

# Integrated Approach to Irrigation Development and Water-Use Efficiency

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**Water Resources Department**

# IRRIGATION LANDSCAPE IN MADHYA PRADESH

## ARABLE LAND IN THE STATE




A third watered, a third under way, a third still to be taken up.

## THE THREE LAYERS

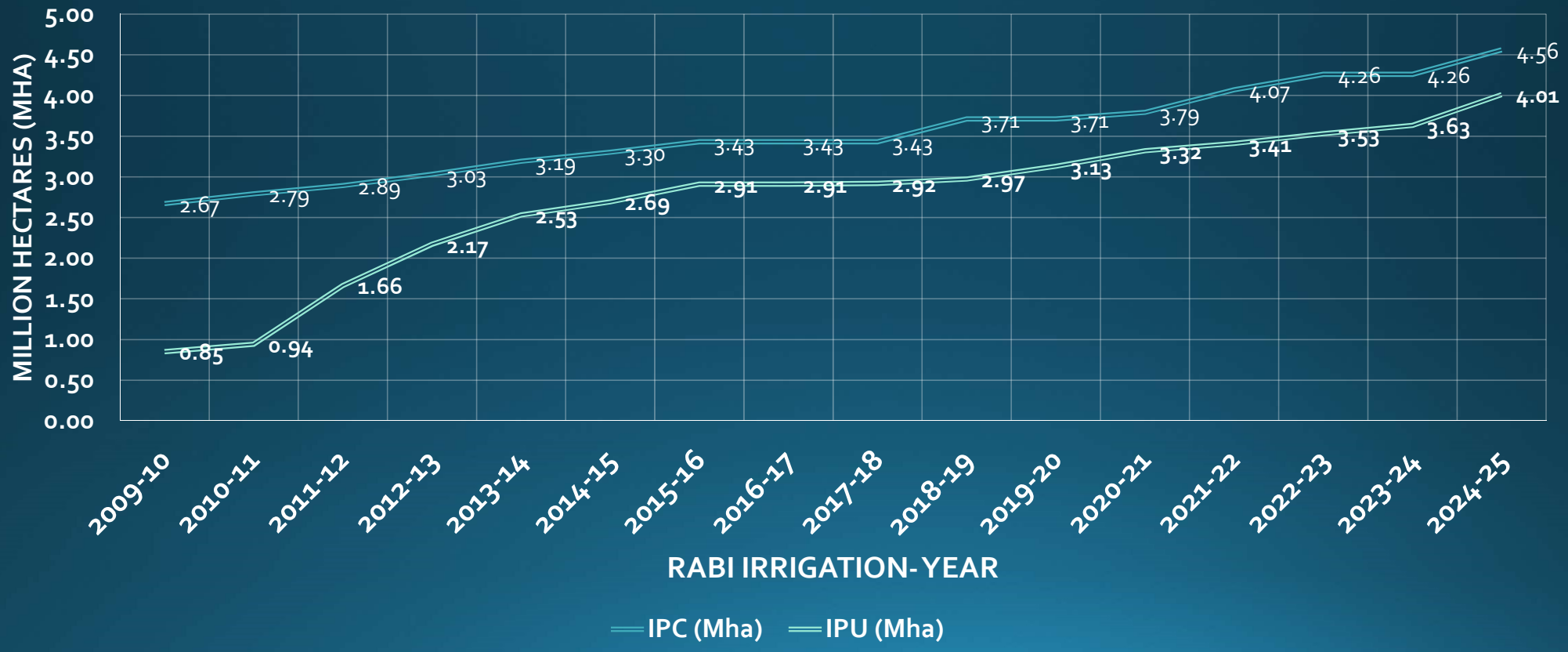
**54.06** lakh ha
**Already irrigated**
**34.88%**

**56.51** lakh ha
**Under implementation**
**36.46%**

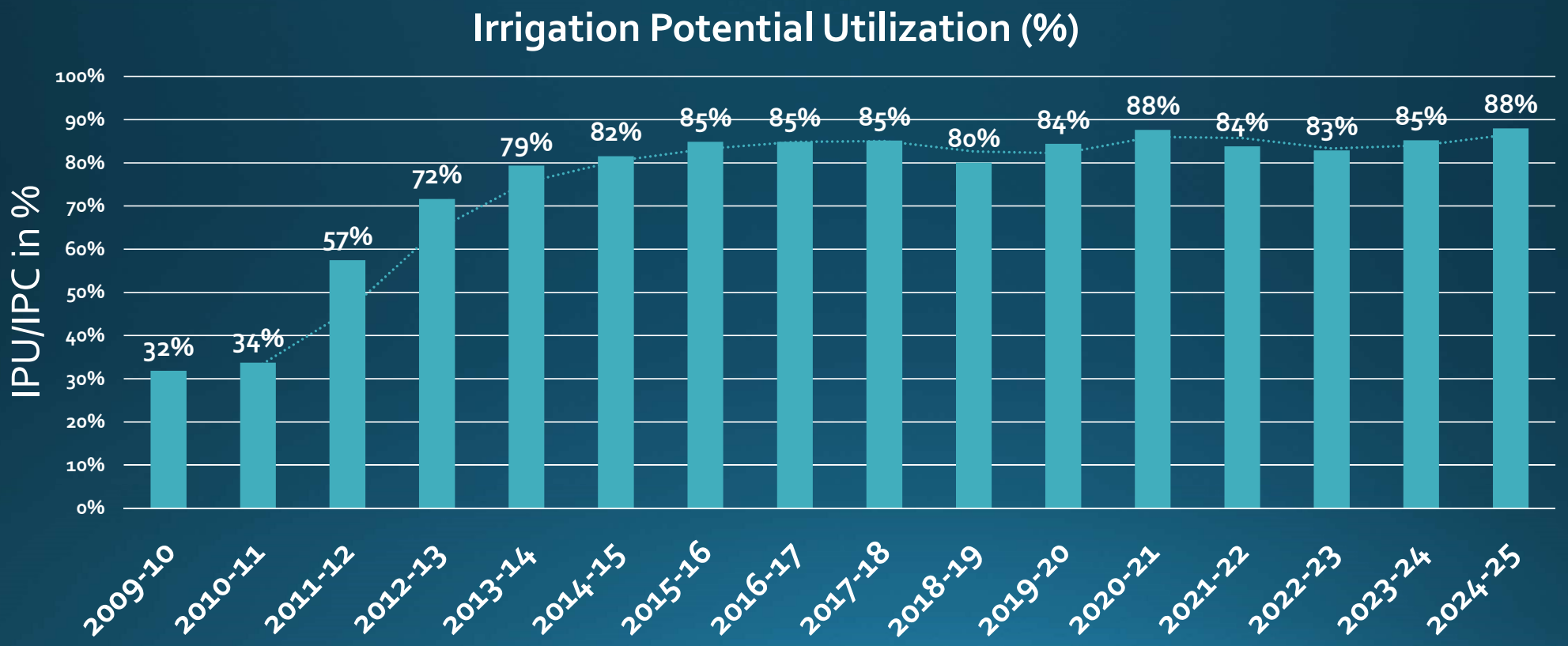
**44.43** lakh ha
**Yet to be taken up**
**28.66%**

