Rationalizing Energy Subsidies in Agriculture:

A scoping study of agricultural subsidies in Haryana, India

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September 2015

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Executive Summary

Agricultural policies in India have a direct impact on the Indian economy. In particular, irrigation policies have an overarching impact on agricultural output, since they affect the economy, food security and the environment. Currently, most agriculture in India is irrigated through groundwater, and this has made India the world's largest user of groundwater for irrigation. Such large use of groundwater for irrigation has serious environmental and economic implications. It inevitably stresses groundwater levels, and it also requires an enormous amount of energy to pump up groundwater, a problem that is only aggravated as water levels fall. This energy comes from either electricity-powered pumps or diesel-powered pumps. We need to investigate how different policies incentivize the use of groundwater irrigation to understand the impacts of possible reforms. This scoping study is a contribution to that much-needed research.

This study identifies agricultural subsidies in general and then quantifies the major irrigation and agricultural electricity subsidies. The study understands the need and complexity of electricity subsidy for irrigation. The study concludes with options available for reform through electricity, irrigation and fertilizer. Haryana was selected for a deeper analysis of reform options, and the quantification exercises were done particularly for the state for several reasons:

- It is one of the *key agricultural states* in the country. Haryana has a high percentage of rural households engaged in agriculture (61 per cent) and 69.1 per cent of these generate their primary income from agricultural activities.
- The number of wells in the 5 to 20 metre (m) category is alarmingly large (67 per cent), and a large percentage of the wells recorded a fall in *water levels*. The water levels will only severely deteriorate with time given the high groundwater extraction rates.
- Ironically, given this situation, Haryana also has the *lowest power tariffs* for agricultural consumers (INR 0.08–0.10 per kilowatt hour, in the 2014–2015 fiscal year [FY]) across India. Like other states with agricultural power subsidies, Haryana is powered by primarily electric pump sets (72 per cent; the remaining 28 per cent are diesel driven). The share of electric pump sets is likely to increase as a result of the 2013 diesel price liberalization.
- Additionally, compared to other Indian states, the average monthly income from crop production is one of the highest in the country at INR 10,916, making it one of the richer Indian states.

This research analyzes and quantifies the subsidies for producers for surface water, electricity (primarily directed at groundwater irrigation) and fertilizers in Haryana. Other agricultural subsidies include those on farm equipment and credit services to farmers. However, they were excluded from the study since they do not affect the energy-irrigation nexus directly. The subsidies were tabulated for three principal crops of Haryana—wheat, paddy and sugarcane. The quantification exercise revealed the following results, highlighting the *need to focus on electricity subsidies*:

- Surface water irrigation subsidy: approximately 13 per cent of total subsidies.
- *Electricity (groundwater irrigation) subsidy: approximately 46 per cent of total subsidies.*
- Fertilizer subsidy: approximately 41 per cent of total subsidies.

The high percentage of electricity subsidies explains the alarmingly low groundwater levels. Electricity subsidies have enabled farmers to access electricity at prices below the marginal cost of supply, thereby lowering the cost of irrigation and groundwater extraction, an essential input in agricultural production. However, these benefits have come at *an environmental cost through groundwater exploitation and a financial burden on distribution companies (DISCOMs)*. They have also influenced cropping patterns by distorting decisions over electricity consumption and groundwater extraction and inducing farmers to grow more water-intensive crops.

From FY 2010–11 to FY 2013–14, electricity subsidies formed a huge chunk of the DISCOMs' total revenue gap (approximately 74 per cent) as well as their annual revenue requirement (approximately 26 per cent). These figures are expected to increase with rising power supply costs. In its recent order, the Haryana Electricity Regulatory Commission (HERC) ruled that Fuel Surcharge Adjustment costs amounting to INR 6,043 crore must be recovered from non-agricultural consumers. Though not implemented to date, this strategy is unsustainable in the long term and calls for implementation of new business models in the electricity sector in Haryana.

A sensitivity analysis was carried out to determine the impact of subsidies on crop production, and one of the outcomes was that, out of the three focus crops, wheat would be affected the most by subsidy reforms, since its profit margins are the lowest among the three focus crops. On the other hand, profit margins are highest for rice paddy, probably because most of it is being exported (basmati variety). Hence, a paddy farmer is least affected by subsidy reforms. This study recommends that electricity reforms should be spatially targeted at districts growing rice.

The study investigated the following alternative business models and delved into the objectives, challenges and interventions for each of them:

- Solar pumps – very high upfront cost even after capital subsidy and questions over performance capabilities. Could work if the farmer can sell excess power back to the grid. Broadly, a one-time subsidy on solar pumps is better than a year-on-year subsidy on the operational expenditure (OPEX). To mitigate the problem of uncontrolled water uptake, potentially depleting further groundwater levels, electricity resale to the grid is possible (along the lines of a pilot program in Gujarat), but uncertain. Implementation of a pilot would need to be complemented with political economy efforts to increase resource valuation among farmers and other stakeholders.
- Energy-efficient pumps – relatively less expensive than solar pumps. However, measurement, verification and determination of savings are a challenge. The problem of uncontrolled water uptake, potentially depleting further groundwater levels, must be considered. A pilot program would need to be complemented with political economy efforts to increase resource valuation among farmers and other stakeholders.
- Micro-irrigation techniques – more water/energy efficient but may not be economically viable for crops that require flood irrigation. Uptake has been slow due to high upfront capital cost and limited improvement in farm yields.
- Direct cash transfer scheme for fertilizers – laced with several challenges such as correct identification of beneficiaries, indexation based on market prices, access to banking services in rural areas, setting up an extensive IT infrastructure to track movement of fertilizers, etc. Impact on the supply side also needs to be investigated in greater detail. Will also require coordination between various government entities.
- Others – crop diversification, public-private partnerships in irrigation, etc.

Given the diversity of Haryana in terms of groundwater levels, canal water availability, electricity supply, fertilizer availability and soil quality, along with a host of other region-specific issues, this study recommends *spatial targeting: developing crop-specific strategies for select districts should be the way forward*. The study makes some recommendations, but for these to be successful, a study of the political economy of resource valuation among farmers and other stakeholders is required. There is also a need for pilot projects to communicate the real cost of energy and water consumption.

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PART 1

INTRODUCTION TO THE ELECTRICITY-IRRIGATION NEXUS IN INDIA

1.0 Introduction to the Electricity-Irrigation Nexus in India

Irrigation policy reform has recently gained prominence in India. This is mainly a result of the impact of irrigation policies on the economy, food security and the environment. While irrigation and agriculture are of key economic significance, they are also crucial in the effort to guarantee food security for more than 1.2 billion people. However, it has now become evident that the sustainability of agricultural policies in general and irrigation policies in particular is problematic. This is the case for environmental sustainability (i.e., water depletion, soil erosion, etc.), but also for economic and social sustainability (i.e., financially distressed distribution companies [DISCOMs] and governments, increased production costs, etc.).

To say the least, agricultural policies in India have been and remain a cornerstone of the nation's economy. The agricultural sector contributes 13.9 per cent to India's gross domestic product (GDP) and supports 54.6 per cent of total employment (Government of India, 2014, p. 137). Currently, most agriculture in India is irrigated through groundwater. According to the last agricultural census, the area irrigated by groundwater has increased from 5 million hectares (ha) in 1950 to 63 million ha in 2009–10, representing a 1,100 per cent increase (Central Statistics Office, 2013). Moreover, India is the world's largest user of groundwater for irrigation. The World Bank (2012) estimated that India currently uses about 230 cubic kilometres of groundwater per year, which is more than 25 per cent of the global total.

Such large use of groundwater for irrigation has serious environmental and economic implications. It inevitably stresses groundwater levels. It also requires an enormous amount of energy to pump up groundwater; a problem that is only aggravating as water levels fall. This energy comes from either electricity-powered pumps or diesel-powered pumps. As the Indian government deregulated diesel prices in October 2014, economic theory would suggest that diesel use for irrigation pump sets would rationalize. In many states, however, electricity remains heavily subsidized, particularly so for farmers.

How different policies incentivize the use of groundwater irrigation needs to be investigated to understand the impacts of possible reforms. This scoping study is a contribution to that much-needed research. Section 1 contextualizes the electricity-irrigation nexus in India and concludes with the selection of Haryana for deeper analysis. Section 2 identifies agricultural subsidies in general and quantifies the major irrigation and agricultural electricity subsidies in the Haryana. It also compares these subsidies with fertilizer subsidies, which remain important in agriculture. Finally, Section 3 discusses reform options for Haryana. It maps out a number of options available to reform electricity, irrigation and fertilizer subsidies, and links these options back to Haryana. In understanding both the complexity and necessity of electricity subsidy reform, this study finally touches upon the impacts that electricity subsidy reform might have.

1.1 THE IRRIGATION SECTOR IN INDIA

Up until the 1970s, India's irrigation policies were largely monsoon dependent. Under the British rule, India engaged in building canals and tanks. This legacy carried on post-independence in 1947. This type of surface irrigation included (and includes) water sourced from canals through diversion of river water, tanks, ponds and so forth (Shah, 2009). After the 1970s, individual farmers began migrating towards groundwater irrigation. This development of groundwater irrigation was triggered by the innovation of boreholes, mechanized diesel and electric pumps.

These tools allowed farmers to spread irrigation to terrains that were previously impossible to reach with surface irrigation. Pumps also allowed an increasing number of marginal and smallholder farmers to start irrigating land. Today, farmers generally prefer groundwater for irrigation because its supply is reliable, can be controlled by the farmer and does not directly depend on public institutions (Bhattarai, Saktivadive, & Hussain, 2002). The development of groundwater irrigation quickly led to positive impacts, such as an increase in agricultural productivity and farmer incomes. With groundwater, a lower water usage per hectare was able to achieve higher agricultural yields compared to the previous period of flow irrigation. Pump ownership became a considerable asset that allowed farmers the freedom to choose crops, even water-intensive ones, in areas prone to water shortages.

Given its positive economic and food security impacts, the government supported these farmers by introducing subsidy schemes. These schemes did not only directly support pumps but also subsidized the fuel (electricity or diesel) that was needed to run them. This resulted in a significant increase of energy consumption for irrigation. In 2013–2014, the agricultural sector consumed 22 per cent of total electricity for irrigation (Planning Commission, 2014b, Annex 3). Consequently, subsidized power led to a boom in groundwater use and adds to the woes of the power utilities that face severe commercial losses as a result of unrecovered subsidies. By now, groundwater irrigation is the main driver of the energy-water nexus.

While contributing to agricultural economics and food security, this shift in irrigation practices has significant, and growing, negative impacts. The increased usage and reliance on groundwater has led to over-extraction and exploitation of previous groundwater reserves. Groundwater levels are extremely stressed in areas with electric pumps (Mukherji, Shah, & Giordano, 2012). This implies that, in such areas, farmers are installing pump sets to be able to extract deeper groundwater, with the consequence of further depleting groundwater levels. The Central Ground Water Board (CGWB) announced that 56 per cent of wells already showed a decline in water reserves and that a deficit in annual groundwater reserves is looming (Mohan, 2014).

These worrying results make for a compelling case to understand the complexity of irrigation subsidies, particularly those related to the provision of under-priced electricity for groundwater extraction. Furthermore, the irrigation sector is facing other severe financial losses related to surface water policies. Irrigation policies are under the administrative control of state governments and while farmers are charged for using surface water for irrigation, many state governments have not revised water tariffs for over two decades. This has led to revenue losses and insufficient funds to innovate infrastructure or even cover standard operation and maintenance costs (Varma, Dhingra, & Swamy, 2013).

1.2 THE ELECTRICITY SECTOR IN INDIA

After independence, the government took control of electricity supply and enacted the Electricity Supply Act of 1948, which created State Electricity Boards (SEB) to systematically develop electricity generation and supply all across India. Power reforms were initiated in 1991 and again in 2003 to restructure the SEBs into different companies for generation, transmission and distribution. The development narrative of achieving electricity access for every household was the reason for governmental control of electricity. The same social objective motivated the government to launch schemes for enhancing access for rural households. For example, Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)[1] was launched in 2005 and merged together all former rural electricity schemes (Planning Commission, 2014a). This developmental agenda firmly politicized electricity tariffs, which led the government to cross-subsidize electricity for domestic and agricultural users by increasing tariffs for industrial consumption.

By 1999–2000 cross subsididation increased industrial tariffs to 15 times the level of agricultural tariffs and about double the level of prices for domestic consumers. The agricultural tariff also remains well below the electricity production cost. For example, in 2010–11 the average all India cost of per kilowatt hour (kWh) of power was INR 3.78, but the agricultural sector was only charged INR 1.15 per kwh of power (Central Electricity Authority, 2014, p.

[1] RGGVY was renamed Deendayal Upadhyaya Gram Jyoti Yojana in November 2014.

35). Logically, this impacted the financial health of the SEBs, which were often unable to pay the electricity suppliers (Thakur et al., 2004). The central government initiated reforms in 1991 and 2003 but these were unable to ameliorate the financial health of SEBs. In 2013-2014, SEBs across India faced a commercial loss of INR 311.48 billion (USD 4.8 billion) (Planning Commission, 2014b, Annex 4). In part, this loss is a result of the aforementioned high subsidization in the agricultural sector.

Energy subsidies to agricultural consumers changed the patterns of irrigation, as groundwater extraction is strongly influenced by diesel and electricity tariffs. Between 1951 and 2002, the number of public and private tube wells increased from 3,865 to 19,800 (Agarwal & Singh, 2007, p. 328). This growth continued after 2002 and by the end of 2009–10 the number of electric pumps alone stood at 1 million (Mukherjee & Rawat, 2012). By now, any reforms in the energy-irrigation nexus needs to be cognizant of the direct impacts on both sectors, and indirect impacts across the economy and on households' livelihoods.

1.3 COMPLEX REFORMS

The dominant narrative for implementing reforms has been both economic and environmental. On one side, reformers have pointed at the economic costs to the agricultural sector from the non-availability of water (i.e., when available water reserves cannot match demand). On another side, researchers have focused on the financial losses to public utilities as a result of the electricity and diesel subsidies to agricultural users. Policies to reform the energy-irrigation nexus have most often been pursued either via the electricity sector or via the irrigation sector. Both electricity and irrigation are administered at the state level. State governments have often pursued different reforms and achieved different results.

One strand of reform has aimed at integrating multiple reforms. This would recognize the multi-dimensional problem of the nexus rather than treating it either via the electricity or via the irrigation sector (see Figure 1.1). So far, different terrains, political circumstances and administrative implementation have mostly kept reforms characterized as either electricity or irrigation reforms.

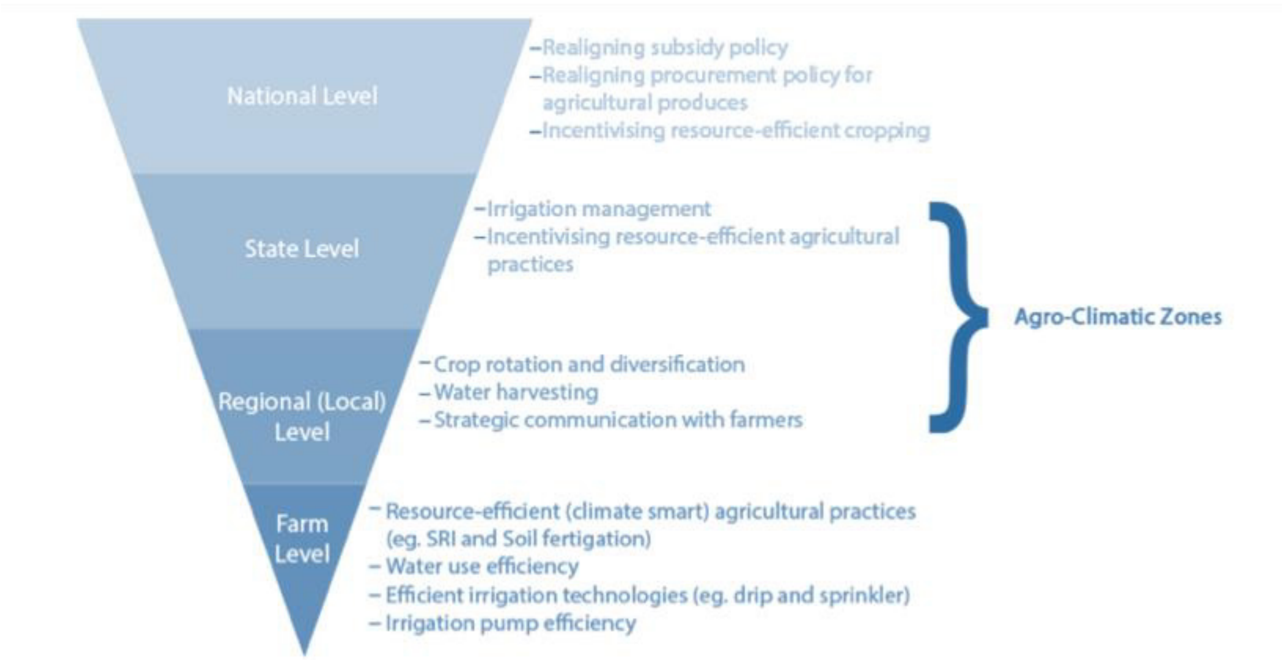


FIGURE 1.1: Multi-Level Interventions for Resource-Use Efficiency in Agriculture

Source: Swain (2015, p. 6)

1.3.1 Irrigation Sector Reforms

Irrigation reforms for slowing down or reversing groundwater depletion have roughly pursued three different strands. A first strand targets the community management of groundwater and is commonly referred to as integrated watershed management. A second strand of reforms is concerned with recharging groundwater levels through a re-examination of cropping patterns and spatial management. A third strand of reforms focuses on the installation of more water-efficient technologies. From one side, water-efficient pump sets are roughly similar to the installation of energy-efficient pump sets. The difference is mainly discursive, as one set of reforms emphasizes energy efficiency and the other emphasizes water efficiency. In either case, there is always the risk of a rebound effect. From another side, reforms focusing on technology innovation include the installation of drip and sprinkler irrigation systems. These reforms, and their potential for the selected case study (Haryana) are more extensively discussed in Section 3.

Apart from these groundwater-focused reforms, investments in surface irrigation infrastructure as a means to halt groundwater extraction have received mixed reviews. This is because canal irrigation projects are not viewed as reforms that can immediately address the groundwater problem. Finally, the use and distribution of more water-efficient seeds have recently gained prominence.

1.3.2 Electricity Sector Reforms

Electricity sector reforms bundle policies based on technology and economic efficiencies. Many reforms have attempted to restrict overconsumption of electricity for extracting groundwater by adjusting the tariff system. Electricity for agricultural consumers is priced either on the basis of per-unit energy consumed (called a metered tariff) or on the basis of the capacity (horsepower) of the irrigation pump (called a flat-rate tariff). Since electricity is administered through state governments, different states have implemented either one of these tariff structures or, occasionally, a hybrid structure where energy charges are based both on consumption and on a fixed charge associated with the irrigation pump set. Most states in India have subsidized agricultural power consumption by opting for a flat-rate tariff system (Swain & Charnoz, 2012). The northern states of Punjab, Uttar Pradesh and Haryana started this flat-rate tariff in the early 1970s and were soon followed by the southern states during the late 1970s. Electricity tariff reforms have thus not only treated the level of the tariff, but also how tariffs are set. Suggestions have often included a switch from flat-rate tariffs to metered tariffs, or a change in how flat-rate tariffs are operated.

Another set of electricity reforms have focused on separating the feeders based on users—agricultural, domestic and commercial. Connections are then metered to improve energy audits. At times, feeder segregation has been combined with high-capital investments such as the installation of high-voltage distribution systems (HVDSs). HVDSs improve the quality of power supply and prevent illegal power leakage (Mukherji, Shah, & Giordano, 2012). Besides HVDS, other areas involving high capital costs have involved replacing traditional electric pump sets with solar-powered pump sets, and replacing energy-inefficient pump sets with more energy-efficient ones. These reforms and their potential for the selected case study (Haryana) are more extensively discussed in Section 3.

There are several stakeholders and a complex interplay of variables determining reform outcomes. Some variables are easy to track. These include public utility revenues, power transmission and distribution losses; prices in groundwater markets; and so forth. Others, however, are more difficult to monitor and include groundwater tables, farmer incomes, strength of farmer lobbies, technology of reforms, types of domestic users and so forth. A complete list of stakeholders is listed in Table 1. There will be differences in how reform affects different stakeholders and this table attempts to bring out the heterogeneity within the agricultural community. For example, water buyers from the groundwater markets are negatively impacted when universal metering is implemented, but pump owners do not lose out. Therefore, any suggested reform should be evaluated and accepted after mapping its impact on every stakeholder.

1.4 THE COMPLEX POLITICAL ECONOMY OF REFORMS

Many agricultural producers consider providing low-priced water and electricity as a political right, which makes reform particularly difficult in states where these producers have a strong political voice and access to policy-makers. However, in addition to agricultural producers, many other stakeholders indirectly benefit from subsidy policies. This is mainly the case for those that are employed in the agricultural supply chain, for those in the irrigation technology supply chain and for the final food consumers. The main disadvantaged actors are the financially distressed DISCOMs and the government, which eventually bears the burden. To understand the political economy of subsidies and their potential reform, it is necessary to do an in-depth analysis of the particular trade-offs of every set of stakeholders, and their mobilizing potential to influence the decision-making process. Table 1.1 demonstrates, in a general manner, the variety of stakeholder groups.

TABLE 1.1: Stakeholders Affected by Reforms

STAKEHOLDERS AFFECTED BY REFORMS	METRIC TO MEASURE IMPACT
Public utilities – DISCOMS and state electricity boards, irrigation department, Ministry of Agriculture	Revenue, annual profit and loss statements, groundwater irrigated area versus area under different irrigation method, volume of subsidy given to agricultural farmers for pump sets
Agricultural consumers – marginal and smallholder farmers, farmer water buyers and landless labourers	Price of water in groundwater markets after reforms are introduced, number of pump sets sold after reforms, pumping behaviour/hours used by pump-set owners, yields of crops, farmer incomes, changes in choice of crops for cultivation, community-based water management techniques
Village-level users – institutions like schools, hospitals, village industries and domestic users	Number of hours of power supply per day
Pump-set manufacturers, repairs	Incomes and pump set sales
Public Distribution System (PDS) kerosene retailers – Fair Price Shop (FPS) owners	A comparison of sales of pump sets by fuel (solar, kerosene, diesel and electric) to check if a cheaper fuel is influencing choice of pump
Political lobbies of farmers	The strength of the farmer lobbies dictates if the reform will be politically acceptable

Source: Adapted from Shah, Bhatt, Shah, & Talati (2008, p. 1,239)

During the Green Revolution of the 1960s, Indian states focused on food security and received aid from international agencies like the World Bank that gave them the ability to invest in rural electrification to increase groundwater irrigation (Shah, Scott et al., 2004). By the 1970s, the SEBs were already bearing the financial burden of irrigation subsidies and the energy-irrigation nexus was identified as a problem. In its work, the World Bank focuses on the poor nature of subsidy targeting and its implications for the reduced hours of rural power supply and the larger costs of electricity theft. It supports reforms that focus on the efficient use of water and fuel resources through electricity metering and per-unit tariffs. This has also involved measures like incentive packages for farmers to invest in efficient pumps (World Bank, 2002). Other donors working on the irrigation-energy nexus have included the U.S. Agency for International Development (USAID) via the International Food Policy Research Institute (Birner, Gupta, Sharma, & Palaniswamy, 2007) on a number of policy options, and USAID specifically on energy-efficient pump sets (through its renewable energy program in India). In general, however, the International Water Management

Institute (IWMI) has been the most active on the energy-irrigation nexus and has authored several research projects, through the lens of both electricity sector reforms and irrigation sector reforms (Mukherji, Shah & Verma, 2010). They have also recently launched a solar pump pilot scheme in Gujarat. This scheme is the first in which farmers are allowed and encouraged to resell electricity to the grid.

1.5 JUSTIFICATION OF RESEARCH AND SCOPE

With an aim of achieving food security, agricultural policies and aid provided by international donors initially supported groundwater irrigation. However, by the 1970s, these policies in the form of subsidized pump sets for farmers, free electricity and so forth began to affect the financial health of the utilities or State Electricity Boards. There were also findings that groundwater reserves were being overexploited, which would affect future yield levels. This energy-irrigation nexus has received increasing attention by several international agencies that have suggested reforms.

However, the uptake of reforms has been slow and many schemes left the marginal farmers worse off by restricting access to the groundwater market. Most reform strategies approach the electricity-pricing tariff for farmers. Some reforms are also rooted in the irrigation sector. However, no reform has uniformly been accepted as the breakthrough solution because of differences in political scenarios, farmer lobbies, geographical terrains, hydrological conditions and so forth. This report aims to examine the energy-irrigation nexus in detail in one state: Haryana. The case study from this state will be used to study the role of electricity subsidies in the groundwater scenario. The research will use existing literature to identify and generate the most suitable reforms given the local conditions at play in the state. The research will conclude by introducing an assessment of the complexity of electricity subsidy reform.

2.0 Profiling Indian States

This section lists out data of key agricultural states against a selection of scoping variables. This profiling exercise will identify states most relevant in the energy-irrigation nexus discussion and where we could expect the largest reform impact. This information will be used to select the case study upon which the remainder of this report will focus. To assist in the selection of a state for the case study, a list of scoping variables was drawn. These scoping variables are based on analyzing data that can reveal the status of farmer incomes, agricultural growth, DISCOMs' health and environmental factors in different states. These dimensions are chosen because they involve all the stakeholders affected by subsidies. The measurement of these factors can help identify states where there is a pressing need to address the energy-irrigation nexus and its associated impacts.

