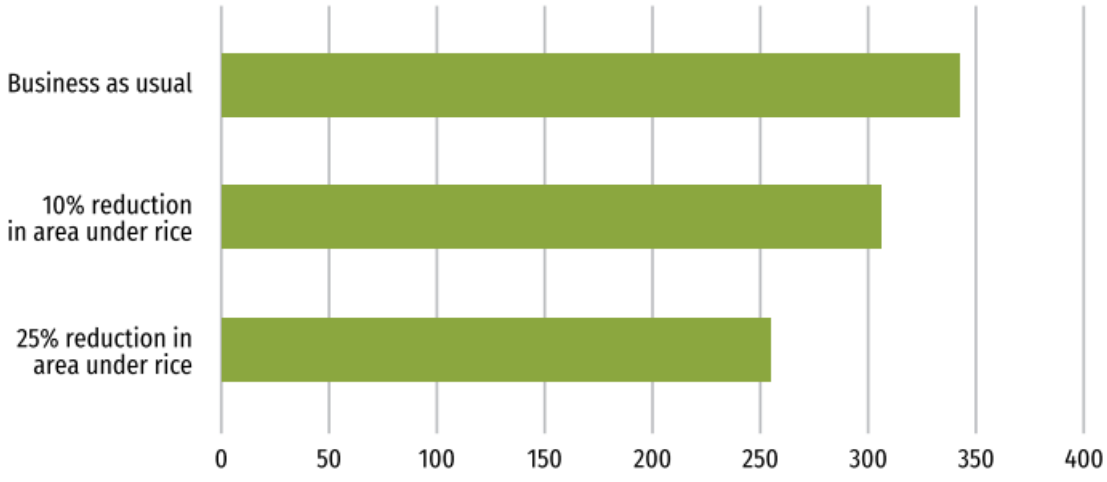
Promoting Agricultural Diversification and Climate Resiliency in India

Moving from rice to more sustainable crops can significantly lower Chhattisgarh's greenhouse gas emissions

Agriculture is the second largest contributor of greenhouse gas (GHG) emissions in the world at 23–34% of total emissions. Rice cultivation, in particular, creates a significant amount of emissions. In this context, India faces a three-pronged policy challenge: (1) reducing agricultural emissions to mitigate climate change, (2) adapting to climate risks to reduce livelihood vulnerability, and (3) increasing agricultural productivity to meet growing food and nutritional demands. Underscoring the urgency of these challenges, India bears a third of the world's undernutrition burden, is ranked among the top 10 countries at risk from the effects of climate change and has an agricultural sector that accounts for close to a quarter of its overall emissions.

Research conducted by the Tata-Cornell Institute for Agriculture and Nutrition (TCI), in collaboration with Professional Assistance for Development Action (PRADAN), aims to show that Chhattisgarh—India's "rice bowl"—can reduce its GHG emissions and make its agricultural sector more resilient to climate change by diversifying away from rice production in favor of climate-smart crops, like pulses, oilseeds, and millets.

Potential Chhattisgarh methane emissions by 2030 with crop diversification (in Gigagrams)



As the producer of 22% of the world's rice, India is the leading emitter of rice-related methane. The state-led, institutionalized procurement process for the Public Distribution System has been key to the dominance of rice cultivation. India's pro-rice policies are part of a broader framework dating back to the Green Revolution, during which minimum support prices (MSPs) and subsidies for fertilizers and irrigation incentivized the cultivation of high-yielding rice and wheat varieties in the country, marginalizing other crops.

If Chhattisgarh reduces its area under rice by 25%, its emissions from rice cultivation would drop from 340.13 Gg to 255.10 Gg and India's rice-related emissions would decrease by nearly 3%.

Rice production, climate change, and diversification

The Green Revolution ushered in the era of high-yielding varieties of rice and wheat, which was further boosted by related policies, like input subsidies and state-led procurement. While these high-yielding varieties have been crucial in reducing India's food insecurity, they have also promoted monocropping and crop concentration. Such patterns of cultivation are concerning, particularly, as they promote reliance on a limited set of crops, exacerbating challenges related to food security and climate resilience.

