

Water Harvesting and Groundwater Recharge in Saurashtra in the 1990s

*A Community-Led Water Revolution and Its Long-Run Impact on Agriculture and
Livestock*

Detailed Note

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Executive Summary

Between the mid-1980s and the early 2000s, Saurashtra's farmers, religious and community organisations, NGOs and eventually the Gujarat government built one of India's largest distributed groundwater-recharge efforts: tens of thousands of check dams, percolation tanks, recharge wells and related structures, financed and maintained substantially through community contribution rather than government fiat alone. This note traces that movement from its origins in individual farmer experimentation, through mass mobilisation led by the Swadhyaya Parivar and a cluster of NGOs, to its adoption and scaling by the Gujarat government as the Sardar Patel Sahbhagi Jal Sanchay Yojana from 2000 onward.

The Aga Khan Rural Support Programme (India) — AKRSP(I) — is examined in Section 4 as a case study within this broader movement: one of several NGOs that operationalised a distinctive, replicable model of community-led site selection, cost-sharing, construction and maintenance, illustrated through its Amrapur and Sapar check dam experiments and corroborated by contemporaneous programme records from Devgad and elsewhere. AKRSP(I)'s significance lies less in the volume of structures it personally built than in demonstrating and documenting a governance model — moving water infrastructure from a “government asset” to a “community asset” — that other NGOs adapted and that government itself later absorbed into its own subsidy programme.

On the evidence reviewed, the movement measurably improved Saurashtra's groundwater position through the 1990s and into the mid-2000s, though later years show renewed stress in a meaningful share of monitored wells as pumping and irrigated area expanded faster than recharge — a reminder that infrastructure alone does not constitute groundwater governance. Agricultural impact is real but the district-level evidence for it is thinner than the state-level narrative: this note relies on the most specific data available — Bhadar dam command-area irrigation and six-village cropping-intensity figures for Rajkot district — rather than implying a smooth, universal gain. Livestock and dairying emerge as at least as important a channel of impact as crop agriculture: secure water and irrigated fodder allowed farmers to keep more and better animals and reduced distress migration, though this legacy is now shared with the National Dairy Development Board's institutional and genetic programmes, exemplified by the newer Maahi producer-company model alongside Saurashtra's older district cooperative unions.

The note is equally candid about limits. Site-selection and construction quality declined as the movement scaled into a government subsidy programme; a structural paradox means that successful recharge can itself encourage the pumping growth that erodes it; and coastal Saurashtra's salinity problem required, and still requires, complementary interventions beyond recharge alone. The overall assessment in Section 14 situates the movement's achievement within this fuller, more recent picture, including Gujarat's continued presence among states with concentrated over-exploited groundwater units even as national indicators have improved since 2017.

The strongest lesson, developed in the Conclusion, is not “build check dams” but that durable local ownership — communities that select sites, contribute to cost, and maintain what they build — combined



with appropriate technical support and government backing at scale, is what converted a farmer-led response to drought into a landscape-level transformation of Saurashtra's water, agricultural and livestock economy.



1. Background: Saurashtra's Water Crisis

The experience of Saurashtra in Gujarat during 1990s represents one of India's most important episodes of community-led groundwater recharge and decentralized water harvesting. Its significance lies in where it began: not in a large government irrigation programme, but in the initiative of farmers, village communities, religious and philanthropic organisations, NGOs and local leaders responding to a severe and worsening water crisis.



Figure 1. A dry watercourse cutting across Saurashtra scrubland before treatment: no bund, no check structure, nothing to hold the monsoon flow back from running straight off the catchment. (Illustrative photograph.)



Geo-hydrologically, Saurashtra can be divided into two distinct zones. The northern and central zone — comprising Rajkot, Surendranagar, Jamnagar, Porbandar, Devbhumi Dwarka and Amreli districts — receives highly erratic rainfall, averaging between 250 mm and 600 mm a year, placing it among the region's lowest-rainfall areas. Its terrain is moderately undulating to rolling, underlain by hard basaltic rock just a few feet below the surface, which offers little natural groundwater storage. Agriculture here was historically almost entirely rainfed, but the spread of diesel and electric pump sets through the 1970s and 1980s encouraged rapid, largely unregulated groundwater extraction.

The second zone is the southern coastal belt — Junagadh, Bhavnagar and Veraval districts — which typically receives torrential rainfall in occasional heavy years interspersed with runs of low-rainfall years. Geomorphologically, limestone formations a few feet below the surface make this belt more conducive to groundwater recharge, but extraction beyond the natural rate of replenishment turned this advantage into a liability. As water tables in coastal villages fell and wells ran dry or their yields declined, saline seawater began intruding into the aquifers. Each monsoon, fresh recharge water mixed with this saline water, diluting it but not to a level safe for irrigation; farmers nonetheless used this brackish water for supplementary irrigation of kharif crops — mostly groundnut and cotton — and of winter crops such as wheat, onion and sugarcane. Repeated year after year, this practice progressively salinised the soil, eroding land productivity and the agriculture-based livelihoods of these coastal communities.

As an immediate response, farmers began replacing high-water-requiring groundnut and cotton with lower-water crops — sesame, maize, green gram and black gram in the kharif season, and gram in place of wheat in the rabi season. Sugarcane, being especially water-intensive, was phased out almost entirely in both seasons. A number of sugar mills and cotton-ginning factories in the area consequently closed, and many oil mills began operating well below capacity. Recognising the severity of the situation for the region's land, water and agricultural economy, the Government of Gujarat set up a dedicated wing of the state irrigation department — the Salinity Ingress Prevention Cell (SIPC), based in Bhavnagar — to address the problem specifically.¹

¹Background on Saurashtra's regional geo-hydrology, the coastal salinity mechanism and the state's early institutional response (SIPC) draws on inputs provided by Chandra Shekhar (C.S.) Pathak (personal communication with the author, September 2026).



Figure 2. A harvested Saurashtra field lying bare and dry between rains — the kind of moisture-stressed cropland that motivated the search for ways to keep monsoon runoff on the land rather than losing it to rapid runoff. (Illustrative photograph.)

The crisis became acute after successive droughts in the mid-to-late 1980s. Annual rainfall in Saurashtra fell to only about 93 mm in 1987, while 1985 and 1986 both received roughly 40 percent below normal rainfall². The combination of drought, groundwater depletion and growing dependence on irrigation created a powerful incentive for farmers to experiment with capturing and storing monsoon runoff rather than watching it drain away.

The significance of what followed lies less in the raw count of structures built than in a change in how rural Saurashtra thought about rainwater. Instead of allowing the short, intense monsoon flows to run off toward the sea, farmers increasingly sought to hold water on the land and put it back into the aquifer beneath their own fields.

²Patel, P. M., Saha, D. & Shah, T. (2020), "Sustainability of groundwater through community-driven distributed recharge: An analysis of arguments for water scarce regions of semi-arid India," *Journal of Hydrology: Regional Studies*, 29, 100680.



Saurashtra's water crisis in numbers

	Indicator (late 1980s baseline)
1987 annual rainfall	≈93 mm — an extreme drought year
1985–86 rainfall shortfall	≈40% below the long-period normal
Dominant irrigation source	Groundwater — over 80% of Gujarat's net irrigated area
Terrain constraint	Hard-rock basaltic aquifers with low natural storage/recharge capacity
Coastal impact	Progressive seawater intrusion as freshwater heads fell

Sources: Patel, Saha & Shah (2020); World Bank, *Drought-Proofing through Groundwater Recharge* (2020).



Figure 3. A seasonal Saurashtra stream in the dry season: a small, shallow pool is all that remains where villagers gather to wash and draw water — the kind of intermittent flow the recharge movement sought to capture rather than let run to waste. (Illustrative photograph.)

2. The Beginning of the Recharge Movement

The movement's origins lie with individual farmers experimenting with ways of diverting monsoon runoff into their own wells. This was a genuinely unconventional idea: farmers had long been advised against letting silt-laden runoff into wells, for fear that sediment would clog fractures in the aquifer and reduce well productivity.



Repeated drought forced farmers to challenge that conventional wisdom. They began building simple channels, filters and settling arrangements so that relatively clean runoff could enter wells and recharge the aquifer beneath. Results were sufficiently encouraging that the practice spread rapidly from farm to farm and village to village³.



Figure 4. Looking down a masonry-lined open well of the kind farmers learned to recharge directly with filtered monsoon runoff — an unconventional idea at the time, since silt had long been thought to clog and ruin a well. (Illustrative photograph.)

By the early 1990s, scattered farmer experimentation had grown into a much wider social movement. The Swadhyaya Parivar, a spiritual and social movement founded by Pandurang Shastri Athavale, was particularly important in mobilising voluntary labour (shramdaan) and spreading the practice of well recharge across villages that had no prior connection to one another. Other religious organisations, local leaders, philanthropists, NGOs and business communities subsequently joined in⁴.

A number of NGOs lent further impetus to this effort in the coastal areas, including Aga Khan Rural Support Program (India) {AKRSP(I)}, the Ambuja Cement Foundation, the Tata Chemicals Society for Rural Development (TCSR), the Pidilite-promoted Triveni Kalyan Foundation, the Excel Industries-promoted Vivekanand Research and Training Institute (VRTI), and — joining somewhat later — the Sir Ratan Tata Trust-promoted Coastal Salinity Prevention Cell (CSPC). Their common approach centred on community participation: involving beneficiaries in site selection, planning, implementation and cost-sharing, so that a

³World Bank (2020), Drought-Proofing through Groundwater Recharge: Lessons from Chief Ministers' Initiatives in Four Indian States, Water Global Practice Knowledge Note, Washington, DC: World Bank.

⁴Shah, T. (2000/2009), "Mobilizing social energy against environmental challenge: understanding the groundwater recharge movement in western India," Natural Resources Forum, 24(3).



sense of ownership would carry through to post-construction repair and maintenance. A number of corporate houses and banking institutions also came forward to fund these organisations' work.⁵

Two further civil-society vehicles, organised around farmer and diaspora financing of check dams rather than corporate CSR, added significant scale to this coastal effort. The Vruksha Prem Seva Trust, led by Limbhabhai Patel, built an estimated 3,000 check dams across 42 villages — mainly in Rajkot district — between 1999 and 2005 alone, structured so that farmers contributed labour and money alongside a government grant, giving them, in the Trust's own account, “an incentive to maintain” what they had helped build. The Saurashtra Jaldhara Trust, founded in 1999–2000 by the Surat-based diamond entrepreneur Mathurbhai Savani, mobilised the region's large diaspora of Saurashtra-origin diamond-industry workers in Surat to fund water-conservation works in their native villages, and over roughly two decades reports having invested about Rs 145 crore in building an estimated 20,000 check dams on rivers and roadways across the region.⁶

Estimates of scale vary with source and definition, but all point to an extraordinary rate of adoption. One widely cited estimate puts the number of wells recharged in Saurashtra at roughly 92,000–98,000 between 1992 and 1996, alongside about 300 new recharge ponds. A separate estimate — cited in the World Bank's review and attributed to a 2002 assessment by Gohil — puts the number of dug wells recharged with Swadhyaya volunteer assistance alone at more than 230,000 by the end of 1994⁷. The differences reflect different sources, timeframes and definitions of a “recharge structure,” but the order of magnitude — tens of thousands of individually small interventions within a few years — is consistent across every account.

