Balancing Food Energy Water (FEW) Nexus - Policy prescriptions for Sustainable Management

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Yugal Joshi
Programme Director
Water & Land Resources, IT&Telecom
Culture & Tourism
NITI Aayog
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Understanding the FEW Nexus

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Nexus: A complicated series of connections between different things.
Oxford Dictionary

Food Security

Requires water for irrigation, energy for production/ processing/ transportation.

Water Security

Requires energy for pumping/ treatment/ supply, directly supports food production and supply.

Energy Security

Requires water for cooling/ hydropower, powers food/water systems.

Systematic balanced management of these resources is crucial for nations.

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Water-food-energy nexus

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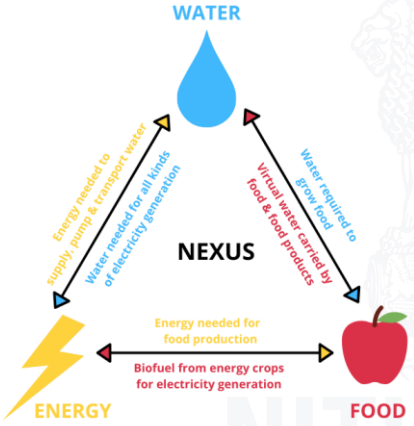

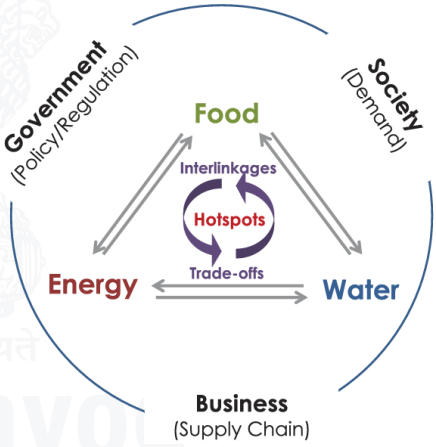

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India's Food Landscape: Growing Demand, Resource Strain

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Top Producer

India is the second largest producer of rice, wheat, sugarcane globally.

Water Intensive

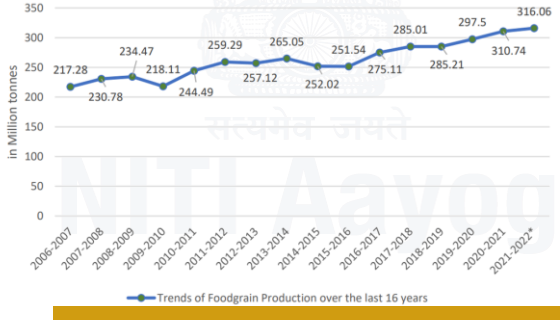
Agriculture consumes about 80% of India's total freshwater.

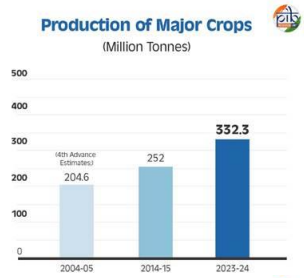
Record Production

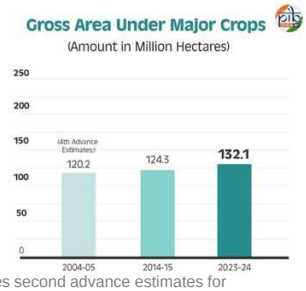
Food grain production reached a record 332.3 million tonnes in 2023-24.

