Agriculture Demand Side Management - New Delivery Mechanisms

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SHAKTI SUSTAINABLE ENERGY FOUNDATION

MP ENSYSTEMS Advisory Pvt. Ltd.

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Shakti Sustainable Energy Foundation (Shakti) seeks to facilitate India's transition to a cleaner energy future by aiding the design and implementation of policies that promote clean power, energy efficiency, sustainable urban transport and climate action. Working collaboratively with policy makers, civil society, industry, think tanks and academia, Shakti seeks to catalyze transformative solutions to meet India's energy needs in clean and sustainable ways.

ABOUT MPENSYSTEMS

MP Ensystems is a niche energy and environmental sector consultancy and advisory firm that was set up in 2012. MP Ensystems works with electricity regulatory commissions to evolve benign regulatory and policy structures that enable implementers to innovate new resource efficient products and approaches to meet resource conservation benefits. As a non-partisan expert business organization, through technical assistance from bilateral and multilateral funders, MP Ensystems has also assisted electricity distribution licensees in designing, implementing and evaluating demand-side management and energy conservation programs.

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ABBREVIATIONS

DISCOM	Distribution Company
DL	Distribution Licensee
DSM	Demand Side Management
kWh	kilo Watt hour
MNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MSP	Minimum Support Price
PPP	Public Private Partnership
T&D	Transmission and Distribution

ABSTRACT

The agriculture sector receives power at low rates and is subsidised by other consumer segments and the state government. State Governments pay subsidies to DISCOMs to bridge the gap between cost of supply and revenues earned. Non-payment of such subsidies resulting from low tariffs is a major contributor to financial losses incurred by DISCOMs. Additionally, despite large government subsidies to the agriculture sector (fertiliser, electricity etc.), farm income in India is less than half of Indian average per capita income. Neither farmers nor DISCOMs are benefitting from the current set up.

Realizing the need to reduce the amount of electricity used in the agriculture sector, several Demand Side Management programs and models have been implemented in India, which focused on replacing inefficient pump sets with efficient ones. Despite significant efforts, these programs have not yielded proportional benefits, partly because they have not been able to address the primary objective of water conservation and management while not being able to break the vicious circle of inefficient pumping and low power quality. It is important to explore new alternatives to promote agriculture DSM efforts.

Farmers who use electricity in the agricultural sector do not want electricity as a commodity. Electricity is simply the means to get water, the commodity they essentially require. This paper explores alternative models to better manage electricity in agriculture, with a focus on promoting water conservation and improving productivity. We propose a departure from conventional water use practices through better off-farm and on-farm water and energy management. A key proposition suggested in this study is to decouple farm-based income with the livelihood options available in rural economies for a finite period to allow for the farmland rejuvenation process. This is possible through alternate livelihood options in the rural sector while enhancing water resource availability and productivity through alternate cropping strategies. Success of such a model would depend on the ability of DISCOMs to collaborate with other stakeholders such as the state government agriculture, water resources and rural livelihood departments.

1. INTRODUCTION AND PROBLEM STATEMENT

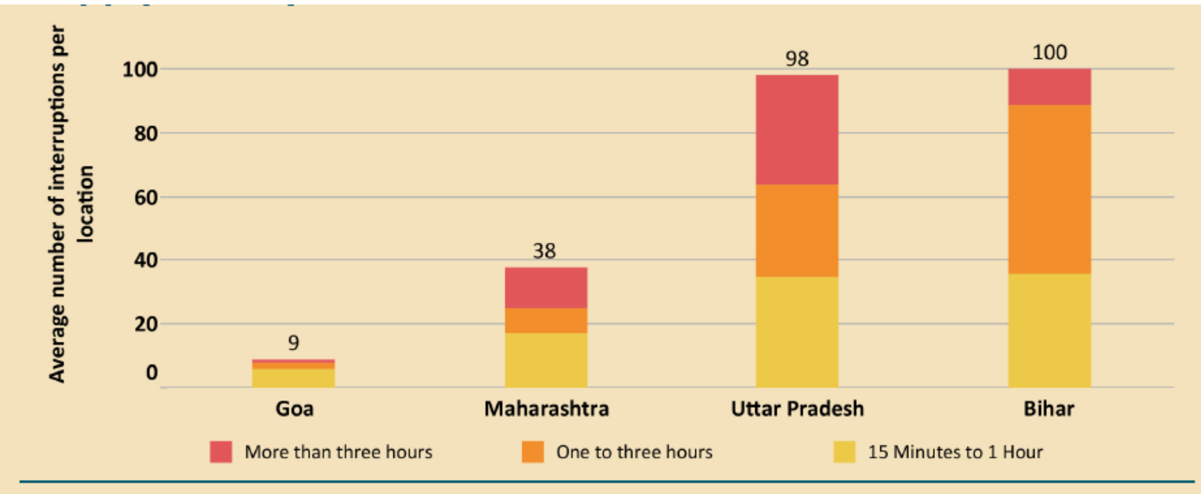
Agriculture sector is key to the rural and national economies with over 30% of population in India dependent on its success for sustenance. This Working Paper aims to deliberate solutions to the problems faced by Distribution Licensees (DLs)/Distribution Companies (DISCOMs) supplying electricity to the agricultural sector. It proposes an innovative approach to improving electricity distribution licensees' finances by combating over-use of water in agriculture. This can be achieved by providing financial and other support to farmers when they practice sustainable, water-efficient crop selection. We explore this topic through a detailed deliberation in this section followed by review of relevant data and our analysis. At the end of this paper we propose alternate solutions to be explored.

The Indian agriculture sector enjoys perpetual low electricity tariffs. In 2013, average agricultural tariff—energy charges only—in the major agricultural states of Punjab, Haryana, Maharashtra, Uttar Pradesh (UP) and Andhra Pradesh were as low as INR 2 per kilowatt hour (kWh). By comparison, average commercial tariff was INR 7.68 per kWh and industrial tariff was INR 5.88 per kWh in the same year.

Electricity regulations require the state governments to bridge the gap between the average cost of supply and tariff pertaining to a specific category through subsidy transfers to the distribution licensees. Non-payment of such subsidies resulting from low tariffs is a major contributor to financial losses incurred by DISCOMs and in effect state governments. According to a 2016 Power Finance Corporation (PFC) report, aggregate losses suffered by DISCOMs in 2014-2015 stood at INR 58,000 crores (approximately US$ 1 billion), which is 14% of annual revenues of all DISCOMs.

In different states, farmers have complained about the non-availability and the suboptimal quality of power. **Figure 1** shows the quality of power supplied to farmers and residential consumers in rural areas in December 2016.

