

## Interrogating Energy-Water Nexus in Indian Agriculture

*Efficiency vs. Political Stability and Food Security*

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## Abstract

Agricultural electricity subsidy is a unique feature of the Indian electricity supply industry. Immediately after electricity was put under public control and the state governments received the authority to set electricity prices, electricity pricing emerged as a powerful political tool. Since 1990s, agricultural electricity pricing has been criticised as a populist paradox, contributing to various economic and environmental inefficiencies. In response, few state governments have attempted to reform agricultural electricity subsidies and improve resource use in the sector. Building on technocratic neo-liberal discourse, current reform initiatives seek to rationalise tariffs – raise tariff to near cost of supply if not actual cost. The outcome varies across states, but largely resisted by the farmers and consequently, stalled.

The existing literatures seek to analyse the impact of such subsidies and tend to recommend technocratic solutions focussed on economic efficiency, ignoring the social and political dimensions. This paper argues that agricultural electricity subsidy in India is closely linked with food security, poverty alleviation, state finance, water scarcity and now increasingly with climate change. Drawing on state level experience, the paper suggests a holistic approach to reform electricity subsidy and water use inefficiency in agriculture.

## Introduction

Agricultural electricity subsidy is a unique feature of the Indian electricity supply industry. Immediately after electricity was put under public control and the state governments received the authority to set electricity prices, electricity pricing emerged as a powerful political tool. Since late 1960s, political parties have campaigned for a subsidised supply of electricity for agricultural use, to create a vote-bank of farmers. Consequently, many states have ensured agricultural electricity supply at a highly subsidised rate, occasionally free, and frequently unmeasured. Although the agricultural subsidies are pursued as political instruments, they have been marketed as developmental policies seeking to increase agricultural income, ensuring food security and reducing rural poverty.

With the advent of neo-liberal reforms, agricultural electricity pricing has been criticised as a populist paradox. The subsidy policy has been criticised on various grounds. First, it does not help farmers, particularly the poorest among them, as this free electricity is largely being stolen by non-agricultural consumers or captured by a few large farmers. Second, the subsidy policy, even after cross-subsidisation from industrial and commercial consumers, has driven the electric utilities and state governments into financial crisis. In many cases, as in Andhra Pradesh and Punjab, the amount of the agricultural electricity subsidy is much higher than the state's spending on health or education. Third, the policy has prompted the unaccounted and uncontrolled use of electricity. Consequently, this policy has been blamed as one of the major sources of the current electricity crisis in India. Finally, the policy has also been blamed due to its environmental implications. It has prompted the overuse of groundwater for irrigation, resulting in the depletion of water tables (Swain and Charnoz, 2012).

In response, over the period of last two decades, few state governments have attempted to reform agricultural electricity subsidies and improve resource use efficiency in the sector. Building on technocratic neo-liberal discourse, these reform initiatives seek to rationalise tariffs- raise tariff to near cost of supply, if not actual cost. The outcome varies across states, but largely resisted by the farmers and consequently, stalled.

Though there is a huge body of literature on agricultural subsidies, particularly on electricity subsidies, in India, most of them seek to analyse the impact of such subsidies and tend to recommend technocratic solutions focused on economic efficiency, ignoring the social and political dimensions. However, agricultural electricity subsidy in India is closely linked with food security, poverty alleviation, state finance, water scarcity and now increasingly with climate change. Such a complex issue needs to be dealt prudently, with an embedded and inclusive approach, with a careful consideration of social, political, economic and environmental aspects. Drawing on empirical evidence and analysing socio-economic-political and environmental dimensions, the paper seeks to make a case for more holistic approach to reform agricultural electricity subsidy and improve resource use efficiency.

## Institutionalisation of Agricultural Electricity Subsidy

Subsidised agricultural electricity pricing has frequently been framed as a populist policy pursued by state governments or political parties to gain political support of peasantry community. It is argued that, after the Green Revolution, there was an organised farmers lobby for subsidised agricultural inputs including subsidised electricity for irrigation. These demands were often supported and responded to by the newly emerged regional political parties with a support base in the peasantry (Dubash and Rajan, 2001; Gulati and Narayanan, 2003; Birner *et al.*, 2007). With the emergence of these regional parties and their political success, agricultural subsidies have grown over time (Badiani and Jessoe, 2011).

However, this account of origins of subsidised electricity pricing is narrow in its explanation. It is definitely true that there was a political agenda behind and that it has been used as a political tool over time. But there was an equally important developmental agenda in origin of the policy. On the other hand, electricity is not a direct input for agriculture; it is an input for irrigation through groundwater extraction when direct water supply is not feasible or failed. It is water that matters for agriculture.

