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As glaciers retreat in North India, rivers shrink and floods grow

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Author: [Ashutosh Sharma](#)

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Jammu's Tawi River flows through Jassore village in Jammu and Kashmir, India. The river which slows to a trickle in summers, bursts its banks during rainy periods, with flash floods triggering erosion and threatening lives. THOMSON REUTERS FOUNDATION/Ashutosh Sharma

JAMMU, India (Thomson Reuters Foundation) – The Tawi River once surged through the city of Jammu in northern India so deep and swift that residents were forced to take a boat to get across. Today the sluggish waterway is barely knee deep for much of the year, its bed a dumping ground for untreated city waste.

What has changed in half a century? In part, retreating glaciers and deforestation that are changing the river's flow, leading to both increasingly dry periods and worsening floods.

"The glaciers and barrier lakes in the Jujdhar and Seojdhar ranges, which contribute a larger share of water to Tawi, have almost disappeared," said M.M. Munshi, retired director of operations in Jammu and Kashmir state for the Geological Survey of India, and one of those who used to cross the Tawi by boat.

Right now, “water flow in all the rivers in the state is decreasing. The perpetual snow line in Jammu and Kashmir has gone up to 16,000 feet from 13,000 feet in the last hundred years,” said Munshi, who continues to consult on groundwater and glacier issues for the geological survey.

“It’s happening at an alarming rate because of a combination of factors like global warming, shrinking forest cover and increasing human interference. ... If the water flow keeps receding at this rate, people won’t get water for even drinking,” he warned.

These changes are affecting most of all those who relied on plentiful water for their livelihoods. Farmers in Goran, Sumbh and Nard villages in Kathua district say they have abandoned traditional crops such as paddy rice for maize and beans, which need less water as the Basantar River has become a seasonal river.

FROM SHORTAGE TO FLOOD

But water shortages are not the only consequence of changing weather patterns. During the wet season, extremely heavy rainfall frequently causes the region’s rivers to flood, eroding agricultural land and damaging standing crops.

Jassore village, situated on the left bank of Tawi in Jammu district, loses large tracts of farmland to flash floods every year. About 20 families in the village have been displaced, but district officials say that building embankments along the river to protect the land would be too expensive.

“My house is barely at a distance of 20 feet from the river and I fear it will get washed away in the flash flood any time soon,” said a worried villager, Sham Lal.

Livestock, as well as crops, are threatened. “While we were crossing the Tawi, my 18 buffaloes and two cows were washed away in a flash flood,” said Mohammad Shafi, a milkman of Katiyal Kalai village in Jammu district, recounting an incident three years ago. “I had a narrow escape.”

Rangers on the Pakistani side of the river eventually returned most of the livestock, which managed to swim to the other side, but two buffalo were killed, Shafi said.

People crossing the Tawi River or working along it similarly have been washed away by flash floods, villagers in the area report.

WHAT IS DRIVING CHANGE?

The main reasons for the flash floods are the loss of forests and other green cover in the river’s catchment, combined with quarrying and sand mining in riverbeds, according to Bushan Parimoo, president of the Environment Awareness Forum, a nongovernmental organisation that is leading a “Save Tawi” campaign.

"Due to loss of greenery, the soil can't retain the rain water. A large number of traditional ponds and wetlands have been encroached upon," Parimoo said. "Consequently, most of the rain water flows into the rivers, triggering flash floods."

Parimoo called for a range of responses, including intensive forest planting, a ban on extensive excavation of the riverbed, the revival of ponds and wetlands and construction of barrages. "Otherwise there is no hope," he said.

Jammu has a limited network of irrigation canals, but the depletion of its rivers is causing the most distant canals to dry up every summer, posing a threat to agriculture. Sushil Aima, chief engineer for irrigation and flood control in Jammu, said that his department is responding by constructing check dams and barrages for water storage as well as reviving traditional ponds to recharge groundwater.

Besides losing their water, rivers are also experiencing environmental deterioration from the dumping of untreated municipal and industrial waste.

Yash Paul, a scientist at Jammu and Kashmir State Pollution Control Board said that growing urban areas and great industrialisation are leading to more pollution in large stretches of rivers such as the Devika in Udhampur district.

"The river has become polluted to the extent that one can't even take a bath in it," he said. "If water flow keeps receding in the rivers and the pollution level keeps increasing, as is happening now, it's going to have serious impact on human beings, livestock and crops."

ENOUGH DRINKING WATER?

