India's Century:
Sustainable and inclusive growth

A FICCI-McKinsey multi-year forum

Water Committee Report

Challenges and opportunities in the Water sector

Key challenges / What is needed

- **Overall Economic Risk:** The demand for water is rising exponentially while supply is becoming more erratic and uncertain. Unless appropriate actions are taken to conserve this valuable resource, the water shortage could result in a **six-percent loss in GDP by 2050**
  - ~820 million people (largely rural population) have a per capita water availability of <1,000 m3[1]; 12 percent of the population is already living **"Day Zero" scenario**, with no access to clean water within or near their homes
  - India uses **>80% of its freshwater** each year and is the only country under extreme stress in its category ('not in an arid / semi-arid region').
  - Large swathes of land exposed to flood (12%) and droughts (68%)
- **Challenge for Manufacturing, Supply Chains and Agriculture Based Industries:** As water demand is projected to double supply by 2030 and nearly 65 percent of the country's reservoirs could run dry, agriculture would be the worst hit, followed by industries that are heavily dependent on water and agriculture, such as food processing, beverages, textiles, metals, chemical, paper and leather. Thus, effecting operations and supply chain of the industries.
- **Significant Distribution Losses:** Water losses due to defective pipes, leakages, unattended damaged supply pipes, water theft; is one of the major challenges and directly impacts the system's revenue. In India, non-revenue water is around 38% which is above the global average range.
- **Extent of Untreated Wastewater:** ~70 per cent of India's wastewater goes directly into rivers and lakes. India generates ~62,000 MLD of domestic sewage in urban centres. There are 920 sewage treatment plants (STPs) operated primarily by municipal corporations, with a treatment capacity of ~23,000 MLD, i.e., merely 37 percent of generation. Only 33 percent of India's urban wastewater is actually treated, and an even smaller portion is reused. This untreated wastewater is one of the major causes of surface water and groundwater pollution in the country. .

Opportunities / Tailwinds

- **Source sustainability** is heavily dependent on groundwater and groundwater is recharged every year through rainfall and other sources such as return flow from irrigation, canal seepage, recharge from surface water bodies etc.
  - **Presently, India captures only 8% of its annual rainfall**, among the lowest in the world. Catching rainwater where it falls using traditional and innovative practices is need of the hour.
  - Comprehensive water budgets and adoption of standards for net-zero water certifications can help recharge aquifers, along with protecting surface water resources from water pollution
  - ~90% of India's water demand comes from Agriculture, creating the opportunity for **optimizing agricultural water use** through a variety of interventions, including micro-irrigation adoption (led by govt. incentives under 'Per Drop more Crop' under PMKSY), and proliferation of water efficient, high-yield farming practices (for e.g., India uses ~20% more water than global average for rice production)
- **Reuse & Recycle**
  - Lack of proper infrastructure and awareness of wastewater recycling has resulted in over exploitation of India's water resources. There is a huge potential in reusing and recycling the treated wastewater at least for non-potable purposes. A recovery-based closed loop system could transform wastewater treatment by leveraging PPP models for municipal water re-use, and driving millions of dollars in operational water savings for industries.
- **Distribution Efficiency**
  - Progressive water metering and tariff systems can be aligned with the Smart Cities programme which will ensure economic viability for utilities and fair pricing for consumers. Measures to be taken which lead towards improving water use efficiency, reducing leakages, water theft etc.

1. 1,000 m3 is the official threshold for "Water Scarcity" as per the Falkenmark Index

India's Century Vision for Water Sector

XX – 2030 Aspiration

XX – 2047 Aspiration

>1700[1] m^3

From ~1400-1500 m^3 in 2021[2]

Per capita water availability

90-100%[3]

From 27% in 2021-2022[4]

Domestic wastewater treated

85 - 90%[5]

From <30% in 2021-2022[6]

Waste-Water recycled for municipal, industrial, agricultural purposes

100%

From ~49%[17] in 2022

Access to Drinking Water for All Households[18]

40-45%[9]

From ~8% in 2019 - 2020[10]

Rainwater Harvested (by 2030)

45 – 50%[11]

90 – 100%[12]

From ~19% in 2021[13]

Penetration rate of Micro-irrigation systems

80-90%[14]

From 45% in 2021[15]

Degree of Implementation of Integrated Water Resource Management[16]

5-10%[7]

