# Mohanpura-Kundalia Irrigation Project

*India's Smartest and most innovative Irrigation Project*

**Mohanpura-Kundalia Project Management Unit**
Madhya Pradesh Water Resources Department

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# 1. Overview of Mohanpura-Kundalia Irrigation Project

The Mohanpura–Kundalia Irrigation Projects, located in the drought-prone districts of **Rajgarh and Agar-Malwa** in Madhya Pradesh, are India's most advanced and large-scale implementations of pressurized piped irrigation systems.
Envisioned under the Hon'ble Prime Minister Shri Narendra Modi's national mission of "Har Khet Ko Paani,"the projects aim to irrigate over **290,000 hectares** of cultivable command area and benefit more than **1,100 villages** and **5 lakh farmers**, making them a model for sustainable and equitable agricultural transformation.
The projects are powered by a combined 26,000 km-long underground pressurized pipe network, connected to 20 strategically located pumping stations.
*Water is delivered directly to the field from the reservoir via underground pressurised pipes* with 20 meters of residual head (2 bar pressure) and distributed volumetrically through 1 to 1.25-hectare outlets via outlet management system, all monitored and controlled via a centralized SCADA-based automation system.

This pressurized irrigation infrastructure has significantly **increased water use efficiency** from a traditional **38% to over 80%.**

The **Mohanpura Project** lifts water from the **Newaj River** to irrigate over 1,45,000 hectares through multiple sub-projects on the right and left banks, while the **Kundalia Project**, constructed on the **Kalisindh River**, provides irrigation to 1,39,600 hectares across its right and left bank command areas.

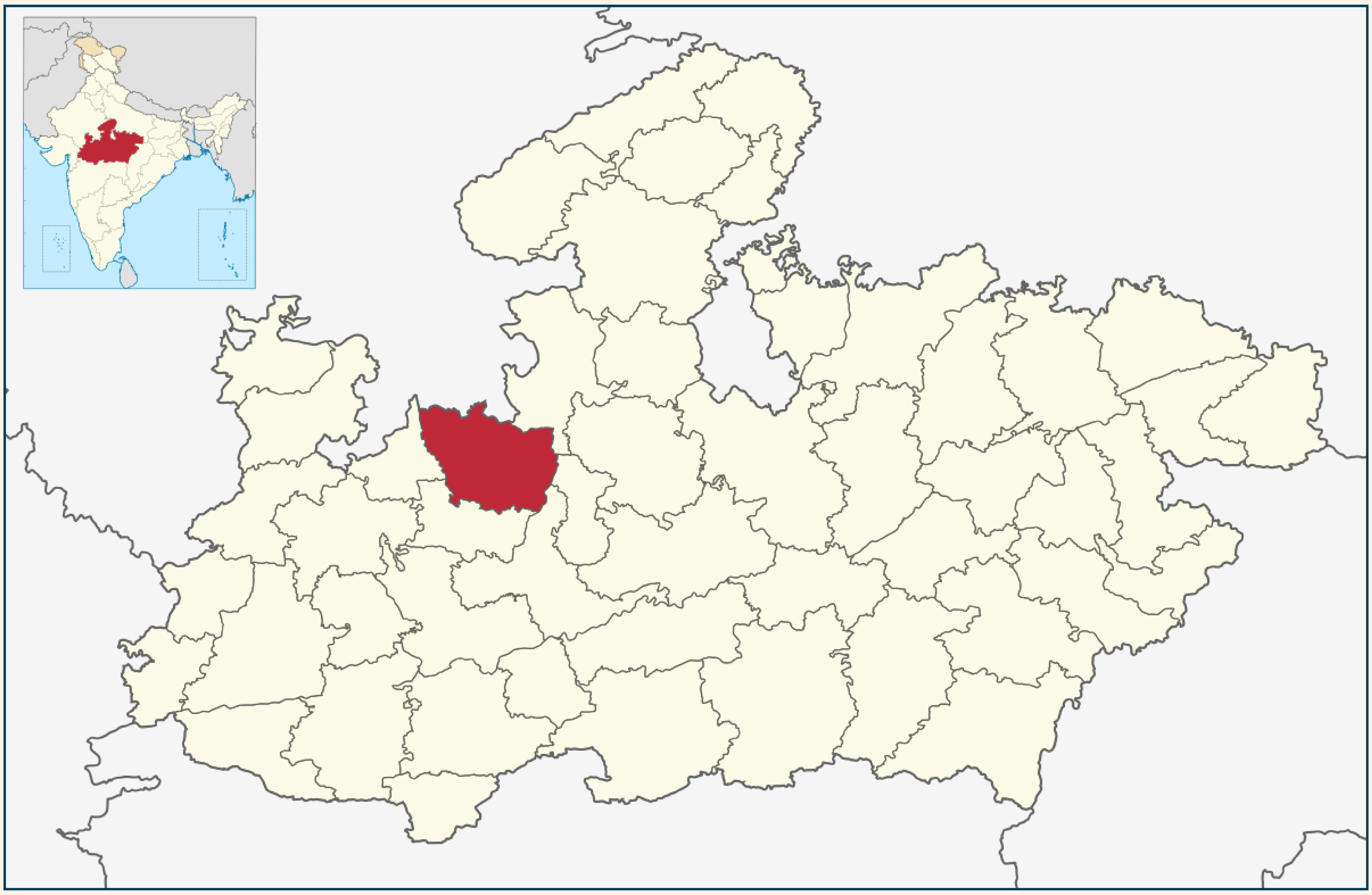
Outcomes from both projects include *a marked increase in crop intensity, crop diversification, and 4x wheat procurement volumes, verified through both procurement records and NDVI-based satellite imagery from 2019 to 2024. The system also reduces carbon emissions significantly—by an estimated 2,186 metric tonnes of $CO_2$ per season, amounting to a 65,580 metric tonne reduction over the 30-year lifespan, equivalent to removing over 14,000 vehicles from the road.*