An acute shortage of drinking water in the region has led to demonstrations by protesters during the past few summers. The state government now is setting up several water treatment plants on rivers in the area to meet demand for drinking water and has started an awareness campaign. It is also encouraging the formation of village sanitation committees to revive traditional ponds and other water bodies to try to restore groundwater levels.

Suresh Chugh, director of the state's Department of Ecology, Environment and Remote Sensing, said in an interview that at least 10 state government departments were working together to develop and implement a climate change action plan for the state, including reviving the local Himalayan ecosystem to boost water security.

"Jammu and Kashmir has been categorized as one of the most vulnerable states in the country," Chugh said. "Since (we are) a food deficit state, the depleting water resources pose greater risks."

Officials are also working on new agricultural policies because “we are witnessing some visible changes in the cropping pattern,” he said.

Chugh said that a team of more than 100 scientists at the state’s Sher-E-Kashmir University of Agricultural Sciences and Technology was developing drought-resistant crops for farmers.

'Intelligent' power rationing eases Indian state's irrigation woes

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Author: [Manipadma Jena](#)

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Farmers in India's Gujarat state have learned to value irrigation water thanks to a system that provides them with subsidised, rationed power for their pumps, storing spare water in tanks like these.
PHOTO/IWMI

NEW DELHI (Thomson Reuters Foundation) – A scheme to separate agricultural and domestic power supplies in Gujarat has been recognised by the United Nations for making irrigation more efficient and dramatically improving the Indian state's farm productivity.

The \$290 million rural rewiring project, named Jyotigram Yojana (JGY) or “village light scheme”, has been implemented in almost all of Gujarat's 18,000 villages.

The mostly semi-arid, drought-prone state is industrialising rapidly, but nearly half the population still depend on agriculture. Since the late 1980s, groundwater aquifers have been seriously depleted.

A principal cause of that was highly subsidised electric power provided to farmers by the state utility. With electricity costing farmers next to nothing, they had no incentive to irrigate efficiently, and many diverted power intended for domestic use to pump extra water which they sold on at a profit.

Use of electric pumps in Gujarat increased by 585 percent between 1971 and 2001, compared with an increase of just 56 percent in the use of unsubsidised diesel pumps.

Electricity bills were mostly flat-rate, and the Gujarat Electricity Board was unable to hike prices because the state's political leaders did not want to alienate farmers, a large constituency of voters. With no control over the amount of electricity used, the utility went bankrupt.

As a result there was no investment in the power grid, further worsening the supply for domestic users, public services and small-scale industries, especially in rural areas.

Gujarat's solution was to split rural electricity feeder lines to supply farm pumps separately from household and commercial users.

The previously shared connection provided 16 hours of single-phase supply, intended for domestic use, and eight hours of higher-voltage, three-phase supply from which farmers could run their irrigation pumps.

In practice, many farmers illegally converted the single-phase supply to three-phase in order to pump water for longer and sell it on the informal market.

UN-WATER AWARD

Under the new system, introduced in 2003 and completed in 2006, non-farm customers receive a 24-hour three-phase supply that is metered, at unsubsidised rates.

Meanwhile, the agriculture feeder lines provide eight hours a day of uninterrupted, full-voltage power for farmers who operate tube wells.

The timing of this supply alternates weekly between high-cost peak daytime power and cheaper night-time power. This has reduced overall costs for the power utility, which is still required to provide a 75 percent subsidy to farmers, who pay 0.75 Indian rupees (1.25 US cents) for one unit of electricity.

The prize-winning power separation scheme was based on research by ITP, a Gujarat-based partnership between the International Water Management Institute (IWMI) and the Sir Ratan Tata Trust.

The project received UN-Water's "Water for Life" Best Practices Award on Mar. 21, the eve of World Water Day, in Tokyo. The global award recognises sustainable techniques in water-resource management.

"(We) decided to select this practice for directly tackling the socioeconomic and environmental challenges related to the improvement of the energy-irrigation nexus ... and for its strong potential for replication," said the Water for Life jury.

The benefits of separating the power supplies have spread through the state, says Tushaar Shah, leader of the ITP.

"The high-quality, predictable and reliable power supply incentivised farmers to grow crops with high returns and cultivate all land they owned," he said.

Large- and medium-scale farmers have switched from cereals to high-value crops like Bt cotton, tobacco, oilseed, spices, and fruit and flower orchards, maximising returns from every drop of water.

POOREST FARMERS LOSE OUT?