**Two-thirds of the State's farmland is still waiting for water**

# Initial Steps: Closing the Irrigation Potential Created (IPC) and Utilized (IPU) Gap



# Initial Steps: Improving System Utilization



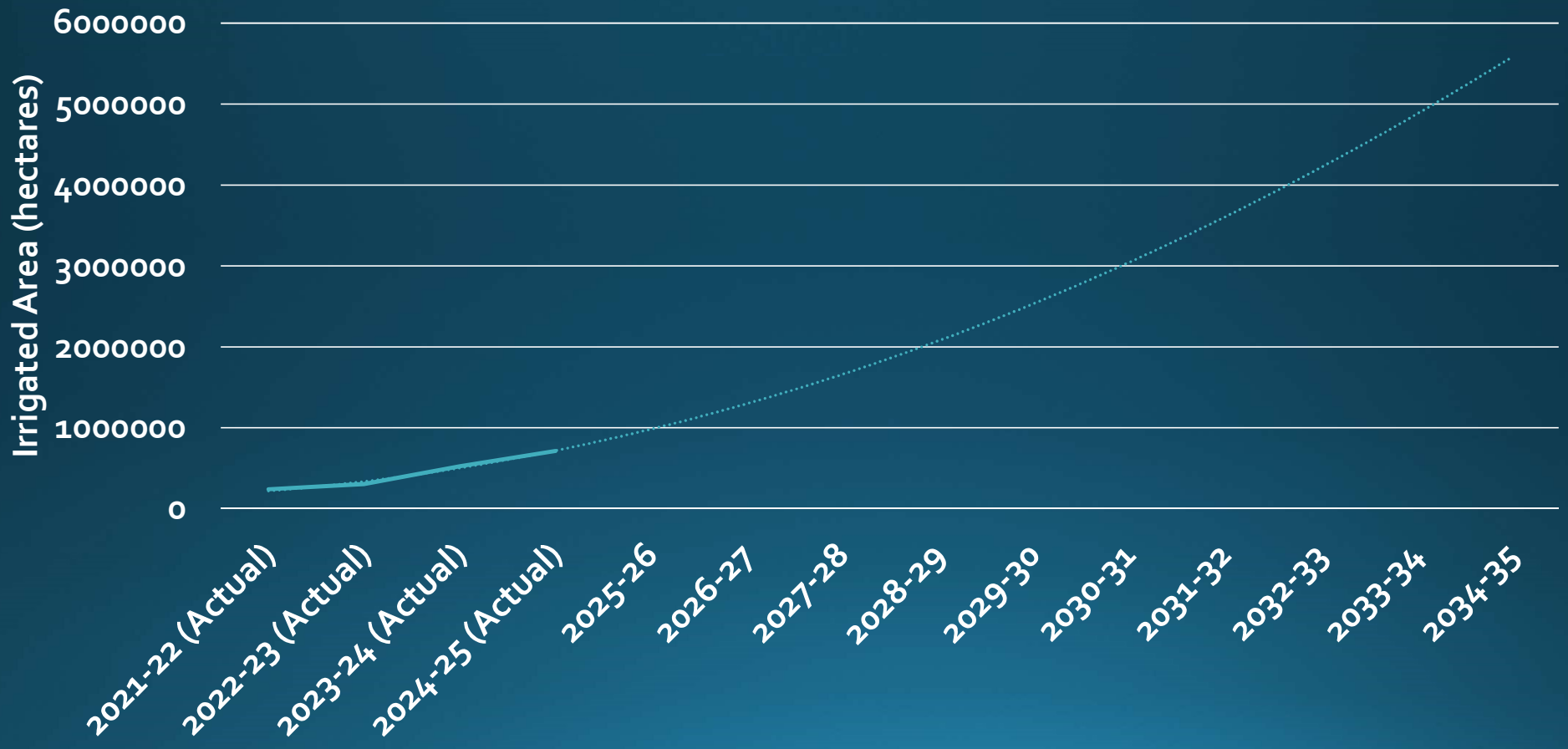
# Current Phase: Doubling irrigated area with same amount of water

- Focus on improving water use efficiency in line with National Water Mission
- Initial project(s): Transformation (re-modelled/hybrid)
- New projects: Canals are an exception rather than a rule
- Fully Pressurized Piped Irrigation projects (from dam to field)-

**Pressurized piped irrigation projects under implementation in 56.51 lakh ha CCA**

- Improved energy efficiency in centralized pumping
- Micro-irrigation ready service delivery
- Scope for in-line fertigation

# Irrigation Through Pressurized Conduits



# Mohanpura-Kundalia Projects

01 The western part of Madhya Pradesh was on the verge of desertification.

02 Prior to 2010, Rajgarh was among the least irrigated districts of Madhya Pradesh and was marked as an Aspirational district.

03 Until 2013, only 8% of the district's total geographical area was irrigated.

04 The government set an ambitious program to harness the Newaj and Kalisindh rivers, tributaries of the Chambal River, aiming to impound more than 1,200 MCM of water at Rajgarh.

