CHAPTER 3

EMPOWERING SMALLHOLDER FARMERS TO CONTINUE TO FEED THE WORLD

KEY MESSAGES

- Smallholder farmers in developing countries, who produce nearly a third of the world's food, stand at the frontlines of the climate crisis. With limited resources, small landholdings, and heavy dependence on rainfall, their livelihoods are increasingly vulnerable to rising temperatures, shifting weather patterns, and extreme climate events.
- A combination of responses are required to support smallholders, including enabling them to manage watersheds; practice climate-resilient agriculture approaches adapted to local context; establish self-help and support groups to strengthen agency; and access information to support decision-making.
- Watershed management led by communities has the potential to transform the economy of rural areas by increasing agricultural production, reviving soils and aquifers, harvesting rainfall, and restoring the balance of nature.
- Digital tools must allow reciprocal communication, so farmers can communicate directly with experts for information that is tailored to their needs, and co-create solutions.
- Women farmers are central to adaptation. Self-help groups and Farmer-Producer Organizations can support them in taking leadership roles in decision-making and shaping markets.

Devolving Decision Making

Addressing Structural Inequalities

Investing in Local Capacities

Building Understanding

IN THIS CHAPTER

- From Collapse to Renewal
- Smallholder Farmers at Risk
- A Nationwide Movement for Managing Water
- Communities as Water Stewards
- Climate-Resilient Agriculture
- Institutionalizing Solidarity and Support
- Information to Deal with a Changing World
- Scaling Up and Shaping Policy
- The Road Ahead

> **Most villagers migrated seasonally to brick kilns or nearby cities to earn enough to eat.**
>
> Vanita Ugale, a resident of Kumbharwadi

FROM COLLAPSE TO RENEWAL

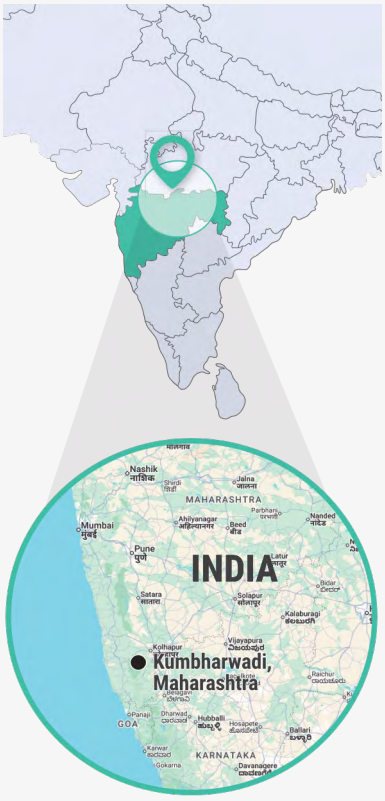
In the late 1990s, Kumbharwadi, a drought-prone village in Maharashtra, India, was on the brink of ecological collapse. Called the village of potters, it was a place where residents struggled to earn enough to survive. Rain was scarce. The village was served by a single well, which ran dry every summer, leaving residents dependent on water tankers. "Most villagers migrated seasonally to brick kilns or nearby cities to earn enough to eat," recalls Vanita Ugale, a resident of Kumbharwadi.

Then came inspiration. Kumbharwadi's neighboring village, Darewadi, used to be in a similar situation, facing severe water scarcity, infertile lands, and limited cropping capacity. Like Kumbharwadi, Darewadi received only about 450 millimeters of annual rainfall, enough to support agriculture for just three to four months a year. But it had transformed itself through something called watershed development.

Watershed development restores watershed ecosystems to direct, harvest, and store rain, while improving soil health and ecosystem function, and ultimately increasing agricultural income and livelihoods. The residents of Darewadi had built contour trenches, check dams, bunds, and gully plugs with support from the Watershed Organisation Trust (WOTR), resulting in dramatic changes. Cultivable land increased, and cropping months expanded from three to four months to nine to ten months per year, supporting year-round employment. Village Development Committees and the Village Water Management Team emerged as community stewards, overseeing resource use, banning borewell drilling, and managing collective decisions.