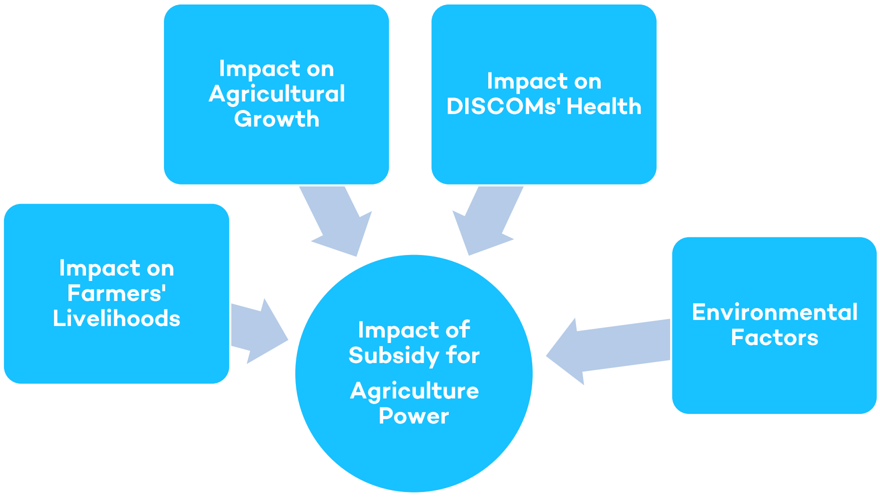


FIGURE 1.2: Factors Contributing to the Impact of Electricity Subsidies on the Agricultural Sector

2.1 UNDERSTANDING THE NEXUS: GDP CONTRIBUTION AND GROUNDWATER LEVELS

From the initial list of 29 states in India, 12 states were shortlisted. Each of these 12 states contributed more than INR 250 billion towards the agriculture and allied sector.[2] The shortlisting reveals states that contribute significantly to the agriculture sector and hence are the biggest consumers of input resources like water and electricity for irrigation. These states are listed in Table 1.2. The rest of this section focuses on extracting data for these key 12 states.

"...measurement of these factors can help identify states where there is a pressing need to address the energy-irrigation nexus and its associated impacts."

[2] The agriculture and allied sector consists of agriculture, forestry and logging, and fishing subsectors. Agriculture is the main component, amounting to almost 95 per cent of the overall GDP of the sector.

TABLE 1.2: Contribution of Agriculture and Allied Sector to State GDP

STATE	STATE GDP FOR FY 2012-13 (INR BILLION)	AGRICULTURE & ALLIED SECTOR (INR BILLION)	%
Uttar Pradesh	4,431.91	1,007.65	22.74%
Andhra Pradesh	4,321.12	820.48	18.99%
Maharashtra	8,258.32	650.76	7.88%
West Bengal	3,451.56	590.56	17.11%
Madhya Pradesh	2,147.41	561.71	26.16%
Rajasthan	2,342.30	495.49	21.15%
Gujarat	4,272.19	475.94	11.14%
Karnataka	2,982.41	419.07	14.05%
Bihar	1,589.71	367.08	23.09%
Punjab	1,645.88	359.42	21.84%
Tamil Nadu	4,479.44	326.00	7.28%
Haryana	1,867.38	293.48	15.72%

Source: Planning Commission (2014a)

From among the states listed in the table above, the situation on groundwater consumption was analyzed by comparing the number of wells as per their depth. In Table 1.3, the number of wells is reflective of the physical terrain and the groundwater situation in the state. For example, Rajasthan has a larger number of deeper wells (depth of 20 m or more) because the geographical terrain is mainly a desert. States like Uttar Pradesh and Bihar have lower deep wells because they are in the Gangetic plains, and groundwater is easily accessible below the surface. But increasingly, states that earlier were abundant in groundwater now have to dig their wells deeper. For example, states like Punjab and Haryana now have more wells with depths of 5 m or more.

TABLE 1.3: State-Level Status of Groundwater Levels

STATE	NUMBER OF WELLS < 5 M		NUMBER OF WELLS 5 TO 20 M		NUMBER OF WELLS > 20 M	
Rajasthan	260	29%	317	35%	334	37%
Gujarat	227	32%	396	56%	82	12%
Punjab	41	23%	100	55%	40	22%
Tamil Nadu	183	30%	402	65%	35	6%
Madhya Pradesh	672	73%	216	24%	29	3%
Uttar Pradesh	521	61%	312	36%	24	3%
Andhra Pradesh	424	57%	310	41%	16	2%
Haryana	29	21%	90	67%	16	12%
Maharashtra	613	59%	405	39%	16	2%
West Bengal	394	68%	179	31%	8	1%
Karnataka	378	43%	502	57%	2	-
Bihar	207	84%	39	16%	0	-

Source: Central Groundwater Board (2013, Annex 2)

West Bengal, Bihar and Karnataka were excluded due to an almost negligible number of wells at depths greater than 20 m. Rajasthan, on account of having an extremely high percentage of wells in the depth greater than 20 m category, has been excluded from our analysis as well. Uttar Pradesh was left out owing to its location in the Gangetic plains with a vast majority of its wells at less than a 20 m depth. The agricultural GDP contribution and the number of deep wells give the following shortlist of key states:

- Andhra Pradesh
- Gujarat
- Haryana
- Madhya Pradesh
- Maharashtra
- Punjab
- Tamil Nadu

2.2 UNDERSTANDING THE NEXUS: IN-DEPTH PROFILING

The shortlisted states were subsequently ranked based on more scoping variables for agricultural growth, farmers' livelihoods, DISCOMs' financial health and environmental factors. Ultimately, this information was presented in a decision matrix that allows us to grasp which states appear particularly ready for energy subsidy rationalization.

> *"…states like Punjab and Haryana now have more wells with depths of 5 m or more."*

TABLE 1.4: Scoping Variables for Case Study Selection

STATE	STATE GDP FOR FY 2012-13 (INR BILLION)
Impact on agricultural growth	• Percentage of agriculture and allied sector in state's GDP (done) • Number of rural and agricultural households • Percentage of agricultural households with income from primarily agricultural activities
Impact on farmer's livelihood	• Net income of agricultural households from crop production • Percentage of small, marginal, medium and large farmers • Number of agricultural households with outstanding loans • Number of agricultural households with Below Poverty Line (BPL) ration cards
Impact on DISCOMs' health	• Current agriculture tariff • Gross tariff subsidy to the agriculture sector
Environmental factors	• Current status of groundwater levels (done) • Groundwater availability and use • Trend in groundwater depletion

2.2.1 Impact on Agricultural Growth

2.2.1.1 Number of Agricultural Households as a Percentage of Rural Households

This variable indicates the number of households that are involved in agriculture in rural areas. Any subsidy reform will have a cascading effect on these households. Quantifying the percentage of households affected is an important shortlisting factor. In Table 1.5, the top states are Madhya Pradesh, Gujarat and Haryana.

TABLE 1.5: Number of Agricultural Households as a Percentage of Rural Households

STATE	NUMBER OF RURAL HOUSEHOLDS (00S)	NUMBER OF AGRICULTURAL HOUSEHOLDS (00S)	%
Madhya Pradesh	84,666	59,950	71%
Gujarat	58,719	39,305	67%
Haryana	25,849	15,693	61%
Maharashtra	125,182	70,970	57%
Punjab	27,552	14,083	51%
Andhra Pradesh	86,763	35,968	41%
Tamil Nadu	93,607	32,443	35%

Source: Planning Commission (2014a)

2.2.1.2 Percentage of Agricultural Households with Principal Income from Agricultural Activities

This variable investigates the number of households that will also be affected, and therefore it is a subset of the previous variable. But these households will be affected more severely since agriculture is their primary income-generating activity. In Figure 1.3, Haryana Maharashtra and Madhya Pradesh are the states with the highest population deriving their principal income from agriculture.

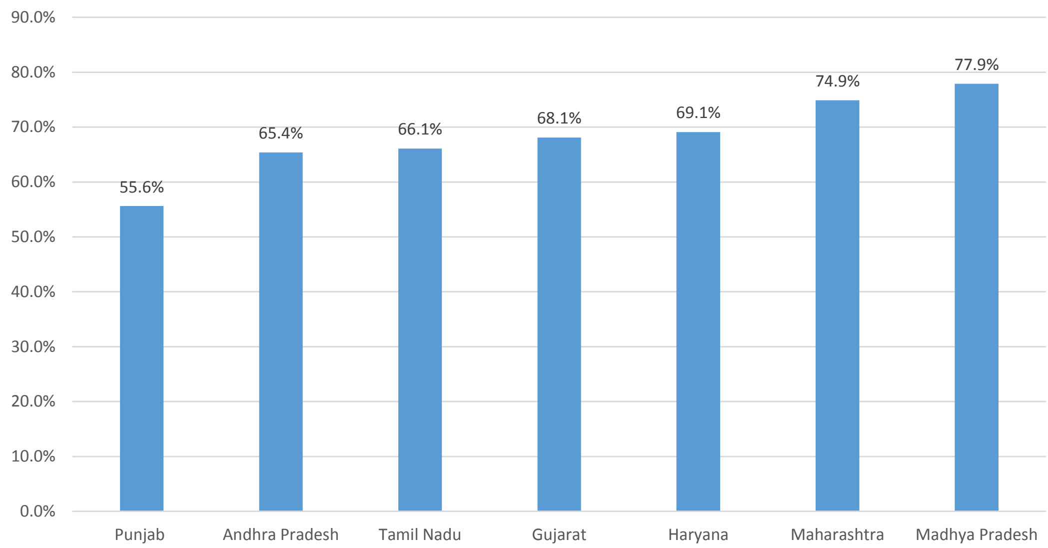


FIGURE 1.3: Percentage of Households with Principally Agricultural Income (per 1,000 households)

Source: Ministry of Statistics (2014, p. 15)

2.2.2 Impact on Farmers' Livelihoods

2.2.2.1 Average Income of Agricultural Households from Crop Production

This variable enables us to categorize states based on the average monthly income, so those states where incomes are high and consequently subsidies are less needed can be targeted for reform. Table 1.6 demonstrates that Punjab, Haryana and Madhya Pradesh make a case for subsidy reform since they have the highest monthly incomes.

TABLE 1.6: Average Monthly Income of Agricultural Households

STATE	TOTAL REVENUE (TR) [INR]	TOTAL EXPENSES (TE) [INR]	NET INCOM (NI = TR-TE)
Madhya Pradesh	84,666	59,950	71%
Gujarat	58,719	39,305	67%
Haryana	25,849	15,693	61%
Maharashtra	125,182	70,970	57%
Punjab	27,552	14,083	51%
Andhra Pradesh	86,763	35,968	41%
Tamil Nadu	93,607	32,443	35%

Source: Ministry of Statistics (2014, p. 36)

2.2.2.2 Farmers with Outstanding Loans

This financial health indicator of the agricultural households reveals the percentage of farmers in debt. Figure 1.4 reveals that farmers from Haryana, Punjab and Gujarat have the fewest outstanding debts and appear to be in better financial health.

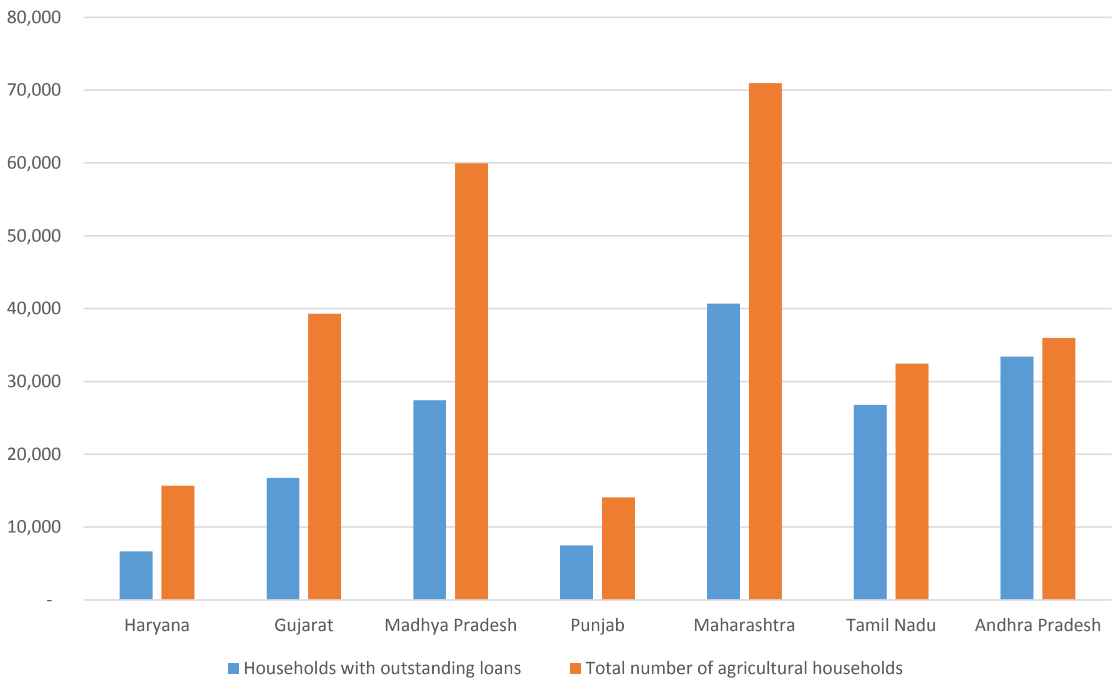


FIGURE 1.4: Agricultural Households with Outstanding Loans
Source: Ministry of Statistics (2014, p. 24)

Furthermore, when the average amount of outstanding loan was compared with the average annual income, Punjab and Haryana have the lowest percentages among the states being considered.

TABLE 1.7: Outstanding Loans as a Percentage of Average Annual Income

STATE	AVERAGE ANNUAL INCOME (INR)	AVERAGE AMOUNT OF OUTSTANDING LOAN (INR)	OUTSTANDING LOAN AS A PERCENTAGE OF INCOME
Punjab	196,188	119,500	60.91%
Haryana	130,992	79,000	60.31%
Madhya Pradesh	51,048	32,100	62.88%
Maharashtra	48,252	54,700	113.36%
Gujarat	42,276	38,100	90.12%
Tamil Nadu	29,688	115,900	390.39%
Andhra Pradesh	27,492	123,400	448.86%

Source: Ministry of Statistics (2014, p. 36)

2.2.2.3 Distribution of Farmers as per Land Holding Size

Typically, smaller-size landowners require subsidies, and therefore subsidy reform should target states that have a higher percentage of large landowners. Figures 1.5 and 1.6 show that Punjab, Haryana and Gujarat have the fewest marginal and small operational holdings and have the highest number of medium and large operational holdings.

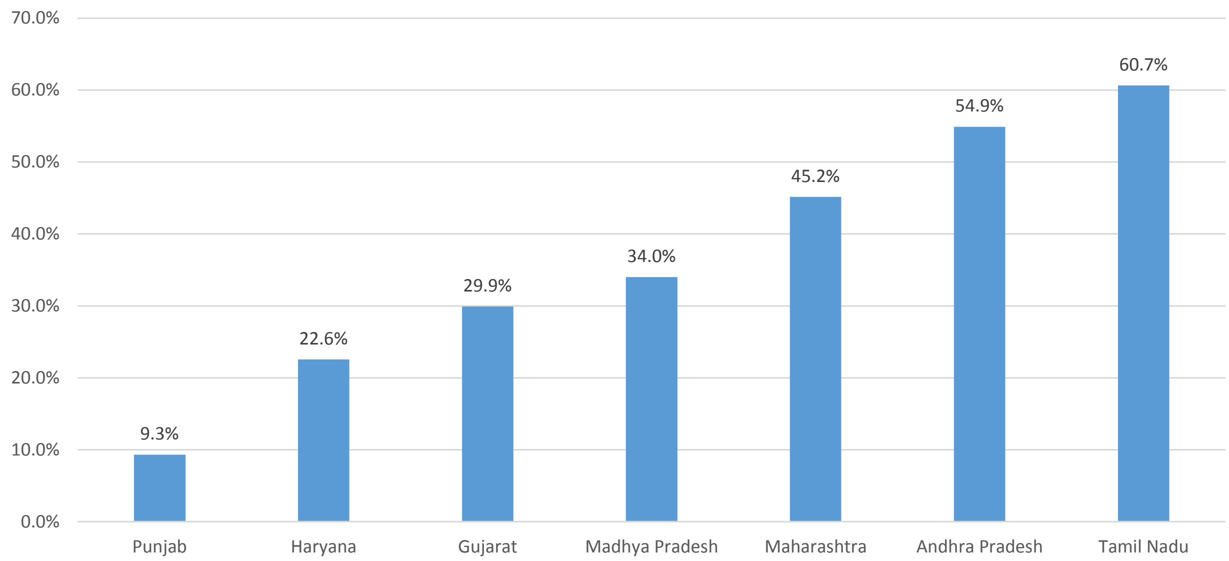


FIGURE 1.5: Distribution of Marginal (<1 ha) and Small (1–2 ha) Land Holdings

Source: Ministry of Agriculture (2014, Table 5)

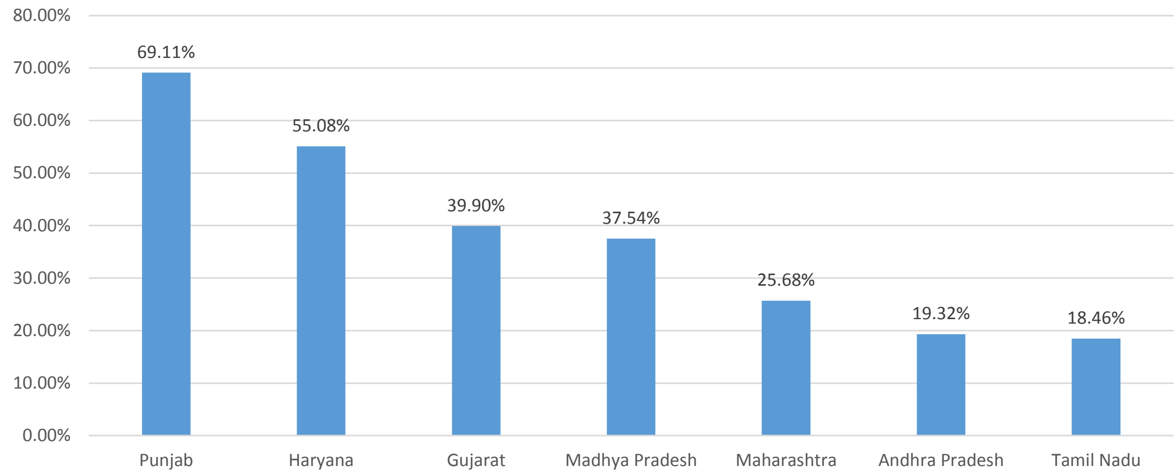


FIGURE 1.6: Distribution of Medium (2–10 ha) and Large (>10 ha) Holdings

Source: Ministry of Agriculture (2014, Table 5)

2.2.3 Impact on DISCOMs' Financial Health

2.2.3.1 State-Level Tariffs and Subsidies to the Agricultural Sector

Since electricity tariffs are under state administration, states differ on electricity tariffs based on political and economic considerations. Table 1.8 reveals that Haryana, Punjab and Madhya Pradesh offer the largest power subsidy to the agricultural sector.

TABLE 1.8: Electricity Tariffs and Subsidies to the Agriculture Sector for FY 2014–15

STATE	POWER TARIFF – AGRICULTURAL CONSUMER (INR)	SUBSIDY TO AGRICULTURAL POWER (INR CRORES)
Haryana[1]	0.08 – 0.10	5,284
Punjab[2]	0	4,454
Maharashtra[3]	2.10	3,500
Andhra Pradesh[4]	0.50 – 1.0	4,300
Tamil Nadu[5]	3.22	3,260
Gujarat[6]	0.60	1,101
Madhya Pradesh[7]	3.20 – 4.05	5,905

Source: Respective SERC tariff orders:

[1] Haryana Electricity Regulatory Commission. (2014a, pp. 123–124)
[2] Punjab State Electricity Regulatory Commission (2014, pp. 270 & 277)
[3] Maharashtra State Electricity Distribution Co. Ltd. (2012, p. 6)
[4] Andhra Pradesh Electricity Regulatory Commission (2013, pp. 170 & 175)
[5] Tamil Nadu Electricity Regulatory Commission (2014, pp. 251 & 254)
[6] Gujarat Electricity Regulatory Commission (2014, p. 102)
[7] Madhya Pradesh Electricity Regulatory Commission (2014, pp. 90 & 170)

2.2.4 Environmental Factors

2.2.4.1 Groundwater Availability, Utilization and Projected Demand

These data reveal states that have an alarming scenario of negative groundwater availability for future irrigation. Table 1.9 reveals that states like Punjab and Haryana are extracting much more groundwater than is available, and aquifers cannot match this speed of extraction.

TABLE 1.9: Groundwater Availability and Use

STATE	NET ANNUAL GROUNDWATER AVAILABILITY (BCM)	TOTAL ANNUAL GROUNDWATER CONSUMPTION (BCM)	GROUNDWATER AVAILABILITY FOR FUTURE IRRIGATION USE (BCM)
Punjab	20.35	34.66	-14.57
Haryana	9.8	12.43	-2.7
Tamil Nadu	20.65	16.56	4.70
Gujarat	17.35	12.99	5.32
Madhya Pradesh	32.25	17.99	13.76
Andhra Pradesh	30.76	14.15	15.89
Maharashtra	33.81	16.95	16.32

Source: Central Groundwater Board (2013, Table 3)

2.2.4.2 Groundwater Depletion Trend

Table 1.10 reveals the percentage of wells where groundwater has been monitored and has recorded falling levels. Most of the wells in Gujarat, Punjab and Haryana have recorded falling groundwater levels.

TABLE 1.10: Falling Groundwater Levels

STATE	TOTAL NUMBER OF WELLS ANALYZED	NUMBER OF WELLS THAT RECORDED A RISE IN WATER LEVELS	NUMBER OF WELLS THAT RECORDED A FALL IN WATER LEVELS
Gujarat	675	204 (30.22%)	471 (69.78%)
Punjab	178	54 (30.34%)	124 (69.66%)
Haryana	88	33 (37.5%)	55 (62.5%)
Maharashtra	980	424 (43.27%)	556 (56.73%)
Tamil Nadu	617	325 (52.67%)	292 (47.33%)
Andhra Pradesh	700	382 (54.57%)	318 (45.43%)
Madhya Pradesh	918	701 (76.36%)	217 (23.64%)

Source: Central Groundwater Board (2013, Annex XIII)

2.3 CONCLUSION AND CASE SELECTION

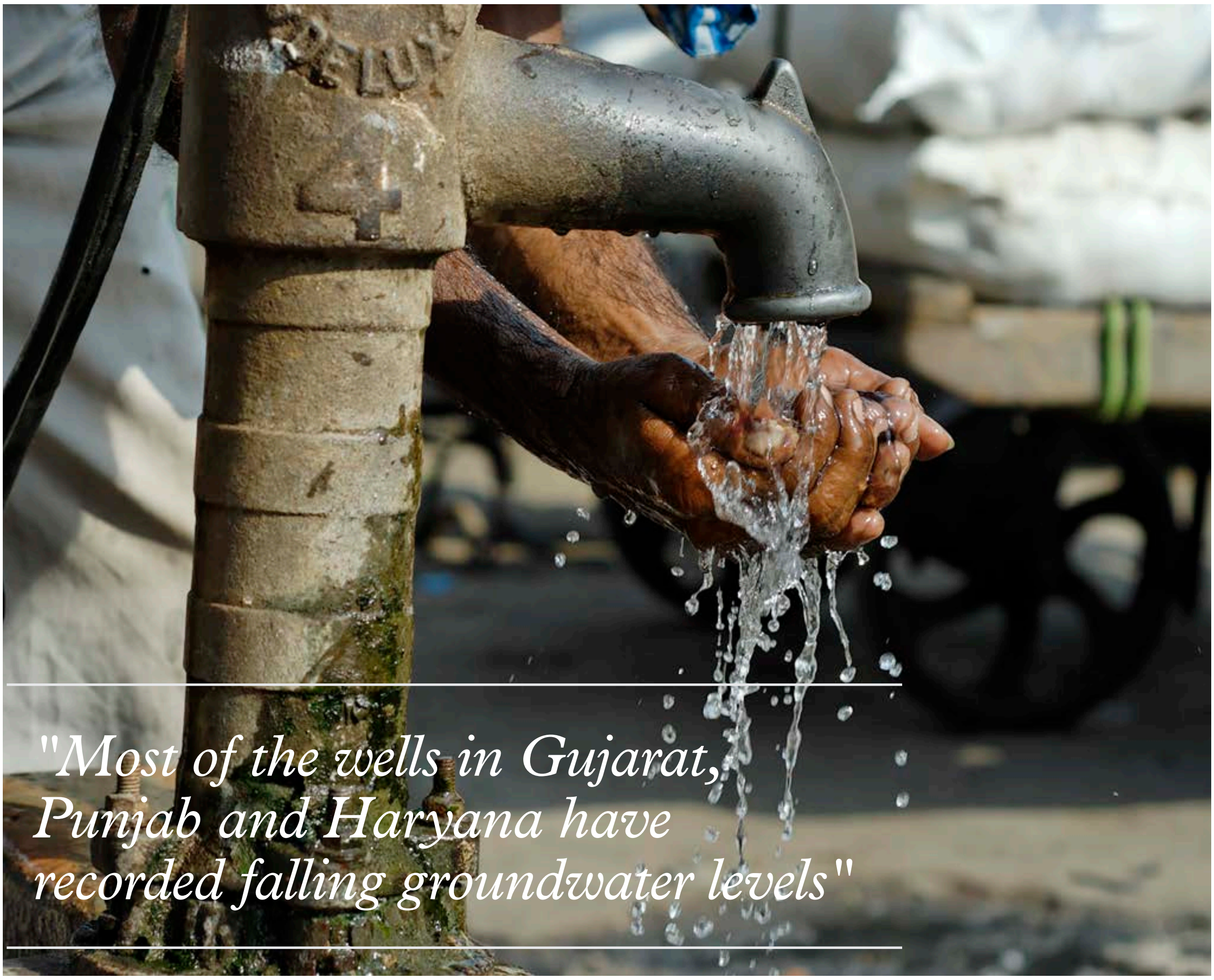
Based on the above variables, states were awarded points on a scale of one to seven based on their ranking in the scoping variable being considered. Seven indicates that the state appears ideally suited for subsidy rationalization. For example:

- Farmers in Punjab have the highest net income from crop cultivation
- High incomes imply there is room for subsidy rationalization
- Punjab gets a score of seven on this parameter

Based on these metrics, the following decision matrix demonstrates that Haryana (HR), with a score of 64 points, appears suitable for subsidy reform and, hence, is selected for the case study.