Why there is a perceived demand for subsidised electricity in agriculture instead of water? Did the farmers really demand subsidised electricity? At present, there are criticisms and opposition to subsidised agricultural electricity pricing from domestic as well as international interest groups. Why did not this criticism and opposition surface at the initial stage when the subsidies were introduced? To understand the origin of it all, we need to look at the political economy of post-independence India and how it shaped agricultural policies.

During the mid-1960s, the economic condition in India was the worst ever during the post-independence period; per capita income was at its low, major industries were severely hit by recession and unemployment was mounting. At the same time, India was faced with a severe food shortage due to ever increasing population and several natural calamities affecting agricultural yields. As a result, the government was forced to import food grains from the US at a heavy political price. Moreover, there was uncertainty about the ability of the food surplus countries to continue to cater the needs of the food deficient countries (Dasgupta, 1977).

After the drought of 1965-66, the food scarcity of India turned into a horror when Paddock brothers predicted that there will be widespread famine in different parts of the world, including India, by 1975 and the United States, the only food surplus country then, would not be able to sustain India as it would adopt a policy of discriminating in favour of only those countries who could be saved (Paddock and Paddock, 1967).

In response to the situation, the Government of India brought out a new deal for agricultural development to improve food security of the country. Though food self-sufficiency was the primary concern, the new agricultural policy was expected to contribute to economic development of the country through increased employment, income and livelihood security. The new deal, named as Green Revolution, involved continued expansion of farming areas and multiple cropping in existing farmland

through new technologies. Large amount of land was brought under cultivation. Hybrid seeds were introduced. Natural and organic fertilisers were replaced by chemical fertilisers and locally made pesticides were replaced by chemical pesticides. The result was positive; by 1975, India became self-sufficient in food production against paddock brothers' prediction (Swain and Charnoz, 2012).

This radical agricultural programme received widespread support from all kinds of interest groups. Political parties and state governments well received the programme as it offered multiple benefits like food security, livelihood security, poverty eradication, increased GDP, and increased employment. The elite farmers with control over the farmer community, who were annoyed with the food procurement policy of the government, were happy with the new agricultural policy that offered them higher income while reinstating their power relationship with smaller farmers (Dasgupta, 1977).

The industrial elites of India were supportive to the Green Revolution in anticipation of multiple benefits from the new programme. The programme was expected to provide a regular food supply to their workers at a cheap price and save the precious foreign exchange used for food import for import of materials for industrial development. At the same time, the new agricultural strategy created a new demand for manufactured products like fertilisers, pesticides and farm machineries, which was compatible with and promoted industrial development. It was also compatible with the interests of large section of the multinational firms which specialised in producing petrochemicals and farm machinery (Dasgupta, 1977).

Moreover, international development organisations like the Ford Foundation, World Bank and United States Agency for International Development (USAID), who had been pushing for modernisation of agriculture involving use of chemical fertilisers and high yielding seeds (Shiva, 1991), supported the new agricultural policy and provided funding for its implementation. The new agricultural policy had effectively brought about a convergence of interests of various power groups including the rural elites, domestic industrial elites, multinational industries, international development agencies and domestic governments.

The Green Revolution which popularised the high yielding seeds was highly dependent on two additional inputs, viz. fertiliser and water. In the absence of these inputs, the high yielding seeds, even with the new technologies, do not perform better than the indigenous seeds. Both these inputs are inter-dependent. Higher use of chemical fertilisers increases the nitrogen uptake of plants and upsets their carbon/nitrogen balance, causing metabolic problems to which the plants react by taking up extra water (Shiva, 1991).

As Food and Agriculture Organisation (2002: 69-70) notes: "Fertiliser use correlates positively with tubewell ownership and with the adequacy of irrigation supplies, and the marginal productivity of fertiliser is higher where households have access to adequate irrigation supplies. Fertiliser use also correlates with tubewell installation, as a reliable source of water enhances the productivity of land and fertiliser." The new agricultural programme that was highly dependent on

additional inputs, required long-term state subsidy and planning (Harriss-White and Janakarajan, 1997). Subsequently, the states have responded with subsidised inputs, particularly fertiliser and electricity subsidies that constitute a major part of the agricultural subsidies.