It gave Kumbharwadi's residents hope. If Darewadi could reclaim its fields and dignity, why couldn't they?

Over the next 14 years, they worked to transform their dying village into one that is thriving. The transformation was remarkable. The village created a water storage capacity of 100 million liters. Kumbharwadi now has 330 hectares of cultivated land, of which 210 hectares are irrigated. From 1998 to 2012, US$ 2.7–3.9 million in investments yielded US$ 9–10 million in benefits—a net present value estimated at US$ 5–7.4 million. Groundwater levels rebounded from 6.5 meters below ground to just 3 meters. Lands once considered wastelands have been transformed into productive fields.



Kumbharwadi residents transformed their village and benefited from increased crop and livestock production.

Planting trees, banning livestock grazing, and other strategies produced US$ 30,000–43,000 in benefits for each household over 15 years in increased crop and livestock production, avoided costs of water storage tanks, and more.[12] Households gained health, nutrition, biodiversity, and gender empowerment dividends—including improved school attendance, reduced migration, and expanded women's agency through self-help groups. They were able to withstand droughts better. Farmers took a risk and opted to cultivate a larger number (24) of crops in smaller areas, rather than cultivate a few crops over larger areas as they did during years of normal rainfall. This paid off as a climate adaptation strategy.[13]

Sanskar Panlot Samiti, the committee set up to maintain and manage water-harvesting structures, remains active to this day, with rotating members ensuring that water self-sufficiency is sustained.

The journey that began in Darewadi and Kumbharwadi has ripples far beyond, reshaping farming and water management across India and offering important lessons for supporting smallholder farmers across the world to deal with the impacts of climate change.

SMALLHOLDER FARMERS AT RISK

Across developing countries, smallholder farmers—who produce nearly a third of the world's food—stand at the frontlines of the climate crisis. With limited resources, small landholdings, and heavy dependence on rainfall, their livelihoods are increasingly vulnerable to rising temperatures, shifting weather patterns, and extreme climate events.

Rising Temperatures and Unpredictable Rainfall: Average global temperatures have risen by 1.1°C since pre-industrial levels, but developing countries are experiencing disproportionate warming. In South Asia, heatwaves now arrive earlier and last longer, reducing crop yields and increasing heat stress on both farmers and livestock. Sub-Saharan Africa faces erratic rainfall and prolonged dry spells, affecting the timing and success of sowing seasons. A 2025 study warns that for every 1°C of warming, maize yields would decline by 4.03% on average globally. For rice, the decline would be 1.1% initially, accelerating to 7.1% per 1°C after 3.13°C of warming. Wheat yields would initially drop by 6.1% per 1°C, with losses increasing to 8.2% after 2.38°C of warming.[14]

Increased Frequency of Extreme Events: Climate change is also intensifying droughts, floods, and cyclones, disproportionately affecting farming communities in regions least equipped to cope. In South Asia, recurring floods destroy crops, homes, and seed reserves, forcing families to migrate temporarily or permanently. In East Africa, multi-season droughts have left millions facing acute food insecurity. In Latin America, hurricanes increasingly damage irrigation systems and transport networks, cutting off farmers from markets. These shocks erode farmers' savings, deepen debt cycles, and reduce their ability to invest in climate-resilient practices.