Figure 1 Power Cuts in Rural Areas, August 2017



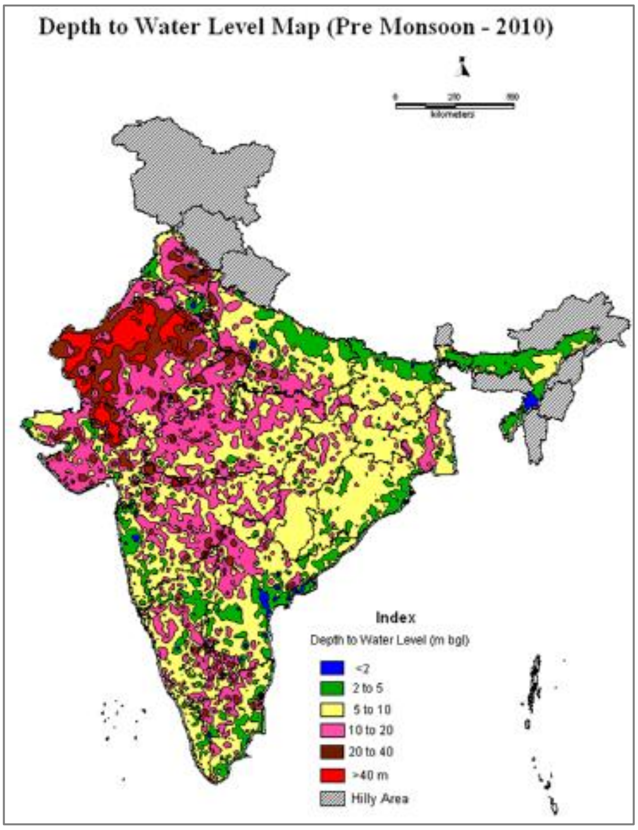
Source: (Prayas Energy Group, 2017)

Poor power quality, non-availability and inconvenient pumping hours has led farmers to undertake various coping strategies such as installing oversized pumpsets. Failure of pumpsets is one of the outcomes of poor power quality if the coping strategy is inadequate (see box: **Vicious Circle of Low Power Quality in Agriculture** below).

Vicious Circle of Inefficient Pumpsets and Low Power Quality in Agriculture

By providing power to agriculture at a flat (and sometimes free) rate, farmers have used inefficient pumpsets and excessively pumped groundwater. Since most farmers don't use capacitors or motor protection equipment, voltage fluctuations occur and power factor is low. The overuse of power and limited revenue usually forces DISCOMs to reduce power supply to off-peak hours. Provision of electricity at night has led farmers to use automatic starters, with most pumpsets starting automatically at the same time, resulting in a heavy initial load that burdens the overall infrastructure. These factors have led to frequent motor burnouts and in response, farmers have moved to using less efficient, fluctuation-resistant pumpsets. As a result, overall power quality worsens, which in turn leads to increasing pumpset and Distribution Transformer damage (Sagebiel J., 2016).

Figure 2 Declining Ground Water Table



Source: (WRIS, 2011)

Cheap, erratic power supply is one of the main reasons for farmers using larger pump sets. This has led to greater water withdrawals and further water-intensive crop selection, and in turn caused an alarming depletion of the ground water table. **Figure 2** shows stressed groundwater tables in the Indian states.

The government provides a number of subsidies to farmers, of which electricity and fertilizer subsidies are the largest. In 2015-16, fertilizer subsidy in India was INR 70,000 crore. In the same period the annual electricity subsidy was INR 37,800 crore. However, despite these subsidies, average farm income per household per month in 2012-13 was INR 6,426 (NSSO, 2016). This is less than half of India's average monthly income of INR 13,500.

These facts indicate that farmers and DISCOMs both suffer from the current status of pricing and service delivery. A thorough analysis through interactions with the stakeholders enabled us to consider alternative ways to solve the problem. It is clear that the electricity sector alone cannot provide the solution in the agriculture sector. The problems in the agricultural electricity sector can only be solved by co-management of electricity and water. The solution lies on both sides of the electricity meter. On the utility side by improving the quality and reliability of power supply and on the farmers side by improving the selection and efficiency of pumpsets as well as enhancing irrigation water efficiency and farm income through water conservation, redirecting subsidies and promoting sustainable cropping patterns. The objective of this Working Paper is to define the problems faced by DISCOMs supplying electricity to the agricultural sector and propose a solution to rationalize the sector's electricity consumption.

2. DATA REVIEW AND ANALYSIS

Using publicly available data, as well as anecdotal evidence from sector stakeholders, we analyse the link between electricity and water use in agriculture in this section. In addition, we also provide insight into the severity of the problems facing DISCOMs and farmers.

2.1 Electricity and Water Consumption in Agriculture

The Indian agricultural sector accounts for 18% of the country's Gross Domestic Product (GDP) and employs 50% of its labour force (Department of Agriculture, 2016-17). About 34% of net sown area is irrigated, with the remainder dependent on the rains. Irrigation is provided mainly through surface water (canals, tanks) and ground water (wells, tube wells). Close to half of irrigated farmland uses ground water for irrigation (Department of Agriculture, 2011).

The agricultural sector consumes more than 18% of the total electricity supplied in the country. In large irrigation-dependant states such as Maharashtra, Punjab, Haryana, Andhra Pradesh, the sector consumes over 25% of total electricity supplied.

Data estimates in 2014 showed that there are more than 15 million agricultural pump sets connected to the grid, while 8 million pump sets are diesel-powered (India Infraline, 2014). Across the sector, electricity supply is either free or the tariff applicable is very low. Other major issues include:

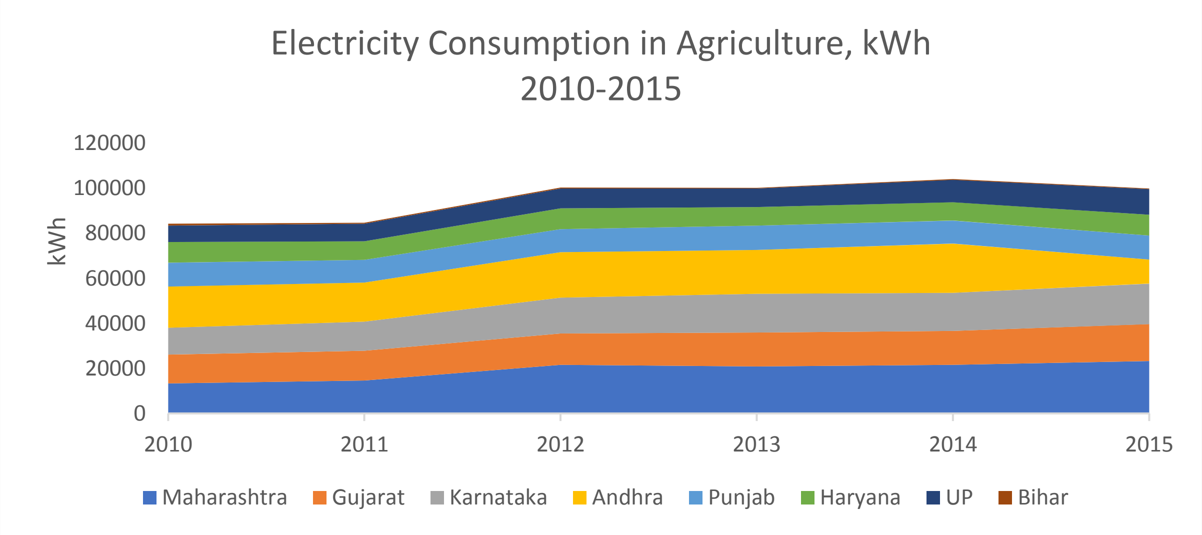
- Non-existent or limited metering of power supply
- Poor quality power supply
- Power theft
- High transmission and distribution (T&D) losses

Agriculture consumes more than 80% of the country's water resources (FAO, 2012) and more than 60% of the water used for irrigation is ground water (World Bank, 2012). In some states such as Haryana and Punjab, ground water use exceeds the amount of recharge into aquifers. The issue is compounded by non-existent or limited metering of water supply. Given the low input costs of water and electricity, water-intensive crops such as sugarcane and rice are cultivated to maximise incomes.

2.2 Electricity Consumption in Agriculture – 2010-2015 (kWh)

Agriculture is responsible for approximately 18% of India's overall electricity consumption, but accounts for only 7% of revenue generation for DISCOMs (SSEF, 2014).

