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ENHANCED WATER USE EFFICIENCY AND AGRARIAN ELECTRICITY SUBSIDY REFORM IN PUNJAB

Way Forward

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GIZ project

Climate Change Adaptation in Rural Areas of India

Technical Partner

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New Delhi, India
December, 2019

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LIST OF ABBREVIATIONS

CTR	Conventional Transplanted Rice
CCA-RAI	Climate Change Adaptation-Rural Areas in India
DSR	Direct Seeded Rice
GIC	Green Innovation Centres for the Agriculture and Food Sector – India
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
MoEFCC	Ministry of Environment,Forest and Climate Change
PSCST	Punjab State Council for Science and Technology
PSPCL	Punjab State Power Corporation Limited
PSERC	Punjab State Electricity Regulatory Commission
SAPCC	State Action Plan on Climate Change

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ABOUT THE REPORT

The project 'Climate Change Adaptation in Rural Areas-India (CCA-RAI)' being implemented under the bilateral cooperation of Ministry of Environment, Forest and Climate Change (MoEFCC) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH-India, aims to integrate climate adaptation measures into the national and state development planning. It also aims to develop concrete pilot experiences on adaptation measures in partnership with identified States and supports up-scaling of successful technical and financial adaptation approaches. Punjab is one of the partner states and the nodal partner is the Punjab Council for Science and Technology. The study was carried out as part of the project in partnership with Vasudha foundation and PSCST.

GIZ's role.

Support for Implementation of the Project in coordination with the Punjab State Council on Science and Technology

Purpose of this report.

Addressing vulnerabilities of Punjab to the impacts of climate change. The focus was on enhancing water use efficiency of paddy cultivation since that is a major driver of groundwater water depletion, and a major cause of climate vulnerability of the state. In addition, we also tried to address issues of rice straw management through an integrated approach

BACKGROUND AND CONTEXT

Punjab is a largely agrarian state and as such, is highly vulnerable to climate change. The two major aspects of Punjab's vulnerability to climate arises from a high level of dependence on groundwater for irrigation, as well as planting of rice during the Kharif (summer) season (July to October) by most farmers of the state. Rice is a thirsty, water intensive crop and the resultant demand on groundwater for irrigating Punjab's rice fields has led to a situation where groundwater levels have been declining continuously for the past few decades.

In view of the fact that groundwater recharge is expected to further decline considering the disrupted rainfall patterns and greater evaporation of surface water due to rise in average temperatures. The economy of Punjab in general and the livelihoods of millions of its farmers is at risk of getting affected negatively as greater and greater impacts of climate change begin to unfold. Further, this risk is unlikely to abate or be minimized since the existing system of agrarian incentives, primarily consisting of offering to procure produce at the minimum support price, encourages farmers to follow the same unsustainable and resource intensive agriculture practices that they have been on for many years.

Against the above background a two-year study was carried out to understand the options that could possibly be available for minimizing or eliminating the over exploitation of groundwater for the cultivation of rice. Thus, an initial feasibility study was carried out to gauge farmer's views regarding the problem. This was done primarily through Focus Group Discussions in several villages to understand the issues from the perspective of the farmers. What emerged from these discussions was that farmers were quite aware of the risks and challenges of continuing to cultivate rice through the traditional conventional methods, but were unable to make the switch to the more efficient direct seeded rice method of cultivation due to a lack of knowledge and awareness regarding direct seeded rice cultivation, as well as aversion to make any changes in their ongoing cultivation practices.

This situation analysis led us to explore possibilities of providing incentives to farmers by tweaking the existing framework of incentives that is being provided by the Government of Punjab in the form of free electricity supply for irrigation. During the course of interactions with the farmers while implementing the project, as well as an in-depth analysis of the data for electricity consumption provided by the Punjab State Power Corporation Limited, we were able to establish that an upfront conditional incentive of Rs. 1,500 per acre would be sufficient to induce the farmers to make the switch from the existing water intensive conventional transplanted rice method of cultivation method to direct seeded rice cultivation method, supported, of course, by appropriate and adequate extension services from the Punjab Agricultural University, as well as champions of direct seeded rice cultivation that could hand hold the new comers into the direct seeded rice cultivation fold. In pursuance of this approach, we were able to persuade 19 farmers from various villages in Bathinda district to cultivate 60 acres and 8 farmers from different villages in Moga District to cultivate 50 acres of land using the technique of Direct seeding.

Districts covered

ECONOMIC PROFILE OF PUNJAB

Punjab is a state divided into 22 districts with a geographical area of 50,362 sq. km (Statistical Abstract of Punjab, 2018). It is the 16th populous state in India with 2,77,04,236 people, which is 2.30% of India's population, which is projected to grow to 3,15,97,883 by 2021 (Statistical Abstract of Punjab, 2018). Geographically, the largest district in the State is Sangrur (3610 sq. km.), while the smallest is Pathankot (929 sq. km.) (Punjab at a Glance, 2015). Punjab is a relatively prosperous state and has a per capita income (Rs. 1,19,261) that is much higher than the national average (Rs. 94,130) at current prices (2015-16) (Statistical Abstract of Punjab, 2016). SBS Nagar i.e. Nawan Shahar District has the highest per capita income in Punjab (Rs. 1,02,202) while the lowest per capita income is reported from Pathankot (Rs. 54,514) at current prices (2011-12) (Punjab at a Glance, 2015). Of the total population of 2.77 crores, 1.73 crores (62%) people live in rural areas (Statistical Abstract of Punjab, 2018) and 75.8% of the population is literate (Statistical Abstract of Punjab, 2018).

The state's Gross State Domestic Product (GSDP), in Rupees, increased at a Compound Annual Growth Rate of 8.9 per cent between 2011-12 and 2018-19 to Rs 5.18 trillion from Rs 2.67 trillion (US$ 74.98 billion from US$ 38.64 billion) at current prices. (Statistical Abstract of Punjab, 2018)

TREND OF GSDP OF PUNJAB (AT CURRENT PRICES) OVER THE YEARS

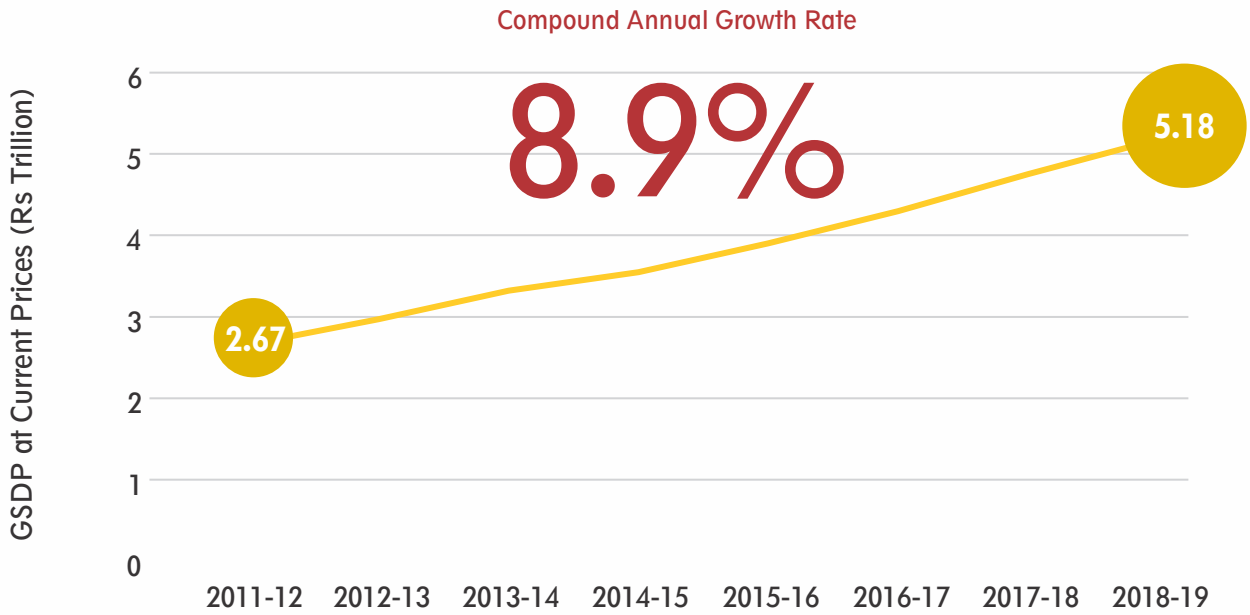
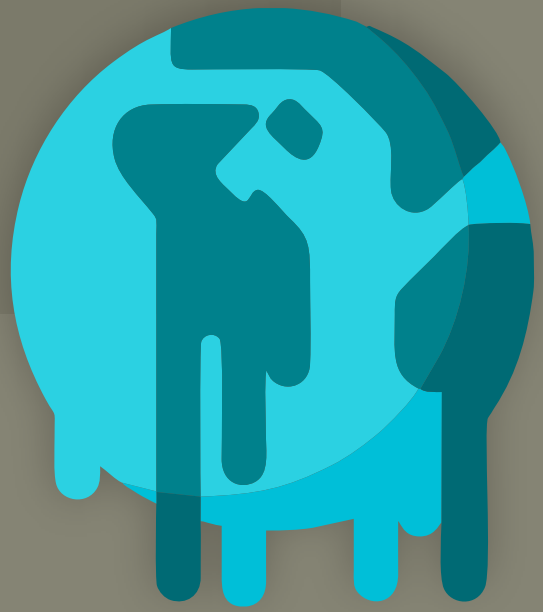