Beyond technical achievements, the projects have directly addressed deep-rooted socio-economic challenges. In regions once dominated by seasonal migration and subsistence agriculture, farmers now cultivate up to three crops per year, stay rooted in their villages.
The projects exemplify a participatory and inclusive approach to irrigation management and have become learning sites for delegations from across India and abroad, including the Government of Morocco.

Awarded the **CBIP Award 2024 for excellence in Integrated Water Resource Management**, the Mohanpura–Kundalia Projects have emerged as national benchmarks for future-ready irrigation systems—combining infrastructure, technology, efficiency, and equity to ensure water security and agrarian prosperity in central India.

## 2. Background

Before the inception of the Mohanpura–Kundalia Irrigation Projects, Rajgarh—Madhya Pradesh's westernmost district bordering the arid regions of Rajasthan—stood on the brink of desertification. With only **60,000 hectares** land under irrigation, the region faced **acute water scarcity**. The consequences were dire: a large number of farmers were left with barren lands, forced into seasonal migration in search of livelihoods. In extreme circumstances, some even resorted to crime as a means of survival. Traditional canal-based irrigation was insufficient, fragmented, and unreliable, and the topography did not favor gravity-driven water systems.



## 3. Why This Technology Was Adopted

In 2014, under the visionary leadership of the *Hon'ble Prime Minister Shri Narendra Modi and the national mission of "Har Khet Ko Paani,"* a bold initiative was launched to transform Rajgarh's agricultural landscape. The construction of two major multipurpose dams—Mohanpura on the Newaj River and Kundalia on the Kalisindh River—was initiated. These dams, completed in a record time of three years, were designed to jointly store over 1,200 million cubic meters (MCM) of water and irrigate over 1.2 lakh hectares via conventional canal systems.

However, assessments revealed that the conventional open canal system could not serve the full command area due to limited water availability. The Newaj sub-basin had a demand of approximately 877 MCM to irrigate 2.1 lakh hectares across the Newaj, Parbati, and Kalisindh basins. Yet, the Mohanpura dam could only provide 510 MCM for agriculture after accounting for drinking, environmental, and industrial uses. Using traditional methods, this could irrigate only 87,000 hectares.

To bridge this gap, a paradigm shift was essential. In 2018, a **dedicated Project Management Unit (PMU)** introduced a pioneering solution—the **Pressurized Irrigation Network (PIN)**.

This advanced system, coupled with micro-irrigation readiness and SCADA-based automation, enabled efficient, volumetric, and on-demand water delivery directly to farmers' fields. The system was designed to function even in difficult terrain, ensuring equitable access regardless of location or elevation.

The Mohanpura Right Bank system, the first such integrated PIN+SCADA setup in Madhya Pradesh, was commissioned in the semi-arid belt of Tanwarwad near Kalipeeth.

Over time, a massive infrastructure with State of art Technology was created:

- 26,000 km of underground pressurized pipelines,
- 20 strategically located pumping stations,
- Serving a contiguous command area of over 290,000 hectares across 1100 villages.