05 Land acquisition, rehabilitation and construction of Mohanpura-Kundalia Dams began in 2014.
.

06 The dams were fully constructed and commissioned in 2017-18, achieving completion in a record time of three years.

# Mohanpura and Kundalia Irrigation Project – Success story

Largest contiguous command served by a pressurised piped network from Reservoir to Farm.

## Water supply from reservoir to field across 290,000+ hectares.




RESERVOIR TO FARM

### Largest Pressurized Piped Irrigation Network

01 **Benchmarking water use efficiency**

WUE measured and Validated **+80%**

02 **New age pumping systems**

Combined efficiency +83%, VFD enabled controlled for optimized operations.

03 **Largest smart irrigation system.**

Volumetric control up to 5 ha. outlet. delivery up to 1 ha outlet with 20 meter head.

04 **Evidence, not assertion**

Satellite NDVI, audits, farmer feedback.

**Benefited more than 500k farmers**

## BACKGROUND

# Demand was high - The availability was not.



Before the project — barren land, unreliable groundwater

## THE ARITHMETIC

More than 4,00,000 ha within the techno-economic feasible range of the reservoirs lay barren and un-irrigated. The storage available could irrigate only about 1,50,000 ha by conventional means.

| | |
|---|---|
| **Demand in feasible range** | **4,00,000+ ha** |
| **What storage can serve conventionally** | **1,50,000 ha** |
| **What Mohanpura Kundalia PPIN network now serves** | **2,91,975 ha** |

**Catering to maximum demand, an efficient and smart irrigation network was designed — a need-based design, not a standard one.**

### NO GLOBAL PRECEDENCE

**There was no global precedent for implementing on this scale, in an integrated manner, at this amount of risk.**

That is what gave the special emphasis to take it up as a flagship project, and to house trained and efficient engineers in a dedicated PMU. An investment of ₹9,281 crore could not be run on ordinary departmental process.

**₹9,281 crore · 2,91,975 ha**

**Listed under Best Practices by the Ministry of Jal Shakti, PMKSY–AIBP** · pmksy.mowr.gov.in/aibp-mis/BestPractise.aspx

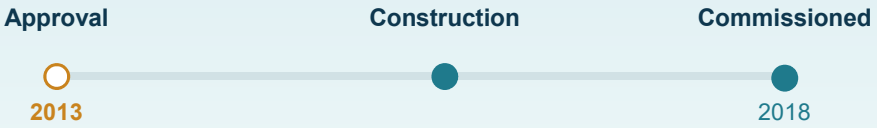
## THE DAM

Two reservoirs were built in the sanctioned period.

| 616.21 | 592.75 | 1,209 | 2014 – 2018 | ~30% |
|---|---|---|---|---|
| MCM · Mohanpura | MCM · Kundalia | MCM stored in all | both dams built | of project cost is R&R and construction of Dams |

DAM TIMELINE

### Commencement to commissioning




Both dams were commenced and completed inside the sanctioned construction period, with no stoppage on account of land or clearances.

WHAT THE DAM WORK INVOLVED

- **Hydrology and design**
  Standard reservoir engineering. No part of the project's innovation sits here.
- **Land acquisition and R&R**
  Special package for land acquisition and R&R was approved by the state cabinet for expeditious settlement
- **Geological conditions**
  An MoU with the Geological Survey of India brought their team to site often, so calls on unexpected strata were taken there and then.

**The dam created the asset. It did not solve the problem.**

THE IMPETUS

# The dam was inaugurated - The harder part follows




**The inauguration of the dam by the Hon'ble Prime Minister on 30th June 2018, gave impetus to take up the innovative pressurized pipe irrigation with smart water management.**