TABLE 1.11: Case Study Decision Matrix

SCOPING VARIABLE		MP	PB	AP	HR	GJ	MH	TN
Impact on agricultural growth	Contribution of agriculture to state GDP	7	6	5	4	3	2	1
	No. of agricultural households	7	3	2	5	6	4	1
	% of agricultural households with principally agricultural income	7	1	2	5	4	6	3
Impact on farmers' livelihoods	Net Income of agricultural households	5	7	1	6	3	4	2
	No. of agricultural households with outstanding loans	5	4	1	7	6	3	2
	% of small and marginal farmers	4	7	2	6	5	3	1
	% of medium and large farmers	4	7	2	6	5	3	1
	No. of agricultural households with BPL ration cards	2	6	1	7	3	5	4
Impact on DISCOMs' health	Power subsidy to agricultural sector	1	6	4	7	2	5	3
Environmental factors	Current groundwater status	3	7	2	6	4	1	5
	Groundwater depletion trend	1	6	2	5	7	4	3
TOTAL		**46**	**60**	**24**	**64**	**48**	**40**	**26**



"Most of the wells in Gujarat, Punjab and Haryana have recorded falling groundwater levels"

PART II

QUANTIFYING THE ELECTRICITY-IRRIGATION NEXUS IN HARYANA, INDIA

1.0 Haryana Agricultural Profile

The profiling exercise in the previous section yielded Haryana as the focus state of our study. This section provides a brief introduction about the state, its agricultural profile and the status of its groundwater resources and irrigation network.

1.1 AGRICULTURAL STRONGHOLD

The State of Haryana was created on November 1, 1966, and has displayed exemplary growth since its formation. The state GDP has grown from INR 958 billion (FY 2005) to INR 1,867 billion (FY 2013) at an impressive Compounded Annual Growth Rate (CAGR) of 7.7 per cent. Although a geographically small state (44,212 square km) accounting for only 1.4 per cent of the total area of the country, Haryana's average contribution to the national GDP at constant (2004–05) prices has been recorded as 3.3 per cent from FY 2005 to FY 2013.

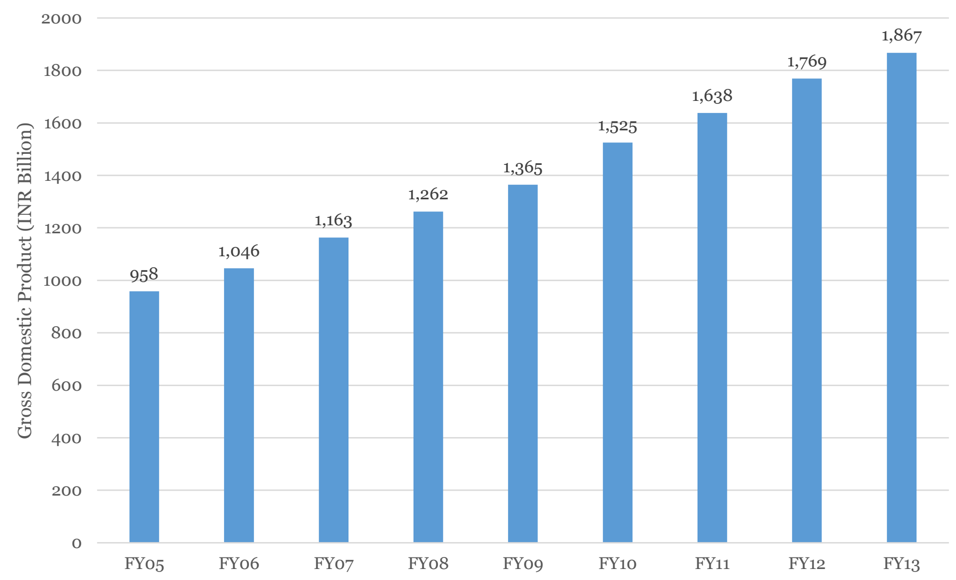


Figure 2.1: State Gross Domestic Product of Haryana FY 2005–FY 2013 (at constant 2004–05 prices)

Source: Planning Commission (2014a)

Agriculture has remained the mainstay and leading occupation of the people of Haryana since its inception. The agriculture and allied sector has contributed 19.0 per cent on average to the state's GDP with an average year-on-year growth rate of 3.67 per cent from FY 2005 to FY 2013, although this share has been on the decline recently due to growing contributions of the services and industry sectors. However, high GDP growth without consistent and rapid agricultural growth has accelerated inflation in the state, jeopardizing the overall growth process. Therefore, the growth of the agriculture and allied sector continues to be a critical factor in the overall performance of the state economy.

1.2 CROP PRODUCTION

There are two agro-climatic zones in the state. The northwestern part is suitable for paddy, wheat, vegetables and temperate fruits, and the southwestern part is suitable for high-quality agricultural produce, tropical fruits, exotic vegetables and herbal and medicinal plants. Wheat and paddy are the two principal crops grown in Haryana during the rabi and kharif seasons respectively, which will also be our focus crops in this study. To study the impact of subsidy reforms on a cash crop, it was decided to consider the case of sugarcane.

Karnal, Kaithal and Kurukshetra districts are the primary sources of paddy production in the state, accounting for more than 39 per cent of the total production in 2013–14. Similarly, Hisar, Fatehabad and Sirsa districts are the chief production centres of wheat, collectively amounting to almost 30 per cent of wheat production in the state in 2013–14. For sugarcane, the important districts are Yamuna Nagar, Ambala and Karnal, which contributed more than 48 per cent in 2012–13.

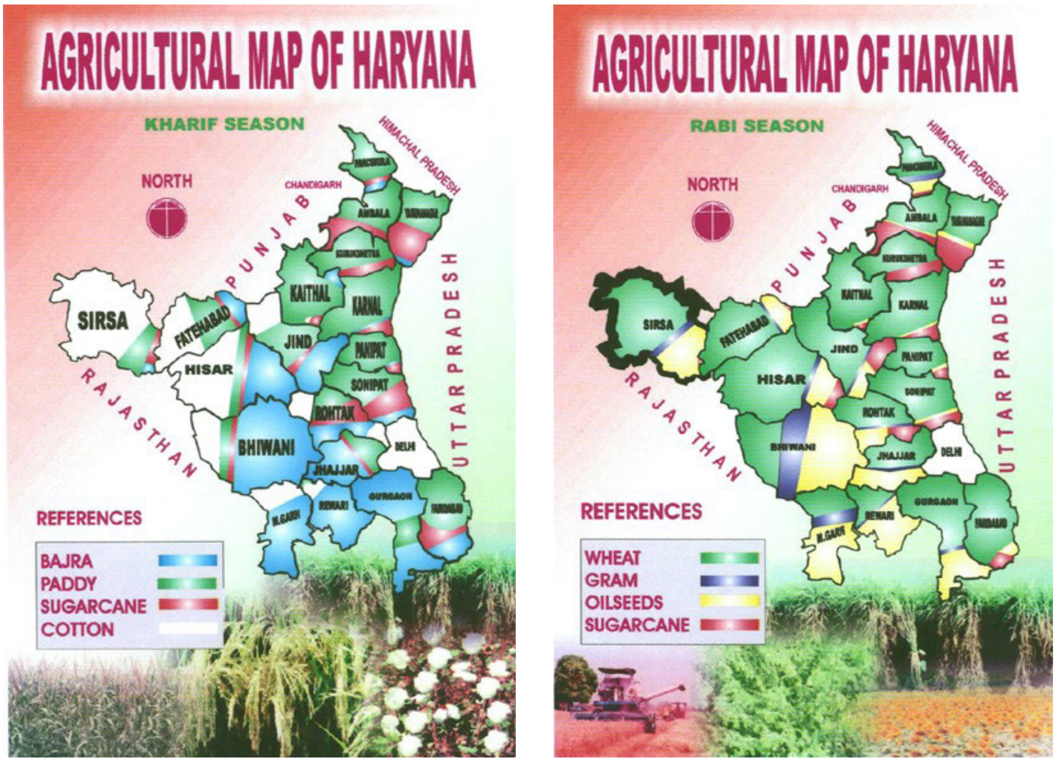


Figure 2.2: Agricultural Maps of Haryana

Source: Department of Agriculture, Haryana (2014)

Table 2.1: Crops Grown in Haryana in Kharif Season (2013–14)

CROP	GROSS AREA (1,000 HECTARES)	NUMBER OF WELLS THAT RECORDED A RISE IN WATER LEVELS	NUMBER OF WELLS THAT RECORDED A FALL IN WATER LEVELS
Paddy/Rice	1,228	3,256	3,998
Cotton	564	608	343
Bajra	404	2057	831
Sugarcane	101	730	74
Jowar	72	550	40
Pulses	18	850	15
Maize	9	3,000	27

Source: Agriculture Department, Haryana (2014)

Table 2.2: Crops Grown in Haryana in Rabi Season (2013–14)

CROP	GROSS AREA (1,000 HECTARES)	AVERAGE YIELD (KG/HECTARE)	TOTAL YIELD (1,000 TONNES)
Wheat	2,499	4,722	11,800
Rape Seed & Mustard	537	1,639	880
Gram	83	903	75
Barley	39	3,923	153
Sunflower	5	2,400	12

Source: Agriculture Department, Haryana (2014)

1.3 RAINFALL TRENDS AND GROUNDWATER SITUATION

Climate change and deforestation have resulted in declining rainfall levels in Haryana recently. Figure 2.3 shows the variation in average rainfall for the months of June, July, August and September (monsoon season) from 2009 to 2013 for the key agricultural districts identified in the previous section. There is an overall decreasing trend in average precipitation that has dire implications for agriculture, which relies heavily on rainfall.

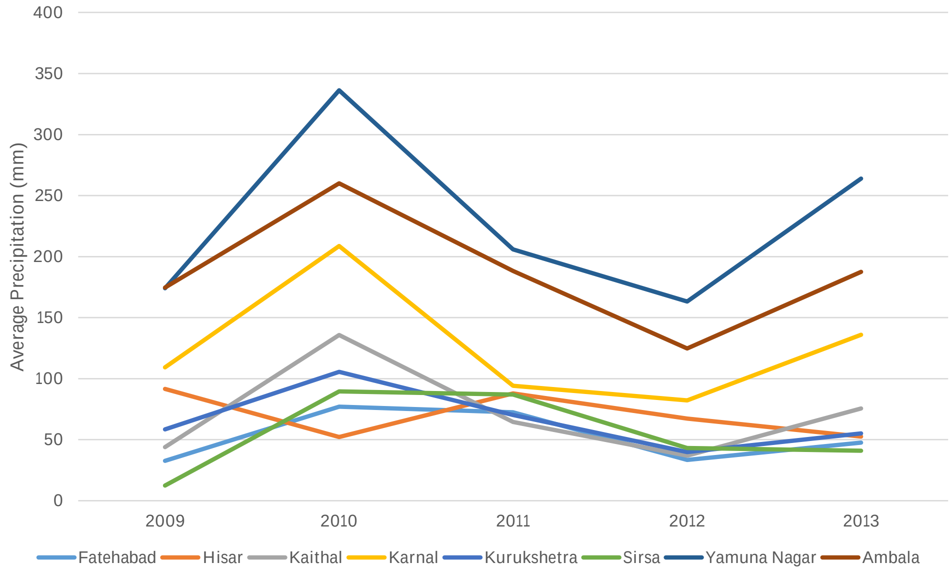


Figure 2.3: Average Rainfall for June, July, August and September (Monsoon Season)

Source: Indian Meteorological Department (n.d.); ICF Analysis

Deficient rains add another dimension to the crisis. Groundwater mainly depends on rainfall for recharge, so less rain means less groundwater availability. A failed monsoon also means farmers draw more groundwater to irrigate their crops, particularly paddy, accelerating the fall of the water table.

The groundwater scenario in most parts of Haryana is alarming to say the least. The Central Ground Water Board is the national authority that monitors groundwater levels in the country and implements groundwater recharging/replenishing schemes. As per data recorded by its monitoring wells in August 2012, water was found 5–20 m below ground level (bgl) in 66.67 per cent of the cases and 11.85 per cent wells displayed water depth between 20–40 m bgl. Moreover, when compared to the decadal (August 2002 to 2011) average water depth, 62.5 per cent of the wells analyzed recorded a fall in water levels (Central Ground Water Board, 2013).

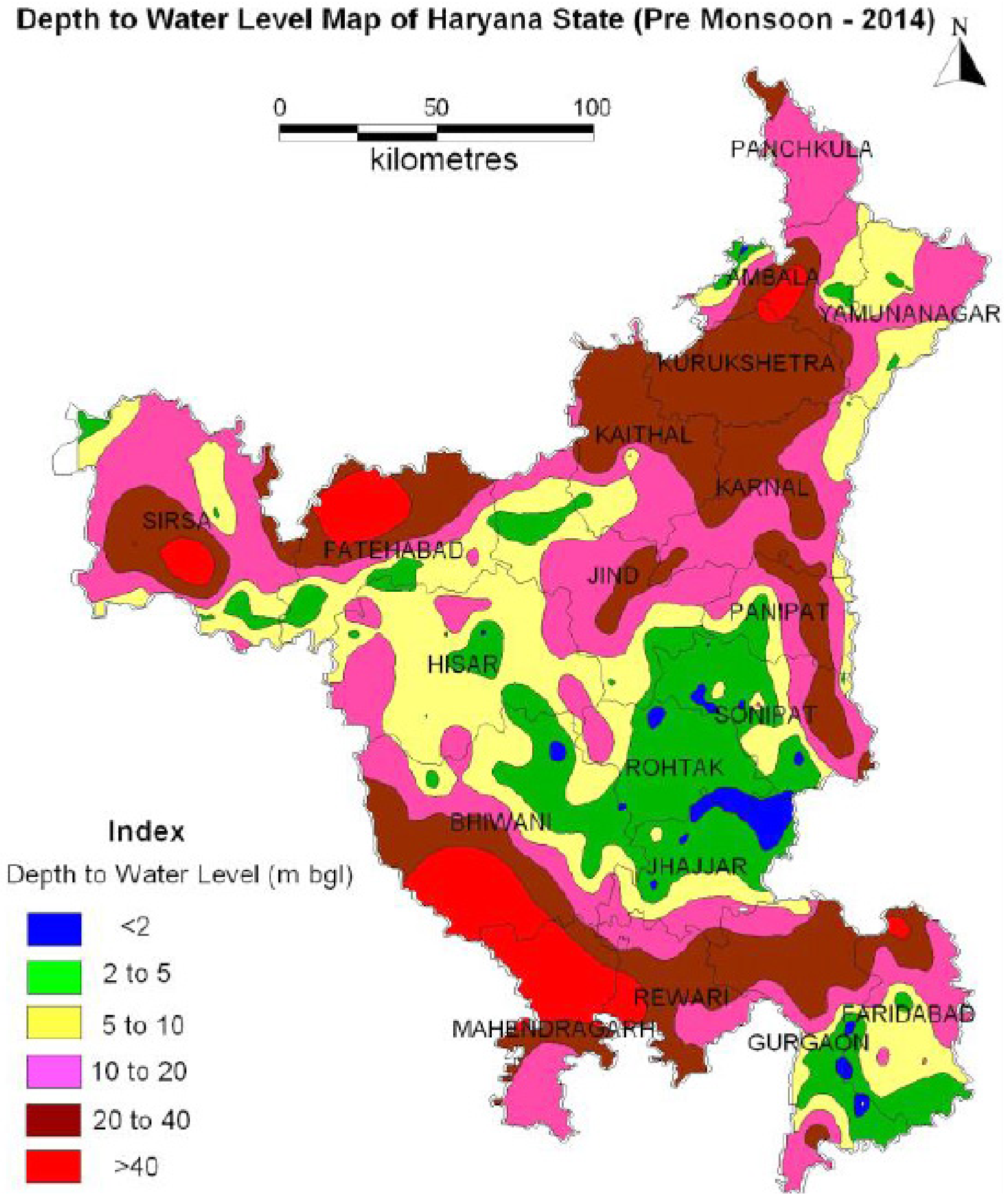


Figure 2.4: Groundwater Scenario for Haryana (Pre-Monsoon 2014)

Source: Central Ground Water Board (2014, p. 18)

Groundwater-depleted areas overlap with the chief agricultural districts of the state, notably Karnal, Kurukshetra and Kaithal. This has serious implications for groundwater usage and electricity consumption in these regions. The situation can be expected to deteriorate with further economic growth and urbanization unless drastic measures are taken for groundwater development.

1.4 WATER RESOURCES AND IRRIGATION

Haryana lies in the basins of the Indus and the Yamuna rivers and receives water from the Sutlej and Yamuna rivers and its share from the surplus water of the Ravi and Beas rivers, as per various interstate agreements.

There are no perennial rivers in Haryana. Ghaggar is the only seasonal river, which flows through the northern fringes of the state. The availability of water vis-à-vis demand is less, which has created an imbalance and sometimes leads to conflict. In view of the scarce availability of surface irrigation water, the development of a canal network assumed vital importance for the state. Out of a total geographical area of 4.42 million hectares (Mha), 3.82 Mha is culturable, of which 2.97 Mha is covered by surface irrigation with 14,370 km of canal networks under the following canal systems (Government of Haryana, 2011):

- Bhakra Canal System covering a Cultural Command Area (CCA) of 1.28 Mha in the northwestern and western parts of Haryana.
- Western Yamuna Canal system covering a CCA of 1.00 Mha in the northeastern and central parts of Haryana.
- Gurgaon Canal and Agra Canal Systems covering a CCA of 0.12 Mha in the southeastern parts of Haryana.
- Lift canals (Jawahar Lal Nehru, Loharu and Jui lift irrigation schemes) covering a CCA of 0.57 Mha in southwestern parts of Haryana bordering Rajasthan.

The following map graphically represents the major irrigation systems in Haryana.

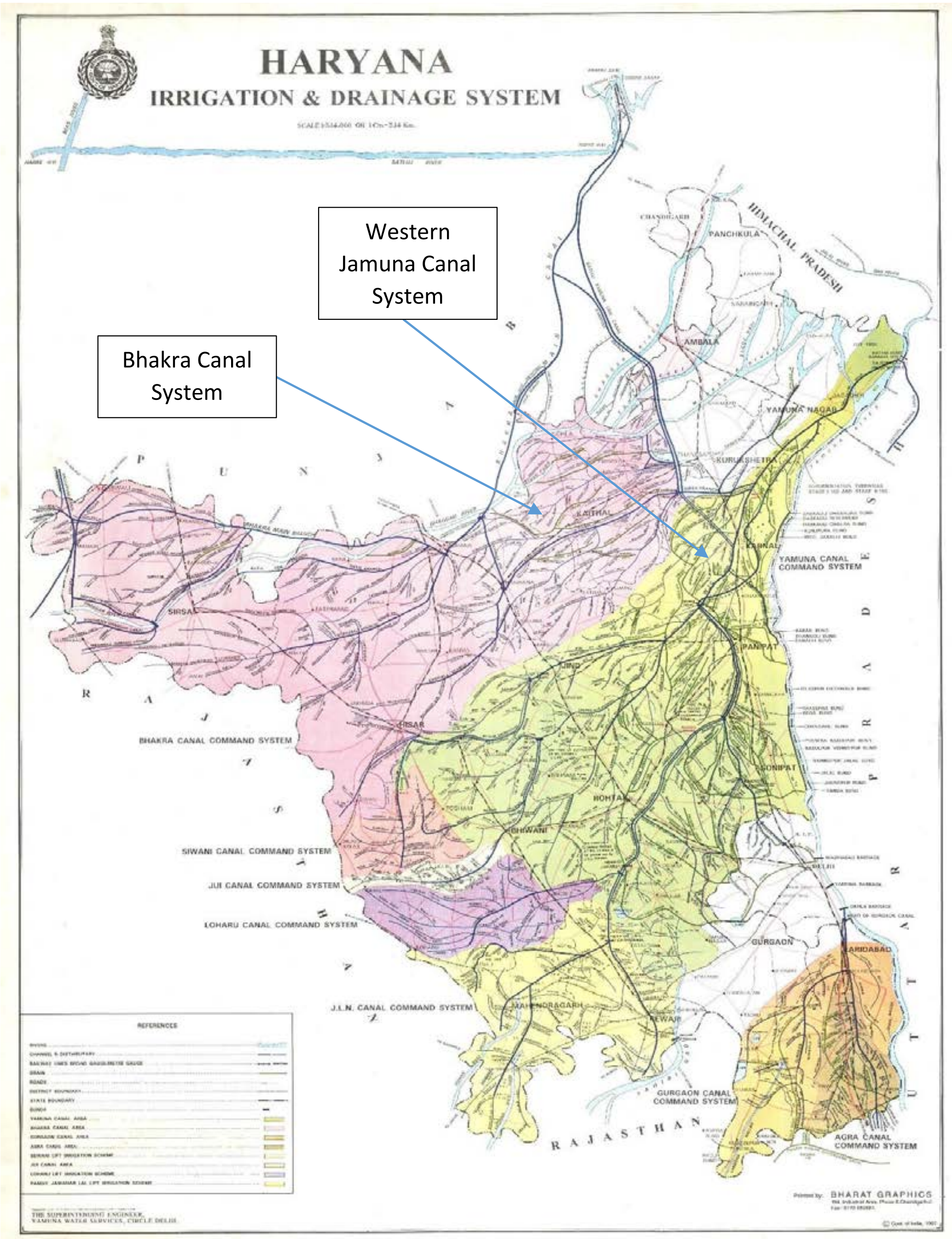


Figure 2.5: Canal and Drainage System in Haryana

Source: Irrigation and Water Resources Department, Haryana (1997)

2.0 Water Use and Availability

2.1 INDIA'S WATER USE

The two main sources of water in India are rainfall and glacial snowmelt in the Himalayas. India has an annual average precipitation of 1,170 mm, and about 80 per cent of the total area of the country experiences annual rainfall of 750 mm or more.

Owing to the large spatial and temporal variability in the rainfall, water resource distribution is highly skewed in space and time (Food and Agriculture Organization [FAO], 2009). Agriculture accounts for a significant percentage of the national GDP—17 per cent in 2009 (FAO, 2009).

Table 2.3: Top Groundwater-Extracting Nations

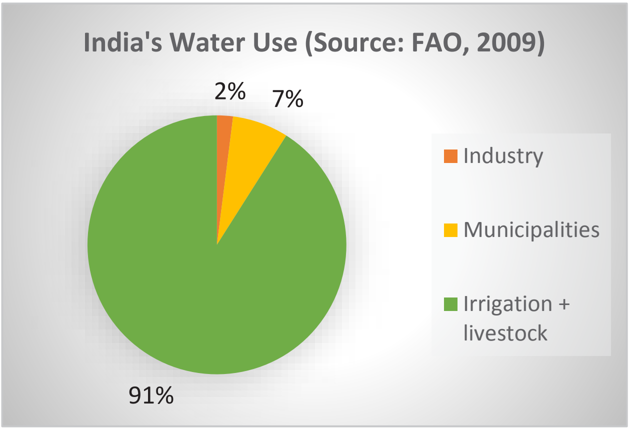
Country	Population 2010 (in thousands)	Groundwater extraction			
		Estimated groundwater extraction 2010 (km^3/yr)	Breakdown by sector		
			Groundwater extraction for irrigation (%)	Groundwater extraction for domestic use (%)	Groundwater extraction for industry (%)
India	1224614	251.00	89	9	2
China	1341335	111.95	54	20	26
United States	310384	111.70	71	23	6
Pakistan	173593	64.82	94	6	0
Iran	73974	63.40	87	11	2
Bangladesh	148692	30.21	86	13	1
Mexico	113423	29.45	72	22	6
Saudi Arabia	27448	24.24	92	5	3
Indonesia	239871	14.93	2	93	5
Turkey	72752	13.22	60	32	8
Russia	142985	11.62	3	79	18
Syria	20411	11.29	90	5	5
Japan	126536	10.94	23	29	48
Thailand	69122	10.74	14	60	26
Italy	60551	10.40	67	23	10

Source: National Ground Water Association (2015)

India has seen a steady decline in per capita freshwater resources over the last century, from a per capita freshwater resource availability of 5,277 m^3 in 1955 to 1,896 m^3 in 1997 (Sengupta 2004). It was estimated at 1,155 m^3 from 2010–2014 (World Bank, 2015). Despite this, India is among the highest users of groundwater and surface water for irrigation of agricultural crops in the world (see Table 2.3 above). According the National Groundwater Association of the United States, India withdrew an estimated 251 billion cubic meters (bcm) of groundwater for agricultural irrigation in 2010.

FAO estimates that, in 2010, India's water withdrawal was 760 km^3, of which 91 per cent or 688 km^3 was for agriculture. In addition, about 56 km^3 is for municipal use, and 17 km^3 is for industrial use (FAO, 2009).

Agriculture in India uses both surface and groundwater. In 1990, total water withdrawal was estimated at 500 km^3, of which 92 per cent was for irrigation. Primary surface water withdrawal was 362 km^3, while the amount coming from primary groundwater was an estimated 190 km^3. More recent global estimates indicate that India has the largest estimated annual groundwater extraction by 2010 at 251 km^3/yr and 89 per cent of this is used for irrigation (FAO, 2009). Most parts of India follow a two-crop system, a kharif crop over the summer months of June to October (the monsoon months) and a rabi crop over the winter months of November to April.



