of the farmers were tasked with feeding their goats in a semi-intensive stall-feeding scenario. Feed was provided by the project. The eight remaining households act as a control and continue their traditional goat feeding practices. We have completed sampling in three seasons: summer, rainy, and winter. During each season we have conducted surveys in each of the 16 households, conducted regular focus groups, recorded observations of goat feeding behaviors, weighed more than 200 goats monthly, collected forage samples of the most commonly consumed forages, had those forage samples identified by botanists, analyzed forage samples for nutritional components, and taken fecal samples to estimate fecal output and parasite load.

Lab analyses are underway, but survey findings and researcher experiences have shown the challenges involved in implementing stall feeding in tribal regions. We have met with much opposition regarding modifications to daily scheduling, views about what is healthy for goats, ideas about goats' mental wellbeing with less browsing, the logistics of how to deliver feed to households, etc. Still, all farmers participating have complied with the study and are feeding their goats accordingly on a daily basis.

Local findings have been consistent with the national story regarding changes in forest resources and goat populations. Farmers reported in both villages that more than half of their grazing lands have been converted to agricultural lands in the last 10-20 years while the livestock population has steadily increased due to market demand. Even with this alarming trend, and acknowledgement that the goats are less healthy because of reduced forage availability, farmers made it clear that they will not consider their livestock production system to be problematic until the forest is gone.



From the government side, the District Divisional Forest Officer explained that the forest department does not systematically evaluate the effects of grazing on forests, and only when nationally aggregated satellite data shows a forest has been reduced to less than 40 percent canopy cover would the department know there was any problem and consider the land degraded. Local forest reduction and lack of oversight of land changes reinforce the need for more research on this topic. Solutions for reducing land pressure, coupled with better data for evaluation, will help to build more sustainable solutions for these communities that depend heavily on forest resources.

SCHOLAR SPOTLIGHT

Maureen Valentine, TCI Scholar and Ph.D. Candidate, Animal Science

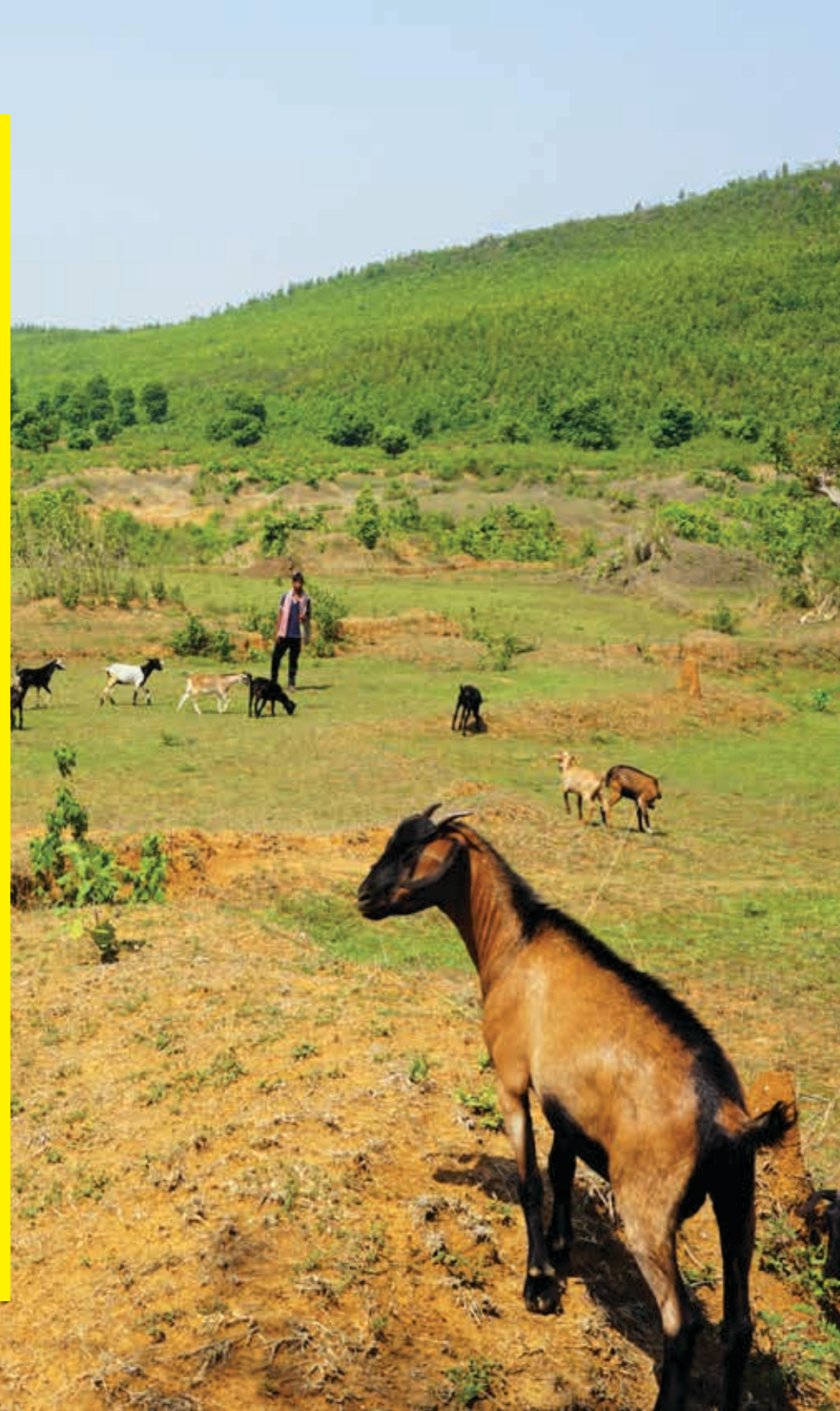
Livestock is a critical component of the complicated



story explaining rural livelihoods in India. As human and livestock populations increase rapidly, we must consider the impacts of livestock on already taxed land, and potential options for sustainable intensification. My background in animal science and international agriculture has prepared me to address a topic

that is at times overlooked in discussions about rural agriculture and food security.

I have been in India since February 2016 for my one year of field work as a TCI Scholar and plan to return to the U.S. in early 2017. I have established a goat feeding experiment in Kandhamal District of Odisha in two tribal villages with about 200 goats. We are providing feed to half of the goats, and the other half are remaining in their traditional grazing system. Across three seasons, we are measuring a number of variables to gauge the impact of this feeding system on local goats, and the potential adoption by rural, tribal farmers of a more intensive system. This year has been both challenging and rewarding, and I look forward to returning to Cornell with regular Internet access and quiet spaces to tease through all my data and communicate my findings to a larger audience.



We are interested in seeing the final analyses comparing changes in goat populations within these different livestock systems, and to derive potential implications for goat feeding in rural, tribal areas of Odisha. We will communicate our findings with partners implementing livestock programs and government agencies shaping small ruminant livestock policy to contribute to decision-makers' thoughts about what they consider to be a 'sustainable livestock feeding system'.

SOIL HEALTH TOOLKIT: DEVELOPING A MULTI-FACETED TESTING PLATFORM

The TCI Soil Health Project focuses on soil health enhancement to improve agricultural productivity, reduce malnutrition, and enhance the rural environment. During 2015, 133 soil samples were taken from 29 catchments in Jharkhand, India, including crop fields and natural areas. Samples were taken from four distinct landscape positions (or micro-watershed areas).



1. Uncultivated land: located on the upper boundary ridges of the micro-watershed characterized by forest areas or large trees that indicated no cultivation had taken place for some time, if ever.
2. Upland: cultivated fields adjacent but lower in the

watershed to the uncultivated land, non-terraced or banded.

3. Middle-upland: adjacent to upland, lower in the watershed profile, banded or terraced fields that are seasonally or perennially wet.
4. Lowland: lowest profile of the banded or terraced fields, seasonally or perennially wet.

Despite a homogeneous agricultural system (paddy rice), analysis conducted in 2016 by TCI Scholar Phil Frost shows higher values of particular soil health indicators in some districts and landscapes. This variance could be due to differences in soil type, farmer economic capacity, and/or heterogeneous management practices—all factors that could influence soil health.

Using the Comprehensive Assessment of Soil Health methodology developed at Cornell's School of Integrative Plant Science, the TCI team evaluated agronomically important soil functions (including physical, biological, and chemical properties) and calculated a soil health score for each sample based on the standard local context of Jharkhand.

Overall, the current state of soil health in Jharkhand reflects a challenging environment with biologically poor, nutrient—deficient, mono-cropped, anthropogenic soil that—with management changes—could become more productive and supply health benefits and nutrition to those who farm it. In particular, our findings revealed soils that are very low in phosphorous and deficient in organic matter, active carbon, and respiration.

In response, the TCI Soil Health Project proposes system interventions (such as direct-seeded rice, second cropping, and crop-residue retention) coupled with other soil management practices (such as reducing/eliminating tillage and improving nutrient levels and pH). We are sharing our knowledge and findings

with NGO-partners (e.g., PRADAN) who provide agricultural extension services and thus interact directly with farmers in Jharkhand. We also rely on institutions with whom we have formed new relationships in Ranchi—such as Birsa Agricultural University—to ensure information dissemination.

Finally, we have identified a need to have multiple soil health tools that extension and NGO consultants can use in the field which facilitate soil health assessment, education, and direct conversation with farmers. We evaluated the SoilDoc kit, which measures multiple indicators and can serve as a laboratory-in-a-box and a conversation-starter with farmers. While there is a need to simplify the toolkit to make it less expensive and more portable, we have confirmed the priority soil health indicators the toolkit should be able to test in a field environment. The next step is to design a simplified soil health toolkit that can be widely implemented in the Indian agricultural environment, and the development of management advice for soil health improvement in the Jharkhand context.

Project highlight: International Workshop on Soil Health

In January 2016, a very successful TCI-sponsored International Workshop on Soil Health was presented at Birsa Agricultural University, Ranchi with over 250 scientists, extension specialists, and agricultural administrators from all parts of India. The TCI Soil Health Project team and representatives from Cornell University (including Dr. Harold van Es, Dr. Peter Hobbs, Dr. David Rossiter, and Mr. Phil Frost) as well as scientists from the Indian Center of Agricultural Engineering, the Indian Institute of Soil Science, ICRISAT, CIMMYT, Borlaug Institute, and PRADAN presented on soil health concepts. Subsequent to the Ranchi conference, the TCI/Cornell team traveled to the Borlaug Institute sites in Pusa, Jabalpur, and Ludhiana



in Punjab where researchers are conducting long-term trials of various cropping systems and management practices that influence soil health. Overall, these interactions are fostering knowledge-sharing, partnership development, and capacity-building between India-based and Cornell-based soil scientists and the NGOs and research institutes that are in the best position to bring soil health concepts to policymakers, extension service providers, and farmers in India.