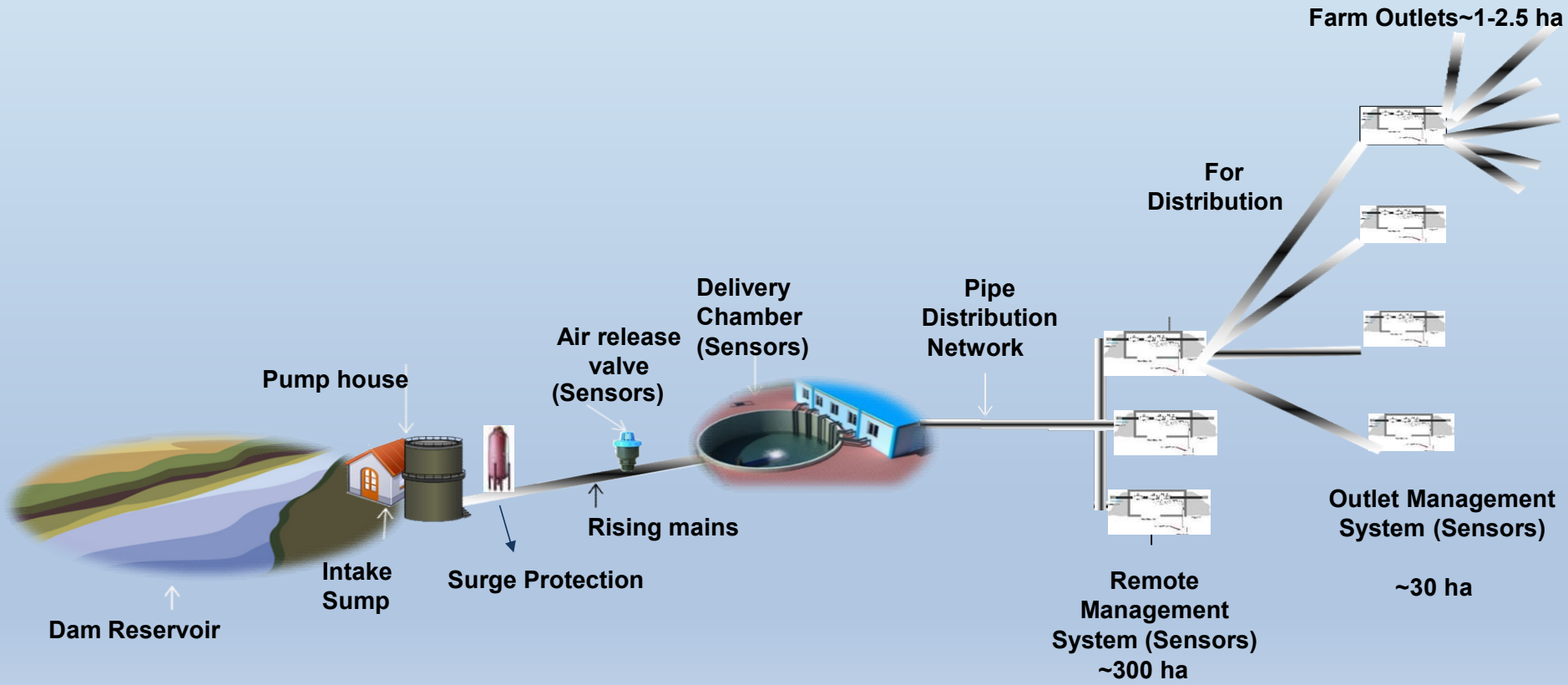
IN THE SAME YEAR

## A dedicated PMU was established

Established with a focused approach of timely completion, and staffed with expertise in integrated river basin planning

- **Focused approach**
  timely completion held as the single objective
- **Expertise in place**
  trained and efficient engineers, not a coordination desk
- **One unit**
  design through commissioning, institutional memory

# MOHANPURA-KUNDALIA MODEL



# PROJECT SCHEMATIC – Kundalia RB

Villages: 208
CCA: 67,091 Ha
Power: 38.69 MW

**Rising Main**
**MS Pipe –** 9.2 km length,
2200 - 2700 mm Dia

**DC-1** Capacity 14,253 cum
Dia 50m, Height 9.4m
FSL+475m

**DC-2B** Capacity 20,674 cum
Dia 40m, Height 19.25m
FSL+504m

**DC-2A** Capacity 20,674 cum
Dia 37m, Height 21.75m
FSL+504m

**Pump House –**
VT Pumps & Motors
4200 kW each (8W + 2S)
10337 Cum/hr @ Head 114m

2600 kW each (3W + 1S)
8664 Cum/hr @ Head 84.5m

EOT Crane 65T
Semi Gantry Crane 10T

RM-1 (2.2m dia) Length – 2.05 KM

RM-2 (2.7m dia) Length – 3.58 KM

RM-3 (2.7m dia) Length – 3.58 KM

DC 1

DC-2B

DC-2A

Zone –1 (15779 Ha)

Zone –2 (7395 Ha)

Zone –3 (43917 Ha)

Pump House

**Distribution Network**
**MS Pipe** – 339 km length
400 - 2700 mm Dia
**HDPE** - 6355 km length
(63 - 280 mm dia)

**132/11.5 kV Switch Yard of 40MW**

**220/132 KV Nalkheda Substation**

**Kundalia Dam FRL +400.00 m**

Approach Channel 2.55 km

132 kV Transmission Line 24.12 km

# Reservoir to farm, SCADA enabled

The same water, followed end to end — from the reservoir to a green field.



1

**Reservoir**

Water stored behind the dam



2

**Pump house**

Lifted and pressurised



3

**Rising and gravity mains**

Carried across the command



4

**Automation box at field**

Metered, controlled, remotely read



5

**Green fields**

Delivered at the farm gate

## THE DESIGN ANSWER

A state-of-the-art pressurised piped irrigation network was designed with all new-age technologies, so that the same stored water could reach a far larger command.

### WHAT ONE MCM OF WATER IRRIGATES

**Pressurised network** — **350–500 ha**

**Open canal** — **170–225 ha**

**SCADA · OMS · RMS · AMS — monitored and controlled centrally, end to end**

## SETTLED BEFORE DESIGN

- **Basin plan first**
  Chambal sub-basin drawn in house with IHE Delft, Netherlands.
- **Clearances at inception**
  Forest and environment applied for at the very start, then followed up.
- **Contract fixed early**
  Turnkey and DBO, with payment tied to performance.

## THE PRESSURISED PIPED NETWORK

# The PPIN turned stored water into irrigation

This is where the project had no precedent, and where the whole implementation risk sat.

| 26,662 | 23 | 10,100 | 1,50,000+ | ~70% | 2018 – 2023 |
|---|---|---|---|---|---|
| km of pipe | Pump houses | Outlet units with volumetric control | Field sensors | Project cost | Laid and commissioned |

### RESERVOIR TO FARM

**One system, end to end**

| | | |
|---|---|---|
| Reservoir | Pump house | Rising main |
| Distribution network | Outlet unit | Field |

**SCADA · OMS · RMS · AMS**

Water is delivered volumetrically to 1 to 1.25 hectare outlets at 20 m residual head, monitored and controlled centrally. Water use efficiency rose from 38% to over 80%.



Pump house and rising main, commissioned

About 70% of efforts/ investment went into the network laying, not the dam — 26,662 km of pipe crosses far more land than a reservoir does.

## THE PRESSURISED PIPED NETWORK

# The commissioned system, package by package

What is actually running on the ground, and the order in which it was brought into service.



**Balancing reservoirs**



**Filtration units at the pump house**



**Pump house control panels**



**Solar-powered outlet management unit**

PPIN TIMELINE

### Package to package, area by area

| Design and award | First area watered | Original designed area | O&M |
|---|---|---|---|
| 2016-2017 | 2018-19 | 2023-2024 | in progress |

### IN SUMMARY

The originally sanctioned design was commissioned by 2022. Extensions taken during the period were on account of COVID and force majeure, and are shown separately from the newly sanctioned scope.