Reducing from ~35 - 45%[8] in 2020

Non-revenue water %age

1. Benchmark - international standard for water stress; 2. Source: Ministry of Jal Shakti; 3. Benchmark – global best-in-class countries, basis UN SDG 6 Dashboard; 4. Source: UN SDG 6 Dashboard; 5. Benchmarked against Israel (global best-in-class, data source: Govt. of Israel Water Authority; 6. Source: Central Pollution Control Board; 7. Benchmarked against Singapore (global best-in-class, data source: Asian Water Development Outlook 2020; 8. Range obtained basis IWA Report - Quantifying the global non-revenue water problem (2019), ADB Estimates; 9. Benchmark taken basis US Geological Survey methodology elucidated in "Rainwater Harvesting Benchmarks to Address South Asia's Urban Water Crisis", (2020) Economic and Political Weekly, Vol. 55, Issue No. 7, pp. 14-16; 10. Source: PMO; 11. Benchmark taken basis Ministry of Agriculture & Farmer's Welfare's target of adding 10 MHA of micro-irrigation covered area by 2025 (total irrigated area of India is ~68 MHA basis Government of India data); 12. 2047 Benchmark taken basis global best-in-class (Israel);13. Source: Government of India (13.78 MHA of ~68 MHA covered in 2022; 14. UN SDG 6 Dashboard – global best-in-class; 15. Source: CWC submission for SDG Indicator 6.5.1; 16.Comprehensive framework of water resources management at all levels comprising of enabling environment, institutions & participation, management instruments & financing for water resource development and management; 17. Jal Jeevan Mission Press Release, May 2022; 18. Improved water source (e.g., piped connection) available on premises, when needed, and free from contamination

Key Unlocks for Water

Actors ■ **Companies** ■ **Industry bodies** ■ **Central Government** ■ **State Government**

- **Ensure Source Sustainability** for water, by

  a) Setting Industrial Net-Zero water targets & driving Zero-Liquid Discharge adoption, to mitigate water-intensity of operations to achieve savings, address water unavailability related challenges, and prevent future industrial water-conflicts and

  b) Optimizing agricultural water use, by shifting towards water-efficient germplasm (esp. for water intensive crops such as wheat, rice with largest planted area), shifting acreage towards water-efficient alternative crops (e.g., millets), and scaling up micro-irrigation practices

- **Drive Water Re-Use and Recycling** – **Establish market-making body under Jal Shakti Ministry to** aggregate demand across ULBs in India, act as credit intermediary, and create standardized bidding documents for water-related PPPs to significantly accelerate creation and operationalization of municipal and industrial water treatment projects

- **Achieve Distribution Efficiency, through State govt. regulations to help track economic value of agricultural, industrial & municipal water** through mandatory water-metering with variable tariffs, to enable targeted savings interventions & incentivize efficient use via tariff adjustment basis localized water stress, consumption trends, boosting ROI of water savings projects

Unlocks at Company and Industry Level (1 of 2)

Actors Companies | Industry bodies | Central Government | State Government

SOURCE SUSTAINABILITY

Water Budgeting	• **Water Budgeting Standards -** Companies located in a particular catchment/watershed basin from where they are drawing water could adopt common water stewardship standards (e.g., WWF - India Water Stewardship network, which drives adherence to the international Alliance for Water Stewardship (AWS) standards) to collectively quantify and map water use and water risk, to facilitate creation of water budgets for their catchment areas, to ensure sustainable extraction practices • **Water Accounting & Auditing Solutions** – Companies could set up and invest in a common body create high-integrity water-neutrality certification agencies (similar to carbon credit accounting companies), in partnership with international bodies such as CEO Water Mandate, UNEP, WWF etc., with skilling programs to train and certify surveyors to measure compliance • **Water-related ESG Goals –** Companies in water-intensive industries could take the lead in reporting water risk/water performance with stakeholders in annual reports, ESG reports and disclosures for increased water accountability
Corporate Targets	• **ZLD (Zero Liquid Discharge) adoption & water-neutrality initiatives** – Companies in water-intensive industries (e.g., pulp and paper, mining, chemicals, oil and gas, water service provision) to set corporate Net-Zero water targets to spearhead mitigation of operational water intensity and achieve savings by taking up advanced Zero-Liquid Discharge projects (e.g., 100% treatment in CETP plants) to eliminate water unavailability related operational challenges • Companies could share **knowledge on best practices** for water management and treatment and promote adoption of best practice in industry groups.
Water-Efficient Agriculture	• **Companies directly involved in the agricultural supply chain** (e.g., irrigation systems manufacturers, chemicals & fertilizer manufacturers, food and textiles providers) can drive industry-wide initiatives **to promote water-efficient agricultural practices:** — **Work with farmers to adopt best-available germplasm** (esp. for water intensive crops such as wheat, rice with largest planted area) while shifting acreage towards & marketing water-efficient alternatives to wheat/rice such as millets to customers — **Scaling up investments in micro-irrigation** (drip, sprinkler irrigation), supported by adoption of water-efficient agricultural practices such as no-till farming to reduce water-intensity of agricultural and achieve operational savings — **Setting up vertical Farming** systems, using low power consumption technology, which would be able to produce 10x more yield (per unit land) and with 95% less water usage (by capturing and circulating run-off water)[1].

