

CRACKED EARTH

A REMOTE WATER
WORKS IN RURAL INDIA
IS COMMANDING
INTERNATIONAL
ATTENTION
TEXT AND PHOTOS
BY LOLLY MERRELL

The wind blowing off the ochre plains west of New Delhi is so hot that we roll up the windows of our non-air-conditioned vehicle, reasoning that the collective heat of four bodies is less than the 122 degrees outside. The trip to Alwar, Rajasthan, is usually four hours, but the Tata, a popular four-cylinder Indian-made SUV, preferred by clinic doctors and academics, is nearing 80 mph on the raised straightaway. The driver strikes potholes at such speed that we launch a little at each hit, in *Dukes of Hazzard* form. Nevertheless, the man sitting next to me, Rajinder Singh, has dropped his head into the folds of his white cotton Kurta, pulled his bare feet under him, and sleeps. I wrap two bottles of water in my sweat-stained

handkerchief, in the hope of insulating it at a drinkable temperature. Before we left Delhi, the driver hung a water bladder made of camel skin from the side mirror of the car. Now, crisped in the searing sun, it thumps against the hot metal of his door in a muted heartbeat.

An hour from the glitter and pollution of Delhi, we are the only auto on the highway. Occasionally, we pass a camel-drawn cart, the mahiks lean hard into the reins to steer the camels' somnambulant lope away from our bucking car. The landscape here is mostly monotonous desert, with an occasional acacia tree or withered bush on the roadside. The state is a wasteland on many levels: A few hundred miles west of here is the nuclear weapons testing



Rajinder Singh trods across the ruined site of a large johad project. The Rajasthan Government destroyed the earthen dam, claiming the water belonged to the state, and that the remote site had been designated a helicopter landing strip.

ground in the central plateau. In the north, clandestine poppy fields feed the international heroin market. Farther west, streams of military tanks cross the Great Indian Desert to line the border shared with Pakistan. But ironically, it is this particular region, where I spent several weeks last summer, that has been officially designated a "dark zone." That is, hopelessly drought-ridden for decades.

Still, we pass odd conical huts made of wheat, storage-bale structures that buffer the maelstrom winds and provide shelter for cattle. They're an ancient adaptation that survived the modernizing "Green Revolution," when international aid agencies introduced high-yield, single-crop farming, pesticides, machinery and bore-well irrigation to the economically strained villagers. A single village would have once produced just enough sustenance for the people that the land served. Now, only cash crops—like mustard and wheat—dominate. With it, some criticize, has come malnutrition and irrigation-exacerbated drought.

"That was once a great river," Rajinder says, emerging from his nap, sleepy-eyed. At 45 years old, he has maintained a



who opens the door and hangs his feet over the hot dirt. He drinks the water Indian style—pouring it into his mouth so as not to touch his lips to the cup—and makes impressive grunting sounds as he drinks.

"Wow," I slip, at this unbridled show of satiety.

"Take." And he shoves the full cup toward me. Reluctantly, I drink the water,

road, gawking at us, and assumes a look of indignation. Considering that this is May, the dry season, and the valley is in the grip of a three-year drought, the crowded city has a surprising show of greenery. Even in an average year, the Alwar region receives only 62 centimeters of rain. Nevertheless, we pass heaps of colorful, healthy-looking vegetables filling the stalls that spill into the road.

"This is new. None of this was here before," Rajinder says.

Before is pre-Rajinder, back in the '70s, before he came with a group of social workers and single-handedly changed the landscape. In those early days, he explains, the once-perennial river, the Arvari, was dry. Now, thanks to Rajinder's direction, the river is running at full capacity, year-round, even throughout this especially testing drought. His miraculous feat has drawn teams of hydrologists from around the world to study his technique, and to dissect—hydrologically speaking—how he did it. He has been recognized by the United Nations and local humanitarian and environmental groups, and this past September he won Asia's version of the Nobel Peace Prize, the coveted Magsaysay Award, funded by the Rockefeller Foundation. Now, his methods are regularly debated at high-level hydrology conferences, like the World Water Forum and recent meetings of the World Commission on Dams. Everyone, it seems, wants to understand the Arvari miracle, and make part of it their own.

We drive out of Alwar, and Rajinder assumes his previous slouch. The villagers crowding the road here walk with more purpose, not even glancing as we drive by. When Rajinder first came to

the area, as a 28-year-old fresh out of graduate school in Ayurvedic medicine, he had planned to work with the Tarun Bharat Singh, a social-work organization focused on bringing health care and education to the starving villagers. At first, because of his beard—a grooming anomaly in this state of stylized moustaches—villagers mistook him for a Punjabi terrorist. Then they thought he was just another ineffective sahib talking big about impossible plans. Finally, Rajinder tells me, as we pull off the main road toward a village, an old man named Mangu Kaka approached him and said, "You do little by hand. All by mouth." Rajinder pressed him. "What we need," the man continued, "is johad. Tomorrow, come with digging tools."