MITIGATING RISK FACTORS ASSOCIATED WITH MYCOTOXIN ACCUMULATION ACROSS THE FOOD SYSTEM

Mycotoxins are chemical substances produced by fungi that contaminate many crops and food products before, during, and after harvest. This contamination is especially problematic in hot, semi-arid environments wherein conditions are favorable for growth of the fungus and unfavorable for growth of the plants it infests. Mycotoxins can have severe and lasting implications for nutrition and public health. Aflatoxin, for example, is a potent carcinogen and is linked to liver cancers, cirrhosis, and immunological disorders. In

addition, a growing body of research has linked dietary aflatoxin exposure to childhood stunting, underweight, and impaired neural development in children.

Despite formal standards put in place by governments and agencies worldwide, much of the produce in smallholder-driven food systems in the developing world is bypassed by regulatory efforts. Thus, the extent and impact of mycotoxin contamination in these contexts is not well understood and likely under-reported. Therefore, TCI is characterizing factors (biological, ecological, cultural, socioeconomic, etc.) that influence risk of mycotoxin—specifically aflatoxin and fumonisin—contamination in village food systems.

We are working to understand how regional differences affect a community's propensity to accumulate mycotoxins by spanning several agroecological and sociocultural contexts (namely Telangana, Uttar Pradesh, Bihar, and Odisha) with the objective of

identifying locally relevant, community-driven recommendations for sustainable toxin mitigation.

In July-August 2016, TCI Scholar Anthony Wenndt led our initiative to survey household mycotoxin risk factors in nine villages. Data were collected from roughly 170 total households on 1) household demographics, 2) food production, acquisition, and consumption behaviors, and 3) mycotoxin levels in available food products. Additionally, roughly 50 marketplace vendors were interviewed and food samples were collected from their shops for toxin analysis. Focus group discussions in each village addressed resource access and disseminated agricultural and nutrition information and participatory resource-mapping activities were conducted to establish basic cartography against which spatial analyses will be compared.

During fall 2016, TCI has been working to complete the mycotoxin analyses and process the questionnaire



data. Results from the preliminary survey indicate that there is substantial risk of village-level mycotoxin contamination across cultural and agroecological contexts in India. Aflatoxin was detected in at least 30% of the households in each of the four districts, with the highest incidence in Mahabubnagar district, Telangana (82% of households). Groundnut, maize, sorghum, rice, and pulses were identified as particularly vulnerable commodities in the village food system context. There is evidence to suggest that climate and storage practices are important contributors to mycotoxin accumulation. Consumption of some toxin-prone commodities (such as groundnuts and sorghum) was context-specific, emphasizing the need for mitigation approaches tailored to specific food system contexts.

With this baseline dataset, our researcher will adopt a modeling approach to identify key risk factors associated with mycotoxin accumulation within and across food system contexts. Examples of such factors might include storage conditions, food sources and preferences, crop/fungus genotypes, farming practices, environmental conditions, and socioeconomic status/resource access.

This information will be used to devise sustainable, scalable, context-specific toxin mitigation strategies. These mitigation strategies will be implemented experimentally at selected sites over the 2017-2018 academic year with a view to scaling those that we find to be most effective at reducing the risk of mycotoxin accumulation to various TCI project sites.

Over the long term, we envision that this project will yield useful, broadly applicable insights regarding mycotoxin management in India's village food systems, and may serve as a foundation for scalable intervention programs and longitudinal investigation by local, regional, and/or national entities. Appropriate strategies for mitigating mycotoxin accumulation will be holistic, and will likely integrate stakeholder capacity-building

with enhancements in local-level monitoring, food storage practices, and infrastructure.

CLARIFYING FOOD SAFETY REGULATIONS

Economic growth, rising incomes, and urbanization have influenced Indians' eating habits. There is increased demand for greater variety in food choices, and Indians are becoming more concerned about food quality and safety. The 2015 withdrawal of Maggi noodles—a top ramen brand in India—has drawn further attention to the food safety situation. Meanwhile, monitoring by government agencies and NGOs has raised awareness and demand for safe food.²

According to 2015 global estimates of foodborne diseases, “the risk of foodborne diseases is most severe in low-and middle-income countries, linked to preparing food with unsafe water; poor hygiene and inadequate conditions in food production and storage; lower levels of literacy and education; and insufficient food safety legislation or implementation of such legislation.”³ In India, food-borne diseases can be erratic and often go unreported, but in a nationwide 2006 study 13.2% of households reported food-borne illness.⁴

As agricultural development is considered a means of fostering rural growth and reducing poverty, India needs to hurdle a number of policy, regulatory, infrastructural, and institutional obstacles and to produce food that meets basic quality and safety standards/requirements.

TCI is therefore studying the current food safety regulation situation in India, including legislation, implementation, coverage, and challenges. By analyzing existing food-safety laws, policies, and regulations as well as collecting relevant academic research, TCI is appealing to the Indian government to upgrade existing

food-safety laws, policies, and regulations and calling for more cooperation between organizations and government regulatory entities.

The Food Safety and Standards Act (FSSA) of 2006 was designed to improve the overall food safety of the population and the food trade within and outside the country. The FSSA consolidated responsibility for food



safety in the hands of the Food Safety and Standards Authority of India (FSSAI). In spite of the decade-old transition from the previous food safety laws into the FSSA's integrated standards and regulations, there remain overlapping and residual/pre-existing standards maintained by other regulatory bodies. Clarity is needed if all stakeholders are to conform to FSSA regulations.

In the case of powdered, evaporated, and condensed milks, producers need to meet the mandatory FSSA regulations as well as the compulsory requirements of Bureau of Indian Standards (BIS). Both include standards for hygiene, additives, and limits on contaminants. For fruits and vegetables, FSSA regulations as well as BIS and Agricultural Marketing standards (AGMARK) apply. TCI researcher Hanzhou Yang has focused on studying these standards in milk

and vegetables; she concludes that while all regulatory norms base their criteria on the international standards of the Codex Alimentarius Commission (FAO), it is difficult for food suppliers to follow all the mandatory regulations and difficult for customers to discern the differences in food labeling. And if competing national standards were not confusing enough—after all, some standards are mandatory, some are voluntary—there are also state-level marketing regulations with which to contend. This convoluted policy environment is equally difficult for regulators and producers seeking compliance.

As a public policy priority, the TCI recommends that the government address the existing overlap and remove the ambiguity in responsibility and authority of each organization. The government needs to review the BIS and AGMARK standards separately, merge the regulations above into the FSSA, and make clear the boundary between mandatory and voluntary requirements as well as the divisions of responsibility between FSSAI, BIS, and the Directorate of Marketing and Inspection (DMI), which is responsible for enforcing AGMARK standards.

The government should also pay greater attention to developing the relevant institutional and human resources needed to monitor food safety more effectively. The FSSA establishes a national standard, but administration (including licensing, prosecutions for non-compliance, etc.) is carried out at the state level. Compared with the comprehensiveness of and details in food safety laws, the availability and accessibility of food labs needed to implement and enforce food safety laws varies considerably by region; overall there is a lab and testing-capacity deficit. There also are too few specialists with the knowledge and experience required for administering food safety.

To increase the number of laboratories per million people and upgrade the infrastructure and technology,

the FSSAI should establish or strengthen existing laboratory collaborations between FSSAI and AGMARK laboratories as well as share laboratory data. The government could also delegate greater responsibility to private laboratories; current regulations could be amended so that only failed samples from the private sector are sent to government labs for referral and final analysis. Regarding human capital, FSSAI and academic organizations should design training programs and provide viable employment opportunities for more people to work in this area.

Finally, our analysis finds that producers, consumers, food handlers, and even officials lack awareness of food safety and also lack understanding of the regulations that are constantly updated.

Perhaps the biggest challenges facing food industries seeking to conform to food safety regulations is lack of information and lack of clarity. Food Business Operators (FBOs)—especially the tiny, small- and medium-scale industries—find it difficult to identify relevant procedural and compliance changes and they lack the capacity to track regulatory changes. FSSAI should simplify regulations and standards for FBOs at all levels. Standards must be unambiguous and clear. Also, FSSAI should place greater emphasis on training food handlers. Even small steps such as washing hands frequently and wearing gloves could do much to improve the hygiene situation.

While recent food safety scandals have raised awareness among Indian consumers, such awareness is found disproportionately among urban consumers. Rural consumers also deserve safe, high-quality food, and the government can reach them through mass-media campaigns. FSSAI should work with other ministries to raise awareness and educate the public about workplace, farm, and household hygiene as well as safe use of pesticides. When consumers demand safe foods, industry, producers, and food handlers will comply.