The movement gradually broadened beyond individual wells to include:

- recharge of open wells;
- farm ponds;
- village tanks;
- check dams and anicuts;
- percolation tanks;
- sand dams or bori bandhs;
- desilting of existing water bodies; and
- modification of drainage channels to slow runoff and increase infiltration.

⁵This list of NGOs active in coastal Saurashtra's water-harvesting effort, and their community-participation approach, draws on inputs provided by Chandra Shekhar (C.S.) Pathak (personal communication to the author, September 2026).

⁶Vruksha Prem Seva Trust figures per Down To Earth (2019), “Saurashtra woes: Policy change on check dams leads to water deficit,” <https://www.downtoearth.org.in/water/saurashtra-woes-policy-change-on-check-dams-leads-to-water-deficit-64073>; Saurashtra Jaldhara Trust figures per Saurashtra Jaldhara Trust, profile of Mathur Savani, <https://saujaldharatrast.com/mr-mathur-savani/>, accessed September 2026.

⁷van Steenberg, F. (2006), “Promoting local management in groundwater,” *Hydrogeology Journal*, 14(3), 380-391; corroborated in World Bank (2020), *Drought-Proofing through Groundwater Recharge*, which cites a 2002 estimate (Gohil) of 230,000+ dug wells recharged with Swadhyaya Parivar assistance by end-1994, and separately records that over 130,000 check dams were built across Saurashtra under the state's later Sardar Patel Sahbhagi Jal Sanchay Yojana.



This amounted to a form of distributed managed aquifer recharge: thousands of small, cheap, locally sited interventions that collectively altered the hydrological behaviour of an entire landscape — something no single centralised project could have achieved at comparable cost or speed.

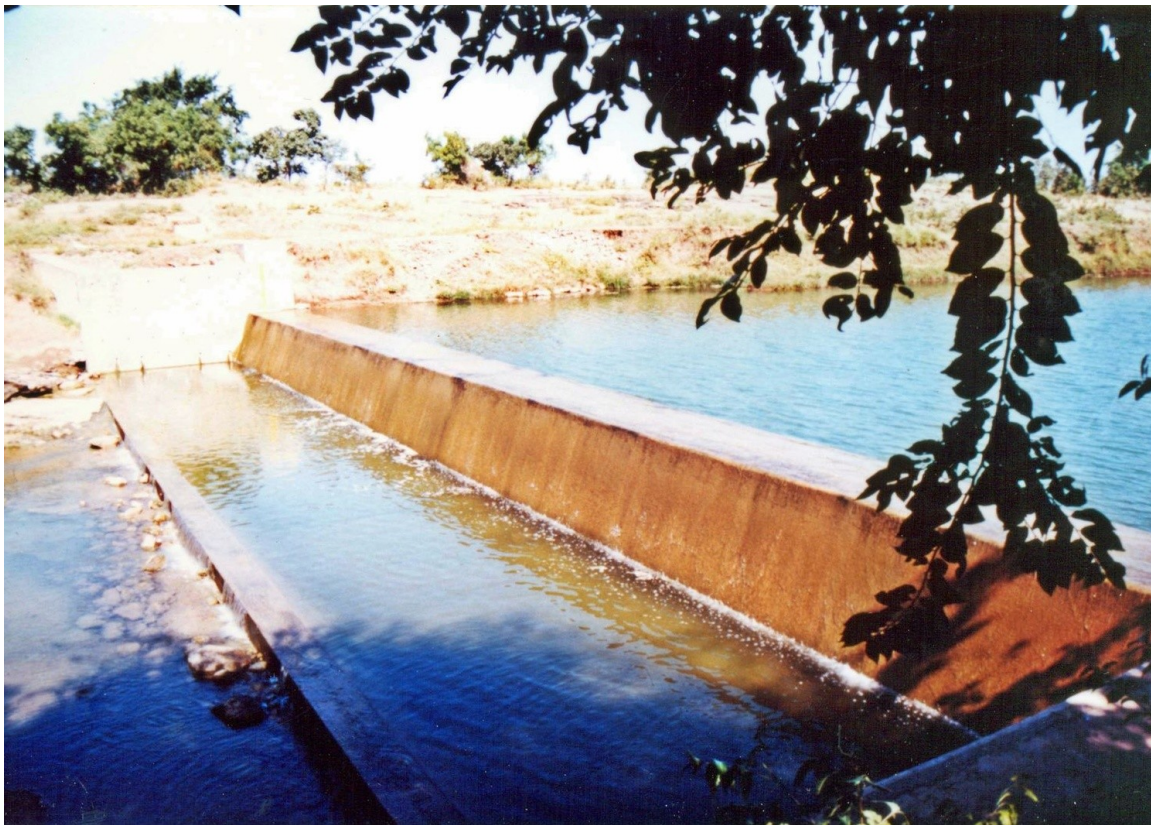


Figure 5. Water spilling over a completed check dam wall into the stream below: the visible, small-scale counterpart to the thousands of similar structures that together made up the recharge movement. (Illustrative photograph.)

3. Why Check Dams Were Particularly Important

Check dams became the movement's signature structure because of Saurashtra's particular physical geography. A conventional large dam stores water in one major reservoir and distributes it through canals. The Saurashtra model worked differently: small masonry or earthen structures were placed across seasonal streams and drainage lines, where they slowed the velocity of runoff, held water back temporarily, and allowed a portion of it to infiltrate the underlying rock.

The principal objective was therefore usually not direct surface irrigation from the check dam itself, but recharge of wells and aquifers downstream and in the surrounding catchment. AKRSP(I)'s own documentation notes that its early check dams and percolation tanks were built primarily for groundwater recharge rather than direct irrigation — which initially made mobilising communities difficult, since



farmers could not see an immediate, visible benefit from contributing to infrastructure whose principal payoff lay underground and some distance away⁸.



Figure 6. A completed check dam's stepped spillway in full flow, water cascading through each notch into the stream below — one of the movement's more substantial structures. (Illustrative photograph.)

A district-level hydrologic study of Rajkot found the district already carried more than 5,000 check dams by the time of the survey — a density of roughly 0.5 structures per square kilometre — with roughly 85 percent of the district's area under agriculture and about 70 percent of irrigation drawn from groundwater, mainly through dug wells. Simulations of a representative 20,000 m³ check dam found annual infiltration in the range of 78,000–141,000 m³, several times the structure's own storage capacity, confirming that a check dam's hydrological value lies overwhelmingly in the water it lets soak away rather than the water it visibly holds⁹.

⁸Aga Khan Rural Support Programme (India), "Community Contribution in Irrigation" (organizational case-study documentation on the Amrapur check dam and Sapar percolation tank), akrspindia.org.in, accessed September 2026.

⁹Frontiers in Water (2021), "Hydrologic Assessment of Check Dam Performances in Semi-Arid Areas: A Case Study from Gujarat, India."



Figure 7. A masonry check dam across a Saurashtra streambed, holding back monsoon flow so it can infiltrate the aquifer beneath rather than run off to the sea. (Illustrative photograph.)

This distinction mattered institutionally as much as technically. It meant the intervention had to combine physical infrastructure with a new kind of community mobilisation: communities were asked to identify sites, contribute resources, supervise construction and subsequently maintain structures whose main benefit — a higher water table — was invisible and shared, rather than a canal or field bund whose benefit was immediate and private.



Figure 8. A check dam's spillway and wing wall photographed dry, well before or after the monsoon flow it is built to hold back — a reminder that a check dam's value lies mostly in water that has already soaked away, not in what is visibly standing. (Illustrative photograph.)

4. Case Study: The Role of the Aga Khan Rural Support Programme (India)

4.1 AKRSP(I)'s distinctive contribution

AKRSP(I) was not the originator of the Saurashtra water-recharge movement as a whole; that movement had already begun through farmer experimentation and Swadhyaya-led mobilisation from the late 1980s. AKRSP(I)'s distinctive contribution was to institutionalise the community-managed approach to water harvesting — to turn a spontaneous social movement into a replicable development model with a defined process for site selection, cost-sharing, construction and maintenance.

AKRSP(I) itself was established in 1983 as part of the Aga Khan Development Network, and began field operations in Gujarat in 1986, initially in Surendranagar, Bharuch and Junagadh districts — two of which, Surendranagar and Junagadh, lie within Saurashtra. This places AKRSP(I) on the ground in the region from the very start of the recharge movement's build-up, several years before its early-1990s peak¹⁰.

AKRSP(I) organises its Gujarat work — now spanning some 15 districts — around three operational regions, two of which are squarely within or adjoining Saurashtra: a coastal-saline region headquartered

¹⁰Aga Khan Rural Support Programme (India), "Gujarat" (akrspindia.org.in/web/wherewework/gujarat) and organisational homepage, accessed September 2026; Aga Khan Development Network, "Agriculture and Food Security — India" (the.akdn.org), accessed September 2026, which dates AKRSP(I)'s founding to 1983 and describes over 30 years of work in Gujarat's drought-prone and coastal-saline areas.



at Gadu, addressing seawater intrusion along the Porbandar–Miyana coastline, and a drought-prone region headquartered at Sayla in Surendranagar district. Junagadh and Surendranagar districts have been treated as a distinct thematic focus for groundwater depletion and salinity ingress within the organisation's own programme documentation¹¹.

AKRSP(I) recognised early that water availability, not land or labour, was the fundamental constraint on agricultural productivity for small farmers in western Gujarat. Its intervention therefore went beyond constructing physical structures: it sought a model in which communities had a durable interest in identifying appropriate investments and maintaining them over time¹². This was a deliberate departure from the prevailing government model of the 1980s and early 1990s, under which drought-relief programmes typically built percolation tanks and check dams with government funds and contractor labour, with limited community involvement — "hardware" that most NGOs of the period did not regard as their domain¹³.



Figure 9. Dry rubble-stone pitching being laid along an embankment under construction, with water already backing up behind it — the kind of "hardware" that most NGOs of the period left to government contractors. (Illustrative photograph.)

¹¹Aga Khan Rural Support Programme (India), organisational website (akrspindia.org.in), accessed September 2026; "Programme Areas of AKRSP(I)," in Aga Khan Foundation, Rural Development in India (2011).

¹²Aga Khan Rural Support Programme (India), "Irrigation" (akrspindia.org.in/web/whatwedo/irrigation), accessed September 2026, which describes water control as "the single greatest constraint for small farmers to have higher agriculture productivity."

¹³Aga Khan Rural Support Programme (India), "Community Contribution in Irrigation," akrspindia.org.in, accessed September 2026.



4.2 The Amrapur and Sapar experiments

Two early interventions are central to AKRSP(I)'s own account of this period: the check dam at Amrapur and the percolation tank at Sapar. AKRSP(I) worked with villagers to establish community contributions toward the identification, construction and subsequent maintenance of both structures. The process reportedly required numerous village meetings, because there was no established precedent for asking a community to contribute toward infrastructure whose principal purpose was invisible, shared groundwater recharge rather than a private field benefit¹⁴.



Figure 10. A completed weir holding back a broad stretch of impounded water on upwards side of its wall.
(Illustrative photograph.)