Mangu was one of the last villagers who could remember how to construct a johad, hand-built, small earthen dams that caught and stored monsoonal waters as they ran down the steep mountains into the Arvari River valley. Sometime in Mangu's youth, following India's independence, the Rajasthani government came in and harvested the majority of the forests, exposing the hills to erosion. Prospectors soon discovered a vein of rare pink marble. Mining ensued, polluting the water systems and diverting the precious river flow into the short-lived quarries. Attempts by the Rajasthani Irrigation Department to "correct" these problems only introduced more of the same. Elaborate engineering projects went unintended, fell into disrepair and actually drained the once-reliable source of year-round water: the Arvari River and the underground aquifer that fed it. The traditional methods of storing water were lost over the century. Starvation loomed, as villagers subsisted on onions and radishes. Dysentery, filariasis, and malaria killed the weak. A mass migration to nearby cities drained the villages of their work force. Apathy set in, and when Rajinder arrived in 1985, the sight was dismal.

Although the remaining labor pool consisted primarily of village elders, women and children, the first johad was successfully built on a small slope that, during the monsoon season, fed what had been the Arvari River, which ran as a drainage channel during floods. As the monsoons filled and overfilled the johad, the water not only flowed over the top of the structure, trickling a consistent stream

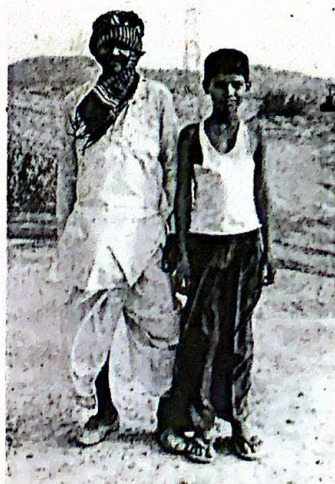
All eyes are on a U.S. Geological Survey project outside of Tucson, where a dry riverbed will be filled with water from the Central Arizona Project canal and left to percolate, naturally, into the aquifer.

doughy, boyish face, though his beard is speckled with gray. He pulls his feet tighter under him, as we pass over a crack in the landscape. A muddy, fouled puddle has drawn three water buffaloes and a farmer to its crusted banks. "This is how they get sick," he mumbles. He yells something in Hindi to his driver, and we pull off the road under the shade of a cluster of acacia trees. The driver gets out, and with a handkerchief over his hands to protect them from the hot metal of the Tata, he removes the water bladder from the mirror, cradling the lumpy skin in his arms while fumbling for a stainless steel cup. He fills it, and hands it to Rajinder,

whose source is unknown. The water is cold. Rajinder smiles.

"Old style. Rajasthani style," he explains. My brain is working: Of course...transpiration, evaporative cooling. The baking wind cooked us but did an efficient number on the wet bladder, cooling its contents. A miracle.

We continue through the scrubby landscape toward a horizon edged with the razorback Arravali Mountains to the northeast. Rajinder pulls out of his slouch to sit up straight as we approach the bustling, small city of Alwar. He stares straight ahead, avoids the celebrity-struck gaze of villagers who walk along the



Top: Rajinder Singh (bearded) surveys the progress of a father/son volunteer johad project. Below: Two brothers from a nearby Arvari village sweat it out in the dusty, 120-degree heat, sleeping at the site of their dam project, and swimming in their success after work.



Left: Angu kaka, the son of the man who passed along the johad secret, tends to the revitalized land. Right: a Rajasthan backhoe.

into the riverbed, but—unbeknownst to Rajinder, who was, admittedly, not a hydrologist—the water also percolated into the ground, recharging the barren aquifer.

Employing camels, hand spades and their time, the villagers eventually constructed more than 50 johads, and began irrigating their fields with narrow channels radiating from the catchments. In two years, the small villages in the Arvari watershed were growing enough crops to sustain them throughout the year. Other traditional water catchments were built—namely in-ground cisterns and small, concrete-fortified “check dams” that stored rainwater in the valley floor during the monsoons—and the villagers noticed a remarkable change: The Arvari riverbed carried water for two more months after the monsoon rains stopped in September.

The Tata leaves the last dregs of Alwar behind us, and we start down a dirt road no wider than a sidewalk into a small, tidy village of ubiquitous mud and thatched-roof homes, decorated with elaborate clay and stone carvings etched into the walls. Women in traditional hot-colored skirts, sprinkled with sewn-in mirrors, carry long green reeds in their arms for weaving. Here, Rajinder is open, his face softens as he greets each person, he waves and smiles, and even finally rolls down the window. He’s called the “johadwallah babu” here—the “bearded man of check dams,” roughly—and makes it a point to greet people by name. The temperature has dropped to a cool 90 degrees, and we come upon a johad being tended by a camel and two turbaned, barefoot men with shovels. Under some green acacia trees about 100 yards from us, a tall old man with a staff, fabulous curled slippers and a toothy grin rises slowly and makes his way toward Rajinder. They each greet, “Namaste,” and he is introduced to us as Mangu’s son.