**OPEN CANAL SYSTEM**

**1 MCM**

→ Can Irrigate 170 – 225 Ha

**PRESSURISED IRRIGATION NETWORK**

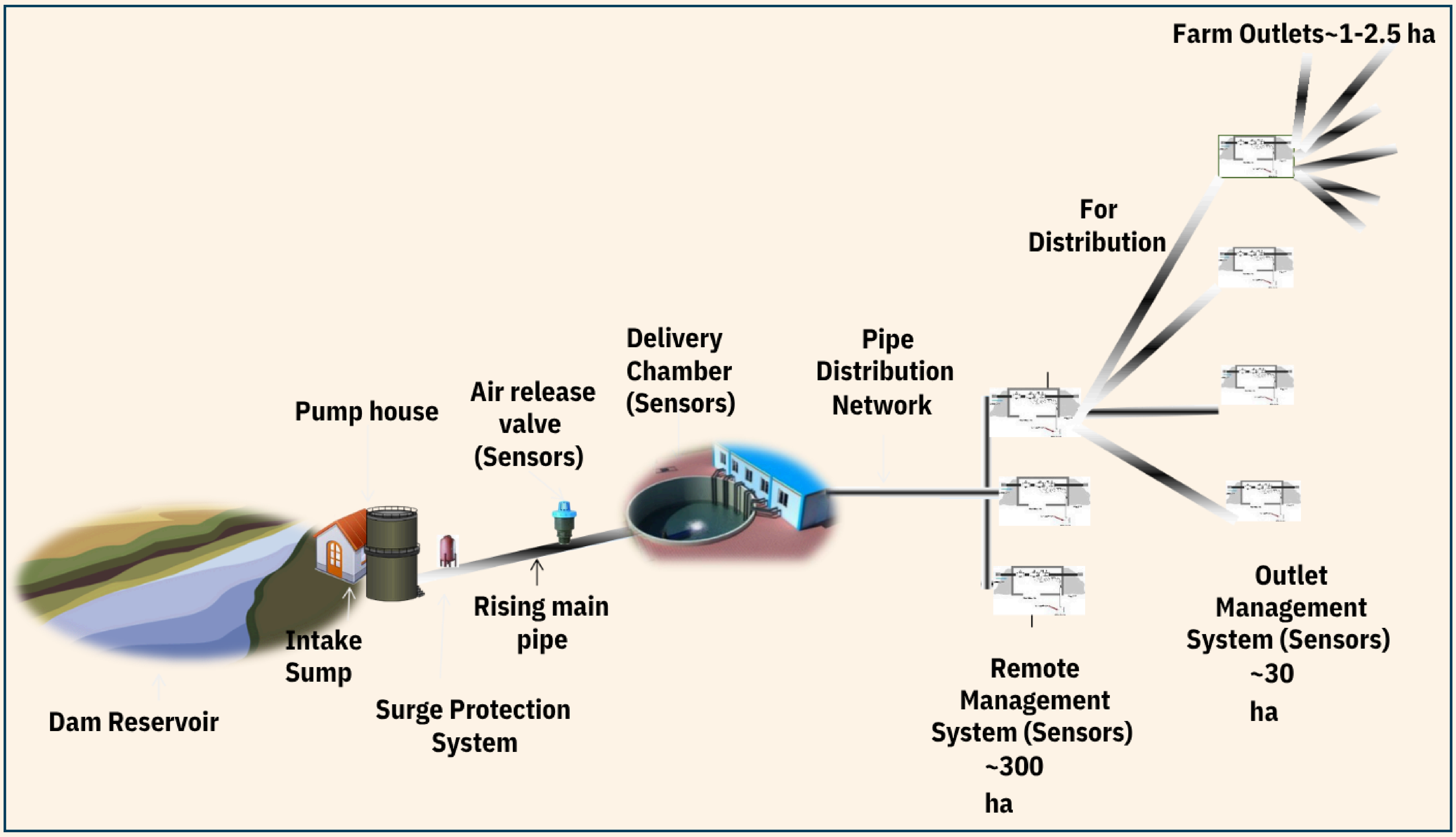
**1 MCM**

→ Designed to Irrigate 350 Ha

→ Observed in Mohanpura PIN is 490 – 510 Ha

# 4. Operation Philosophy

Water is drawn from the reservoir through an **intake sump,** which ensures that only clean water enters the system. It is then transported to the **pump house,** where high-capacity pumps pressurize the water to move it efficiently through the network. The **rising main pipe** carries the pressurized water over long distances or higher elevations, while a **surge protection system** safeguards the infrastructure from pressure shocks or water hammer effects. **Air release valves** with real-time sensors are strategically placed to eliminate trapped air, preventing flow disturbances. Water then enters the **delivery chamber**, where flow and pressure are monitored and stabilized before being distributed. From here, an extensive **underground pipe distribution network** branches out across the command area. Management is done in layers—each ~300-hectare unit is controlled via a r**emote management system** with sensors, ensuring timely and accurate irrigation. Within these, ~30-hectare sub-units are managed through an **outlet management system**, also sensor-equipped for localized control. Finally, water is released to individual fields through **farm outlets**, typically serving 1 to 2.5 hectares, where it is supplied in accordance with crop-specific water requirements, ensuring maximum efficiency and minimal wastage throughout the system.



## 5. Smart Water Management

To manage a project of this scale—spanning over 290,000 hectares and 26,000 km of pressurized piped network, **a tailor-made, state-of-the-art technology ecosystem has been deployed**.
This integrated system ensures real-time control, equitable distribution, and efficient water use from dam to farm.

***Key Operational and Technological Features***

- *Integrated Web SCADA System*
- *Real-time monitoring* and remote automation of all components—from pumping stations to farm-level outlets—allow seamless control and performance tracking across the entire network.
- *Outlet Management System (OMS)*
- Each 20-hectare command unit is equipped with a tamper-proof OMS containing:
    - Pressure & Flow Control Modulating Devices (PFCMDs)
    - Solenoid-controlled On-Off valves for 5-hectare subunits
    - IoT-based controllers with embedded fuzzy logic
    - Solar-powered operation with remote programmability
    - This ensures volumetric delivery (0.34 lps/ha at 20m head) tailored to crop water needs.
- *Air Management System (AMS)*
- 148 AMS units monitor pipeline pressure and detect leaks or theft via pressure differentials, sending real-time alerts through wireless controllers connected to SCADA.
- *LoRa-Based Communication Network*