Figure 1:Trend of GSDP of Punjab(at Current Prices) over the years

Agriculture being the largest single sector of Punjab's economy contributing 26.8% to Punjab's GSDP, much above the national share of agriculture. It is also a major employment generator as 35.59% of the state's workforce is directly engaged in this sector (Statistical Abstract of Punjab, 2018). Despite the major share that agriculture holds up in the state's economy, it is witnessing decline. The contribution of agriculture to Punjab's GDP was 31.13% in 2004-05, which dropped to 26.8% 2017-18 (Statistical Abstract of Punjab, 2018). This decline in the GDP has caused stagnation in the incomes of the agricultural employees encouraging the indebtedness among the laborers as well as the farmers of Punjab.

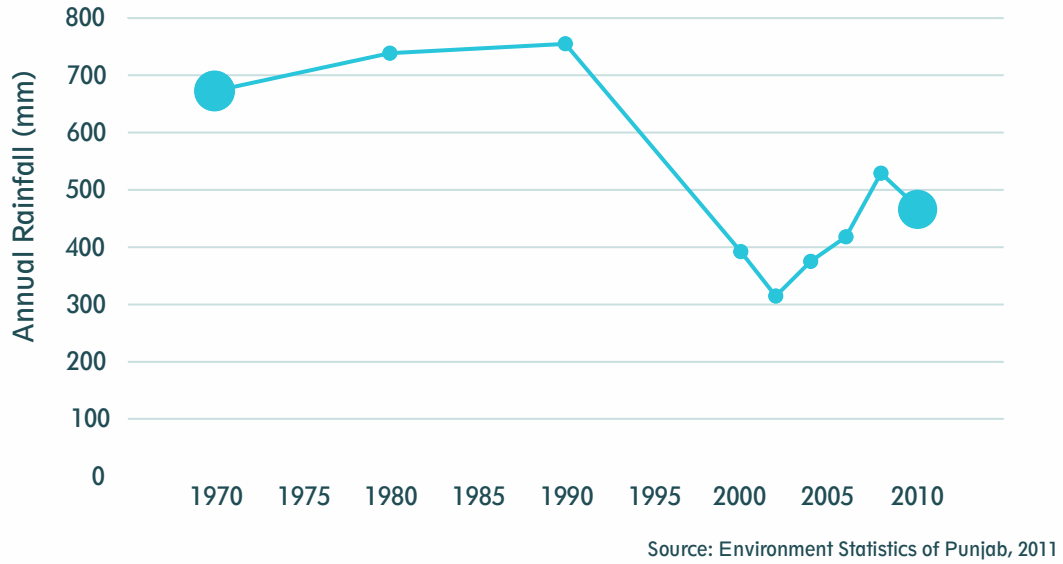
A recent survey conducted by researchers of Punjabi University, Patiala and Dashmesh Khalsa College, Zirakpur, in 1007 households found that 85.9% of all sampled farmers and 80.07% of all sampled agricultural labourers were indebted. Further, the average debt per indebted farming household was Rs. 5.52 lakh, while the average debt per indebted agricultural labourer was Rs. 0.68 lakhs. In addition, the level of debt per operated acre was Rs. 0.71 lakh (Gian Singh, 2017). The implication of all this is that Punjab is a prosperous albeit stagnating economy. According to the state's economic survey 2017-18 (Economic Survey of Punjab, 2017-18) , gross area sown was estimated at 79,000 sq. km. and total food grain production during 2017-18 was estimated at 285.69 million metric tonnes (Economic Survey of Punjab, 2017-18) . A cumulative of 69.6 % of was accounted to wheat and rice only making them the two major sown crops of the state (Economic Survey of Punjab, 2017-18).

RISKS AND VULNERABILITIES ARISING OUT OF CLIMATE CHANGE



Punjab is observing temperature increase, in three decades between 1971-2000, maximum temperatures in Punjab have increased by 0.5-1.0 degrees Celsius, while the minimum temperatures have increased by 0.5-1.5 degrees Celsius respectively (SAPCC, 2014). Rainfall on the other hand has also been disruptive, the monsoon rain has varied normally but the winter and the post-monsoon rainfall has observed a dip, making the state more prone to the less water availability during crucial periods of crop cycle. This in turn further increases the burden on ground water for irrigation. This is also reflected in the figure below. The state has also observed increased and frequent downpour events making the state more susceptible towards low water availability and flood like situations. (SAPCC, 2014)

ANNUAL RAINFALL IN PUNJAB (MM) 1970- 2010



Source: Environment Statistics of Punjab, 2011

Figure 2: Annual average Rainfall in Punjab(mm) 1970-2010

11.5-20.8%

Projected increase in Annual Monsoon Rainfall by 2050

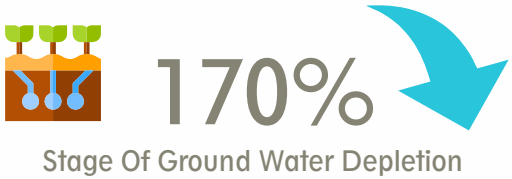
Considering the future projections, the annual precipitation is projected to increase by 13.3-21.5% by 2050, as compared to the baseline period (1961-1990) (SAPCC, 2014). Within this projected increase, the annual monsoon rainfall is projected to increase by 11.5-20.8%. This increase could result in risk of flooding in the state losing much of the excess runoff water unless measures are taken to harvest a significant proportion of this increased precipitation. Apart from this, the state is expected to experience an increase in annual mean maximum temperature of 1.0-1.8 degrees Celsius by 2050. The annual mean minimum temperature is also projected to rise by 1.9-2.1 degrees Celsius by mid-century (SAPCC, 2014).

The State Action Plan on Climate Change (SAPCC) identifies the intensification of rice cultivation as the foremost challenge faced by the agriculture sector in Punjab. The unsustainable practices of cultivation have led to the decrease in water table of the state, the soil has been degraded with increased toxicity due to excessive usage of fertilizers, pesticides and weedicides in the agricultural fields of the state. Further, productivity levels have plateaued, resulting in stagnation of the overall income of the state (SAPCC, 2014).

According to the SAPCC, the situation is set to deteriorate further due to unfolding impacts of climate change. It is projected that with an increase in temperatures by 0.5-2.0 degrees Celsius, rice yields in Punjab are likely to decrease by 0.16-9.6%, while with an increase in temperatures by 1.0-2.0 degrees Celsius, wheat yields are likely to decrease by 14-23% (SAPCC, 2014).