This village is called Bhaonta-Koylala and is home to the famed first johad, Rajinder explains, which the villagers maintained themselves. Following the success of this first project, he organized neighboring villages and taught them how to run their own water management programs. Most of the people connect spiritual importance to their land, and as expected, they consider water an especially sacred resource. Now, weddings are held on the banks of johads—as they were centuries ago—and crops are blessed by having sacred cows drink from the catchments. It was these seemingly superfluous side effects that actually contributed to the remarkable improvement in the land, by reviving the human connection to the ecosystem. Expatriated villagers returned to work on new catchments, and finally, by 1995, the Arvari River ran throughout the entire year.

Mangu’s son, also called Mangu, is speaking animatedly to Rajinder, who introduced me as an American. He nods and translates. “He says that some hydrologists, visiting from the U.S., I think it is Utah, that they went to the Ruparel johad and saw tiger paw marks,” he laughs again as Mangu adds detail. “And they get very scared and want to leave right away.”

With the exception of the tigers, the Utah scientists discovered what I had in the Arvari Valley: a landscape

quite similar to home that’s rocky, arid and washed with monsoons only seasonally. And, like Rajasthan, the arid regions of the U.S. also rely heavily on several “endangered” aquifers, most notably, the massive underwater Ogallala aquifer that extends across eight states from South Dakota to Texas. Estimated to be nearly 10 million years old, Americans have tapped it for centuries, depleting and polluting it simultaneously. And lately, we’ve depleted the replenishable groundwater, tapping into what geologists identify as “fossil” water, the irreplaceable baseline water that keeps the aquifer alive. The Utah scientists, according to Rajinder, hoped to glean some insight into replenishing the Ogallala by figuring out the scientific workings of a johad.

Obviously, the aquifer in the Arvari region isn’t nearly as large as the Ogallala, but the strategy employed by Rajinder is worth observing for its beautiful simplicity. An uninformed visitor to the valley would probably never spot the clusters of johads that dot the hillsides. They are small, earth-colored crescents, like hoofprints, with a damp stripe coming from the downhill wall. The villagers determined the position of each johad from years of observing the monsoonal flow patterns that carved the hillsides each June through September. Constructed of native clay and rubble, the johads permit water to percolate through “native” filters into the underground aquifer, reducing the introduction of potentially incompatible chemicals that, according to hydrologists, could create an imbalance in the sensitive aquifer. The height of each johad is just enough to let water trickle continuously into the river, while maintaining enough

Leaves from the local trees were shaped, dried and stitched together with thorns into a perfect bowl. When we finish dinner, we toss the plates into a trough that feeds the water buffalo.

in the catchment to feed the irrigation channels that water the crops. In addition, the deeper cisterns—which more directly recharge the aquifer—provide water for drinking and bathing. And, in turn, the aquifer feeds the Arvari River through underground springs, replenishing the shallow wells of the villagers. Flooding, thanks to the johads, has been nearly eliminated, as has the devilish erosion that could erase years of expensive investment in seed, fertilizer and labor.

Representatives from the United Nations came to visit about five years ago, and passed along the observation that traditional, even forgotten, water harvesting and storage techniques may hold the key to sustainable water management for both developed and developing countries. “India has undertaken some of the most innovative methods to revive its aquifers,” reported officials at last year’s World Water Forum, a conference of the top water experts and heads of the world’s aid agencies. “The work of NGOs like Tarun Bharat Singh has produced dramatic impact on groundwater recharge.” Massive dams, the hydroengineering fad of the 20th century, are largely seen by these world experts as an expensive blight, and ecologically destructive to boot.

Now, some of the most progressive projects incorporate characteristics of johad technology. Already, this influence has made it to the western U.S. There are currently 1,185 traditional-hybrid projects, called aquifer recharge wells (for recharging only) or aquifer storage and recovery wells (for “banking” water). Unfortunately, one of the oldest and largest of these, in Las Vegas, has problems. The method used there involves injecting treated water (in the Vegas case, from the Colorado River) directly into the aquifer to store during the dry season. But injection wells don’t use the subsoil as a filter, so algae have grown in the wells, blocking the porous channels necessary to recharge them. In addition, most of these wells rely largely on water either diverted from a river, or recycled from aquifer-drawn water. The critical source of the johad approach—harvesting rainwater—is nominally used. But there’s hope: All eyes are on a U.S. Geological Survey project outside of Tucson, where a dry riverbed will be filled with water from the Central Arizona Project canal (which comes from the Colorado River) and left to percolate, naturally, through the surface into the aquifer beneath it. New software developed by USGS scientists, called “InSAR,” uses satellite imagery to map aquifers in three dimensions. Matched against the topography surrounding the aquifer, rainwater flow could now be diverted to wells in previously hard-to-identify recharge zones.