Figure 3 Electricity Consumption in Agriculture, kWh



Source: (Power Finance Corporation, 2016)

Figure 3 and **Table 1** show that, in most states, electricity consumption has been rising between 2010 and 2015. In 2014, per capita electricity consumption crossed 1000 kWh, compared to 957 kWh in 2013 and in some states, electricity consumption rose at 9%.

Table 1 Growth Rate of Electricity Consumption in Four States

State	CAGR Electricity consumption	% Share of Agriculture in total electricity sales, 2014-15
Maharashtra	9.7	28
Gujarat	5.1	25
UP	9.3	18
Haryana	0.1	25
Andhra*	-10.2	26

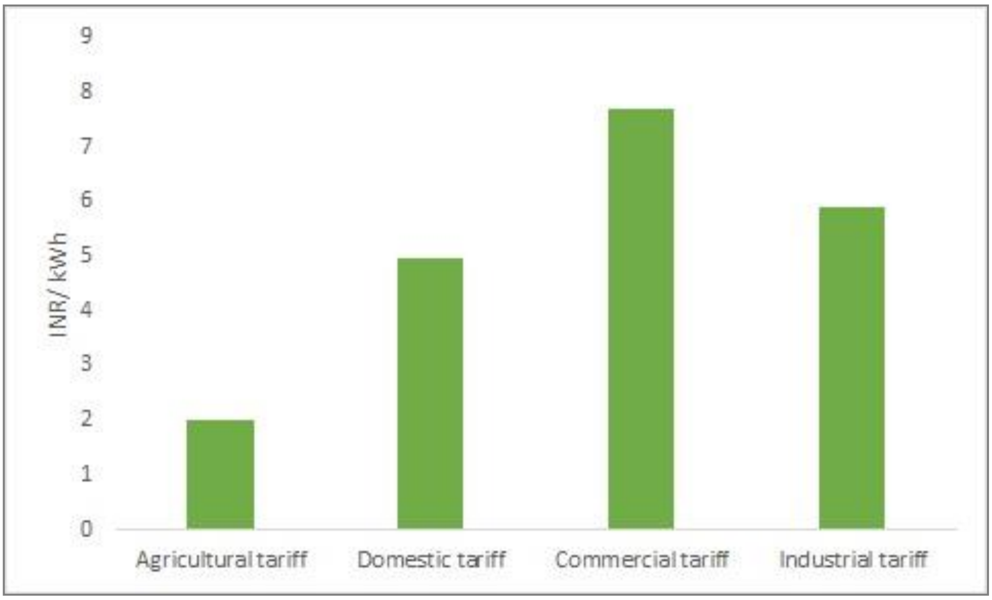
Source: (Power Finance Corporation, 2016)

*Drop in Andhra energy consumption in 2014 due to creation of Telangana state.

2.3 Electricity Tariffs for Agriculture

In the mid-1970s, the State Electricity Boards moved from installing and reading meters to a flat rate (based on connected HP) for agricultural consumers, to help drive the green revolution. At that time, it reduced administration costs when the number of pumpsets was a few hundred thousand. However, its relevance and impact steadily declined as the number of pumpsets increased in the late 1980s onwards. Today it has made agricultural power supply and water use unsustainable since the marginal cost of pumping is zero. Although metering as an alternative was re-introduced in 1993, very few agricultural consumers have metered electricity connections (AEEE, 2016).

Figure 4 Average Tariff for Punjab, Maharashtra, UP and AP



Source: (Power Finance Corporation, 2016)

Figure 4 shows agriculture tariffs in 2014-15—energy charges only—across consumer categories in the major agricultural states of Punjab, Haryana, Maharashtra, Uttar Pradesh and Andhra Pradesh.

This can be compared to **Table 2** showing the comparative tariffs of specific utilities across consumer categories.

Table 2 Utility Tariffs by Category in Major States, 2012

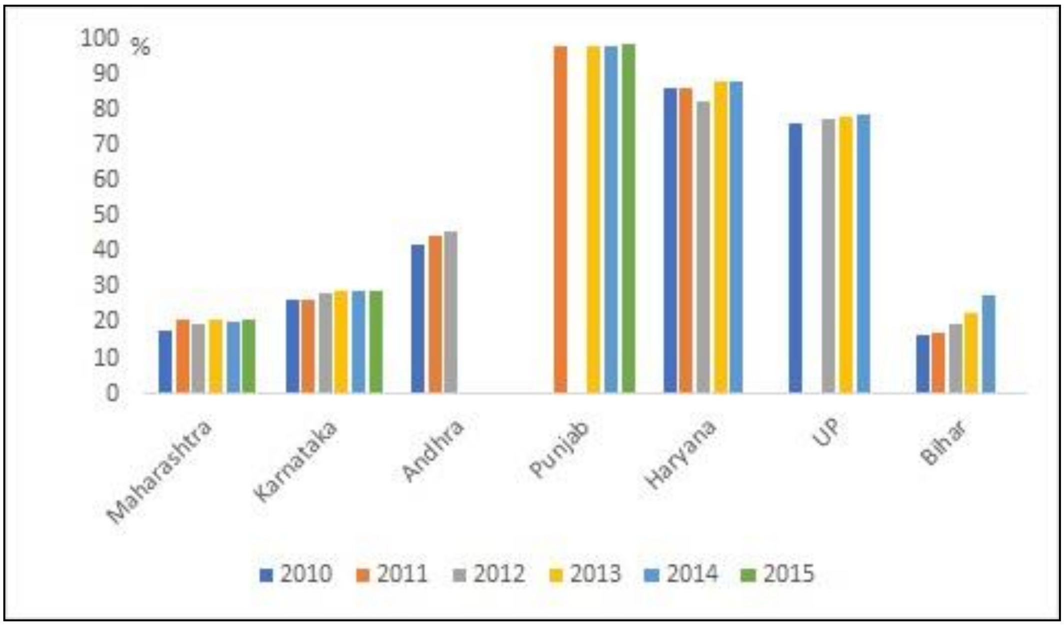
Utility	State	Agriculture	Domestic	Industrial (HT)
PSPCL	Punjab	0	3.85	4.77
DVVN	UP	1.1	2.56	5.69
Paschim VVN	UP	1.37	2.9	5.47
TANGEDCO	Tamil Nadu	0	1.67	6.97
BESCOM	Karnataka	1.24	4	5.64
MSEDCL	Maharashtra	2.15	4.43	6.32
UGVCL	Gujarat	2.1	3.93	5.72

Source: (Power Finance Corporation, 2016)

2.4 Irrigated Area as a Share of Total Cropped Area

Across India, approximately 34% of all cropped land is under irrigation (Department of Agriculture, 2016-17). **Figure 5** shows the percentage share of total cropped area that is irrigated, which is higher in states such as Punjab, Haryana and UP. For Maharashtra, Haryana, UP and Bihar, data used is gross irrigated area as a share of gross cropped area. For Karnataka, Andhra and Punjab, the data used is net irrigated area as a share of gross cropped area.