Agricultural growth in Gujarat has been steady at 8-10 percent for most of the last decade, more than double the national average, according to economists, although some point to other contributing factors such as private seed companies with new technologies, stronger marketing through contract farming, and the flourishing of dairy cooperatives with assured cold storage.

Meanwhile, the formerly indebted state power utility, benefiting from JGY and major energy-sector restructuring, is now selling surplus power to other states.

"What appealed to the jury about our research programme was (that) when (the) energy-groundwater irrigation nexus was not a big issue anywhere globally, we've been making a big deal of it since 12 years now," Shah said in an interview.

"It is now proved that feeder segregation and 'intelligent rationing' of farm power supply can substantially cut groundwater and subsidised electricity wastage (and) boost agricultural growth," he added.

Nonetheless marginal farmers have found their water access cut by the JGY scheme. Because they cannot afford irrigation pumps, they do not qualify for subsidised power and must pay full rates for what they use.

Farmers who do have pumps are turning to more water-intensive crops, so most no longer have excess water to sell on to those without pumps. Scarcity has driven up prices on the informal market by 30-50 percent since JGY began, making the water too expensive for poorer farmers.

NEXT STEPS

Shah argued that further steps need to be taken to rationalise the use of power and minimise costs. He pointed out that India's irrigation needs are highest for 30 to 40 days each year, roughly between November and February, and farmers need power most then.

Farmers would prefer a seasonally adjusted power supply, he said. Instead of the current eight-hour daily ration, more hours could be supplied during the high-demand period, with a limited supply of three or four hours the rest of the year.

Requirements also differ drastically between years with normal rainfall and drought years, he added. In dry years, farmers say they need 13 hours of irrigation daily, even during the monsoon, which is the sowing period.

Since 2012, feeder separation has been replicated to varying degrees in the states of Andhra Pradesh, Haryana, Karnataka, Madhya Pradesh and Punjab, at a total investment of \$3.5 billion.

"For separate feeder lines, a strong government is necessary, since farm power and irrigation are powerful political, vote bank-related issues," Shah said. "Vigorous monitoring of power theft too is necessary; otherwise it defeats the very purpose of power rationing."

Gujarat has taken legal action against more than 100,000 cases of power theft, he added.

Rural India looks to past and present to meet growing water needs

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Author: [Stella Paul](#)

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A woman farmer with an irrigation sprinkler in Poovula Doruvu village in Andhra Pradesh state, southern India. TRF/Stella Paul

HYDERABAD, India (Thomson Reuters Foundation) – Farmers in rural India are adopting a combination of centuries-old water storage methods and modern irrigation techniques to adapt to increasingly dry conditions.

With funding from international donors, the government of the southern state of Andhra Pradesh is renovating thousands of medieval water ponds, and training farmers to use carefully targeted drip irrigation instead of flooding their fields with water.

One of the converts to this mix of old and new methods is 80-year-old rice farmer turned betel-leaf grower Murkhan Appa of Uduguru village. In the mid-1980s, Appa was the first person in Uduguru to dig a borewell to irrigate his 6-acre (2.4-hectare) farm.

Uduguru is in Anantapur district, one of India's driest areas. The village receives just 450 mm of rainfall annually, leaving farmers entirely dependent on groundwater for their livelihood.

With his new well, Appa was able to pump large quantities of water to irrigate his fields. All the other farmers in the village followed his lead, sinking one or more wells on their land so they could flood-irrigate their fields.

But three decades later, Appa has become a staunch critic of indiscriminate groundwater extraction.

"Water is precious. We must use it wisely," is what he tells the Water Use Association (WUA), a village-based citizens' group he heads that campaigns for sustainable use of water in agriculture.

According to the recently released [**World Water Development Report 2014**](#), 70 percent of all water withdrawn globally is for agricultural purposes, and this is likely to increase another 20 percent by 2050. This will further deepen the current water crisis, warns the report.

HALF OF BOREWELLS DRY

Massive extraction has rapidly depleted the groundwater table in Anantapur. According to Purushothama Reddy, deputy director of the district's groundwater department, 50 percent of borewells have gone dry.

"Of the newly drilled borewells, 70 percent are failing to draw water," Reddy said.

That is why Appa and other WUA members are practising sustainable water use, including drip irrigation, water sharing, rainwater harvesting and changes to their cropping patterns.

On his farm, Appa has built a 10-foot square tank which he fills every other day with water pumped from his borewell. He now drip irrigates his land instead of flooding it.