Green Revolution was introduced in selected parts of India with favourable conditions for the new technology and hybrid seeds. Based on its initial success, farmers in other parts of India wanted to use the high yielding seeds and new agricultural technologies to increase their income. They also demanded the additional inputs required to use these seeds. But the initial demand was primarily for chemical fertilisers and access to 'water' for irrigation. When the state was unable to supply surface water to all the farmers, it promoted use of groundwater (Swain and Charnoz, 2012).

Until that period, the existing agricultural electricity consumers were paying a tariff almost close to the average cost of supply and based on actual consumption (Swain, 2006). As the farm level electricity consumption went up, owing to higher consumption of water, the electricity bill for the farmers became huge, eating up a sizable part of their agricultural income. On the other hand, the farmers who had access to surface water supply were getting it at a subsidised price which was a small fraction of the electricity bills their groundwater dependent counterparts paid. Yet, both the category of farmers got equal price for their produce in the market. In that sense, the groundwater dependent farmers were in a disadvantaged position. Consequently, in some parts of India, there emerged a demand for subsidised electricity supply to extract groundwater. At the same time, the net barter terms of trade for agriculture declined during 1970s, as the prices paid by the farmers for inputs increased faster than the prices received for their produces. Therefore, there was an emerging demand for subsidies as compensation (Tyagi, 1987).

In the prevailing political situation, subsidised electricity turned out to be an effective political tool for creating 'vote banks' (Dubash and Rajan, 2001; Swain, 2006). As discussed earlier, the political parties have utilised this opportunity to the fullest possible extent, increasingly providing electricity subsidy in state after state.

## **Impacts and Implications**

While agreeing on the political roots of free power policy and its technical failure to measure subsidies, the technocratic discourse identifies several economic impacts of the policy on farmers, utilities and state governments. The technocratic discourse claims that subsidising electricity prices for agricultural consumption has resulted in economic inefficiencies in electricity supply system, while the policy has failed to be effective in achieving its goals. Though several studies acknowledge social and political benefits accrued through the policy, they emphasise on negative economic impacts of the subsidies. In this section, we review the discourses on these 'negative impacts'.

### Roots of Power Crisis

It is strongly believed that subsidised electricity fosters excessive use of water and electricity (Planning Commission, 2006; Badiani and Jessoe, 2011). With increasing subsidies, the amount of electricity consumption has gone up over the years. Though utilities' inefficiencies, particularly transmission and distribution (T&D) losses, have significantly contributed, agricultural consumption is often blamed for the current power crisis in India. It is partly substantiated by the fact that higher agricultural consumption implies higher T&D losses due to stretch of distribution lines to rural areas. While the demand supply gap at national level hovers around 12 per cent, it is more than 20 per cent in states like Andhra Pradesh and Maharashtra. To meet these gaps and peak demand, the utilities have to procure electricity from surplus states at a much higher cost (often at double the price). This has seriously impaired the fiscal status of utilities.

**Table 1: Agricultural and Industrial Sale (% of Total Sale) and Revenue (Rs/Kwh), 2008-09**

State	Utility	Sale		Revenue	
		Agricultural	Industrial	Agricultural	Industrial
Andhra Pradesh	APCPDCL	29.00	43.29	0.10	3.15
	APEPDCL	17.02	40.64	0.09	3.44
	APNPDCL	51.68	15.69	0.07	3.84
	APSPDCL	28.98	27.40	0.04	3.83
Gujarat	DGVCL	6.42	66.96	1.89	5.34
	MGVCL	15.13	42.33	2.39	5.35
	PGVCL	34.45	40.62	1.89	5.36
	UGVCL	55.77	27.43	1.86	5.49
Maharashtra	MSEDCL	21.90	45.62	1.94	4.78
West Bengal	WBSEDCL	4.78	32.04	1.68	4.17
All India		22.87	35.42		

Source: (PFC, 2010)

**Table 2: Agricultural and Industrial Sale (% of Total Sale) and Revenue (Rs/Kwh), 2008-09**

State	Agriculture (% of Total Energy Sold)	Agriculture (% of Total Revenue)	Industrial (% of Total Energy Sold)	Agriculture (% of Total Revenue)
Andhra Pradesh	31	1	35	47
Gujarat	32	15	43	58
Maharashtra	22	11	46	56
West Bengal	5	2	32	34
All India	23	6	35	47

Source: (PFC, 2010)

Although the agricultural sector accounts for the consumption of around one-fourth of total electricity in India, the revenue from this sector is very low (See Table 1 & 2). While agricultural consumption at national level is around 23 per cent, the revenue leverage from this sector is just six per cent of the total revenue of all Indian electricity utilities. This has resulted in deteriorating financial status of electricity utilities. To cope with this structural financial deficit, utilities have been cutting down investments in maintenance and development of distribution system, which has seriously affected the quality of service for all categories of consumers.

