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An economic analysis of solar water pump sets in Raipur districts of Chhattisgarh

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Abstract
The present study is based on "Economic Analysis of Solar Water Pump Sets in Raipur Districts of Chhattisgarh. Arang block is selected purposively for the study. Primary data was collected for the year 2016-17 and 2019-2020. The findings of the study is that in Raipur district 917 solar pump sets are installed during 2016-17 to 2018-19. In Arang block 297 solar pump sets are installed. The highest subsidy of solar pump is 97.38% provided by MNRE and CREDA to the SC/ ST category famers. Before and after installation of solar pump cropping intensity was 121.63% and 181.60 % respectively. Before and after installation of solar pump the B:C ratio of paddy, wheat, maize and chickpea are 1.52, 1.35, 1.03 and 1.16 respectively. And 2.55, 1.75, 1.36, 1.52 respectively. After installation of solar pump the B:C ratio of green pea and coriander are 2.07 and 2.72.

Keywords: Solar pump, B:C ratio, subsidy, cropping intensity

Introduction
Agriculture play an important role in Indian economy. Nearly 70 percent of India's population depends either directly or indirectly on agriculture, while 44 percent of the 140 million sown hectares depend on irrigation, the remainder rely on the monsoon. Irrigation is essential for crop production. There's growing demand for water to irrigate the crops. In the agricultural sector, highest electricity use goes to irrigation operating pump sets. SOUR SUJALA YOJNA was launched by Prime Minister that provide solar power irrigation pumps to farmers at a subsidized price. Chhattisgarh is the first state to implement the scheme. 2 hp, 3 hp and 5 hp solar pumps were installed under this scheme. In this scheme, 56362 solar water pump sets were installed during 2016 to 2019 in Chhattisgarh state. In the Raipur districts 917 solar water pump sets are installed. CREDA (Chhattisgarh State Renewable Energy Development Agency) provides solar water pump sets at subsidized price to the farmers. The benefits received by the farmers, through the Sour Sujala Yojna, is provided by the agricultural department.

Methodology: The methodological frame work presented under the following headings:
1. 1 Sampling design
2. 2 Collection of data
3. 3 Analytical tools and techniques
4. 4 Description of study area

1. Sampling Design
1.1 Selection of district: Chhattisgarh State consists of 28 districts. The Raipur district is selected randomly for the study.

1.2 Selection of blocks: The Raipur district has four blocks namely Arang, Tilda, Dharsiwa and Abhanpur. Arang block was selected purposively because highest number of solar pumps was installed.

1.3 Selection of villages: Selection of villages is in accordance with the corresponded villages of solar pump user farmer. Villages are kunda, badgaon, chandkhuri, godhi, tekari, parsada, chhatera and borid.

1.4 Selection of farmers: For the research work purpose 49 farmers are selected randomly from the eight village with solar pump sets were listed out.

2. Collection of data: In order to address the objectives of the study, primary as well as secondary data were collected for the study.

2.1 Primary Data: Primary data for the study will be collected from solar pump set user farmers. Information regarding the cost, benefits limitation, impact and various parameters of solar water pump sets usage will be collected from farmer.

2.2 Secondary Data: Secondary data relevant to the objectives of the study were collected from the CREDA (Chhattisgarh State Renewable Energy Development Agency) and Agriculture Department Raipur etc.

Method of computation

1) Cost structure

1. Variable costs- Human labour, Cattle labour, Tractor services, Plant materials, Seed, FYM, Fertilizers and plant protection chemicals, transportation cost.
2. Fix cost-Rental value of owned land, Land revenue, Depreciation.

2) Cost Concepts

Cost concepts were used to estimate the cost of cultivation and derive the measures of efficiency viz., farm business income, family labour income, net income and farm investment income. The cost concepts namely Cost A1, Cost A2, Cost B1, Cost B2, Cost C1, Cost C2 and Cost C3, have been used in this analysis and are derived as follows;

Cost A1:

This cost includes value of purchased material inputs (seed, insecticides and pesticides, manure, fertilizer), hired human labour, animal labour (owned and hired), machinery labour (owned and hired), depreciation on farm implements and farm buildings, irrigation charges, land revenue, cess and other taxes and interest on working capital.