"Using the tank helps minimise the extraction. Earlier, I pumped water every day for two hours. Now, I do it every (other) day for 45-50 minutes," he said.

To help farmers like Appa, the state government is implementing the [**Andhra Pradesh Community Based Tank Management**](#) scheme, a World Bank-funded project that promotes sustainable use of water for irrigation in rural areas by restoring old "water tanks".

There are about 77,000 such tanks in the state of Andhra Pradesh, according to Vinay Kumar, the project's director. Looking more like ponds or small lakes, they were created

by the state's ruling families in medieval times. They were the main source of irrigation for local farmers, but fell into disuse and disrepair with time.

Since 2006, the tank management scheme has been renovating the ponds so that farmers can once again use them for small-scale irrigation. So far 3,000 have been restored, Kumar says.

AWARD FINALIST

In late March, the project was selected as a finalist for the "Water for Life" prize by UN-Water as part of its World Water Day programme. The prize is awarded to the best examples of integrated water management.

"What we have here is a truly participatory model of integrated water management," said Kumar. "We work along with over 50 civil society organisations and village communities that are also the direct beneficiaries."

The project trains villagers to maintain and manage the tanks, monitor and collect data on water availability, analyse the data, and adapt to evolving conditions using sustainable practices.

At Uduguru, the village tank has been restored and the community is being encouraged to use it collectively. According to Appa, the WUA will invest 200,000 Indian rupees (about \$3,300) to keep the tank filled with water from local borewells. "It will be shared by all," he promised.

Drip irrigation, water sprinklers and furrows are also gaining popularity among small-scale and marginal farming communities in the state's coastal region.

SHARED IRRIGATION KITS

In one such village, Poovula Doruvu, villagers are investing collectively in sprinkler irrigation kits under a European Union-funded climate change adaptation project called Adaptcap. Three or four families share a kit comprising an electric pump, sprinkler sets and enough hose for about an acre of land, at a cost of about 400 rupees (\$6.60) per family.

"Every year, we have floods and cyclones which have increased salinity in the soil. Also monsoons are irregular these days. So instead of drilling a borewell, which is very costly, we formed a self-help group to buy and manage the sprinklers," said villager Devadanam Aragela.

According to Aragela, the families now use just a couple of borewells and are saving money on electricity as well as the fruit and vegetables they grow.

Shailendra Kumar Mandal, a researcher at the National Institute of Technology in Patna who has studied the community water management activities at Poovula Doruvu, said the initiative is helping them save nearly 95,000 cubic metres of water and 35 kilowatts of electricity every year.

BETTER LIVELIHOODS

Hydrologist Joseph Plakkottam, who has advised several water management projects, including the tank scheme, said it is important that rural communities reach consensus on adapting their agricultural practices to the changing climate.

Plakkottam cited the example of Gollamada in Adilabad district where the entire village adopted integrated water management to improve their livelihoods.

Though Adilabad receives adequate rainfall overall (more than 560 mm), the district began developing dry pockets like Gollamada. The groundwater table in the village was declining, and drilling borewells would aggravate this.

“It costs at least 80,000 rupees (\$1,300) to drill a borewell. Few of us could afford that. So we decided to grow jawar (sorghum), red gram and sesame, which grow well in a dry climate, unlike rice,” said villager Gongula Padma.

Besides trying out new crops, Gollamada villagers have renovated ponds and tanks to catch rainwater. They have also started a collective cattle farm, enabling them to boost their incomes from milk sales.

“Integrated management of resources is all about overall improvement of livelihoods. This village has proven that successfully,” said consultant Plakkottam.

Water scarcity heightens caste tensions in India

Source: Thomson Reuters Foundation - Thu, 30 Jan 2014 09:15 GMT

Author: [Ashutosh Sharma](#)

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A policeman standing guard near a well that was damaged by upper caste villagers in Rasooch, Jammu and Kashmir. THOMSON REUTERS FOUNDATION/Ashutosh Sharma

KATHUA, India (Thomas Reuters Foundation) – The sleepy village of Rasooch in Jammu and Kashmir is surrounded by arid, rocky hills, denuded of trees. But its placid air belies generations-old tensions between caste groups - tensions which are being exacerbated by a scarcity of safe drinking water, threatening the health of the most socially marginalised villagers.

Rasooch is located in the Siwalik foothill region known as the Kandi belt, in the industrial district of Kathua. The belt extends through the northwestern states of Jammu and Kashmir, Himachal Pradesh, Punjab and Haryana.