Significant Waste

Estimated 40% of food production is lost or wasted, exacerbating demand. (Muth et al., 2019)







*Includes second advance estimates for 2021-22 as on 16.02.2022

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Water resources availability

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Total Precipitation (rainfall + snowfall)
3880 BCM

↓

Total water availability
1999.2 BCM

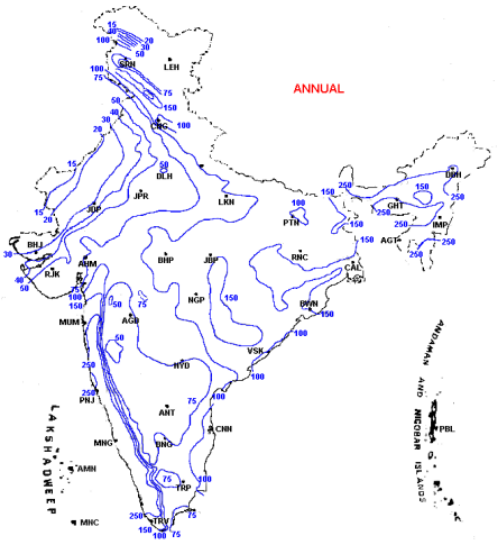
↓

Total utilizable water resources
1139 BCM

↓

Surface water
690 BCM

Groundwater
449 BCM



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Basin-wise average flow and utilizable water (km³/year)

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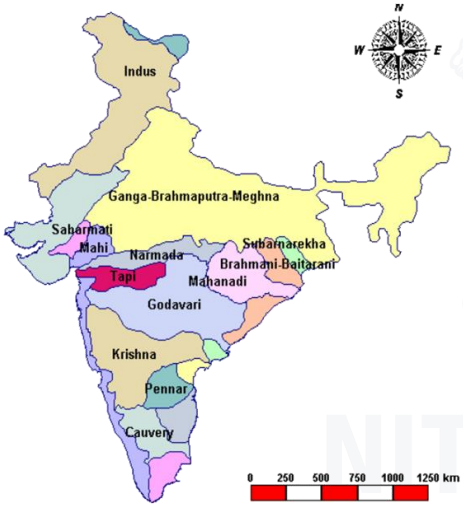

Sl. No.	River Basin	Average Annual Flow	Utilizable Flow
1	Indus	73.31	46
2	Ganga-Brahmaputra-Meghna Basin	1202.43	274
3	Subarnarekha	12.37	6.81
4	Brahmani-Baitarani	28.48	18.3
5	Mahanadi	66.88	49.99
6	Godavari	110.54	76.3
7	Krishna	69.81	58
8	Pennar	6.32	6.86
9	Cauvery	21.36	19
10	Tapi	14.88	14.5
11	Narmada	45.64	34.5
12	Mahi	11.02	3.1
13	Sabarmati	3.81	1.93
14	West flowing rivers of Kachchh and Saurashtra including Luni	15.1	14.98
15	West flowing rivers south of Tapi	200.94	36.21
16	East flowing rivers between Mahanadi and Pennar	22.52	13.11
19	East flowing rivers between Pennar and Cauvery & south of Cauvery	16.46	16.46
21	Rivers draining into Bangladesh	8.57	NA
22	Rivers draining into Myanmar	22.43	NA
	Total (Rounded)	1953	690

(NCIWRD, 1999)

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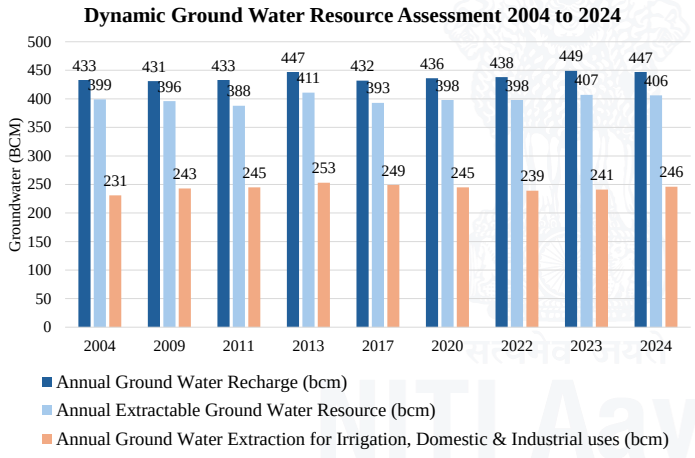
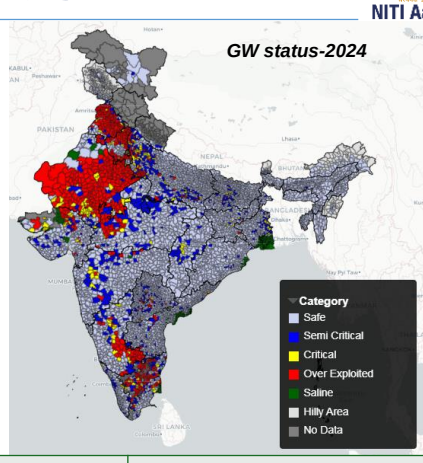
Groundwater resource status