Unlocks at Company and Industry Level (2 of 2)

Actors Companies | Industry bodies | Central Government | State Government

Reuse & Recycle

Use of Treated Wastewater	• Companies can restrict themselves from withdrawing groundwater and extracting freshwater from the surface bodies for their non-potable uses. Instead, can install ETPs/STPs within their units to treat the wastewater and use it in a circular manner for their non-potable uses. The companies can even get treated wastewater from the nearby STPs. — Include usage of treated water (reducing potable water usage) as part of corporate ESG goals
Water Supply & Treatment Technologies	• Companies could collectively establish international Consortia for Water Technologies to develop or invest in domestic production capabilities for supply altering technologies such as desalination (thermal, RO, Wave-powered), atmospheric water generation etc., as well as for advanced water treatment technologies involving bio-enzymes, UV technology, microbial fuel cells, nanofiltration etc. • Private Sector and non-governmental organizations could establish incubators as well as innovation awards programs to provide mentorship, technology, funding and guidance to startups and small enterprises developing water conservation technologies, or could announce prizes for development of specific tech (e.g., lower cost RO membranes)

Distribution Efficiency

Distribution Infrastructure	• **Adopting cities, districts and villages:** Companies under their CSR mandate or any other provision can adopt a city/urban local body/rural area etc. where they can work on the overall management of water and establish models to be followed for water conservation across India (e.g., along similar lines as India Sanitation Coalition's lighthouse initiative). It will include water auditing of the entire water network or the city of town and fixing the infrastructure to save non-revenue water. This can also be done through PPP- based stewardship and regeneration projects for local lakes, aquifers and other water resources
Water Networks Monitoring Technologies	• Utilities companies could invest in **distribution network monitoring** for leakage detection using next-gen technologies (**e.g., satellite imaging, in-pipe robots, IoT based flow sensors**) to plug water losses due to leakage / runoff, powered by automated, advanced-analytics based water flow management systems

Unlocks at Policy Maker Level (1 of 3)

Actors ■ Companies ■ Industry bodies ■ Central Government ■ State Government

SOURCE SUSTAINABILITY

Water Efficient Agriculture	• Central and state governments could incentivize water use efficiency in agriculture sector (80% of India's water consumption) — Drive acreage shift away from water-intensive crops (e.g., rice, wheat) towards water-efficient alternative cereals (millets, sorghum, maize etc.) on demand as well as supply side through central-government driven international outreach programs and PLI schemes for alternative cereal based processed goods manufacturing, expanding ongoing push towards millets (e.g., 2023 declared as international year for millets by UN, PLIs for millet-based processed food products announced in 2022) — State governments could top up central government incentive schemes for micro-irrigation (drip, sprinkler) technologies investment by small and medium farmers through micro-credit schemes — ICAR could further training programs for PDMC (per drop more crop) initiatives through low-bandwidth, e-learning modules for small and medium farmers, to accelerate adoption of **improved irrigation technologies** – micro-irrigation, rain-fed & irrigation drainage and **yield-enhancing & sustainable farming practices** – no-till farming, fertilizer optimization, system of rice intensification, **better crop selection** to reduce water stress from agriculture etc. — Central government could announce grant programs for biotechnology R&D to develop climate resilient, **water-efficient crops**
Sustainability Standards	• Jal Shakti Ministry, collaborating with Bureau of Indian Standards, could create measurement standards for initiatives around source sustainability and regeneration, including methods to assess water-efficiency of consumer products and manufacturing processes – these could culminate in a "Star" system for water-efficiency of products to help translate water impact to consumers
Water Budgeting	• Jal Shakti Ministry and CWC to spearhead creation of **Open National Water Database –** Establish water-consumption tracking systems to map universe of water across watersheds and catchment areas, and usage across all users to ascertain national water supply and demand position, visible for all stakeholders to enable better data-driven water decisions • Centrally accelerate **implementation of IWRM** (Integrated Water Resources Management) by creating creating **Integrated National Water Body for Water Management** under ambit of **Central Water Commission** through capacity building initiatives, training programs

Unlocks at Policy Maker Level (2 of 3)

Actors ■ Companies ■ Industry bodies ■ Central Government ■ State Government

Reuse & Recycle

Water Technologies	• **Central government** to open bilateral channels with other countries leading in water conservation technology (e.g. Australia, Israel) to bring in tried and tested technologies to India that can be replicated — **Promote R&D** by providing seed funds, incentives, academic partnerships for talent creation interventions etc. to commercialize and scale new water supply & treatment technology
Municipal treatment, re-use via PPPs	• **Central government could establish a market-making body**[1] to promote Public-Private-Partnerships and private-sector participation in municipal water supply, distribution, and re-use projects, under the ambit of Jal Shakti Ministry. Proliferation of such projects[2] could yield billions of dollars in water procurement cost savings as well as public health & environmental costs caused by pollution of water bodies. The key role of this body will be to: — **Aggregate demand** across Urban Local Bodies, state governments etc. and facilitate deals between private infrastructure developers and public sector buyers, while reducing financial risk by acting as a credit intermediary — **Standardize bidding documents and MCAs** for water projects across states and jurisdictions to include key provisions for enhancing PPP success and financial feasibility, such as » **Creation of well-defined vendor prequalification criteria,** with clear risk-sharing clauses (e.g., changes in power tariff, arbitration etc.) for water projects » **Service-delivery standards linked to operational revenue,** mutually agreed tariffs for end-users to improve financial viability, scope re-negotiation clauses in the event of poor data on brownfield projects, etc. » **Incentives for comprehensive technical proposal preparation** (e.g., incentives for meeting service delivery standards within initial public outlay) supported by clauses to mitigate issues caused by poor quality in brownfield water infrastructure projects (e.g., contingency fund, renegotiation clauses) » **Robust performance management (e.g.,** through contractual linkage of service delivery standards like water supply, availability, quality with operator revenue, collected from end-users through mutual agreements with municipality • State governments **can mandate construction of STPs and CETPs for industrial MSME clusters** so that MSMEs can use treated wastewater water for non-potable uses without effecting their overall financial budgets, and avoid drawing freshwater.

