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MANAGING WATER, LAND, ENERGY AND FOOD NEXUS FOR SUSTAINABLE WATER RESOURCES MANAGEMENT

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Introduction

- The need to increase food production to meet the growing demands would considerably increase the demand for irrigation water, energy and arable land in tropical and sub-tropical regions.
- The energy demand for irrigation in semi-arid/arid tropics would be even higher than that in humid/sub-humid tropics, as the dependence on groundwater for irrigation is more acute.
- Major shares of the world's uncultivated arable land are in the semi-arid and arid tropics of Africa and Asia, and the crop lands that require irrigation are also mostly in Africa and Asia.
- Since a large proportion of the world's poor & malnourished live there, a significant proportion of the **future increase in water & energy demand** for crop production will be from there.
- The higher population growth in developing countries adds to this problem.

Drivers of growth in water & energy demands

- The manner in which the increased demand for food would drive the demand for water would also be determined by the efficiency of water use in agriculture in the future
- Similarly, the way increase in crop production would drive the energy demand would again be influenced by the technical efficiencies in energy use in that sector.
- In regions where the linkage between **energy** & **irrigation** is strong--such as in groundwater irrigated areas--, water management in agriculture would determine the ability to provide adequate energy supplies for other sectors.
- Here the overall approach that we pursue for **sustainable groundwater management** and **water demand management in agriculture** would be the key to managing water & energy nexus in these regions.
- Reforms in the energy sector, which encompasses technologies, institutions and policies, would also have a big role in managing the energy demand.

Impact of increasing energy demand on water and land resources

- Increased global, national and regional demand for energy can exert pressure on water resources due to water diversion for production of biofuel and use in thermal power plants.
- A typical fossil fuel–based thermal power plant can consume near 3.5m^3 of water per megawatt of power, while the total water required to be diverted would be much larger.
- This can put scarce water and land resources under stress, leading to undesirable effects on food production systems, unless both land and water are in abundance.
- While in **naturally water-scarce areas with abundant arable land**, the **pressure would be on water resources**, in **water-rich areas with limited arable land**, the **pressure would be on land**.
- Therefore, the impacts of energy demand on food production systems would differ from region to region depending on the climate and availability of water and arable land.

Impact of food demand in land-scarce regions on land and water resources of other regions

- In regions that have limited land resources (due to high population density), increase in demand for food can put enormous pressure on land, even if water resources are available in plenty
- Beyond a point, this increase in food demand from water-rich regions will put indirect pressure on other regions that have plenty of arable land to produce more food for export to the former:
- In India, Bihar, UP and WB depend on Punjab, AP for food; In China, South and South East depend on the water-scarce north China plains for agricultural commodities
- This can also cause increase in energy demand for agriculture production in such regions, as they start exporting food to the former

Purpose of this Presentation

- One important aspect of water-energy-food nexus is sustainable use of water and energy resources to meet the growing food security and agricultural growth needs.
- We will illustrate how efficient management of energy economy through efficient pricing and rational supply policies for energy will promote efficient and sustainable water management.
- We will also illustrate how managing water-land nexus can achieve water resource management goals while achieving boost in agriculture production and food security.

Groundwater-energy-food nexus in India

- Groundwater is the major source of irrigation in India, especially in the semi arid & arid regions
- Groundwater irrigation in such areas has been fueled by easy access to electricity in the farm sector, with many millions of pumps used for abstracting water from wells.
- Cheap and easily-accessible bore-drilling technologies, access to pump sets of different sizes and subsidized electricity for farming had made groundwater irrigation viable even in areas with poor groundwater potential.
- The total groundwater abstraction in India is estimated to be around **242** BCM--against a dynamic groundwater resource of around 432 BCM. Most of it is for irrigating crops.
- In semi-arid & water-scarce regions, as compared to canal irrigators, well irrigators tend to allocate more water for growing dry irrigated crops and less for food crops.
- Well irrigation can come to a standstill in many areas with deep water table conditions, if electricity is not supplied to agriculture sector.

Metering Electricity: Why is it important?

- Farm level electricity metering generates information about the use of both energy and groundwater
- Farm level metering helps:
  - Detect electricity theft by individual farmers
  - Assess the actual energy requirements in farming different seasons; and
  - Assess technical losses separately
  - It also helps charging for electricity on the basis of consumption
- Therefore, it is the first step towards managing both groundwater & energy economy