**No comparable network of this size had been built from source to farm. That is why the delivery model had to change.**

BEST PRACTICE · THE SCALE

# Scale of the Mohanpura–Kundalia Projects

Every sub-project, with its command area, pumping, pipeline and outlet units.

| Name of Project | Sub-Project | CCA (Ha) | Pump House | Installed Power (MW) | Rising / Gravity Mains (km) | PDN upto 30 ha (km) | PDN upto 1 ha (km) | Total Pipeline (km) | No. of OMS |
|---|---|---|---|---|---|---|---|---|---|
| Mohanpura Project | Mohanpura Right Bank | 25,600 | 3 No PH | 9.3 | 143 | 589.95 | 1167.88 | 1900.83 | 1263 |
| | Mohanpura Left Bank Rising Mains & Pump Houses | | 3 No PH | 32.38 | 31.57 | – | – | – | – |
| | Mohanpura Left Bank System | 98,116 | 4 No PH | 7.43 | 498.4 | 1292 | 7130 | 8920.4 | 3260 |
| | Extension of Left Bank System (Pachore) | 16,985 | 2 No PH | 7.5 | 91.4 | 272.2 | 960 | 1323.6 | 575 |
| | Extension of Right Bank Canal | 6,454 | 2 No PH | 1.89 | 24.73 | 93 | 320 | 437.73 | 217 |
| | **Sub-Total of MOHANPURA PROJECT** | **147,155** | **14 No PH** | **59** | **789** | **2,247.2** | **9,577.9** | **12,614.1** | **5,315** |
| Kundalia Project | Kundalia Irrigation Project – Left Bank | 63,548 | 4 No PH | 26.38 | 364 | 1367 | 5042 | 6773 | 2259 |
| | Kundalia Irrigation Project – Right Bank | 67,091 | 1 No PH | 40 | 331 | 1200 | 4800 | 6331 | 2180 |
| | Extension of Kundalia Right Bank | 9,836 | 1 No PH | 3.9 | 63.9 | 140.1 | 660.79 | 864.79 | 330 |
| | **Sub-Total of KUNDALIA PROJECT** | **140,475** | **6 No PH** | **70.28** | **758.9** | **2,707.1** | **10,502.8** | **13,968.8** | **4,769** |
| | **Grand Total, Mohanpura–Kundalia** | **287,630** | **20 No PH** | **128.78** | **1,548.0** | **4,954.3** | **20,080.7** | **26,582.9** | **10,084** |

Grand total command of 2,87,630 ha is the commissioned scope. With the 4,345 ha of extension work in progress it reaches the 2,91,975 ha designed command.

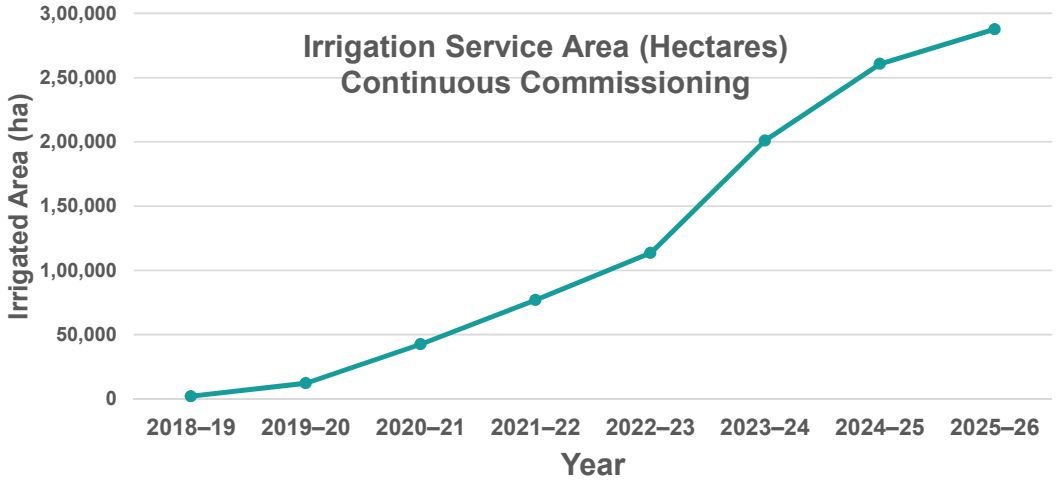
## RESULTS AND IMPACT

# Complete transformation — tangible impacts

What was designed, what has been commissioned, and what is still being added.

| 2,91,975 | 2,87,629 | 4,345 | 100% |
|---|---|---|---|
| hectares designed | hectares commissioned in 2025-26 | hectares of extension in progress | of the original design complete |

Extension in progress: Mohanpura Left Bank Extension Part II and Chhayan Bahadurpura.






Command area under irrigation, 2025

**Continuous commissioning — each completed section was put to work rather than held for a single handover.**

## RESULTS AND IMPACT

# What it changed for the people in the command

The same land, the same families — before the water arrived, and after.



### Before

Barren land and unreliable groundwater across the feasible command.



### After

Assured irrigation to the field, delivered volumetrically at the outlet.



### The people

Families stayed. Seasonal migration for work came down.

## WHY IT MATTERS

**The worth of the result**

**38% → 80%+**

water use efficiency

**Three crops**

where the land grew rainfed

**Families stayed**

seasonal migration came down

**69.1 million units**

of power saved every year

RESULTS AND IMPACT · TANGIBLE IMPACTS

# Crop production

What the assured water did to what the land grows, and to what reaches the market.

**4×**

**more crop reaching the mandi**

about 5.5 to about 21.5 lakh tonnes

**3.5 → 15**

**lakh tonnes of wheat**

in five years

**One → three**

**crops in the year**

on land that grew a single rain-fed crop

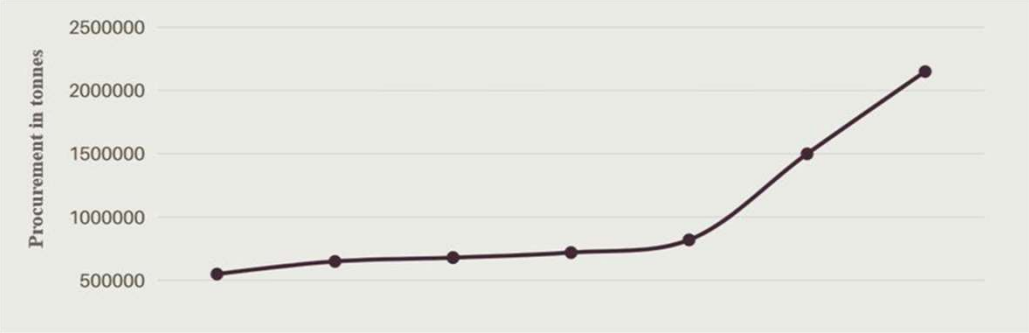
**38% → 80%+**

**water use efficiency**

against an open canal system

## Year-wise agricultural procurement

Arrivals in tonnes, 2018-19 to 2024-25






**Machalpur command under irrigation — drone view**

Procurement is what actually reached the mandi — not an estimate of production. The rise tracks the year-by-year commissioning of the network.