Also, SAPCC observes, the "Net Annual Ground Water Availability to be 20.35 BCM (billion cubic meters) and the Annual Ground Water Draft is 34.66 BCM, with stage of ground water development standing at 170% (SAPCC, 2014) .Ground water exploitation in Punjab is high providing 72% of the total water required for irrigation. About 110 out of the 138 blocks (now spread over all the 145 blocks in the state) are over exploited for ground water, of these 3 blocks are critical and 2 blocks are in semi-critical condition. (SAPCC, 2014)

FUTURE PROJECTIONS AS PER STATE ACTION PLAN ON CLIMATE CHANGE



PADDY AND GROUNDWATER DEPLETION

While paddy is a thirsty crop, producing it in Punjab is even more water intensive than in other parts of the country. For example, according to the Commission for Agricultural Costs and Prices, Punjab requires 5,337 litres of water to grow one kilogram of paddy, double of what's required in West Bengal (2,605 litres), a natural habitat of the crop. Added to this, from 2.27 lakh hectares in 1960, the area under paddy in Punjab rose to 26.12 lakh hectares by the year 2000; a growth rate of 1,050 percent. Further, the area under paddy had increased to 30.46 lakh hectares in 2016-17 (Firstpost Arjun Sharma, 2018). In addition, A survey by the Punjab soil and water conservation department notes that water demand for "agricultural purposes is 43.7 lakh hectare metres, as against a supply of 31.3 lakh hectare metres (Firstpost Arjun Sharma, 2018). The excess demand of 12.4 lakh hectare metres is met through over-exploitation of groundwater resources. As in 2018, there were 12.32 lakh tube wells as compared to 1.92 lakh in 1970-71, the percentage of net area irrigated to net area sown has shown a tremendous increase from 71 percent to 97.4 percent during 1970-71 to 2006-09. Out of the total irrigated area, the area under irrigation by groundwater through tube wells has increased from 55 percent to 73 percent (Firstpost Arjun Sharma, 2018).

The upshot is that by 2023, the water table depth in central Punjab is projected to fall below 70 feet in 66% area, below 100 feet in 34% area and below 130 feet in 7% area of Punjab. Due to the depletion in groundwater resources, irrigation expenditure for rice and wheat crops has increased significantly in the last decade. The increased cost of well deepening and pump replacement (from centrifugal to submersible) has contributed to increasing incidence of farmers' indebtedness with a relatively more adverse effect on the small and marginal farmers who lack enough resources to finance such investments (Gian Singh, 2017).

While the average annual fall in groundwater table in central Punjab was about 17 cm during the 1980s and about 25 cm during the 1990s, it was alarmingly high at 91 cm per annum during 2000–2005 (Firstpost Arjun Sharma, 2018).

Litres of water required to grow 1kg of Paddy

5,337 Punjab | **2,605** West Bengal

Area under paddy in Punjab

2.27 Lakh Hectares 1960

26.12 Lakh Hectares 2000

1,050 %

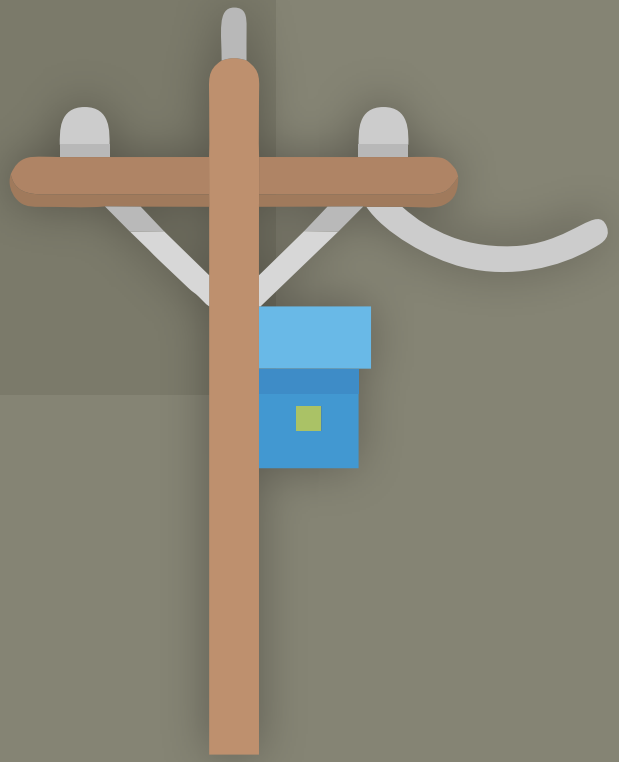
Projected water table depth in Central Punjab by 2023

>70 feet in 66% area

>100 feet in 34% area

>130 feet in 7% area

PADDY AND CONSUMPTION OF ELECTRICITY



The state of Punjab has a dedicated agriculture electricity feeder line and currently, the Government supplies free electricity to farmers for the purpose of using groundwater for irrigation through its agricultural feeders. The total annual supply of electricity for irrigation by the Punjab State Power Corporation Limited was of the order of 13279 million units in 2018-19 (PSPCL, 2013-19). Between 2013-14 till 2018-19, there was a 20% increase in annual agricultural electricity consumption in Punjab with a peak in 2017-18 and marginal decline in 2018-19 as has been shown in Table 1 and Figure 3 below.

13279 MUs

Annual supply of electricity for irrigation by the Punjab State Power Corporation Limited in 2018-19

20%

Increase in annual agricultural electricity consumption in Punjab

AGRICULTURAL ELECTRICITY CONSUMPTION IN PUNJAB(MUS)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Amritsar	513.14	521.92	576.26	495.62	601.96	580.61
Barnala	511.91	548.50	580.04	566.35	672.66	560.23
Bathinda	514.19	572.63	638.01	646.43	715.18	680.25
Faridkot	156.52	204.73	240.49	226.44	264.01	238.94
Fatehgarh Sahib	365.44	375.97	408.83	383.42	418.75	404.02
Fazilka	208.82	222.28	248.93	245.57	284.87	247.56
Firozpur	446.20	472.36	517.53	463.81	549.58	510.48
Gurdaspur	341.90	364.86	428.13	387.43	457.12	428.69
Hoshiarpur	720.30	797.61	865.35	883.76	986.86	888.79
Jalandhar	652.27	1212.16	773.84	699.18	836.41	695.64
Kapurthala	357.79	361.29	429.00	386.68	454.84	430.58
Ludhiana	898.24	936.19	1042.46	912.51	1103.91	1074.68
Mansa	334.51	390.79	460.10	435.54	522.94	445.59
Moga	678.23	736.47	834.49	730.87	899.71	876.49
Muktsar	179.03	208.39	256.63	261.55	285.79	264.78
Pathankot	140.22	140.72	151.61	152.72	161.51	148.62
Patiala	1075.79	1125.36	1270.79	1125.53	1352.03	1136.35
Rupnagar	294.48	331.80	387.54	377.65	474.72	375.41
Sangrur	1475.24	1482.71	1623.43	1351.50	1771.62	1650.43
SAS Nagar	340.51	405.03	457.62	455.19	487.49	468.62
SBS Nagar	274.10	293.69	357.03	337.22	385.00	382.15
Tarn taran	607.13	646.64	733.76	629.20	797.31	790.25
TOTAL	**11085.95**	**12352.11**	**13281.87**	**12154.17**	**14484.31**	**13279.16**

Table 1:Agricultural Electricity Consumption in Punjab (MUs)

ENERGY CONSUMPTION(AP) TREND ACROSS PUNJAB OVER THE PERIOD OF 6 YEARS

Figure 3: Agricultural Electricity consumption (AP) trend across Punjab over the period of 6 years

In monetary terms, the total cost of the free electricity provided for irrigation in Punjab for 2018-19 was estimated to be Rs. 6852 crores[1]. (Tariff Order, 2018-19).

