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SPECIAL REPORT
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A Climate Strategy for a Growing Nation

EDF science is helping struggling Indian farmers fight climate change and grow more food.

By: Shanti Menon

As the climate warms, droughts in India are becoming more frequent and extreme.

About 50 years ago, on the heels of a dreadful famine, India turned to industrial agriculture — hybrid seeds, chemical fertilizers and intensive irrigation — to increase its food supply. It has now become one of the world's largest producers of wheat and rice. But India's "Green Revolution" has come with difficult tradeoffs. The demands of irrigation, along with other factors, are drawing down water supplies, forcing farmers to drill ever deeper to irrigate their thirsty crops. Many farmers are crushed by debt, burdened by the cost of expensive seeds, chemicals and fuel. In one Indian state, more than 20,000 farmers have committed suicide since 2001. And despite the increased production of wheat and rice, malnutrition persists, especially in the countryside.

As India seeks to provide more food and energy to 1.3 billion people, it has also become the world's fourth-largest climate polluter, behind the United States, China and the EU. At the same time, India's farmers are among the most vulnerable to climate change. This summer, nearly half of India was seared by drought. Newspapers reported entire villages, short of water, abandoned. When the rain does come, it falls in torrential bursts, flooding crops instead of nourishing them. "It's not a gentle, sprinkling rain — what we call in Hindi *rimjhim*," says Kritee, a senior scientist in EDF's global climate program. (Note: Her one-word name will be explained shortly.) "It's more like the clouds are bursting."

Farmers learn about climate-smart practices that can increase profits and decrease pollution.

The Indian government is looking for a path to climate resilience that will also build prosperity for its people. It is setting ambitious targets for renewable energy and developing new policies to drive sustainable agriculture. Yet, more needs to be done. While India is exceeding its Paris climate targets, its emissions are still growing, and EDF research suggests that the climate impacts of farming in India may be much larger than previously supposed. The scale of the challenge is great, but so is the opportunity for India — and the world — to chart a safer, more prosperous path forward.

Kritee leads EDF's scientific research on climate-smart agriculture in India, where 800 million people, and 80% of its poor, live in rural areas. If India is able to follow a climate-smart path to rural development, it can promise a

better future not just for its farmers, but for the planet. “Our climate destiny is intertwined with how all underserved populations of the world, including in India, choose to get food, fuel and fiber,” she says.

In addition to her expertise in biogeochemistry, Kritee brings a passion for justice and the wisdom of Zen (she’s also a meditation teacher) to her climate work. We sat down with her to discuss how EDF is helping small farmers in India increase their profits while reducing their pollution, and how her work on the spiritual and emotional dimensions of her life keep her motivated in the face of a sometimes daunting climate battle.

How is climate change impacting India right now?

Climate change often exacerbates the extremes. Droughts are hotter and longer, and then, when rain does come, it’s a cloudburst. These intense rains fall on hard, degraded soils or roads and buildings that can’t retain water. So we see flooding and immense devastation. In July, the city of Mumbai, which has 24 million people, got more than 39 inches of rain in three days. That’s what most U.S. cities get in an entire year. And this happened on the heels of an extreme water shortage in Chennai, another mega-city of 10 million. In Delhi, extreme heat waves can make roads melt. When I was studying in Delhi it got hot, but we never saw anything like that.

Flooding in the Ganges River can threaten lives, crops and property.

Why is EDF working in rural India?

Solving climate change is an all-hands-on-deck effort, and the developing world is a vital partner. Most of India hasn't been built yet, so that's an opportunity and a challenge. Most Indians still live in villages, they cook food on smoky wood stoves, they grow food on one-acre farms and barely make $2 a day. When floods or droughts occur, the rural population is affected the most. But if all those people follow the same path to prosperity as the West did, burning fossil fuels and intensively using nitrogen fertilizer, the planet is in real trouble. Our job is to reimagine how to bring energy and food security to these households by leapfrogging over old technologies. Like using cleaner, highly efficient cookstoves instead of smoky wood-burning stoves that pollute the air and climate. And using climate-smart farming techniques, like more efficient water and fertilizer use, to increase profits and decrease pollution.

Traditional wood-burning stoves create hazardous indoor air pollution as well as climate pollution.

You've been working with small farmers in India to measure greenhouse gas emissions from their crops. How do you talk to them about climate change?

No matter where you are in the world, you can't walk up to a farmer and tell them here's how you should grow your food so you can reduce climate pollution. We don't do that in the U.S. and we don't do it in India either. With

any farmer you have to present a solution that makes economic sense. We call it the triple bottom line: higher yields, higher profits and climate benefits.

