IMPACT OF TWO SCHEMES ON WATER, ENERGY AND FOOD NEXUS: EXAMPLES FROM INDIA

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How the Prime Minister’s Irrigation Scheme (PMKSY), and the Prime Minister’s Scheme for Energy Security & Upliftment of Farmers (PM-KUSUM) helped India to increase its agriculture production, and to reduce electricity consumption.
Indian Scenario: Irrigation-Electricity-Agri Produce

**Gross Sown Area:** 198 mha

**Net Sown Area:** 140 mha

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**Production of major crops**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Production (million tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>118.87</td>
</tr>
<tr>
<td>Wheat</td>
<td>107.86</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>361.04</td>
</tr>
<tr>
<td>Fruits</td>
<td>99.07</td>
</tr>
<tr>
<td>Vegetables</td>
<td>191.77</td>
</tr>
<tr>
<td>Pulses</td>
<td>23.03</td>
</tr>
</tbody>
</table>

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**Sector wise electricity consumption (%)**

- Industry: 25%
- Agriculture: 18%
- Domestic: 8%
- Commercial: 2%
- Traction & Railways: 6%
- Others: 41%

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**Contribution of various sources in irrigation in India**

**Source-wise irrigation (%) among different size classes**

- Marginal (< 1 ha)
  - Canals: 28.4%
  - Tanks: 13.6%
  - Wells: 5.4%
  - Tubewells: 1.7%

- Small (1 to 2 ha)
  - Canals: 46.4%
  - Tanks: 25%
  - Wells: 13.9%
  - Tubewells: 1.9%

- Semi-medium (2 Medium (4 to 10 ha)
  - Canals: 43.7%
  - Tanks: 24.6%
  - Wells: 21.5%
  - Tubewells: 2.1%

- Large (> 10 ha)
  - Canals: 47.7%
  - Tanks: 45.2%
  - Wells: 26%
  - Tubewells: 1.7%

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In each land class, 6% to 7% of irrigation is met from other sources.

**Source:** Agriculture Statistics – 2021; Ministry of Agriculture and Farmers Welfare; Government of India

The contribution of groundwater based sources (Tube-wells and wells) is from 59.8% to 65.7%, across various land sizes.

**Source:** Handbook of Statistics on Indian States 2020-21, Reserve Bank of India, Government of India.
Reliance on groundwater in India

- Groundwater extraction: 245 billion cum.
  - 61.6% of annual groundwater recharge

- In 16% of the geographical area, extraction is more than the annual recharge.

- Wells & tube wells based area increased tremendously
  - From 29% in 1950-51 to 63% as of now.

- Subsidized tariffs and incentives promoted deep tube well

Single Resource: Multiple Agencies

- Irrigation
  - Water Resources Department
  - Watershed management
    - Land Resources Department
  - On-farm water management
    - Agriculture Department

- Lack of coordination
- Less efficient utilization of monetary resources
- Duplication of interventions
- Scattered focus in planning
PMKSY: Prime Minister’s Irrigation Scheme
(Pradhan Mantri Krishi Sinchayee Yojana)

An umbrella scheme amalgamating all relevant components, launched in 2015

- Accelerated Irrigation Benefit Programme
- Irrigation Water to All Farm Fields
- Per Drop More Crop (Micro Irrigation)
- Watershed Development
- PMKSY-Groundwater

PM-KUSUM: Prime Minister’s Scheme for Energy Security & Upliftment of Farmers
Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan

- Launched in 2019
- Aimed at ensuring energy security for farmers in India
- To increase the share of installed capacity of electric power from non-fossil-fuel sources
- Additional income to farmers by selling the solar power to power distribution companies (DISCOMs)

Three components

A. Setting up of 10,000 MW of Decentralized Grid Connected Renewable Energy Power Plants on barren land

B. Installation of 17.50 Lakh stand-alone solar agriculture pumps

C. Solarization of 10 Lakh Grid Connected Agriculture Pumps.
Impacts of interventions

Growth of micro irrigation, post PMKSY

Area brought under micro irrigation (cumulative) in million ha

Source: Ministry of Agriculture and Farmers Welfare; Government of India

6.75 million ha area brought under micro irrigation in the seven years since 2015.
## Progress of PM-KUSUM