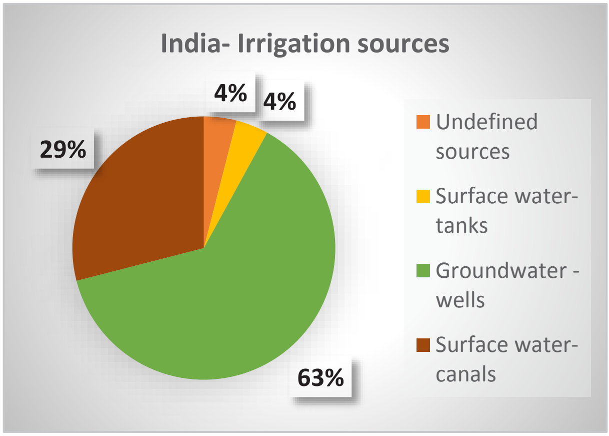


Figure 2.6 India's water use and irrigation sources

Source: FAO (2009)

Kharif (June–October)	Rabi (November–April)
Paddy, sugarcane, fodder, cotton, gram (chickpeas), barley, orchards and vegetables	Wheat, fodder, gram, barley and vegetables.

In many states, especially in Uttar Pradesh, Punjab and Haryana, the conjunctive use of surface water and groundwater has been practiced using canal systems and tube wells, which are installed alongside existing canals (FAO, 2009). Unfortunately this level of irrigation, while contributing to increasing agricultural productivity, has also led to a variety of soil and water-related problems. It is estimated that 8.4 million ha are affected by soil salinity and alkalinity, of which about 5.5 million ha are waterlogged (Singh et al., 2012).

2.2 HARYANA WATER USE

Table 2.7: State of Haryana Relevant Statistics

TOTAL GEOGRAPHICAL AREA	4421,000 HA
Cultivable area percentage	81.8%
Net area irrigated (total)	3102,000 ha
By canals	1345 (43.4%)
By tube wells	1757 (56.6%)
Percent net irrigated sown area	88.30%

Source: Vital Statistics (2015)

Haryana has among the highest rates of groundwater extraction in the country. Based on information published in India's annual groundwater report, and by comparing the data in the 2009 report to the 2014 report, we can see the net level of groundwater availability has declined. A satellite-based study from NASA observed that, over the Indian states of Rajasthan, Punjab and Haryana, groundwater is being depleted at a mean rate of 4.0±1.0 cm/year equivalent height of water (i.e., 17.7±4.5 km^3) between August 2002 and October 2008. During this period, groundwater depletion was equivalent to a net loss of 109 km^3 of water, which is double the capacity of India's largest surface water reservoir (Rodell et al., 2009). Mall et al. (2006) further suggest that "changes in cropping pattern and land-use pattern, over-exploitation of water storage and changes in irrigation and drainage in the Gangetic basin show a reduction in the Ganges discharge by 60 per cent over 25 years. This has led to about 50 per cent drop in water availability in surface water resources" (Adel, 2002).

Irrigation in the region has largely involved conjunctive use of water (i.e., a combination of surface and groundwater). However, with increasing variability, lower controls on groundwater extraction, subsidies in electricity needed for pumping groundwater and improvements in groundwater extraction technologies, the trend is a significant increase in groundwater for crop production in Haryana. In India and Pakistan, groundwater took over surface water as the main irrigation source since the mid-1980s (Shah, 2007). Around 2009, groundwater served 60 per cent or more of irrigated lands (Shah et al., 2009). A study reposted by Erenstein (2009) estimates the water productivity indicator for paddy and wheat in the region, as well as relatively to neighboring regions in Punjab (Pakistan). The report indicates that, on average, farmers irrigated wheat 3.4 times, while they irrigated paddy 34.5 times. Estimated irrigation volumes for paddy are also a multiple of those for wheat: a factor of 8.4 in Haryana. Physical productivity markers (crop yield per volume of physical inputs) for paddy are therefore markedly lower than those for wheat, reflecting significantly higher water inputs in paddy cultivation with relatively similar yields. Compared to wheat, financial water productivity is also lower for paddy in each site, as the higher net revenues for paddy are offset by the higher water inputs. Estimated physical water productivity indicators for wheat are about 1.5 kg/m^3 and about 0.2 kg/m^3. For some major crops (we have looked at wheat, paddy and sugarcane), we have derived the following basic assessments to provide the context of water use and implications.

Table 2.8: Selected Crop and Irrigation Information for Haryana

	PADDY	WHEAT	SUGARCANE
Irrigation Costs (INR/ha)	6,820.18	4,066.90	2,680.43
Derived yield (quintal/ha)	44.14	50.78	654.52
Water productivity indicator (kg/m^3)	0.2	1.5	
Area under principal crops (2007)	1,041	2,365	140

Source: IISD Analysis

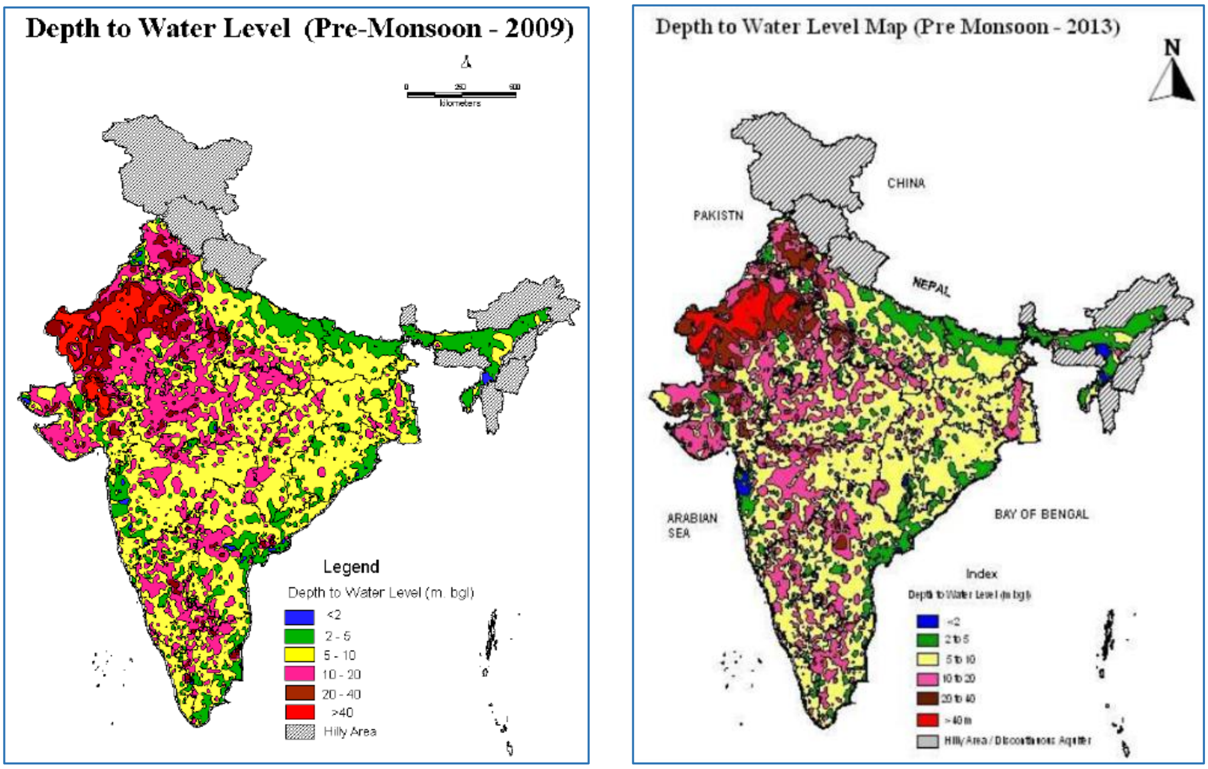


Figure 2.7: Comparison of Water Depth Levels in India (2009 versus 2013)

Source: Government of India (2014, p. 137)

Figure 2.7 visually depicts the lowering groundwater tables within the period from 2009 to 2013, showing a move to groundwater from depths of 5–10 m below ground (yellow) to larger areas in the state at 10–40 m below ground (pink and brown). This indicates that larger areas in Haryana have deeper and less accessible groundwater tables and that overall groundwater potential in the state is diminishing fairly significantly, as demonstrated by the remarkable change over a period of 4–5 years.

Further, the latest published groundwater report (Government of India, 2014) provides data on annual groundwater at the state level—as shown in the synthesis in Table 2.9. Total replenishable groundwater provides the overall level of inflow or recharge of groundwater. Total annual groundwater draft is the total level of extraction for different uses, primarily irrigation and domestic/industrial uses in the case of Haryana. The difference between these two gives the level of availability and, in the case of Haryana, this is a negative amount for the latest reported data in 2009. With a 127 per cent overall groundwater development, Haryana is at the third highest level of groundwater development in a country that ranks highest in the world for groundwater use for irrigation.

Table 2.9: Annual Groundwater Status for Select States in India (all figures in bcm)

State	Annual replenishable groundwater resource					Natural discharge during non-monsoon season	Net annual groundwater availability	Annual groundwater draft			Projected demand for domestic and industrial uses up to 2025	Groundwater availability for future irrigation use	Stage of groundwater development (%)
	Monsoon season		Non-monsoon season		Total			irrigation	Domestic and industrial uses	Total			
	Recharge from rainfall	Rainfall from other sources	Recharge from rainfall	Rainfall from other sources									
Punjab	5.86	10.57	1.34	4.78	22.56	2.21	20.35	33.97	0.69	34.66	0.95	-14.57	170
Rajasthan	8.76	0.67	0.32	2.11	11.86	1.07	10.79	12.86	1.65	14.52	1.84	0.75	135
Haryana	3.53	2.69	1.01	3.25	20.48	0.68	9.80	11.71	0.72	12.43	0.79	-2.70	127

Source: Central Ground Water Board (2014)

2.3 LAND USE

Haryana's land use has been changing moderately in the last few decades. Overall, land use in Haryana is dominated by agriculture. Net sown area (NSA), the area that is sown at least once during a year, has declined marginally from 82.12 per cent in 1995–98 to 80.16 per cent in 2002–05. Although according to Haryana's stage plan developed by the Planning Commission (2009), the net sown area in the state has grown from 3,423,000 hectares in 1966–67 to 3,528,000 hectares in 2004–05. The same source identifies the crops with the highest rate of growth, including wheat, paddy, sugarcane, cotton, etc.

According to Malik (2012), Ambala, Panchkula, Yamuna Nagar, Panipat, Faridabad, Gurgaon and Mahendergarh were the districts where the percentage of NSA was less than the state average (82.12 per cent). NSA accounted for 80–90 per cent of total area in most parts of the state. Sirsa was the only district where NSA accounted for more than 90 per cent of the total area. From 2002 to 2005, the highest proportion NSA is found in Sirsa district, which is 91.9 per cent of the total area. The lowest percentage of NSA is found in Panchkula district, which is due to the development of Panchkula as an administrative city, the establishment of industries, the low fertility of soils and rough surface.

Table 2.10: Haryana Change in Land Use (1995–98 to 2002–05)

LAND-USE CATEGORIES	PERCENTAGE AREA 1995–98	PERCENTAGE AREA 2002–05	PERCENTAGE CHANGE
Forests	2.275	1.02	-55.16
Area under non-agricultural uses	8.69	10.14	16.69
Barren and uncultivable land	2.03	2.25	10.84
Permanent pastures and other grazing land	0.55	0.57	3.64
Area under miscellaneous tree crops	0.098	0.14	42.85
Cultivable wasteland	0.63	0.81	28.57
Fallow land	3.31	4.91	48.34
Net sown area	82.12	80.16	-2.39

Source: Department of Agriculture and Statistical Analysis, Haryana. (2012, 2013, 2014, 2015)

3.0 Identification and Quantification of Major Subsidies Affecting the Electricity-Irrigation Nexus

The approach adopted in this study has been to identify producer subsidies (specific to the focus crops) and to evaluate their monetary benefits as a percentage of the average cost of production on a per-hectare basis. Subsequently, the contribution of surface irrigation and electricity subsidies to the overall basket of subsidies is investigated in greater detail to develop a deeper understanding of the electricity-irrigation nexus and its impacts on cropping profile, electricity consumption pattern, irrigation behaviour, etc. This section delves into the methodology used for identifying and quantifying subsidies on surface water, groundwater (electricity) and fertilizers—the three primary agricultural inputs.

3.1 GROUNDWATER IRRIGATION (ELECTRICITY) SUBSIDY

Irrigation through groundwater uses high-capacity electric or diesel pump sets. In the case of electric agricultural pump (AP) sets, the electricity tariff applicable falls under two categories: AP metered consumers billed on an energy-consumption basis and AP unmetered consumers who are currently paying a flat rate based on pump rating per month. The quantum of subsidies to be set aside each year is determined the Haryana Electricity Regulatory Commission in its annual Tariff Order based on Annual Revenue Requirement filings by the state's distribution utilities. The state of Haryana is served by two DISCOMs:

- Uttar Haryana Bijli Vitran Nigam (UHBVN), which serves the northern region of the state
- Dakshin Haryana Bijli Vitran Nigam (DHBVN), which is responsible for distribution of power in southern Haryana

AP users have to pay only a small fraction of the actual tariff, with the result that, each year, subsidies run into thousands of crores for the agriculture sector. It must be noted here that the entire revenue gap in the AP consumer category is bridged by way of the AP subsidy from the state government, and no consumer category is cross-subsidizing the AP consumers. However, the subsidy from the state government is not always reimbursed, which has invariably resulted in state DISCOMs operating in a state of perpetual loss and poor financial health.

Table 2.11: Subsidy to AP Set Users (FY 2011 to FY 2014)

YEAR	AGGREGATE SUBSIDY TO AP CATEGORY (INR BILLION)
FY 2010–11	34.25
FY 2011–12	34.21
FY 2012–13	39.74
FY 2013–14	48.53

Source: Haryana Electricity Regulatory Commission (2011, 2012, 2013, 2014)

With such substantial levels of subsidies being afforded to farmers, the number of electric pump sets has risen steadily over the years in Haryana, as shown in Table 2.12 and Figure 2.8. As per the latest figures, the total number stands at 772,310 pump sets with 556,664 (72 per cent) being electric.

Table 2.12: Agriculture Pump Sets in Haryana

YEAR	DIESEL SETS	ELECTRIC SETS	TOTAL
1970-71	17,903	86,455	104,358
1975-76	65,092	139,644	204,736
1980-81	109,353	222,674	332,027
1985-86	134,136	272,282	406,418
1990-91	155,842	341,729	497,571
1993-94	214,343	317,297	531,640
1994-95	225,485	321,731	547,216
1995-96	225,848	323,448	549,296
2000-01	255,302	334,171	589,473
2005-06	231,821	386,202	618,023
2010-11	231,146	492,311	723,457
2011-12	225,046	512,311	737,357
2012-13	220,046	532,311	752,357
2013-14 (P)	215,646	556,664	772,310

Source: Department of Agriculture and Statistical Analysis, Haryana (2012, 2013, 2014, 2015)

A direct consequence of this surge in electric pumps has been mounting financial burden on the state's DISCOMs due to excessive use of electricity, non-payment of bills and drastic reductions in groundwater levels across the state.

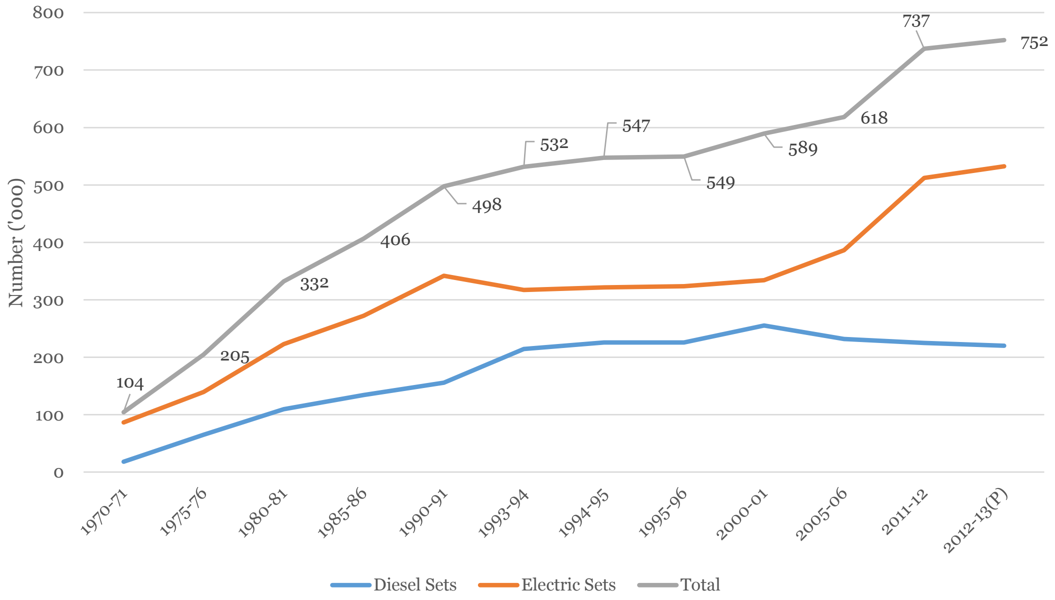


Figure 2.8: Number of Pump Sets in Haryana

Source: Department of Agriculture and Statistical Analysis, Haryana (2012, 2013, 2014, 2015)

Another interesting observation was the district-level distribution of pump sets, which perhaps could indicate the energy intensity of crops being sown. Sugarcane and paddy are water-intensive crops and hence require more pumps per hectare than wheat, as can be seen in Table 2.13. The high density of pumps in their respective districts is indicative of this fact and also represents the trend of opting for groundwater for irrigation due to very low electricity tariffs. This has been the major reason for depletion of groundwater resources in these districts.

Table 2.13: District-Level Distribution of Pump Sets in Haryana

CROP	DISTRICT	PUMP TYPE			PUMP DENSITY (PER 1,000 HA)	PUMP DENSITY (PER 1,000 HA)
		DIESEL	ELECTRIC	TOTAL		
Paddy	Karnal	184	43,416	43,600	382	114
	Kaithal	18,935	44,203	63,138	380	166
	Kurukshetra	8,915	67,627	76,542	276	277
Wheat	Sirsa	19,062	39,147	58,209	688	85
	Hisar	19,556	11,416	30,972	566	55
	Fatehabad	8,750	31,163	39,913	415	96
Sugarcane	Yamuna Nagar	5,802	26,782	32,584	204	160
	Ambala	4,873	22,919	27,792	189	147

Source: Source: Department of Agriculture and Statistical Analysis, Haryana (2014)
(area during 2011–12)*

As mentioned previously in the report, the following amounts were the gross subsidy provided to AP set users from FY 2011 to FY 2014. The same have been normalized using the state's gross cropped area of 6.375 million hectares.

Table 2.14: Electricity Subsidies to AP Set Users (FY 2011 to FY 2014)

YEAR	AGGREGATE SUBSIDY TO AP CATEGORY (INR BILLION)	NORMALIZED ELECTRICITY SUBSIDY (INR/HA)
FY 2010-11	34.25	5,373
FY 2011-12	34.21	5,366
FY 2012-13	39.74	6,234
FY 2013-14	48.53	7,613

Source: Haryana Electricity Regulatory Commission (2011, 2012, 2013, 2014)

3.2 SURFACE WATER IRRIGATION SUBSIDY

Subsidies for water provided to farmers via irrigation projects has been estimated using the Global Subsidy Initiative's Net Cost to Supplier approach, as was done previously for the case of Andhra Pradesh (Palanisami, Mohan, Giordano, & Charles, 2011). In this approach, major irrigation projects serving the state are identified and data pertaining to cost and benefits from each project are obtained. "Subsidy" is defined as the net cost incurred by the supplier of water (state or central government), which is simply equal to total expenditure minus gross receipts.

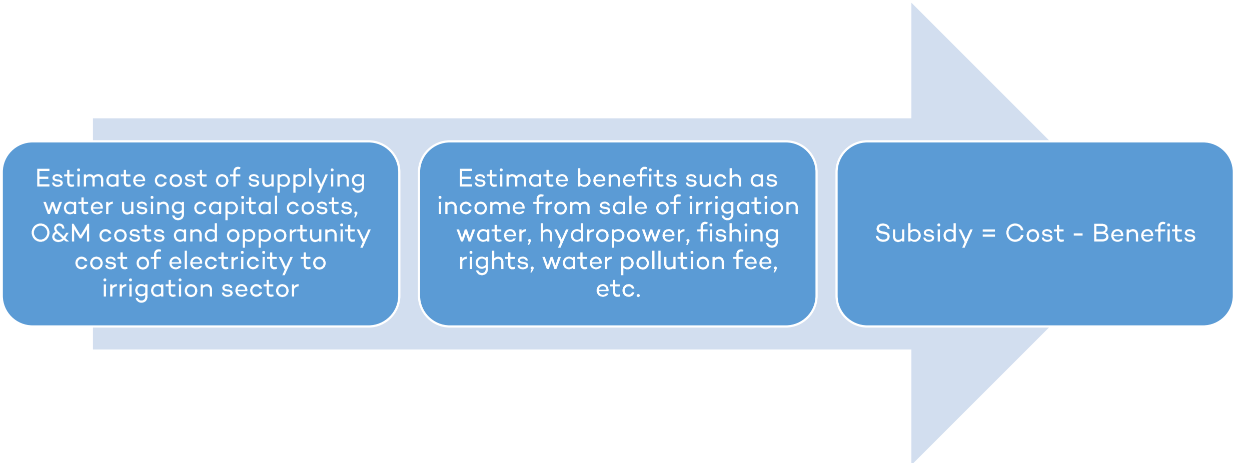


Figure 2.9: GSI's Net Cost to Supplier Approach

The key components of expenses related to a project are:

- Annual capital cost (interest and depreciation charges) or irrigation infrastructure
- Operation and maintenance costs
- Opportunity cost of electricity used for irrigation pumping (electricity subsidy)
- Cost of environmental externalities (if possible)

Similarly, the key components of gross receipts from a project are:

- Revenue realized from the sale of water to agriculture and industry
- Revenue realized from the sale of hydropower
- Revenue realized from the sale of fishing rights (if applicable)
- Revenue realized from the sale of electricity to agricultural users
- Revenue realized from the imposition of pollution taxes

Bhakra Canal Project and Western Jamuna Canal Project are the two largest irrigation projects to have been implemented in Haryana, collectively accounting for almost 77 per cent of the total irrigated area in the state. Together, they serve, among others, the districts of Karnal, Kaithal, Kurukshetra, Hisar, Fatehabad, Yamuna Nagar and Ambala, which have been previously identified as the chief agricultural production centres in the state for wheat, paddy and sugarcane.

For the same financial years, capital expenditure, operation and maintenance costs, depreciation charges and gross revenue receipts were obtained from the Department of Irrigation and Water Resources, Government of Haryana, for major as well as minor irrigation projects in the state. Irrigation subsidies were evaluated using GSI's Net Cost to Supplier approach.

Table 2.15: Irrigation Subsidies in Haryana (FY 2011 to FY 2014)

YEAR	CAPITAL EXPENDITURE (INR MILLION)	ENERGY EXPENSES (INR MILLION)	O&M EXPENSES (INR MILLION)	INTEREST CHARGES (INR MILLION)	TOTAL COST (INR MILLION)	TOTAL REVENUE (INR MILLION)	TOTAL SUBSIDY (INR MILLION)	NORMALIZED SUBSIDY (INR/HA)
FY 2010-11	4,077.5	3,095.4	2,060.3	3,445.1	12,678.3	2,281.9	10,396.4	1,631
FY 2011-12	4,891.1	2,800.5	2,601.9	3,517.1	13,810.6	6,174.7	7,635.9	1,198
FY 2012-13	4,795.0	3,026.3	3,043.4	4,543.3	15,408.0	1,684.8	13,723.2	2,153
FY 2013-14	4,067.6	2,330.4	3,170.2	4,960.2	14,528.4	1,221.4	13,307.0	2,087

Source: Department of Irrigation and Water Resources, Government of Haryana

3.3 COMPARISON WITH FERTILIZER SUBSIDIES

Fertilizers are one of the most important agricultural inputs, and increasing fertilizer use has been a critical component of the green revolution package of inputs and practices. However, an increase in fertilizer use has come at significant costs. While the fiscal burden of fertilizer subsidies has increased significantly, other costs in the form of long-term soil damage, straining of water resources and general saturation of yields due to application of suboptimal nutrient ratios have become important in recent years (Kishore, Praveen, & Roy, 2013). As shown in Figure 2.10, fertilizer usage has been rising steadily in the country, as well as in Haryana, because of the substantial subsidies provided to manufacturers.