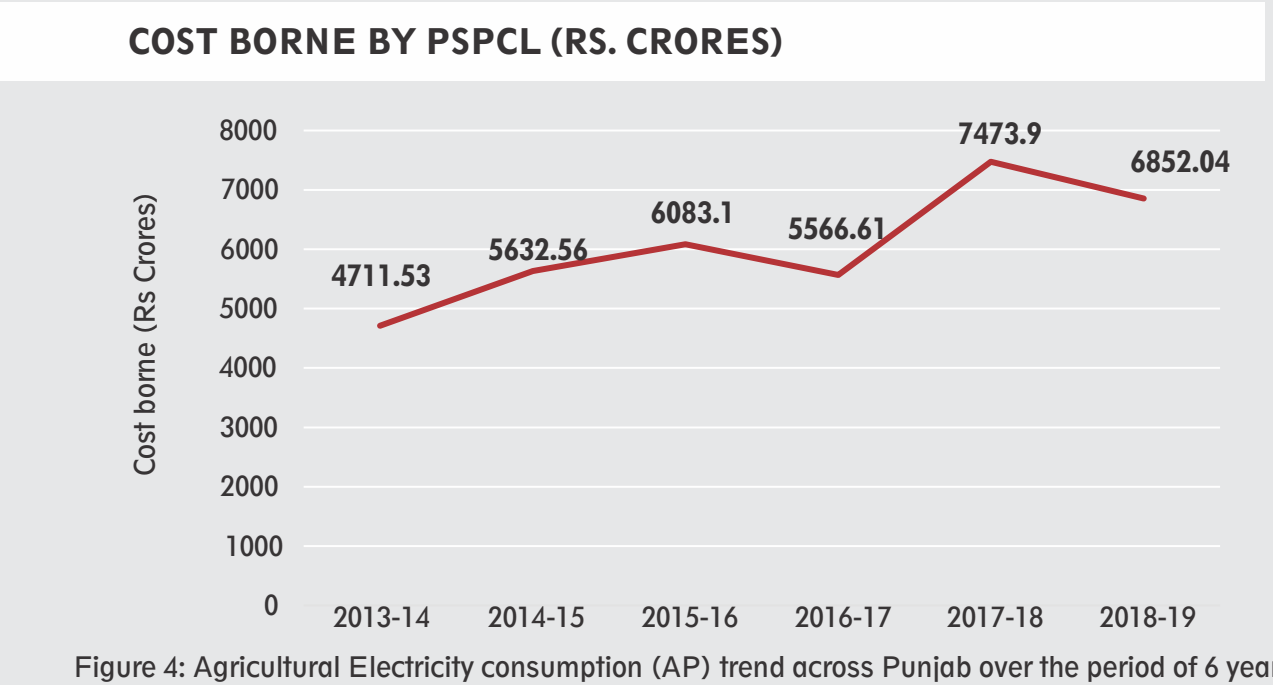


Figure 4: Agricultural Electricity consumption (AP) trend across Punjab over the period of 6 years

This was around 5% of the total expenditure of the annual budget of Punjab (Budget at a Glance, 2018-19) in 2018-19. Given that the consumption of electricity for agriculture has been steadily rising over the years, this burden on the exchequer is likely to continue growing.

The top 5 districts with the highest annual consumption of agricultural electricity consumption in Punjab are given in the figure below.

[1]13279 million units supplied through agricultural feeders @ Rs. 5.16 per unit

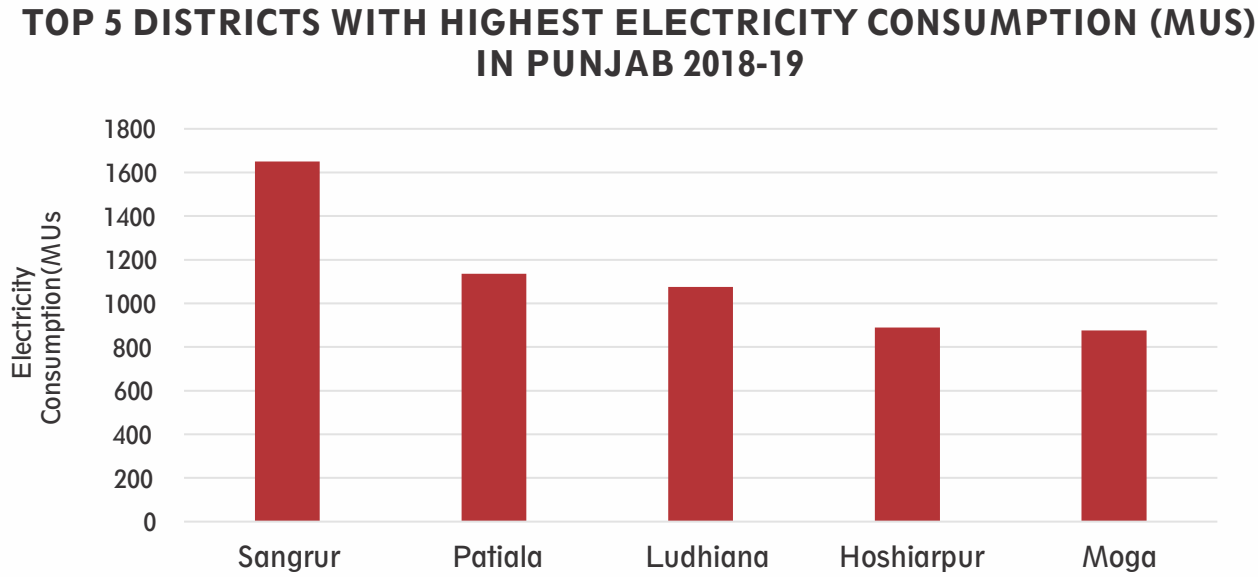
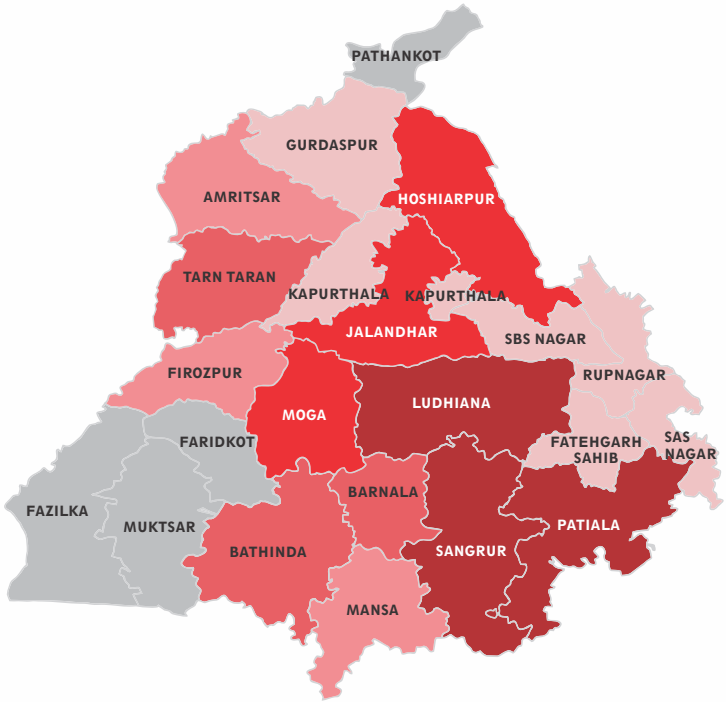


Figure 5:Top 5 districts with highest agricultural electricity consumption in Punjab in 2018-19 (MUs)