The experience demonstrated a principle that has since become close to a truism in Indian water-sector practice, but was far from obvious at the time: water infrastructure is more likely to be built well and maintained over time when the community that depends on it has participated in deciding where and how it is built, and has contributed something of its own — cash, labour or materials — toward it.

This approach subsequently became standard AKRSP(I) practice, and other NGOs working in Gujarat's water sector adopted and adapted elements of it. AKRSP(I) describes the Amrapur-Sapar experience as having helped shift the broader irrigation establishment — including, over time, parts of government — toward a more community-friendly approach to water-infrastructure design¹⁵.

¹⁴ Aga Khan Rural Support Programme (India), "Community Contribution in Irrigation," akrspindia.org.in, accessed September 2026.



AKRSP(I)'s own contemporaneous programme reporting from the mid-1990s corroborates this account with specific village-level detail. At Mithapur in Junagadh district, villagers were sufficiently persuaded by the benefits of a first AKRSP(I)-supported check dam that they raised Rs 33,500–35,000 among themselves, unprompted, to fund a second one, with the village sarpanch and revenue official (talati) both taking an active role in mobilising the contribution. At Virdi, also in Junagadh, farmers contributed Rs 40,000 — about 2.5 percent of the estimated project cost, and, AKRSP(I) recorded, the largest cash contribution collected from any community for a project of this kind up to that point — toward a percolation tank whose prospective benefit was already reflected in a rise in the price of command-area land before construction was even finished. And at Ambala, in Mendarda block, villagers collected the entire community contribution for two check dams themselves, “without any pressure from AKRSP,” a pattern the organisation’s own reporting described as “an exemplary case of people coming together ... for the benefit of the entire community”¹⁶.



Figure 11. A check dam under construction on a Saurashtra streambed: villagers and masons work alongside the concrete shuttering and mixer, the kind of joint construction effort through which communities supervised quality and built a stake in the finished structure. (Illustrative photograph.)

AKRSP(I)'s significance lay less in the volume of structures it personally built than in the fact that it built, documented and publicised a replicable process for doing so with communities rather than for them.

¹⁵Aga Khan Rural Support Programme (India), "Community Contribution in Irrigation," akrspindia.org.in, accessed September 2026.

¹⁶Aga Khan Rural Support Programme (India), Annual Report: Water Resources Development, ("Ambala Check Dam: the whole village comes together!") Aga Khan Rural Support Programme (India), Annual Report: Water Resources Development, 1996 ("Mithapur Check Dam: People's Enthusiasm").



4.3 From "Government Asset" to "Community Asset"

The significance of this shift was institutional as much as technical, and the pattern recurs across the recharge movement's NGO- and community-led actors more broadly — AKRSP(I) is simply the best-documented case of it. The conventional model of the period ran, approximately:

Government identifies → Government finances → Contractor constructs → Government maintains

The emerging community model ran closer to:

*Community identifies → Community contributes → NGO provides technical/financial support →
Community supervises → Community maintains*

This shift had several practical consequences.

Site selection became more participatory

Local farmers held detailed, often tacit knowledge of drainage patterns, seasonal streams, existing wells and the specific low points where water accumulated during intense rainfall. Participatory planning allowed that knowledge to inform engineering decisions that a contractor working from a generic design would not have captured.

Communities developed a stake in construction quality

When villagers contributed labour, materials or money, they had a direct incentive to monitor the quality of construction — a form of built-in social audit that formal contracting arrangements rarely replicate.

Maintenance became a community responsibility

This mattered particularly for check dams and percolation structures, since silt accumulation and physical damage can progressively reduce their effectiveness if no one is responsible for periodic desilting and repair.



Figure 12. Women draw water by rope and pulley from a recharge well ringed with masonry piers — ongoing, everyday use of the kind that gave communities a continuing stake in a structure's maintenance. (Illustrative photograph.)

The structure became a social institution

The physical asset became a focal point for collective decision-making and resource management, and in some villages the seed of a formal water-user institution that outlived the original construction project.



Figure 13. Villagers and masons build up a rubble-and-mortar check dam wall by hand — the kind of direct, supervised labour contribution that gave communities a stake in construction quality. (Illustrative photograph.)

4.4 The Community Contribution Principle

One of the most important lessons from this period was the use of community contribution as an instrument of ownership, not merely as a means of reducing project cost. Contributions took several forms: cash; voluntary labour (shramdaan); locally available construction materials; land or access arrangements; supervision; and an ongoing responsibility for maintenance. This mattered particularly in drought-prone areas where poor farmers often had very limited cash on hand.



Figure 14. A small masonry outlet structure, water pooling behind it — the modest, locally built infrastructure typical of community-financed recharge works. (Illustrative photograph.)

The Devgad case

A contemporary account of Devgad village in Junagadh district illustrates how this worked in practice. Villagers organised themselves, pooled approximately ₹45,000, deposited it in a bank and borrowed against it to help finance construction. They also negotiated favourable prices for cement and bricks, while poorer farmers contributed labour in place of cash. AKRSP (I) provided partial financial support. Two check dams were commissioned in 1996 and completed by 1997. Following the 1998 and 1999 monsoons, the dams reportedly recharged previously depleted groundwater sources and allowed Devgad's farmers to draw water even while neighbouring villages were suffering drought¹⁷.

AKRSP(I)'s own 1996 annual report corroborates the existence and approximate dating of these structures: it records an innovative stream-deepening exercise carried out that year "in the storage area of Devgad check dam in Mendarda block," improving both the dam's storage capacity and, in villagers' own assessment, the recharge rate of wells in its command area¹⁸.

The Devgad experience is valuable precisely because it shows the model was not simply "the NGO builds a check dam." It was a local financial and institutional arrangement — a village credit pool, negotiated material costs and organised labour contribution — that an outside agency supported rather than substituted for.

¹⁷Mistry, M. (2000), "Devgadh: A lesson in drought management," Times of India, 24 April 2000.

¹⁸Aga Khan Rural Support Programme (India), Annual Report: Water Resources Development, 1996 ("Stream Deepening").



Figure 15. A circular masonry well-recharge structure, newly built and not yet in use, beside the channel that will feed it filtered monsoon runoff. (Illustrative photograph.)

5. Case Study: Pidilite Industries' Water-Harvesting and Watershed Initiatives in Bhavnagar District

5.1 A private-sector partner in coastal salinity mitigation

Pidilite Industries, through its corporate social responsibility arm, the Triveni Kalyan Foundation, together with the Gram Nirman Samaj, Gram Dakshinamurty and the Lok Bharti Gramvidyapith (Sanosara), had long been active in water harvesting, watershed development and allied livelihood, education and health programmes in Mahuva taluka of Bhavnagar district — the home district of Pidilite's Chairperson, Mr Madhukar Bhai Parekh. Frequent visits to the area, and repeated representations from farmers about the salinity ingress afflicting their land — a problem that had touched land of his own at Kalsar village as well — gave Shri Parekh a close, personal appreciation of its severity. He came forward to fund 50 percent of the cost of every water-harvesting and salinity-mitigation structure taken up by the state irrigation department across the entire Bhavnagar district, an offer formalised through a memorandum of understanding.

In practice, Pidilite's contribution often exceeded the agreed 50 percent share: under the MOU, any expenditure above the approved estimate was to be borne entirely by Pidilite, in addition to its share of the estimated cost. Responsibilities were clearly divided. Government's role was confined to approving designs, plans and estimates and to quality control and progress monitoring; site identification was carried out jointly by the irrigation department and Pidilite's team with community involvement; and construction



itself was executed by Pidilite, which advanced the full cost from its own resources and was reimbursed by government only to the extent of its 50 percent share on completion.

The mechanism had run successfully, with quality workmanship, transparency and visible impact persuading farmers in the neighbouring Amreli district to petition the Chairperson to extend the same model to their area. He agreed, government consented, and the programme was launched in Amreli in 2021.

5.2 From salinity mitigation to watershed development

The visibility and evident success of the Bhavnagar programme drew wider interest. The District Development Officer (DDO) of Bhavnagar sought a comparable arrangement with Pidilite for watershed-development works implemented by the District Rural Development Agency (DRDA) under various centrally sponsored schemes — activities intended to benefit rainfed farmers in the upper reaches of local micro-watersheds, who typically lacked access to irrigated agriculture. At the initiative of Mr. P. K. Shukla, head of Pidilite's CSR function, a pictorial presentation of watershed-development activities undertaken elsewhere in the country — drawing on the technical experience of the water conservation engineer C. S. Pathak — was organised for the DDO. He responded by asking for a demonstration of a similar, integrated micro-watershed approach at sites identified by Pidilite's team, with a view to eventual replication elsewhere.

Cumulatively, the initiative has led to the development of 413 check dams, 167 ponds and 1,407 farm ponds across the district, ensuring more reliable water availability for agricultural activities.



Figure 16. Check dam constructed at Sanosara, Sihor taluka, one of many structures built under the Pidilite programme across Bhavnagar district. (Photograph: Pidilite Industries / Triveni Kalyan Foundation.)



Figure 17. Repair work under way on a check dam at Reva, Umralla taluka, illustrating the programme's ongoing maintenance activity. (Photograph: Pidilite Industries / Triveni Kalyan Foundation.)

5.3 The Karjada micro-watershed demonstration

Two micro-watershed sites were identified at village Karjada in Jesar taluka of Bhavnagar district and inspected by the DDO together with the DRDA team and villagers. Following this visit, Pidilite's team, again drawing on Mr Pathak's technical guidance, began a demonstration. Three small earthen water-harvesting structures were built in the upper reaches of the identified micro-watersheds, each with a fibre-sheet diaphragm set into the middle of the bund and constructed using borrow material from the spread area, with an end-located channel to carry away excess flow.



Figure 18. Fibre-sheet diaphragm being fixed midway along an earthen water-harvesting structure under construction at village Karjada, Bhavnagar district. (Photograph: Pidilite Industries / Triveni Kalyan Foundation.)



Figure 19. Fibre-sheet fixing under progress on the same earthen structure at village Karjada. (Photograph: Pidilite Industries / Triveni Kalyan Foundation.)



Figure 20. The same earthen water-harvesting structure holding water for the first time after completion, using borrow material from the spread area and an end-located free-flow waste weir. (Photograph: Pidilite Industries / Triveni Kalyan Foundation.)

This was followed by a small, low-cost hybrid check dam in the middle reaches of the drainage line — a composite structure with a loose-boulder body wall, a fibre-sheet diaphragm and earthen support on its upstream face, wrapped in GI wire mesh and capped with a plain cement concrete coping, roughly two metres high and twenty-two metres long, and costing approximately Rs 2.70 lakh including deepening of the spread area. At villagers' request, a pathway was later added along the upstream face of the body wall to allow carts, tractors and other vehicles to cross.



Figure 21. Fibre-sheet fixing under progress during construction of the composite hybrid check dam at village Karjada. (Photograph: Pidilite Industries / Triveni Kalyan Foundation.)



Figure 22. The low-cost composite hybrid check dam under construction at village Karjada, with its loose-boulder body wall, fibre-sheet diaphragm, earthen upstream support and GI-wire-mesh wrapping. (Photograph: Pidilite Industries / Triveni Kalyan Foundation.)