However, state governments have been promoting the utilities to cross-subsidise agricultural consumption with higher prices paid by industrial and commercial consumers to fill the revenue gap. The utilities have indeed made all possible efforts to extract the loss made in agriculture sector from the industrial consumers (See Table 1 & 2). As a result, while the industrial sector consumes 35 per cent of national electricity, it contributes to 47 per cent of total revenue of electricity supply industry. More recently, showing their dissatisfaction with increasing cross-subsidisation, many of the industrial consumers are moving towards captive generation technologies and direct purchase from generators, leaving the utilities in further financial distress.

### *A Drain on State Economy*

Yet, even after cross-subsidising from industrial consumers, there still remains a large revenue gap for the utilities (See Table 3). This gap has been filled through state governments' regular subventions. The state governments are thus obliged to pay for subsidising the agriculture sector. The amount of such subsidies consumed by the utilities has been continuously increasing. Over the 2008-09 fiscal year, they amounted to Rs296,650mn against Rs195,180mn in the previous year (PFC, 2010). This equals to about 12 per cent of India's gross fiscal deficits in the same year. These subsidies have thus been contributing to a large extent to the gross fiscal deficit of India (Sankar, 2004).

**Table 3.3: Subsidy Booked, Subsidy Received, Percentage of Subsidy Booked to Revenue (Sale of Power), 2008-09**

State	Utility	Subsidy Booked (Rs Million)	Subsidy Received (Rs Million)	% of Subsidy booked to Revenue-sale of Power
Andhra Pradesh	APCPDCL	33,720	33,720	53.32
	APEPDCL	6,720	0	25.58
	APNPDCL	20,400	8,430	135.39
	APSPDCL	18,960	4,000	60.58
Gujarat	DGVCL	760	760	3.14
	MGVCL	4,030	4,030	8.33
	PGVCL	5,710	5,710	16.27
	UGVCL	3,600	3,600	16.40
Maharashtra	MSEDCL	0	0	0
West Bengal	WBSEDCL	0	0	0
All India		296,650	183,880	19.09

Source: (PFC, 2010)

Though state governments have been providing a subvention equivalent to the subsidy booked by the utilities, there is a retreat since mid-1990s. Due to growing fiscal deficit in state budgets and ever increasing subsidy amount, many of the states have reduced the subvention amount and some states have stopped providing subventions leaving the utilities in despair. During the year 2008-09, the subsidy released by the state governments has been about 62 per cent of the subsidy booked by the utilities (See Table 3). This has further damaged utilities' finances and efficiency to deliver good quality service.

### *Collateral Damage*

Free power policy not only creates damage to utilities' efficiency and state finance, but also has negative impacts for the farmers. The overuse of water, induced by subsidised input electricity, has in turn led to soil degradation, soil nutrient imbalance and groundwater depletion, all of which might cause decrease in agricultural production. In such a situation, the subsidised input policy contributes to further degradation.

On the other hand, financially weak and over-bordered utilities are not in a position to deliver good quality electricity to agricultural consumers. High subsidies result in a demand that is too heavy for under-financed utilities to satisfy. If they are to survive financially, they inevitably tend to prioritise delivering better service to high paying industrial consumers. The farmers have to bear with poor quality electricity in form of inadequate voltage, limited hours of supply and frequent breakdowns, even though they get it at a cheaper price or free of cost. Poor quality power has indirect costs for the farmers. Frequent breakdowns result in unavailability of water at the time of irrigation peaks when it is most needed. Adding to the indirect cost, it requires investment in backup arrangements like diesel pumps. On other hand, frequent motor burnout due to low voltage costs extra money and time to repair or reinstall motors.

### *Regressive Benefits*

Like any other price subsidies, agricultural electricity subsidies tend to be "regressive" – meaning that they disproportionately benefit larger farmers over smaller farmers (Sant and Dixit, 1996; Howes and Murgai, 2003). The large farmers who consume more electricity benefit more from the policy (World Bank, 2001). The rural economy as a place where the large farmers, who gain disproportionately from this policy, form superior interest groups and exercise control over smaller farmers through patriarchal relations. These large farmers are the winners in the subsidy regime and are framed as the losers from any reform agricultural electricity pricing. So they have been pushing for status quo in agricultural electricity pricing regime. The number of such farmers who gain from the subsidy varies markedly across states (Birner et al., 2007) and that determines intensity of subsidy in respective states.