1. E.g., SECI (Solar Energy Corporation of India) which facilitated growth in solar & renewables projects across India
2. E.g., Orange City Works handling water supply in Nagpur City

Unlocks at Policy Maker Level (3 of 3)

Actors ■ **Companies** ■ **Industry bodies** ■ **Central Government** ■ **State Government**

DISTRIBUTION EFFICIENCY

Non-Revenue Water Reduction

- **Water Regulation:** State governments **could institute regulation for mandatory water-metering** with variable tariffs and thus track economic value of industrial & municipal water to enable targeted savings interventions & incentivize efficient use and boost ROI of water savings projects by:
  - **Instituting water variable tariffs** determined based on localized water stress, rate of water depletion
  - Performance / impact driven pay-outs for installation of modern supply technologies (smart water meters, SCADA implementation) and digital solutions (data analytics, AI for monitoring, maintenance etc.) – possibly under PPP framework[1]

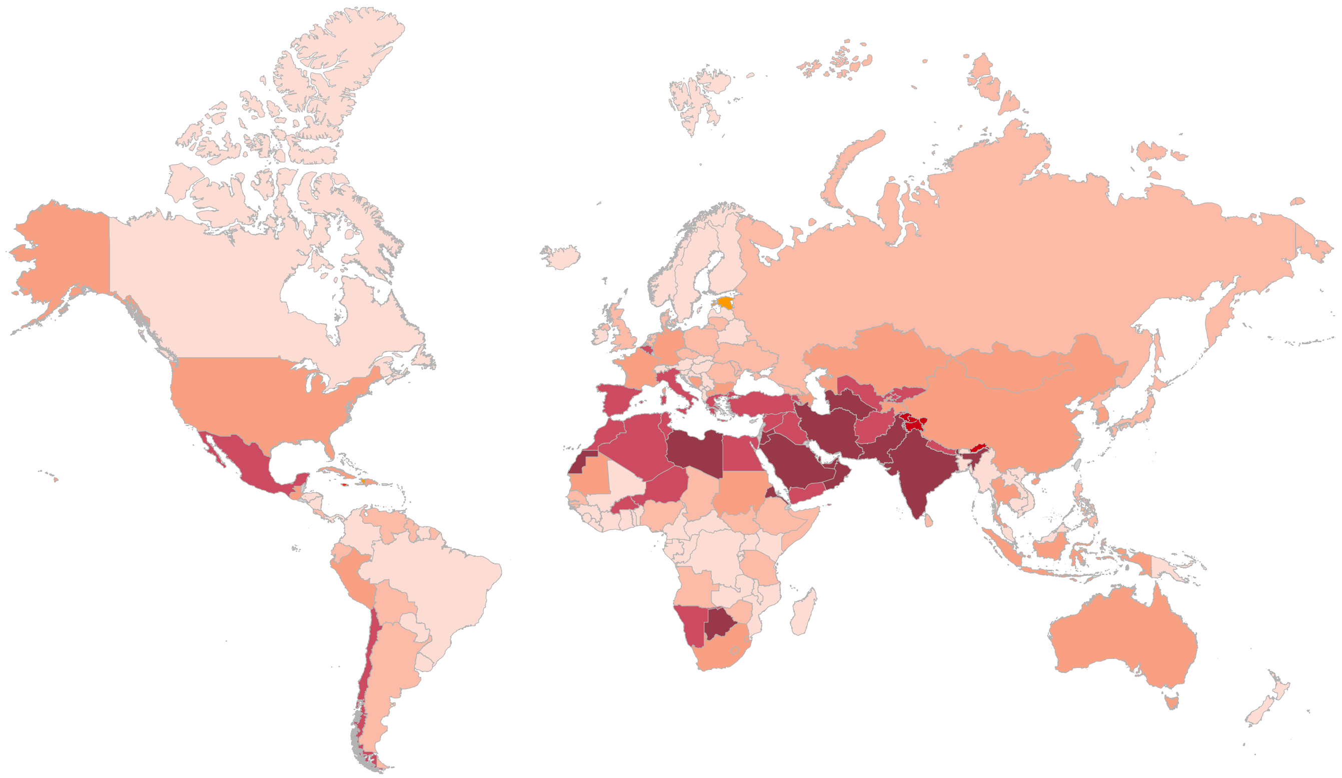
1. Case in point - Orange City Works handling water supply in Nagpur City

Backup

The impact of water stress is being felt globally – India is under extreme stress[1]

Ratio of total water withdrawals to total renewable water supply

Low stress (< 10%) | Low to medium stress (10-20%) | Medium to high stress (20-40%) | High stress (40-80%) | Extremely high stress (> 80%)