- A low-power, long-range (LoRa) wireless communication network connects over 150,000 field sensors, OMS/AMS controllers, and SCADA using 6 high-altitude gateways powered by solar panels.
- *Demand-Based Scheduling*
- Water delivery is scheduled in 6-hour cycles based on aggregated crop water requirements. A centralized control room remotely operates field units, and a Farmer Management System (FMS) mobile app is being developed to allow farmers to register individual water demands digitally.
- Adaptive Pumping System with VFDs
- The intake system uses *Variable Frequency Drives (VFDs)* and *Electrically Operated Butterfly Valves (EO-BFVs)* to dynamically regulate flow according to reservoir levels and seasonal crop demand—especially critical during varying Rabi requirements (50%–100%).

# 6. Administrative and Implementation Success

Implementing a Pressurized Irrigation Network (PIN) of this unprecedented scale required a departure from conventional methods. The cornerstone of success lay in establishing a small yet dedicated team of trained engineers granted operational autonomy, supported by a multi-disciplinary framework that combined civil, mechanical, electrical, electronics, control systems, software, and social engineering. Collaboration with private sector contractors and domain-specialist sub-contractors enriched the in-house capacity and ensured a process-driven, technology-enabled execution model.

Equally vital was the synergy with local political leadership, which provided on-ground legitimacy, accelerated decision-making, and built trust among stakeholders, especially in politically sensitive and remote areas.

However, the journey was not without  challenges. One of the earliest and most significant hurdles was the lack of buy-in from senior departmental engineers, many of whom doubted the feasibility of a PIN system, fearing it would become a non-functional investment. Overcoming this required consistent technical grounding, successful early outcomes, and visible support from experienced private partners.

Another major challenge was convincing the end beneficiaries—farmers, who were indifferent or even disbelieving during implementation, particularly those located at higher elevations and distant from the reservoir. Their hesitation gave way only when water actually reached their fields, underscoring a vital lesson: real-time delivery builds credibility, after which awareness campaigns, demonstrations, and training programs become significantly more effective.

This experience highlighted the necessity of community engagement not just as a communication tool, but as a catalyst to transform irrigation into a farmer-led investment rather than a subsidy-dependent practice. The formation of a focused project unit with continuous institutional support has now created a critical mass of technically skilled personnel across both government and private domains, paving the way for replication of such advanced irrigation models elsewhere.