Category	Units (Blocks/ Mandals/ Talukas)
Safe	4951 (73.39 %)
Semi Critical	711 (10.54%)
Critical	206 (3.05%)
Over Exploited	751 (11.13%)

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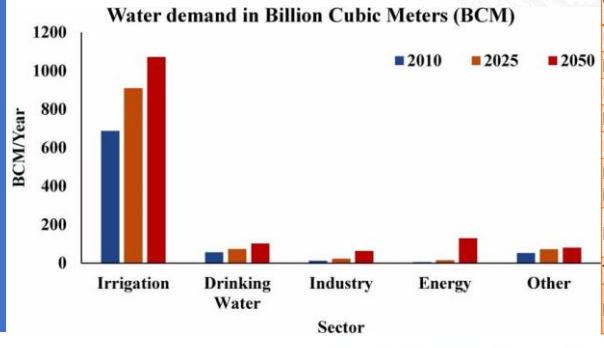
Annual water requirement (km³) for different uses



Uses	Year 1997-98	Year 2025			Year 2050		
		Low	High	%	Low	High	%
Irrigation	524	561	611	72%	628	807	68%
Domestic	30	55	62	7%	90	111	9%
Industries	30	67	67	8%	81	81	7%
Power	9	31	33	4%	63	70	6%
Inland Navigation	0	10	10	1%	15	15	1%
Environment–Ecology	0	10	10	1%	20	20	2%
Evaporation Losses	36	50	50	6%	76	76	7%
Total	629	784	843	100%	973	1180	100%
Population (million)	1286	1333			1346	1581	

(NCIWRD, 1999)

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Water

Current and future scenario

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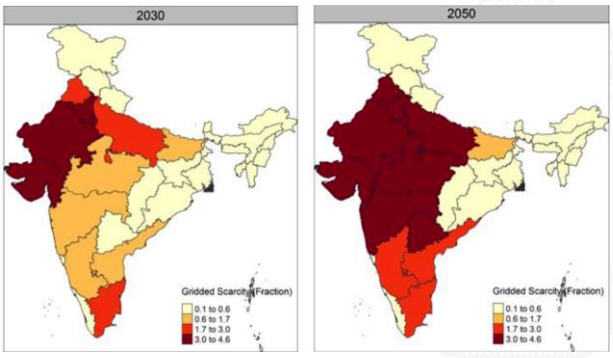
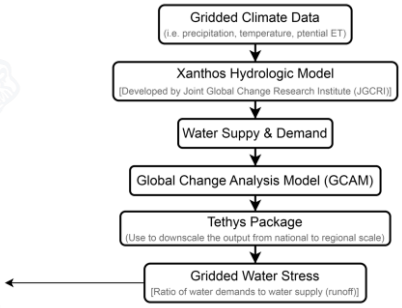
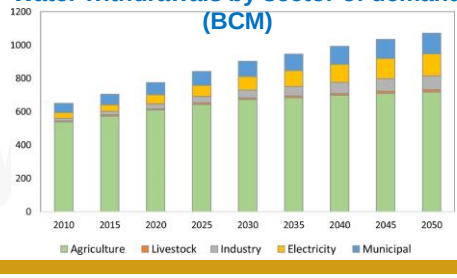
Water-stressed regions in India





Water withdrawals by sector of demand (BCM)



- ✓ Agriculture, cities, and industry account for the largest changes in water withdrawals through 2050.
- ✓ Agriculture, as the far largest sector of water demand, will be specifically susceptive to climate change effects.