India is one of the 17 countries in the world that uses more than 80 percent of its available freshwater supply every year — a rate of use that places its overall water stress as "extremely high". Also, it is the only country among the 17 that is **not in an arid or semi-arid region**

1. Forecast for 2030

Sources: WRI 2019, McKinsey Climate Report, WRI Aqueduct

5B+

People who lack sufficient water at least one a month per year by 2050

$700B+

Additional urban property damage due to flooding by 2030

>70%

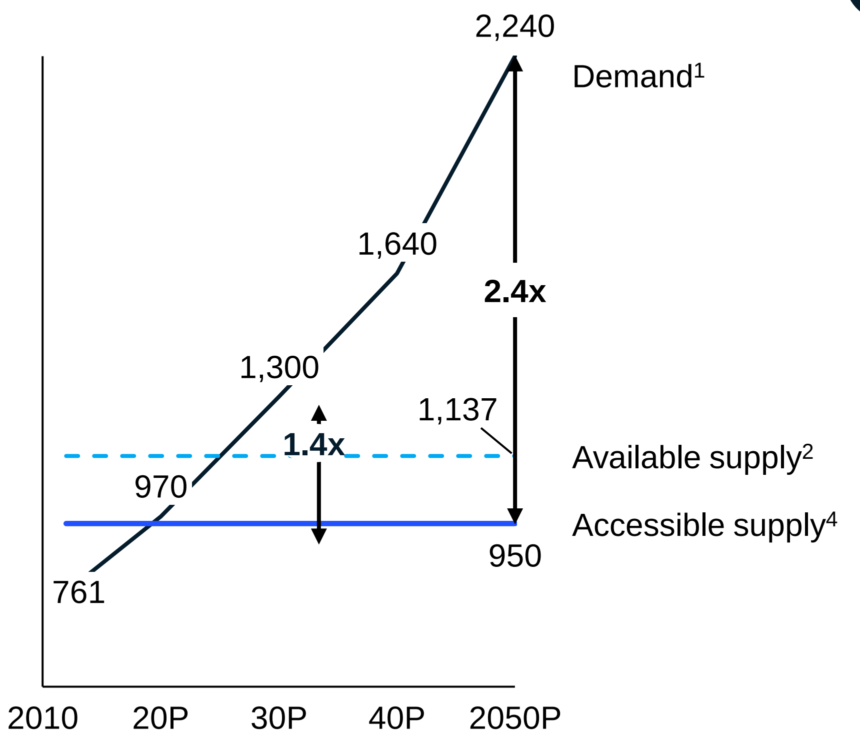
Decrease in mean annual surface water by 2050 in certain regions

Water demand[1] could eclipse supply[4] within this decade, without sustained and widespread interventions for conservation

India's Century of SIG – Poor availability of water will cause sectoral conflicts, food scarcity

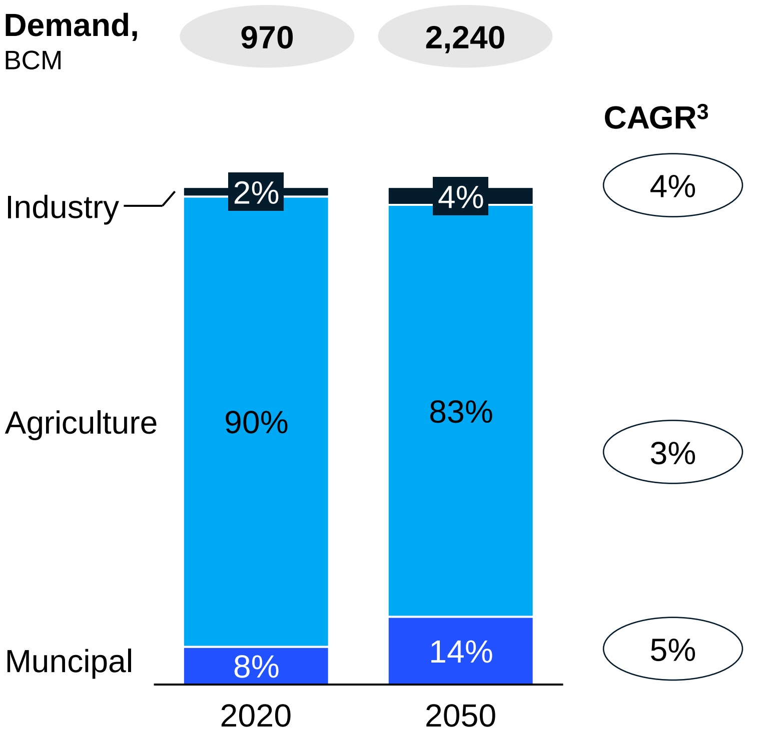
Water Supply and Demand[1]

BCM



Estimated[1] water demand by sector,

BCM



- In case of constant supply/further deterioration, India's demand will surpass supply by **~2.4x** in 2050
- Growing industrial water demand could lead to sectoral water conflicts
- If there is no improvement in supply availability or efficiency in water use, it will likely result in drop in economic and agriculture activity and/or large decline in living conditions