In a future in which the impacts of climate change—higher average temperatures, changes in precipitation, rising sea levels, and an increase in the frequency and intensity of extreme weather events—are expected to negatively affect crop production, specifically, in arid and semi-arid regions, the diversification of cropping patterns is an important way forward.

Hardy, resilient, and nutritious crops, like pulses, millets, and oilseeds, are part of India's historical cultivation patterns, due to their compatibility with the country's agroclimatic conditions. Given the high number of smallholder, marginal, and resource-constrained farmers who cannot afford high input prices, these crops present an excellent alternative to lower costs and maximize profits while building resilience and food security.

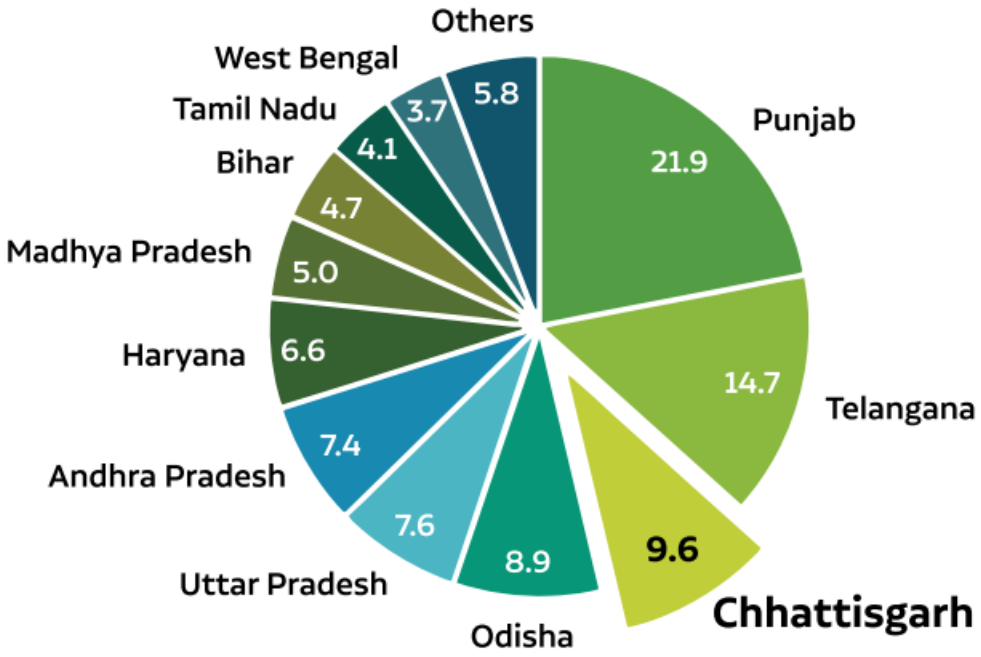
From the perspective of climate-resilience, the crops are characterized by better growth and productivity under low nutrient and input conditions, needing less irrigation, less ulnerability to biotic and abiotic stresses, and less reliance on synthetic fertilizers. They are also shorter in growing

duration vis-à-vis core cereal crops. Thus, diversification has wide-ranging benefits—from climate resilience to livelihoods to nutritional security.

Cultivation, production, and procurement in Chhattisgarh

Rice cultivation has a significant environmental impact through high water consumption and methane production in flooded fields. In Chhattisgarh, it makes up nearly 40% of agriculture, food, and other land use (AFOLU) emissions. Rice is a water-intensive crop; when it is not rainfed during the monsoon season (*kharif*), it is heavily dependent on irrigation. This is a salient challenge, since only 34% of the state's land has effective irrigation.

India's rice procurement by state (percent)



Notes:
1. Average procurement of rice calculated for 2020–21 to 2022–23.
2. Quantity produced and procured in 2021–22 (percent of production procured).
3. Latest production data available for 2020–21.
Source: Food Corporation of India and Directorate of Economics and Statistics (DES)

Despite these challenges, rice production has surged in Chhattisgarh over the last two decades, driven primarily by an increase in procurement by the state government through the decentralized procurement (DCP) system. Between 2014–15 and 2022–23, procurement of rice (in the form of paddy) increased from 50 lakh metric tons to 87.5 lakh metric tons, and rice procurement increased from 34 lakh metric tons to 59 lakh metric tons, at a collective compound annual growth rate of 6%. This sustained increase has made Chhattisgarh the nation's third highest contributor to total rice procurement at approximately 9.6%.