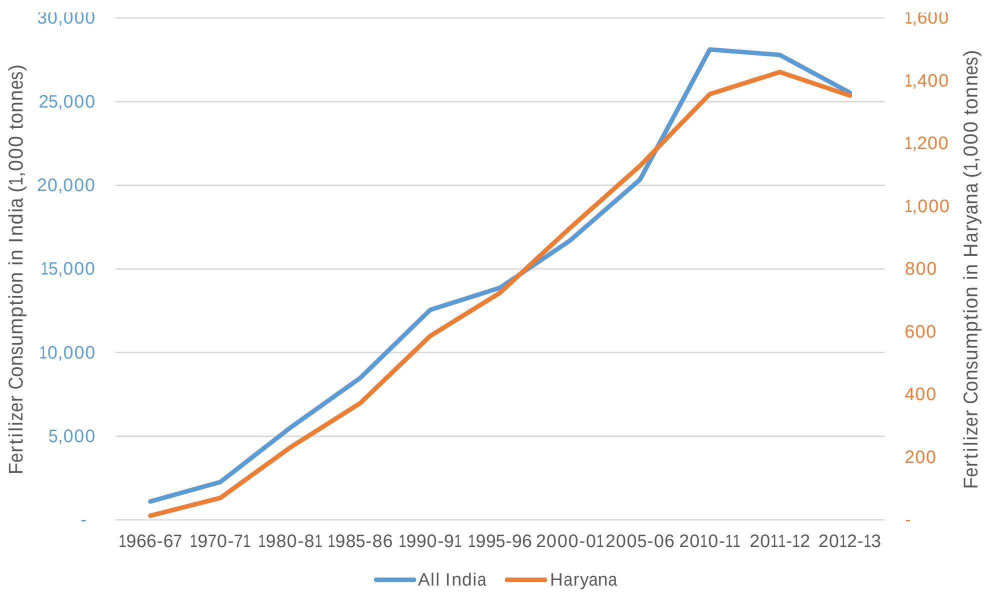


Figure 2.10: Total Consumption of Nitrogen, Phosphorous, Potassium (NPK) Fertilizers in India and Haryana (1,000 tonnes)

Source: Fertiliser Association of India (2014); Department of Agriculture and Statistical Analysis, Haryana (2015)

To quantify a subsidy on fertilizers, all India subsidies on fertilizers were proportionately divided on the basis of share of consumption of NPK fertilizers in Haryana as shown in Table 2.16.

Table 2.16: Fertilizer Subsidies in Haryana (FY 2011 to FY 2014)

YEAR	ALL INDIA NPK CONSUMPTION (1,000 TONS)	HARYANA NPK CONSUMPTION (1,000 TONS)	CONSUMPTION SHARE	ALL INDIA SUBSIDY (INR BILLION)	HARYANA SUBSIDY (INR BILLION)	NORMALIZED SUBSIDY (INR/HA)
FY 2010-11	28,122.2	1,357.62	4.83%	658.37	13.58	3,178
FY 2011-12	27,790.0	1,428.05	5.14%	737.91	14.28	3,792
FY 2012-13	25,536.2	1,353.06	5.30%	705.92	13.53	3,740
FY 2013-14	24,482.4	1,164.67*	4.76%	712.51	11.65	3,390

Source: Fertiliser Association of India (2014); Department of Agriculture and Statistical Analysis, Haryana (2015)

**Provisional figure (up to December 31, 2013)*

Subsidies on electricity, irrigation and fertilizers available to farmers are summarized in Table 2.17.

Table 2.17: A Summary of Subsidies on Electricity, Irrigation and Fertilizers Available to Farmers

	NORMALIZED ELECTRICITY SUBSIDY		NORMALIZED IRRIGATION SUBSIDY		NORMALIZED FERTILIZER SUBSIDY		SUBSIDY
	(INR/HA)	%	(INR/HA)	%	(INR/HA)	%	(INR/HA)
FY 2010-11	5,373	45%	1,631	14%	3,178	42%	11,989
FY 2011-12	5,366	43%	1,198	10%	3,792	48%	12,512
FY 2012-13	6,234	44%	2,153	15 %	3,740	41%	14,254
FY 2013-14	7,613	51%	2,087	14%	3,390	35%	15,017

Source: ICF Analysis

3.4 COMPARISON WITH OTHER AGRICULTURAL SCHEMES

This section briefly discusses several schemes that have been introduced in Haryana over the years. Although they do not have a direct impact on the electricity-irrigation nexus, these schemes highlight the efforts by the state and central governments to augment growth of the agricultural sector and to improve the standard of living and financial well-being of farmers. A complete list of subsidy schemes identified in the agriculture sector in Haryana that were active during 2012–14 has been provided in Appendix A. Some of the important ones have been discussed in the following subsections.

3.4.1 Generic Schemes

Several schemes have been initiated by the state and central governments in Haryana to promote sustainable farming practices, enhance crop productivity, improve soil quality, etc. Some of the key schemes to have been introduced that have a direct impact on farmers' income include the following.

A. Schemes on Primary Agricultural Inputs

a. *Scheme for Stocking and Distribution of Fertilizers by Institutional Agencies*: This scheme has been in operation since 2007–08. Fertilizers are one of the important agricultural inputs used for raising crops. The major fertilizers consumed in Haryana are diammonium phosphate (DAP) and urea. The sale, pricing and quality of fertilizers are regulated under the Fertilizers (Control) Order, 1985, which extends to the whole country. Under this scheme, it is proposed to create a buffer stock of DAP and urea with institutional agencies (such as HAFED, HAIC, HRLDC, etc.) during lean fertilizer consumption periods for compensating the carrying cost to the government.

b. *Scheme for Managing Micro-Nutrients Deficiency in the Soil*: The main objective of the scheme is to provide subsidy at 50 per cent or INR 500 per hectare (whichever is less) with a maximum ceiling of 2 hectares per farmer on the supply of micronutrients fertilizers.

c. *Scheme for Promotion of Sustainable Agriculture*: One of the initiatives under this scheme is to provide 100 per cent seed treatment and fungicides to wheat farmers free of cost.

B. Schemes on Crop Production, Storage and Processing

a. *Scheme for Safe and Scientific Storage of Food Grains*: The objective of this scheme is to provide scientifically fabricated metallic bins at 50 per cent of the cost to general category farmers. It is estimated that post-harvest, about 9.33 per cent of food grains are lost during threshing, transportation and storage, which can amount to crores of rupees. Out of this, 6.58 per cent losses occur during storage. In Haryana, about 60–70 per cent of the agriculture produce is stored at the farm level to meet their domestic food consumption, animal feed requirement and seeds for sowing of ensuing crops. Hence, this scheme aims to minimize losses to stored food grains at the farm level.

C. Fiscal Schemes

a. *National Agriculture Insurance Scheme*: This is a centrally sponsored scheme wherein only a part of the premium is paid by the cultivator and the rest is borne by the central and state governments on a 50/50 basis. It is being implemented on wheat and paddy crops in the Karnal, Kaithal, Rohtak and Jind districts.

b. *Weather-Based Crop Insurance Scheme*: This is also a centrally sponsored scheme and is being implemented in 18 blocks of 17 districts in Haryana where wheat, paddy, cotton and bajra are cultivated.

c. *Credit Services to Farmers*: The government provides loans at low-interest rates and other credit services in the form of subsidies on farm mechanization to farmers. The quantum of loan is determined on the basis of crops raised in the area and the cost of cultivation, which is fixed by a technical committee of the district. If the total of cost of cultivation and cost of consumption (which is assumed to be 25 per cent of cultivation cost) is less than INR 300,000, then a loan is provided at a rate of 7 per cent through subvention. This can be further reduced by up to 4 per cent if the farmer has a good credit history. For loans greater than INR 300,000, interest on the first 300,000 is charged at 7 per cent and at the regular rate on the amount in excess of 300,000 (which varies from bank to bank; usually around 12 per cent).

In addition, another form of subsidy that is intangible and uncountable is that agricultural income is not taxed in India.

D. Crop-Specific Schemes

a. *Technology Mission on Sugarcane*: The Technology Mission on Sugarcane is a state-government-sponsored scheme that aims to increase cultivated area, production and productivity of sugarcane to meet the domestic demand of the country and to bring a reduction in the cost of cultivation and pesticide consumption for enhancing competitiveness in the global market.

The sugarcane scenario in the country, and also in Haryana, has not been satisfactory in recent years. Production has drastically declined, resulting in the closure of many sugar mills. The reduction in sugarcane cultivation in Haryana has mostly been because of large-scale migration towards paddy. Sugarcane faces a stiff challenge from the paddy and wheat cropping system, as both of these are short-duration crops (4–5 months), compared to sugarcane, a 2-year crop. Paddy and wheat also enjoy substantial Minimum Support Price by the Government of India and assured marketing, whereas sugarcane has a staggered harvesting system. Also, the cultivation of wheat and paddy is largely mechanized, whereas sugarcane cultivation is highly labour intensive. The labour problem is becoming acute by the day as migratory labourers prefer urban jobs over agriculture jobs.

b. *National Food Security Mission (NFSM)*: The Government of India launched the centrally sponsored National Food Security Mission in Haryana from Rabi 2007–08. Two crops, namely wheat and pulses, are covered under the mission. It focuses on districts having high potential but a relatively low level of productivity. Seven districts of the state, namely Ambala, Yamunanagar, Bhiwani, Mahendergarh, Gurgaon, Rohtak and Jhajjar, are covered under NFSM-Wheat. The main objective of the mission is to increase production of wheat and pulses through area expansion and productivity enhancement in a sustainable manner in the identified districts in the state. The nature of support provided has been summarized in Table 2.20.

Table 2.18: Nature of Support under National Food Security Mission for Wheat

COMPONENT	PATTERN OF ASSISTANCE
Demonstrations	INR 2,000/per acre
Certified Seed Distribution	50% of the cost limited to INR 500 per quintal
Seed Mini-kits	Free of cost
Micronutrients	50% of the cost limited to INR 500/per hectare
Gypsum	50% of cost of material plus transportation cost limited to INR 750 per hectare; total assistance on Gypsum and Micronutrients should not exceed INR 1,000 per hectare
Zero Till Seed Drill	50% of the cost limited to INR 15,000 per machine
Seed Drill	50% of the cost limited to INR 15,000 per machine
Multi-crop Planter	50% of the cost limited to INR 15,000 per machine
Rotavator	50% of the cost limited to INR 30,000 per machine
Laser Land Leveller	50% of the cost limited to INR 150,000 per machine for a group of farmers
Knap Sack Sprayer	50% of cost limited to INR 3,000 (whichever is less)
Sprinkler Sets	50% of the cost limited to INR 7,500 per hectare
Farmer Field School	INR 17,000/per training

Source: Government of India (2010)

3.4.2 Amnesty Schemes

From time to time, several amnesty schemes have been announced by state and central governments in India, often laden with political undertones. In January 2014, the state government in Haryana launched the Mukhyamantri Kisan and Khetihar Majdoor Jiwan Surksha Yojna. Under this scheme a compensation of INR 500,000 was given in the event of death, while under the Mukhyamantri Gramin Dudharu Pashudhan Surksha Yojna, compensation ranging from INR 20,000 to INR 50,000 was awarded in the event of death of a farmer's cow or buffalo. Under the scheme, for one-time settlement of crop loans, a concession of 50 per cent was given on the interest.

Similarly, in 2013, the Haryana Cabinet approved a One Time Settlement (OTS) scheme for loans taken by farmers from the Cooperation Department. The cabinet approved the Recovery Linked Incentive 2013 scheme of Haryana State Cooperative Agriculture and Rural Development Bank (HSCARDB). The Recovery Linked Incentive (OTS) Scheme of HSCARDB covered those defaulters of District Primary Cooperative Agriculture and Rural Development Bank (DPCARDB) in the state who borrowed loans under any scheme except Purchase of Land Scheme.

PART III

GENERAL REFORM OPTIONS AND CONSIDERATIONS FOR ELECTRICITY SUBSIDY REFORM

1.0 Alternative Business Models

1.1 ELECTRICITY REFORMS

Some business models are aimed at reducing electricity consumption, and that might be promising for irrigation in Haryana, and India more broadly. This section discusses technology-based business models such as solar-energy-based pumps and their feasibility in Haryana, replacement of electric pumps with energy-efficient pumps, and metering and feeder segregation for Haryana agricultural users.

1.1.1 Solar Water Pumping Solution for Haryana

The economic and environmental benefits of replacing diesel-based agricultural pumps as well as old, inefficient electric pumps with solar pumps have been well documented. India uses more than 4 billion litres of diesel fuel and around 85 million tonnes of coal per annum to support its roughly 19 million grid-connected pump sets and 7 million diesel pump sets. Replacing 1 million diesel pumps with solar photovoltaic (PV) pumps would result in diesel use mitigation of 9.4 billion litres over the life cycle of solar pumps, which translates into a carbon dioxide abatement of 25.3 million tonnes. This shift is also expected to result in an increase in crop productivity due to timely availability of water, improved energy access, groundwater conservation and better standards of living in rural areas.

However, the initial capital investment required for a standard solar pump is about 10 times that of a conventional pump, thus making it necessary for subsidies to be provided for the upfront cost. This has been a major deterrent for famers looking for a more reliable and environmentally friendly water pumping solution. Also, since agricultural tariffs are usually the lowest and also highly subsidized, there is no incentive to the agricultural consumer to improve the efficiency of the pump set or replace it, which further compounds the problem. As a result, the uptake of solar pumps in India has been quite slow. India has an installed base of around 12,000 to 13,000 solar agriculture pumps. These are concentrated in a few states—an estimated 70 per cent or more of these are located in Punjab, Rajasthan, Haryana and Bihar.

These pumps have been installed largely by State Nodal Agencies (SNAs) with capital subsidy assistance from the Ministry of New and Renewable Energy (MNRE). MNRE's 30 per cent capital subsidy assistance is coupled with state subsidy assistance that has historically ranged between 50 and 55 per cent to offer subsidized pumps to farmers at 15–20 per cent of their total cost. Table 3.1 shows the state government of Haryana's subsidies on solar water pumping systems.

Table 3.1: Subsidy Framework for Solar Pumps in Haryana

CAPACITY OF SPV PUMP	TOTAL HEAD (SUCTION & DELIVERY)	SOLAR PV (WATT)	COST (INR)	TOTAL GOVERNMENT SUBSIDY (INR)	BENEFICIARY FARMER SHARE (INR)
2 HP (DC Surface Mounted Monoblock Pump)	10 m	1,800	250,000	150,000	100,000
2 HP (DC Submersible Pump)	30 m	1,800	260,000	156,000	104,000
5 HP (DC Submersible Pump)	50 m	4,800	550,000	330,000	220,000

Source: Haryana Renewable Energy Development Agency (YEAR)

The central government has made several announcements in line with its policy of providing an impetus to generate clean and sustainable energy in the country. In September 2014 it launched an ambitious plan of installing 100,000 solar pumping systems for irrigation and drinking purposes under the Off-Grid and Decentralized Solar Applications Scheme. An initial financial support of INR 400 crore has been earmarked for this initiative, and it is proposed that it be implemented throughout India in coordination with the Ministry of Agriculture through SNAs, NABARD and the Ministry of Drinking Water and Sanitation. The duration of this program is 5 years starting from 2014–15, and it is envisaged that by 2020–21 at least 1 million solar pumps will deployed across the country. In its set of guidelines, the government expects this scheme to be implemented in the form of several business models, such as:

- *Grid-connected pumping*: Solar pumps can be installed in place of electricity-driven pumps. Irrigation needs are intermittent, leaving most days with additional power available. Thus, in collaboration with electricity authorities and local utilities, feeding excess power back into the grid could be encouraged.
- *Solar pump mini grid*: Segregation of rural domestic and agricultural feeders has been implemented in several states across the country. This presents an opportunity to introduce high-efficiency electric pumps connected to a transformer based on a PV plant. In case surplus power is available, the PV plant can feed power back into the grid.
- *Replacement of diesel pumps*: Diesel pumps are mostly preferred by small and marginal farmers in areas where grid connection is not available or power supply is unreliable. These pumps are highly inefficient and cause significant greenhouse gas emissions and, as such, farmers have to incur high operating costs on diesel fuel. Replacing such pumps with solar pumps would not only make farming viable for these farmers but also help reduce pollution.
- *Community solar pumps or water as a service*: In some areas, large farmers sell or barter water to those who do not have access to a conventional pumping solution. In such cases, water as a service could be encouraged. The pumps would thus be owned by large farmers or the community, and the service of providing water to other farmers could be established. This would help to develop local enterprises, thereby increasing local employment opportunities.
- *Micro solar pumps*: In some cases, farmers grow vegetables on a very small plot using manual irrigation methods like swing bucket, hand pumps or treadle pumps. Most of these farmers have no access to electricity. A micro solar pump with 0.1 horsepower (HP) to 0.5 HP of power could serve a similar function as a manually operated pump.

Although the government touches upon the idea of providing water as a service, it does not mention any specific details for a potential business model that could be adopted. A typical example is an Energy Services Company (ESCO) model, which can be broadly implemented in four different modes:

- *DISCOM mode*: The DISCOM utilizes its own funds either collected under a tariff regulation or through rationalizing a fraction of the annual subsidy amount and contracts out repair and maintenance of pumps and certain aspects of project works to a project contractor.
- *ESCO mode*: An ESCO that has a contract with the DISCOM finances and implements the project; the ESCO would borrow the project debt and repay it from project energy-saving revenues. Pump manufacturers can also participate as ESCOs in this mode of implementation.
- *HYBRID mode*: ESCO provides part of project funds through debt and equity and signs a contract with the DISCOM, whereas part of the project cost is paid by the DISCOM. ESCO shares energy-saving revenues with the DISCOM.

- *HIGH-TARIFF INDUSTRY* mode: In this mode, high-tariff industrial consumers sponsor projects and borrow to fund them in exchange for a contractual right to purchase a portion of the saved energy at a discount off their high industrial power tariff.

The intervention would lead to lower energy supply on the feeder and, hence, could result in lower subsidy to be paid by the state government. Part of the savings in the subsidy would be paid to the ESCO/utility on an annual basis over a period of time to pay for their investment in pump set enhancement/replacement. To ringfence the payment security mechanism, a large financial institution may be brought in to provide a loan to the project as well as an adequate payment security mechanism to the investors. Utilities can play the important role of monitoring and verification (M&V). The relationships between the various stakeholders in ESCO mode are depicted in Figure 3.1.

Solar pumps are ideally suited only in those areas where water tables are relatively high (<10 m).

As can be seen in Haryana's groundwater map (Figure 2.4), districts such as Jhajjar and Rohtak, which are located in the central region of the state, seem to be better positioned for implementing solar pump pilots. These districts also have large numbers of farmers using diesel pumps for irrigation purposes, and it is safe to assume that most of them would not have a grid connection. The cost of generating energy from a diesel pump typically ranges between INR 8 and INR 10 per kWh and, as such, a farmer spending INR 40,000–50,000 annually on diesel fuel (whose prices have been deregulated) would be more willing to switch to an alternative solution such as solar for meeting his irrigation requirements. The existing diesel pump could be used as a standby on non-sunshine days.

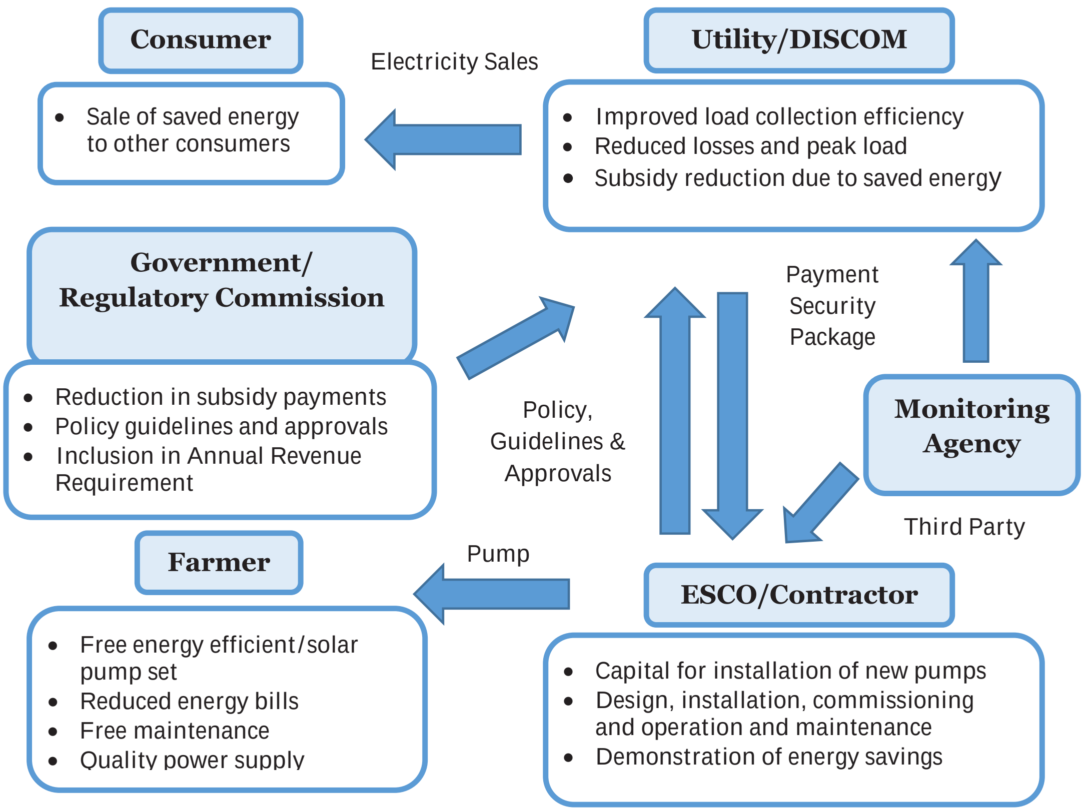


Figure 3.1: The Relationships between the Various Stakeholders in ESCO Mode

1.1.2 Improving the Efficiency of Agriculture Pump Sets

Agriculture accounts for about 27 per cent of electricity consumption in the country, which is increasing due to the government's rural electrification efforts. The electricity is largely used in agricultural pump sets, which generally have very poor efficiency. Most of the pilot projects, as well as other studies, project potential savings of 45–50 per cent by merely replacing inefficient pumps. Overall electricity savings (from 20 million pumps) is estimated to be 62.1 billion units annually. This is estimated to translate into yearly savings of INR 18,000 crore, which reduces the subsidy burden of states by that same amount.

Several efforts have been made to accelerate demand-side management measures in the agriculture sector. Notably, the Agriculture Demand Side Management program (Ag-DSM) initiated by the Bureau of Energy Efficiency carried out pump-set efficiency enhancement pilots through public-private partnerships (PPP). Despite their huge savings potential, none of the pilots could be scaled up to a large extent, possibly due to the following reasons:

- DISCOMs are subsidized to compensate the revenue gap between average cost of supply of electricity and cost of supply to agriculture. As a result, their financial burden is alleviated and there is no incentive for them to change the status quo.
- Because water and electricity are free to farmers, there are dismal incentives for farmers to efficiently use these precious resources.
- Irrigation and electricity subsidies are a politically sensitive subject in India with far-reaching implications. Therefore, any efforts made by the utilities for metering agricultural connections, tariff hikes, etc. face stiff resistance not only from the agrarian community but the political diaspora as well.
- ESCOs are finding it profitable to work in other consumer categories that involve less financial and operational risk. As such, they are less interested in the agriculture sector.
- There is a lack of quality data pertaining to pump set mixes, energy consumption of irrigation pump (IP) sets, sanctioned load and actual connected load of IP sets, head and discharge, metering status, water table position, cropping pattern, etc. Data unavailability has proven to be a major hurdle for Ag-DSM projects.
- Availability of Bureau of Energy Efficiency (BEE) 4- or 5-star-rated efficient pump sets is another crucial aspect that needs to be addressed. Central and state governments could facilitate pump manufacturers with added benefits such as tax holidays, excise and custom duties, etc., to augment their manufacturing capacities.
- Monitoring and verification of implemented pilots has been another major hurdle, with disagreements between the DISCOMs and ESCOs over how energy savings should be calculated. A standard protocol needs to be established that can be followed across the country.
- Agriculture pump sets, despite being energy efficient, are bound to fail in one and a half to two years due to the poor quality of electricity supply. Lack of skilled servicemen and poor after-sales service further dissuade farmers from installing these pumps.

Given their huge savings potential, there is need to reinvigorate the Ag-DSM program and possibly implement it in those districts where paddy is being cultivated. Water levels have already depleted to alarming levels in these areas and, therefore, solar pumps would not be economically viable. Ownership should preferably be with the DISCOM since there is little incentive for farmers to switch to a different solution, unless they can be compensated for energy savings through net metering. Farmers must be required to surrender their old pump, though, for which they can be remunerated as well.

The cost of replacing an inefficient 10 HP pump with a star-rated energy-efficient pump is roughly INR 60,000. If just 10 per cent of the electricity subsidy budget of INR 6,197 crore in 2015–16 is used to sponsor a new scheme, almost 100,000 pumps could be replaced, which is roughly 19 per cent of the existing fleet of inefficient pumps. A typical energy-efficient pump can be expected to fetch around 35 per cent of energy savings, which translates into a payback period of three years. The financial case for energy-efficient pumps has been summarized in Table 3.2.

Table 3.2: Financial Case for Energy-Efficient Pumps

Electricity subsidy for 2015–16	INR 6,197 crore
Energy-efficient pump replacement pilot budget (10% of subsidy)	INR 620 crore
Average cost of 10 HP pump replacement	INR 60,000
Number of pumps that can be replaced	103,282
Total number of electric pumps at the end of 2013–14	556,664
Average energy consumption of conventional pump	11,936 kWh*
Energy saved per pump (35%)	4,178 kWh
Total energy savings	431 MUs
Payback period**	~3 years

Source: ICF Analysis

**Based on a pump rating of 2.2 kW (3 HP) and 200 irrigation days in a year with eight hours of pump operation each day*

***Based on Average Power Purchase Cost of electricity supply to agricultural consumers of INR 7.34/kWh (Haryana Electricity Regulatory Commission, 2015) and a 9 per cent year-on-year increase in Average Power Purchase Cost.*

1.1.3 Feeder Segregation and Metering

Feeder segregation focuses on separating the feeders based on users—agricultural, domestic and commercial. Connections are then metered to improve energy audits. Feeder segregation has been implemented by several states with mixed results. Gujarat and Rajasthan have the longest experience of feeder segregation, and they saw consumer complaints over low-voltage problems fall from 80 per cent to 6 per cent, while complaints over frequent power outages fell from 80 per cent to 50 per cent (Economic Times, 2013).