[9] *(Kholod et al., 2021) (CEEW)*

Impact of water intensive crop production on groundwater

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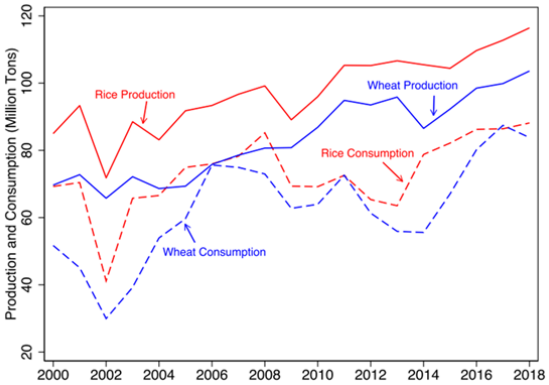
Excess Production of Rice and Wheat



Groundwater stress and growth in rice area

Data Sources: Agriculture Statistics at a Glance 2020

[10] https://doi.org/10.1038/s41467-024-52858-6

Case Study: Punjab

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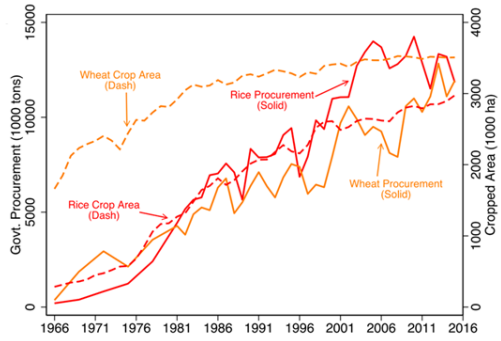
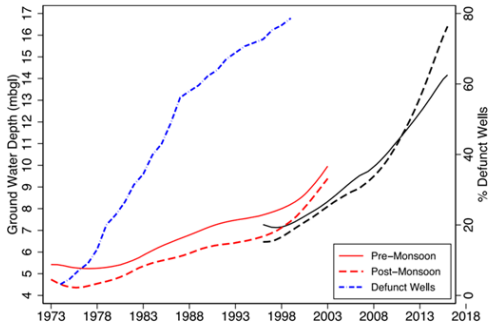
Govt procurement of rice or wheat and cropped area



Trends in groundwater depth and the fraction of defunct wells



11 https://doi.org/10.1038/s41467-024-52858-6

Case Study: Madhya Pradesh

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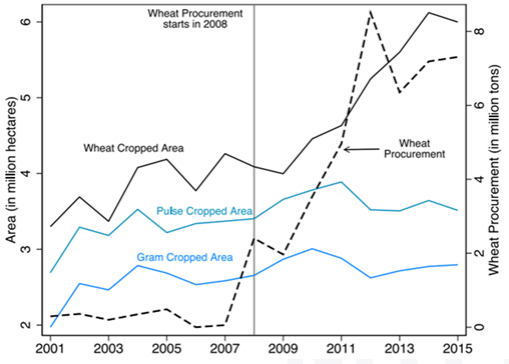
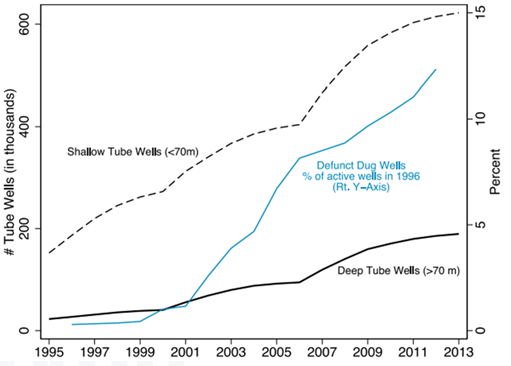
Trends in wheat, pulse, and gram cropped area and in quantity of wheat procured by state agencies



Trends in number of shallow and deep tube wells and defunct wells.