Water Scarcity: Water scarcity driven by climate change is increasingly undermining the livelihoods of smallholder farmers in developing countries. In Vietnam's Central Highlands and South Central Coast, for example, hotter dry seasons and more irregular rainfall have reduced both surface and groundwater availability, causing significant drops in crop yields—particularly for those relying on one or two rainfed crops per year, and among women and ethnic minority farmers with plots under one hectare.[15]

In parts of Sub-Saharan Africa, smallholders who depend almost entirely on rainwater face frequent droughts and longer dry spells, pushing them to overuse limited irrigation infrastructure or resort to expensive groundwater pumping where possible, depleting aquifers, leading to long-term water insecurity.[16]

Soil Degradation: Soil degradation—loss of fertility, structure, organic matter, and moisture-holding capacity—poses a major threat to smallholder farmers, especially as climate change intensifies. Changes in rainfall patterns, more frequent droughts, heavier downpours, and higher temperatures accelerate processes such as erosion, nutrient depletion, organic matter breakdown, and reduced soil water retention. In Ethiopia, for instance, a large share of smallholder farmers report soil nutrient depletion, increased erosion hazards, and declining soil texture, all associated with climate variability. These soil changes are correlated with observable losses in crop yield.[17]

Pest Outbreaks and Crop Diseases: Warming temperatures and changing precipitation patterns have altered pest dynamics, causing unprecedented infestations. In East Africa, the 2020 desert locust invasion—driven partly by climate anomalies in the Indian Ocean—devastated millions of hectares of cropland. In South Asia, rising humidity has increased outbreaks of fungal diseases like rice blast and wheat rust, further threatening food production.

WOTR's integrated model places communities at the heart of climate action.

Gendered Impacts and Social Inequities: Climate change disproportionately affects women farmers, who make up nearly 43% of the agricultural workforce in developing countries, on average.[18] Limited land ownership, restricted access to credit, and unpaid care burdens make it harder for women to adopt climate-smart practices or recover from climate shocks.

Youth and male migration from rural to urban areas—triggered by declining farm incomes—is reshaping community structures and leaving female and older farmers with fewer hands to work the land.

Health Implications: Beyond livelihoods, climate change is affecting farmer health. Heat stress, vector-borne diseases, and contaminated water sources are increasingly common in rural areas. Combined with food insecurity, this creates a vicious cycle where malnutrition, illness, and reduced labor capacity reinforce vulnerability.

The impacts of climate change on smallholder farmers in developing countries are multidimensional—affecting water, soil, crops, health, and social systems simultaneously. These impacts not only reduce agricultural productivity and income, and affect health and well-being, they also force difficult tradeoffs. Farmers may abandon land, shift to less profitable crops, reduce planting frequency, or invest in costly adaptation measures which many cannot afford. Over time, this contributes to increased food insecurity, greater vulnerability, and a widening gap between well-resourced farmers and the poorest smallholders.

Locally driven adaptation strategies—like those championed by WOTR—offer pathways forward for smallholder farmers to strengthen their ability to adapt, recover, and thrive despite mounting climate pressures.

A NATIONWIDE MOVEMENT FOR MANAGING WATER

Smallholder farmers in India are heavily reliant on rainfall, like farmers in other parts of the developing world. Rainfed agriculture accounts for 68% of India's cropped area, provides livelihoods to 480 million people, and accounts for nearly 40% of the total food production.[19] Managing rainwater for both irrigation and domestic use is therefore critical for food and water security.

India's initial efforts in watershed management were focused on the technical aspects of land and water management, mainly led by experts, but the results proved short-term as people sought to maximize individual gains, straining limited resources. Watershed management approaches then evolved to focus on community leadership, gender equity, and capacity-building of local institutions for watershed management. Local communities became informed water stewards, working together to collect and harvest rainwater through water harvesting structures; and to regulate water flow, groundwater recharge, soil erosion, and water quality by planting trees and sustaining forests.