# Performance Evaluation-Mohanpura RB



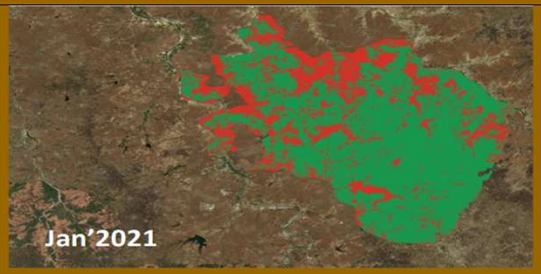


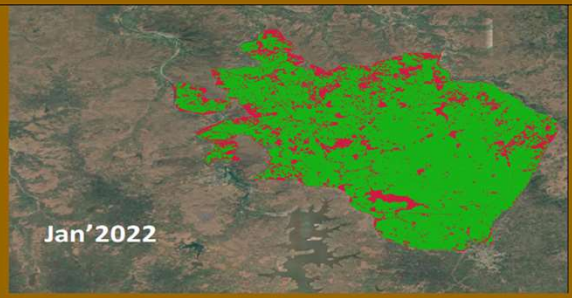


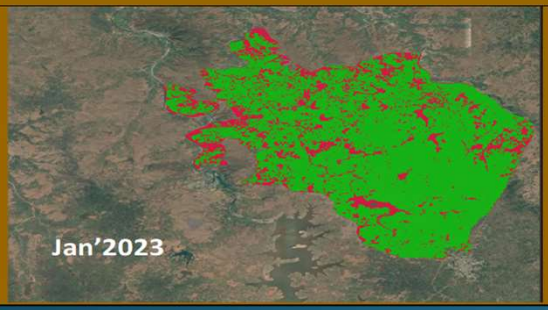


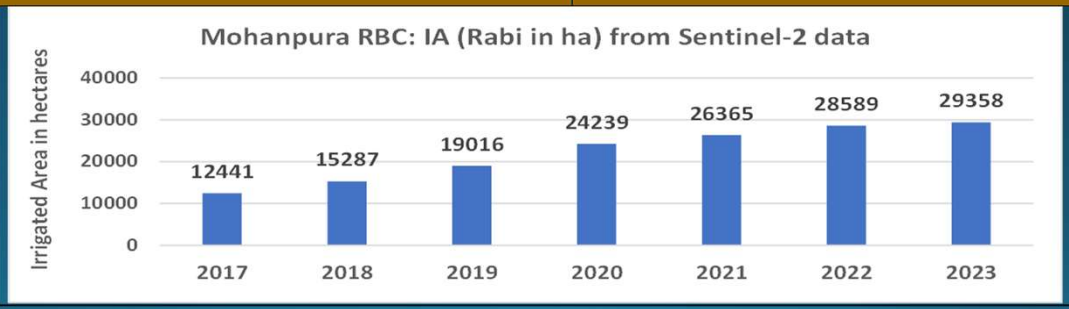






# Performance Evaluation-Mohanpura RB

| Year | Water Delivered in season ($Mm^3$) | No. of Days in Season | Weighted pumping duration at peak discharge (hrs) | CCA/ Irrigated area (ha) | Duty (lps/ha) | IA per unit volume delivered (ha/MCM) |
|---|---|---|---|---|---|---|
| 2019-20 | 27.30 | 98 | 1268 | 24,239 | 0.25 | 888 |
| 2020-21 | 40.01 | 120 | 1920 | 26,365 | 0.22 | 659 |
| 2021-22 | 51.71 | 123 | 1968 | 28,589 | 0.28 | 553 |
| 2022-23 | 55.44 | 128 | 1979 | 29,358 | 0.27 | 530 |

# Comparison of Irrigated Area: Canal Vs PIN

| Name of Project (Madhya Pradesh) | Year of commission | Storage for Irrigation | Irrigation Area in ha | Mode of Irrigation | IA (ha) per MCM of live storage |
|---|---|---|---|---|---|
| Mahi Project | 2012 | 123.44 | 28,127 | CDN | 228 |
| Pench Project | 2018 | 391.20 | 85,000 | CDN | 217 |
| Mohanpura (Right Bank) | 2019 | 55.44 | 29,358 | PIN | 530 |

# Results of PIN transformation (Sample)

| S.No. | Name of Project | Gross Capacity in MCM | Water allocated for irrigation in MCM | Irrigated Area in hectares (ha) | | Increase in area by transformation to PIN in ha | Water Saved in $Mm^3$ |
|---|---|---|---|---|---|---|---|
| | | | | as per original sanction for conventional (canal-partial/full) network | after transformation to Pressurized Pipe Irrigation Network | Col 5-Col 4 | [(Col 3/Col 4 *Col 5)-1] |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | Mohanpura | 616 | 510.0 | 60750 | 145500 | 84750 | 711.48 |
| 2 | Bansujara | 281 | 250.0 | 58800 | 75000 | 16200 | 68.88 |
| 3 | Kundalia | 582 | 490.0 | 112400 | 139600 | 27200 | 118.58 |
| 4 | Pench | 578 | 421.2 | 85000 | 126647 | 41647 | 206.37 |
| 5 | Panchamnagar | 99 | 86.24 | 12000 | 25000 | 13000 | 93.43 |
| Total | | 2155.67 | 1757.44 | 328,950 | 511,747 | 182,797 | 1198.74 |