ENERGY CONSUMPTION PATTERN ACROSS THE DISTRICTS OF PUNJAB IN 2017-18

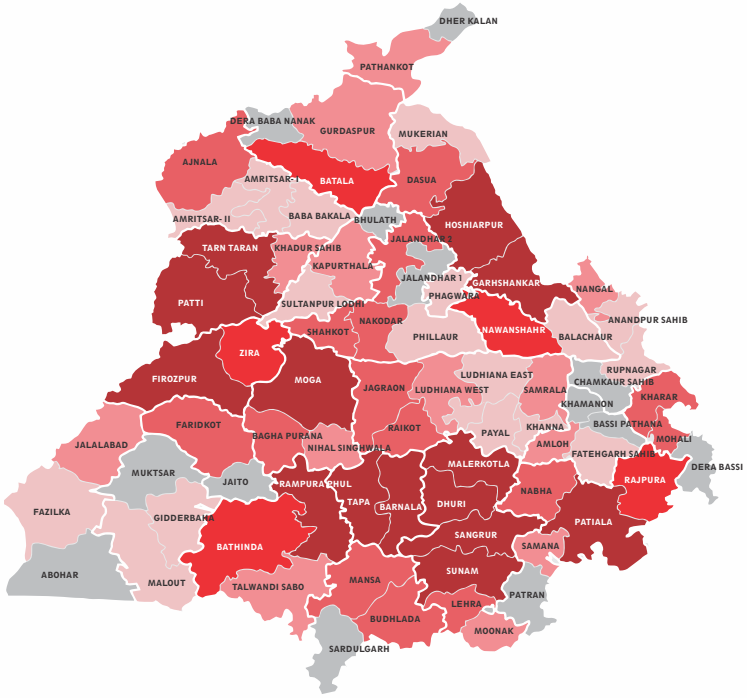


Energy Consumption (kWh)
Average (658377578)

- <50% below average (161513390 - 329188789)
- >25% and upto 50% below average (329188790 - 493783184)
- Upto 25% below average (493783185 - 658377578)
- Upto 25% above average (658377579 - 822971973)
- >25% and upto 50% above average (822971974 - 987566368)
- >50% above average (987566369 - 1771624903)

Figure 6:Agricultural Electricity Consumption Pattern across the districts of Punjab (Annual,2017-18) (PSPCL, 2013-19)

ENERGY CONSUMPTION PATTERN ACROSS THE TALUKAS OF PUNJAB IN 2017-18



Energy Consumption (kWh)
Average (188107880)

- <50% below average (15293360 - 94053940)
- >25% and upto 50% below average (94053941 - 141080910)
- Upto 25% below average (141080911 - 188107880)
- Upto 25% above average (188107881 - 235134849)
- >25% and upto 50% above average (235134850 - 282161819)
- >50% above average (282161820 - 507562663)

Figure 7:Agricultural Electricity Consumption Pattern across the talukas of Punjab (Annual,2017-18) (PSPCL, 2013-19)

However, the annual consumption of electricity for agriculture provides only one part of the story. When we look at monthly patterns of consumption of agricultural electricity, this is the picture that emerges for the state as a whole:

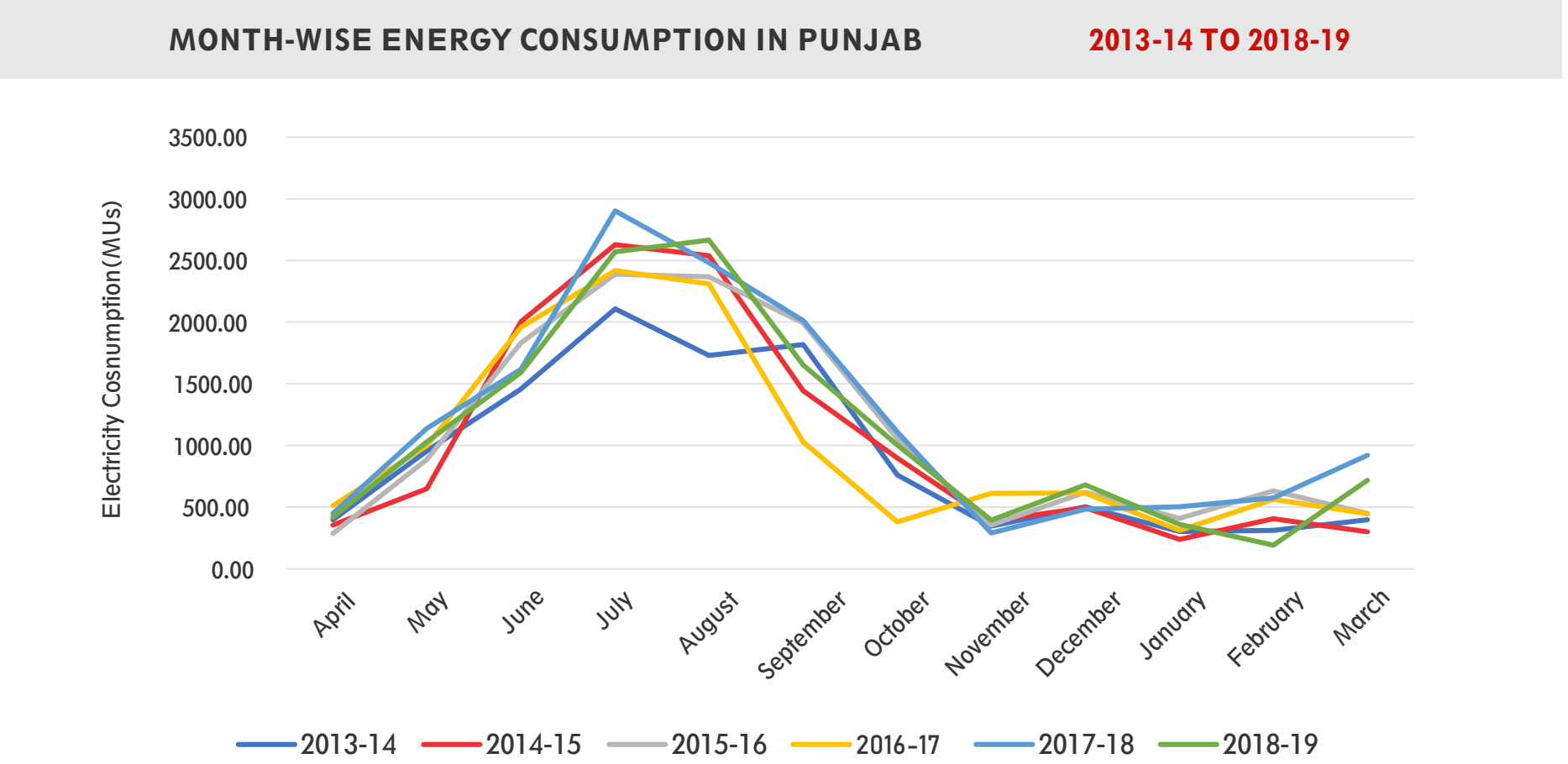


Figure 8: Month-wise Agricultural Electricity Consumption in Punjab State from the year 2013-2014 to 2018-2019 (PSPCL, 2013-19)

What clearly emerges from the chart given above is that the maximum consumption of agricultural electricity takes place between June and September. These are also the months when there is maximum need for irrigation of the paddy crop in Punjab. Between 2013-14 and 2018-19, the proportion of consumption of agricultural electricity during these four months ranged between 69% in 2014-15 to 64% in 2018-19[2]. Thus it is safe to assume that on an average, around two-thirds of the agricultural electricity consumed annually in Punjab is for irrigation of the Paddy crop.

[2] The following section of the report provides a detailed explanation on the proportion of agricultural electricity consumed in rice season with respect to rest of the year.