Watershed development was scaled up nationally in 2009, through an Integrated Watershed Management Program implemented by the Ministry of Rural Development's Department of Land Resources. Since 2015, the Program is implemented as a watershed component of the Pradhan Mantri Krishi Sinchayee Yojana, through a decentralized structure that includes community watershed management committees. Between 2014 and 2022, 764,000 water harvesting structures have been created or rejuvenated, covering 1.64 million hectares for rainfed agriculture.[20] The Program aims to cover 55 million hectares of rainfed land by 2027.[21]

Community-led watershed management practices in dryland areas have led to significant results in India, improving soil moisture retention by 20–25%, soil loss by 25–50%, runoff by 50–60%, agricultural productivity by 30–45%, and water use efficiency by 15–25%.[22]

Modern water-saving technologies like drip irrigation and sprinkler systems are introduced in the WSI approach to help farmers make the most of every drop.

COMMUNITIES AS WATER STEWARDS

In 2015, WOTR and the WOTR Centre for Resilience Studies (W-CReS) launched the Water Stewardship Initiative (WSI)—an approach for climate-smart and locally led water governance, aiming to transform water users into active custodians of this precious resource.

Under the WSI approach, villagers come together to understand their water realities through a participatory water assessment.[23] WOTR's experts capacitate the villagers to understand the water cycle, including geology and aquifer recharge. They then learn to assess the water requirements of humans and farm animals, and the irrigation requirements of each crop, to create a village water budget—a practical plan that balances domestic and agricultural needs while encouraging efficient water use. Modern water-saving technologies like drip irrigation and sprinkler systems are introduced to help farmers make the most of every drop.

To ensure collective responsibility, under the Gram Panchayat (basic governing institution in an Indian village), the Jal Sevak[24] (trained youth who provide technical guidance and are responsible for motivating and mobilizing the villagers) and Village Water Management Team monitor and manage water usage. Villagers are trained to grasp vital concepts—from the water cycle and local geology to aquifer recharge zones and groundwater percolation. They learn how to calculate water requirements for households, livestock, and crops and are encouraged to adopt efficient irrigation methods.

CLIMATE-RESILIENT AGRICULTURE

Building on the fundamentals of community-led watershed development and water governance, WOTR has initiated efforts focused on climate-resilient agriculture (CRA) to deal with climate variabilities like consecutive droughts and variation in rainfall.

WOTR's model of CRA goes beyond improving crop yields, focusing also on restoring ecosystems and empowering farmers to lead change. In addition to efficient water management through watershed development and climate-smart irrigation, the approach integrates methods such as sustainable organic farming to revive soil health; farming techniques such as multilayer farming to maximize productivity on limited land; institutionalizing solidarity among smallholder farmers for shared learning and collective growth; and technology-driven solutions to support informed decision-making.

Techniques like multilayer farming[25] (growing crops of varying heights on the same plot) support smallholders to make the most of their land while protecting natural resources. Multilayering helps farmers harvest seasonal fruits and vegetables year-round, improving food security; earn additional income by selling surplus produce; enrich the soil with leaf litter and organic mulch, improving moisture retention; and naturally control pests, as some crops act as trap crops.

Rather than a uniform approach to CRA, responses had to be contextualized. In some cases, support was necessary to continue sustainable traditional practices. In others, the damage caused by years of unsustainable agricultural practices had to be reversed.

Abedan has never abandoned the organic farming methods passed down through generations.

In Madaul village, in the tribal heartlands of Odisha, India, for instance, 70-year-old Abedan never abandoned the organic farming methods passed down through generations. While most neighbors shifted to using chemicals in search of higher yields, Abedan continued cultivating millet, pulses, and vegetables the traditional way.

But farming in Madaul was far from easy. Situated on higher ground, the village suffered from rapid water runoff, leaving soils dry despite 1,200 mm of annual rainfall. Irregular monsoons and rising heat made things worse, forcing many farmers to abandon traditional crops.

WOTR introduced soil and water conservation techniques like bunding, continuous contour trenches, and loose boulder structures in 2021. A check dam was built on Abedan's land, benefiting 10 farmers with year-round water access. Villagers were trained in using tools like sprinkler irrigation systems and learned how to prepare organic formulations.