Figure 5 State-wise Irrigated Area as Share of Total Cropped Area, 2010-2015

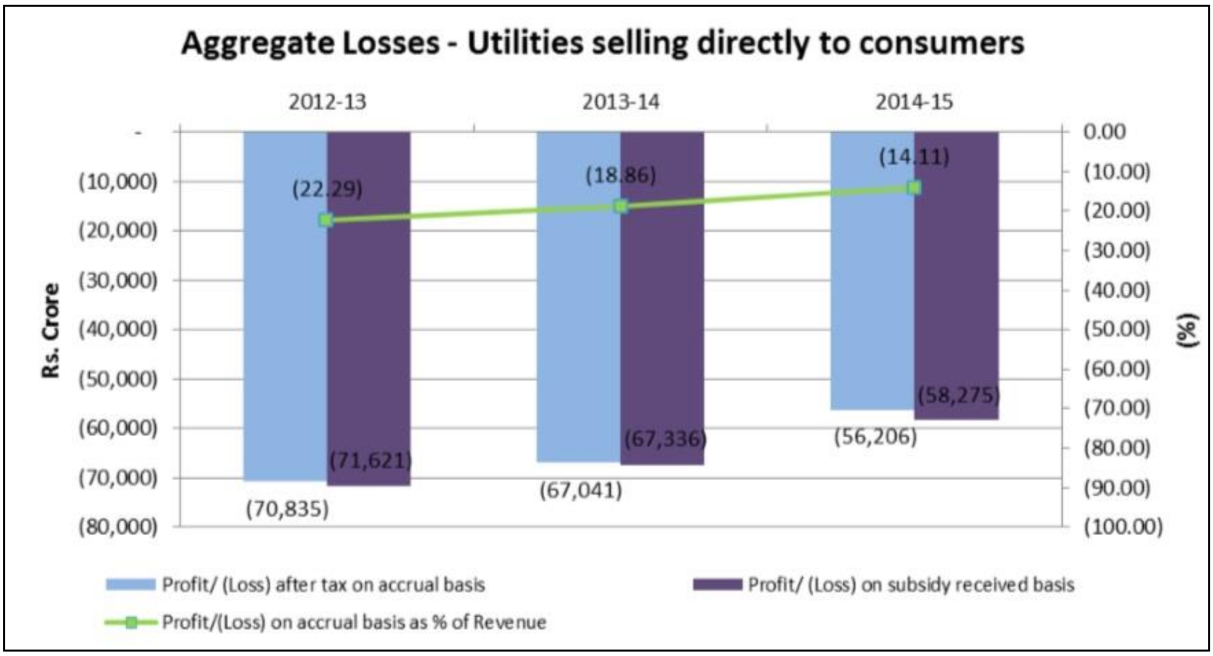


Source: (Mospi, 2017)

2.5 DISCOM losses

A Power Finance Corporation (PFC) report on the performance of DISCOM finances noted that losses had decreased over the past three years. The report noted that while the losses have reduced from INR 71,000 crores to INR 58,000 crores, the subsidies given to DISCOMs by state governments increased by 13% (Power Finance Corporation, 2016).

Figure 6 All-India Aggregate Losses of DISCOMs, 2012-2015



Source: (Power Finance Corporation, 2016)

2.6 Agriculture Sector Subsidies

As this paper focuses on understanding the true nature of subsidies in the agriculture sector, it is important to look beyond the electricity sector to track possible positive externalities that can enhance the state and national finances. Agriculture sector subsidies can be categorized as direct and indirect. Direct subsidies involve actual payment of funds by the government to farmers. Indirect subsidies by comparison involve payments made by the government to other entities but still benefit farmers. Both the central and state governments provide direct and indirect subsidies to farmers in India.

Export subsidies are an example of direct subsidies given to farmers. Minimum Support Price (MSP) for agricultural produce is a price protection mechanism provided by the government. However it is treated as a direct subsidy if the MSP is greater than the market equilibrium price.

Indirect subsidies comprise subsidies for fertilizer, electricity, seeds, agricultural equipment, irrigation, credit, transportation, information, and storage. In 2015-2016, fertilizer subsidy in

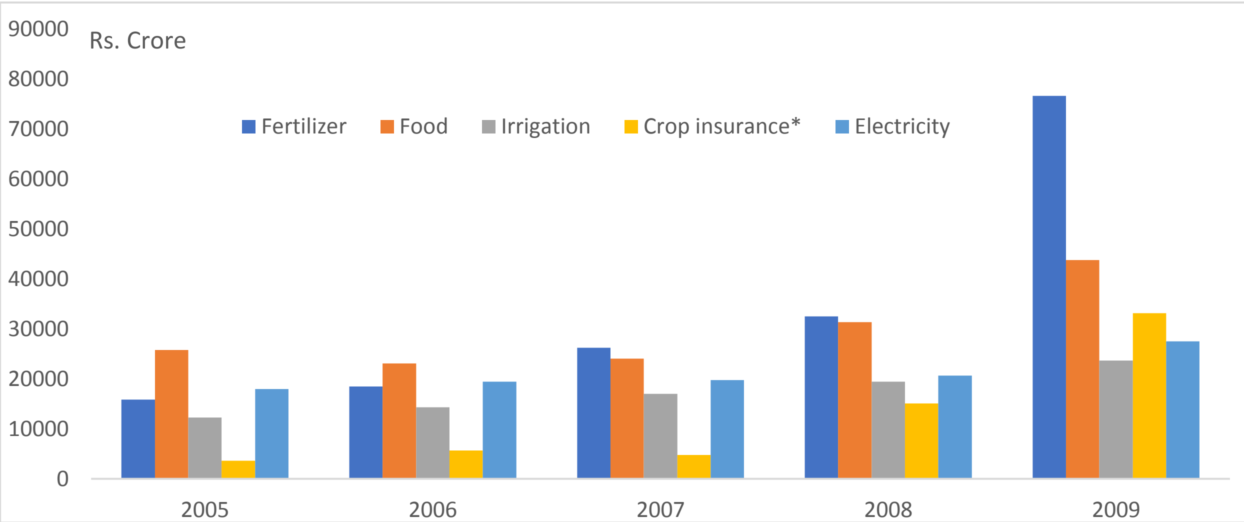
India was INR 70,000 crore. In the same period the annual electricity subsidy was INR 37,800 crore (Department of Agriculture, 2016).

It is noteworthy that the beneficiaries of these subsidies, as well as infrastructure, investment, technology innovations, and extension efforts are confined to specific regions in the country, namely in "irrigated and coastal" areas, with farmers in "rain-fed" regions in the rest of India not receiving the benefit of these subsidies (Ray, 2011). The disparity in subsidies has led to a widening income gap between regions and is also a cause of social tension and political unrest.

2.6.1 Major Subsidies for Agriculture

The trend of increase in subsidies by the government to the agriculture sector is shown in **Figure 7**. The fertiliser subsidy increased drastically from 2008 to 2009, due to the change in the method of calculating costs. From a "cost-plus" approach, the government moved to import parity pricing (IPP) for complex fertilisers. This led to a steep increase in the price of all fertilisers and raw materials. However, this was not accompanied by a rise in food grain production. In 2009, the government moved to a "nutrient-based" approach for fertiliser subsidy. This led to a sharp rise in prices of phosphoric and potassic fertilisers and increased application of urea, which in turn affected the soil nutrient balance (Mint, 2015).