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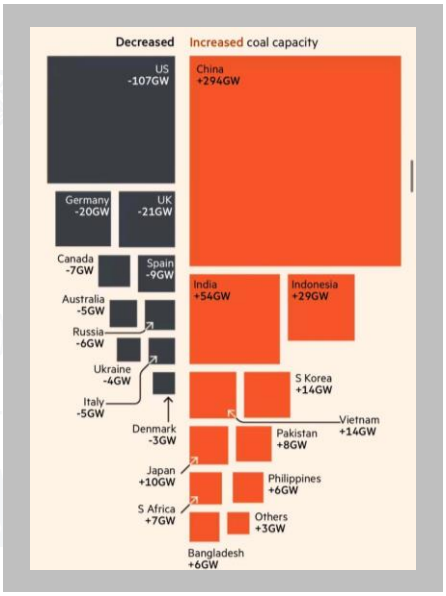
Change in coal-fire power capacity by country, GW, 2015-2024



Source: Global Energy Monitor •10 countries with most added and most retired capacity from 2015-24 shown

Energy
Sectorial consumption

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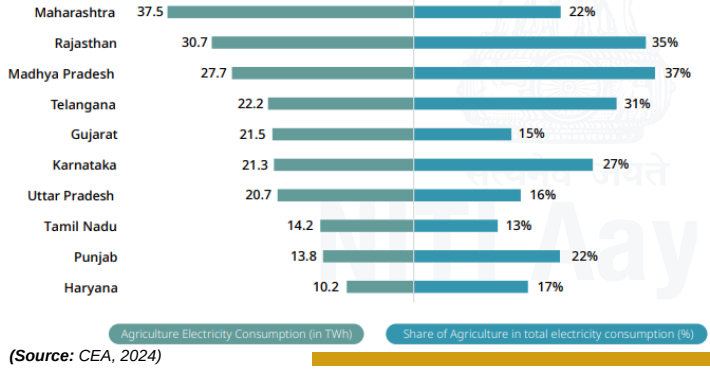
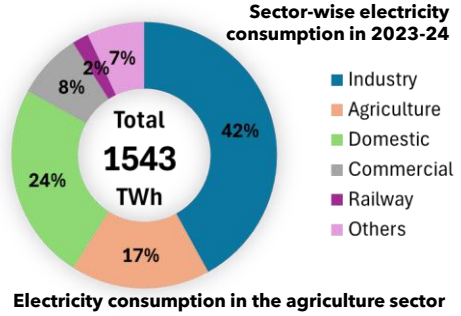
Data on energy for different assessment years

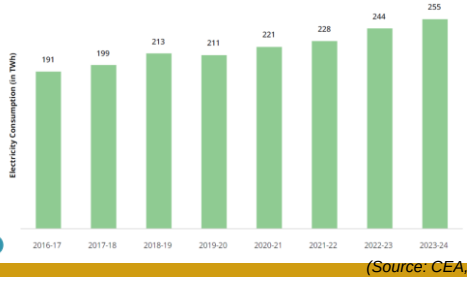
Top 10 states with highest agriculture electricity consumption in 2022-23



Sector-wise electricity consumption in 2023-24



Electricity consumption in the agriculture sector



***(Source:** CEA, 2024)*

(Source: CEA, 2024)

Energy
pumping of water for irrigation

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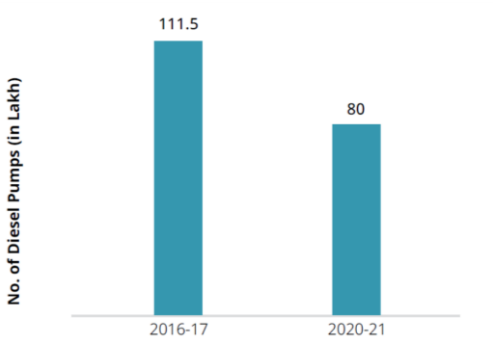
Number of Pump Sets Energised and Solar Pumps (in lakhs)

Year	Pump Sets Energised (in Lakhs)	Solar Pumps (in Lakhs)
2016-17	207.8	1.2
2017-18	215.1	1.71
2018-19	218	2.37
2019-20	220.4	2.56
2020-21	220.9	2.87
2021-22	266.7	3.5
2022-23	271.6	5.27