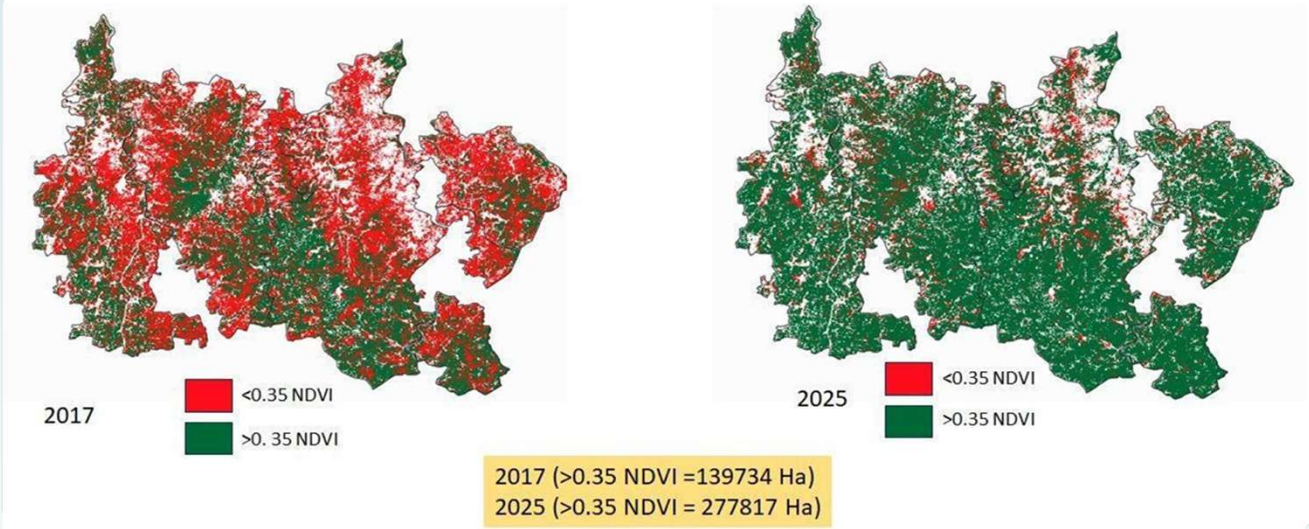
- Saving of about 1200 MCM with conversion to PIN in 5 projects
- Land acquisition of to 9000 ha & Rehabilitation of 6000 PAF avoided, apart from financial savings

RESULTS AND IMPACT · TANGIBLE IMPACTS

# Verified from satellite imageries

Normalised Difference Vegetation Index across the command, 2017 against 2025.

### >0.35 NDVI — Mohanpura – Kundalia Contiguous command




WHAT THE SATELLITE SHOWS

**1,39,734 ha**

above 0.35 NDVI in 2017

**2,77,817 ha**

above 0.35 NDVI in 2025

**≈ 2×**

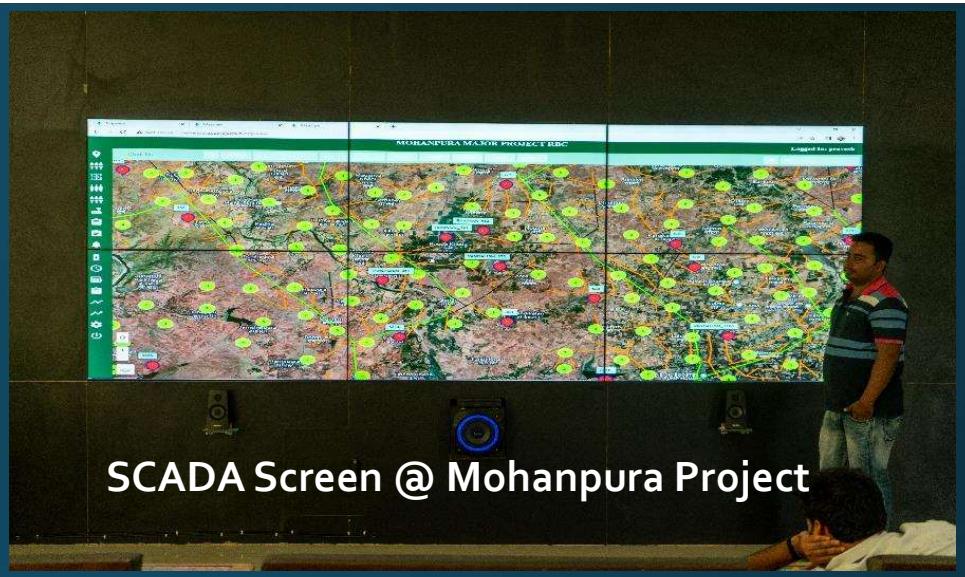
increase in irrigated agriculture

**Assessed across all seven command areas — an independent reading of the same result.**

NDVI measured at a 0.35 threshold, January acquisitions, 2017 and 2025; Copernicus-Sentinel-2.