Figure 7 Subsidies to Agriculture Sector, 2005-2009



Source: (Planning Commission, 2014)

*Insurance subsidy for marginal farmers

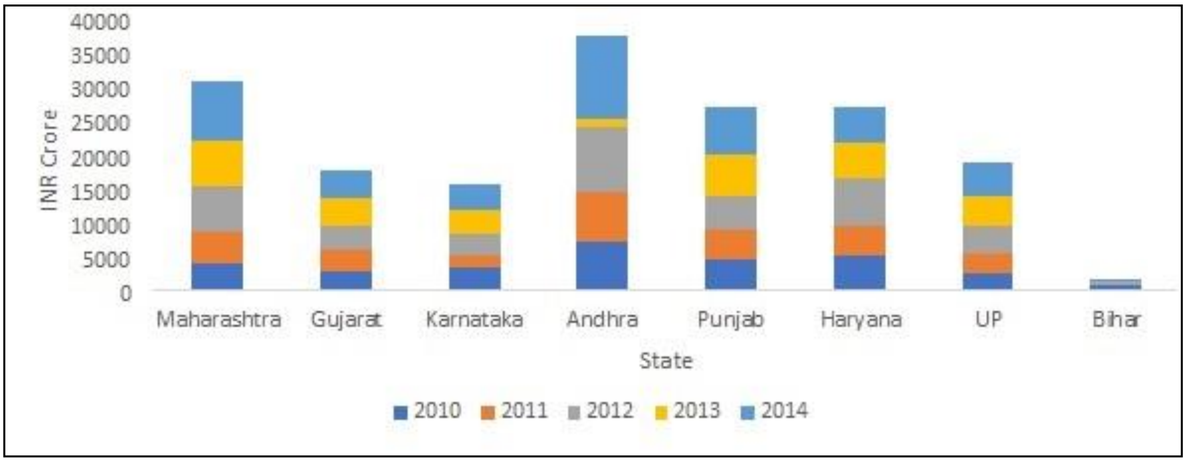
2.6.2 Electricity Subsidies to Agriculture

DISCOMs incur financial losses in supplying electricity to agricultural consumers, amounting to the difference between the cost of supply and the revenue realized through the sale of power. This financial loss is sought to be "subsidized" in two ways to enable the DISCOM balance its books. The first is cross-subsidization, whereby high-paying sectors such as large commercial and industrial consumers pay more than the cost the utility takes to supply them. There are obvious limits to raising industrial and commercial tariffs to increase the amount due to cross-subsidization, as it would make industry non-competitive and create unemployment if industries decide to shut down or relocate. High tariffs may also force industries to co-generate or use captive power and rely on the grid only for back-up or critical loads. Both Open Access and Rooftop Solar policies support the subsidizing consumers to look up to alternate resources that are getting cheaper by the day. The second subsidy mechanism for DISCOMs is a direct subsidy, which is the direct transfer of state government resources from the exchequer. In this paper, electricity subsidies to agriculture focus on the latter and not the former.

State government subsidies to DISCOMs have been increasing over the past few years, amounting to INR 48,181 crore in 2014-15 and accounting for over 13% of revenue. It is worth noting that state governments do not necessarily release the entire amount of subsidy booked by DISCOMs, leading to ballooning deficits at DISCOMs. Non-availability of cash to buy electricity is one of the most prominent barriers faced by the DISCOMs today.

Figure 8 and **Table 3** show the rising electricity subsidies in eight key states. The state's power demand as well as political scenario are factors that lead to rising subsidies. For example, in Maharashtra, prior to state elections, the Government had announced a power subsidy of INR 700 crore (100 million USD) per month in 2014 (Times of India, 2014).

Figure 8 Electricity Subsidies to Agriculture, 2010-2014



Source: (Planning Commission, 2014)

Table 3 Electricity Subsidies for Agriculture by State

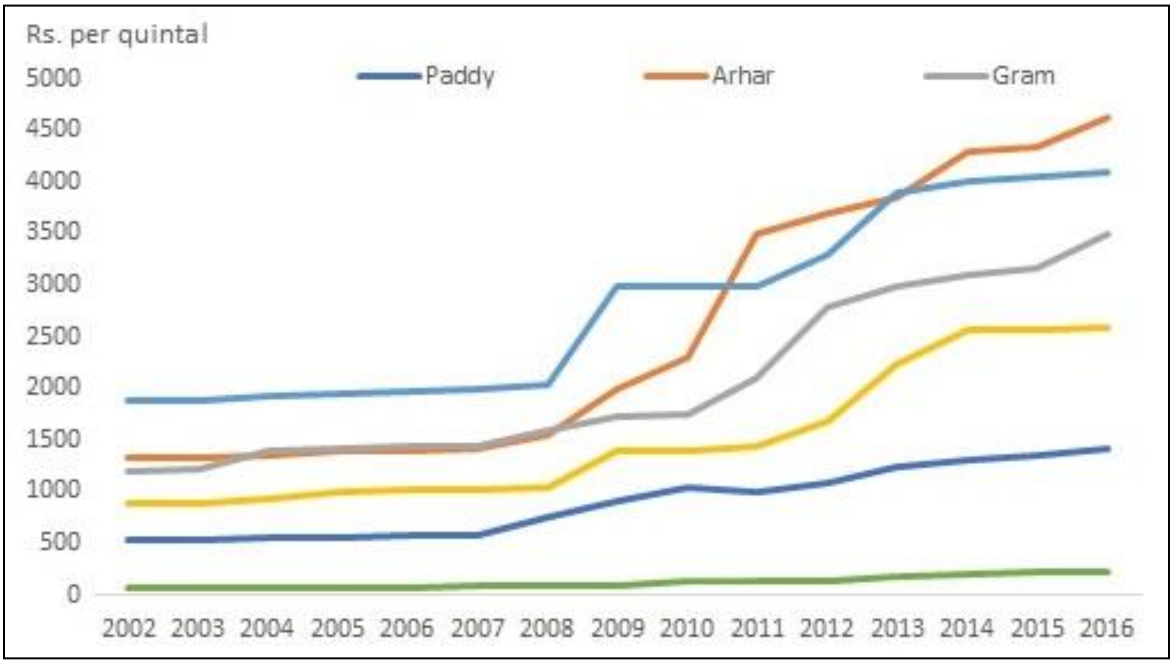
	2010	2011	2012	2013	2014
Maharashtra	3715	4742	6710	6837	8494
Gujarat	2618	3339	3454	3893	4322
Karnataka	3134	1969	3057	3540	3756
Andhra	7192	7215	9423	1177	12321
Punjab	4485	4283	4919	6236	6958
Haryana	4983	4271	6994	5202	5436
UP	2495	2837	4173	4252	4999
Bihar	515	248	364	243	230

Source: (Planning Commission, 2014)

2.6.3 Minimum Support Price

The government's Minimum Support Price (MSP) policy aims at reducing fluctuations in farm income and keeping food prices stable. MSP is also used to incentivise farmers to grow specific crops.

MSP is announced at the beginning of the season by the Commission for Agricultural Costs and Prices and is based on factors such as demand, supply, trends in input costs, domestic and international trends in crop prices and inflation. MSP applies to a limited number of crops



and the chart below shows the rise in MSP between 2002 and 2016.

Figure 9 Minimum Support Price, 2002- 2016

Source: (Department of Agriculture, 2017)

2.6.4 Average Annual Subsidy per Acre

The average farm household income in 2012-13 was INR 6,426 (NSSO, 2016). This is less than half of India's average monthly income of INR 13,500.