Haryana implemented feeder segregation in 2005–06, but because of delays the project was finally completed by 2010. World Bank conducted a study in 2013 to estimate the impact of feeder segregation and found a significant variance between utility records and actual connections (World Bank, 2013, p. 56). Specifically, the study found "a relatively large proportion of consumers without working meters; significant variation in actual connected load vis-à-vis utility records; higher hours of 3-phase supply made available ranging between 8 to 14 hours; and finally, peak load was higher than connected load indicating the presence of unauthorized load" (World Bank, 2013, p. 57).

This clearly indicates that feeder segregation requires monitoring to ensure assumptions like "the feeder is still carrying minimum non-agricultural load." There are other technical improvements that feeder segregation could have implemented, like consumer indexing, the mapping of consumers and their loads to respective feeders. In the end, the results of feeder segregation suggest that these technical reforms can equip policy-makers and utilities with better data but cannot solve the complex problem of electricity-irrigation.

1.2 IRRIGATION REFORMS

1.2.1 Sprinkler and Drip Irrigation

Although water is a renewable resource, its availability in appropriate quality and quantity is under severe stress due to increasing demand from various sectors. Agriculture is the largest user of water, consuming more than 80 per cent of the country's exploitable water resources. The overall development of the agriculture sector and the intended growth rate in GDP is largely dependent on the judicious use of the available water resources. While irrigation projects (major and medium) have contributed to the development of water resources, the conventional methods of water conveyance and irrigation, being highly inefficient, have led to water wastage and also to several ecological problems like water logging, salinization and soil degradation, making productive agricultural lands unproductive. The use of modern irrigation methods like drip and sprinkler irrigation is the only alternative for efficient use of surface and groundwater resources.

The advantages of drip irrigation systems (DISs) include highly efficient water use and greater crop yields compared to other irrigation methods. In addition, crops irrigated using DISs generally require less tillage and are of better quality. DISs also contribute to improved plant protection, reduced occurrences of plant diseases and greater efficiencies in the use of fertilizers, because water containing the agrochemicals is applied directly to the plant roots in the quantities necessary for optimal plant production. For a similar reason, DISs can also make use of lower-quality water, resulting in no return flows, tail water losses or increased soil erosion. Because water is applied in optimal quantities, plants generally have a shorter growing season and produce fruit earlier, with less weed growth and pest damage than conventionally irrigated crops. The lower labour requirements result in relatively low operational costs, with savings in labour of up to 90 per cent of the costs associated with conventional systems, in part, because mechanical operations can be carried out simultaneously with the application of irrigation water.

In this regard, a micro-irrigation scheme was launched in 2006–07 in the state on a sharing basis with the central government. This scheme was later upgraded in the form of the National Mission on Micro Irrigation (NMMI) in 2010–11. From 2014 to 2015, this is being implemented under National Mission for Sustainable Agriculture (NMSA) as the central government has subsumed NMMI into NMSA. INR 58.8 crore has been sanctioned by the state government under this scheme for the year 2015–16. Table 3.3 lists this scheme's achievements per fiscal year.

"While irrigation projects (major and medium) have contributed to the development of water resources, the conventional methods of water conveyance and irrigation, being highly inefficient..."

Table 3.3: Achievement of Micro-Irrigation Scheme by Fiscal Year

FY	AREA COVERED DURING THE FY (HA)	CUMULATIVE AREA (HA)
2006-07	2,676	-
2007-08	7,777	10,453
2008-09	22,309	32,762
2009-10	3,258	36,020
2010-11	9,154	45,174
2011-12	8,713	53,887
2012-13	6,559	60,446
2013-14	6,364	66,810
2014-15	3,166	69,976

Source: Department of Horticulture, Haryana (2015)

1.2.2 Spatial Targeting through Crop Choices

One way of targeting subsidy reform is by targeting certain geographic areas that consistently overuse their groundwater supplies. The Global Water Partnership (2014) provides an example of "groundwater salinization control zones" to manage extraction, particularly in areas where there is risk of irreversible damage to soil and water systems. Another complementary method to augment groundwater replenishment is using managed aquifer recharge.

Sakthivadivel et al. (1999) used remote sensing and geographic information systems (GIS) to assess and demonstrate wheat productivity per unit area based on irrigation while keeping other variables such as soil type, water table long-term trend, groundwater quality, distributary level discharge, rainfall and evapotranspiration in mind. While the study focused on the use of remote sensing and GIS for assessment, it highlighted the high productivity of the agricultural sector and the high emphasis on irrigation due to large-scale irrigation schemes, such as that associated with the Bhakra project for surface and groundwater irrigation in Haryana. The study also highlighted that farmers' success in growing a high proportion of wheat and reaching high production levels is being achieved by using large amounts of fresh water (and energy) and questioned the long-term sustainability of these initiatives.

Table 3.4 synthesizes district-level data on groundwater potential, water-related issues and crop choices from a variety of sources and starts to provide the basis for spatial management and targeting subsidies to match water availability, crop types and relevant water-related issues.

TABLE 3.4: Haryana Districts' Spatial Variables

DISTRICT	TOTAL	UTILIZABLE GROUNDWATER POTENTIAL (million cubic metres [MCM]) OUTSIDE COMMAND	INSIDE COMMAND	WATER-RELATED PROBLEMS	CROP CHOICES
Panchkula	151.5	151.5	0.0		Wheat and paddy
Ambala	364.5	266.1	98.4	Nitrate	Wheat, paddy, maize and sugarcane
Yamunanagar	740.8	444.5	296.3		Wheat sugarcane, gram maize, paddy. Also sunflower and fruits
Kurukshetra	493.3	296.0	196.3	Salinity	Wheat, paddy, sugarcane
Karnal	1068.4	0.0	1,068.4	Salinity	Paddu
Panipat	471.9	0.0	471.9		Wheat and paddy. Also sunflower
Sonipat	770.4	0.0	770.4	Saline zone; nitrate	Sugarcane, millet, barley, pulses, oil-crops, sunflower and mushrooms. Fruits including lemon, guava, melons
Faridabad	656.1	78.7	577.4	Marginal groundwater; nitrate	Wheat, millet, mustard
Kaithal	712.7	0.0	712.7	Marginal groundwater; fluoride	Wheat, paddy
Jind	900.0	0.0	900.0	Nitrate	Paddy, millet, barley, pulses, cotton, sugarcane, oil crops, and wheat. Also sunflower
Rohtak	587.5	0.0	587/5	Saline zone	Barley, millet, sugarcane, oat, wheat, cotton and gram
Gurgaon	499.7	204.9	294.8	Marginal groundwater; fluoride; nitrate	Barley, millet oat and gram, vegetables
Rewari	280.0	11.2	268.8	Fresh and marginal groundwater	Wheat, paddy and sugarcane
Sirsa	781.3	0.0	781.3		Cotton, paddy, grams and mustard
Hissar	852.8	0.0	852.8	Saline groundwater; Saline zone; fluoride, nitrate	Cotton, millet, maize, paddy, wheat, gram and mustard
Bhiwani	522.4	0.0	522.4	Marginal and saline groundwater; saline zone	Cotton, paddy, wheat, mustard and gram
Mahendragarh	199.9	0.0	199.9	Fresh and marginal groundwater	Mustard, barley, wheat, gram and mustard; also cotton ad sunflower
Jhajjar	540.4	27.0	513.4	Saline zone	Wheat and paddy
Fatehabad	585.6	0.0	585.6	Saline groundwater	Wheat and paddy

Sources: Tahal Consulting Engineer LTD (2000) World Bank (2001) Planning Commission (2009) Kumar (n.d.).

The national Planning Commission (2009) acknowledges that "accurate mapping of groundwater zones as per their suitability for domestic, irrigation and industrial uses is highly desirable for proper management of groundwater resources and to safeguard human beings from consumption of poor quality groundwater." To check further deterioration of groundwater quality in the state, regular monitoring of its chemical quality is necessary. Subsidy reform can be used for better understanding the best match of water, soil and other underlying factors for long-term sustainability of crop yields and economic growth in Haryana.

The Government of Haryana (2014) reports on state crop production, and a review of this reveals a significant increase in water-intensive crops such as paddy over the years. For example, Haryana produces 44 per cent of the country's basmati rice, a premium, export-quality rice with high economic returns, but it is also high on water consumption (All India Rice Exporters Association, 2012). The Planning Commission identifies the need to switch from traditional patterns of paddy-wheat rotation towards "oilseeds, pulses, fruits, and vegetables as the need of the hour" (Planning Commission, 2009). Examples of such reforms are evident, and one example is of a successful program in 2005–2006 in the state to diversify and wean farmers in Kurukshetra, Karnal, Yamuna Nagar, Kaithal and Fatehabad off of summer paddy to moong and dhaincha (Planning Commission, 2009).

Subsidies can help target less water-intensive crops for the region, as the government implements alternative policy measures to encourage paddy growing in areas of the country where water is more naturally abundant (Central Ground Water Board, 2014). As part of a crop-diversification program in Haryana, Punjab and Western Uttar Pradesh, the government recognizes the negative impacts of regional crop dominance and encourages crop diversification to improve economic returns and mitigate negative water impacts in areas of the country. "Dwindling groundwater resources in Haryana due to excess withdrawal of water for irrigation led to impurities in the water—a cause of attendant crop health effects" (Central Ground Water Board, 2014). Negative impacts of continuous cultivation of paddy-wheat cropping systems have resulted in crop yield stagnation, weed infestation, groundwater contamination, pests, diseases and deterioration of soil health. The need to diversify comes from a need to not only improve soil and water conditions, but also for economic growth and crop returns.

1.2.3 Integrated Watershed Management

Many of these programs for improving overall and long-term soil and water management in the state can be improved through strategic watershed management approaches that help us understand the root causes of the problems and help revitalize watersheds for maintaining sustainable agricultural yields and livelihoods. Researchers have long shown that watershed-level management is a preferred way to deal with hydrologic and related land issues. Measures to improve groundwater, for example, must combine surface water management, groundwater management, water demand management and land management using a basin approach focused on aquifers and vulnerable recharge areas. Integrated watershed management approaches provide guidance for the management of land and water for a variety of social, economic and ecological objectives. Agarwal and Narain (2002) talk about watershed management as a way to increase water availability, water quality, participation and economic efficiency. While integrated watershed management is a well-developed program in India, Haryana has numerous examples of successful and impactful watershed management with tangible impacts on water quality and quantity resulting in improved productivity and livelihoods. The case study below provides one prominent example of reversing soil and water problems through an integrated approach.

Case example: A case of integrated watershed management for soil and water management

(Adapted from TEEB case by Agarwal & Narain, 2010)

Farmers in Sukhomajri were supported by the Government of India and international funding agencies to undertake a program of specific actions to revitalize an otherwise degraded and water-scarce region within Haryana. Using targeted landscape-management approaches such as small dams and re-vegetation, farmers were able to plan and implement a series of mechanical and vegetative measures to affect a significant change in soil erosion and water recharge within a short span of a decade. This project was initiated in 1979 and a Water Users' Association was set up in 1982, charged with implementing watershed management, dam management and the collection of fees from water users. Benefits of this program were felt in the agricultural watershed and extended to the downstream inhabitants of the state capital, Chandigarh.

Sukhomajri is the first village in India to have tax levied on the income it earns from the ecological regeneration of its degraded watershed. Other than economic growth, the village has seen significant increases in the productivity of its two staple crops—wheat and maize. Wheat yields, for example, have increased from 8.0 q/ha (1975–76) to 27 q/ha (1999–2000) and 30.76 q/ha (2007–2008). Since this project, the government has developed and funded hundreds of such projects to improve the state of land and water in different parts of the country.

In the context of irrigation subsidies, Sukhomajri provides a Haryana-specific example of prioritized government attention to resources for reversing the ecological impacts of land and water use, such as increased water for irrigation and improved forestry. It also yielded a wide range of economic returns, such as timber from reforested areas, excess biomass production being used as raw material for paper mills and an overall increase in usable natural resources. Targeting irrigation subsidies for strategic, coordinated efforts for a variety of social, economic and environmental benefits provide an opportunity for agricultural subsidy reform.

1.2.4 Contract Farming

Contract farming can be defined as an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under so-called forward agreements, frequently at predetermined prices. The farmer commits to providing a specific commodity in quantities and at quality standards determined by the purchaser. The purchaser commits to buying the crops and also usually provides some production support (technology, fertilizer, advice, etc.).

Contract farming can lead to improved irrigation services when:

- The private partners are responsible to deliver services such as the extension of the distribution network, quality monitoring or maintenance of the pumps.
- The private partners commit to delivering new irrigation technologies such as drip irrigation to improve water-use efficiency.
- Crops are selected based on their water requirements.
- There are contractual obligations to slow the abstraction of groundwater for irrigation, to reduce surface water use or otherwise to conserve scarce water resources.

The purported advantage of contract farming is the combination of the efficiency and knowledge of the small farmer with the corporate management skills, assured markets and reduced input costs provided by the private sector. This approach has been quite successful in crop diversification, arresting the depletion of groundwater, saving energy, saving agro-inputs, conserving scarce water, introducing improved technology, providing easy credit to farmers and assuring purchase of produce by the company.

Contract farming can, however, lead to conflict related to unfair contractual arrangements, land tenure and land use, and the role of rural farmers as stewards. While the merits and risks of the contract farming model will not be presented in detail here, it is important to keep in mind that the existence of an adequate legal framework—and ensuring the involvement of the farmers in developing and negotiating the contract—is crucial for the successful implementation and long-term sustainability of contract farming operations.

1.2.4.1 Farm Service Agreement

The private sector can also partner directly with smallholder farmers and communities for the provision of farm-level services. Services might be on-farm, such as planting, harvesting and water application, or off-farm, such as storing, processing and marketing (e.g., out-grower services). Such farm services, by improving the agricultural performance of water users, are likely to improve the viability of irrigation infrastructure. The level of investment required depends on the services provided. Farm services can be integral or separate from infrastructure operation, management and maintenance (OMM).

1.2.4.2 Hub Farm Agreement

The private sector can be engaged to undertake commercial agricultural production through a land concession or lease. This might be on unoccupied land owned by the government or third parties, or community land held under collective title and leased in return for a fee of share in commercial operations. The hub farm has purely commercial aims, and will require a certain scale in order to offer commercial opportunities (especially for food crops). Private capital is required for on-farm investments, while irrigation fees can reflect any or all infrastructure-related costs.

1.2.5 Public-Private Partnerships in Irrigation

Public-private partnerships (PPPs) can be defined as long-term contractual and risk-sharing arrangements under which governments share the risks of developing public infrastructure and providing public services with private counterparties. With the tight competition for limited public funds, PPPs can attract private investment into projects of public interest, especially in the infrastructure sector. PPPs are the preferred infrastructure development mechanism in India, and have been used extensively in the transport, roads, railways, energy and communications sectors. This section examines if PPPs in irrigation are an option for resolving the irrigation-electricity nexus.

Traditionally, irrigation schemes in India are of a highly social nature, in order to support traditional small-scale producers. But they often lack the necessary managerial, technological and financial capacity to make adequate use of the full potential of irrigation techniques. Furthermore, cost recovery is usually insufficient to cover the maintenance of the system. To address these issues, the Planning Commission and the Ministry of Water Resources started considering private-sector involvement in irrigation as early as 1995, setting up various committees to look into matters and propose policy.

1.2.5.1 The Challenge for PPPs in Irrigation

The challenge is that the private-sector partners need a degree of certainty that they will be able to recover their investments, maintaining their for-profit motivations. Meanwhile the irrigation sector offers limited scope for revenue generation due to low water charges and poor recovery rates. Pure private investment is thus largely ruled out. Varma et al. (2013) propose that under such conditions, the most feasible avenues available to attract private-sector involvement in the irrigation sector are: (i) a provision for viable gap funding (VGF) by the government, (ii) provision of incentives for execution of projects by private investors or (iii) a healthy mix of the above two options.

Thus it is expected that some form of public "subsidy" will always be necessary to make irrigation PPPs feasible, but the PPP model can still provide for a more targeted use of public sector funds to spur agricultural productivity. It can also be useful to establish the principle of financial autonomy, to raise professional standards by introducing improved management, to improve maintenance of the system, to promote water and energy efficiency, and to relieve the government of some fiscal and administrative burdens. All of these features improve the value for money.

1.2.5.2 Options for Structuring PPPs in Irrigation

The two main contractual forms of PPPs in irrigation are presented in Table 3.5. In both cases, the private partner that will be in charge of providing the public service of supplying water for irrigation and the operation and management of the system establishes a Special Purpose Vehicle (SPV). Their repayment can come through:

- User fees: the private counterparties are paid from fees collected from the end-user rather than from the government.
- Availability payments: private counterparties are paid a fee based on the "availability" of the asset and service by the public sector.

Table 3.5: Main Contractual Forms of PPPs in Irrigation

TYPE OF CONTRACT	STRUCTURE
Operation, Management and Maintenance (OMM)	The private sector is engaged to undertake OMM of infrastructure services for defined recipients. The private sector provides a service for which it receives a fee (either from the government or from users). Where rehabilitation or construction works are required, they can also be part of the contract. Assets are publicly financed, and this is an appropriate form of contract where there is limited scope to raise private capital.
Infrastructure Concession	The private sector is engaged to raise commercial finance for infrastructure development and then construct, operate, manage and maintain the infrastructure. Investment and financing costs must be recovered through fees (either from the government or from users). End-user risk is significant in irrigation projects where often the users are not fully defined at the beginning of the project (it depends on how many farmers take up the water from the system). It might be possible to share end-user risk between the public and private parties, for instance with a guarantee on minimum revenue. The investment may be undertaken in whole or in part by the private sector where, for instance, there is grant funding available to bear some of the investment costs.

Source: Public Private Partnerships in Infrastructure Resource Centre (2014)

As mentioned above, experience in the irrigation sector to date shows that public investment in irrigation projects is crucial even under a PPP in order to guarantee bankability. The most likely financing scenario for PPPs in the irrigation sector is thus one whereby the concessionaire obtains part of its remuneration through fees charged to users, and another portion through availability payments. Due to the inherent difficulties in fee collection, the availability payment reduces the risks of service demand and supply, price fluctuation, tariff level and noncompliance by users, and is a mechanism for guaranteeing the sustainability of the service.

Beyond this, the remuneration of the private-sector counterpart (i.e., their availability payments) should be based on their performance. The objective of the PPP contract will be the provision of a service (i.e., properly maintaining and operating the infrastructure and making it available for the farmers to use). The private partner will only be entitled to the availability payments if, during each reporting period (monthly, quarterly or another frequency), the service is delivered in a timely and adequate manner. The remuneration should be at least partially variable, according to the rating achieved by the private partner in terms of the various quality and performance requirements stated in the PPP contract. This can also be linked to energy- or water-saving targets.

1.2.5.3 Lessons from International Experiences in PPPs in Irrigation

A few countries have successfully experimented with active participation of the private sector and the involvement of users in the development of the irrigation sector. PPPs in irrigation have been piloted in Morocco (2004), Zambia (2008), Brazil (2009), Egypt (2011) and Ethiopia (2011). In all cases, public support constitutes the most important guarantee for sustainable irrigation projects. Table 3.6 summarizes this international experience.

Haryana can draw from these experiences particularly on capital expenditure efficiency, on saving water, on generating awareness and appreciation for water charges and, finally, on mitigating demand or payment risk.

Table 3.6: Global Experiences with PPPs in Irrigation

LOCATION	PPP	OTHER PROJECT FEATURES
Guerdane, Morocco (2004)	Guerdane was the first irrigation project under a PPP agreement in the world. The Moroccan government entered a 30-year concession with Omnium Nord-African to build, co-finance and manage an irrigation network to channel water from the dam complex and distribute it to farmers in Guerdane. The total project costs were USD 85 million and government provided USD 50 million, half as a grant and half as a subsidized loan. The private partner provided the balance. The concessionaire has exclusivity to channel and distribute irrigation water in the perimeter. Operational, commercial and financial risks related to the project were allocated to the various stakeholders. The construction and collection risks were allocated to the concessionaire and the government was responsible for ensuring water security. The demand/payment risk was mitigated by a subscription campaign and farmers paid an initial fee covering the average cost of on-farm connection. The concessionaire's construction obligation did not start until subscriptions were received for 80 per cent of the water available. The only selection criterion was the lowest water tariff, which supported the government's goal of making surface water accessible to the largest number of farmers possible. The public subsidy was designed to maintain water tariffs equivalent to current pumping costs.	Farming activity: Cash crops Size & scope: Up to 10,000 ha PPP model: Design-Build-Operate (DBO) Bidding variable: Lowest tariff Bidding Status: Two bids. Operating successfully.
West Nile Delta, Egypt (2011)	The West Nile Delta project was designed as concession to design, build and operate the irrigation system. After setting up the infrastructure, the operator should assume full operational responsibility for 30 years and assume the associated demand and commercial risks. The project costs were USD 450 million and the public government not only provided funding but also owned the assets and assumed currency risks. This PPP introduced a two-part tariff system requesting farmers pay both an annual fixed fee based on the served area and a consumption fee based on water usage.	Farming activity: Mixed Size & scope: 80,000 ha PPP model: DBO Bidding variable: Lowest tariff Bidding Status: One bid (not opened). Project was restructured.
Chanyanya, Zambia (2008)	Project costs: USD 2.5 million (pilot) + USD 32 million This irrigation PPP brought together small farmers and commercial farmers in Chanyanya, Zambia. The project provides farmers with access to a year-long irrigation program, including a centralized management to create a sustainable commercial farming operation. The total costs were USD 34.5 million and it was funded both by Zambia Government and InfroCo Africa. InfroCo Africa stimulates greater private investment in African infrastructure development by acting as a principal project developer, focusing on lower-income countries, and funding early-stage, high-risk initiatives. It takes an equity stake in the project and makes decisions that will lead to a socially responsible and successful construction and operation. InfraCo Africa is funded by Private Infrastructure Development Group, a coalition of donors mobilizing private sector investment to assist developing countries in providing infrastructure that will boost economic development and combat poverty.	Farming activity: Subsistence Size & scope: 300-2,600 ha PPP model: Build Operate Transfer Bidding variable: Lowest tariff Bidding Status: InfraCo led development. Operating successfully.
Megach-Sebara, Ethiopia (2011)	In this PPP, it was proposed that the Private Sector Company should operate and maintain the existing irrigation network for 8–10 years at USD 47 million in cost. The government financed all the irrigation and water distribution equipment necessary in almost all levels, but farmers constructed the quaternary (small and closest) network. Farmer associations were created with the objective to increase expected collection of user fees.	Farming activity: Subsistence Size & scope: 4,040 ha PPP model: Operate & Maintain Bidding variable: Quality-based & minimum OMM payment Bidding Status: Five bids. Under negotiation.
Pontal, Brazil (2009)	A PPP to operate, maintain and enhance existing irrigation infrastructure. The project expects to cover an area of 7,717 ha for commercial agriculture and the government will cede land and already existing infrastructure for irrigation. The private company will be paid from the water tariffs charged to final customers and the maximum price charged may not exceed the one specified in the agreement.	Size and Scope: 7,717 ha

Source: Public Private Partnership in Infrastructure Resource Centre (2014)

1.3 FERTILIZER REFORMS

1.3.1 Direct Cash Transfer for Fertilizer

Fertilizers in India are produced or imported by entities in both the private and public sectors. However, they are distributed through a massive supply chain of private wholesalers and retailers. Fertilizer prices are administered by way of subsidy transfer to manufacturers. The first fertilizer sale involves a transfer from domestic manufacturers and import sources to dealers/ wholesalers. The dealers then sell the fertilizer stocks to the retailers from whom the farmers purchase the product. Cooperative producers have their own network for fertilizer distribution, which comprises state-, district-, taluk/block- and village-level societies. The farmer thus purchases subsidized fertilizers at an affordable price.

Urea is the only controlled fertilizer and is sold at statutory notified uniform sale price. Decontrolled phosphatic and potassic (P&K) fertilizers are sold at indicative maximum retail prices (MRPs). The problems faced by the manufacturers in earning a reasonable return on their investment with reference to controlled prices are mitigated by providing support under the New Pricing Scheme for Urea units and the Concession Scheme for decontrolled P&K fertilizers. The statutorily notified sale price and indicative MRP is generally less than the cost of production of the respective manufacturing unit. The difference between the cost of production and the selling price/MRP is paid as subsidy/concession to manufacturers. As the consumer prices of both indigenous and imported fertilizers are fixed uniformly, financial support is also given on imported urea and decontrolled P&K fertilizers.

Of the total urea distributed/consumed, close to 80 per cent is indigenous while the rest is imported through three designated canalizing agencies—MMTC Ltd., Indian Potash Limited (IPL) and State Trading Corporation (STC). The costs associated with urea imports are borne by the government, and the MRP at which the imported urea is sold to the farmers is treated as recovery. Subsidy for all domestic urea-producing units is different due to a range of factors such as pre-set norms, cost of fuel, technology, taxes, etc. Subsidies for urea range from INR 1,000/ MT to INR 8,000/MT for gas-based units. For naphtha-based units, subsidies range from INR 20,500/MT to INR 24,000/MT and for furnace oil/low-sulphur heavy stock-based units, subsidies range between INR 9,500/MT and INR 16,500/ MT. The subsidy is exclusive of freight, which is reimbursed separately.

For indigenously manufactured urea, two types of claims of subsidy are being disbursed:

- Regular claims: Quantity dispatched from plant/port and corresponding receipt in that particular month (i.e., quantity received against dispatches made in the current month).
- Residual claims: Quantity dispatched in the current month but received in the subsequent month. These claims each month pertain to quantities dispatched in the previous month and are settled at the subsidy rate of the month of dispatch.

As of April 1, 2010, the government has implemented the Nutrient-Based Subsidy (NBS) for P&K fertilizers and the MRPs of these fertilizers have been left open for rationalization by manufacturers. The NBS is announced on an annual basis, taking into account benchmark prices. It is uniform for imported as well as indigenously produced P&K fertilizers.