*Figure 23. The completed composite hybrid check dam at village Karjada, with backfilling of soil still pending.
(Photograph: Pidilite Industries / Triveni Kalyan Foundation.)*



Figure 24. The completed hybrid check dam after its first monsoon flow, with the upstream pathway later added for carts, tractors and other vehicles. (Photograph: Pidilite Industries / Triveni Kalyan Foundation.)

The Karjada demonstration was conceived as an ideal, replicable model for watershed-development activities in the adjoining Amreli, Junagadh and Gir-Somnath districts, which share similar terrain and comparable potential for such structures, as well as for allied activities such as community and private wasteland development and cultivated-land treatment through field bunding and terracing. It could not, however, be carried forward at the time, owing to the outbreak of the COVID-19 pandemic, a change in the administrative setup, and pressing demand from farmers to focus instead on larger structures in the lower reaches of micro-watersheds and on rivers and rivulets. It may nonetheless be worth reinitiating in the wider interest of farming communities with land in the upper reaches of micro-watersheds, who remain largely dependent on rainfed agriculture.

6. From NGO Innovation to Government Policy

Government agencies were active alongside the NGOs from an early stage. The Gujarat Land Development Corporation (GLDC), District Rural Development Agencies (DRDAs) and NABARD, among others, implemented water-harvesting and soil-and-water-conservation works through central- and state-government funding under various centrally sponsored schemes, including the National Watershed Development Programme for Rainfed Areas (NWDPPRA) of the Ministry of Rural Development, the National Rural Employment Guarantee Scheme (NREGS) and the Drought Prone Areas Programme (DPAP). NGOs



were themselves engaged as implementing agencies under several of these schemes, NWDPRA in particular.

With many agencies implementing these programmes simultaneously, and area selection based on village boundaries rather than hydrologically delineated micro-watersheds, overlapping coverage became a recurring problem. The state government addressed this by assigning micro-watershed delineation to the State Remote Sensing Agency (SRSA) and constituting district-level committees, chaired by the District Development Officer of each district, to allocate a distinct, map-coded micro-watershed to a single implementing agency. This allocation applied specifically to watershed-development activities rather than to water-harvesting and water-resource creation, which therefore proceeded without the same territorial restriction — though in practice, NGOs generally confined themselves to villages not already being served by another NGO, while government agencies such as the Panchayat irrigation department and GLDC kept their minor-irrigation and recharge work within the boundaries the state government had assigned to them.¹⁹

The success and visibility of the decentralised water-harvesting movement eventually reshaped government policy. The Government of Gujarat launched the Sardar Patel Sahbhagi Jal Sanchay Yojana (the Sardar Patel Participatory Water Conservation Programme, SPPWCP) in January 2000, offering a 60 percent construction subsidy for check dams built with community participation and contribution²⁰. The programme represented a major transition: practices developed through farmer and NGO initiative over the previous decade were folded into a large-scale, government-financed programme, while — at least in its original design — retaining the community-contribution principle that AKRSP(I) and others had pioneered. Under this programme, responsibility for site selection, planning, design, cost estimation and implementation rested with the Gram Panchayats, with the state government contributing 60 percent of the cost — the origin of the scheme's popular name, the “60:40 Yojana”.²¹

The scale of construction that followed was extraordinary by any standard. The first phase of SPPWCP alone produced 10,257 check dams by September 2000²². A 2002 assessment (Gohil) put cumulative check-dam construction under the programme at over 130,000 across Saurashtra²³. A separate case study covering the 2005–09 period estimates roughly 100,000 check dams built across Gujarat in that window alone, with approximately 55,000 of them in Saurashtra²⁴. By 2018, one farm-level survey put the

¹⁹This account of the government agencies, centrally sponsored schemes and inter-agency watershed-allocation arrangements active alongside the NGOs draws on inputs provided by Chandra Shekhar (C.S.) Pathak (personal communication to the author, September 2026).

²⁰Sekhri, S. (2012), “Role of Policy Reforms in Promoting Groundwater Conservation in India,” paper prepared for the India Policy Forum 2012, National Council of Applied Economic Research (NCAER)/Brookings Institution, discussion of Gujarat's Sardar Patel Participatory Water Conservation Project; corroborated by Frontiers in Environmental Science (2022), “Benefits, equity, and sustainability of community rainwater harvesting structures.”

²¹This detail on the Sardar Patel Sahbhagi Jal Sanchay Yojana's Gram Panchayat-led governance structure draws on inputs provided by Chandra Shekhar (C.S.) Pathak (personal communication to the authors, September 2026).

²²Sekhri, S. (2012), “Role of Policy Reforms in Promoting Groundwater Conservation in India,” India Policy Forum 2012, NCAER/Brookings Institution, discussion of the Sardar Patel Participatory Water Conservation Project (SPPWCP).

²³Cited in World Bank (2020), Drought-Proofing through Groundwater Recharge, Washington, DC: World Bank.

²⁴Chinnasamy, P., Misra, G., Shah, T., Maheshwari, B. & Prathapar, S. (2015), “Evaluating the effectiveness of water infrastructures for increasing groundwater recharge and agricultural production – A case study of Gujarat, India,” *Agricultural Water Management*, 158, 179-188.



cumulative Gujarat-wide total above 90,000 check dams, of which some 27,000 were located in Saurashtra specifically, still built with the same 60 percent government subsidy formula²⁵. At the district level, Rajkot alone was reported to carry more than 5,000 check dams by the early 2020s²⁶.

These figures are not fully reconcilable with one another — they come from different surveys, different years and sometimes different definitions of what counts as a "check dam" — but together they leave no doubt about the order of magnitude: several tens of thousands of check dams built across Saurashtra alone between 2000 and the late 2010s, layered on top of the roughly 92,000–98,000 well recharges and 230,000-plus Swadhyaya-assisted dug well recharges of the preceding decade. The government programme thus transformed what had begun as a decentralised social movement into one of the world's largest single experiments in distributed groundwater recharge.

²⁵Frontiers in Environmental Science (2022), "Benefits, equity, and sustainability of community rainwater harvesting structures: An assessment based on farm scale social survey."

²⁶Frontiers in Water (2021), "Hydrologic Assessment of Check Dam Performances in Semi-Arid Areas."



Figure 25. A larger check dam of the kind built at scale once government subsidy carried the community-recharge idea well beyond what the original movement could fund on its own. (Illustrative photograph.)

A cautionary counter-current

Even as the Sardar Patel Sahbhagi Jal Sanchay Yojana carried the community-recharge idea to a scale the original movement could never have reached on its own, the shift from thousands of small, locally financed structures to a single large state subsidy programme changed the character of what was being built. Because the subsidy covered 60 percent of construction cost — and, in practice, contractors and local elected representatives came to dominate site selection in many talukas — the discipline that AKRSP(I)'s community-financed model had imposed through cost-sharing weakened as volumes rose. Accounts of the programme's early years already point to faster construction and more visible political credit-claiming around inauguration events, alongside less consistent attention to hydrogeological suitability than the farmer- and NGO-led structures of the 1990s had received²⁷. This is not a reason to discount the programme's achievements, documented in the numbers above; it is the first sign in the record of a tension — between scale and fidelity to the original community-led model — that becomes central to Section 12.

²⁷ Sekhri, S. (2012), "Role of Policy Reforms in Promoting Groundwater Conservation in India," paper prepared for the India Policy Forum 2012, National Council of Applied Economic Research (NCAER)/Brookings Institution, discussion of Gujarat's Sardar Patel Participatory Water Conservation Project; corroborated by Frontiers in Environmental Science (2022), "Benefits, equity, and sustainability of community rainwater harvesting structures."



Figure 26. A percolation tank overflowing after the monsoon: water is held back by a low concrete wall so it can soak into the ground rather than run straight off the catchment. (Illustrative photograph.)

7. Impact on Groundwater

The most important measurable impact of the movement was on groundwater availability, though the precise contribution of check dams and other recharge structures — as opposed to good rainfall years or the arrival of Narmada canal water in parts of the region — remains a live subject of scientific debate.

The Patel, Saha and Shah (2020) analysis

A particularly important study compared Saurashtra to the broadly comparable, but recharge-movement-free, regions of Vidarbha and Marathwada. Between 2004 and 2009 in Saurashtra:

- groundwater draft increased by approximately 15 percent, from 351,772 to 403,328 hectare-metres;
- despite this rising extraction, the stage of groundwater development remained broadly stable at around 68 percent;
- the number of Saurashtra administrative blocks classified as critical, semi-critical or over-exploited fell sharply — from 41 in 2004 to 7 in 2009, 2 in 2011 and just 1 in 2013

The researchers conclude that the community-supported distributed recharge movement is an important explanation for improved groundwater recharge in Saurashtra during 2004–09, having specifically tried to



separate the effect of the recharge structures from the effect of favourable rainfall over the same period²⁸. This is materially stronger evidence than simply observing that water levels rose after check dams were built, since it controls for the alternative explanation that better monsoons alone were responsible.



Figure 27. A recharge pond holding water well past the monsoon, its banks bare of vegetation and a dead tree still standing in what is now open water. (Illustrative photograph.)

A comparable, better-documented case: North Gujarat's Sujalam Sufalam Yojana

Because granular before/after hydrological data specific to Saurashtra's thousands of small structures is not always publicly available at village level, it is useful to look at a comparable, better-documented World Bank case study from North Gujarat's Sujalam Sufalam Yojana — a parallel but administratively distinct recharge programme built around a 337-kilometre spreading canal and roughly 200,000 planned farm ponds across ten water-scarce districts. In villages along the canal's "Stretch 1":

- the water table rose by an average of 11.6 metres in treatment villages (from 95.7 to 84.1 metres below ground level);
- average tube well depth fell from 108.5 to 37.5 metres;
- irrigated area rose from 46.9 percent to 76.4 percent of cultivated land

This North Gujarat evidence is not a substitute for Saurashtra-specific data, and the two programmes differ in design — North Gujarat's model relies on a large spreading canal rather than thousands of independent check dams — but it is useful as an illustration, from the same state and the same World Bank

²⁸Patel, Saha & Shah (2020), *Journal of Hydrology: Regional Studies*.



assessment methodology, of the order of magnitude by which sustained recharge investment can move a water table in Gujarat's hard-rock and alluvial terrain²⁹.



Figure 28. An open well-being recharged by the storage area of a percolation tank. (Illustrative photograph.)

A more mixed and recent picture

Gains of this kind have not been uniform or permanent. Gujarat-wide, the area experiencing groundwater decline fell from about 27,600 square kilometres in 2001 to about 4,400 square kilometres by 2006 — a striking improvement contemporaneous with the recharge movement's peak. But a 2016 assessment specific to Saurashtra found a less encouraging picture: 73 percent of monitored wells showed falling water levels, with 24 percent recording declines exceeding four metres, against only 33 percent showing any rise (and that a modest 0–2 metres)³⁰. At Rajkot district level specifically, the stage of groundwater development stood at 72.01 percent in 2004, against a state figure of 76.47 percent — near the boundary the Central Ground Water Board treats as "critical"³¹.

Read together, the evidence supports a nuanced conclusion: the distributed recharge movement measurably improved Saurashtra's groundwater position through the 1990s and into the 2004–09 period examined by Patel, Saha and Shah, but it did not permanently solve the region's structural over-extraction

²⁹World Bank (2020), Drought-Proofing through Groundwater Recharge.