The overall subsidies provided by the government to the agricultural sector were discussed in the previous section. However, agricultural subsidies do not equally benefit all farmers across India. For instance, MSP benefits are only provided to farmers growing paddy, wheat, maize, sorghum, pearl millet, barley, ragi, gram, tur, moong, urad, lentil,

Table 4 Average Annual Subsidy per acre

Annual subsidy bill, INR million	3,640,000
Average farm size,acres	2.8
Number of farm holdings, million	138.35
Subsidy per acre, INR	9,262

Source: (NSSO, 2010), (GoI, 2015), (GoI, 2011) groundnut, rapeseed-mustard, soya bean, sesame, sunflower, safflower, niger seed, copra, sugarcane, cotton and raw jute. Rice is the most heavily subsidized crop followed by wheat, sugarcane and cotton. Most of the subsidies benefit farmers with large holdings in Uttar Pradesh, Andhra, Maharashtra, Madhya Pradesh and Punjab (IIM A, 2009).

In order to estimate the average subsidy received by a farmer, (and given that the actual subsidy received varies greatly across regions, by land size, crop grown etc), we followed two approaches:

a. To estimate the subsidy provided by the government to the average farmer, data on the number of farm holdings and average farm size from the Agriculture Census 2015 and the Indian census 1990 was used. Data on the annual total farm subsidy bill was obtained from India's filings to the World Trade Organisation (WTO) in 2015. Based on this data, a rough estimate was made that the annual subsidy provided by the government to an average farmer is approximately INR 9,000 per acre.
b. Using the approach of calculating Aggregate Measure of Support (AMS) to agriculture, we found that the overall subsidy to agriculture in India is negative. First, since domestic produce prices are significantly below international prices, there is a large implicit tax on the agriculture sector. Additionally, input subsidies and zero income tax lead to lower prices, which benefits consumers, not farmers (Ray, 2011).

3. HIGHLIGHTS OF AGRICULTURE DSM PROGRAMS IN INDIA

This section of the paper discusses the major Agriculture DSM programs implemented across India and highlights some of the programs implemented across the country to promote water efficiency in agriculture.

3.1 Energy efficiency programs for Indian agriculture

Energy efficiency and DSM in agriculture in India has been driven by pump set replacement programs. The two main areas of improvement have been:

- Efficiency of the pumping system
- Standards for induction motors and pump sets

3.1.1 Fuel-switching for agriculture pump-sets in Gujarat

Among the early pumpset efficiency programs in India, a pilot pump replacement was launched during 1980s in Gujarat. However, this was not a DSM program, as it targeted diesel pumpsets and not electric pumps. The program covered over 1000 component retrofits—including piping, foot-valves and pumps—which led to energy savings of 22%.

3.1.2 Motors replacement initiative

An early Ag DSM program (possibly the first by a DISCOM) was implemented in Nalgonda District, Andhra Pradesh in the late 90s with support from the Depart for International Development, UK (DfID). The beneficiary was the erstwhile Andhra Pradesh State Electricity Board (APSEB) and the project involved replacement of three phase electric motor pumpsets by single phase electric motor pumpsets. While the project resulted in some electricity savings it was not considered successful, for the following principal reasons:

a. Farmers were reluctant to replace existing pumpsets with a lower HP capacity new pumpset. They were however agreeable to switch to pumpset of the same capacity. Thus connected load remained almost the same and demand savings were negligible.
b. Since the farmers were reluctant to replace their existing pumpsets, three-phase supply network could not be removed and remained as a back-up. A separate single phase line was erected to provide power to the new single phase pumps.

3.1.3 USAID's WENEXA initiative

The Water Energy Nexus Activity (WENEXA) was conceived and designed in 2004 by USAID under a bilateral partnership with Ministry of Power. The program addressed the intricate co-management of energy and water resources in agriculture through enhanced power distribution and end use efficiency, coupled with sound water management practices. Under the WENEXA project, an innovative market-based solution was established to replace old pumpsets with new efficient ones. The pilot was based at Doddabalapur and implemented in partnership with a DISCOM- BESCOM. This demonstration project involving the replacement of over 600 pumpsets was the first market driven public-private partnership between BESCOM and a private energy service company. The WENEXA pilot showed substantial energy savings alongwith improvement in the water table.

3.1.4 BEE’s ESCO-implemented pumpset replacement program

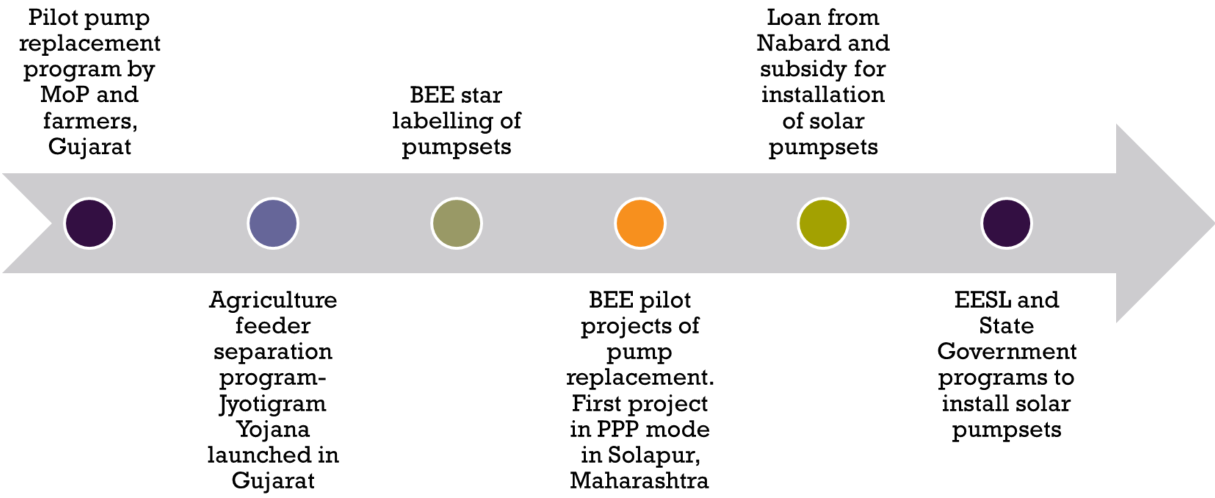
A landmark DSM program in improving agricultural energy efficiency was the Bureau of Energy Efficiency (BEE) standards and labelling of induction motors and pump sets. While labelling is voluntary, government agencies mandate star-rated pumps in their programs. The BEE pilot pump replacement program in Solapur, Maharashtra in 2009 aimed to replace over 3,500 inefficient pumps. This program was noteworthy for its inclusion of Energy Service Companies (ESCOs) in the implementation plan.

3.1.5 AgDSM initiative of EESL

Energy Efficiency Services Limited (EESL) launched an AgDSM program that involved procurement of BEE 5-star rated pumps and their delivery to famers over the counter. EESL carried out awareness and promotion campaigns to secure farmer participation. EESL employed local firms to provide installation and repair services to remove existing pump sets and install new ones. Incentives such as free repair and maintenance were also provided. Despite the success of the program, it was curtailed since it was not suitable for scale-up at a pace that would be adequate to meet the government’s efficiency targets.

Currently, EESL has launched a solar PV mini-grid plus pumping program to deploy energy efficient solar pumps along with solar PV panels connected to a minigrid. This is expected to create incentives for the farmer to reduce consumption of electricity and provide an alternate source of reliable power for the pumpset. The program targets replacing 10 lakh pump sets a year. EESL will also pay for maintenance of the pumps and expects to recover costs through the energy savings achieved (AEEE, 2016).

Figure 10 Agriculture DSM Program Highlights



Source: (AEEE, 2016)

Figure 10 shows a timeline of major Agriculture DSM programs and **Table 5** describes the programs.