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Source: *(CEA, 2024) and (MoSPI, 2024)*

Energy subsidies to the farmers

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State	Scheme name	Subsidy Pattern
Gujarat	Jyotigram Yojana	Ensure that a 24-hour, three-phase quality power supply to the rural areas.
Rajasthan	Mukhyamantri Kisan Mitra Urja Yojana	Rs 1000 per month and maximum of 12000 per year on electricity bill to metered agricultural consumers.
Punjab	Free Power to Farmers	Provides 100% free electricity to farmers for tubewells.
Haryana	Electricity Subsidy for Agriculture	₹2/unit subsidy for agricultural consumers.
Andhra Pradesh	Free Power Scheme	9 hours/day of free grid electricity to farmers.
Chhattisgarh	Krishak Jeevan Jyoti Yojana	Provides free electricity to farmers for agriculture pumps of 6000 units per year

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State providing support to solar based pumping

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Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM-KUSUM) Scheme: Under this scheme, central government provide subsidy upto 30% or 50% of the total cost is given for the installation of standalone solar pumps.

Sate	Scheme name	Subsidy Pattern
Gujarat	Suryashakti Kisan Yojana (SKY)	30% subsidy on capital cost
Maharashtra	Mukhyamantri Saur Krushi Pump Yojana	95% of cost subsidized for small/marginal farmers
Haryana	Solar Tubewell Scheme	Subsidy up to 75%
Chhattisgarh	Saur Sujala Yojana	Provide solar-powered irrigation pumps of 3HP and 5HP capacity to a cost vary from 7000 to 20000 depending on the category of farmer.
Maharashtra	Mukhyamantri Saur Krishi Pump Yojana (MSKPY)	Provides 3–5 HP solar pumps to farmers with up to 95% subsidy.
Odisha	SAURA Scheme	Offers 1–3 HP standalone solar pumps with up to 90% subsidy for agriculture in remote/tribal regions.
Jharkhand	Saur Jal Scheme (SJY)	Provides off-grid solar pumps along with water storage for irrigation in remote areas.
Bihar	Saur Kranti Sanchay Yojana	State-led scheme offering standalone solar irrigation systems with 70–80% subsidy
Uttarakhand	Solar Pump Distribution	Solar pumps provided for hill & remote agricultural areas.
West Bengal	Jal Dharo Jal Bharo	Supports solar micro-irrigation systems for small/marginal farmers in rainfed zones.
Tripura	Tripura Solar Irrigation Project	State-funded rollout of 1–2 HP standalone solar pumps in remote tribal blocks.
Assam	State Solar Pump Program	Provides 1–5 HP pumps to individual farmers in flood-prone areas.
Himachal	Solar Pumping Scheme for Hills	Special state subsidy (up to 90%) for off-grid solar pumps in hilly terrain.

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State level intervention to reduce groundwater pumping for irrigation

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Crop diversification

Haryana

"Mera Pani Meri Virasat" offers farmers ₹7,000 per acre to reduce paddy cultivation and promote alternative crops like maize, cotton, oilseeds, pulses, onions, fodder, and vegetables.

Punjab

Under the National Adaptation Fund for Climate Change (NAFCC) project, farmers are offered a cash incentive of ₹23,500 per hectare for shifting from paddy to maize or cotton cultivation.

Uttar Pradesh

UP is actively promoting the Crop Diversification Programme (CDP) in Western UP, encouraging farmers to replace paddy with crops like maize, pulses, and oilseeds.