Today, Abedan grows groundnut, sweet corn, cowpeas, paddy, and cashew alongside his traditional crops. His income has steadily risen, but for him, farming is still about nurturing the soil and producing pure, healthy food. "For me, farming is more than livelihood—it's about caring for the land," he says. "Now, even the younger generation is returning to organic practices."

Meanwhile, in Khaparkheda, a small village in Maharashtra, India, years of chemical farming had hardened the soil in Gulabrao's small farm into rock. Even tractors struggled to till the land.

Farmers like Gulabrao once relied on cattle for ploughing and manure. But as tractors became cheaper and more accessible, livestock numbers dwindled—reducing the natural

supply of organic manure. The increasing dependence on chemical fertilizers and pesticides promised higher yields but, over time, pests grew resistant, input costs skyrocketed, and soils degraded.

Gulabrao knew something had to change. In 2021, he trained in CRA, and with support from WOTR, established a Bio-Input Resource Centre (BRC) in his village to produce organic fertilizers and pesticides locally.

At first, fellow farmers were hesitant. But when they tested Gulabrao's organic inputs on one-acre plots, the results were undeniable: high-quality chili yields at half the cost. Word spread quickly, and more farmers adopted organic methods.

"We realized our soils were alive," Gulabrao says. "Organic practices restored fertility, reduced costs, and gave us confidence in the future."

Today, his BRC supports hundreds of farmers across Jalna district, proving how local leadership, learning, and community action can revive entire farming systems.

WOTR also supports farmers to conduct their own experiments in CRA and share results with peers. In Morwal village, in the desert state of Rajasthan, India, for instance, declining soil fertility is pushing families toward chemical dependence. Here, three farmers—Kusava, her mother-in-law Dhapubai, and Ambalal, a WOTR-trained community change agent—decided to challenge the status quo.

They planted maize using organic methods on one half of their 1.25 acre plot, and chemical inputs on the other.

The results were astonishing. The organic maize was larger, sweeter, and higher yielding, producing 1.5 quintals compared to just one quintal the previous year. Inspired by the success, Ambalal applied organic formulations to his ridge gourd farm, producing 100 kilograms in one season from his two-acre farm. Soon, neighboring farmers began visiting Morwal to witness the transformation. What started as a small experiment is now reshaping farming practices across Udaipur.

> **We realized our soils were alive. Organic practices restored fertility, reduced costs, and gave us confidence in the future.**
>
> Gulabrao, a farmer from Khaparkheda village, Maharashtra, India

Ambalal applied organic formulations to his ridge gourd farm, producing 100 kilograms in one season.

Climate-Resilient Agriculture approaches must be adapted to local contexts.

INSTITUTIONALIZING SOLIDARITY AND SUPPORT

Smallholder farmers often struggle to adopt climate-adaptive practices and technologies due to a combination of factors, including a lack of training, the high cost of these new methods, limited access to resources, and the uncertainty of their benefits, especially under normal weather conditions, which can make them appear less worthwhile to invest in. These come on top of their everyday challenges such as high input costs, limited market access, lack of information on the support available, and lack of bargaining power.

WOTR addresses these challenges through Farmer-Producer Organizations (FPOs)—farmer-owned enterprises that:

- Facilitate collective branding and direct market linkages.
- Reduce costs through bulk input procurement.
- Provide shared equipment and training through Farmer Field Schools.
- Educate farmers on government schemes and financial inclusion.
- Promote gender equity, offering lower membership fees, leadership training, and control over collection centers and BRCs.

FPOs also encourage farmers to reflect on environmental changes through Transformative Scenario Planning workshops, a process developed by Reos Partners,[26] where they are encouraged to reflect on how their landscape has changed over the past decade and envision future landscapes, and adopt ecosystem-based adaptation strategies.

The participation of women farmers in the FPOs is facilitated through lower membership fees for women, the provision of subsidized inputs, and leadership training. Women manage collection centers that handle produce from multiple farmers, operate BRCs, and become directors of FPOs.