But, as I soon discover, the challenge of managing a sustainable water project extends far beyond building johads or analyzing satellite images. We leave Mangu and the village, past rippling fields of mustard greens as Rajinder directs the driver to a project on the other end of the valley. “You will see what we have to deal with,” he warns me, leaning into the dashboard. We pull next to what looks like the beginnings of a johad. It’s actually the end of the johad, I’m told. “You know what they wanted to build here?” Rajinder announces, agitated. He walks quickly over the dirt expanse and sweeps his



arm along a chalk line drawn about 50 feet down the strip of earth. At the end, a crumbling johad wall—truly a rare sight, to see anything under his watch in disrepair—is narrated by a sign in Hindi. “This sign...here take a photo,” he implores. “It says the Government of Rajasthan has taken down the johad to build a helicopter landing strip.” A one-foot square of damp soil is surrounded by sun-scorched, cracked earth. “This

charged 377 times for various infractions—his favorite, he smiles at the audacity—was for fraud. Officials tried to spread a rumor that Rajinder was filling the johads with water brought in by tanker from Delhi.

But the threats soon came from beyond the irrigation department. After the villagers began to harvest trees they had planted, they were charged with timber poaching, because the nursery fell

another weird twist, the added wildlife and trees also drew real timber and animal poachers. The villagers, especially protective of their hard-earned natural resources, captured the poachers and forced them to work on building more johads, as punishment for their crimes.

We conclude our journey across the Arvari Valley at the Tarun Bharat Singh headquarters, which is also Rajinder's home most of the year. Down a forested, brick-lined driveway we park in front of a large two-story horseshoe-shaped building. On the front terrace, clusters of men in white robes and turbans and women in bright dress sit together talking quietly or alone, reading beneath the shade of a tree. Facing the front terrace is an elaborately painted wall with hundreds of figures and names. “This is all the money that has been earned and spent, and all the locations of the johad and other water systems in the area,” Rajinder says, beginning the tour. The writing wraps around the wall, into the room next door. The final tally: 4,500 johads in more than 1,000 villages.

We walk around the sprawling compound, past a tree farm, a field of wildflowers and an organic garden. We surprise a couple teenagers leaning on a mud fence, holding shovels against their bony chests and comparing stringy moustaches. Rajinder barks at them in Hindi for nearly five minutes, then we sit down at the edge of an immense hole in the ground, at least 25 feet deep, that's the newest cistern for the property. “The boys are lazy. Most of the men are very lazy,”

he says, looking back at the teens. “The women are very reliable and hardworking. They are the best trainees.” Rajinder, in turn has made it easy for the women to come to the compound for several days at a time, to learn the johad technique and how to organize their villages to maintain the structures. He provides lodging, day care and food for the women, at no cost.

That night I finish a meal mixed of vegetables in a Rajasthani gravy and a thick, fresh wheat chapati—all from the garden in back—and eat it off of a plate that could have come from the Chinette school of Andy Goldsworthy. Leaves from the local trees were shaped, dried and stitched together with thorns into a perfect bowl. When we finish dinner, we toss the plates into a trough that feeds the water buffalo.

I retire with my pillow on the roof of the building with everyone else. Someone plays a drum quietly. I can't sleep—it's still in the 90s—so I look off the edge of the roof. Rajinder is on the front terrace. Laying on a string cot in his white Kurta, I can hear him snoring. His driver quietly pads around the cot, ladling water from a bucket he is carrying, creating a small pond to cool the concrete around the johadwallah babu. ■

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was one of the largest catchments,” he goes on, more sadly now. “And this. This is always happening.”

Indeed, in only the second year of Rajinder's arrival, as the river showed signs of restoration, the Rajasthan Irrigation Department moved in and charged him with damming the monsoonal waters and hoarding it for the villagers. This, despite the obvious fact that the river was not only running at increased water capacity, but for several months longer than it had in decades. Since then, Rajinder Singh has been

within the buffer zone of the nearby Sariska Tiger Preserve. The water catchments also revived the Ruparel River, a tributary of the Arvari, which runs through the heart of the preserve. As expected, it plumped up the animal population, including tigers. This drew Valmik Thapar, a well-known tiger conservationist, and a good friend of Rajinder to talk to him about relocating the villagers to avoid any tiger/human conflicts. I actually met Rajinder through Thapar, but clearly the two of them have a history of difficult issues between them. And, in