Table 5 Agri DSM Programs in India

Program	Objectives	Cost	Strengths	Weaknesses
Feeder Segregation in Rajasthan, Gujarat, Andhra, Haryana, Punjab, Karnataka, Maharashtra and MP	• Improved power supply to rural non-agricultural consumers • Improved load management for agricultural customers. • Transparency, capping agricultural subsidies and stabilising financial position of discoms • Reduction in line losses • Improved management of environmental resources	Cost per feeder ranged* from Rs 45 lakh in Haryana to Rs 68 lakh in Gujarat	• Improved load management • Improved power supply to rural consumers • Improved socio economic conditions of rural consumers • In Punjab, virtual feeder segregation failed and increased supply and poor distribution system led to higher losses • Now included in UDAY scheme and being monitored by the government	Benefit Cost analysis shows that feeder segregation projects may not be viable unless: Reduction in line losses is more than five percentage points The DISCOM realizes at least 80% of the average cost of supply through tariff and subsidy A single load segregation approach may not work for all states

Program	Objectives	Cost	Strengths	Weaknesses
Pump replacement by EESL- 10 lakh inefficient pump sets to be replaced with star rated efficient pump sets, free of cost, along with maintenance (Program discontinued)	• Replace conventional pumps with EE pumps, which are 30-40% more efficient, but cost 20% more	• EESL program costs per pump ranged from Rs. 50,000 in Karnataka to Rs. 70,000 in Andhra	30% energy savings from pilots in Karnataka, Andhra, Telangana, Rajasthan • Total cost of electricity saved is expected to exceed the total installed cost of the pump sets over its useful life, leading to net economic gain	• Technical, geographical, financial, monitoring, institutional challenges encountered, as well as resistance from farmers
Performance contracting program by BEE, involving ESCOs	To carry out market based transformation in agriculture pumping sector by launching few pilot projects and introducing policy based interventions		• Pilot in Solapur, Maharashtra led to 6.1 MU savings achieved by replacing 2209 inefficient pumps with BEE star rated pumps • M&V protocol designed and implemented	Capacity building sessions held in different states, DPRs issued but no large scale implementation occurred

Program	Objectives	Cost	Strengths	Weaknesses
Solar pump sets including 1) Solar PV mini-grid plus pumping program 2) Solar PV generation systems for agricultural loads	Solar to replace diesel as the fuel for pumping among small and marginal farmers, lacking access to the electricity grid		Diesel use mitigation is expected to lead to diesel subsidy saving, CO_2 emission abatement, forex savings, improved energy access and better crop yields	Programs currently under way

Sources: World Bank, 2013; EESL, 2015; BEE, 2014; Shakti Foundation 2014

3.2 Initiatives in Water Resource Management

Government of India Initiative

The Government of India formulated the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) in July 2015 to promote water use efficiency.

The 'More crop per drop' initiative under the PMKSY aims at:

- Improving water use efficiency
- Promoting micro irrigation
- Enhancing recharge of aquifers and introducing sustainable water conservation practices
- Promoting watershed approach towards soil and water conservation, regeneration of ground water, arresting runoff and providing livelihood options
- Facilitating extension activities including water harvesting, water management and crop alignment
- Promoting the use of efficient electric/solar pump sets

In addition to PMKSY, the central government has also initiated a collaborative project with the European Union called Water4Crops. The aim of this project is to promote biotechnological wastewater treatment and reuse in agriculture systems. The project comprises an Indo-European consortium of 36 organizations—14 Indian and 22 European—belonging to research institutions, universities, large industries and small and medium-sized enterprises (SMEs).

Since the inception of the program, priority irrigation projects to be built or repaired have been identified, though not as yet completed. There have been reports of an increase in the cover of micro-irrigation and soil health cards have been issued to farmers. The actual impact of these programs can only be evaluated over a longer period of time.

<u>State Government Efforts</u>

State Governments have launched programs to promote water conservation and reduce groundwater depletion. Typically, these projects focus on building infrastructure to collect and store water, and do not include DISCOMS, pumpsets and energy conservation. As an example, in 2015 the Maharashtra Government launched a project called the 'Jalyukta Shivar Abhiyan' with the objective of making the state drought-free by 2019. The project focused on deepening streams, constructing check dams, working on *nullahs* (drains) and digging farm ponds. The state has so far incurred an expenditure of INR 5,000 crores. While the project has helped bring 12,000 acres of land under irrigation, there has been concern that indiscriminate digging of ponds under the project has accelerated groundwater depletion (The Hindu, 2017).

Community-led Initiatives in Water Resource Management

A number of water resource management in agriculture has been undertaken by groups of farmers. While these initiatives were at first developed by NGOs, they are subsequently taken up by farmers and village panchayats and replicated in other districts. These initiatives typically focus on water conservation at the community level and do not tackle agricultural electricity consumption.

Some noteworthy community-level groundwater initiatives across India include:

- **Pani Panchayat**: These are water user groups in drought-prone regions of Maharashtra. They focus on ensuring equity of access to water (GSSD, 2001).
- **Water Warriors**: In Rajasthan, villagers contributed resources to build traditional earthen dams, or *johads*, to recharge ground water (SIWI, 2015).
- **Jal Chaupal: In Uttar Pradesh, informal groups meet to share knowledge and take actions** such as, for example, cleaning village ponds. The activity is supported by the World Bank (Water Aid India, 2016).

4. AN ALTERNATIVE APPROACH

In the preceding sections, we have attempted to capture the challenges faced by DISCOMs in supplying electricity to agriculture consumers and the different types of agriculture DSM programs that have been implemented so far. With this Working Paper, we aim to propose an innovative agricultural DSM structure.

4.1 Projected Structure

As is evident from our analysis, DISCOMS suffer a loss of revenue when they sell electricity to the agricultural sector, since agricultural tariffs are subsidised by the state and by other consumer categories, as discussed in Section 2. It is important to note here that farmers who use electricity in the agricultural sector do not want electricity as a commodity. Electricity is simply the means to get water, the commodity they essentially require.

After analysing the farming and water sectors, certain drawbacks in the current agricultural DSM concept can be identified. As an example, consider an agricultural pump set rated at 7.5 kilowatt (kW) being downsized and replaced with a 5 kW pump set. If this 5 kW pumpset is meant to pump only 200 feet of groundwater, and if groundwater levels dip, it is not going to cater to the lower water table. For this reason the solution does not only lie in the electricity sector, but also in the water sector. Essentially, ground water recharge, on-farm water conservation—more crop per drop of water—and efficient pump-sets form complementary components of the solution. These are all essential complementing conditions.