³⁰World Bank (2020), Drought-Proofing through Groundwater Recharge (2001–06 figures); Down To Earth (2019), "Saurashtra woes" (2016 well-level data).

³¹Cited in Mudrakartha, S. (2012), "Ground Water Recharge Management in Saurashtra, India: Learnings for Water Governance," PhD thesis, Suresh Gyan Vihar University, Jaipur, drawing on Central Ground Water Board data.



problem, and later years show renewed stress in a meaningful share of monitored wells — a point taken up further in Section 12.



Figure 29. A cart track running through a stand of coconut palms and other groundwater-dependent vegetation. (Illustrative photograph.)

Salinity and the Coastal Saurashtra Problem

Coastal Saurashtra faced a particularly difficult combination of groundwater depletion and saline-water intrusion. Intensive pumping lowered groundwater levels and made coastal aquifers more vulnerable to inward saline flow. Groundwater recharge therefore carried an additional benefit specific to this belt: maintaining or restoring the freshwater head could help reduce the hydraulic gradient that draws saline water inland.

Seawater intrusion along this coast was first scientifically documented in the 1970s, when hydrochemical surveys of the Mangrol–Chorwad stretch established a clear chloride gradient increasing toward the sea and correlated it with the pattern of inland groundwater draft.³² By 1976, when the Government of Gujarat first attempted an official assessment, salinity ingress was already estimated to have affected 779 villages, a population of about 13.3 lakh (1.33 million) and roughly 10.65 lakh hectares of coastal land; by the early

³²R.N. Athavale et al., “Hydrochemical evidence of sea water intrusion along the Mangrol-Chorwad coast of Saurashtra, Gujarat,” *Hydrological Sciences Bulletin*, Vol. 24, No. 1 (1979), <https://www.tandfonline.com/doi/abs/10.1080/02626667909491835>.



2020s, estimates put Saurashtra's saline coastal belt at around 2,500 villages, with intrusion advancing up to 15 kilometres inland in the worst-affected talukas.³³

The state's formal response took shape through a series of High-Level Committees (HLCs) convened in the 1970s and early 1980s. HLC-I was set up in 1976 under the chairmanship of the state's Chief Secretary, H.K.L. Kapur, and focused on the roughly 160-kilometre Una–Madhavpur reach, recommending a package of preventive works originally costed at about Rs 64 crore and later revised to about Rs 100.24 crore. A second committee, HLC-II, followed in 1978 under Chief Secretary K. Shivraj, extending the assessment to further reaches covering some 965 kilometres of coastline in total, with a substantially larger package of the order of Rs 168.70 crore, later revised to a range of roughly Rs 802.54 crore to Rs 1,427.30 crore. Both committees organised their recommendations around four categories of intervention — regulating groundwater extraction, artificial recharge, direct salinity-control structures such as tidal regulators and bandharas, and coastal reclamation — and it was to carry these recommendations forward that the Gujarat Irrigation Department set up a dedicated field formation, the Salinity Ingress Prevention Circle (SIPC), as the principal executing agency for coastal salinity-control works across Saurashtra.³⁴

Reasoning that sweet-water reserves built up close to the salinity-affected belt could both recharge the aquifer and hold back the advancing seawater, SIPC constructed a series of large check dams — known locally as bandharas — at the points where rivers and rivulets of the region met the sea. These were comparatively low structures, typically 2 to 4 metres high but 500 metres or more in length, with a large spread area and substantial storage capacity: many retained upward of 2,000 million cubic feet (mcft) of sweet water. On a rough estimate, a single reservoir of this kind could supply roughly five waterings of 2.5 inches to 40,000 acres, or one watering of the same depth to 200,000 acres — more in the case of larger bandharas.

Over time, however, it became clear that the bandharas were not fully achieving their intended purpose. Saline seawater persisted just below the one-to-two-metre column of sweet water that collected in their spread areas (at mean sea level), which limited the improvement in water quality in nearby wells. This left farmers with land within about two kilometres of a bandhara's periphery drawing down the sweet water before it could evaporate or otherwise go to waste — reserves that, if unused, typically lasted only until the end of December or the start of January.

³³Figures as cited in a Gujarat Technological University teaching presentation on salinity ingress prevention works, summarising Government of Gujarat/GWRDC data, <https://www.slideshare.net/slideshow/salinity-prevention-47900420/47900420>, accessed September 2026; on the 2,500-village, 15-kilometre estimate, “No longer at sea,” Tata Trusts Horizons, April 2023, <https://horizons.tatatrusts.org/2023/april/tata-trusts-horizons-no-longer-at-sea-cspc.html>.

³⁴Comptroller and Auditor General of India (2010), Audit Report for the year ended 31 March 2010 — Government of Gujarat (Civil), Chapter on the Salinity Ingress Prevention Programme, https://cag.gov.in/webroot/uploads/download_audit_report/2010/Gujarat_Civil_2010.pdf; committee chairmanship and cost figures as summarised in a Gujarat Technological University presentation on salinity ingress prevention, <https://www.slideshare.net/slideshow/salinity-prevention-47900420/47900420>, accessed September 2026. Note: the CAG's account and SIPC's own project documentation record the agency as the Salinity Ingress Prevention Circle, headquartered at Rajkot, with a separate Kachchh Irrigation Circle at Bhuj covering the Kachchh coast; cf. footnote 1 above, which — per C.S. Pathak's account — records the agency as the Salinity Ingress Prevention Cell, based in Bhavnagar. This note has not been able to independently reconcile the discrepancy in name and headquarters between the two sources and flags it for the authors' attention.



At the same time, because much of each bandhara's storage remained unused, farmers further from the periphery began pressing for access to these surplus reserves. SIPC responded by digging reverse, spreading and link canals, with beds set just a few inches above mean sea level, to carry water to these more distant areas — giving a fresh lease of life to many farmers who lived beyond the bandharas' immediate reach and were themselves contending with salinity ingress.³⁵



Figure 30. A freshwater storage pond near Saurashtra's coast, fringed by coconut palms: maintaining such freshwater heads is central to holding back saline intrusion along the coastline. (Illustrative photograph.)

By 2010, cumulative completion figures for SIPC's works — spanning tidal regulators, bandharas, recharge reservoirs, check dams, recharge tanks, nala plugging and afforestation — stood at 13 tidal regulators, 29 bandharas, 15 recharge reservoirs, 661 check dams, 28 recharge tanks and 4,487 nala plugs, together with afforestation over about 5,867 hectares. Substantial as these totals are in absolute terms, a Comptroller and Auditor General (CAG) review found that even by March 2010 — some 18 to 32 years after the two HLC reports had been accepted — only about 41 percent of the 3,357 individual works the committees had recommended (1,374 works) had actually been completed, with progress highly uneven by reach: 98 percent of works sanctioned for the Una–Madhavpur reach, where HLC-I's original assessment had concentrated, were finished by March 2010, against only 44 percent for Bhavnagar–Una, 26 percent for Madhavpur–Maliya and 29 percent for Maliya–Lakhpur. The CAG traced this shortfall to fund diversion (about Rs 50.37 crore of Twelfth Finance Commission grants routed to divisions not executing the

³⁵This account of SIPC's bandhara programme — its design rationale, storage capacity and later extension through canals — draws on inputs provided by Chandra Shekhar (C.S.) Pathak (personal communication to the author, September 2026).



sanctioned works), incomplete works rendering roughly Rs 43.11 crore infructuous, land-acquisition delays, and a chronic shortage of technical staff in the executing coastal divisions.³⁶

This uneven completion record lines up closely with where the problem continued to worsen through the 1990s. Comparing 2007–08 observations against the HLC-era baseline of 1977–84, the state's own monitoring recorded a further 15 percent increase in salinity-affected area — an additional 88,947 hectares — with only the Una–Madhavpur reach, where SIPC's works were most nearly complete, showing a marginal decline; the Madhavpur–Maliya and Lakhpur–Maliya reaches, where completion rates were only 26 and 29 percent respectively, registered increases of 92 percent and 85 percent. The deterioration also carried a documented public-health dimension: a baseline health survey covering 1,165 villages in the salinity-affected belt found kidney stones reported in 890 villages, gastric ailments in 753 villages and fluorosis in 337 villages — conditions plausibly linked to chronically saline and mineral-laden drinking water drawn from the same deteriorating aquifers.³⁷

Salinity struck at drinking water even more directly than at irrigation, since shallow hand-pumps and wells were often the first sources to turn brackish, and the Gujarat Water Supply and Sewerage Board (GWSSB) increasingly had to substitute engineered, often long-distance, piped supply from less-affected sources for the local groundwater villages had traditionally relied on. Where piped supply still fell short, GWSSB fell back on emergency tanker relief and, for the most saline or remote coastal habitations, small reverse-osmosis units; and it was to address the specific problem of 'tail-end' villages under-served by these multi-village schemes that the state set up the Water and Sanitation Management Organisation (WASMO) in 2002, shifting from direct provision toward facilitating village-level Pani Samitis able to monitor equity along the pipeline.³⁸

This became an explicit component of subsequent water-management work in coastal Gujarat. AKRSP(I)'s coastal-saline programme region — headquartered at Mangrol and covering the Porbandar-to-Miyana coastline — is organised specifically around this problem, and the organisation's broader water programme today includes groundwater recharge through check dams, percolation tanks and watershed work alongside irrigation and demand-side measures³⁹. It is nevertheless important to distinguish between demonstrating recharge in general and proving that any particular set of check dams reversed

³⁶Comptroller and Auditor General of India, Audit Report for the year ended 31 March 2010 — Government of Gujarat (Civil), Chapter on the Salinity Ingress Prevention Programme, https://cag.gov.in/webroot/uploads/download_audit_report/2010/Gujarat_Civil_2010.pdf.

³⁷Figures on the 15 percent/88,947-hectare increase and the health-survey findings are from the Comptroller and Auditor General of India (2010), Audit Report for the year ended 31 March 2010 — Government of Gujarat (Civil), https://cag.gov.in/webroot/uploads/download_audit_report/2010/Gujarat_Civil_2010.pdf; the reach-wise 92 percent (Madhavpur–Maliya) and 85 percent (Lakhpur–Maliya) increases are cited in a secondary summary of official data at <https://www.isignal.in/agriculture/in-gujarat-agriculture-in-stress-due-to-saltwater-ingress-882484>, accessed September 2026.

³⁸Gujarat Water Supply and Sewerage Board, statutory functions and rural water supply mandate, <https://gwssb.gujarat.gov.in/rural-water-supply-programme>, accessed September 2026; "The Gujarat State-Wide Water Supply Grid: a step towards water security," Third World Centre for Water Management, 2015, <https://thirdworldcentre.org/wp-content/uploads/2015/05/The-Gujarat-State.pdf>; India Water Portal (2016), "The water and sanitation management organisation (WASMO) of Gujarat," <https://www.indiawaterportal.org/articles/water-and-sanitation-management-organisation-wasmo-gujarat>.

³⁹Aga Khan Rural Support Programme (India), organisational website and "Irrigation" page (akrspindia.org.in), accessed September 2026.



salinity in a specific locality; such claims require site-specific hydrogeological evidence that is not available for every stretch of coastline.