## Technocratic Reform Approach

From the discussion above, it is evident that the policy debate dominated by technocrats emphasises on impacts of free power policy that affects economic efficiencies. Economists claim that absurdly low price of electricity is one of the major reasons for irrigation inefficiency and inefficiency of electricity utilities. With this backdrop, the policy debate in India has been largely concerned with questions of which technocratic solutions work best (Birner *et al.*, 2007).

The most recommended solution that has gained support in domestic policy debate as well as from international community is to 'get the price right'. Indian and international technocrats often refer to the low price of electricity as the root cause of all problems. So, they claim getting the price right, i.e. to the level of cost of supply and charges based on consumption, will address all the problems around free power policy.

First, raising the price is expected to rationalise electricity and water consumption, improve irrigation efficiency and promote conservation by farmers. Water and electricity efficiency in irrigation is required under the current changing climate.

Second, charging the farmers based on their consumption and at the level of cost of delivery would improve the fiscal status of electricity utilities. Financially stable electricity utilities are expected to supply better quality electricity, which would relieve the farmers from indirect expenses incurred to cope with poor quality of electricity.

Third, financially stable utilities would be no more a burden on the state economy. The vast amount of money transferred to utilities to sustain subsidies could be invested in other development sectors. Finally, when farmers rationalise electricity consumption there will be significant reduction in the load from agriculture sector, which in turn will help the country move out of current power shortage.

Based on these assumptions, since the introduction of economic liberalisation in early 1990s, international development agencies have been pushing for metering of agricultural connections and increase in agricultural electricity price. The World Bank and Asian Development Bank (ADB) have made increase in tariff coupled with universal metering a pre-condition for financing power sector reforms. There were some efforts made to reform agricultural electricity supply during the 1990s, in line with liberalisation of the Indian economy. In 1991, a high-level committee of six chief ministers and the finance and power ministers recommended that the state adopt a minimum agricultural tariff. In 1996, a conference of chief ministers agreed to set a minimum tariff of Rs 0.50 per Kwh and increase it within three years to 50 per cent of the average cost of supply (Dubash and Rajan, 2001). After one and half decades, none of the states have implemented this policy, even though it was reiterated time and again. Rather than following this agreement, an increasing number of states decided to supply electricity free of charge.

Empirical studies conducted on agricultural water and electricity consumption claim that rise in electricity tariff could result in efficiency improvement in electricity and water consumption in irrigated agriculture (Moench and Kumar,

1994; Kumar and Singh, 2001). Moench (1995) argues that electricity prices can be used as a tool for managing groundwater resources. Though the study does not propose full cost recovery to agricultural electricity prices, it finds subsidised consumption based change structures could be effective.

Kumar (2005) suggests positive impact of electricity prices shift, i.e. induced marginal cost of electricity on physical efficiency of water use, and water and energy productivity in agriculture. Kumar (2009) claims introducing marginal cost for water and electricity not only promote efficient use of water as manifested by higher farm-level water productivity, but also more sustainable use of water. A study conducted by the World Bank claims that improving the quality of electricity services to agriculture, and therefore, improving farmers' income and agricultural growth requires reforming pricing structure. Measuring agricultural consumption by installing meters and charging the farmers the marginal cost of electricity supply base on their consumption can create a win-win situation for the farmers, utilities and state governments. Drawing on two empirical cases studies, Andhra Pradesh and Haryana, it finds that farmers are willing to pay for better quality of electricity (World Bank, 2001).

However, 'getting the price right' solution does not have enough empirical validity. It is not clear how far this solution can address the problems around free power policy. Recently, some of the India states have started slowly implementing this solution. States like West Bengal and Uttarakhand have started metering agricultural electricity supply.

Following a different approach, several states in India have undertaken programs of rural feeder segregation which involve separation of rural non-agricultural and agricultural consumers by connecting them to separate feeders, thereby physically separating paid and nominally-paid loads. Through this mechanism, utilities have attempted to measure and limit the amount of power supplied free for irrigation, while ensuring that rural non-agricultural consumers receive better quality supply for longer periods. The following section aims to analyse the experiences in West Bengal and Gujarat.

## **Indian Experience: Insights from West Bengal and Gujarat**

### ***West Bengal Model***

The removal of meters for agricultural connection was arguably the biggest blunder in the process of institutionalising agricultural electricity subsidies. Reinstallation of meters to measure the actual consumption is therefore a prerequisite for reforms. While few states have taken initiatives in this direction, West Bengal successfully metered agricultural connections.