For complex fertilizers, the subsidy is released in two tranches:

- On-Account claims, which comprise 85–90 per cent of the total subsidy amount. This fraction is released on the basis of the quantity received in the district either at the manufacturer's or at the dealer's warehouse.
- Balance claims, which comprise 10–15 per cent of the total amount. This tranche is released after the on-account quantity is sold to the dealer or retailer, as the case may be (first point sale).

It has long been a matter of debate as to who ultimately benefits from these subsidies, with opinion divided between fertilizer manufactures and farmers. For better delivery of fertilizers to farmers and greater efficiency and cost effectiveness, the Government of India constituted a committee in February 2011 under Nandan Nilekani, Chairman, Unique Identification Authority of India (UIDAI). Its mandate was to recommend a solution to provide fertilizer subsidies through direct cash transfer (DCT). In implementing a DCT for fertilizers, the committee suggested a phased introduction, being aware of the challenges faced by a DCT system in India, particularly for food and fertilizers.

The committee proposed that a DCT for fertilizers be implemented in three phases. In Phase I, a comprehensive digital map of the fertilizer supply chain is to be produced, by creating an online database to monitor the movement of fertilizers all the way from plants to retailers. To this end, a Fertilizer Monitoring System (FMS) has been implemented by the Department of Fertilizers, which monitors the distribution and movement of fertilizers along with import of finished fertilizers, fertilizer inputs and production by indigenous units. In Phase II, the cash transfer is to be provided to retailers, based on their receipt of fertilizers from wholesalers. This is to be followed by cash transfers to farmers to purchase fertilizers in Phase III, which hinges on the coverage of Aadhaar cards in the country.

However, a DCT scheme for fertilizers brings with it a plethora of challenges, such as the following:

- *Identification of beneficiaries*: The identification of beneficiaries is far more complex in the case of fertilizers as compared to other cash transfer schemes such as the Mahatma Gandhi National Rural Employment Guarantee Scheme, and it requires a high level of coordination between different government bodies. Existing identification systems such as Aadhar cards cannot identify if a cardholder is a farmer or not. The system of land records in India is also quite complex, with several agencies involved in maintaining them. Further, the records are often outdated.
- *Mechanism for delivery of cash in time*: Fertilizers are a time-sensitive product and any delay in their delivery would result in loss of produce to the farmers. Hence, there needs to be a seamless system in place for timely depositing of cash into the bank accounts of farmers. The proposed DCT of fertilizers would likely require the cooperation of several ministries, and various central and state departments. Significant investments in the banking sector will be needed as well since banking services cover only a small fraction of the population in India.
- *Indexation based on market price*: The success of a DCT is contingent on how well it preserves the purchasing power of farmers for buying fertilizers. If fertilizer prices are decontrolled, there would be a greater synchronization with world prices. These prices, especially for fertilizers such as urea, could be higher and more volatile. Since it is difficult to predict volatility, indexation would require official adjustments in amounts to be transferred from time to time.
- *Preservation of the right incentives in production and distribution*: If cash transfers reach farmers in time and are properly indexed, there is likely to be a significant effect on fertilizer demand. The local supply conditions need to support this change. Though a DCT does not mandate spending on fertilizers, several farmers not buying fertilizers now could begin doing so, resulting in an increase in demand. Without a demand-supply match overall, or locally, fertilizer prices could spike. Strategies such as maintaining adequate stocks at the selling point and timely delivery should be followed at the outset to avoid this outcome.

1.4 CONCLUSION

Table 3.7 summarizes the reforms suggested for electricity, irrigation and fertilizer subsidies and brings out the challenges for each reform. Implementing any single reform has not brought about the desired impact on the electricity-irrigation problem. Hence there is a need for implementing reforms in collaboration.

Table 3.7: Electricity, Irrigation and Fertilizer Reforms and Challenges

SECTOR	REFORM	CHALLENGE
Electricity	Solar Water Pumps	An initial high-capital investment for the solar pumps will require subsidy assistance for the farmer. In addition, farmers have little incentive to adopt it since electricity tariffs are less. The pumps have to be installed in conjunction with other policy measures like ensuring they are grid connected (so farmers have an incentive to save electricity from pumping and sell it back to the grid) and increasing electricity tariffs.
	Energy-Efficient Pump Sets	Relatively less expensive than solar pumps. However, monitoring, verification and determination of savings are a challenge.
	Metering or Feeder Segregation	Post feeder segregation evaluations showed that there is still a discrepancy with utility records and actual consumption.
Irrigation	Micro-Irrigation: Drip and Sprinkler	More water/energy efficient but may not be suitable for those crops which require flood irrigation.
	Spatial Targeting through Crop Choices	Spatial targeting programs have been successfully run in Haryana in the past to wean farmers off the paddy-wheat cropping pattern to oil seeds. These programs can be studied in detail to scale them at the state level. However, spatial targeting is technology intensive and requires accurate mapping of groundwater levels, salinity zones and other metrics.
	Integrated Water Shed Management	India has a well-developed program on integrated watershed management. Many successful examples like Sukhomajri have benefited when governments decide to prioritize attention to this method. Apart from the government, the method also requires strong actions by a united community of farmers.
	Contract Farming	Contract farming has the potential to be very successful and invite water-saving irrigation techniques like drip, easy access to finance for farmers and crop diversification. However, an extensive legal framework is required to protect farmers from unfair contracts, land tenure and land use.
	PPP in Irrigation	PPPs in irrigation can never be a pure private-sector investment and will always require some public subsidy. Also, a large-scale successful PPP in the irrigation sector is yet to be seen (internationally). All current international PPPs in the irrigation sector are at a pilot stage and under observation.
Fertilizer	Direct Cash Transfer for Fertilizer	Laced with several challenges such as correct identification of beneficiaries, indexation based on market prices, access to banking services in rural areas, and setting up an extensive IT infrastructure to track movement of fertilizers, etc. Impact on the supply side also needs to be investigated in greater detail. Coordination between various government entities will be required.

However, in light of the challenges imposed by each reform, this study favours spatial targeting of crops by investing in technology requirements coupled with energy-efficient pumps and solar pumps. This is because the economics work in favour of energy-efficient and solar pumps over the other reforms since changing electricity tariffs involves a massive political hurdle. The targeting of zones that grow a particular crop pattern will ease implementation challenges by allowing one set of reforms to be implemented through the zone and hence draw out the highest positive impact.

2.0 Reforming Electricity Subsidies: Impacts and Policy Interventions

As already indicated, reforming electricity subsidies is a daunting task for any government. It is crucial to understand potential impacts on production costs, producers' livelihoods, the wider value chain, the electricity sector, and water impact and availability. While different solutions such as solar pumps or energy-efficient pumps will have different impacts, there are a number of considerations that can inform policy-makers on what policy interventions and political economy work should be prioritized while developing and implementing the technicalities of alternative business models. It also demonstrates which groups may support or oppose reform; however, it does not specify yet the strength of each group's access to the decision-making process and how influence occurs.

2.1 CROP PRODUCTION AND PRODUCTION COSTS

Several impacts on the production level of these three crops following the removal of electricity and fertilizer subsidies can be foreseen and are discussed here. Table 3.8 summarizes these assumptions for all three crops, highlighting potential impact differences.

Table 3.8: Potential Impacts of Electricity and Fertilizer Subsidy Reform on the Production Stages of Wheat, Rice and Sugarcane

SUBSIDY REFORM	DESCRIPTION	WHEAT	PADDY	SUGARCANE
Electricity subsidy reform	Potential impacts on seed suppliers are varied depending on the original cost of seeds and their degree of water intensity.	Change in seed preferences and a possible shift to less water-intensive seeds.	Lesser impact on seeds since the growing technique is water intensive.	Unlikely to have an impact as seed cost depends on inherent processes to source them rather than energy or water usage.
	Changes in irrigation techniques towards more efficient, less water-intensive ones.	Farmers may prefer to switch irrigation techniques to micro (drip/sprinkler) to save on irrigation charges.	Paddy will bear a strong impact from irrigation charges in years that have a weak monsoon; but since the fields require standing water, irrigation techniques might not change.	Sugarcane will be affected less compared to the other two crops, as irrigation costs represent a lesser percentage of production costs for sugarcane than for wheat or paddy.
	Potential impacts on labour (human, animal, mechanical) are difficult to predict due to lack of information and the many factors involved in labour prices. However, the assumption is that machine work might be affected by electricity reform more than human or animal labour.			
Fertilizer subsidy reform	Impacts are hard to predict, as several factors influence fertilizer use, but the extent of the impacts could be influenced by the quantity of fertilizer consumed.	Farmers may shift to water-soluble fertilizers like potash or phosphorous but these are more expensive and not readily available. Fertilizers like urea and DAP (currently used) require fields to be flooded.	Since irrigation techniques may not change, fertilizer (closely linked to irrigation techniques and consumption) also may not change.	There will be minimal impact on this crop since the amount of fertilizer consumed is far less as compared to wheat and paddy.

The impact of subsidies on production costs depends on the share of each input to the overall cost. State-level costs of cultivation for different crops in India are evaluated by the Department of Agriculture and Cooperation based on data collected through annual surveys. For the year 2011–12, production costs for wheat, sugarcane and paddy in Haryana on a per-item basis are shown in Table 3.9.

Table 3.9: Cost of Cultivation for Wheat, Sugarcane and Paddy in Haryana for 2011–12 (INR/hectare)

COST ITEM	WHEAT		SUGARCANE		PADDY	
	COST	% SHARE	COST	% SHARE	COST	% SHARE
Operational Costs	**27,402.52**	**53.55%**	**58,202.18**	**52.17%**	**36,183.74**	**64.33%**
Human Labour	*9,363.15*	*18.30%*	*28,092.45*	*25.18%*	*17,532.06*	*31.17%*
Family	5,988.94		5,523.99		7,121.09	
Attached	261.85		790.01		1,380.09	
Casual	3,112.36		21,778.45		9,030.88	
Animal Labour	*211.38*	*0.41%*	*251.09*	*0.23%*	*265.13*	*0.47%*
Hired	0.13		91.55		-	
Owned	211.25		159.54		265.13	
Machine Labour	*6,780.89*	*13.25%*	*5,682.74*	*5.09%*	*4,184.05*	*7.44%*
Hired	5,707.38		2,410.67		3,096.10	
Owned	1,073.51		3,272.07		1,087.95	
Seed	*1,813.56*	*3.54%*	*12,995.01*	*11.65%*	*820.21*	*1.46%*
Fertilizer & Manure	*3,870.20*	*7.56%*	*3,980.30*	*3.57%*	*3,235.97*	*5.75%*
Fertilizer	3,867.82		3,643.79		3,184.00	
Manure	2.38		336.51		51.97	
Insecticides	*647.07*	*1.26%*	*1,421.44*	*1.27%*	*2,441.74*	*4.34%*
Irrigation Charges	*4,066.90*	*7.95%*	*2,680.43*	*2.40%*	*6,820.18*	*12.13%*
Miscellaneous	*0.47*	*0.00%*	*-*	*0.00%*	*3.71*	*0.01%*
Interest on Working Capital	*648.90*	*1.27%*	*3,098.72*	*2.78%*	*880.69*	*1.57%*
Fixed Costs	**23,767.99**	**46.45%**	**53,362.02**	**47.83%**	**20,062.06**	**35.67%**
Rental Value of Owned Land	20,073.43	39.23%	46,899.45	42.04%	17,116.78	30.43%
Rent Paid For Leased-in-Land	21.94	0.04%	-	0.00%	110.30	0.20%
Land Revenue, Taxes, Cesses	-	0.00%	-	0.00%	-	0.00%
Depreciation on Implements & Farm Building	320.69	0.63%	268.75	0.24%	182.91	0.33%
Interest on Fixed Capital	3,351.93	6.55%	6,193.82	5.55%	2,652.07	4.72%
Total Cost	**51,170.51**		**111,564.20**		**56,245.80**	

Source: Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Government of India (2014)

Operational costs account for the majority of the overall cultivation cost with a share of 53.55 per cent, 52.17 per cent and 64.33 per cent for wheat, sugarcane and paddy, respectively. Fertilizer and irrigation charges combined account for 28.96 per cent of operational costs for wheat, 11.44 per cent for sugarcane and 27.79 per cent for paddy. Sugarcane and paddy are particularly labour-intensive and, hence, the cost of human labour is much higher for these two crops. Irrigation requirements for paddy are also significantly higher than the other two, which results in increased irrigation charges.

The impact of subsidies on operational costs has been evaluated by calculating them as a percentage of the latter. Results for 2010–11 and 2011–12 are summarized in Table 3.10.

Table 3.10: Quantum of Subsidies in Comparison to Operational Costs of Cultivation for Wheat, Sugarcane and Paddy in Haryana (2011–12)

CROP	IRRIGATION SUBSIDY	ELECTRICITY SUBSIDY	FERTILIZER SUBSIDY
Wheat	4%	20%	22%
Sugarcane	2%	9%	10%
Paddy	3%	15%	16%

Source: ICF Analysis

Table 3.11 shows a similar analysis for the year 2010–11.

Table 3.11: Quantum of Subsidies in Comparison to Operational Costs of Cultivation for Wheat, Sugarcane and Paddy in Haryana (2010-11)

CROP	IRRIGATION SUBSIDY	ELECTRICITY SUBSIDY	FERTILIZER SUBSIDY
Wheat	7%	24%	22%
Sugarcane	4%	14%	13%
Paddy	6%	19%	18%

Source: ICF Analysis

Hence, it is expected that, out of the three focus crops, wheat will be affected the most with any reforms/removal of subsidies. Fertilizer and electricity subsidies have the most considerable impact owing to their higher shares in the overall basket of subsidies.

2.2 LIVELIHOODS

Subsidies are an integral part of the agriculture sector in India and have led to self-sufficiency, employment creation, support to small-scale producers for adopting modern technologies and inputs, reduction of price instability and improvement of the income of farm households. The Government of India began giving subsidies for various production inputs to farmers on a large scale in the 1970s and 1980s, including fertilizer and credit from the central government, and power and irrigation subsidies from state governments. It should be recognized that these subsidies were critical in jump-starting the "Green Revolution" in the 1970s and 1980s by encouraging farmers to adopt modern high-yielding varieties and techniques of production.

The broad-based adoption of high-yielding varieties, extensive use of fertilizers, improved access to water through public and private investments in irrigation and power, and improved access to markets through public investments in rural infrastructure have been important in sustaining agricultural growth in Haryana. These conditions have led to a steady increase in the state's average agricultural income per hectare from privately owned land holdings as well as in the contribution of the agriculture and allied sector towards the state's GDP. Tables 3.12 and 3.13 quantify the savings from subsidies based on an average gross income per hectare from the three focus crops for the years 2010–11 and 2011–12. Wheat benefits highly from subsidies. It must be noted that there was a substantial increase in the minimum support price of sugarcane from INR 117/quintal in 2010–11 to INR 145/quintal in 2011–12, resulting in a significant increase in the profit margin.

Table 3.12: Savings on Account of Subsidies for Paddy, Wheat and Sugarcane (2011–12)

CROP	COST OF CULTIVATION (INR/HA)	GROSS INCOME (INR/HA)	NET PROFIT (INR/HA)	IRRIGATION SUBSIDY (INR/HA)	ELECTRICITY SUBSIDY (INR/HA)	FERTILIZER SUBSIDY (INR/HA)	GROSS SUBSIDIES AS % OF NET PROFIT
Wheat	51,171	68,552	17,381	1,198	5,366	5,948	72%
Sugarcane	111,564	143,737	32,173				39%
Paddy	56,246	104,810	48,564				26%

Source: Department of Economic and Statistical Analysis (2013) & ICF Analysis

Table 3.13: Savings on Account of Subsidies for Paddy, Wheat and Sugarcane (2010–11)

CROP	COST OF CULTIVATION (INR/HA)	GROSS INCOME (INR/HA)	NET PROFIT (INR/HA)	IRRIGATION SUBSIDY (INR/HA)	ELECTRICITY SUBSIDY (INR/HA)	FERTILIZER SUBSIDY (INR/HA)	GROSS SUBSIDIES AS % OF NET PROFIT
Wheat	42,323	61,637	19,314	1.631	5,373	4,986	62%
Sugarcane	86,276	105,594	19,318				62%
Paddy	49,868	98,798	48,930				25%

Source: Department of Economic and Statistical Analysis (2013); ICF Analysis

2.3 VALUE CHAIN

A value-chain approach describes the wide spectrum of activities required to bring a product—from input to processing through different stages of production and finally—to the market. This describes and enlists various stakeholders from farmers, retailers selling input products like seeds, fertilizers, irrigation departments supplying water to retailers and middlemen who bring the produce to the market (United Nations Industrial Development Organization, 2009). At every step, a stakeholder adds value to the product, bringing it closer in shape to the final product. Any change brought about in the input stage (like electricity, water, etc.) will affect the series of stakeholders in the subsequent activities of the product.

There will be potential impacts of electricity and fertilizer subsidy reform on the production of wheat, paddy and sugarcane. Adopting a value-chain approach allows for a holistic assessment of subsidy reform impacts on the agricultural sector in Haryana. The following section presents the results from the three case studies—on wheat, paddy and sugarcane. First, the main activities and actors involved at the production level are described. Then, production costs for each crop are identified and some initial reflections on possible impacts of subsidy reform on the production level are provided for all three crops.

While inputs required at the production level are similar for each crop—including seeds, fertilizers, mechanical and manual labour, irrigation, insecticides and pesticides—their needed quantity can greatly vary, implying different production costs overall. For example, sugarcane requires much more manual labour than wheat, which contributes to a higher production cost for sugarcane. These considerations are important as subsidy reform in the electricity sector, essentially meaning an increase in electricity and water costs will have different economic impacts on these inputs and, in turn, on the various actors engaged in their provision and production of the crop as well as on other actors, beyond the farm.

2.3.1 Wheat

India is the second largest wheat-producing country in the world (AgriCoop, 2015, p. 3). This rabi crop is grown between November and April, and its production and productivity have significantly increased since 2006. Haryana State is a major wheat producer in India. In 2011–12, it contributed to 13.5 per cent of India's wheat production (Department of Economic Affairs, 2011), making it the third-largest wheat producing state after Uttar Pradesh and Punjab.

2.3.1.1 Wheat Production Stage

Several activities take place at the wheat production stage, which are similar for all crop production. For better clarity, in this study, "production stage" takes into account input suppliers—see Table 3.14 below—which includes manufacturers, wholesalers, retailers and producers. Beyond the production level, a number of actors and activities are essential to transform the crop into a consumable food (or energy) product—for example, through intermediaries (such as collectors, traders, brokers), wholesalers, processors (such as flour millers) and retailers. In the case of wheat, it is transformed into four products by millers—bread flour, cake flour, semolina and bran—with by-products such as wheat husk that are sold as animal feed (McCarthy, Singh, & Schiff, 2008). Support services are other essential services that provide training, transportation systems, financial services, technological equipment, pest controls, etc. All these actors and activities are part of what is called a crop value chain (McCarthy, Singh, & Schiff, 2008).

Table 3.14: Wheat Input Suppliers

INPUT SUPPLIERS	ACTORS INVOLVED
Seeds	• Seed producers and developers – research universities, public institutions, private companies. • Haryana Seed Development Corporation – distributes subsidized seeds through government, cooperatives or private certified dealers. • Wholesalers and retailers – procure seeds from the government in bigger cities and sell it to smaller retailers or directly to farmers at the village or district level.
Fertilizer	• Fertilizer manufacturers (private and public companies) • Cooperatives (State Cooperative Marketing Federation, district- and village-level cooperatives). The Indian Farmer Fertilizer Cooperative supplies subsidized fertilizer to cooperative societies. • Private fertilizer retailers.
Irrigation	• Groundwater irrigation – electric groundwater pump sets connect through two utility companies in Haryana: Uttar Haryana Bijli Vitran Nigam (UHBVN) and Dakshin Haryana Bijli Vitran Nigam (DHBVN). • Surface water irrigation – The Irrigation Department allows connection of farms to canals for sourcing water through underground pipes, etc. • Pump set manufacturers and repair – diesel and electric. • Buyers from the underground water market.
Electricity	• Electricity utility companies – UHBVN and DHBVN

The producers themselves prepare the land by ploughing it, planting the seeds, irrigating it and using inputs such as fertilizers, seeds, pesticides and water to grow the crops until harvest. In Haryana, most labour is practiced by the farmer's family or by casual labour hired for the season. Farmers also own animals to help with production and most of these are owned. Farmers may also use machines and other technological inputs.

Other actors vital in the value chain are part of what is referred to as extension services, such as actors providing financial services in the form of credits, including commercial, rural and cooperative banks. or information on crop prices and meteorological bulletins.

Looking at some of the key inputs in more detail, we find that fertilizer marketing and distribution channels are numerous. After being manufactured, fertilizers are essentially distributed and sold to farmers through three main channels: cooperatives, private retailers and manufacturers themselves (see Figure 3.2). The state subsidizes fertilizers by giving subsidies directly to manufacturing companies so that the product retailed through farmers' cooperatives at the district or village level is available at a lower price.

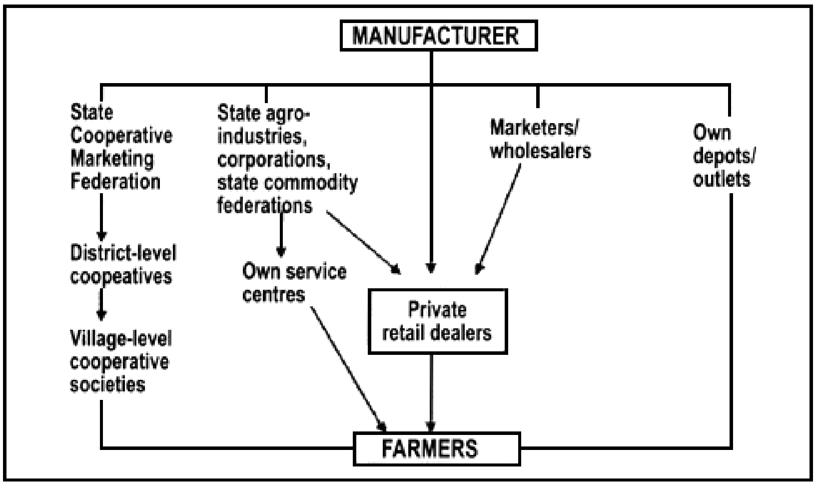


Figure 3.2: Fertilizer Distribution Channels in India

Source: FAO (2005, p. 40)

In 2003 wheat production was the second highest consumer of fertilizers in India, accounting for 21 per cent of total fertilizer production after consumption for paddy production (FAO, 2005). The quantity of needed fertilizer depends on several factors, including the type of seed variety, soil quality and composition, irrigation techniques, etc. More fertilizer is used in irrigated fields than in rain-fed areas (Mujeri, Shahana, Chowdhury, & Haider, 2012, p. 8).

Seeds are sourced by farmers through three agents: markets, farmer's own seeds or a government agency (Ghimire, Mehar, & Mittal, 2012). In the markets, farmers can buy seeds from cooperatives, retailers, distributors or dealers (Sahu, 2010, p. 70). The main government agency is the Haryana Seed Development Corporation. Most farmers prefer open pollination as they can save up to 65 per cent of seeds and only need to purchase new seeds to fulfil the remaining 35 per cent required for sowing (Sahu, 2010, p. 29).

Irrigation water is sourced through canals (surface water irrigation) or groundwater. The Irrigation Department supplies water through canals. The Irrigation Department builds new canals and repairs the existing ones, but the final lifting of water from the canal to the farms is the responsibility of the farmer.

Groundwater irrigation requires an electricity connection through a DISCOM and an electricity pump set. Private companies offer diesel and electricity pump sets. The major actors involved in groundwater irrigation are the DISCOMs, pump-set manufacturers, farmers that own pumps and any farmers that buy water from the former. Most medium to large farmers own electric pumps, while small or marginal farmers often have to purchase water from other farmers or own collective pumps with other farmers (World Bank, 2001a).

2.3.1.2 Wheat Production Costs

In order to assess the economic impacts of existing subsidies and subsidy reforms, the overall production cost of wheat needs to be determined. To do so, costs of individual inputs were identified and their cost proportions are presented in Figure 3.3 below. Mechanical and machine labour are the most costly inputs, followed by water irrigation charges, fertilizers and, finally, seed sourcing. Insecticide costs have relatively small incidence on overall production costs.

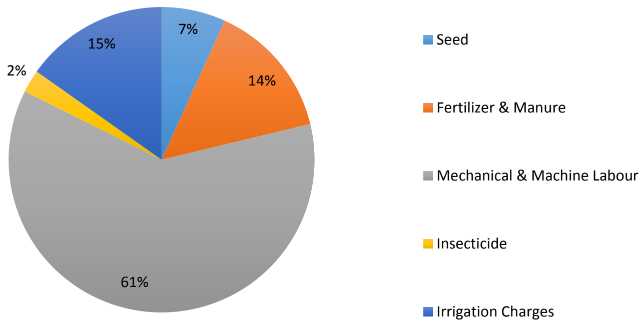


Figure 3.3: Input Costs for Wheat

Source: Ministry of Agriculture (2011–12)

2.3.2 Paddy

Rice is grown during the kharif season from May to November, especially in northern India. The plant sowing time in Haryana begins in May and harvesting begins in September and finishes in November (Government of India, 2012, p. 31). In 2011–12, national paddy production was 100 million tonnes, of which Haryana produced 2.81 million tonnes or nearly 3 per cent of the national production (Agricultural Cooperative, 2014, p. 12). While Haryana is not the state producing the most paddy, within this state, paddy is the most produced kharif food crop, which includes bajra, jowar, maize and pulses (Department of Agriculture Haryana, 2013).