8. Impact on Agriculture

The hydrological changes described above had significant, though uneven, agricultural consequences. The most immediate benefit was not necessarily assured perennial irrigation, but greater resilience to rainfall variability — the difference, in many seasons, between a harvest and a crop failure.



Figure 31. Sprinkler irrigation on a Saurashtra groundnut field, drawing on groundwater that recharge structures helped keep within reach through the dry season. (Illustrative photograph.)

The variability that recharge was meant to buffer against was severe. Under the Bhadar dam command area in Rajkot district, the share of command area actually irrigated ranged from 97 percent in the good monsoon year of 1996–97 to effectively zero in both 1999–2000 and 2000–01 — a swing that illustrates exactly the kind of acute vulnerability that pushed farmers toward independent, decentralised water security rather than reliance on a single large scheme⁴⁰.

At state level, Gujarat's cropping pattern shifted markedly over the two decades in which the recharge movement and its government successor programme were active: horticulture's share of gross cropped area rose from about 3 percent in 1990–91 to about 11 percent by 2010–11, while the combined share of cereals and pulses fell from about 45 percent to about 37 percent over the same period — consistent with

⁴⁰Mudrakartha, S. (2012), "Ground Water Recharge Management in Saurashtra, India: Learnings for Water Governance," PhD thesis, Suresh Gyan Vihar University, Jaipur.



farmers moving toward higher-value, more water-responsive crops as water security improved⁴¹. In the North Gujarat Sujalam Sufalam comparison case cited above, the gross value of agricultural output in treatment villages rose by 125 percent, to about ₹124 crore, with incremental crop output up by roughly 31 percent — again offered as an order-of-magnitude illustration rather than a Saurashtra-specific figure⁴².



Figure 32. A coconut plantation on irrigated land: the kind of higher-value horticulture into which Gujarat's cropping pattern shifted as water security improved. (Illustrative photograph.)

Farm-level accounts from Saurashtra itself show both the promise and the limits of this pattern. One Rajkot-district farmer, Dineshbhai Babariya, was able to take a second cotton harvest within a single year on 1.6 acres because of water made available by a nearby check dam. In the same reporting, however, another farmer, Janakbhai Gadhvi, recorded a loss of about ₹32,000 on a four-acre cotton farm — his third consecutive year of loss — in a village where government records showed essentially no functioning recharge structures despite official claims to the contrary, and where only 40 percent of 1,200 command-area acres could be irrigated in a year that received just 101 mm of monsoon rainfall⁴³. The contrast between these two farmers, a short distance apart, is a useful corrective against treating "check dams" as a uniform intervention: outcomes depended heavily on whether a structure was well sited, well-built and, crucially, still functioning.

⁴¹World Bank (2020), Drought-Proofing through Groundwater Recharge.

⁴²World Bank (2020), Drought-Proofing through Groundwater Recharge.

⁴³Down To Earth (2019), "Saurashtra woes: Policy change on check dams leads to water deficit."



The Devgad case discussed in Section 4 offers the positive counterpart at village scale: two community-financed and AKRSP (I)-supported check dams commissioned in 1996–97 allowed Devgad's farmers to draw groundwater through the 1998 and 1999 monsoons even as neighbouring, non-recharged villages faced drought conditions.

Complementing this water-security narrative, the region's agricultural research institutions worked in parallel on crop-side adaptation to salinity. Gujarat Agricultural University's College of Agriculture at Junagadh — reorganised into the independent Junagadh Agricultural University (JAU) in 2004 — steered farmers in the worst-affected coastal tracts toward salt-tolerant and lower-water alternatives to the groundnut, sugarcane and wheat that had driven the original over-extraction, work later reinforced by the ICAR-Central Soil Salinity Research Institute's Regional Research Station at Bharuch, which developed a salt-tolerant desi cotton line (G Cot 23), field-tested through 2011–13, and salt-tolerant wheat varieties for Gujarat's coastal and inland saline soils, alongside recommendations on subsurface drainage, leaching and mangrove replanting for the coastal belt.⁴⁴

This process subsequently interacted with — and cannot be neatly separated from — other major changes in Gujarat agriculture over the same decades, including road and electricity expansion, market access, agricultural technology, and above all the rapid, state-wide adoption of Bt cotton after 2002. It would therefore be misleading to attribute the whole of Gujarat's agricultural growth to check dams. The more defensible conclusion is that water harvesting and groundwater recharge created an important enabling condition for agricultural intensification and diversification in Saurashtra, operating alongside — and interacting with — these other drivers of change.

9. Impact on the Livestock and Dairy Sector

Water security affects Saurashtra's rural economy through a second channel that the early literature on the recharge movement discusses less than crop agriculture, but which is arguably just as important to household income: livestock and dairying. Gujarat's dairy economy — built around the Amul cooperative model — depends on secure drinking water for animals, and, indirectly but heavily, on irrigated fodder cultivation (green fodder, berseem, lucerne and irrigated fodder-maize among Saurashtra's staples), both of which are constrained precisely by the groundwater availability that check dams and well recharge were designed to protect.

⁴⁴Junagadh Agricultural University, institutional history, https://en.wikipedia.org/wiki/Junagadh_Agricultural_University, accessed September 2026; ICAR, "Herbaceum Cotton: An ideal option for coastal and inland saline soils of Gujarat," <https://icar.org.in/en/node/2251>, accessed September 2026; Chinchmalatpure, A.R. (2019), "Assessment and Management of Natural Resources of Coastal Gujarat towards Enhancing Productivity and Ensuring Food Security," Journal of the Indian Society of Coastal Agricultural Research, 36(2), <https://epubs.icar.org.in/index.php/JISCAR/article/view/89000>.



Figure 33. Sprinklers irrigate a fodder field near an electricity pylon and coconut palms — the irrigated green fodder that Saurashtra's dairy animals depend on through the dry season. (Illustrative photograph.)

What farmers themselves report

Field research on Saurashtra's recharge villages records farmers attributing gains in both crop and livestock income directly to increased water availability, alongside a consequent reduction in seasonal, distress-driven out-migration — migration that in dry years often took men and, with them, herding and dairying labour away from the village for months at a time⁴⁵. This is consistent with the broader logic of the movement: a farmer with secure well water can grow irrigated fodder and keep more, and more productive, animals through the dry season, rather than being forced to sell or under-feed livestock when wells and ponds run dry.

⁴⁵Mudrakartha, S. (2012), "Ground Water Recharge Management in Saurashtra, India: Learnings for Water Governance," PhD thesis, Suresh Gyan Vihar University, Jaipur.



Figure 34. Cattle watering at the edge of a recharge pond — the kind of secure, dry-season drinking water and grazing access that Saurashtra's dairy economy depends on. (Illustrative photograph.)

NDDB and the shift from cooperative to producer company

Water security is only one input into Saurashtra's dairy economy, and the larger institutional story is the one written by the National Dairy Development Board (NDDB). NDDB was established in 1965 under Dr Verghese Kurien to replicate the Kaira ("Amul") cooperative model across India, and its Operation Flood programme, launched in 1970, helped move India from a milk-deficit country to the world's largest milk producer by 1998 by organising some 81,000 village-level dairy cooperatives on the Anand pattern⁴⁶

By the early 2000s, however, several of Gujarat's district cooperative unions — including some in Saurashtra — were losing members to private traders. Farmers in cooperative villages reported that union staff routinely under-recorded milk-fat content to reduce payouts, and that union governance had become subject to local political interference; one farmer's account from Chotila taluka cites this dysfunction as the direct reason members stopped supplying their village society⁴⁷. NDDB's response was not to reform the cooperative unions directly but to promote an alternative legal form, the 'producer company', created by a 2002 amendment to the Companies Act (Part IXA), which combines the one-member-one-vote and profit-sharing principles of a cooperative with the governance autonomy of a

⁴⁶National Dairy Development Board, "Genesis" and "The Anand Pattern" (nddb.coop/about/genesis), and "New Generation Cooperatives leading to Producer Companies" (nddb.coop/services/cooperative/newgen), both accessed September 2026; the New Generation Cooperative pilot was launched in the Saurashtra-Kachchh region in November 2005, beginning in Junagadh district.

⁴⁷Sood, J. (2014), "New milky way," Down To Earth, 30 January 2014.



company answerable to farmer-shareholders rather than to a state department. NDDB piloted this 'New Generation Cooperative' model in the Saurashtra-Kachchh region starting in November 2005, beginning in Junagadh district; besides Saurashtra's own Maahi, comparable producer companies now operate in several other states, including Paayas, Saahaj, Baani and Sreeja⁴⁸.

The Maahi Milk Producer Company

The clearest embodiment of this shift in Saurashtra is Maahi Milk Producer Company Limited, incorporated on 7 June 2012 and beginning commercial operations on 18 March 2013. Unlike the cooperative unions it substantially supplements across its operating area, Maahi carries no capital contribution from either NDDB or government: it was built entirely from farmer-members' own share capital, with NDDB Dairy Services providing technical and managerial support rather than ownership. At launch, around 150 NDDB-trained field staff worked through some 2,260 villages to mobilise membership; by the time operations began, Maahi had approximately 85,000 farmer-members across roughly 2,140 villages, procuring about 700,000 litres of milk a day and selling around 300,000 litres a day in pouched form⁴⁹.

Growth since has been substantial. By December 2023, membership had risen to 104,099 registered farmer-members, organised through 2,542 village-level milk pooling points across eleven districts of the Saurashtra and Kutch region, and the company's total operating income reached ₹1,734.67 crore in 2022–23, with procurement still growing at close to 10 percent a year⁵⁰. Headquartered at village Khandheri (Paddhari taluka, Rajkot district), the company today markets liquid milk, paneer, ghee, dahi, buttermilk and flavoured milk under the Maahi brand, alongside a compound cattle-feed business that feeds directly back into the productivity gains discussed below⁵¹. Maahi's arrival did not replace Saurashtra's older district dairy unions so much as create a second, parallel institutional channel operating across much of the same geography discussed below; both models now compete, and in places cooperate, for the same farmers' milk. Whatever their institutional differences, both depend on the same underlying resource base — secure drinking water for the animal and, still more, irrigated fodder to sustain milk yield through Saurashtra's long dry season — that groundwater recharge was designed to protect.

The scale of Gujarat's dairy expansion

At the state level, the growth of Gujarat's dairy sector over the decades following the recharge movement has been dramatic, though it reflects a bundle of causes — cooperative expansion, breed improvement, veterinary services and market access, not water availability alone. Gujarat's milk production rose by about 119.63 lakh (11.963 million) tonnes over the 22 years to 2022–23, an average annual growth rate of about 10.23 percent, compared with 8.46 percent nationally over the same period; the state now

⁴⁸National Dairy Development Board, "Genesis" and "The Anand Pattern" (nddb.coop/about/genesis), and "New Generation Cooperatives leading to Producer Companies" (nddb.coop/services/cooperative/newgen), both accessed September 2026; the New Generation Cooperative pilot was launched in the Saurashtra-Kachchh region in November 2005, beginning in Junagadh district.

⁴⁹Business Standard (2013), "Maahi heats up dairy market in Gujarat," 11 June 2013.