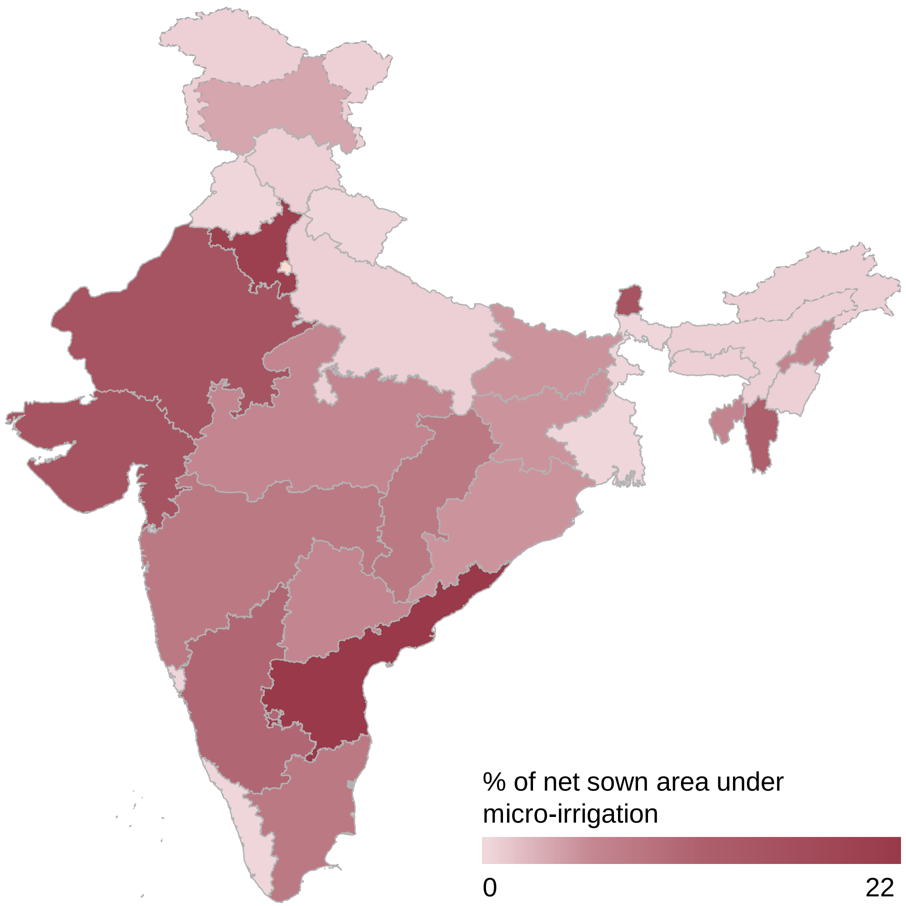
1. Demand – Historic demand extrapolated using industry forecast and GDP per capita increase
2. CWC - estimated that owing to topographic, hydrological and other constraints, the utilizable water with conventional approach is 1137 BCM which comprises of 690 BCM of surface water and 447 BCM of replenishable ground water resources
3. From 2012-2050
4. Accessible supply- available supply that can be extracted, adjustments made basis reliability, infrastructural constraints and environmental loss

Source: McKinsey team analysis, Aqua Stat database, CWC, http://cwc.gov.in/water-resource-estimation

Precision farming uses technology to utilize inputs in precise amounts at the right time

- Precision farming (PF) uses **technology** to cater to the needs of **individual plots and crops**
- Instead of applying similar inputs across the entire field, the approach **distributes** them on a **site-specific basis**
- PF is a **combination** of various **technologies** rather than a one-off approach
- The system is **yet to become an integral part** of mainstream farming systems

% of net sown area under Micro-irrigation



30-200%

Potential increase in yield vs. conventional systems

10-20 kg/ha

Reduction in usage of Nitrogen fertilizer

30-70%

Water savings in orchard vegetables through micro-irrigation techniques

25-30%

Reduction in GHG emissions

30-100%

Rise in cultivation costs (As per TNPFP study)

Source: CEEW 2021

Modern irrigation systems are expected to save up to 50-75% of water compared to traditional flood irrigation

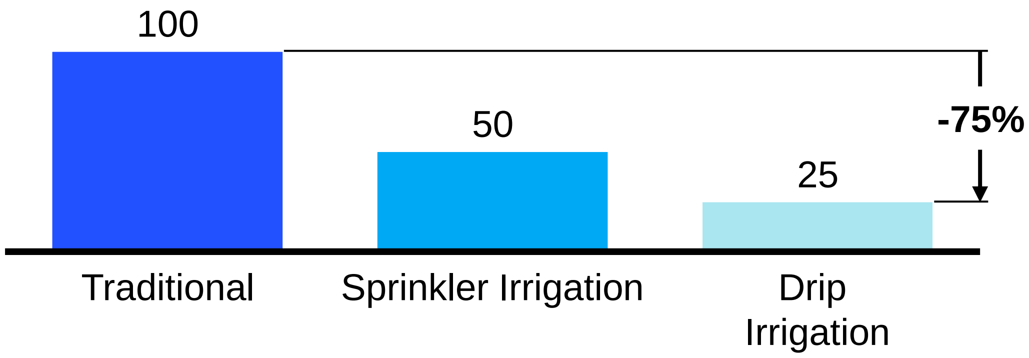
Sprinkler irrigation

A planned irrigation system in which water is applied by means of perforated pipes or nozzles operated under pressure to form a spray pattern.