INFORMATION TO DEAL WITH A CHANGING WORLD

Resilience to climate change isn't just about soil and water—it's also about information, especially in a world where traditional farming wisdom is being challenged by unpredictable climate systems. Smallholder farmers often struggle without timely, hyperlocal weather forecasts or insights into market trends.

To bridge this gap, WOTR developed the FarmPrecise app in collaboration with the Indian Meteorological Department (IMD) and the Indian Council of Agricultural Research (ICAR), supported by Qualcomm Wireless Reach. The app provides farmers with:

- Five-day hyperlocal weather forecasts.
- AI-powered crop and nutrient advisories in regional languages.
- Real-time price tracking and market insights.
- A fertilizer calculator to optimize soil nutrition.
- A digital resource library for pest and disease management.

The app enables farmers to communicate directly with experts at WOTR and W-CreS, and also with other farmers, ensuring that the information provided is tailored to local needs and allowing co-created solutions. The app also includes a multilingual AI chatbot offering expert-proofed responses on farming practices.

For farmers, FarmPrecise has transformed decision-making—from sowing schedules to harvest planning—making agriculture smarter and more resilient.

Resilience to climate change isn't just about soil and water—it's also about information.

WOTR will continue to deliver cutting-edge technologies to India's smallholder farmers.

SCALING UP AND SHAPING POLICY

Beyond simply piloting community-led responses to climate change, WOTR's work is increasingly shaping state, national, and global policies. WOTR is represented on a national committee that is preparing a framework for village-level climate change adaptation plans under India's National Mission for Sustainable Agriculture. WOTR and W-CReS co-developed India's first state-level policy for ecosystem-based adaptation in Maharashtra, India, and Maharashtra's Mahavistar app for farmers incorporates Application Programming Interfaces from FarmPrecise.

WOTR's work empowers farmers with actionable insights and resources that enhance resilience and sustainable agriculture.

As one of 30 global nonprofits chosen for Google's AI for Changemakers Accelerator Program, WOTR will continue to deliver cutting-edge technologies to India's smallholder farmers, including real-time farm advisories and pest outbreak forecasts. The organization is already working with the Indian Institute of Tropical Meteorology to integrate climate science with community-level advisory systems, to monitor soil moisture, temperature, and other meteorological variables necessary for adaptive decision-making.

These efforts demonstrate the role of local resilience strategies in driving national climate policies and inspiring global solutions.

THE ROAD AHEAD

For WOTR, climate resilience is an ongoing journey. Across eight Indian states, thousands of smallholder farmers that they work with are proving that sustainable farming is economically viable; that communities thrive when knowledge, resources, and decisions are shared; and that climate-resilient agriculture can restore ecosystems while securing food and income.

WOTR's integrated model places communities at the heart of climate action, enabling them to become self-reliant, adaptive, and resilient while upholding the core LLA Principles:

- **Decentralized decision-making:** Through FPOs, farmers collectively decide what to grow, when to sow, and where to sell, strengthening local ownership and sustainable practices.
- **Inclusive participation:** Lower membership fees, leadership training, and Self-Help Groups empower women to manage collection centers and BRCs, ensuring equity in decision-making.
- **Stronger local institutions:** Representatives from existing local institutions are equipped through regular training in CRA practices, water management, and farmer-led learning.

WOTR's approach shows how combining local knowledge, capacity-building, and adaptive technologies can turn rural communities into innovators of climate-smart, resilient agriculture.

- **Risk-aware planning:** Smallholder farmers are provided with the tools and information they need to understand climate risks and co-create solutions.

This approach turns farmers into leaders, ensuring climate solutions are designed, owned, and driven by the community itself.

As countries in the Global South grapple with climate uncertainty, WOTR's model offers a replicable framework: one that blends community leadership, technological innovation, and ecosystem restoration to build a future where farming and nature coexist in harmony.