Farmers are buried under debt. They can't get credit. They don't have money to invest in something like a new irrigation system. They travel a long way to buy seeds and they turn out to be mixed with stones. Or if they're able to grow the food, they can't sell it! I can't tell you how many meetings I've been to where a farmer says he can only afford to go to market twice a year. Or he had 100 kilograms of cauliflower but was only able to sell 10 and now he doesn't know what to do with the rest. Because he has no cold storage.

It's bewildering. How do you ask them to follow our advice on climate when they are facing so many existential problems?

Most Indian farmers live on $2 a day and are on the front lines of climate impacts.

So what kind of solutions can we offer farmers?

We are working with partners on the ground to offer comprehensive solutions that will help farmers become more profitable while also reducing their environmental impacts. If we want them to accept our advice, we have to first build trust.

Through our partner, we're working with about 15,000 farmers in the state of Bihar, in a district called West Champaran. It happens to be the site of one of Gandhi's first successful nonviolent protests, where tenant farmers who were

being forced to grow indigo were able to change unfair agricultural laws. Our partners have microentrepreneurs in villages across the district who stock high-quality seeds and materials, and have direct links to big buyers, so they can buy farmers' produce at a 5% to 10% premium. So we give farmers access to better inputs and markets. We help with things like crop insurance and credit lines. There are a number of creative solutions, like forming a coalition so a whole community can get a bank loan that a single farmer would not be able to get.

Sumathy, a farmer and research volunteer, helps track local temperature and rainfall.

We've developed an app that farmers can use to solve problems in their fields. If they have a smartphone, which several thousand do, they can snap a picture of their field and ask an expert, "What pest is this? Why are these leaves yellow?" For those who don't, the local microentrepreneur has a smartphone and works as the point person. There's a toll-free number they can call too.

As part of this whole package, the farmers get our recommendations on how to be more efficient with fertilizer, irrigation and pest control, which will also help increase the amount of food they grow. Like, "You don't need 60 kilograms of fertilizer, you only need 20 if you apply it at a particular time in the growth cycle." These things give farmers a sense of security that we have their well-being in mind and we are not just using them to test our theories.

We're finding that, on average, farmers are increasing their profits by 5%

to 10% when they use the app, because they're able to increase their yields by about 10% to 20%, and use less fertilizer and less energy to pump water. When you offer a whole system that helps, then people are willing to listen to your recommendations. Now the state and national governments are taking notice and want to work with us.

Tell me about the surprising results of your rice research in India, which got global media coverage.

My team sent me some results that I really couldn't believe. Rice is the single most important crop for the poor in Asia and Africa. We use more land, water and chemicals for rice than any other crop. Our objective was to measure the climate impacts of rice cultivation, comparing different farming techniques. Rice farms all over the world are known to produce methane, so I expected we would see changes in methane. Instead they found extremely high amounts of nitrous oxide, which is a much more powerful greenhouse gas than methane. I thought, 'What is happening? Are our instruments not working?' But after five years of measurements and modeling, we realized we were correct, and we had discovered a big nitrous oxide problem. We found the climate impact of rice farms could potentially be equal to the global impact of methane from oil and gas. And the current recommendations to reduce methane from rice farming might cause more harm than good by increasing nitrous oxide.

More than 1 billion people worldwide depend on rice farming to make a living.

That was such a groundbreaking discovery. What does it say about the importance EDF places on scientific research?

EDF focuses on rigorous science. We do not peddle solutions that are half-baked. We started this research to look at something very specific, which was to measure the greenhouse gas impact of climate-smart farming practices versus business-as-usual farming. But when I spoke to the team about the unexpected results we were seeing, I got the go-ahead to explore deeper. I had so much support for this work. We see this over and over and again at EDF. Through science, we make fundamental discoveries that can set a new course for solutions.

Carefully monitoring water levels can greatly reduce climate pollution from rice farming.

In the case of rice, we were able to find an elegant solution. When farmers use a moderate level of water to flood their fields, and do it at specific times, they can decrease their climate impact up to 60%.

But you can't tell a farmer living on $2 a day to start monitoring and managing his water supply. That's why giving them a comprehensive program to increase yields and profits along with teaching them how to manage water levels is so important.

We're also working with global research institutions to change their recommendations for rice cultivation and create a funding stream for simple tools that can help farmers monitor their water use.

How else has EDF's work in India grown over the past few years?

EDF and our partners are growing our comprehensive smartphone-based initiative to 200,000 farmers next year. We've also launched a major scientific collaboration that brings together local agricultural universities, Cornell University, the government of Bihar and international agricultural research groups. The goal is to give farmers customized information for their crop and soil type. You can't make a blanket recommendation, like it takes this much nitrogen and phosphorus and potassium to grow food. Each farmer's soils are a little different. They grow different crops. They use their own recipe that they have tweaked over years or decades. So we're trying to develop low-cost soil sensors that can help us figure out soil quality cheaply and quickly but accurately.