ENERGY CONSUMPTION PATTERN ACROSS THE DISTRICTS OF PUNJAB 2017-18

JUNE

Energy Consumption (kWh)
Average (73559293)

- <50% below average (17191980 - 36779646)
- >25% and upto 50% below average (36779647 - 55169469)
- Upto 25% below average (55169470 - 73559293)
- Upto 25% above average (73559294 - 91949116)
- >25% and upto 50% above average (91949117 - 110338939)
- >50% above average (110338940 - 219859152)

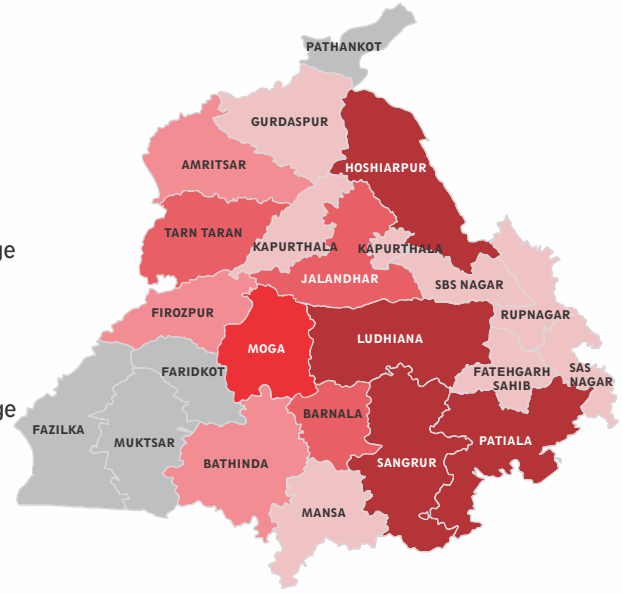


Figure 9:Agricultural Electricity Consumption Pattern across districts of Punjab (June,2017-18) (PSPCL, 2013-19)

JULY

Energy Consumption (kWh)
Average (131913457)

- <50% below average (22280870 - 65956728)
- >25% and upto 50% below average (65956729 - 98935092)
- Upto 25% below average (98935093 - 131913457)
- Upto 25% above average (131913458 - 164891821)
- >25% and upto 50% above average (164891822 - 197870185)
- >50% above average (197870186 - 379872080)

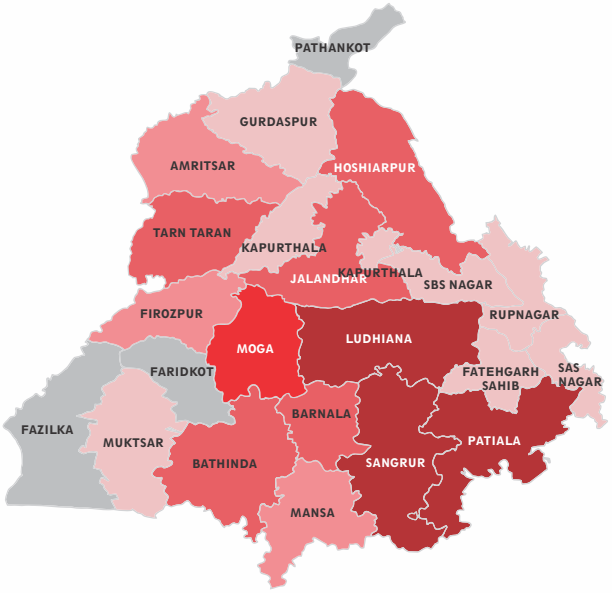


Figure 10:Agricultural Electricity Consumption Pattern across districts of Punjab (July,2017-18) (PSPCL, 2013-19)

AUGUST

Energy Consumption (kWh)
Average (112801751)

- <50% below average (19036630 - 56400876)
- >25% and upto 50% below average (56400877 - 84601313)
- Upto 25% below average (84601314 - 112801751)
- Upto 25% above average (112801752 - 141002189)
- >25% and upto 50% above average (141002190 - 169202627)
- >50% above average (169202628 - 293518717)

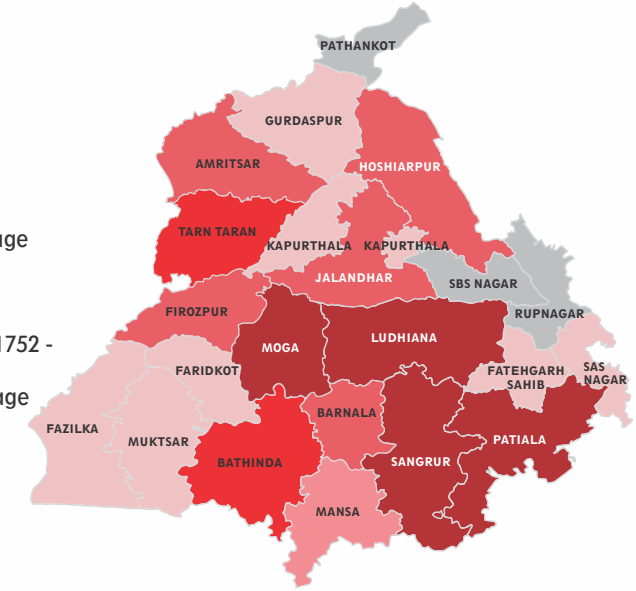


Figure 11:Agricultural Electricity Consumption Pattern across districts of Punjab (August,2017-18) (PSPCL, 2013-19)

SEPTEMBER

Energy Consumption (kWh)
Average (91463247)

- <50% below average (18710710 - 45731623)
- >25% and upto 50% below average (45731624 - 68597435)
- Upto 25% below average (68597436 - 91463247)
- Upto 25% above average (91463248 - 114329058)
- >25% and upto 50% above average (114329059 - 137194870)
- >50% above average (137194871 - 241176046)

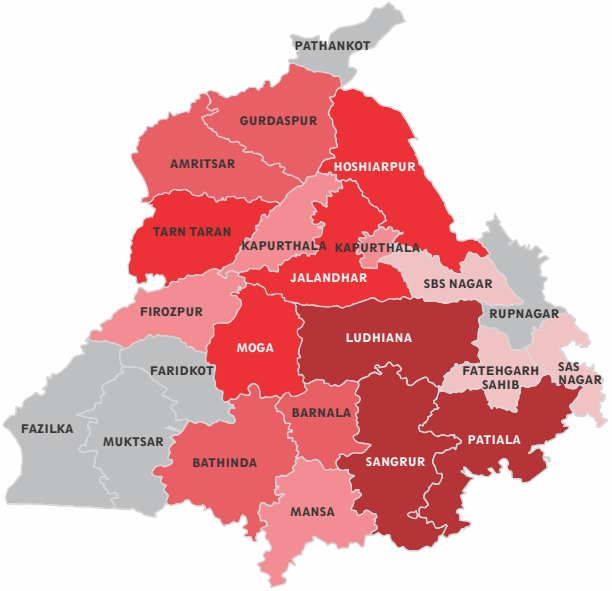


Figure 12:Agricultural Electricity Consumption Pattern across districts of Punjab (September,2017-18) (PSPCL, 2013-19)

ELECTRICITY CONSUMPTION (MUS) DURING THE WHOLE YEAR VS. DURING THE RICE SEASON

	Electricity Consumption(MUs)	
Year	During the year	During the Rice season
2013-14	11085.95	7111.68
2014-15	12352.11	8618.29
2015-16	13281.87	8582.43
2016-17	12154.17	7713.93
2017-18	14484.31	9014.23
2018-19	13279.16	8481.137

Table 2: Agricultural Electricity consumption (Mus) during the whole year vs. during the Rice season (PSPCL, 2013-19)