# 7. Strategic Impact

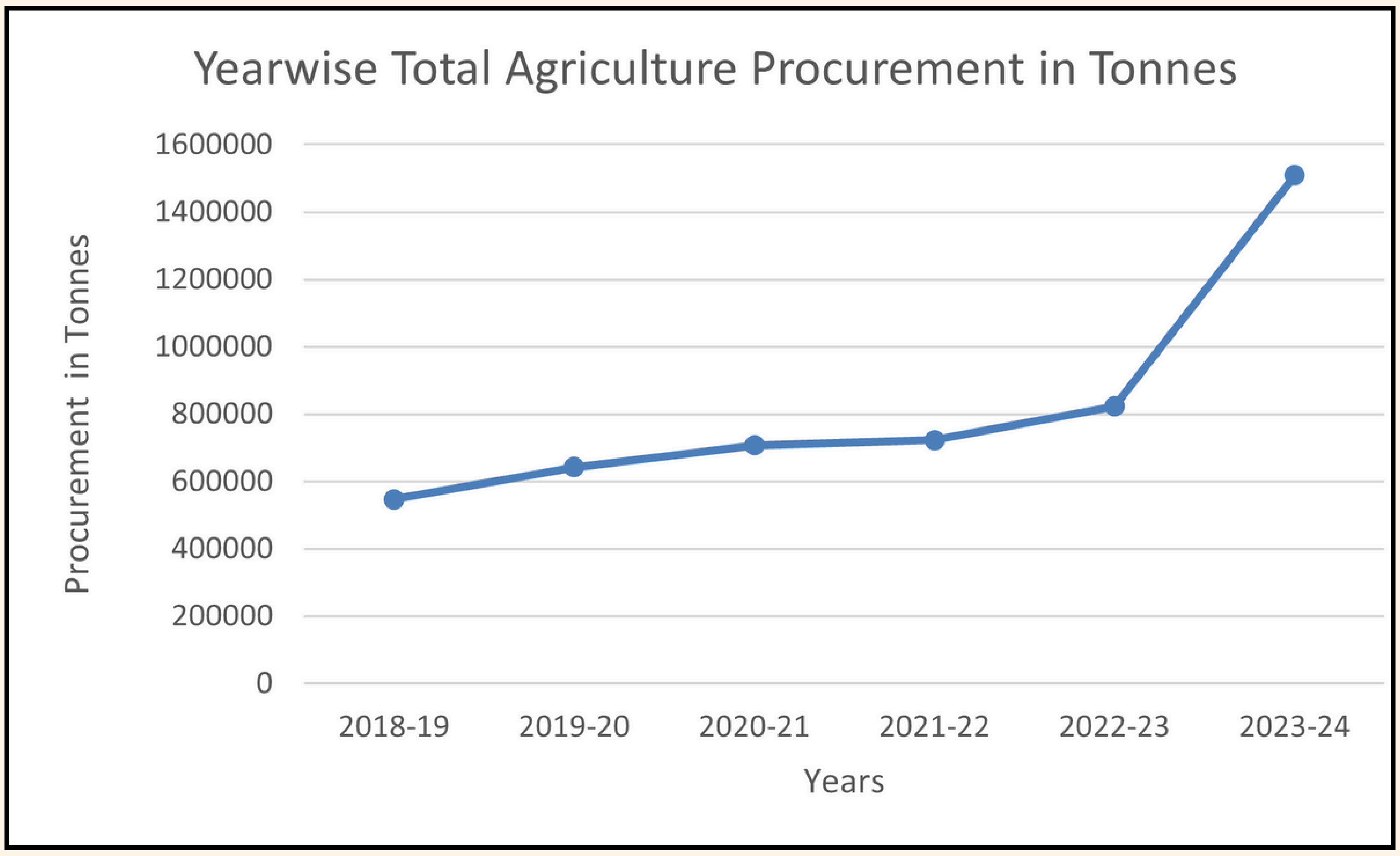
## 7.1 Improved Water Use Efficiency

The project has achieved a flow duty of 0.23 to 0.28 liters per second per hectare, significantly lower than the traditional 0.6 to 1.2 lps/ha required in conventional open canal systems. Compared to the design flow of 0.34 lps/ha, this indicates high operational optimization. Furthermore, the water productivity stands at 495 hectares per million cubic meters ($Mm^3$) in the Mohanpura sub-project—over 2.1 times higher than the national average of ~220 ha/$Mm^3$.