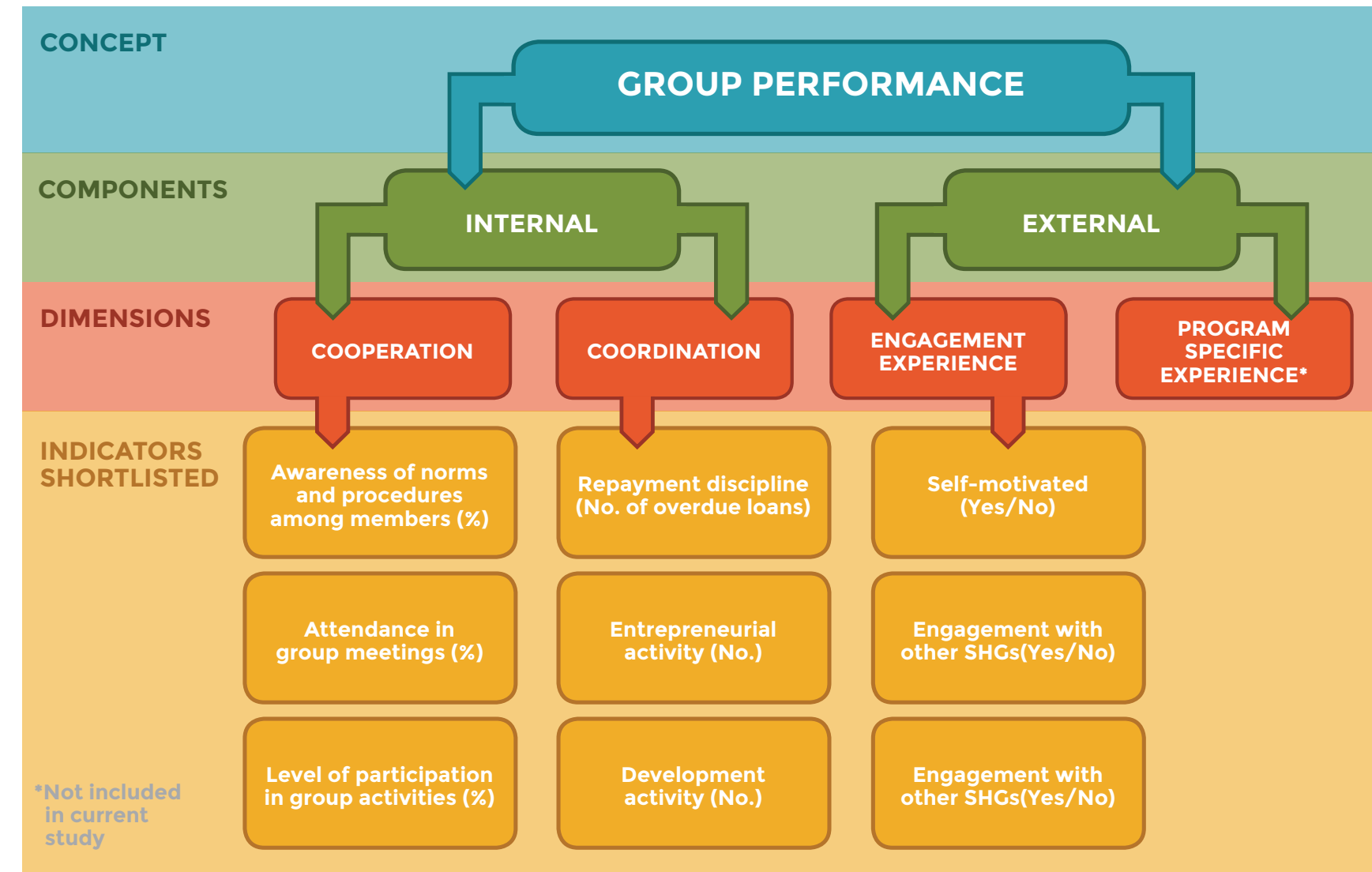
MEASURING WOMEN'S SELF-HELP GROUP PERFORMANCE

Women's SHGs increasingly facilitate the decentralized delivery of agriculture and nutrition interventions around the world. Since their origins in the microfinance revolution of the 1980s, SHGs in India have brought rural women together and provided them with access to formal banking, income-generating opportunities, training, and exposure to public welfare schemes. Given their unique status as savings and credit organizations with considerable autonomy in scope and functioning, these groups build social capital and empowerment that can be leveraged to attain developmental goals and delivery of basic service amenities.

Assessments of SHG participation find positive effects on indicators of social capital, women's empowerment, health, and nutrition, but SHG-based programs often fail. Several studies raise important questions regarding the sustainability and evolution of such groups as well as the characteristics distinguishing those that are capable of being true agents of change from those that lack sufficient social capital. Conclusive evidence is also not yet present on the ability and suitability of SHGs to take on causes beyond their primary savings and credit responsibilities, such as improving agriculture and nutrition.

In this context, development practitioners can benefit from better process evaluation and more effective metrics for gauging the performance and potential of women's SHGs to meet these new expectations. However, given the multiple roles SHGs perform, group success cannot be captured by any single indicator. Current measures focus heavily on group administration and repayment discipline, serving more as credit-rating tools for lenders and indicators of administrative self-sufficiency for self-help promoting

Conceptual Framework for Multidimensional Metric of SHG Performance⁶



institutions (SHPIs). Few measures represent the full range of responsibilities and expectations currently placed on SHGs, and those that do are often not generalizable across SHGs established by distinct SHPIs.

The TCI has endeavored to create a metric of group performance that can be used to assess an SHG's success, resulting in a representative index to score SHG performance. This effort was led by TCI researcher Samyuktha Kannan as part of her Master's thesis under the guidance of TCI Director Prabhu Pingali and TCI Faculty Fellow Mark Constat. The aim was to ensure that the resulting tool would be flexible and easy to use when comparing multiple SHG typologies and when used by program implementers in multiple contexts. The study draws on the latest theory and current policy environment involving SHGs and is based on primary data on 170 SHGs collected by Ms. Kannan in Odisha over three weeks in the summer of 2015. The study's major contribution is in treating SHG performance as a multidimensional construct encompassing multiple definitions of SHG success.

There is, however, no consensus on defining group success. While most SHGs are mandated to follow a few basic rules, wide variation exists in the norms promoted

by the institutions involved. Additionally, SHPIs use their own unique performance measures. In an attempt to define a standard yet flexible performance metric relevant to all stakeholders, we reviewed the literature on collective action and organizational behavior and specific studies on "Membership Based Organizations of the Poor (MBOP)."⁵ The multidimensional nature of SHG performance is understood as encompassing both internal aspects (of group functioning and adherence to norms) and external aspects (of engagement with development policy) to fully capture the role played by SHGs in participatory development. Data from the primary survey were used to develop and test a representative index.

The empirical challenge is finding techniques suitable to the large number of categorical indicators of performance and shortlisting appropriate indicators that may represent the dimensions identified by theory. We used, in part, the Alkire-Foster count method to create the index and employed several tests of reliability, validity, and internal consistency to identify the best measure from available data. Our analysis indicates that the final index displayed consistent and meaningful relationships with other indicators of positive performance that were not included as well as with a set

of expected determinants. The distribution of groups by adjusted index score (0-10) is displayed in Figure 6. Using this SHG index methodology we can also identify the specific dimension along which an SHG is performing poorly. In our sample, we found that groups performed most poorly in "external engagement" (38% of the groups) and "cooperation" (33%) compared with performance along the "coordination" dimension (9%), which consisted primarily of administrative requirements that are typically well understood and easily monitored by SHPIs.

This work identifies and formalizes a multi-dimensional framework for evaluating SHG performance that can be used by stakeholders during development and engagement with SHGs, providing a more accurate understanding and better representation of an SHG's capacity to play a role in community development. Our SHG index is applicable across various SHG typologies with scope for further validation, refinement, and expansion. Going forward, the index's external and predictive validity will need to be tested in other program contexts using other SHG datasets. The TCI is committed to expanding the knowledge base on what defines SHG success. We support our partners who work to build capacity among these groups and impress upon them and other development agencies the importance of evaluating and nurturing SHGs before, during, and after utilizing them as a platform for program implementation.

TRANSFORMATION THROUGH SELF-HELP GROUP PARTICIPATION

Self-help group (SHG) interventions have focused primarily on positive community outcomes resulting from SHG participation. However, we lack understanding of the processes and triggers that lead

to a SHG participant's transformation into a person with a sense of agency and empowerment. By closing this knowledge gap and identifying the processes and triggers through this research initiative, researchers and practitioners alike can better recognize how to support women both inside and outside SHGs who have not experienced such transformations.

Therefore, TCI has been investigating the motives and rationale that determine whether women do or do not participate in SHGs as well as the means by which women participating in such groups are more empowered and develop an enhanced sense of agency.



Working with our partner PRADAN, field interviews were conducted in June and July 2016, primarily in the Barabazar Block of the Purulia District in West Bengal, India. PRADAN has been working since 1997 in this block to establish and support SHGs and today they support approximately 2,220 SHG members in the block, comprising 150 SHGs. All five SHGs interviewed were established by PRADAN for the purpose of increasing the well-being of their communities through both financial and social mechanisms. These groups serve as both important sources of microfinance for their members and also as platforms for social and political mobilization through SHG federations (the

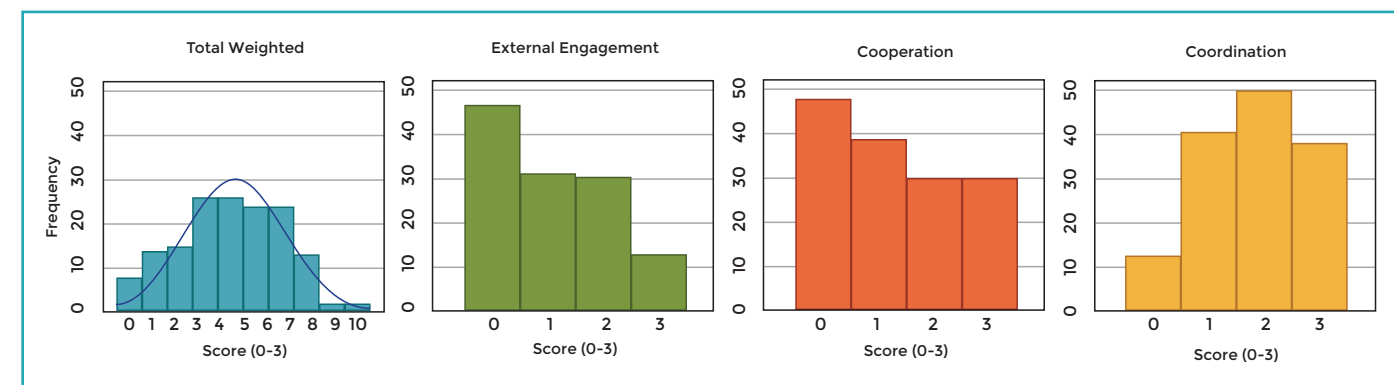


Figure 6

women-led institutional bodies supporting SHGs). PRADAN's experience suggests that the SHG structure facilitates member empowerment and creates building blocks for change in the larger community. However, exactly how SHG processes facilitate an individual's transformation remains unknown—that is what this research seeks to clarify and name. This effort is led by TCI researcher Jessica Sokolow.

Interviews conducted with SHG members in Barabazar found that, while women acknowledged the significant benefits of the SHG's savings and credit processes, they often placed greater emphasis on the importance of the social and psychosocial benefits resulting from their participation, including greater mobility, knowledge, and confidence. Participants described their transformation as a piecemeal development, including attending weekly SHG meetings and trainings outside the village, where they learned to interact with others and obtained new knowledge, fostering greater confidence within themselves.