PROPORTION OF ELECTRICITY USED IN PUNJAB FOR IRRIGATING PADDY FIELDS

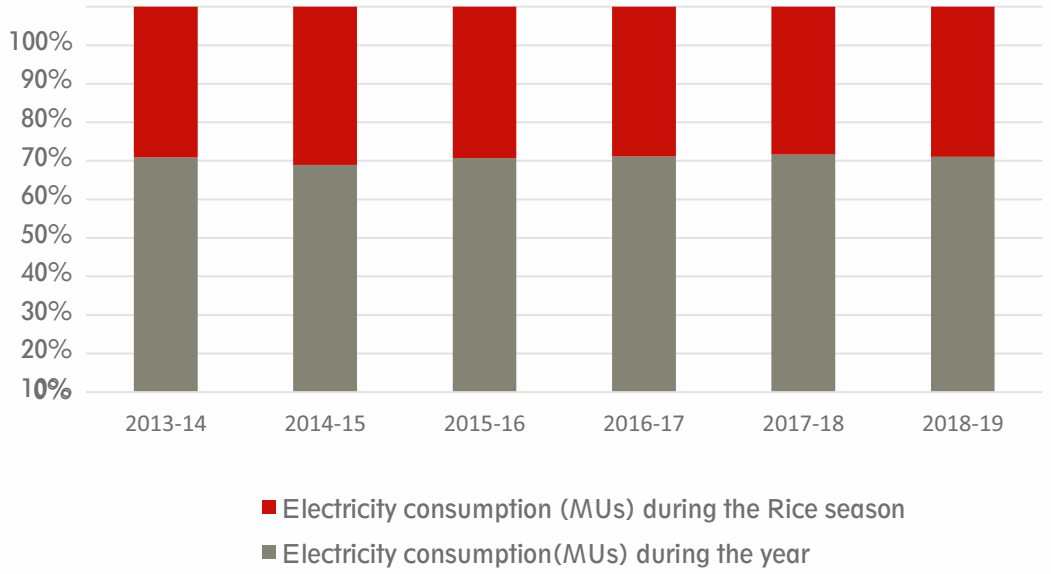


Figure 13: The proportion of agricultural electricity consumed for irrigating the paddy fields of the State Punjab from the year 2013-2014 to 2018-2019 (PSPCL, 2013-19)

Assuming that two-thirds of the annual electricity was consumed for irrigation of paddy during June-September 2017[3] also, the total expenditure incurred in subsidizing paddy irrigation could easily be assumed to be Rs. 3,780 crores[4] (PSPCL, 2013-19).

[3] The following section of the report provides a detailed breakdown of electricity subsidy expenditure for paddy for 2017-18, since the data for net sown area under Paddy was not available for 2018-19 years

[4] Refer to Annexure-V

POSSIBLE PATHWAY FOR REDUCING CONSUMPTION OF ELECTRICITY AND DEPLETION OF GROUNDWATER

THROUGH FACILITATING A SWITCH OVER TO DIRECT SEEDED RICE FROM CONVENTIONAL TRANSPLANTED RICE

At present, the net sown area of paddy in Punjab is around 75 lakh acres[5] (Agricultural Statistics, 2017-18). Conventional Transplanted Rice (CTR) is the method through which paddy is being cultivated on most of this land. As already mentioned above, around 9014.23 million units of electricity is consumed resulting in a burden of Rs. 3,780 crores annually on the exchequer. There is, however, a small but growing number of farmers in Punjab that are beginning to grow paddy through the Direct Seeded Rice (DSR) method. According to a survey that was done by Vasudha Foundation[6]. There are significant advantages that growing paddy through DSR method provides when compared with CTR method. The chief among these is substantial savings per acre on labour costs, of the order of around Rs. 2,200[7] per acre, and around a 10%[8] bump in yield per acre. However, farmers are not switching over in substantial numbers, primarily due to a lack of information and knowledge about DSR. An additional factor is that farmers in Punjab have become risk-averse, and thus an initial incentive, preferably a monetary incentive by the State Government, would help more and more farmers to take the plunge.

The project's interactions with the farmers over a period of two years suggests that an incentive of, of around Rs. 1,500 per acre for a period of around 3 years would help to persuade the farmers to make the switch from CTR to DSR. Such a switch could result in substantial slowing down, and perhaps even reversal of the depletion of groundwater in Punjab. This is because DSR has substantially less requirement of irrigation than CTR that will also result in substantial savings in the consumption of electricity during the paddy-growing season (Mahesh K. Gathalaa, 2013).

The question, however, is how can such a scheme of incentivizing farmers to make the CTR to DSR switch be financed?

The farmers of Punjab are consuming around 900 units of electricity per acre during the paddy season[9].

ELECTRICITY CONSUMED PER ACRE FOR RICE PLANTED THROUGH CTR		
Electricity units consumed per acre, annually on total cultivated land (KwH/acre)	Electricity units consumed per acre during Rice season (KwH/acre)	Electricity units consumed per acre during Non- Rice season (KwH/acre)
1421.02	937.87	483.14

Table 3: Comparison of Electricity consumed per acre for Rice and Non-Rice season.

[5] 75,73,615 Acres
[6] Refer to Annexure-I
[7] Refer to Annexure-I
[8] Refer to Annexure-I99
[9] Refer to Annexure-V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The Project as part of the study installed electrical gauges on irrigation pump sets in two farms, one in which paddy was being grown through the DSR method, and another in which paddy was being grown through the CTR method. The readings on the gauges show that consumption of agricultural electricity per acre in the field where paddy was being cultivated through DSR was around 45% of that being cultivated through CTR.

Thus, if one were to assume a state-wide switchover from CTR to DSR on the entire 75 lakh acres in Punjab, there would be savings in consumption of electricity for agriculture of around **500 units per acre**[10].

This, in turn, would imply a saving of around Rs. 2,661.68 per acre for the state exchequer, which would amount to a whopping **Rs. 2079 crores**[11].

Further, the State Exchequer would also benefit if the electricity not consumed by the farmers for irrigation during the paddy-growing season could be sold to paying consumers in the domestic or industrial sectors or even fed into the grid for sale to electricity deficit states in the rest of the country. This potential for revenue generation is further explained below.

According to the Power Purchase Agreements of PSPCL for 2017-18, the corporation had to buy 26348.18 MU(s) of electricity from Traders/Independent Power Producers @ around Rs. 3.8/Unit, costing the corporation a sum of Rs.10036.75 Cr.

However, as calculated in the previous sections, we understand that if DSR was prevalent across the state, PSPCL would have saved close to **4029MU(s)**[12] of electricity, which, would have reduced some burden out of the 26348.18 MU(s) to 22319.18 MU(s), saving PSPCL **Rs.1003.21 Cr.**(Calculations below)

Potential Units assumed to be saved (MUs)	Avg. cost of buying each unit through IPPs/Traders(Rs.)	Potential Reduction in monetary burden(Crore)
4029	2.49	1003.21

The cost of buying each unit is as per the Tariff order and Power Purchase Agreements of Punjab State Electricity Regulatory Commission. (Tariff Order, 2018-19)

[10]Refer to Annexure-V
[11]Refer to Annexure-V
[12]Refer to Annexure-V

SELLING THE ELECTRICITY SAVED

Electricity units(MUs)

4029

If the electricity is supplied to the	Residential Sector	Commercial/Industrial Sector	Medium Scale Industries	Large Scale Industries
Cost per unit (Rs.)	5.16	5.58	5.72	5.93
Estimated Revenue(Cr)	**2078.96**	**2248.18**	**2304.58**	**2389.19**

The cost of buying each unit is as per the Tariff order of PSERC. (Tariff Order 2018-19)

In addition, the State exchequer would also not need to purchase electricity from the energy exchange and that too would be an additional fiscal saving, that is explained below

PSPCL bought **662.40 MU(s)** through Netbanking at **Rs.3.67/unit** at **Rs.268.90 Cr**, so the 4029MU(s) saved directly nullify the impact of Netbanking on PSCL, in fact, result in revenue generation through the remaining **3366.6 MU(s).**

Electricity Units (MUs)	Cost per unit of Residential Supply (Rs.)	Estimated Revenue(Cr)
3366.6	**5.16**	**1737.16**