<table>
<thead>
<tr>
<th>Component</th>
<th>Final Target</th>
<th>Total sanctioned so far</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Decentralized Grid Connected Plants</td>
<td>10000 MW</td>
<td>4886 MW</td>
</tr>
<tr>
<td>B Stand-alone Solar Agriculture Pumps</td>
<td>1.75 million pumps</td>
<td>0.81 million pumps</td>
</tr>
<tr>
<td>C Grid Connected Agriculture Pumps</td>
<td>1.0 million pumps</td>
<td>0.15 million pumps</td>
</tr>
</tbody>
</table>

**Source:** PM-KUSUM Dashboard, Ministry of New and Renewable Energy, Government of India; https://pmkusum.mnre.gov.in

## Regions leading in PM-KUSUM implementation

- Haryana
- Punjab
- Rajasthan
- Uttar Pradesh
- Gujarat
- Madhya Pradesh
- Maharashtra

**Source:** PM-KUSUM Dashboard
https://pmkusum.mnre.gov.in

**Groundwater Situation**

- Over-exploited
- Critical
- Semi-critical

**Source:** Central Groundwater Board, Government of India.
Electricity consumption by agriculture sector

Source: Energy Statistics India-2021, Ministry of Statistics and Programme Implementation; Government of India

**Plausible reasons → Flattening electricity usage**

- Assured canal irrigation through PMKSY
- Reduced usage of ground water
- Saving in energy consumed for pumping
- Additional micro irrigation area of 6.75 mha
- Saving in irrigation water
- Saving in energy consumed for pumping
- Launch of PM-KUSUM, campaigns & meetings
- Awareness + Power purchase by DISCOMs
- Triggered a behaviour change

**Benefit of additional micro irrigation area of 6.75 million ha**

At most: 16.9 BCM water and 23.5 Giga Units (23475 GWh) electricity.

At least: 10.1 BCM water and 6 Giga Units (6000 GWh)

**Assumptions:**
- * 30% to 50% saving in water
- ** Head varies from 25 m to 160 m
- *** Discharge of a 25 stage 5 HP pump in 4 inch dia bore well considered. (2.7 to 6.3 cum/hr)
Rise in production of total food grains

An increase of 46 million tonnes in 5 years (2015-16 to 2019-20)

Half-decadal growth in production of food grains in %

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-15</td>
<td>3.09%</td>
</tr>
<tr>
<td>2015-20</td>
<td>18.27%</td>
</tr>
</tbody>
</table>

Source: Handbook of Statistics on Indian States 2020-21, Reserve Bank of India, Government of India.

Impact on yield of major crops

Average yield of total food grains increased by more than 300 kg/ha in the five years past 2015-16

Half-decadal growth of yield of food grains in %

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<tbody>
<tr>
<td>2010-15</td>
<td>5.75%</td>
</tr>
<tr>
<td>2015-20</td>
<td>14.80%</td>
</tr>
</tbody>
</table>

Source: Handbook of Statistics on Indian States 2020-21, Reserve Bank of India, Government of India.
Role of irrigation coverage

Production of pulses

Area under pulses

| Total: 20.59 mha | Irrigated: 4.38 mha | Un-irrigated: 16.21 mha | Irrigation Coverage: 21% |

Yield and production of pulses have been following more or less similar trends before and after the introduction of PMKSY. This reinforces the argument that PMKSY influenced the increase in yield and production of the crops which are significantly covered by canal irrigation.

Conclusions

The PMKSY scheme could bring visible improvement in the water-energy-food nexus by increasing yield and production of crops under canal irrigation.

The Per Drop More Crop (PDMC) component of the PMKSY helped to save a considerable volume of water, and a significant quantity of electricity.

The PM-KUSUM scheme, which is in its initial years of implementation, has been positively contributing to the gain of nexus in high ground water extracting regions.

The combined effect of PMKSY and PM-KUSUM contributed to the flattening of the electricity consumption trend in 2019-20 and 2020-21, which was on a rising trajectory.
photo shot in a small river in a state in the west coast of southern India named “Kerala”, which means “the Land of Coconut Trees.”