Efficiency impacts of pro-rata pricing

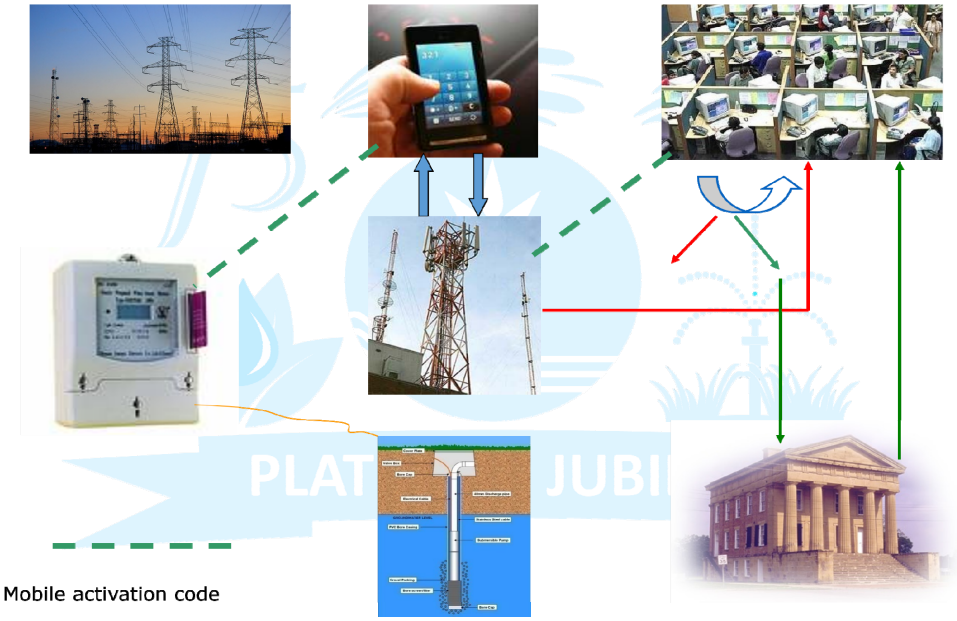
- Consumption based pricing creates incentives among farmers to generates higher return per unit volume of water
- When confronted with marginal cost and under high tariff, farmers use water & electricity more efficiently; select crops & farming systems that are more water efficient
- Higher pro rata tariff does not lead to reduced income from crop production as farmers use water & other inputs judiciously
- They obtain higher return per unit of cultivated land also

Sustainability and equity impacts of pro rata and subsidized pricing of energy

- Farmers use less groundwater per unit of land; thus addressing questions of sustainability
- Returns from farming are inelastic to tariff; but elastic to control over irrigation water
- Pricing does not increase monopoly prices charged by well owners
- Price at which water is traded in the market is not decided by the cost of production of water by individual well owners, but by market conditions
- So subsidized prices for diesel and electricity will not have a positive impact on equity in access to groundwater in water abundant regions

Pre paid meters: technological innovations for introducing pricing reforms

- It prevent electricity pilferage through manipulation of pump capacity
- Can be operated through tokens; scratch cards, magnetic cards or recharged digitally through internet & SMS.
- It helps electricity utility restricts the use of electricity by the consumers
- The utility can decide on the "energy quota" for each farmer on the basis of either:
  - Connected load, and total hours of power supply; or
  - Sustainable abstraction levels per unit of irrigated land
- Database for every agricultural consumer of the connected load, location, etc. is required
- Farmers pay & obtain activation code through mobile SMS



Source: Slim Zekri, 2008

Managing Land-Water Nexus to Improve Sustainability of Water and Energy Use, in Food Production

- Recent research using global datasets showed that the agricultural production potential of a country is determined by the access to cultivable land, and sufficient amount of water resources that can being that land under production (which is influenced by the climate)
- ***Water adequacy index***, ***per capita cultivable land***, ***good pasture land per capita*** and ***favourable climate*** are the key
- Most land-rich regions of India that are producing agricultural surplus are witnessing **groundwater depletion & environmental water scarcity**
- The only way to improve **water resources management** while ensuring sustainable agriculture production is to import water for irrigation from water-rich regions that are land-scarce (**eastern India**, for instance)
- It increases **WAI of the region**, boosts **per capita cultivated land** (with increased cropping intensity) and improves the quality of pasture land
- Gravity irrigation through canals also replenishes the shallow aquifers of such regions, especially when surplus water is available

Conclusions

- In semi arid and arid regions, with groundwater stress, metering & pro rata pricing of electricity improves efficiency, equity and sustainable of groundwater use in agriculture
- It is also socio-economically viable; orientation of farmer organizations and politicians is crucial to get wider acceptance of ideas
- Government can offer subsidies for meters if farmers are willing to go for pro rata pricing with energy rationing
- In the long run, absolutely water-scarce regions (NW India, peninsular India & western India) that face groundwater depletion and environmental water stress will have to look for water imports from water-rich but land-scarce regions to achieve sustainable water resources management while achieving sustainable food production

Implications for Policy

- Water-scarce regions that are agriculturally prosperous should first look at water demand management, for which managing water-energy nexus is crucial
- Consumption-based pricing of electricity and energy rationing will have some impact on food production, as there could be a tendency to allocate the available water for water-efficient cash crops
- Therefore such policies should be implemented sparingly
- Food security and water management should consider availability of arable land for food production (along with water); since land cannot be transferred, policies should look at **transferring water from land-scarce & water-rich regions** to regions that are rich in arable land but facing acute water shortages

Thank You