Drip Irrigation

A planned irrigation system in which water is applied directly to the Root Zone of plants by means of applicators operated under low pressure with the applicators being placed either on or below the surface of the ground.

Water usage comparison[1] %



Average cost	500-1000 $/ha Replacement: ~40 years	1200-1800 $/ha Replacement: 20 to 30 years	3000-3500 $/ha Replacement: 7-20 years

GoI's '**Per Drop More Crop**' component under the PMKSY promotes use of drip and sprinkler irrigation by farmers, and is a great initiative to **drive adoption of micro-irrigation technologies** in agriculture across the country. Annual allotment of **Rs. 4000 crore has already been allocated** and to the State Governments and Micro Irrigation Fund corpus of **Rs. 5000 crore has been created with NABARD**

1. Maximum achievable water savings

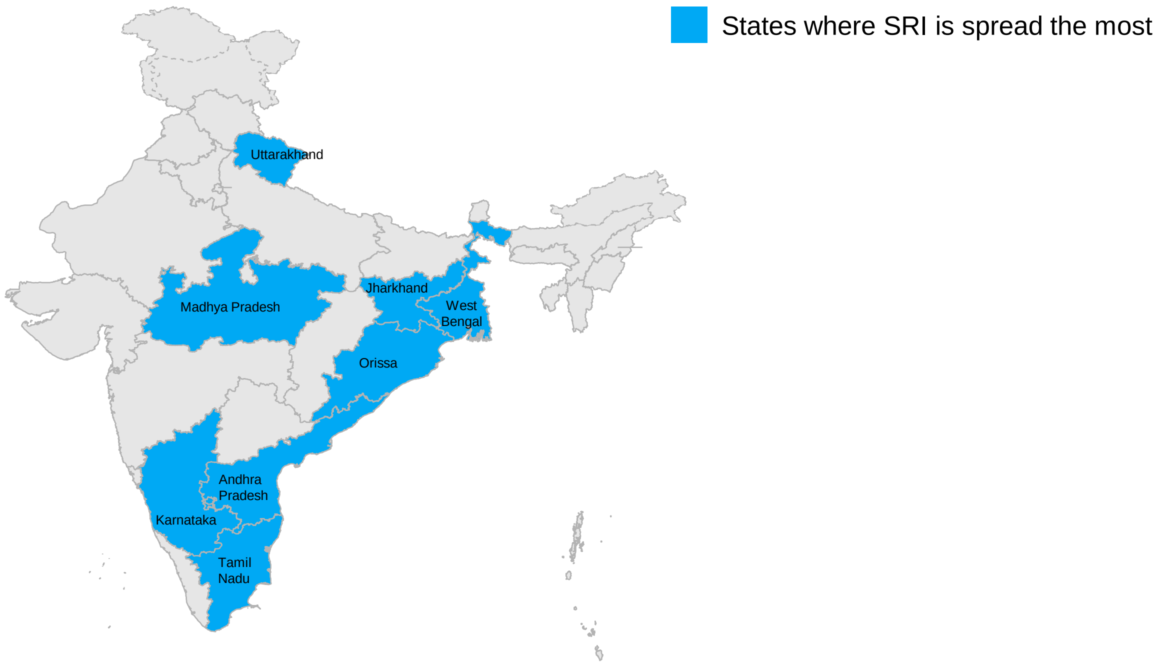
Source: McKinsey analysis and PIB,2020

SRI -70% of India's agricultural water demand is for rice cultivation

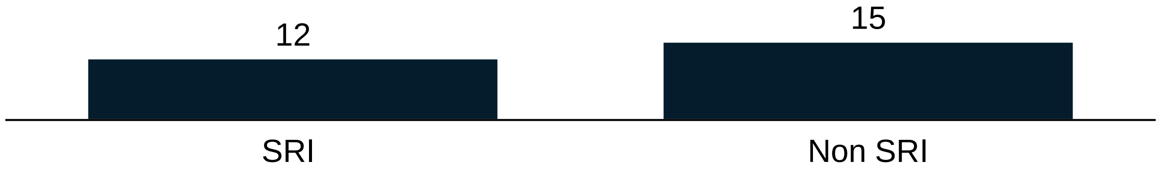
The system of rice intensification, or SRI, is a climate-smart agroecological approach for increasing rice and other crops' productivity by changing the management of the plant, soil, water, and nutrients. SRI is based on four main principles that interact with each other:

- Early, quick, and healthy plant establishment
- Reduced plant density
- Improved soil conditions through enhancing soil organic matter
- Reduced and controlled water application

50-95% of the districts in highlighted states practice SRI



Water requirement per hectare; Million Liters



20-50%

Average increase in yield[1]

In Andhra Pradesh, SRI reduced total GHG emission by **>25%** per hectare

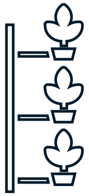
SRI grains are less prone to breakage during milling, improving the net edible output by **~10%**

Being a knowledge intensive practice, availability of skilled labor is a constraint to adoption.