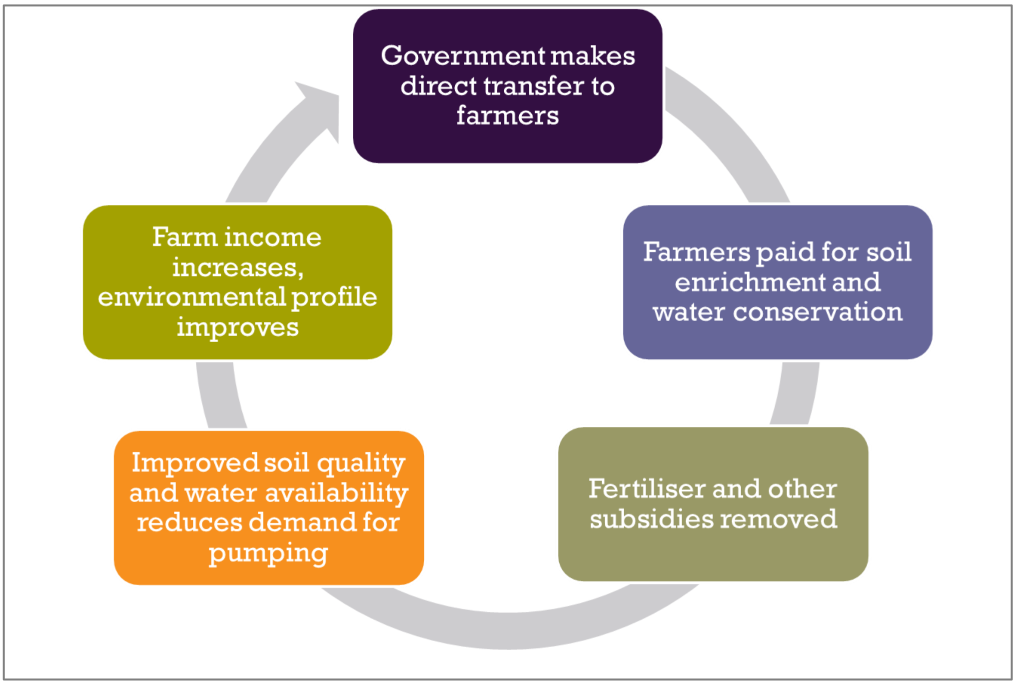
Let us consider the goals of farmers now. Farmers cultivate their land with the primary objective of earning a livelihood. The proposition is to create a structure where:

- First, farmers recharge and continually keep recharging the groundwater table. Groundwater recharge must become an essential part of the agricultural DSM activity.
- Second, alternative efforts to conserve water must be encouraged. These include changing the cropping pattern and using Micro-Irrigation Systems (MIS) by creating on-farm ponds with reduced evaporation losses. Several state governments (Maharashtra and Karnataka for example) have mandated the use of MIS in the sugarcane.

- Third, ensure alternate livelihood opportunities for agriculturists so they can consider forgoing certain income for an interim period.

In other words, the structure proposed connects livelihood opportunities, water conservation measures and electricity demand in the farmland as part of a single unified package.

Figure 11 Proposed Agriculture DSM Structure



To move forward on this proposed structure, the government and the DISCOMs can consider collaborating with stakeholders in the water sector, the agricultural sector, and rural livelihood. There are several projects such as MNREGA which offer specific livelihood opportunities to rural youth for common and community activities such as building roads or farm ponds. One option recommended is that for a period of three years, farmers on a rolling basis, do not engage in agricultural activity. This would ensure food security is maintained while providing the time for the farms not being irrigated to build check dams and other water harvesting structures. Farmers would also need to ensure that any run-off flowing outside the farm land goes into the soil. This would help in recharging and improving the soil moisture content. It would also help create recharge wells, which in turn would improve the ground water table. In a cooperative structure, a group of farmers can work together to ensure groundwater recharging and to develop certain types of check dams. These check dams can cater to water requirements. This would also enable them to use micro irrigation systems that would reduce the overall water-use per acre or per ton of agricultural produce. In addition to the above, a review of agricultural pumps in the country is also recommended. A combination of improving agricultural pumps and water conservation measures by using micro irrigation systems is essential and merits exploration. This is the new structure proposed as a part of the agricultural DSM project.

4.1.1 Proposed Institutional Framework

This section describes how the structure proposed earlier can work at an institutional level.

1. **Stakeholder Mapping**

The first step would be to use the results of land and water use surveys to identify the stakeholders in the sector. In addition to farmers, groups such as landless labourers and water management groups depend on electricity for farming. The sale of water from farms for non-agricultural purposes, such as to tankers for supply to cities, should also be noted.

2. **Setting-up new Institutions**

As a first step, a simple public-private partnership (PPP) structure must be created where a group of farmers, or the cooperatives form a partnership with representatives from state Government departments including Agriculture and Rural Development, Irrigation, Power as well as a representative from the DISCOMs. This body will initially commission a project report on water consumption, power consumption, ground water, crop selection and farm income scenario in the state, starting with a pilot district. On completion of the project report, it is to be shared with DISCOMs, the water resources department, the agriculture department and the rural livelihoods department so that they can create a common platform to promote resource efficiency initiatives.

3. **Funding through Agriculture subsidies**

The proposed mechanism requires funding for the inception report, payments to farmers for changing the cropping pattern, building check dams and rejuvenating the land. The fund are to be made available through subsidies given by the government for farm-based electricity consumption. These are to be diverted, using an escrow mechanism, to a single separate account. While estimates of total subsidies provided are available, the initial report will estimate the funds required to pay for investments in soil rejuvenation, water table enhancement etc.

This account will receive electricity subsidies, livelihood opportunity budgets and any other farm-related subsidies. From this common account, the group of farmers would:

- Pay for the evaluation report
- Evaluate changes in the cropping pattern
- Start rejuvenating the soil moisture content
- Examine the percolation and recharge on farms
- Create check dams
- Create a structure to collectively purchase micro irrigations systems

With all of these activities, this model would allow some farm land to be converted as a part of the rural DSM.

4. Inclusion of Renewables

There is currently a strong and growing interest in renewable energy, as well as government programs promoting solar pumping. The program could include setting up a substation with wind, micro hydro/pico hydro and solar farms connected to it. This substation could then feed multiple agricultural pump sets. It can be used as a form of consolidation of electricity consumption in the agricultural sector.

Such a substation, owned by the DISCOM, can even start monitoring the energy consumption at a particular feeder. Reduction in kWh consumption can be measured every day. One can then correlate this information with agricultural land and farmland ownership.

5. Political economy

An important component of the program would be to garner support from stakeholders, including farmers, farm labourers, cooperatives, DISCOMs and politicians. Stakeholder consultations, pilot projects, stalls at agricultural fairs and meetings with ministers of relevant ministries are a part of creating awareness of the long term benefits of the program. After creating awareness among farmers, the next step is to build a constituency of support among farmers, in order to put pressure on political parties to support the program.

6. Phase-out of the program

The program is envisaged as a temporary measure to rejuvenate soil and the water table, before farmers return to regular agriculture. The program is expected to be phased out over 10 years, as soil quality improves, the demand for electricity for pumping reduces and farm incomes rise. Regular surveying and reporting the findings through a dashboard similar to those created for rural electrification are to be enabled.

7. Dispute Resolution

Given the radical nature of this program, we expect there to be challenges such as resistance from farmers, non-compliance, lack of monitoring, delay in release of funds by Government etc. The institutional structure should set up a monitoring and verification arm, that has farmers and government officials as members and employs a third-party firm to verify implementation, gaps and other hurdles.

Given this overall structure, we propose conducting a pilot program in selected districts of major states, to identify problems, develop solutions, act as a showcase for study tours of farmers and government officials and build a constituency of supporters who can evangelise the program.

5. CONCLUSION

The Government, DISCOMs, water utilities, cooperatives and funding agencies have all made efforts in the past to solve the interlinked problems of DISCOM losses, groundwater depletion and low farm income. These efforts have had a tangible impact on a specific part of the problem but cannot solve the problem at a systemic level. Through this Working Paper, we have developed a disruptive solution- an alternative means of DSM implementation in the agricultural sector.

It is opportune to think of the electricity sector to lead this initiative by launching PPP bids with collaboration with farmers' cooperatives or private entities. One can consider rain-fed regions and other regions that get water supplied through the canal systems and canal networks. This approach is proposed after consultation with stakeholders in the energy, water and agriculture sectors. Going forward, state governments can attempt to launch policies to take forward the proposed new agricultural DSM approach.

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