Through this process of both absorbing and sharing knowledge—thus making changes within themselves and others, and paired with mutual support from their group members—women were able to assume greater

decision-making authority within the home. As a result, many women make changes within their households, such as diversifying family diets or distributing food equally to both genders. Furthermore, following these changes women often exercise their new-found agency to make changes in society, for example by fighting against child marriage and domestic abuse.

However, many women still contend with formidable constraints on this transformative process, preventing them from making changes both within and outside themselves. This includes financial constraints on the household, often seen in cases where a family does not own its own land, which requires women to prioritize labor and household work opportunities, particularly as many male members of their households migrate for work. As a result, they are not able to attend the trainings or take on important leadership roles that will enable them to experience social and psychosocial changes contributing to their enhanced sense of agency.

Findings from this work will help TCI and its partners define better ways to assist women (within and outside of SHGs) who, due to constraining factors, are not experiencing transformations. This research will also help development practitioners at PRADAN aid the current SHG institutional structure more effectively as well as design interventions that build on important leverage points in the process of transformation while addressing constraining factors. As a result, PRADAN can help empower more women and support large-scale social mobilization.

These results also provide insights into how SHGs work, as they are an important development and empowerment model used throughout India and beyond. While SHG interventions and their outcomes can vary greatly from place to place, this study aims to understand, from the perspective of the women participating in PRADAN's SHGs in the Barabazar Block, the important economic, social and psychosocial

impacts experienced as a result of SHG participation. Consequently, this research reveals that SHGs have the power to promote a multifaceted transformative process. To maximize the impact of these interventions, however, SHGs must balance the—sometimes differing—needs of women seeking greater economic, social, and psychosocial capacities. This work strongly suggests that further research of this kind can shed light on the impact of SHGs in communities around the world and methods by which the interventions can be strengthened, particularly under differing social, economic, political, and cultural circumstances.

DO ADOLESCENTS GAIN OR LOSE IN FOOD ALLOCATION?

Why is it that at the same income level and household structure some households contain malnourished members while others do not? Many causes have been attributed to this phenomenon, such as differences in kin and social networks, purchasing power, food preferences, and demand for women's time. All of these factors influence a household's ability to acquire food, but they do not explain what happens to the food once it reaches the household.

Knowledge regarding the differential allocation of food in households could provide insight into which individuals benefit and to what degree and from what food. Intra-household food allocation (IHFA) patterns may explain why some household members can be malnourished while others are not. What's more, within the same household various kinds of malnutrition can exist simultaneously (e.g., the same household could include a stunted child, an iron-deficient mother, and an obese father) and allocation behaviors may account for these differences in nutrition outcomes. In fact, there is a body of literature available on the importance of understanding IHFA and its implications for maternal and child nutrition.

IHFA is not easy to study. When planning and implementing food security programs/policies we must account not only for the factors that contribute to a household's ability to access food in the "household pot" but also for the individual's ability to access needed food and nutrients.



Within a household, food could be distributed according to gender, age, or status. For example, in many societies including India, males typically are served first, followed by women and children. Wage-earners could receive a disproportionately larger share of a household's food supply than other members. Or, the decision-maker could distribute food according to how he/she perceives each member's need, which may or may not have any relationship to actual need.

Similarly, not all the foods consumed in a household may be allocated according to the same system. Staple foods may be plentiful and hence shared freely, while other more nutrient-dense foods may be allocated with greater care. In some societies, a disproportionate share of meat may go to wage earners, but dairy products or fruits may be fed mainly to children. As such, IHFA dynamics affect not only calories but also how nutrients are distributed.



The TCI and its partner ICRISAT endeavored to understand these existing patterns of IHFA and nutrition dynamics in selected villages in the semi-arid tropics, focusing in particular on allocation to adolescents relative to their household's pot. Adolescence is a critical period in human development in which the body physically prepares for the age of reproduction; moreover, adolescents make decisions that will impact them for the rest of their lives. This includes developing nutrition habits, finishing their education and, in many rural villages in India, facing the prospect of marrying. While there is much policy discussion of interventions for adolescent girls, we must do more than pay lip service to them, and we cannot marginalize adolescent boys in the process of supporting adolescent girls. We concentrate on

adolescents (age 10-19) because a) they represent 20% of a large and growing Indian population, b) this is a vastly under-researched group, and c) interventions targeting this group might break the vicious, intergenerational cycle of malnutrition.

Given the established role of IHFA in affecting the nutrition status of certain age and gender groups, we hypothesized that IHFA also influences the nutrition status of adolescents. This intensive, two-week exploratory study covered 58 households in Solapur district, Maharashtra (21 in Kalman village and 37 in Shirapur village), comprising 81 adolescents (10-19 years), of which 35 were girls and 46 boys. The villages are part of the Village Dynamics in South Asia project led by ICRISAT. This collaborative research activity between the TCI and the Market, Institutions, Nutrition, and Diversity unit at ICRISAT was a continuation of previous summer internship efforts to improve nutrition metrics and assess household-, individual-, and market-level dietary diversity. [More can be read on the Minimum Nutrition Dataset for Agriculture (MNDA) and the Market-Level Dietary Diversity (MLDD) methodologies in TCI's 2015 Annual Report.] While our sample size is small, our general findings reveal important directionality in trends and some of our specific findings are statistically significant.

With this joint TCI-ICRISAT effort, we were able to:

1. Determine the nutritional quality of adolescent diets in Maharashtra, India and compare them with the nutritional quality of their overall household diets. We accomplished this by ascertaining both individual and household dietary diversity via the MNDA (a three-day food recall). We also used the MLDD tool on the village's market to assess changes in household and individual dietary diversity relative to market day.
2. Analyze the role of IHFA in influencing the specific nutrient statuses of adolescents in Maharashtra. We

determined the specific macro- and micronutrient intake levels of individual adolescents and their households using Gibson's 24-hour recall methodology (an open-ended, weight-based, interactive method for assessing nutritional diversity).⁷

3. Determine which government programs are targeting adolescents in Maharashtra and evaluate the efficacy of these programs in reaching their target populations and improving the nutritional status of adolescents.

Our initial findings confirm a gender bias against female adolescents. Nutrients for which we found statistically significant differences in intake between adolescent males and females included energy, protein, iron, zinc, riboflavin, thiamin, phosphorus, and niacin. We also find that male and female adolescents have slightly less diverse diets compared to the entire household pot, suggesting an age bias against this group. The lack of gender differences in diet diversity also suggests that gender biases in allocation do not affect females' diet quality, but in terms of quantity adolescent girls are receiving less than their appropriate portions (relative to their respective household pots and family composition).

Overall, female adolescents were diet-deficient even in diet-sufficient households whereas male adolescents were diet-sufficient even in diet-deficient households. This indicates a clear gender bias in terms of allocation of food and consequently nutrition.

To address this problem, programs such as the Kishori Shakti Yojna (Adolescent Girls Scheme) in Maharashtra could be extremely effective in reducing the gap in micronutrient levels between adolescent males and females, especially if the meals distributed in this system included more nutrient-rich food items such as milk, eggs, green leafy vegetables, groundnut curries,

and sorghum roti. Within any household care must be taken to ensure equitable distribution to male and female adolescents of curries and animal-source foods (particularly milk and eggs), as these dishes contain high amounts of energy, protein, and iron and are the

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Prabhu Pingali and Naveen Sunder.
"Transitioning towards nutrition sensitive food systems in developing countries—a review." *Annual Review of Resource Economics*. Volume 9. (2017). (Forthcoming)

main sources of these nutrients in this diet. Behavior-change communication strategies and awareness-raising are needed to make IHFA more equitable and to meet the nutritional requirements of every household member.

SEEING THE WHOLE PICTURE: INDIA'S TRIPLE BURDEN OF MALNUTRITION

Since the mid-1950s, real per capita income in India increased constantly, with the rate of growth accelerating since the early 1980s. Despite this remarkable economic progress, India lags on essential social indicators such as the prevalence of stunting, underweight, poverty, and communicable diseases. According to 2014-16 estimates, 194.6 million Indians are undernourished, which is roughly 15% of the total population. Undernourishment in India has declined by nearly 36% since 1990, but this decrease is negligible in comparison with what has occurred in other highly populated countries such as China, which has reduced

undernourishment by 61% over the same period.⁸ The incongruity between India's economic growth and its social indicators indicates that economic expansion does not necessarily translate into social wellbeing.

While stunting and wasting rates are steadily declining at the national level, micronutrient deficiencies remain stagnant, and the percentage of overweight and obese people in India is increasing. The co-existence of these three faces of malnutrition within the same population is called the triple burden of malnutrition.

We have set out to better explain the directionality and consequences of these trends, both at the national level and by state. (We analyzed state-level trends for Bihar, Odisha, and Uttar Pradesh, e.g., at the three TARINA intervention locations.) Led by TCI researcher Karina Acosta, the TCI has compiled and compared multiple datasets, including the Indian Human Development Survey (IHDS) 2005 and 2011; the National Family Health Survey (NFHS) 1992/3, 1998/9, 2005/6, 2015/16;

the Annual Health Survey (AHS) and its component Clinical, Anthropometric and Bio-chemical (CAB) 2014; the Rapid Survey of Children (RSoc) 2013/14, and the District Level Health Survey (DLHS) 2002. We used the best available statistics on anthropometry, hemoglobin, population characteristics, and geographic representativeness. In our analysis we found inconsistencies in some of the nutrition indicators across data sources. Data that are consistent through time and across geographic units would obviously be preferable, but by comparing the datasets we can confirm whether they are telling the same story.