A further stimulus to paddy production is provided by the state government's "top-up" to the centrally announced MSP. In 2020–21, the Government of Chhattisgarh procured paddy at Rs. 2,500 per quintal—more than Rs 600 above the MSP set by the national government—by paying ₹10,000/acre under the *Rajiv Gandhi Kisan Nyay Yojana*.[1]

Bonuses over centrally announced paddy MSP given by the Chhattisgarh state government

MSP/Year	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
MSP (Common)	1,750	1,815	1,868	1,940	2,040	2,183
MSP (Grade A)	1,770	1,835	1,888	1,960	2,060	2,203
Chhattisgarh Bonus	Common: 750	685	632*			19,257**
	Grade A: 730		612*			
Chhattisgarh MSP (Common)	2,050	2,000	2,000	2,000	2,040	2,183
Chhattisgarh MSP (Grade A)	2,070	2,020	2,020	2,020	2,060	2,203

* The Government of Chhattisgarh procured paddy from farmers at Rs. 2,500 per quintal by paying Rs. 10,000/acre under the Rajiv Gandhi Kisan Nyay Yojana.
** The Government of Chhattisgarh paid paddy farmers this amount per acre with a procurement ceiling of 21 quintal per acre.

Source: Food Corporation of India, Chhattisgarh State Cooperative Marketing Federation (CGMARKFED), Food Price Bulletin, and DES.

Increased paddy production has also coincided with greater proliferation of irrigation infrastructure in the state. From 2018–2020, the area under assured irrigation in Chhattisgarh increased by 3.32 lakh hectares. Under the *Saur Sujala Yojana*, nearly 42,000 solar irrigation pumps have been supplied at subsidized prices across the state since 2016.

This combination of factors has ensconced paddy as the primary food crop in the agricultural production system of Chhattisgarh, which limits food system diversification in cultivation and marketing practices.

Reducing Emissions through Diversification

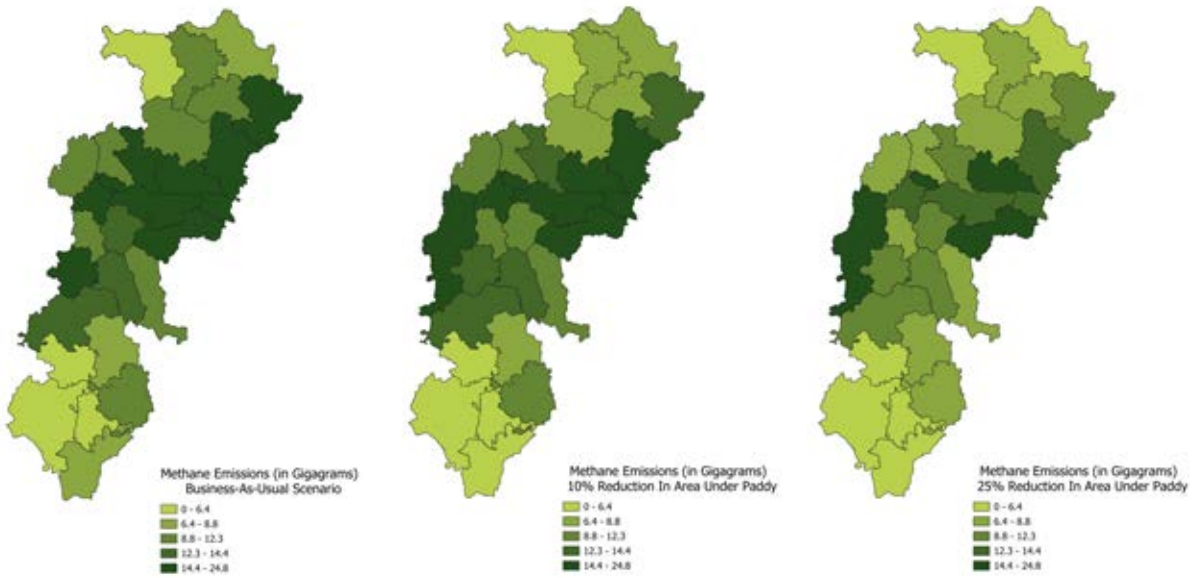
TCI research shows that reducing rice cultivation in Chhattisgarh in favor of millets, pulses, and oilseeds has the potential to shift districts from high-emitting sources of methane emissions into diversified, climate-smart enclaves with significantly reduced GHG footprints. In particular, the

[1] Based on an average output of 15 quintals per acre, the government calculates that this would equate to an incentive of almost Rs 10,000 per acre.

central western and central eastern rice-growing districts have immense potential to diversify and reduce emissions.