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Adoption of micro irrigation

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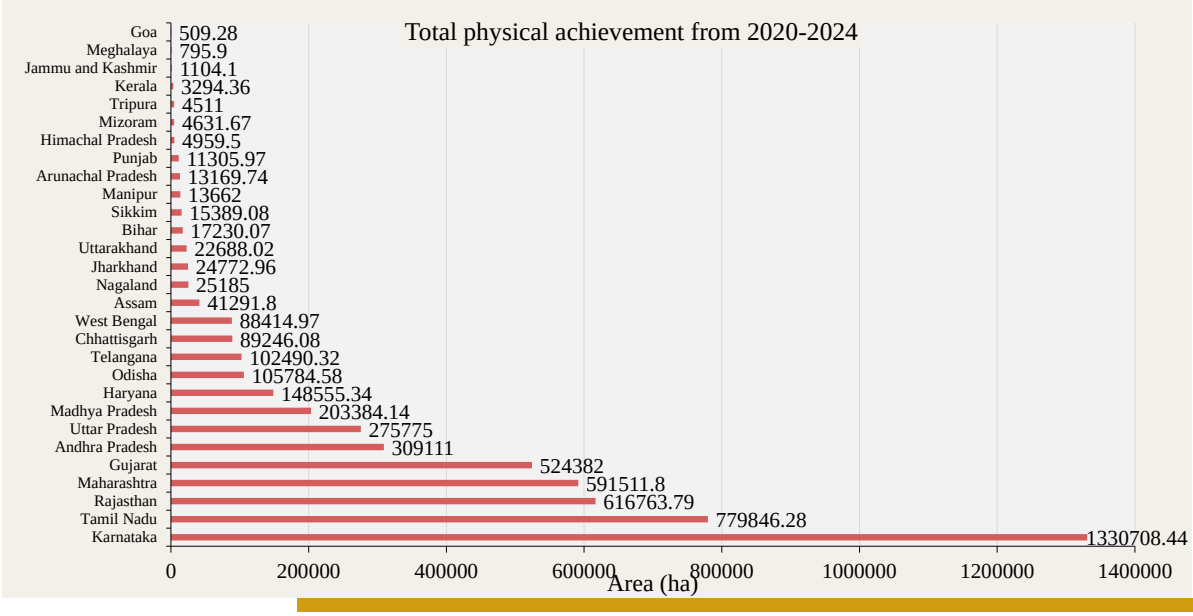

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Policy Prescriptions

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Hari Ram uses a solar-powered pump to supply water to his farm in Solawata, Jaipur Rajasthan Photo Courtesy: Yale University.

A satellite image of solar panels on farmland in Yemen. GOOGLE EARTH

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Policy Prescriptions

- ✓ Changing food habits – Sri Ann (millets mission)
- ✓ Crop Diversification – amplify sporadic best examples across the country
- ✓ Reduced food wastage/ create more storage.
- ✓ Higher MSP for less water intensive crops.
- ✓ Shifting to surface water – canal/ tank/ farm pond/ tanka etc.
- ✓ Prioritise funding irrigation water use efficiency improvement works vis-à-vis projects completion.
- ✓ Role out the new pilot Modernization of Command Area Development Works with farming community participation.
- ✓ Link solar pump subsidy for irrigation to compulsory installing sensor to assess water drawn.
- ✓ Adoption of water saving guidelines of PM KUSUM scheme to be monitored and link it to subsidy release.

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- ✓ Avoid solar pump installation as an augmentation for existing grid connected pump.
- ✓ Establish cross-sectoral governance - Guidelines of programmes having externality to be confirmed/ examine by the stake-holding Ministries. Examples -
  - ❖ M/o of Agriculture guidelines for micro irrigation (PMKSY) to prioritise funding of those adopting irrigation solar pumps under PM KUSUM.
  - ❖ Department of Drinking Water and Sanitation can examine guidelines for subsidy to irrigation solar pumps under PM KUSUM for their impact on rural drinking water sources.
- ✓ Use power of start-ups for monitoring cross-sectoral governance.
- ✓ State to eliminate the uncertainty of subsidized grid-power availability for agriculture.
- ✓ Excess solar energy to be put in the grid instead of drawing ground water– Gujarat example .
- ✓ Prepare local water budgets with community support for prioritizing water use.
- ✓ Revive 24 lakh water bodies for increasing storage and recharge – increases groundwater level & reduces energy consumption.

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Thank you!