⁵⁰CARE Ratings Limited, Press Release: Maahi Milk Producer Company Limited, 14 February 2024.

⁵¹Maahi Milk Producer Company Limited, corporate website (maahimilk.com), accessed September 2026, and Annual Report 2024–25.



produces about 172.80 lakh tonnes of milk a year, some 7.49 percent of India's total, and ranks fourth among Indian states. Per-capita milk availability in Gujarat rose from about 291 grams a day in 2000–01 to about 670 grams a day in 2022–23, comfortably ahead of the national average of 459 grams. Average animal productivity over the same period rose by roughly 57 percent for indigenous cows, 31 percent for crossbred cows, 38 percent for buffaloes and 51 percent for goats⁵². The Amul federation itself grew from six-member district unions in 1973 to eighteen today, together collecting more than three crore (30 million) litres of milk a day across the state⁵³.

Saurashtra's district dairy unions

Saurashtra's own district milk unions grew substantially over this period, illustrating the scale of the underlying livestock economy even where a clean, water-specific causal line cannot be drawn. Rajkot district's Gopal Dairy, procuring milk from 801 dairy cooperative societies (including 470 women's societies) across 14 talukas, saw its turnover rise from about ₹169.24 crore in 2007–08 to about ₹777.15 crore in 2016–17, and by the mid-2010s was marketing more than 3.05 lakh litres of milk a day through some 4,130 retail outlets. Amreli district's AMR Dairy, registered in 2002 and operational from 2007, began with procurement of just 2,500 kilograms a day from 26 village societies; within roughly a decade it had grown to more than 700 village cooperative societies with over 35,000 affiliated farmer-members, and peak-season procurement of about 2.5 lakh litres a day. Bhavnagar district's Sarvottam Dairy, established in 2004, added further processing capacity to the region over the same period⁵⁴.

Reading the livestock evidence honestly

The livestock and dairy evidence in this section should be read with the same caution applied to the agricultural evidence in Section 8. Farmers' own reports of reduced distress migration and improved livestock income are valuable because they capture lived experience directly, but they are qualitative, self-reported and drawn from a limited number of recharge villages; they are not a substitute for a large-sample panel comparing livestock holdings, milk yield or fodder area in recharge and non-recharge villages over time, which does not appear to exist in the published literature. Equally, the institutional and genetic gains documented above — Maahi's growth to over 104,000 members, and NDDB's Gir-breeding results — are themselves recent and geographically partial: Maahi's eleven operating districts and roughly one lakh members represent a substantial but still minority share of Saurashtra and Kutch's dairy-farming households, most of whom continue to be served by the older cooperative unions or by traders outside either institutional channel. The honest conclusion is a conjunctive rather than a competing one: water availability, cooperative and producer-company institution-building, and genetic improvement are three largely independent levers that have moved together over the same three decades, each raising the ceiling

⁵²DeshGujarat (2024), "Gujarat's milk production up by 119.63 lakh metric tons in 22 years; average growth of 10.23%," 25 November 2024, citing Government of Gujarat animal husbandry data.

⁵³DeshGujarat (2024), citing GCMMF/Amul data.

⁵⁴JETIR (2019), "District Co-operative Milk Unions of Gujarat," Journal of Emerging Technologies and Innovative Research, drawing on individual union records.



the others could reach, but none sufficient on its own to explain the scale of Gujarat's dairy transformation.

Groundwater recharge was, and remains, an important supporting condition for Saurashtra's livestock economy: it helped secure drinking water for animals through the dry season, supported irrigated fodder cultivation where wells stayed productive, and, by reducing distress migration, kept household labour available for daily dairying. But it operated as one enabling factor within a much larger transformation of Gujarat's dairy sector — a transformation whose primary architects, on the institutional and genetic side, have been NDDDB, the Amul federation's cooperative unions and, more recently, producer companies such as Maahi.

10. Social and Livelihood Impacts

Reduced vulnerability

Access to recharged groundwater provided a buffer against erratic monsoons. The ability to irrigate a standing crop through a short dry spell within the season could make the difference between a harvest and a crop failure.

Increased agricultural investment

Greater water security encouraged farmers to invest in land improvement, seed, fertiliser, irrigation equipment and other inputs that make sense only once water risk has fallen below a certain threshold.



Figure 35. Women farmers in an irrigated field — water security in Saurashtra's recharge villages touched domestic and farm life alike. (Illustrative photograph.)



Reduced distress migration

Where agriculture and livestock-keeping became more viable through the dry season, the pressure toward seasonal, distress-driven out-migration eased — a pattern reported directly by farmers in Saurashtra's recharge villages⁵⁵.

Increased land values

Successful recharge villages saw substantial increases in agricultural land values. The Devgad case illustrates the pattern directly: land values there had fallen as wells dried up, and recovered as water availability improved following the 1996–97 check dams⁵⁶.

New community institutions

Perhaps the most enduring contribution of this period was the creation of local institutions capable of collectively managing water infrastructure — village-level bodies that, at their best, outlasted the original construction project and went on to manage desilting, repair and dispute resolution long after the NGO or government scheme that funded the initial structure had moved on.

11. Environmental Impact

The decentralised approach also produced environmental benefits beyond groundwater itself. By slowing runoff and increasing infiltration, check dams and recharge structures increased soil moisture, extended the period of surface-water availability, supported vegetation and biomass, reduced the severity of short-term water stress, and in places helped restore local streams and drainage systems. The literature on the movement describes broad-based ecological benefits of this kind, including changes to the local micro-environment and increased vegetation cover⁵⁷.

12. Limits and Unintended Consequences

The Saurashtra experience should not be romanticised. Two distinct problems emerged as the movement scaled up.

Declining site-selection and construction quality at scale

Once government programmes began subsidising check-dam construction at 60 percent — and, in the Rajkot-district episode described in Section 6, effectively displacing community-financed construction with fully or near-fully subsidised contractor-built structures — the discipline that community cost-sharing had imposed on site selection and construction quality weakened in places. A 2022 farm-scale survey found that only 61 percent of surveyed farmers reported benefiting from check dams overall, with the

⁵⁵Mudrakartha, S. (2012), "Ground Water Recharge Management in Saurashtra, India: Learnings for Water Governance," PhD thesis, Suresh Gyan Vihar University, Jaipur.

⁵⁶Mistry, M. (2000), "Devgadh: A lesson in drought management."

⁵⁷See Shah, T. (2000/2009), "Mobilizing social energy against environmental challenge," *Natural Resources Forum*, 24(3) (cited above, n. 4), and van Steenberg, F. (2006), "Promoting local management in groundwater," *Hydrogeology Journal*, 14(3), 380–391 (cited above, n. 7), on the recharge movement's ecological effects.



figure falling sharply with distance from a structure (87.3 percent of farmers within 250 metres reporting a benefit, against just 49.5 percent beyond 1,000 metres). The same survey found 40 percent of surveyed check dams effectively non-operational, 72.8 percent of farmers reporting zero involvement in maintenance, and 91.2 percent reporting no role at all in the original construction phase — a marked contrast with the AKRSP(I) and Devgadhi models of the 1990s, in which community involvement in construction was the entire point. A 2019 analysis reached a similar conclusion, contrasting later government-built check dams — constructed, in its account, without adequate site research or maintenance arrangements — with the earlier NGO- and community-led model.

The scale-up had a further, more specific consequence in the bandhara areas. Large-scale construction of check dams in the upper catchments of the bandharas — implemented in partnership with the Panchayats — intercepted so much runoff that many bandharas began running under capacity, and in some areas no further sites remained for new structures. As with much Panchayat-implemented work, however, site selection and construction quality were, with some exceptions, often compromised: a number of these check dams were badly damaged and were later taken up by NGOs for repair and, in some cases, deepened to restore capacity.⁵⁸



Figure 36. A check dam photographed from a distance with water flowing over it. (Illustrative photograph.)

⁵⁸This account of the interaction between upstream check-dam construction and downstream bandhara storage, and of the resulting repair work, draws on inputs provided by Chandra Shekhar (C.S.) Pathak (personal communication to the author, September 2026).



The groundwater governance paradox

There is also a structural paradox at the heart of the whole approach. Successful recharge increases groundwater availability, which in turn encourages farmers to invest in additional pumping capacity and expand irrigated area — precisely the behaviour that caused the original crisis. If pumping grows faster than recharge, the initial gains can erode over time, which is one plausible reading of the more discouraging 2016 well-level data discussed in Section 7. Recharge infrastructure, in other words, is not the same thing as sustainable groundwater management; it changes the water balance in one direction, but does nothing by itself to constrain extraction on the other side of the ledger.

Subsidies, adoption and the limits of storage: a 2024 case study

A 2024 study of the Kamadhiya catchment in Saurashtra adds a further, more current dimension to this governance paradox. Comparing farmer adoption of two very different water interventions — subsidised drip irrigation (a 50 percent government subsidy, but only 16 percent farmer adoption) against unsubsidised private borewells (no subsidy, but 24.5 percent adoption) — the study found that farmers systematically preferred capital-intensive supply augmentation over demand-side efficiency, and that proximity to a community check dam had a negligible effect on adoption decisions, consistent with check dams providing limited and short-lived storage relative to farmers' actual water needs⁵⁹. More troublingly, the same study found that reaching one working borewell in Saurashtra's hard-rock terrain required, on average, drilling 2.3 wells, raising the risk of accelerated depletion and degradation of deeper aquifers as farmers who can afford repeated drilling attempts pursue a private water source that smaller and marginal farmers cannot match — a mechanism that could reproduce, at greater depth and with starker inequality, the very extraction-versus-recharge imbalance described above⁶⁰. The study's own recommendation — that subsidy alone will not shift farmer behaviour without accompanying extension services, post-adoption support and training — applies as much to future recharge and desilting programmes as to the drip-irrigation subsidy it examined directly.

The Saurashtra experience therefore demonstrates the importance of combining recharge with:

- groundwater monitoring;
- crop-water budgeting;
- water-use efficiency and micro-irrigation;
- crop diversification;
- some form of regulation of extraction;
- community groundwater governance institutions; and
- attention to downstream and environmental flows.

⁵⁹Frontiers in Water (2024), "Subsidies alone are not enough to increase adoption of agricultural water management interventions," case study of the Kamadhiya catchment, Saurashtra, Gujarat.

⁶⁰Frontiers in Water (2024), "Subsidies alone are not enough to increase adoption of agricultural water management interventions," case study of the Kamadhiya catchment, Saurashtra, Gujarat.



13. What the Saurashtra Experience Really Demonstrates

The most important lesson from Saurashtra is not simply that check dams work. It is that small, distributed interventions can produce large, landscape-level impacts when combined with social mobilisation and appropriate institutions. Five elements appear particularly important:

1. *Local problem recognition*

The movement emerged because farmers themselves experienced declining groundwater and crop failure directly — not because an external agency identified a problem on their behalf.

2. *Local experimentation*

Farmers experimented with well recharge and progressively developed simple, low-cost technologies suited to their own conditions.

3. *Social mobilisation*

Religious organisations, community leaders, NGOs, philanthropists and farmers themselves helped spread successful practices far faster than any single agency's own outreach could have.

4. *Institutional innovation*

Organisations such as AKRSP(I) demonstrated how community contribution, participatory site selection and local maintenance could be built into a formal, replicable development model.