Right now, soil testing is expensive, and you need about 4 to 5 pounds of soil for each analysis. We want to bring that down to a tablespoon and about $2 to assess how much nitrogen or potassium is already in your soil, so you can be more efficient with fertilizer. That tailored information will save money, increase yields and also prevent climate pollution from nitrous oxide.

> "She was beaming and so proud to tell me that her face and hands no longer became black from soot that comes from burning wood."

We worked with local partners to bring clean cookstoves to a quarter of a million households in India, and now we're scaling up that work in two states. One of my favorite moments was with a woman whose wood-fired cooking at home was replaced by a biogas cookstove. She was beaming and so proud to tell me that her face and hands no longer became black from soot that comes from burning wood. She was pointing to all the walls of her house and saying, "See, see, these walls don't get black now!"

We're also compiling a repository of Indian research into air pollution that will make thousands of studies accessible online. We want to highlight Indian expertise on this issue and inform where India can best focus its efforts to

combat air pollution. Similar to how we're tackling global methane pollution — by filling in data gaps, you can chart solutions.

What makes you feel optimistic about working in India?

I have tremendous confidence that our framework for rural development is right. We gained trust by giving farmers solutions they really needed, what they were hungry for. I mean, we would be out there crunching our numbers on how much climate impact our efforts are making, and we'll keep doing that. But at the most basic level, farmer satisfaction and our ability to gain their trust — that's huge. Because farmers talk to each other. These communities are strong. They are the ones moving this work forward.

It helps that our work aligns well with government priorities and they too are keen to test new ideas. Finding solutions that can be scaled up is half the battle.

You go by one name, Kritee. Can you explain the significance of that?

It goes back to feminism. My mom didn't change her last name after she got married, and when I was born, she only put my first name on my birth certificate. She said, "My daughter will decide what she wants to pick as her last name." I went by one name all my life, but when I came to the United States the computer systems couldn't handle it! They refused to give me a visa with just a first name, so they made Kritee my last name and put the letters FNU — first name unknown — for my first name. So for the first few years my name was Fnu Kritee.

Your mom sounds like a strong woman! And you come from a long line of fighters. Your grandfather was a freedom fighter in India.

He was a lawyer and activist who worked alongside Gandhi in the Indian independence movement. His courage is definitely an ongoing inspiration for me.

With that activist background, why did you become a scientist?

Kritee, a Zen Buddhist priest with a Ph.D., wants to use science to make society more just.

I have a curiosity about natural phenomena, about how life came to be. So I studied science but I was always passionate about social justice. Just before I came to the U.S. to get my Ph.D., I spent a summer with my grandfather's colleagues visiting villages in India. Seeing the poverty, the pollution, the people who felt voiceless — it pierced my heart.

When I got to Rutgers to study bioinformatics — basically writing code to figure out where genes are in a genome — I became depressed. I wanted to do something as a scientist to make society more just. That's how I eventually made my way into the climate field and to a post-doc at Princeton that led me to EDF. Now I'm constantly at that interface of scientific research and environmental justice. That's what keeps me excited about our work in India.

You're also Zen Buddhist priest. How does that help your work as a climate scientist?

To be in this field, it's not enough to use your intellect alone. You need to bring your heart, spirit and intellect together. If I didn't meditate and work on my psychological and spiritual health, I would be paralyzed! That inner work is the backbone of the other two wings of my life, climate and justice. That's how I'm able to keep flying.

My husband, who's also a climate scientist, is my constant companion in crime, and we teach mediation together. With several other Buddhist

teachers, I helped co-found the Rocky Mountain Ecodharma Retreat Center outside Boulder, Colorado. It's on a 180-acre nature preserve where we hold low-cost workshops and retreats to help people regain their connection with nature and re-energize to fight ecological and social injustice.

Climate grief is very real. People can get burnt out and depressed. I work with a lot of climate scientists. In fact, I'm holding a weeklong yoga and meditation retreat for women of color who work on climate: scientists, journalists, lawyers, activists, anyone in the field. To keep facing this truth that we are facing, on top of the racism and sexism, it can be daunting.

What advice do you have for people struggling with climate anxiety?

The most important thing is friendship and community. Feeling alone is frustrating. You get angry, and that leads to denial. I want to distract myself so I'll binge-watch Netflix, right? If we want to take courageous action and build the kind of world we want to build, we have to come together as communities that do the psychological and spiritual work and the policy and advocacy work together.

Also, pay attention to how you feel. I always say that emotion is e-motion, it gets us to move. Don't suppress what you feel, because underneath that grief is love. And if we can touch that love with the help of our community, it will power our climate and social justice movements.

For more information, please contact EDF Member Services at 800-684-3322 or email members@edf.org.

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