In rural areas of the Kandi belt, residents are largely dependent on wells and ponds for water, which in recent years has become a scarce commodity.

Amrish Vaid, programme coordinator at Kathua's District Farm Science Centre, said that the water table has been affected by erratic rainfall over the past 20 years. And Sonam Lotus, director of the Meteorological Department in Srinagar, the summer capital of Jammu and Kashmir, confirmed that the area is experiencing unpredictable and fluctuating levels of rain.

Even though the Jammu region recorded above-average rainfall last year, in villages like Rasooch the water crisis is a daily reality. While the waterways of the Kandi belt can be raging torrents in the rainy season, these streams slow to a trickle or are completely dry in summer.

Experts and villagers say that the erratic rainfall is one of the causes of growing water scarcity, along with more denuded hills, high levels of soil erosion, a lack of proper water management and the disappearance of age-old systems of water harvesting through village ponds.

Increasingly, social tensions in Rasooch are coming to a head over water, particularly access to the remaining working drinking water wells.

DALITS ASSAULTED

The most marginalised residents of the village are Dalits, a low-caste minority still treated here as "untouchables". Dalits say that upper caste communities have become increasingly hostile and belligerent whenever Dalits try to use village wells – something they have often been banned from doing, but have little alternative to in seasons when streams have run dry.

"In my village, the upper caste villagers don't allow us to share water from clean water wells," said Sardari Lal, a Dalit man. He said the supply of water delivered through pipes laid 20 years ago was irregular and often brackish, contaminated and unfit for drinking.

"We gave many representations to government officials and held protest demonstrations too but to no avail," he said, adding that some in his community who were financially better off had left the village to settle elsewhere.

In 2012, the State High Court, following an incident in which a number of Dalit women were reportedly assaulted for attempting to take water from a village well, ordered water deliveries to ease tensions.

"The court got samples of the piped supply water tested which proved that the water was not safe for drinking," Sardari said. "It directed the local administration to arrange a tanker to ensure a regular supply of clean water to the Dalits as an interim solution. But after a few months of providing a regular supply, the tanker now comes to our village only occasionally and we are again facing the worst kind of drinking water scarcity."

A middle-aged Dalit woman in Rasoooh, who did not want to give her name, was one of the women attacked when they tried to use the community well.

“Our children were falling ill after drinking unsafe water. When it was brought to her notice, the District Development Commissioner visited the village and encouraged us to use water from the clean wells,” the woman said.

“But after the official left, when a group of women neared a ‘forbidden’ well, we were roughed up and our clothes were torn by upper caste people,” she said.

HIGH CASTE PRIORITY

After that, police officers started to guard the well. But the well then was damaged by a group from an upper caste, “sending out a clear message that caste barriers on sharing natural resources were here to stay,” the woman said.

“Clean drinking water is the most precious commodity to us. Usually, we use stored water provided by the tanker that comes to the village once in a while but at times we take water from any source and use it for drinking after boiling it,” she added.

While Dalit women are dependent on the water tanker or upon ponds or sources abandoned by the upper caste villagers due to the poor quality of water, upper caste women continue to enjoy a monopoly over fresh water wells.

And on the increasingly rare occasions when the water tanker comes to Rasoooh, and villagers jostle to collect as much water as possible, the enforcement of caste codes means higher caste groups get priority, local people said.

Rahul, a local activist who uses only his first name, said that while there are laws against caste prejudice, “these laws need to be implemented in letter and spirit. It’s only through development and education that the society can be made caste-neutral.”

A study by the National Institute of Hydrology confirmed that “while the government claims that almost all villages in the Kandi belt have been covered under drinking water schemes, the reality is something different. When demand for water sharply rises in summer, villagers often turn to the ponds for drinking water, which is not fit for human consumption. Quite often the same pond serves as a drinking water source for cattle.”

The study found that water-bearing aquifers in the region were deep and difficult to reach, meaning ground water was inadequate. It stressed the need for rainwater harvesting to meet domestic and agricultural needs.

Taj Chaudhary, executive engineer of Kathua’s Public Health Engineering Department, said he was not aware of any acute water scarcity facing village Dalits due to erratic supplies. But he said steps would be taken to ensure a regular supply of water.

FEATURE-Climate-smart farmers get tech savvy to save India's bread basket

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Author: [Nita Bhalla](#)

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Labourers work in a paddy field in Karnal district in the northern Indian state of Haryana September 2, 2014. Picture taken Sept. 2, 2014. REUTERS/Thomson Reuters Foundation/Nita Bhalla

KARNAL, India (Thomson Reuters Foundation) - Erratic weather, rising temperatures, declining water resources and labour shortages are threatening India's bread basket state of Haryana, forcing farmers to abandon age-old practices and adopt technology to ensure food supplies for millions.