2.3.2.1 Paddy Production Stage

Most of the activities in the paddy value chain, and in particular at the production level, are similar to that of wheat (see section 2.3.1). However, in contrast with wheat production, paddy crops are much more water intensive and they require carefully timed irrigation and differing water depth depending on the growth stage. In India, 50 per cent of the paddy production is irrigated, while the other half depends on rainfall, particularly in the eastern part of the country. In Haryana, fields are irrigated through flood irrigation sourced from groundwater or canal or rainwater (Government of India, 2012, p. 17). In addition to controlling water levels and providing timed irrigation, paddy saplings have to be manually transplanted from the nursery to the field. Thus it is also a more labour-intensive crop than wheat. Paddy production also uses much more fertilizer in India than wheat, accounting for 31 per cent of total fertilizer use in 2003 (FAO, 2005). Beyond the farm, rice is transformed in mills, where it is cleaned, whitened, polished and blended, among other processes, before being bagged for retailing. Additionally, rice by-products are directly reused on the farm as cattle feed or extracted for bran oil and used as a base for soap, for the thatching of roofs and in the paper industry.

2.3.2.2 Paddy Production Costs

To determine overall paddy production costs, the costs of individual inputs are identified and their proportions presented in Figure 3.4. The highest input costs come from manual and machine labour. Irrigation costs come far behind, followed by fertilizer, insecticide and seeds.

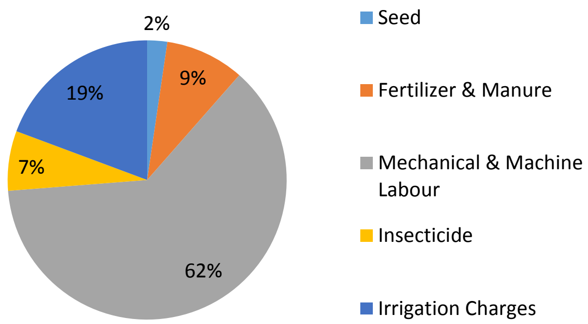


Figure 3.4: Input Costs for Paddy

Source: Ministry of Agriculture (2011–12)

2.3.3 Sugarcane

India is the second largest producer of sugarcane in the world, after Brazil. This cash crop is very important for India's economy, as it provides the raw material for the sugar industry. However, Haryana is not the largest state producer of sugarcane. Compared to, for example, Bihar, Maharashtra and Uttar Pradesh in 2009–10, Haryana produced only 1.8 per cent of the total sugarcane produced in the country (Fair Labor Association, 2012, p. 11). Nonetheless, it provides an example of subsidy reform impacts on cash crops.

Sugarcane is a long-duration crop, as it takes a long time from seeding to harvest. From January to February, the land is prepared and sowing begins in March. The crop is finally harvested in January of the next year. However, farmers try to sow the crop immediately after wheat harvesting finishes in March, which can create a slight delay in the crop's growth.

2.3.3.1 Sugarcane Production Stage

The sugarcane value chain is similar to wheat and paddy in terms of actors, and activities, except for the sugarcane mills and the sugar industry itself.

Seed sourcing and distribution is currently a problem in the state (Ministry of Consumer Affairs, Food and Public Distribution, 2013, p. 176). Seed varieties are not properly developed for the agro-climate of the state and there have been recommendations to solve this problem.

Contrary to wheat and paddy production, sugarcane production needs much less fertilizer. In 2003 sugarcane production accounted for only 5.4 per cent of fertilizer consumption in India (FAO, 2005).

Irrigating sugarcane fields is also very demanding, as fields need to be irrigated frequently after sowing until the plants mature.

2.3.3.2 Sugarcane Production Costs

Sugarcane seeds are very costly and account for 24 per cent of total production costs, compared to only 7 and 2 per cent for wheat and paddy respectively. Similarly to the other two crops in this study, manual and machine labour represent the highest costs. Additionally, sugarcane production is one of the most human labour-intensive products (see Figure 3.5).

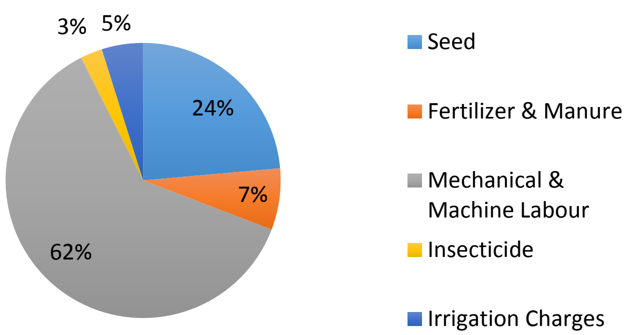


Figure 3.5: Input Costs for Sugarcane

Source: Ministry of Agriculture (2011–12)

2.4 ELECTRICITY SECTOR

In India, electricity subsidies have enabled farmers to access electricity at prices below the marginal cost of supply, thereby lowering the cost of irrigation and groundwater extraction, an essential input in agricultural production. The expansion and uptake of tube wells for irrigation has largely been expedited by subsidized electricity prices, which reduced the price of groundwater extraction. In turn, this growth in irrigation increased agricultural yields, lowered food prices and increased demand for agricultural labour. However, these benefits have come at the cost of groundwater exploitation and financial burden on the electricity utilities. They have also influenced cropping patterns by distorting decisions over electricity consumption and groundwater extraction and inducing farmers to grow more water-intensive crops. According to many sources, electricity subsidies are responsible for the poor and unreliable electricity service in India.

India has increasingly relied on groundwater extraction for agriculture and is currently the largest extractor of groundwater, consuming 250 km^3 of groundwater annually (Badiani & Jessoe, 2011). Electricity subsidies have led to indiscriminate use of groundwater for irrigation resulting in severe depletion of water tables. In Haryana itself, more than two thirds of water depth monitoring wells reported depths greater than five metres in 2012–13 and about 62.5 per cent of wells recorded a fall in water levels from the previous year (Central Groundwater Board, 2013). A similar situation prevails in other predominantly agricultural states as well. Typically, electricity to farmers is subsidized by charging industrial and commercial consumers higher tariffs. This has encouraged the use of captive power plants by these sectors, thereby lowering the base from which the electricity utilities fund these subsidies. This lack of revenue has forced state DISCOMs to run in a state of perpetual loss and become dependent on the government for meeting their annual budget deficits.

Rationalization of electricity subsidies would certainly result in more revenue generation for DISCOMs and improve their financial health, thereby enabling them to reinforce their infrastructure and improve the quality of their services. It would also lead to judicious use of electricity for groundwater extraction by farmers, which, if combined with groundwater restoration programs, could lead to replenishment of the country's groundwater resources.

2.5 NEXT STEPS FOR IMPACT ASSESSMENT OF SUBSIDY REFORM

To assess the impacts of subsidy reforms, current subsidy impacts need to be appropriately assessed, not only for farmers but also for input suppliers and other actors along the crop value chains. Special focus should be given to assess the differentiated impacts between larger and smaller farmers. Both categories of farmers will have important consequences for political incentives to support reforms. Reforms that further marginalize poor farmers are unlikely to be recommended or accepted, while reforms that further support larger farmers are likely to receive support from a majority of the population that are medium to large land holders in Haryana State. Any reforms would have to ensure that farmers are not made poorer as a result of these reforms and that minimum yield levels for a set income level are respected to push forward reforms.

It is important to assess the actual cost of water to farmers. Despite an increase in upfront costs if electricity subsidies are removed, overall costs from avoiding leakages, damages to the pumps, their repair and additional diesel pumps purchases might compensate and even surpass the initial rise in water costs (World Bank, 2001a). Moreover, improved water provision might reduce the likelihood of water theft by other sectors, which could in turn increase the water made available for farming (World Bank, 2001a). This has consequences for the potential behavioural changes farmers might display, for example, the assumption that farmers might be tempted to switch to diesel pumps or solar pumps if they can afford to, as they perceive higher water costs might not hold if all costs are accounted for.

An assessment of benefits from such subsidy reforms is also needed along the value chain. The World Bank (2001a, 2001b) identified farmers' willingness to pay for improved service quality. Positive impacts on electricity utilities would be able to reduce their lost revenue gap, which reached about INR 7 billion per year (World Bank, 2001a), and improve their supply, including maintenance and repair services. However, studies on other actors' willingness to pay for improved services have not been assessed.

Important questions that remain to be answered include whether removing fertilizer and electricity subsidies will reduce crop yields, and thus reduce farmers' income, possibly increasing poverty levels. Or will improvements to electricity supply compensate for any losses and, on the contrary, increase yields as water is provided in a more constant and predictable manner? Who will bear the burden of reform subsidies? Who stands to benefit the most? What would be the overall economic impact on the farmers' households? What are the combined impacts of removing subsidies to both electricity and fertilizers? What will happen if subsidies are not removed?

Answers to these questions will provide a solid foundation to develop policy recommendations for how best to reform agricultural subsidies in Haryana State while preserving and improving this vital sector.

"Reforms that further marginalize poor farmers are unlikely to be recommended or accepted..."

3.0 Policy Interventions

To usher in meaningful reforms in the agriculture sector, there is a need to segregate and quantify the subsidies. These subsidies collectively can be provided to farmers based on output instead of subsidizing each and every input (for example electricity, fertilizer, seeds, etc.) in the value chain. All the subsidies can be built into the Minimum Support Price or the State Advisory Price for example, while all other inputs may be charged at the market price. This would result in a shift from an input-driven to an output-driven subsidy regime. However these changes are to be taken up in phases over a longer period of time.

To start with, farmers need to be made responsible for their consumption of electricity and other commodities. Today there are no incentives for farmers to reduce the electricity consumption of water pumps. As such, these pumps keep running indefinitely, wasting groundwater and electricity unless the DISCOM switches off the supply. Effectively, the switches for turning off these water pumps are at the DISCOM substations only.

As a first step towards bringing in more accountability for water and electricity consumption by farmers, the electricity supply must be measured and monitored. The cost of installing, managing and monitoring electricity meters at each farm may be prohibitively expensive for the DISCOM; therefore, innovative solutions must be developed for managing the electricity usage at the farm level.

One such mechanism could be to monitor the supply at the feeder level for a group of farms that are connected to a specific feeder. DISCOMs can provide a quota of subsidized electricity in number of units (kWh) to this group of farmers each month. This quota can be decided based on the acres of field being irrigated by the water pumps connected to this specific feeder or through other proxies. If the farms collectively use more electricity than that provided as per the quota, then this group of farmers may be charged a higher tariff. Or simply their higher and lower usage of electricity in a month would be adjusted against the quota for subsequent months. It simply means that if the usage of electricity in a month exceeds the quota, then the availability of electricity may be reduced in the next month.

We have developed a few ideas on interventions in the irrigation and electricity sectors, with an emphasis on efficient pumps, solar water pumps and fertilizer usage in the field as outlined in the following two tables. However, for any of these mechanisms to be successful, the farmers are required to be made accountable for their usage of valuable resources, as discussed above.

Table 3.15: Recommended Policy Interventions for the Irrigation Sector

SECTOR	REFORM	SPECIFIC POLICY INTERVENTIONS NEEDED
Irrigation	Micro-Irrigation: Drip and Sprinkler	- Develop spatial analysis of what crops and districts can be targeted for drip and sprinkler irrigation. - Analyze the cost-efficiency of the previous NMMI/NMSA schemes and based on the results; revise funding for FY 2016–2017.
	Spatial Targeting through Crop Choices	- Use remote sensing and GIS to assess spatial variables of groundwater zones across Haryana State. This is a first step in planning subsidy rationalization measures. - Analyze the replicability of the 2005–2006 crop-diversification program to move away from a conventional wheat-paddy rotation system. Specify districts where this is feasible.
	Integrated Watershed Management	- Analyze replicability of the Sukhomajri program in Haryana State, while introducing modern watershed management strategies.
	Contract Farming	- Analyze the potential of contract farming agreements between processing and marketing firms and small holders to integrate best irrigation practices.
	PPP in Irrigation	- Assess the technical and political economy challenges associated with gradually augmenting water and energy prices. - Implement water metering (both surface and groundwater) across Haryana State. - Prepare a communication campaign on metering to augment the valuation of scarce resources.

Table 3.16: Recommended Policy Interventions for Solar Pumps, Energy-Efficient Pumps and Fertilizers

ENERGY-EFFICIENT PUMPS	SOLAR PUMPS	FERTILIZERS
Objectives • To achieve wide-scale replacement of existing inefficient electric pumps with star-rated energy-efficient pumps • To promote water conservation and groundwater restoration practices	*Objectives* • To mainstream the application of solar energy in water pumping applications • To bring about a change in public perception of the reliability of solar pumps	*Objectives* • To implement a DCT scheme for fertilizers along the lines of the liquid petroleum gas subsidy scheme.
Challenges • No incentive for farmers to change their pumping solution. • Unsegregated feeders and unmetered connections. • Pump connection records with DISCOMs out of date. • Lack of energy-efficient pumps in the market and poor after-sales service. • Lack of standard monitoring and verification methodology.	*Challenges* • High upfront cost. • Questions over reliability/performance. • Slow cost reduction due to capital subsidy structure. • Possibility of continued use of diesel/electric pumps by farmers. • Additional maintenance burden for farmers and fear of panel theft. • Significant under-utilization of solar system on non-irrigation days.	*Challenges* • Identification of appropriate beneficiaries. • Mechanism for timely delivery of cash to beneficiaries. • Indexation based on market prices to preserve purchasing power of beneficiaries. • Preservation of right incentives in production and distribution to prevent artificial price spikes. • Implications for manufacturers not very well understood.

Interventions
• Identify segregated agriculture feeders and meter all pump connections on those feeders.
• Conduct survey of existing pump connections to update DISCOMs' records.
• Remunerate farmers for scrap value of old pump.
• Incentivize manufacturing of energy-efficient pumps and setting up of service centres in pilot districts.
• Encourage rational use of electricity at the individual pump or feeder level by:
  o Compensating third-party service providers or community for energy savings through net metering mechanism.
  o Allotting a quota of free units based on irrigation requirements and charging for excess consumption.
• Mandate all new connections to be energy efficient.
• Improve HT-LT ratio to reduce transmission losses.
• Implement water table recharge schemes simultaneously.
• Run awareness campaigns on the harmful effects of excess groundwater extraction.
• Plan for energy-efficient pumps to be retro-fitted with a solar panel, VFD and inverter in a phased manner.
	Interventions
	• Determine appropriate pump capacity based on water table depth and irrigation requirement to avoid over-design.
	• For individual pump replacements:
	  o Identify regions with high concentration of stand-alone diesel pumps and water table levels <10 m (diesel pump could be used as back-up on non-sunshine days).
	  o Mandate farmers to surrender old connection in case of electric pumps.
	• For solar mini-grid. applications:
	  o Identify segregated feeders that could be powered by solar panels.
	  o Establish a feed-in-tariff mechanism to enable sale of excess power on non-irrigation days.
	  o Plan for pumps connected to these feeders to be replaced with energy-efficient pumps in a phased manner.
	• Run awareness campaigns among farmers to inform them of solar power technology's limitations and capabilities.
		Interventions
		• Update land records and extend coverage of Aadhar cards in pilot districts.
		• Expand rural banking services in selected regions for seamless deposit of cash in farmers' bank accounts.
		• Enhance IT network to enable tracking of fertilizer bags from manufacturing unit to point of sale.
		• Constitute a committee to determine official adjustments in cash transfers to reflect international market prices.
		• Mandate maintenance of adequate stocks at the selling point and ensure timely delivery to avoid artificial price inflation.
		• Intensify soil-health testing and communicate results to farmers.
		• Run awareness campaigns to encourage optimal use of fertilizers to prevent soil damage.
		• Possibly combine seeds with the fertilizer bag to address requirement of quality seeds.

4.0 Way Forward

Haryana is one of the leading agricultural states in India and one of the highest users of groundwater in the country. Haryana, like most Indian states, has subsidized the use of electricity for irrigation to improve overall agricultural productivity. As a result of high use of irrigation, the agricultural sector in Haryana is a very high consumer of groundwater as a stable and controllable means of water for agriculture—as opposed to surface water, that is subject to the vagaries of weather and rainfall—and has more controls in place for access and use. As a result of growing groundwater use, Haryana is experiencing a number of soil- and water-related problems. These include the lowering of groundwater tables, the rise of saline water, waterlogging and the subsidence of land.

Irrigation subsidy reforms can be used in conjunction with other programs to help reverse some of these ecological issues. Suggested means of targeting subsidy reform for specifically improving the state of soil and water in the state include spatial targeting of areas that are particularly vulnerable through groundwater control zones. Paddy farmers located in the Karnal or Kurukshetra districts may be targeted for conducting inefficient pump replacement with Energy-Efficient Pump System (EEPS) pilots. Groundwater levels in these areas are very low and, hence, solar pumps would not be practically or economically feasible. Additionally, there is a large number of diesel pumps in Rohtak and Jhajjar districts, where water table levels are less than 10 m. This makes these districts suitable for solar pump pilots since the per-unit cost of power generated from a diesel pump is much more than that from solar—hence there is an incentive for a farmer (who is probably not connected to the grid) to change their pumping system.

At the same time, such technical solutions will need to be immediately complemented by governmental efforts to change the political economy of subsidies. Without achieving a change in resource valuation among agricultural producers and across the value chain, any reform attempt will be difficult. From one side, producers will continue to underestimate the (scarcity) value of energy and water, which may not lead to a reduction in consumption. Increasing technological efficiency without increasing the price may result in a rebound effect. This potential effect is often considered to be worse with users that do not associate resource use with a certain form of societal responsibility. From another side, technological solutions that attempt to counter the immediate energy subsidy bill such as solar pumps or electricity-efficient pumps may increase the use of water. To mitigate this effect, solar pump schemes could allow and encourage the reselling of excess electricity to the grid. Electricity-efficient pumps, however, need to cope with this problem differently, especially as their use is more targeted toward areas with already low groundwater levels. An in-depth analysis of stakeholder trade-offs, organizational structure and method of access to the decision making process can allow for the setup of a strategic communication campaign.

Also included in our policy suggestions are targeting crop choices and specific technologies for improving irrigation efficiency, both for improved supply and demand management of water. Finally a broader recommendation is to use subsidies to support broader programs that might include a variety of different aspects such as integrated watershed management programs that are already popular in India and provide the basis for looking at a variety of issues in tandem with providing the best solutions in a systematic way. Integrated watershed management looks for long-term solutions for agriculture in conjunction with other water users.

Just as subsidies have helped Haryana's agriculture be successful as one of India's green revolution states, well-designed reformed subsidies can contribute to improving the overall, long-term sustainability of Haryana's agricultural production, while safeguarding its land and water resources.

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Appendix A

S. NO.	NAME OF THE SCHEME	12TH 5-YEAR PLAN (2012–17) OUTLAY	2012–13		2013–14		2014–15
			REVISED OUTLAY	ACTUAL EXP.	REVISED OUTLAY	ACTUAL EXP.	PROPOSED OUTLAY
	Crop Husbandry						
1	Scheme for Quality Control on Agriculture Inputs	1,370	157	135	165	156	300
2	Scheme for Providing Soil and Water Testing Services to Farmers	1,400	100	100	60	38	100
3	Scheme for Stocking and Distribution of Fertilizers by Institutional Agencies	4,650	850	850	1,808	1,808	1,300
4	Scheme for Managing the Micro-nutrients Deficiency in the Soil	4,000	220	206	180	162	400
5	Scheme for Setting up of Biological Control Lab at Sirsa under Integrated Pest Management	73	14	14	22	17	50
6	Scheme for Safe and Scientific Storage of Food-grains by General Category Farmers	1,005	140	140	-	-	300
7	Scheme for Promotion of Crop Diversification	5,000	504	504	515	499	800
8	Scheme for Strengthening of Agricultural Extension Infrastructure	3,000	155	176	540	298	850
9	Scheme for Promotion of Sustainable Agriculture – Strategic Initiatives	8,500	870	904	1,375	1,199	1,300
10	Scheme for Agriculture Extension Training Services to Farmers	600	100	94	105	101	148
11	Scheme for Agricultural Engineering and Trial Boring	2,324	200	197	355	337	300
12	Scheme for Rastriya Krishi Vikas Yojna (RKVY)	148,000	26,000	16,148	38,125	20,661	19,665
13	Scheme for Rastriya Krishi Vikas Yojna (RKVY) for Scheduled Castes	2,000	400	314	625	4	335
14	Scheme for Technology Mission on Sugarcane	1,810	150	148	359	308	500
15	Scheme for Constitution of Haryana Kisan Ayog	1,625	169	181	250	158	300
16	Scheme for Promotion of Cotton Cultivation in Haryana State	3,000	290	288	450	323	450
17	Scheme for Scientific Bee Keeping quality Honey Production for SC farmers including Agriculture and Non Agriculture Labor	1,900	679	380	430	107	450
18	Scheme for Safe and Scientific Storage of Food-grains by Scheduled Castes Farmers	1,985	600	300	300	-	400
19	Scheme for Improvement of Agriculture Statistics	158	-	-	1	1	25
20	Scheme for Plant Health Care through E-Pest Surveillance	360	-	-	-	-	1
21	Scheme for Macro Management of Agriculture (90:10)	20	40	26	-	-	-
22	Scheme for Macro Management of Agriculture for Scheduled Castes Farmers (90:10)	5	50	44	-	-	-
23	Integrated Scheme of Oilseeds, Pulses, Oil-palm and Maize (ISOPOM) (75:25)	2,196	250	215	250	112	200

24	Integrated Scheme of Oilseeds, Pulses, Oil-palm and Maize for Scheduled Castes Farmers (ISOPOM) (75:25)	80	20	13	25	5	25
25	Scheme for Intensive Cotton Development under Mini Mission-II of Technology Mission on Cotton (75:25)	66	12	7	8	4	15
26	Scheme for Intensive Cotton Development under Mini Mission-II of Technology Mission on Cotton for Scheduled Castes Farmers (75:25)	12	2	1	4	1	5
27	Scheme for Support to State Extension Programme for Extension Reforms (90:10)	1,345	190	59	250	151	220
28	Scheme for Support to State Extension Programme for Extension Reforms for Scheduled Castes Farmers (90:10)	-	-	-	-	-	40
29	Scheme for National Agriculture Insurance (50:50)	1,450	-	-	304	304	250
30	Scheme for Weather Based Crop Insurance (50:50)	11,500	700	700	2,521	2,521	4,000
31	Scheme for Modified National Agriculture Insurance Scheme (50:50)	9,586	100	37	1,000	969	1,000
32	Scheme for National Project on Management of Soil Health and Fertility (50:50)	1,680	80	48	22	15	200
33	Scheme for Providing Implements/ machinery on Subsidy to the Group of Farmers of SC Category	-	49	-	50	-	500
34	Scheme for Providing Loan from NABARD for the Construction of Godown by HAIC	-	1,409	711	575	574	1
35	National Food Security Mission (NFSM)	-	-	-	-	-	5,500
36	National Oilseed and Oil-palm Mission	-	-	-	-	-	300
37	National Mission on Agriculture Extension & Technology	-	-	-	-	-	500
	Total	**220,700**	**34,500**	**22,940**	**50,674**	**30,831**	**40,730**
	Soil and Water Conservation						
35	Scheme for Providing Assistance on Adoption of Water Saving Technologies	5,155	742	681	975	714	1,000
36	Scheme for Development of Saline/ Waterlogged Soils in Haryana State	1,345	120	106	105	86	190
37	Scheme for Integrated Watershed Development and Management Project in the State	3,220	200	181	590	566	500
38	Scheme for State Land Use Board, Haryana	280	-	-	-	-	10
	Total	**10,000**	**1,062**	**967**	**1,670**	**1,365**	**1,700**
	Crop Husbandry Centrally Sponsored Schemes (sharing basis) (Center Share)						
1	Scheme for Macro Management of Agriculture (90:10)	210		231	-	-	-
2	Scheme for Macro Management of Agriculture for Scheduled Castes Farmers (90:10)	15	450	394	-	-	-
3	Integrated Scheme of Oilseeds, Pulses, Oil-palm and Maize (ISOPOM) (75:25)	6,556	1,050	647	725	335	-
4	Integrated Scheme of Oilseeds, Pulses, Oil-palm and Maize for Scheduled Castes Farmers (ISOPOM) (75:25)	300	80	40	75	14	-

5	Scheme for Intensive Cotton Development under Mini Mission-II of Technology Mission on Cotton (75:25)	606	70	50	55	31	-
6	Scheme for Intensive Cotton Development under Mini Mission-II of Technology Mission on Cotton for Scheduled Castes Farmers (75:25)	60	12	10	14	3	-
7	Scheme for Support to State Extension Programme for Extension Reforms (90:10)	13,431	2,460	865	2,360	1,082	-
8	Scheme for Development of Saline/ Waterlogged Soils in Haryana State	1,345	-	-	1	-	220
	Total	**22,523**	**5,122**	**2,237**	**3,230**	**1,465**	**220**
	Centrally Sponsored Schemes (100% basis)						
1	Scheme for Setting up of Biogas Plants	1,277	250	164	250	55	250
2	Scheme for Setting up of Biogas Plants for SC Component	-	-	-	-	-	1
3	Scheme for Promotion and Strengthening of Agricultural Mechanization through Training, Testing and Demonstration	336	101	43	101	57	110
4	Scheme for Strengthening and Modernization of Pest Management Approach (token provision)	5	-	-	-	-	1
5	Scheme for Timely Reporting of Estimates of Area and Production of Principal Crops	352	44	39	25	23	50
6	Scheme for Improvement of Crops Statistics	277	27	27	37	36	45
7	Scheme for National Project on Organic Farming	1,000	10	-	-	-	50
8	Scheme for National Food Security Mission	18,500	5,000	3,045	5,000	3,004	-
9	Scheme for Post-harvest Technology and Management	325	200	2	200	64	300
10	Scheme for Development of Infrastructure Facilities for Production of Distribution of Quality Seed for Scheduled Castes Farmers		561	140	-	-	25
11	Scheme for Development of Infrastructure Facilities for Production of Distribution of Quality Seed (subsidy component)		400	400	-	-	50
	Total	**22,071**	**6,593**	**3,860**	**5,613**	**3,239**	**882**
	Grand Total	**275,295**	**47,277**	**30,005**	**61,187**	**36,900**	**43,532**

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