Multiple datasets confirm downward changes in stunting in children under five years of age and under three years of age (Figure 7). However, the results suggest that improvement was negligible during the 1990s, especially compared with the change observed between the end of the twentieth century and 2006. Unfortunately, lack of improvement in micronutrient malnutrition in women and children, particularly

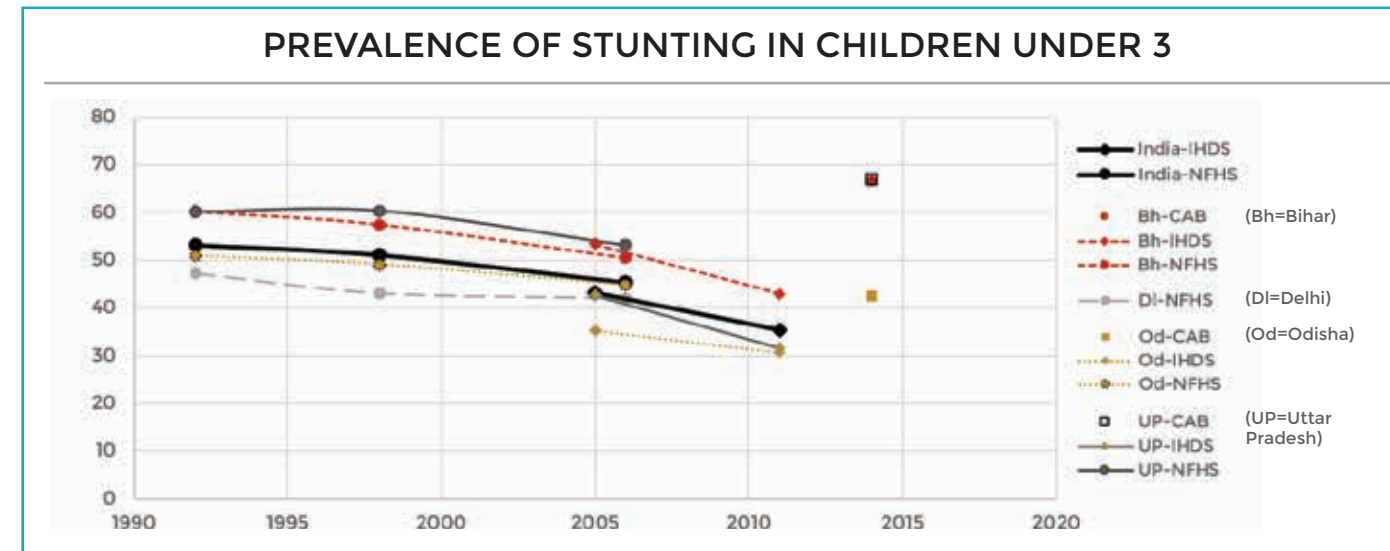


Figure 7

in anemia prevalence, overshadows these positive achievements. Meanwhile, overweight and obesity has increased from single-digit values in the early 1970s to values above 10% since the 2010s. Since the rise in BMI is associated with cardiovascular diseases, diabetes, musculoskeletal disorders, and some cancers, this rise in overweight/obesity is no small public health issue.

It is also worth highlighting that there are persistent gaps between geographic units within India. For example, states with relatively high income, such as Kerala, have experienced a major overweight and obesity burden while states such as Odisha, Uttar Pradesh, and Bihar face a higher burden of stunting and micronutrient deficiencies. In addition to regional differences, there are noticeable discrepancies when comparing rural and urban indicators. This applies not only to malnutrition indicators such as the level of stunted children, but also to the still enormous differences in sanitation conditions (which are linked to malnutrition). For instance, in 2005/6 the proportion of families without toilet facilities was 74% in rural areas and 17% in urban areas.

To understand the cost of the triple burden to the Indian population, the TCI has used DALYs (Disability-adjusted life-years; e.g., the number of years of life lost due to ill-health, disability, or early death) to quantify the loss in life expectancy due to major diseases associated with malnutrition. We learned among other findings that although there is persistently high prevalence of communicable diseases during the first years of life, mostly associated with such infectious diseases as diarrhea among children, a high proportion of lives lost during adulthood are due to non-communicable diseases, especially cardiovascular diseases. If infections and parasitic diseases, which are almost eradicated in developed countries, were eliminated in India, average life expectancy at birth might well increase by 2.24 years. Furthermore, stamping out circulatory diseases might have an even

greater impact. The absence of this group of diseases would contribute to augmenting life expectancy at birth by 7 years. These results are consistent with the data collected by the Million Death Study, which verifies that nowadays cardiovascular disease is not an exclusive problem of high-income regions in India, but also affects lower-income regions such as Bihar and UP. The NFHS also reported an impressive increase in overweight/obesity in Bihar, with rates almost doubling within a decade (from 2005 to 2015).



We note, then, a close association between malnutrition and disease burden. Given the loss of life and loss in life expectancy resulting directly from malnutrition and indirectly from the associated increased frequency and intensity of disease, India must enhance its public health, nutrition, and agriculture policies. Relying on economic performance to improve social outcomes is insufficient. Moreover, India's public policies should not concentrate exclusively on reducing the proportion of the population that is stunted; halting the increase in overweight and obesity trends would be a huge benefit. Likewise, India must improve its efforts to attain a more comprehensive database of malnutrition indicators. This would add a great value to understanding the triple burden phenomena in India and its states. Consistent, higher-quality data help us track trends and assess the efficacy of the ongoing efforts. We must identify the types of malnutrition on which we have made the least progress so that we can reallocate public resources to them.⁹ Less targeted public policies and less strategic investments will be produced in the absence of a clear map of the malnutrition situation. In the meantime, we must do the best we can with the data that exists.

GETTING TO ZERO HUNGER: LEARNING FROM THE MDGS FOR THE SDGS

The World Food Summit (WFS) goals and the Millennium Development Goals (MDGs) framework were the first systematic global attempts to monitor progress toward reducing hunger. At the 1996 WFS in Rome, representatives from 182 nations pledged “to eradicate hunger in all countries, with an immediate view to reducing the absolute number of undernourished people to half their present level no later than 2015.” The undernourished are those who fall below the minimum level of dietary consumption for a given country and year. Five years later, in 2001,

TARGETS AND ACHIEVEMENTS OF THE MDGS AND WFS GOALS¹⁰

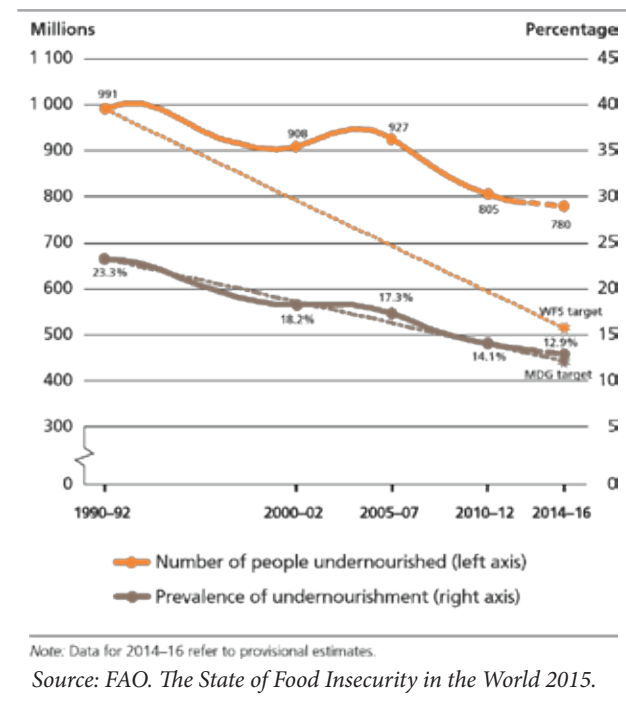


Figure 8

at the United Nations (UN), representatives from 189 nations ratified (within the MDG framework) a second benchmark for the multidimensional fight against extreme poverty. Under this declaration, countries pledged “to halve, by the year 2015, the proportion of the world's people whose income is less than one dollar a day and the proportion of people who suffer from hunger.” While the WFS pledged to halve the “absolute number” of undernourished, the MDGs aimed to halve the “prevalence” of the same.

The MDG targets were largely met, as data shows a decline from 23.3% in 1990-1992 to 12.9% in 2014-

2016 in the prevalence of undernourished people in developing countries, less than one percentage point short of the target (Figure 8). The WFS goal of halving the absolute numbers, on the other hand, missed by a large margin. In 1990-92, just fewer than one billion people in developing countries were undernourished. Reducing this number by half would have required bringing it down to 515 million, about 265 million fewer people than the current estimate of 780 million. Thus, absolute progress toward hunger reduction was much lower than the relative progress achieved.

These two initiatives, however, played a crucial role in shaping global thinking and action regarding poverty and hunger, paving the way for the bolder and more comprehensive Sustainable Development Goals (SDGs) in 2015. The 17 goals and 169 targets of the SDGs aim “to build on the work of the MDGs and complete what they did not achieve.”¹¹ Goal 2 of the SDGs is to end hunger, end all forms of malnutrition, double the agricultural productivity and incomes of small-scale farmers, ensure an environmentally sustainable food production system, and maintain the genetic diversity of seeds and cultivated plants. It tackles malnutrition explicitly, a goal that was absent from the MDG framework. It also places added emphasis on sustainable food systems, focusing on environmental issues. It targets achieving these goals by 2030.

Addressing interregional inequalities in agricultural development and the persistence of malnourishment (including micronutrient deficiencies), especially among women and children, pose the most difficult challenges to achieving the SDG goals. Southern Asia and sub-Saharan Africa house 35.4% and 27.7% of the global undernourished, respectively. Sixty-five percent of the world's undernourished people live in only six countries—India, China, Pakistan, Ethiopia, Bangladesh and Indonesia—nearly all of which fall within the three regions where the hunger burden is greatest.

There are regional disparities in hidden hunger and stunting as well. The MDG and WFS goals for hunger reduction have focused on calorie security but not proportionally enough on micronutrient deficiencies that manifest as hidden hunger. This has had the greatest impact on child and maternal nutrition in developing countries. According to the World Health Organization (WHO), 50% of pregnant women in developing countries are anemic and anemia contributes to 20% of all maternal deaths. Regarding child health, although the prevalence of stunting has been reduced globally from 39.6% to 23.8%, the absolute numbers have not exhibited a sufficiently rapid decrease. Between 1990 and 2014, although the number of stunted children declined from 225 million to 159 million globally, Africa and Oceania saw 23% and 67% increases in the number of stunted children, respectively, during the same period.

PUBLICATION ALERT

Pingali, Prabhu, Megan Witwer and Mathew Abraham. “Getting to zero hunger: Learning from the MDGs for the SDGs.” Chapter 5 in *International Society and Sustainable Development Goals*. (Portada: Thomson Reuters ARANZADI, 2016).

A holistic approach is needed to achieve the SDG 2 objectives. This food systems approach depends critically on developing the agricultural sector to enable improved access to nutritious food through the income pathway and through the promotion of nutritious food cultivation at the farm level. Three components of this approach call for a) boosting small producer agricultural productivity to improve incomes, b) designing policy strategies to rectify regional disparities, and c) addressing complementary issues including water

and sanitation access and safety, diversification of diets, and improving food quality and safety.