While agricultural electricity subsidy is an insignificant part of the state budget and a negligible share of state fiscal deficit in West Bengal, it is well covered through cross-subsidisation. However, utilities blame subsidies for their deteriorating finances. In response, the state has initiated mandatory metering of agricultural electricity connections. Beginning in 2007, the initiative involves installation of cellular-based meters that can record consumption on a time-of-day basis. This high-tech metering

enables the utility to charge the farmers on the basis of actual load and time of consumption. The goals are to better manage agricultural load, reduce agricultural subsidy, improve revenue realisation and phase out cross-subsidisation from industrial consumers (Swain and Charnoz, 2012).

One major outcome of the metering reforms in West Bengal is a new incentive structure within the groundwater market. As the new arrangement requires that pump owners pay only for the amount of electricity consumed, they no longer have the same incentive to sell water. As a result, the water buyers have lost bargaining power. The pump owners therefore increased water price by 30-50 per cent after the reforms, even though the annual electricity bill has actually gone down. This price adjustment has helped the wealthier farmers by reducing their electricity bills and increasing their profit from selling water (Mukherji *et al.*, 2010).

Meanwhile, the water buyers face problems like advance payment and unavailability of water at desired times, which impairs the equity of access to water. The implications for the utility have been mixed; while the utility has gained through reduced peak load and loss, it faces a short-term reduction in revenue (Mukherji *et al.*, 2009).

In the long run, the groundwater market might be significantly transformed, marked by an increase in pump ownership, as the cost of electricity comes down. While the reform measure has some positive implications for efficiency gain, it has short-term negative impacts on equity of irrigation water access and does not have any significant implications for electricity and water conservation.

### *Gujarat Model*

Rural load segregation reduces the agricultural load and improves rural electricity supply by connecting rural non-agricultural and agricultural consumers to separate feeders. About eight states have initiated such rural load segregation schemes. However, Gujarat is the only case where the scheme is implemented throughout the state and has been touted as a success.

In response to the groundwater and power crises in 2003, the Gujarat government introduced *Jyotigram Yojana* (Lighted Village Scheme) to improve rural electricity supply. The scheme segregated the rural non-agricultural load from the agricultural load with the objective of ensuring better and differentiated quality of supply. These feeders were also metered to ensure accuracy in energy accounting (World Bank, 2013). The scheme resulted in a parallel rural transmission network across the state, at a cost of Rs12.9bn.

The scheme resulted in two significant improvements: (a) non-agricultural consumers received 24 hours of electricity supply for domestic use and for schools, hospitals, market places and village industries, and (b) farmers received limited hours of electricity supply, but what they received was good quality. The scheme has also benefited the utilities by reducing losses, thefts and agricultural consumption; thus, it has improved peak load management and better revenue realisation in proportion to consumption. But the nominal financial gain, in lieu of reduced consumption, is not enough to meet the required return on the large investments made in the scheme (World Bank, 2013).

The state has, however, benefited from reduced subsidy burden. From a groundwater perspective, rationing the electricity supply has put a cap on the collective extraction of groundwater and contributed to groundwater conservation (Swain and Charnoz, 2012).

Though farmers appreciate the improvement in quality, they are not unreservedly happy with the scheme, particularly the rationed supply. Farmers in the water-abundant areas of central and southern Gujarat, who used to operate their pumps for 18-20 hours a day and sell water to small and marginal farmers, have lost an additional source of income. However, water buyers are worst hit, as the groundwater markets have shrunk and water prices have increased from 40 to 60 per cent. As a result, irrigation access for the small and marginal farmers has declined, pushing many out of irrigated farming and thus reasonable livelihood. Landless labourers are also affected by reduced opportunities for farm work as total irrigated area has declined. These farmers claim that *Jyotigram Yojana* has adversely affected their agricultural yield and income (Swain and Charnoz, 2012).

### **Need for a Holistic Approach**

Agricultural electricity subsidy has been interpreted as a unilateral problem that leads to economic inefficiencies affecting the farmers, utilities and state governments. Consequently, the solutions proposed are unilateral, focused on revising the price and/ or improving pumping efficiency. Throughout this work, we have challenged this narrow approach to agricultural electricity subsidies. We have demonstrated that raising electricity prices for farmers does not address the problem, rather leads to several other problems bearing welfare costs. Doing away with these subsidies may aggravate the problem of rural poverty by reducing farmers' disposable income and the problem of food security by reducing agricultural yield. As for improving pumping efficiency, this solution is claimed to have produced positive outcomes in a few pilot cases, there is yet no clear evidence and technical assessment available.