| Name of Project | Year of commissioning | Storage for Irrigation | Irrigation Area in ha | Mode of Irrigation | IA (ha) per MCM of live storage |
|---|---|---|---|---|---|
| **Mahi Project** | 2012 | 123.44 | 28127 | CDN | 228 |
| **Pench Project** | 2018 | 391.20 | 85000 | CDN | 217 |
| **Mohanpura Right Bank** | 2019 | 51.71 | 25600 | PIN | 495 |

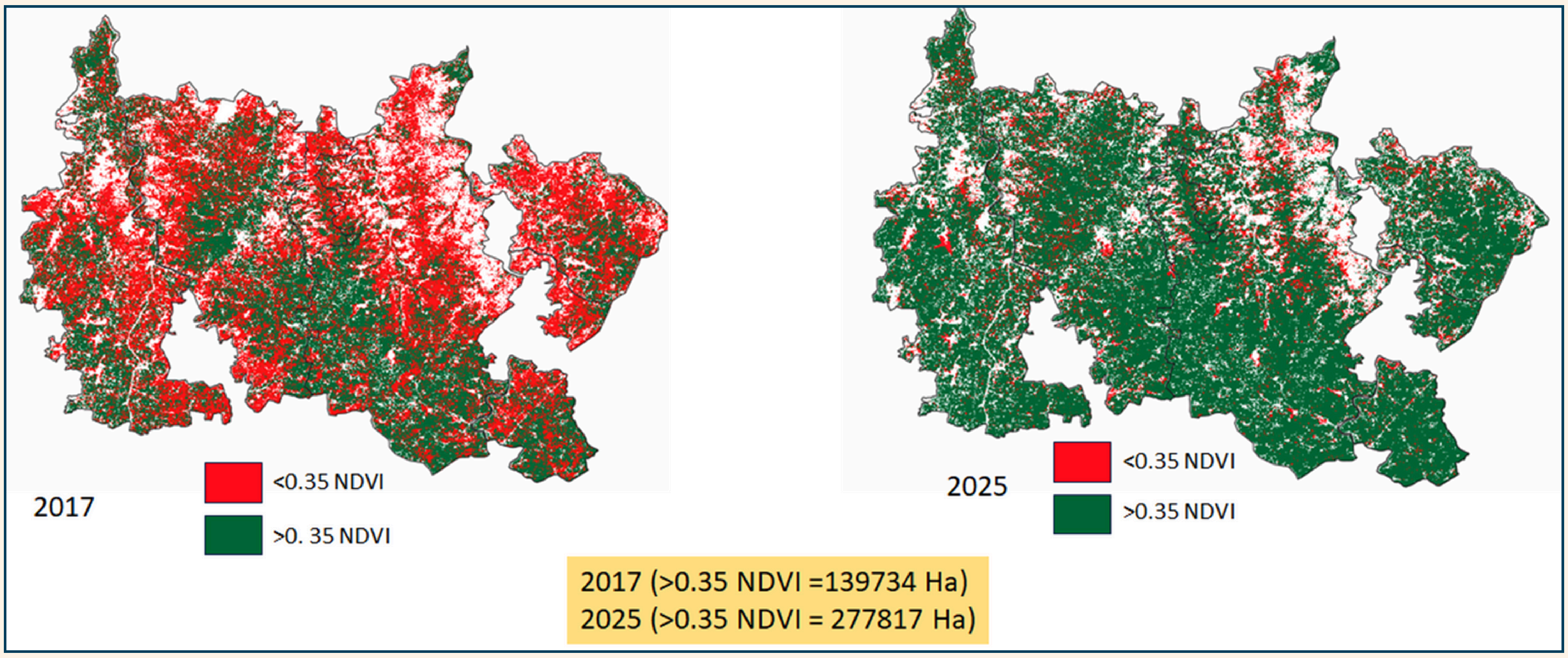
## 7.2 Surge in Crop Production

The availability of assured and timely irrigation has led to a remarkable increase in crop productivity across the command area. In Rajgarh district, wheat procurement rose from 3.5 lakh metric tonnes to over 15 lakh metric tonnes within a span of five years. This growth has been fueled by expanded irrigation coverage and the shift from single-season to multiple-season cropping.