Chhattisgarh contributes 9% of India's methane emissions from paddy cultivation. If the state is successful in reducing 10% of its area under paddy by 2030, emissions from rice cultivation will decrease from 340.13 Gg to 306.12 Gg; national rice-related emissions will be reduced by nearly 1%. If the area under rice decreases by 25%, the state's emissions from rice cultivation would drop to 255.10 Gg, and India's rice emissions would be reduced by nearly 3%.

District-level methane emissions from rice cultivation in Chhattisgarh under three diversification scenarios



TCI researchers made these estimations using the recommendations from the 2019 Intergovernmental Panel on Climate Change's report on Methane Emission from Rice Cultivation. The 2nd Biennial Update Report, part of India's Second National Communication to the United Nations Framework Convention on Climate Change, was used for Tier II country specific emission factors for rice. This report provides emissions factors for seven distinct water management practices.[2] The area under paddy, irrigated, and rainfed was obtained from the Directorate of Economics & Statistics, Ministry of Agriculture and Farmers Welfare, and further divided into the above-mentioned water regimes.

[2] These practices are: irrigated continuously flooded, irrigated single aeration, irrigated multiple aeration, rainfed flood prone, rainfed drought prone, deepwater, and upland.

These estimates show the significant mitigation and adaptation potential of agricultural diversification in Chhattisgarh. In the context of India's food security and climate-related challenges, they provide clear evidence of the importance of shifting away from cropping systems dominated by paddy.

Policy Infrastructure to Promote Diversification

Despite the entrenched nature of paddy in Chhattisgarh, a policy landscape and infrastructure that supports sustainable and diversified agriculture exists today:

- The Chhattisgarh Millet Mission and the National Food Security Mission promote diversification by creating awareness and providing incentives and inputs for farmers to cultivate pulses, millets, and oilseeds. Interventions targeting improved access to high-quality inputs address critical gaps in the agricultural value chain, ensuring farmers can optimize production potential.
- The State Rural Livelihoods Mission harnesses the power of women and self-help groups to promote sustainable and climate-smart agriculture. The Mission prioritizes training and extension services to equip farmers with skills for sustainable practices, such as organic farming and water conservation.

While nascent in scale and nature, these programs collectively work to support farmers and promote diversified, sustainable, and remunerative agriculture.

Transformation of Agricultural Systems for Climate Resilience

This policy brief was produced as part of the joint TCI–PRADAN project, Transformation of Agricultural Systems for Climate Resilience. The project aims to identify credible pathways to diversify agriculture in Chhattisgarh away from rice in order to improve climate resiliency, increase farm income, and encourage nutritious dietary practices.

The project focuses on three key interventions:

- **Education and awareness:** Providing farmers with timely information on climate change impacts and promoting sustainable agricultural practices through demonstrations, including training on improved agronomic practices, pest management, and postharvest technologies.
- **Market access:** Enhancing market opportunities by connecting farmers with high quality seeds, fertilizers, and agricultural value chains.

- **Irrigation infrastructure:** Developing community-based irrigation systems to support the cultivation of non-paddy crops, including the promotion of water harvesting structures, such as farm ponds and solar lift-irrigation systems, especially in underutilized upland areas.

About TCI

TCI is a long-term research initiative that develops and assesses innovative, food systems-based approaches to reducing poverty and improving nutrition and livelihoods in the developing world, with a specific focus on India.