1. Variation in yield depends on rice variety, climatic conditions, crop's biological dynamics, how well SRI was implemented etc.

Source: CEEW 2021

Vertical farming - Hydraulic driven vertical farming is a low power consumption technology which produces 10x more yield with 95% less water



Vertical Framing

- Hydraulic driven vertical farm systems consists of rotating tiers of growing troughs (hydroponic or soil) mounted on an aluminum frame
- Rotation ensures plants receive uniform sunlight, irrigation and nutrients as they pass through different points in the structure
- Powered by a hydraulic system which uses the momentum of flowing water and gravity to rotate the troughs, utilizing only 40W electricity (~1 light bulb) to power a 9m tall tower
- Irrigation system is closed-loop, recirculating water that would have been wasted as run-off

10x	95%	75%
More yield / unit land[1]	Less water used[1]	Less fertilizer used[1]

World's first low carbon, hydraulic driven vertical farm has been implemented by Skygreen in Singapore to produce spinach, cabbage, lettuce, and other vegetables

1. Compared to open field farms

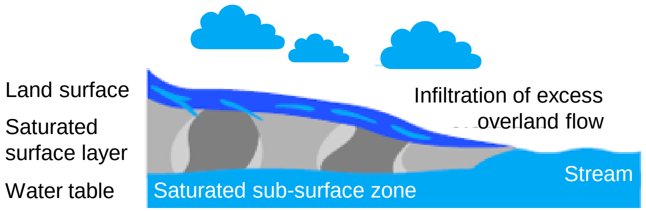
Source: Press Search; Plant factories versus greenhouses: Comparison of resource use efficiency. Agricultural Systems 2018, 160, 31–43

Rain-water harvesting is a savior for a country like India, which receives an appreciable amount of rainfall

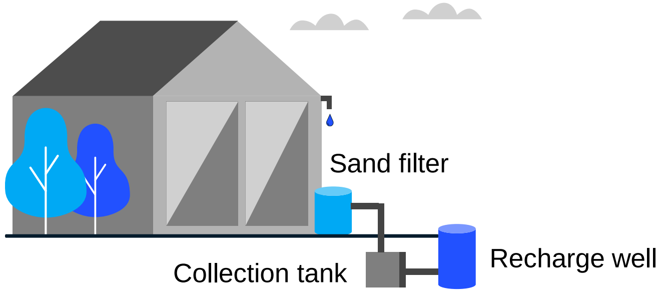
Rainwater harvesting (RWH) is a process of collecting, conveying and storing rainfall in an area for beneficial purposes

Key methods for RWH

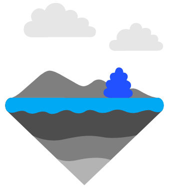
Surface run-off rainwater harvesting



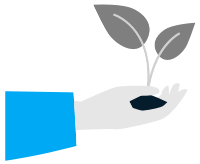
Rooftop rainwater harvesting



For an average rainfall on **1000mm,** approximately **4 million liters** of rainwater can be collected in a year from an acre of land[1]



>20 million ha
to estimated area under RWH activities in India



< 5 million
farmers practice RWH activities in India

Medium and large landholders tend to practice RWH activities more

- In some states, RWH structures have **improved both on-farm income due to increased crop yields and off-farm income due to diversified activities** such as fishing and cattle herding
- Under the MNREGS[2], **-290,000 water conservation, and water harvesting works/ structures are completed,** as of February 2020
- In various parts of the country (Karnataka, Odisha, Tamil Nadu), **rainwater structures and recharged aquifers have improved the groundwater levels.**
- Improvement in quality of life by **reduced working hours** and **empowering women** through participatory process in areas where RWH programs were implemented
- **Less adoption among small-holding farmers** due to concerns about the loss of land to RVVH structures. **More evidence on economic viability** will help encourage smaller farmers

1. CPCB Envis 2016 - Rain water harvesting in India
2. Mahatma Gandhi National Rural Employment Guarantee Scheme

Source: CEEW

Case study – Increased groundwater levels in Chennai via government-led efforts in implementation of Rain Water Harvesting

Context

Chennai has **largely depended** on **groundwater source** for its water needs

Rapid urbanization has **deprived** the city of open surfaces for **natural ground water recharge** while also leading to decline in ground water levels due to **overexploitation**

Approach

In 2002, the State government **enacted a law** making **Rain Water Harvesting** mandatory in all buildings in the state of Tamil Nadu, becoming the **first Indian state** to do so

Awareness raising activities were carried out for 1-2 years in the entire state

- Setting up of **rain centers**
- Preparation of **resource material** such as brochures, posters and video films
- **Workshops** for plumbers, masons as well as residents

Impact

The government achieved **100% coverage** in **roof top** Rain Water Harvesting

In the following 3 years, **groundwater** levels in Chennai rose by **6-8 meters** in most areas as a result of **good monsoon** and enactment of the law

Source: Chennai Metro Water, Central Ground Water Board, IEEE, Press search