Improving pumping efficiency without improving water use efficiency could in fact lead to serious problems. Farmers are always demanding for more water than what is currently accessible to them: once pumping efficiency is improved, they can extract more and more, which may in turn aggravate the depletion of groundwater tables. As these tables go further down, the amount of electricity required to draw water would increase. Electricity and water use in irrigation are very much intertwined. A true solution to the problem would need to address both the problems simultaneously.

Analysing agricultural electricity subsidy from environmental, economic and socio-political aspects, we find it to be a multi-dimensional problem. The issue is well linked with groundwater problem, rural poverty and food security. Addressing one aspect of it would not solve in any sustainable way. There is need for a much broader and embedded approach that considers all dimensions simultaneously. Though the state has identified several dimensions of the problem, they are still treated as independent problems rather than as a complex network. For example, the proposed solution for energy efficiency (improving water pumps efficiency)

does not consider water use efficiency. Similarly, the proposed solution for cheap electricity prices does not consider the rural poverty dimension. Unequal importance and pursuance of these policies have led to improvement in one dimension often at the cost of other.

In developing its agricultural electricity supply strategy, India needs to shift to considering and weighing externally and internally oriented strategies more directly against each other, instead of thinking of them as separable. This research emphasised the need to bundle policies together so that they can produce better outcomes. At the same time, there are several interests at stake that necessitates bundling of interests. In the following section, we make a range of suggestions towards a wider approach to the problem. Here we emphasise the need to integrate electricity management with water and agriculture management along the following recommendations.

- a) *Improving Surface Irrigation.* Since 1950, India has made direct public investment in providing surface irrigation infrastructure. After six decades of public development and public spending, around one third of the irrigated lands have access to surface water. Despite the regular expansion of created potential and increased capital investments, the actual surface irrigated areas have almost stagnated since mid-1980s. Those who are deprived of surface water are bound and motivated to extract groundwater for irrigation, resulting in a much faster development and use of the groundwater potential. Consequently, around two-third of India's irrigated lands are irrigated through groundwater, which has caused rapid increase in electricity consumption in agriculture sector.

One obvious solution lies in the expansion of surface irrigation system. With good monsoon rainfall and water sources like Himalayan glaciers and wide network of river, India has a huge untapped potential. It is urgent to revitalise the existing network of canals to reduce dependence on groundwater. Though detailed studies are required for precise estimates, it seems likely that surface irrigation expansion can produce much larger economic benefit to the farmers and the state at a lower level of capital investment - than investments required in groundwater, particularly when taking into account the cost of subsidies and Agricultural Demand Side Management (AgDSM).

- b) *Groundwater Table Management.* Depleting groundwater tables are one of the major reasons for increasing demand for electricity in groundwater irrigation. Yet, the state has not done enough to recharge groundwater resources. While India receives a good amount of rainfall that can recharge these tables, much of it is wasted or discharged to the sea. There is a need for promoting innovative schemes to recharge them. Individual farmers can do a lot in this direction by harvesting rain water, yet the state need to promote awareness and initiate a range of actions. Though some states have taken initiatives to promote rainwater harvesting, they were not pursued with adequate vigour or well presented to the farmers. On this front, combined efforts of the state and individual farmers are required. Groundwater recharge will not only address the problem of depleting water tables, but also will reduce the demand for electricity to draw water.

c) *Improving Technologies for Lift Irrigation.* There is a strong need to promote alternative and more efficient technologies for crop irrigation. To date, the most popular method is flood irrigation. Water is pumped to the field and is allowed to flow along the ground among the crops. This method is widespread as it is simple and cheap. The problem is that about one-half of the water used ends up not getting to the crops, which means lot of wasted water through evaporation and unwanted runoff. Alternative and more efficient methods of irrigation have developed that can reduce water demands. Drip irrigation for instance saves water by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing and emitters. This method of irrigation is very water efficient, but more suitable for horticulture.