## 7.3 Enhanced Irrigation Access

Satellite-based NDVI (Normalized Difference Vegetation Index) and GIS mapping validate the significant increase in green cover and vegetation density post-implementation, indicating robust on-ground performance. This widespread access has turned previously rain-fed or uncultivated land into productive zones



### 7.4 Energy Conservation

Centralised pumping station is provided in the projects to deliver the water to the irrigated area of 2,90,000+ Ha area. Considering the large size pumps to handle large flow rates and advanced automation and control system, the overall system efficiency is higher. The power calculation for the pumping station is shown in table below.

| Parameter | Centralized Pumping | Individual Farmer Pumping | Saving |
|---|---|---|---|
| Command Area | 290000 | 290000 | |
| Pump Efficiency | 80% | 46% | 34% |
| Power Consumption | 130 MW | 226 MW | 96 MW |
| Energy Consumption | 93.6 Million Kw-h | 162.7 Million Kw-h | 69.1 Million Kw-h |

### 7.5 Environmental Impact and Reduction in Carbon Footprint

Due to the centralized pumping system with high efficiency, there is a net reduction of 69 million kW-hr of energy consumption, as shown above, compared to conventional pumping systems used by individual farmers. This reduction in energy usage results in a decrease in greenhouse gas emissions equivalent to a carbon footprint reduction of 2186 metric tonnes of $CO_2$ per irrigation season (calculated at 1 kW-hr = 0.23314 kg $CO_2$). Along with providing equitable irrigation water access to every farmer, the system achieves substantial electricity savings, leading to a recurring reduction in the carbon footprint each season. Over the 30-year project lifespan, the cumulative carbon footprint reduction is projected to be 65,580 metric tonnes, equivalent to removing 14,257 passenger vehicles from the road (considering that a typical passenger vehicle emits about 4.6 metric tonnes of $CO_2$ per year).

### 7.6 Mitigation of Local Distress Migration

Prior to the project's implementation, many locals had no choice but to migrate to nearby towns such as Kota, Tonk, and Jaipur in Rajasthan to work as laborers, depriving their families of a permanent home and their children of stable educational opportunities. With the commissioning of the project and the assured availability of irrigation water across 1,300 villages, farmers can now cultivate their lands effectively, often harvesting a second crop. This has not only encouraged villagers to remain in their communities but has also revitalized the local economy, ensuring food security, stable livelihoods, and opportunities for sustainable development.

*The Mohanpura-Kundalia Irrigation Project exemplifies how a focused, large-scale government initiative can trigger widespread socio-economic renewal. As assured irrigation improved farm yields and stabilized incomes, rural households began investing in agricultural capital—tractors, borewells, drip systems—and diversifying into allied sectors like dairy and horticulture. Rising incomes also led to a noticeable surge in consumer spending, with families purchasing motorcycles, appliances, and constructing pucca homes. Educational outcomes improved too; school enrollments rose, particularly among girls, as economic security reduced the need for child labor and out-migration. The cultural fabric of villages has also been revitalized—festivals, once subdued due to economic hardship, are now celebrated with renewed vigor, reflecting a deeper sense of dignity, belonging, and social confidence. What began as an irrigation project has thus grown into a vehicle for holistic rural transformation.*

## 8. Best Practices & Conclusion

The Mohanpura-Kundalia Irrigation Project shows how large-scale government efforts, when planned smartly and implemented well, can change lives. One of the biggest pressurized piped irrigation systems in the world, this project has improved water use efficiency from just 38% to over 80%. This was achieved by using modern technology, real-time data, automated systems, and by designing the system to meet actual needs on the ground.