Using machines which sow rice directly, devices to inform when to irrigate and phone messages warning of infestations, thousands of farmers are

learning to adapt to climate change, boost soil fertility and reduce their carbon emissions.

"At first, many farmers were unsure. It's a big risk to change the way you have farmed for decades and try new things. Agriculture in these parts is not just a livelihood, it's a way of life," said Harpreet Singh, 36, a farmer in the village of Birnaraya, 130 km (80 miles) north of Delhi.

"But over the last four years, through these technologies, we have learnt to save water and fertilisers, cut our costs for hired labour, improved the resilience of our crops and also reduced pollution by not burning crop residues."

Singh is from one of 12,000 farming households across 27 villages in Haryana's Karnal district working with scientists from the Consultative Group on International Agricultural Research (CGIAR) to pilot climate smart techniques aimed at sustaining one of the country's most fertile belts.

SAVING INDIA'S BREADBASKET

Since India's so-called "Green Revolution" - a massive government programme rolled out in the 1960s and 1970s which increased the use of fertilisers and irrigation to boost farm output - Haryana's rice production has soared to almost 4 million tonnes in 2013/14 compared to 334,000 tonnes in 1966/67.

But while the Green Revolution may be credited with ending famine across the country, it has come at a cost and, coupled with more unpredictable weather attributed to global warming, India's food security is once again at risk.

Almost half a century on, farmers face environmental problems such as depleted groundwater because of intensive pumping for irrigation, soil degradation and soil salinity.

"Resources are depleting. Groundwater levels are falling, there is emerging climate variability, the soil health is worsening, and profitability is going down," said M.L. Jat, an agronomist with the International Maize and Wheat Improvement Centre.

The Indo-Gangetic Plains - which include the rice and wheat states of Haryana and Punjab - are particularly vulnerable to climate change, say experts from the U.N. Intergovernmental Panel on Climate Change (IPCC).

Scientists predict average temperatures here to increase by as much as five degrees Celsius by 2080, seriously affecting wheat crops. An April study by the Indian Agricultural Research Institute projects climate change may reduce India's wheat yield by between 6 to 23 percent by 2050.

Rice will also be hit due to unpredictable rainfall. Indian officials say the water table has fallen between one and 13 metres in different parts of Karnal over the last two decades.

The region, which is heavily dependent on migrant labour from poorer states, is also facing shortages due to a government scheme to employ more people in construction near their homes.

"HAPPY SEEDERS"

In response to these challenges, agricultural groups are introducing Karnal's farmers to a host of climate smart technologies.

These include techniques such as direct seeding which involves sowing seeds by machines rather than transplanting manually, which reduces labour and water.

Other new technology includes Lazer Levellers - tractor-towed, laser-controlled devices - that produce a flat surface for cultivation, requiring 25 to 30 percent less water.

Farmers are being introduced to tools such as "Happy Seeders" which can be attached to the back of tractors. These remove crop residues, blending them into the soil, preventing the practice of burning crop residues that has led to increased emissions and depleted soil fertility.

"We didn't know anything about these advanced technology machines before," said Manoj Kumar Munjal, 40, who farms a 20-acre plot of land in Taorori village.

"We have learnt about these machines and set up a cooperative where we all put in the money together and bought machines and share them. Now everyone is using it."

Farmers are also receive voice messages giving weather forecasts, informing of new seed varieties and infestations.

EXPENSIVE TECHNOLOGIES

But these technologies do not come cheap. A Lazer Leveller, for example, costs more than \$6,000.

In villages such as Munjal's, farmers have clubbed together to buy new machinery, while in others, one farmer invests in the hardware and rents it out to others.

CGIAR said a similar project is underway in the eastern state of Bihar using lower cost techniques on smaller plots.

On his sprawling 90-acre farm, Harpreet Singh crouched down amongst his rice paddy stalks and checked his tensiometer, a device planted in the ground to measure moisture content.

Singh said over the last four years, his income has increased by 15 percent due to savings made on electricity for irrigation, diesel for residue burning, labour and fertilisers. But it is the saving on water which satisfies him the most.

"Day by day, the ground water levels are going down and down. If we continue like this, its only a matter of time before we don't have water to drink, let alone to farm," he said.