Sprinkler irrigation is another method similar to rainfall. Water is sprayed into the air and irrigates entire soil surface through spray heads so that it breaks up into small water drops. Though both technologies are commercially available in India, they have not received much popular attention due to their cost. Most of the farmers are not in a position to make the upfront investment required to install these systems. However, the state can play a facilitating role by marketing and subsidising these technologies to farmers. These methods of irrigation not only save water and thus electricity, but also save farmers' disposable income.

d) *Modifying Agricultural Practices.* Some easy and cheap methods can reduce a lot of water and electricity demand. Land levelling is one such traditional practice that can save lot of water and improve crop management. The unevenness in land level within a field has a major effect on yields. It results in uneven water coverage, which means that more water is needed to wet up the soil. Land levelling not only improves water use efficiency, but also contributes to better yield by reducing weeds and uneven maturing of crops. Mulching is another agricultural practice that increases moisture retention capacity of land, reduces need for water, reduces erosion, provides nutrients, suppresses weed growth and increases fertility. Instead of burning the organic residues, which is a common practice in India, the farmer can use them as mulch. Though the farmers are aware of these agricultural practices, they often do not rely upon them to avoid extra labour required or due to lack of proper awareness on the benefits. In the actual situation, there is an urgent need to reintroduce these practices in Indian agriculture.

e) *Promoting organic agriculture.* From the climate change perspective, organic agriculture offers a lot of potential. Following the method, agriculturist can minimise emissions and sequester significant quantities of atmospheric carbon dioxide, especially in soil. Additionally, organic agriculture offers alternatives to energy-intensive agricultural inputs such as chemical fertilisers and pesticides. Global adoption of organic agriculture has the potential to sequester up to 72 percent of current annual agricultural GHG emissions (Scialabba and Muller-Lindenlauf, 2010) and up to 32 percent of all current man-made GHG emissions (INFOAM, 2009).

The state need to promote further research on organic agriculture and can help farmers by spreading awareness on this practice. Prevailing fertiliser subsidy is one of the reasons for high water use. Farmers have a perception that

higher use of chemical fertilisers can fetch better yields. Subsidised fertilisers encourage farmers to use them more and more. As we have discussed, higher use of chemical fertiliser requires higher use of water. Therefore, there is a need to reduce consumption of chemical fertilisers and promote use of organic fertilisers which the farmers can produce at zero cost.

- f) *Crop and Variety Diversification.* Crop diversification is another rational and cost-effective method to improve water and energy use efficiency in agriculture (Lin, 2011). Farmers can save a lot of water and electricity by farming less water intensive crops or choose to grow less water intensive variants of the same crop. India already has developed less water intensive variant of wheat and rice. The state can facilitate this process by promoting research on new crops and market them to farmers. This approach not only contributes to climate mitigation by promoting conservation of water and energy but also has potential to improve resilience of agriculture to climate change impacts.
- g) *Realigning Food Procurement Policy.* The state can facilitate crop and variety diversification by realigning food procurement policy. At present, water intensive crops are ensured a protective price and thus have a better market value. In that backdrop, farmers have little incentive to go for less water intensive crops which cannot fetch them good price. The state need to realign its food procurement policy by ensuring higher price incentives to less water intensive crops.
- h) *Redesigning Subsidy Policy.* The current unmeasured and uniform agricultural electricity subsidies are damaging as they benefit more the high consuming farmers and induce unrestricted consumption. Redesigning these subsidies with direct transfers to the targeted beneficiaries can enhance electricity and water use efficiency. For instance, the goal can be achieved by providing stronger price incentive (low tariff) to low consuming farmers and lower price incentive (high tariff) to high consuming farmers. However, there is a need to devise tools for direct transfer of subsidies to needy farmers. Moreover, it would require measuring electricity supply to agricultural consumers.
- i) *Improving Pump Efficiency.* Finally, but only finally, improving pump efficiency is useful to improve the overall energy efficiency in agriculture. Indian states have already started working on this. But the current AgDSM programme needs to better align a range of interests for faster implementation. It particularly needs to ensure farmers active participation so that they have a real stake in the process and share the cost and benefits, which would require innovative arrangements. Active engagement of electricity regulatory commissions, issuing regulatory mandates for timely implementation, is also necessary for better implementation.

Much of these suggested initiatives require the state to play a greater role, while seeking contribution from individual farmers. The state again needs to engage in capacity building and awareness campaigns to promote greater community participation. We again reemphasise the need to take a broader and integrated approach to promote efficiency in agricultural electricity use. What the India state has been doing is certainly commendable, but remains far too narrow in its

approach. Solely focusing on improving pump efficiency, for instance, cannot be deemed a perfect idea as it may also carry a range of negative impacts, like depleting water tables even faster and decrease incentives to manage water demand. That is why, we call upon India to focus first on optimising water demand in agriculture before improving the energy efficiency of any of its devices. The support of the international community, we believe, should be entirely rethought in this light.

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