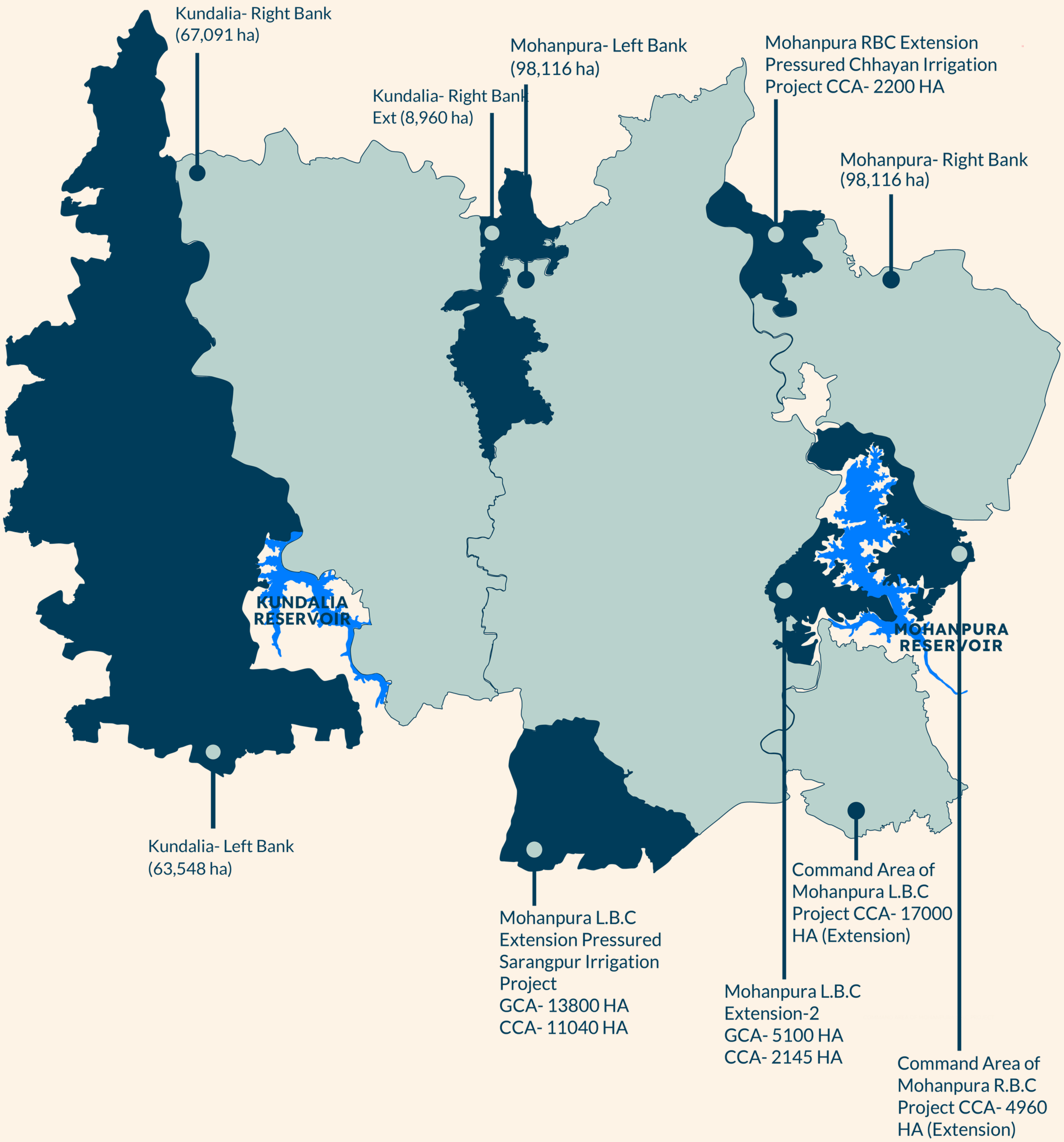
What makes this project easy to replicate in other regions is its outcome-focused and people-centered approach. It didn't just build infrastructure—it also trained people, connected departments, and used digital tools to make sure water is used wisely and reaches those who need it.

The project moved away from traditional, one-size-fits-all planning and instead responded to local realities and long-term needs.

The biggest lesson is about governance—how we plan and deliver public services. Instead of reacting to problems after they happen, this project focused on predicting challenges and solving them early. It replaced isolated efforts with cooperation across departments and kept the focus on results, not just spending or activity. This kind of ethical, smart, and participatory governance is the need of the hour.

As India faces growing water and climate challenges, the Mohanpura-Kundalia model offers a clear path forward. It proves that when governments focus on impact, use technology wisely, and include people in the process, even the most complex problems can be solved in a way that benefits everyone—sustainably and fairly.

# WORLD LARGEST  CONTIGUOUS AREA WITH PIN (RESERVOIR TO FARM)



# Mohanpura Dam

RESERVOIR DATA

A) Capacity

| | |
|---|---|
| a. Gross storage capacity - | 616.27 Mcum |
| b. Dead storage capacity (at RL 380m) - | 39.03 Mcum |
| c. Live storage capacity (at RL 398m) - | 572.96 Mcum |

# Kundalia Dam

RESERVOIR DATA

A) Capacity

| | |
|---|---|
| a. Gross storage capacity - | 582.75 Mcum |
| b. Dead storage capacity - | 30.00 Mcum |
| c. Live storage capacity - | 552.75 Mcum |