There is ample evidence of a strong relationship between productivity growth and reduced undernourishment, stunting, and child mortality. The bulk of the world's agricultural production takes place on small and marginal farms (less than 2 hectares in size) and presently there are over 500 million small farms cultivated by two billion of the world's poor. Policy and supports designed to improve small producer agriculture through investments in infrastructure such as irrigation and credit, services such as R&D, and promotion of traditional staples such as cassava, millets, barley, and sorghum to improve diet diversity are vitally necessary. Programs focused on productivity gains in traditional staples have been shown to improve incomes in sub-Saharan Africa.

Levels of agricultural transformation in developing countries vary widely. In low-production agricultural systems, policymakers should focus on increasing



production of traditional staples, infrastructure development, and gender-focused labor-saving technology coupled with such interventions as bio-fortification and kitchen gardens, which are potent interventions for improving nutrition. Modernizing food systems must shift from a cereal-focused production system to a more diversified production system along with better linkages to markets and value chains to improve incomes and nutritional access. The role of supporting policies that enable behavioral change through women's empowerment and environmental change through better access to water and sanitation in both types of production systems is needed to complement an agriculture growth-centered pathway to better nutritional status.

Tasked with eradicating hunger in all forms, the SDGs have a mammoth mission to achieve. Informed by the lessons of the MDGs and WFS, a holistic food systems approach is needed to address the challenges the earlier attempts were not able to address fully. Tackling the issues of small farm production and interregional

disparity as well as supporting gender- and nutrition-based policies are fundamental to achieving these targets by 2030. Multisectoral collaboration—including state, civil society, and private sector participation within and across these groups—is essential to achieving the ambitious and necessary objective of zero hunger.

India and the Zero Hunger Target

India is among the countries that did not achieve the MDG hunger targets. In 2015, although undernourishment declined to 40%, it was well above the target of 26%. Despite this lackluster result, there has been much progress in reducing undernutrition. In fact, the national prevalence of stunting declined from 48% in 2005-06 to 39% in 2013-14. However, much remains to be done. According to the United Nations Development Program (UNDP), one quarter of the world's undernourished, one-third of its underweight children, and nearly one-third of the world's food-insecure population live in India. Therefore, for India, the SDG target of eradicating hunger represents a formidable challenge. The most pressing issues—beyond basic food or calorie security—involve tackling micronutrient deficiencies (“hidden hunger”) and curtailing the emerging overweight/obesity trend and its associated increase in the prevalence of non-communicable diseases such as cardiovascular disease and diabetes.

Using the food systems approach to address food security, interventions should be designed and promoted on both the supply and demand sides of food. India is a modernizing agricultural system so, on the supply side, interventions focused on smallholder farmers promise to improve yields, accelerate the shift from cereal-based systems, and increase market accessibility. In this respect, market linkages through private value chains and aggregation models through cooperative-like groups are crucial to improving incomes. This income pathway to better nutrition

depends on small farm viability. On the demand side, improving access to a diverse and healthy diet is key to improving nutritional status. Moreover, consumers must demand more from their food. For example, in the realm of food safety, consumers should learn to demand labeling, high quality, and affordability.



At TCI, our research and dissemination activities embody this food systems approach. Various scholars have been working on action research projects pertaining to water and sanitation, women's empowerment and the promotion of labor-saving technologies to reduce women's drudgery, and integrated livestock programs. We have implemented a flour fortification project that triggers demand-side changes through women's SHGs in the state of Gujarat. Regarding supply-side challenges, we have also studied markets and value chains to understand how small producers can be effectively linked to markets to improve incomes and nutritional access at the household level. The Gates Foundation-funded TARINA project (described in the next section) will help us test and promote food systems at scale in the lagging regions of India.



TARINA

TCI LAUNCHES ITS FLAGSHIP PROJECT: TARINA

In December 2015, the TCI was awarded a US\$13.4 million grant from the Bill & Melinda Gates Foundation to help boost the nutrition profile of agriculture in India. With this funding, the TCI is scaling up its work on promoting a more diversified and nutritious food system. We aim to enhance the availability and affordability of nutrient-rich foods for the rural poor by influencing the design of ongoing and future agricultural projects, programs, and policies. We will achieve this through the integration of nutrition-focused objectives, actions, and metrics into agricultural initiatives that are committed to delivering adequate food to local populations, primarily in the states of Bihar, Odisha, and Uttar Pradesh, where the burden of malnutrition is greatest.

The broad objectives of the project are to:

1. Provide technical assistance in redesigning agricultural projects to ensure nutrition outcomes at scale.
2. Provide assistance and evidence for policy reform that enhances diet quality at affordable prices.
3. Build capacity to design and implement nutrition-sensitive agricultural programs and policies.

To implement these objectives, the TCI connects policy-focused academics from diverse disciplines with impact-focused implementation partners through a consortium called Technical Assistance and Research for Indian Nutrition and Agriculture (TARINA). Led by the TCI, TARINA links the research capacities of Cornell University, Emory University, the International Food Policy Research Institute (IFPRI), and the Tata Institute of Social Sciences (TISS) with the technical capacities of leading non-governmental organizations (NGOs) and development partners—BAIF Development Research

Foundation, CARE India, Grameen Development Services (GDS), and Tata Trusts. Collectively, the consortium provides the leadership, expertise, and convergent action that are needed to tackle the complex problem of malnutrition in India (Figure 9).

Since TARINA's inception, the TCI has established a Center of Excellence (CoE) in New Delhi as part of its efforts to support the project and its main objectives. The CoE offers a mix of evidence, capacity, and advocacy for implementing nutrition-sensitive agriculture in the Indian context by providing high-quality products and services such as research papers, policy briefs, training manuals, workshops, and policy



Figure 9

seminars. As the center expands, it will serve as a central repository of information and knowledge to support building stronger linkages between agriculture and nutrition as well as a hub for a network of national and international experts working in this space. While the CoE was founded under TARINA, it is envisaged eventually to evolve into an autonomous entity that is able to sustain itself well beyond the life of the grant through the provision of demand-driven technical assistance and expertise.

HOW TARINA TACKLES MALNUTRITION: A FOOD SYSTEMS APPROACH

Over the past 50 years, the Green Revolution has ushered in new technologies that have enhanced staple grain productivity and transformed India's agricultural landscape. As farmlands planted with diverse crops were converted to monoculture fields of wheat and rice, land dedicated to nutrient-rich foods such as fresh fruits, vegetables, and pulses diminished. While significant progress has been made toward hunger reduction, Indian diets have become increasingly centered on staple grains. Today, much of the country's rural population suffers from chronic malnutrition and micronutrient deficiencies. Consequently, childhood stunting and wasting as well as anemia in both women and children persist at stubbornly high rates.

Since the Green Revolution, the food security challenge has evolved. It is no longer an issue focused merely on making enough calories available, but rather on enhancing food diversity and quality to address malnutrition in its many dimensions. Outdated agricultural policies biased toward staple grains cannot fully address contemporary nutrition challenges. As such, there is an urgent need to reorient agriculture and development policies toward nutrition outcomes.

TARINA aims to redirect agricultural policy away from "staple grain fundamentalism" toward a much broader food systems focus, which considers the need to integrate and build better connections between agriculture and nutrition. More specifically, it emphasizes agricultural pathways for improving the rural poor's year-round access to affordable, diverse, and high-quality foods that are rich in micronutrients.

TARINA's food systems approach to improving diet diversity and quality requires knowledge of factors that influence both agriculture and nutrition within and between stages of the food supply chain as well as within and between scales, from households to villages, districts, and beyond. Simply defined, a food system includes all individuals, enterprises, and institutions that influence the supply, demand, consumption, and absorption of food and micronutrients. Figure 10 outlines the interconnected components of a food system.

The food systems approach involves not only ground-level interventions at various stages of the food value chain through the redesign of agricultural projects and programs, but also policy reforms to ensure a level playing field for the production and marketing of nutrient-rich food crops such as fresh fruits, vegetables, pulses, and livestock products. This goal can be achieved through large-scale investments in transportation infrastructure, cold storage for perishable products, and local markets to reduce transaction costs.

Furthermore, policies could be adopted to offset strong price incentives for producing staple grains, which are generated by price supports, input subsidies, and investments in research and development (R&D). Establishing a "crop neutral" policy environment (i.e., one that removes biases towards a single crop or group of crops) is critical to creating a more robust and diversified food system that enhances the availability and affordability of nutritious foods.