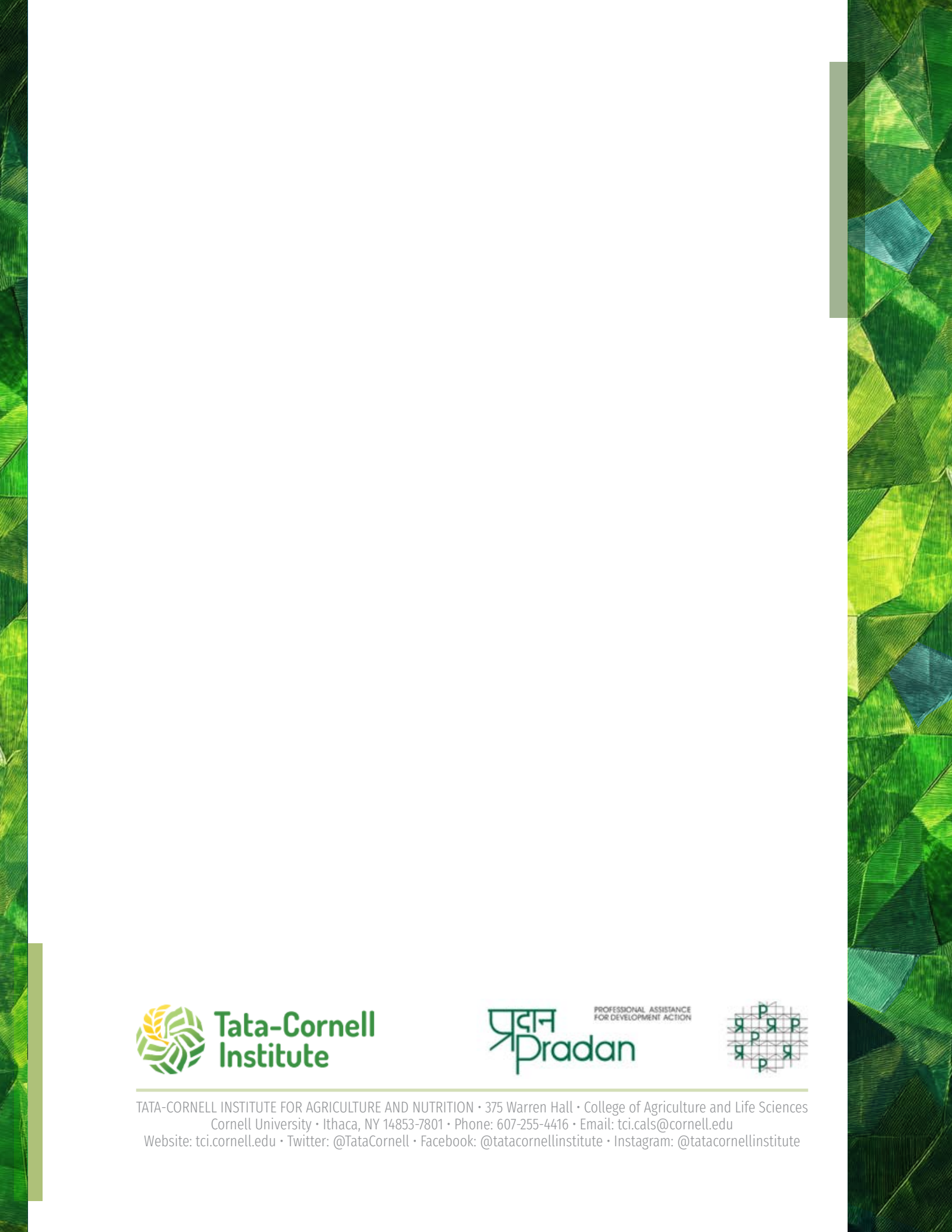
With a diverse team of researchers and graduate students, TCI blends high-quality academic research, field-based projects, and policy analysis to generate and share knowledge relevant to policymakers, research institutions, and development agencies. As a multidisciplinary initiative, TCI provides a space where soil scientists, climate specialists, economists, nutritionists, food scientists, sociologists, and more can learn from each other's work, share their research approaches and methodologies, and expand their perspectives on the complex nexus of agriculture, nutrition, and development.

TCI's main office is located on Cornell University's campus in Ithaca, New York, where it is part of the College of Agriculture and Life Sciences and is hosted by the Department of Global Development. The institute also has a satellite office in New Delhi, India, where the Institute's Center of Excellence is based.

Learn more

To learn more about the Transformation of Agricultural Systems for Climate Resilience project, visit:

https://tci.cornell.edu/?projects=transformation-of-agricultural-systems-for-climate-resilience



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