CONCLUSIONS AND RECOMMENDATIONS

Punjab is a state whose vulnerability to climate change in the water sector is being amplified due to existing cropping patterns, especially the cultivation of Paddy during the Kharif season. There is enough evidence to suggest that continuing Paddy cultivation through the prevalent CTR method will continue to deplete the groundwater resources of Punjab. At the same time, the state's exchequer is continuing to incur substantial costs in providing free electricity for irrigation to Punjab's farmers. These costs are expected to continue rising as rainfall patterns continue to get disrupted due to climate change. Further, the farmers of Punjab find themselves unable to grow any crop other than Paddy during the Kharif since it has an assured market due to procurement at the minimum support price, as well as the inability of the farmers to risk growing alternative crops due to their indebtedness and the general situation of economic distress in agriculture. In this scenario, we propose that the Government of Punjab initiate a scheme to provide a financial incentive of Rs. 1,500 per acre for a period of 3 years to farmers to shift from cultivation of paddy through the Conventional Transplanted Rice method to the Direct Seeded Rice method. The study/project has shown an analysis of the potential savings in electricity consumption in cultivating Paddy through the DSR method that, the incentive that we recommend be paid to the farmers to switch from CTR, could easily be financed through the savings that would accrue to the Punjab State Power Corporation Limited. Further, the Punjab State Power Corporation Limited could also generate additional revenues by supplying the additionally available electricity to other paying consumers in Punjab or feed it into the grid to earn revenues from other electricity deficient states. This measure would also lead to significant savings in consumption of ground water and could potentially lead to an arrest or even reversal in the current trends of depletion of ground water resources of Punjab. This is because, if one were to take consumption of electricity for irrigation as a proxy for ground water extraction, it can be safely assumed that the farmers of Punjab could grow the same amount of Paddy with half the water required for irrigation if they switch over from Conventional Transplanted Rice to Direct Seeded Rice method of paddy cultivation.

With this background, the specific recommendations that we would like to make are the following:

1 The State Government must urgently begin engaging with all the relevant stakeholders to promote Direct Seeded Rice (DSR) cultivation of Paddy in Punjab.

2 In order to incentivize the farmers to switch over to DSR, the government can offer an incentive of Rs. 1,500 per acre to farmers that agree to switch. Our calculations show that this entire amount could be financed through the reduced consumption of electricity that would arise out of the switch from Conventional Transplanted Rice (CTR) to DSR, thereby in the long run, leading to fiscal savings from reduced subsidy burdens arising out of free electricity supply for irrigation. In addition, farmers can also receive an additional Rs. 500, conditional upon sustainable straw management after harvesting the paddy crop.

3 The State Government must also urgently push for the adoption of DSR in Punjab to halt or reverse the alarming drop in the ground water table across the state. Our own experiences in the field suggest that, taking the consumption of electricity as a proxy, the consumption of ground water for the cultivation of Paddy could be halved in these parts where farmers switch over to DSR from CTR. This would, in turn, significantly reduce the problem of over extraction of ground water in Punjab and lead to the stabilization of the State's water table.

Farmer's reactions after adoption of Direct Seeded Rice method of paddy cultivation

सराहनीय

गांव महराज के युवा किसान गुरप्रीत बने राज्य के किसानों के लिए प्रेरणास्रोत

धान की सीधी बुआई से बचाया लाखों लीटर पानी और लागत खर्च भी कम रहा

सुनाम धूंद • बठिंडा

पंजाब जल संकट से जूझ रहा है। धान के सीजन में पानी की खपत और बढ़ जाती है। ऐसे में बठिंडा के गांव महराज निवासी युवा किसान गुरप्रीत सिंह कृषि विभाग की सीधी बुआई की तकनीक अपनाकर न केवल प्रत्येक धान के सीजन में लाखों लीटर पानी की बचत कर रहे हैं, बल्कि करीब 1.50 लाख रुपये की सीधी बचत भी कर रहे हैं।

गुरप्रीत राज्य के मालवा क्षेत्र का पहला किसान है, जिसने इस तकनीक को अपनाकर न केवल स्वयं पानी की बचत के साथ साथ लागत खर्च में बचत कर रहे हैं, बल्कि वह राज्य के किसानों के लिए भी प्रेरणा स्रोत बने हुए हैं। वह औरों को भी यह तकनीक अपनाने के लिए प्रेरित करते रहते हैं। गुरप्रीत को उसके

33 वर्षीय किसान ने वर्ष 2009 में शुरू की थी सीधी बुआई

33 वर्षीय गुरप्रीत सिंह के अनुसार उसके पास 43 एकड़ जमीन है, जिसमें वह पिछले दस वर्षों से सीधी बुआई कर रहे हैं। दस वर्ष पहले पेप्सी कंपनी ने गांव मित्त पत्ती में चार कनाल जमीन में धान की सीधी बुआई करके दिखाई थी। फसल तैयार होने के उपरांत उसके तथा परंपरागत बुआई के झाड़ में कोई अंतर नहीं था, बल्कि परंपरागत बुआई से कुछ हद तक अधिक ही झाड़ प्राप्त हुआ था। इस उपलब्धि को देखने के बाद गुरप्रीत ने पहले पहल एक एकड़ में सीधी बुआई की। जिसके अच्छे परिणाम मिले, तो अगले वर्षों में उसने सीधी बुआई करने वाली मशीन खरीदकर अपने पूरे रकबे में ही इस तकनीक से बुआई करने लगे। उसकी प्रेरणा से इस समय बाघा दर्जन से

प्रति एकड़ तीन हजार रुपये की बचत

गुरप्रीत ने बताया कि परंपरागत धान की रोपाई से प्रति एकड़ लगभग साढ़े चार हजार रुपये का खर्च आता है। इसमें 3000 रुपये लेबर, 500 रुपये की पनीरी तथा 2000 रुपये खेत तैयार करने पर खर्च हो जाते हैं। लेकिन सीधी बुआई में खेत तैयार करने और बीज पर मात्र 1500 रुपये एक एकड़ पर खर्च होते हैं। इस तरह से तीन हजार रुपये का खर्च एक एकड़ में सीधे ही बच जाता है। प्रति एकड़ करीब 30 फीसद पानी की बचत हो जाती है। परंपरागत बुआई में खेत को पहले ही लबालब पानी से भरना पड़ता है। इसके बाद भी लगातार इसी तरह पानी खड़ा रखना पड़ता है। जबकि सीधी बुआई के एक हफ्ते बाद पानी देना पड़ता है। इसके बाद भी एक हफ्ते बाद सीमित मात्रा में पानी लगता है।

जोखिम लेने से डरते हैं किसान

वास्तव में किसान जोखिम लेने से डरते हैं। सीधी

गेहूं के उत्पादन में अधिक झाड़

धान की सीधी बुआई वाले खेत में अगली गेहूं की फसल में प्रति एकड़ एक क्विंटल तक अधिक झाड़ प्राप्त होता है। चूंकि परंपरागत धान की बुआई करने वाले किसान फसल कटने के बाद उस खेत को आग के हवाले भी कर देते हैं, जबकि सीधी बुआई वाले किसान धान की पराली को भी खेत में हल से मिला देते हैं। अधिक पानी और आग से धरती के रोम बंद हो जाते हैं, जबकि सीधी बुआई से ऐसा नहीं होता। कृषि विज्ञान केंद्र के सहायक निदेशक जतिंदर सिंह बराड़ कहते हैं कि किसानों को इस तकनीक को अपनाना चाहिए। इसमें पानी और लागत खर्च में बड़ी बचत होती है। वहीं अगली गेहूं की फसल में भी अधिक झाड़ मिलता है।

पानी देना पड़ता है। अधिक पानी से फसल खराब

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ANNEXURE

Annexure-I
Survey carried out to compare the practice of cultivating rice through of Direct Seeding with Conventional Transplanting.

Annexure-II
Schedule that was Administered to Farmers Cultivating Paddy Through DSR Method

Annexure-III
Schedule that was administered to Farmers Cultivating Paddy Through Conventional Transplanting Method

Annexure-IV
Patterns of Electricity consumed for agriculture in the state of Punjab from 2013-14 to 2017-18

Annexure-V
How a shift from CTR to DSR would benefit the state of Punjab?

Annexure-VI
Details of Area of land covered under Sustainable Straw Management

Annexure-VII
Details of villages and the area of land where DSR was practiced for the first time.