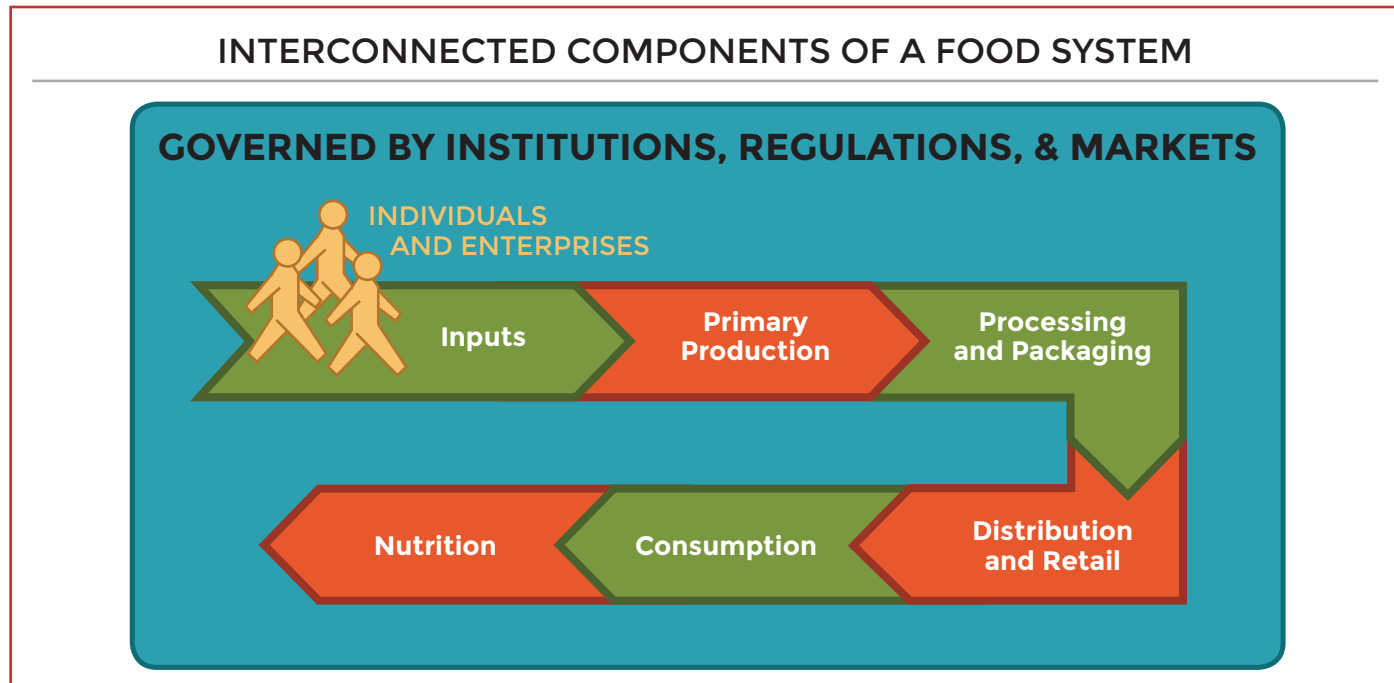


Figure 10

SHAPING FAVORABLE POLICIES TO ACHIEVE FOOD SYSTEMS DIVERSITY: AN AGENDA FOR ACTION

On August 5, 2016 the TCI held a public policy panel discussion in New Delhi on “Promoting Diversity in Food Systems for Improved Nutrition Outcomes in India” to celebrate the inauguration of TARINA.

Led by six distinguished speakers, representing the Government of India, academia, and the donor community, the panel discussion ignited a lively debate over the challenges that constrain food systems diversity

as well as opportunities for shaping new policies to address these challenges.

The panelists underscored that India’s excessively skewed policy environment, which subsidizes the production and consumption of staple grains, primarily wheat and rice, represents a major constraint. These crops are included in the country’s Public Distribution System (PDS) and are given a minimum support price (MSP) to protect farmers from market instability.

On the production side, such policies have established a guaranteed price floor and government procurement of output from farmers, distorting incentives in favor of staple grains. On the consumption side, the PDS has subsidized staple grains for poor consumers, reducing

the dietary intake of more expensive non-staples such as fruits, vegetables, and pulses.

Two strategies were proposed to eliminate policy biases and encourage diversification of agricultural production. The first would involve removing policies that create price incentives and replacing them with an income support program through cash transfers to farmers. This would help bolster farmer incomes while also giving farmers the autonomy to make crop selection decisions.

The second strategy would involve expanding the PDS to include more nutritious, non-staple food crops. Assured procurement of these crops would not only encourage farmers to increase production but would also subsidize consumption, especially for low-income households. However, panelists argued that while this

option might work well for pulses, it would be much more difficult for perishable commodities like fruits and vegetables, due to the high risk and cost associated with marketing and storing fresh foods. Many agreed that more appropriate policies for perishable crops include the strengthening of value chains, investment in post-harvest management technologies, and the development of government-supported cooperatives, similar to the Amul dairy cooperative.

Panelists identified food processing and cold storage as critical means of increasing incentives for the production of fresh foods. Investment in agro-processing industries and food retail enterprises that strengthen value chains and reduce transaction costs for farmers can raise farmer incomes and generate employment opportunities while also delivering high-quality, high-value foods to consumers. Furthermore,



Distinguished panelists (from left to right): Dr. Prabhu Pingali, Professor of Applied Economics at Cornell University & Director of TCI; Dr. Purvi Mehta-Bhatt, Deputy Director and Head of Agriculture for South Asia at the Bill & Melinda Gates Foundation; Dr. Ashok Gulati, Infosys Chair Professor at the Indian Council for Research on International Economic Relations (ICRIER); Dr. Shobha Shetty, Rural Development Sector Manager for the South Asia Region at the World Bank; Dr. P.K. Joshi, Director for South Asia at the International Food Policy Research Institute (IFPRI); and Dr. Suresh Pal, Member at the Commission for Agricultural Costs and Prices (CACP).

increasing the number of cold storage facilities, specifically pre-cooler and dispatch rooms as well as refrigerated transport vehicles, is necessary to reduce food wastage and the flooding of markets.

India's current pulse deficit was highlighted as an area of concern. Some panelists claimed that national trade policy lacks consistency and is unable to respond to fluctuations in demand and supply of pulses as well as other important food crops. Trade policies that supplement deficits in domestic production and export surplus are critical to avoid food wastage and loss of farmer incomes as well as to ensure a sufficient supply of nutritious food and micronutrients for the population.

Developing export markets was proposed as an avenue for selling domestic food surplus. By investing in food processing and exploring the country's comparative advantage in food exports, India may be able to meet international demand for processed foods and attract foreign direct investment to its agro-processing industry. An assured market with global companies has the potential to significantly raise incomes for smallholder farmers.

Reservations were expressed regarding any strategy for diversifying agricultural production that involves shifting land suitable for rice production to non-staples. Increasing agricultural diversity, while also bearing ecological and environmental limitations in mind, emerged as an important issue. Panelists called for greater investment in research, technology, and extension services for environmentally sensitive or climate-smart agriculture, with solutions that are specific to the natural resource base of India.

Although the dialogue focused primarily on methods for increasing the diversification of India's food supply, consumer education was emphasized as a critical means of enhancing demand for more nutritious, non-staple food crops. One of the strategies proposed would

exploit innovation in marketing, particularly for new sources of protein such as reconstituted soya dal and other products that include nutrient supplements. Marketing combined with educational messaging will increase consumer awareness and overall intake of more nutritious foods.

Following the event, an "agenda for action" was devised by the CoE based on the main challenges and solutions that were shared and discussed. The agenda proposes a five-point pathway for moving India beyond its traditional focus on staple grains toward a more

PUBLICATION ALERT

Mehta, Vanya. "Shaping Favorable Policies to Achieve Food Systems Diversity: An Agenda for Action." Policy Brief No. 1, TCI-TARINA, Sept 2016.

Recommended Five-Point Pathway:

1. Encourage diversification of smallholder production systems towards more nutritious crops and livestock products
2. Reduce inefficiencies in smallholder participation in value chains for nutritious crops
3. Educate and create incentives to adopt environmentally sensitive agricultural management practices
4. Enhance consumer demand for more nutritious foods
5. Trade policies that supplement deficits in domestic production and export surplus

diversified food system. These five pathways are defined in a policy brief that was prepared by the CoE and disseminated to a wide range of stakeholders, with the aim of triggering increased action and policy reforms that improve nutrition outcomes in the future.

FOOD SYSTEMS DIAGNOSTIC STUDY (FSDS)

TARINA provides field-based technical assistance for designing, implementing, and scaling agricultural initiatives that ensure positive nutrition outcomes. It does this by integrating nutrition-focused objectives, actions, and metrics into projects and programs implemented by NGO and development partners in three Indian states—Bihar, Odisha, and Uttar Pradesh—where the burden of malnutrition is greatest. Project locations in each state are highlighted in the map on the following page.

At the onset of the project, the TARINA consortium determined it was necessary to undertake a rapid assessment of the food systems context in each location before interventions best suited to addressing local nutritional challenges could be properly designed and implemented. Therefore, the consortium launched a Food Systems Diagnostic Study (FSDS) that ran from February to March 2016 across the three project locations. The aim of the FSDS was to identify specific aspects of field settings that constrain or facilitate achieving the project's overall goal of creating a more nutrition-sensitive food system. The FSDS was intended to support the consortium's efforts to identify and design interventions for reorienting agricultural initiatives toward nutrition outcomes and to sharpen data collection for monitoring and evaluating the impact of these interventions over time (Figure 11).

The methods used for data collection at each project location included focus group discussions (FGDs) with