5. *State recognition and scaling*

Government eventually adopted and massively scaled the approach through the Sardar Patel Sahbhagi Jal Sanchay Yojana — with the caveat, discussed in Section 12, that scale and fidelity to the original community-led model did not always travel together.

This sequence is perhaps best represented as:

*Crisis → Farmer experimentation → Community movement → NGO institutionalisation →
Government adoption → Large-scale infrastructure → Agricultural and livestock transformation*



14. Overall Assessment of Impact

The Saurashtra experience of the 1990s can reasonably be regarded as a landmark in India's history of decentralised water management. Its impact can be summarised as follows:

	Impact
Water	Increased local storage and groundwater recharge across tens of thousands of individually small structures
Groundwater	Improved recharge and a sharp fall in critical/over-exploited blocks (41→1, 2004–2013), though later years show renewed stress in places
Agriculture	Greater crop security, cropping-pattern diversification toward horticulture, and scope for multiple cropping where recharge held
Livestock & dairy	Supported irrigated fodder and dry-season drinking-water security; operated alongside a largely independent institutional and genetic transformation led by NDDB, Amul's cooperative unions and, since 2013, producer companies such as Maahi
Livelihoods	Higher agricultural viability, reduced distress migration, and land-value recovery in successful villages
Institutions	New village-level bodies for water management; earlier and more durable Water User Associations under PIM
Technology	Development and diffusion of simple, low-cost recharge techniques suited to hard-rock terrain
Governance	Influenced the shift from top-down to participatory water conservation, formalised in the 2007 PIM Act
Policy	Directly informed the Sardar Patel Sahbhagi Jal Sanchay Yojana (2000), one of India's largest participatory water-harvesting programmes
Environment	Improved local soil moisture, vegetation and hydrological conditions in treated catchments
Resilience	Created a buffer against monsoon variability, though one that a governance gap on the extraction side can erode over time

At the same time, the experience shows that infrastructure must be accompanied by groundwater governance. Later increases in pumping, crop intensification and, in places, the indiscriminate construction of poorly sited or unmaintained structures show that recharge without demand management can eventually recreate the very cycle of groundwater stress the movement set out to solve



— a pattern the 2024 Kamadhiya evidence in Section 12 suggests is now reasserting itself through unregulated private borewell drilling rather than through check dams themselves.

Nationally, India's most recent Dynamic Ground Water Resource Assessment (2024) found a measurable overall improvement since 2017 — the share of 'safe' assessment units rose from 62.6 to 73.4 percent, and 'over-exploited' units fell from 17.24 to 11.13 percent, with water-conservation structures contributing nearly double the recharge volume they did in 2017 — but placed Gujarat among a small group of states, alongside Punjab, Haryana, Rajasthan and others, where over-exploited and critical units remain concentrated⁶¹. Saurashtra's own water balance, in other words, is no longer being decided solely, or even primarily, by the check dams and well recharge this note has described: it now sits alongside a state-wide desilting programme, the Sujalam Sufalam Jal Abhiyan (under way since 2018 across roughly 1.07 lakh works), and a large interbasin transfer, the SAUNI Yojana, moving about one million acre-feet of Narmada water through 1,320 kilometres of pipeline to 99 reservoirs across the region⁶². This is a reminder that the distributed, farmer-led model this note documents was Saurashtra's starting point, not its permanent or exclusive water strategy.

⁶¹Central Ground Water Board, Dynamic Ground Water Resource Assessment Report, 2024.

⁶²ANI (2025), "World Water Day: How drought-prone Gujarat became water-rich state in last 2.5 decades," 21 March 2025, citing Government of Gujarat data.



15. Conclusion

The Saurashtra water-harvesting experience of the 1990s represents a remarkable transition from drought relief to drought resilience. The movement began not with a major government project but with farmers responding to an existential crisis: repeated drought, depleted wells and unreliable agriculture. Faced with this, farmers began experimenting with ways of retaining monsoon runoff and putting it back into the ground. Religious and community organisations, above all the Swadhyaya Parivar, helped spread the practice at a scale no single agency could have achieved alone, while NGOs and philanthropists provided technical and financial support.

The significance of the Saurashtra experience extends well beyond check dams, and well beyond crop agriculture. Its most durable, if least remarked-upon, legacy runs through the region's livestock and dairy economy: secure drinking water and irrigated fodder allowed Saurashtra's farmers to keep more and better animals through the dry season, and to stay in the village to tend them rather than migrating for work. But that legacy is now a shared one. The genetic and institutional infrastructure built separately by NDDDB — from the Anand-pattern cooperatives of Operation Flood through to the newer producer-company model exemplified by Maahi, which has grown to more than 104,000 farmer-members across eleven operating districts within little more than a decade — has done at least as much as water security to determine how far that dairy economy could actually grow. Neither factor substitutes for the other: a well-bred, well-organised dairy animal still needs water, and secure water alone does not organise a farmer-owned supply chain. The two strands, documented separately in Section 9, are best read together as complementary rather than competing explanations of Saurashtra's rural transformation.

The Saurashtra story also offers a genuine, and still current, caution for water-resilience programmes elsewhere. Scaling a good idea through a large subsidy programme, as the Sardar Patel Sahbhagi Jal Sanchay Yojana did from 2000 onward, extended the recharge model's reach dramatically but risked losing the community ownership that had made the original model durable — a risk Section 12's 2022 farm-survey evidence, and its 2024 Kamadhiya-catchment findings on subsidy-driven borewell adoption, suggest has partly materialised. Nor did check-dam infrastructure, on its own, ever address the extraction side of the water balance: as Section 14 notes, India's most recent national groundwater assessment shows real improvement since 2017, but continues to place Gujarat among the states where over-exploited and critical units remain concentrated, and Saurashtra's water strategy today rests as much on the state-wide Sujalam Sufalam desilting programme and the Narmada-fed SAUNI pipeline network as on the distributed, farmer-led recharge this note has traced from its 1980s origins.

The strongest lesson from Saurashtra is consequently not “build check dams.” It is: build local water systems that communities understand, contribute to, own and manage — and connect these local systems to appropriate technical knowledge, public policy, and groundwater governance on the extraction side as much as the recharge side. The region's parallel experience with dairy institution-building suggests a corollary: the same principle — durable local ownership, backed by patient technical support — built Saurashtra's water systems and, largely independently, its dairy economy, and the two together offer the fuller account of how rural Saurashtra changed over the past four decades.



Glossary

Term	Definition
AKRSP(I)	Aga Khan Rural Support Programme (India), an NGO under the Aga Khan Development Network, established 1983; examined in Section 4 as a case study within the broader Saurashtra recharge movement.
AMR Dairy	Amreli district's cooperative milk union, registered in 2002 and operational from 2007.
Anand pattern	The three-tier cooperative dairy model (village society – district union – state federation) pioneered at Anand, Gujarat, and replicated nationally through Operation Flood.
Anicut	A small diversion or check structure built across a stream to divert or hold back water; used in this note as a general term alongside “check dam.”
Bandhara	A masonry or earthen storage structure used along the Saurashtra coast, among other purposes to check the inland advance of saline groundwater.
Bori bandh	A temporary check structure made of sand-filled sacks (a “sack dam”), used for small-scale, low-cost groundwater recharge.
CAG	Comptroller and Auditor General of India, the constitutional auditor whose reports are cited on the Salinity Ingress Prevention Programme.
Check dam	A small masonry or earthen structure built across a seasonal stream to slow and impound monsoon runoff so that it recharges groundwater rather than running off; the principal structure of the Saurashtra recharge movement.
Command area	The area of land that an irrigation or water structure is designed to serve.
Cropping intensity	Gross cropped area as a percentage of net sown area in a year; a measure of how many times land is cropped, capturing double- and multiple-cropping.
CSPC	Coastal Salinity Prevention Cell, promoted by the Sir



	Ratan Tata Trust, active in coastal Saurashtra water-harvesting work.
CSR	Corporate social responsibility.
Distributed (managed) aquifer recharge	Recharging groundwater through many small, dispersed structures rather than a single centralised project — the defining feature of the Saurashtra movement.
DPAP	Drought Prone Areas Programme, a centrally sponsored government scheme under which water-harvesting and soil-conservation works were implemented.
GCMMF / Amul	Gujarat Co-operative Milk Marketing Federation, the apex marketing body for Gujarat's district dairy unions, which sells under the Amul brand.
GLDC	Gujarat Land Development Corporation, a state agency implementing water-harvesting and soil-and-water-conservation works.
Gram Panchayat	The elected village-level local government body, given responsibility for site selection and implementation under the Sardar Patel Sahbhagi Jal Sanchay Yojana.
GWSSB	Gujarat Water Supply and Sewerage Board, the state agency responsible for piped drinking-water supply.
HLC	High-Level Committee; a series of committees convened by the Gujarat government from 1976 onward to address coastal salinity ingress.
ICAR	Indian Council of Agricultural Research.
JAU	Junagadh Agricultural University, formed in 2004 from the former Gujarat Agricultural University's College of Agriculture at Junagadh.
Maahi	Maahi Milk Producer Company Limited, a farmer-owned “New Generation Cooperative” producer company operating across Saurashtra and Kutch, incorporated 2012.
NABARD	National Bank for Agriculture and Rural Development.
NDDB	National Dairy Development Board, established 1965, architect of India's Operation Flood dairy-cooperative movement.
NGO	Non-governmental organisation.



NREGS	National Rural Employment Guarantee Scheme.
NWDPA	National Watershed Development Programme for Rainfed Areas, a Ministry of Rural Development scheme.
Operation Flood	NDDB's national dairy-development programme, launched 1970, which moved India from a milk-deficit country to the world's largest milk producer.
Percolation tank	A small impoundment built specifically to hold water so that it percolates into the ground and recharges the aquifer, as distinct from a check dam's primary function of slowing streamflow.
Producer company	A farmer-owned corporate legal form created by a 2002 amendment to the Companies Act (Part IXA), combining cooperative governance principles with company-law autonomy; the basis of NDDB's "New Generation Cooperative" model, exemplified by Maahi.
SAUNI Yojana	Saurashtra Narmada Avtaran Irrigation Yojana, a large interbasin-transfer scheme moving Narmada river water to reservoirs across Saurashtra via pipeline.
Shramdaan	Voluntary community labour; central to the Swadhyaya Parivar's mobilisation of the recharge movement.
SIPC	Salinity Ingress Prevention Cell/Circle, the Gujarat Irrigation Department field formation responsible for coastal salinity-control works.
SPPWCP ("60:40 yojana")	Sardar Patel Sahbhagi Jal Sanchay Yojana (Sardar Patel Participatory Water Conservation Programme), the Gujarat government's check-dam subsidy programme launched January 2000, offering a 60 percent construction subsidy.
SRSA	State Remote Sensing Agency, tasked with micro-watershed delineation to coordinate implementing agencies.
Swadhyaya Parivar	A spiritual and social movement founded by Pandurang Shastri Athavale, credited with mobilising voluntary labour and spreading well-recharge practice at scale across Saurashtra from the late 1980s.
WASMO	Water and Sanitation Management Organisation, set up by the Gujarat government in 2002 to facilitate village-



	level management of piped drinking-water supply.
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