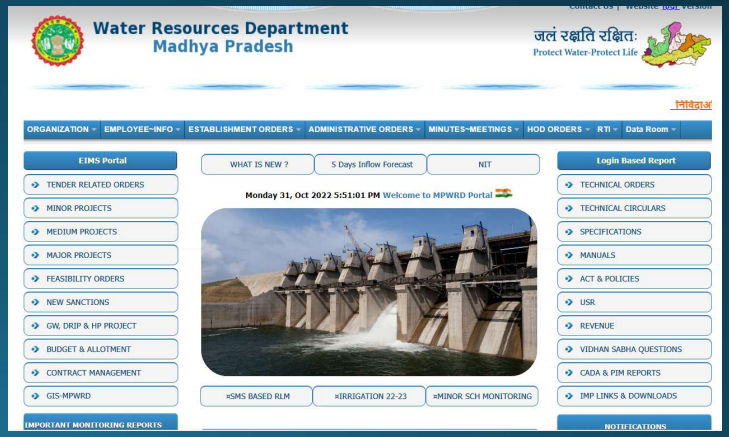
Kundalia: Village Dharola, Agar

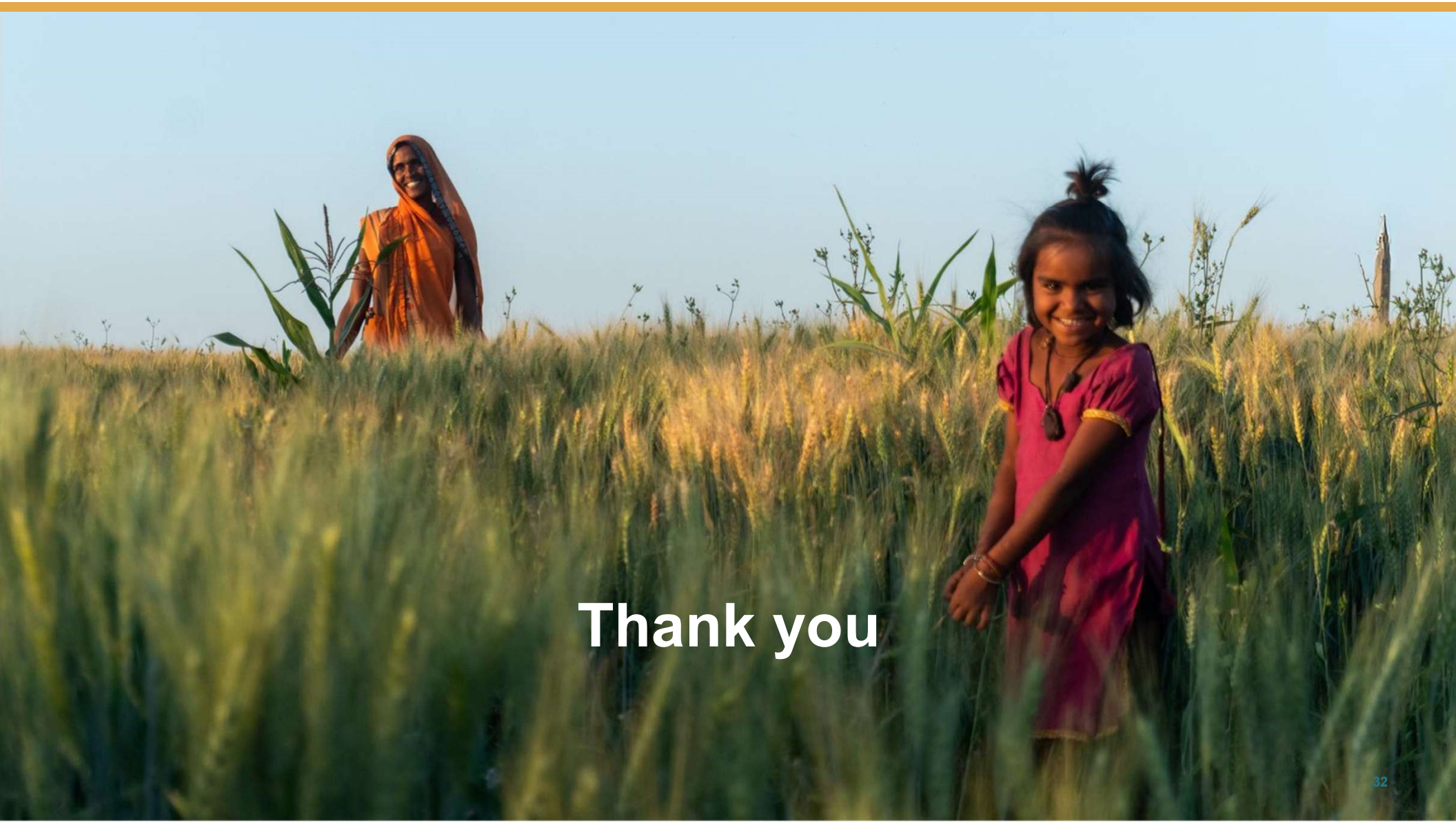


SCADA Screen @ Mohanpura Project

# Takeaways

- Adoption of PINs in all new projects- huge water use efficiency gains
- High scope of (mindful) replication
- Climate Resilience
- Highly efficient systems leading to assured water sources for expansion of irrigated area, drinking, domestic, environmental, industrial use




Thank you








DC-1A/1B
Kundalia Reservoir
Pump House-1
Workshop Building
132/11 KV Switchyard
Electrical control Building
Fire Water Pump House
Air Handling Unit Building



# Kheti, migration and livestock

Recorded village by village by PMU officials, in the field.

### Kheti — the cropped area itself

**300–400 → 1,200**

bigha of wheat in one village





*“The village grew 300 to 400 bigha of wheat before. Now it is 1,200 bigha in all.”*

**Pipalkheda**

**Sowing tripled, yields up, new crops in**

### Migration

**Stopped**

the seasonal move to other states for work





*“It is the dam's blessing — nobody leaves this village any more.”*

**Machalpur**

**Seasonal migration stopped**

### Livestock and fodder

**12 months**

green fodder now available





*“In summer nobody sowed green fodder for the buffaloes. Now every household keeps it all twelve months.”*

**Kataria Khedi**

**Green fodder twelve months a year**

Farmer quotations recorded on video during the 100 Days, 100 Villages drive

# Groundwater, milk and schooling

Recorded village by village by PMU officials, in the field.

## Groundwater

**700 ft**

how deep the borewells had gone






*“The borewell had gone to 700 feet. Everything shut down in January. Now there is plenty of water.”*

**Pipliyakulmi**

**Wells and borewells are no longer the fallback**

## Milk production

**100 → 200**

litres per shift, village collection





*“The village used to collect 100 litres a shift. Now it is 200 — it has doubled.”*

**Malyahedi**

**Village collection doubled**

## Schooling

**Stayed**

families no longer travel for work





*“We no longer go out to cut fields, so the children go to school.”*

**Chuwadliya**

**Children in school, not in the harvest**

Farmer quotations recorded on video during the 100 Days, 100 Villages drive