FLOW CHART OF FSDS OUTCOMES

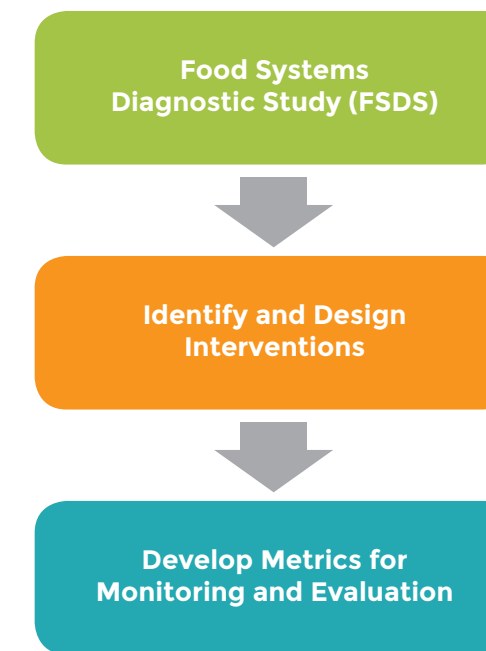
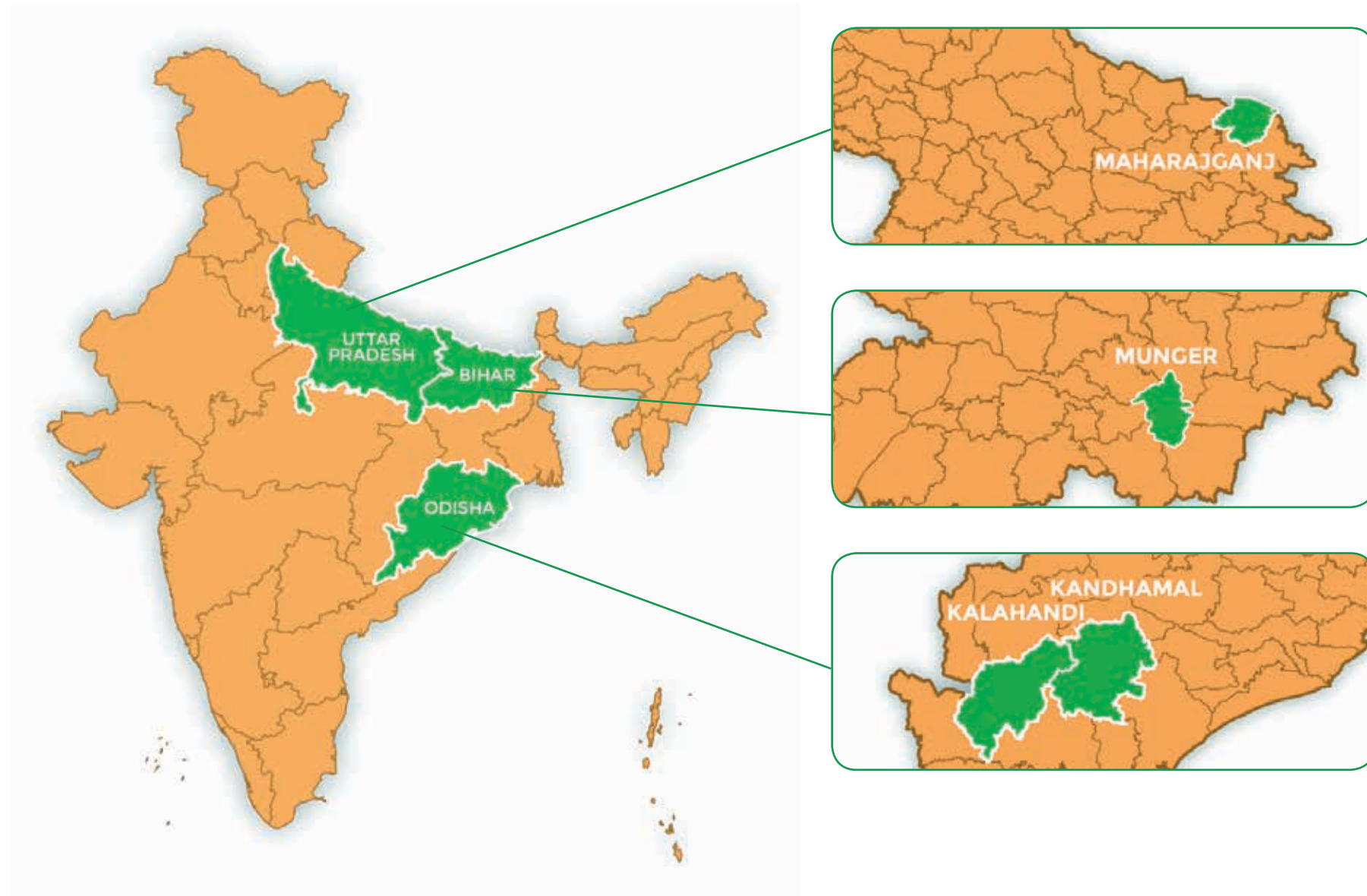


Figure 11

households and groups within villages, such as women's self-help groups (SHGs), producer groups, and literacy groups. They also included individual interviews with key informants, such as smallholder farmers, health workers, agricultural extension scientists, nutritionists, and veterinary officers.

In each village, the FSDS team completed a transect walk to document observations related to agricultural production; animal husbandry; food storage; and water, sanitation and health (WASH) practices. Additionally, the team visited local and regional food markets as well as field sites where existing agricultural and rural

TARINA PROJECT LOCATIONS



development initiatives are being implemented by NGO partners or other local organizations.

The FSDS was carried out over the course of four to five days at each location by a team of eight or more staff members from TCI, BAIF, CARE, and GDS. Two villages were visited per day, and the recording and summation of data collected took place at the end of each day. This was typically followed by an FSDS team consultative meeting, where general impressions from site visits were shared and interventions were devised according to the objectives and expected outcomes of TARINA.

The consultative process involved in the FSDS served as a platform for sharing inter-organizational knowledge and expertise. Ultimately, this led to the identification of opportunities for cross-fertilization between partners and across locations.

The FSDS resulted in a set of priority interventions that are currently being implemented by consortium partners. Each intervention takes into account the local context and was designed to either alleviate factors that constrain or maximize factors that facilitate achieving the project's goal of creating a more diversified and nutritious food system. Furthermore, findings from the FSDS have been used to develop metrics for baseline surveys that will be implemented across the three project locations in the coming year to track both project-wide and intervention-specific outcomes.

ONGOING AND PLANNED ACTIVITIES

As the primary grantee, the TCI is the convening agency responsible for coordinating the TARINA consortium as well as providing oversight and ensuring accountability among partners. Through the CoE in New Delhi, we are spearheading the monitoring and evaluation

(M&E) component of the project. We are also making substantial research contributions to help further institutionalize nutrition-sensitive agriculture in India.

TCI has been working alongside consortium partners to implement field-based interventions that ensure nutrition outcomes at scale. Each partner offers a unique set of skills, knowledge, tools, and experience to help us achieve this goal. For example, BAIF is contributing its expertise in livestock breeding and in developing cropping systems for the diversification and intensification of agricultural production on small- to medium-sized plots. Additionally, CARE's gender transformation toolkit has been identified as an effective and potentially scalable approach to empowering women through gender-based dialogue, awareness-building, and behavior change. Similarly, GDS' Community-Led Total Sanitation (CLTS) program has also been identified as an effective and scalable approach for reducing open defecation through education, awareness-building, and behavior change.

TCI's research aims to support the efforts of consortium partners and to inform the design of nutrition-sensitive projects, programs, and policies. TCI research activities focus primarily on the following topics:

- Mitigating risk factors associated with mycotoxin accumulation across the food system
- Labor-saving technologies for reducing women's drudgery
- Pulse production, trade, and markets
- Linkages between sanitation and nutrition outcomes
- Nutrition-focused metrics for food systems, agricultural policies, and programs

A key objective of the TARINA CoE is translating TCI research into policy action. Thus, we plan to continue generating policy briefs and initiating dialogue around strategic policy issues by engaging with government and other stakeholders, at both the national and state levels,

PUBLICATION ALERT FROM THE CENTER OF EXCELLENCE



POLICY BRIEFS

Shaping Favorable Policies to Achieve Food Systems Diversity: An Agenda for Action
TCI-TARINA Policy Brief No. 1 • Sept. 2016
By Ms. Vanya Mehta

Sufficiency of Macronutrients and Micronutrients in the Indian Food Supply
TCI-TARINA Policy Brief No. 2 • Oct. 2016
By Dr. Julia Felice

Spatial Analysis: Visualizing Shifts in Agriculture in India
TCI-TARINA Policy Brief No. 3 • Oct. 2016
By Ms. Hillary Byerly

MANUALS

Guidelines for Incorporating Dietary Diversity Metrics in Agriculture-Nutrition Surveys
Operational Manual for Using Dietary Diversity Indicators in Field Research
TCI-TARINA Training Manual No. 1 • June 2016
By Dr. Soumya Gupta

Guidelines for Assessing Women's Empowerment in Agriculture
Operational Manual for Using the Women's Empowerment in Agriculture Index (WEAI) in Field Research
TCI-TARINA Training Manual No. 2 • Sept. 2016
By Dr. Soumya Gupta

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through various policy fora, seminars, and academic conferences.



Finally, as part of the overall M&E component of the project, the CoE is preparing to roll out a baseline survey across the four districts in the three Indian states where TARINA is operating. From December 2016 through February 2017, data will be collected in 30 villages (15 controls and 15 treatments) within each of the four districts. Thirty households will be interviewed in each village, resulting in a total sample size of 3,600 households. The information gathered is expected to form part of a larger panel dataset, which will likely be augmented through an endline evaluation slated for December 2018 through February 2019. The final panel dataset will be used to assess the impact of field-based interventions and the extent to which project objectives were achieved.

RESEARCHER SPOTLIGHT

Dr. Soumya Gupta wins inaugural Paula Kantor Award for Excellence in Field Research

A former TCI Scholar and current TCI Postdoctoral Associate, Dr. Soumya Gupta was awarded the 2015 inaugural Paula Kantor Award for Excellence in Field Research. The Kantor Award has been instituted by the International Council for Research on Women (ICRW) in memory of the legacy of their former colleague Dr. Paula Kantor, who was a research expert in the field of gender and international development until her tragic demise in 2015. Soumya was presented the award at the ICRW's 40th anniversary celebrations in New Delhi in January 2016, in recognition of her dissertation research at TCI.¹² Her work examined the extent to which women's empowerment in rural communities of central India is influenced by agricultural management practices and how these practices, in turn, influence the quality of women's diets and their vulnerability to iron deficiency.

Her research is among the first to systematically and empirically assess the empowerment status of women in India as it relates to agricultural determinants and nutritional outcomes. It recognizes the fact that while women's empowerment influences agricultural choices, it can also influence nutritional outcomes.

"I am honored to be the first recipient of the Paula Kantor Award for Excellence in Field Research. There is a great need for better data (and metrics) in the field of agriculture, nutrition and women's empowerment. In light of that, the Paula Kantor award acknowledges the importance of gathering primary data for evidence-based research. At the same time, the Award also recognizes the tremendous effort that goes into designing a field-based data collection activity that is methodologically robust, contextually relevant, and ethically sound. I am inspired by Paula's work and life, and with this award look forward to continuing my research on the linkages between nutrition and agriculture with a focus on women's empowerment, and contributing to policy reform in a meaningful way."

Soumya is continuing her association with TCI as a postdoctoral associate with TCI's flagship project TARINA. She is based at the Center of Excellence and is providing technical research inputs as part of the TARINA consortium in India.¹³





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Mr. Amit Anshumali, Ph.D. candidate, Development Sociology. Research: The effect of off-farm employment on women's relative autonomy in rural India.

Mr. Phil Frost, M.S. candidate, Crop and Soil Sciences. Research: Developing a soil health assessment framework for Indian agriculture.

Ms. Maureen Valentine, Ph.D. candidate, Animal Science. Research: Trade-offs with the intensification of goat systems in India.

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Dr. Soumya Gupta, Postdoctoral Associate. Research: Nutrition-sensitive agriculture, M&E of TARINA.

Dr. Anaka Aiyar, Postdoctoral Associate. Research: Mechanisms of malnutrition in India.

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Digital Green

Emory University

Grameen Development Services (GDS)

International Crops Research Institute for the Semi-arid Tropics (ICRISAT)

International Food Policy Research Institute (IFPRI)

Mahatma Gandhi Institute of Medical Sciences (MGIMS)

Maharaja Sayajirao University of Baroda

Professional Assistance for Development Action (PRADAN)

Sight and Life (think tank of DSM Nutritional Products Ltd.)

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ENDNOTES


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