Cost A2

Cost A1 + rent paid for leased in land. In the present study, all the selected farmers were owner cultivators. Hence Cost A1 and Cost A2 were same.

Cost B1

Cost A2 + interest on amount of owned capital invested in the business excluding the value of land

Cost B2

Cost B1 + rental value of owned land less land revenue + rent paid for leased-in land.

Cost C1

Cost B1 + imputed value of family labour.

Cost C2

Cost B2 + imputed value of family labour.

Cost C3

Cost C2 + 10 per cent of Cost C2 (on account of managerial functions performed by the farmer).

Result and Discussion

Present status of the solar water pump sets in the study area: In India total number of solar pump sets installed is 181521. Chhattisgarh state has the highest number of solar pump installation i.e. 56362. Followed by Andhra Pradesh with 28267 installation.

Year and social category wise number of solar water pumps sets installed in Chhattisgarh: Solar water pumps sets installed in Chhattisgarh during the 2016-17 to 2018-19. Solar water pump sets was installed in 3 phase. Number of Solar water pump sets installed during the phase-I (2016-17) was 12080. In Phase-II (2017-18) 24445 solar water pump sets was installed and in phase-III 19837 solar water pump sets were installed. It is shown in table 1.

Table 1: Year and category wise number of solar pump sets in Chhattisgarh

S. No	Category	Phase-I (2016-17)	Phase-I (2017-18)	Phase-I (2018-19)	Total	Percentage
1	ST	6342	13705	12057	32104	56.96
2	SC	694	1543	882	3119	05.53
3	OBC	4372	7699	5694	17765	31.51
4	GN	672	1498	1204	3374	05.98
	Total	12080	24445	19837	56362	100.00

Source: Agriculture department Raipur

Block wise number of solar water pump sets installed in Raipur district: solar water pump sets installed in Raipur districts of Chhattisgarh during the year 2016-17 to 2018-19. Number of solar water pump sets installed in Arang, Abhanpur, Dharshiwa and Tilda block of Raipur was 297, 179, 184 and 256 respectively. In Arang block no. of solar water pump sets installed during the year 2016-17, 2017-18 and 2018-19 was 118, 105 and 74 respectively. In Abhanpur block no. of solar water pump sets during the years 2016-17, 2017-18 and 2018-19 was 83, 40 and 57 respectively. In Dharshiwa block no.of solar water pump sets installed during the years 2016-17, 2017-18 and 2018-19 was 65, 63 and 56 respectively. In Tilda block no. of solar water sets during the year 2016-17, 2017-18 and 2018-19 was 87, 94 and 75 respectively. It is shown in table 2.

Table 2: Block wise solar water pump sets installed in Raipur district

S. No.	Block	2016-17	2017-18	2018-19	Total	Percentage (%)
1	Arang	118	105	74	**297**	32.38
2	Abhanpur	83	40	57	179	19.52
3	Dharshiwa	65	63	56	184	20.06
4	Tilda	87	94	75	256	27.91
	Total	353	302	262	917	100.00

Source: Agriculture department of Raipur

Investment required for installing solar pump sets

Cost of various component required in installing solar pump sets: Pump set controller (VFD) takes largest share 34% followed by solar PV modules 30%.Structure component take 18% of the total cost and other necessary materials of system, transportation and establishment charge and foundation (civil works) charge contributed 6,6,and 6 per cent respectively shown in table 3.

Subsidy pattern and farmer's share in swps: The contribution of MNRE and CREDA to solar water pump sets was 93.27% for GN category farmers. For OBC category farmers the contribution was 95.51%. And 97.38% contribution of MNRE and CREDA to solar water pump sets for the SC and ST category famers. Farmer's share for installation of solar water pump sets was 6.72%, 4.48% and 2.61% for GN, OBC, and SC/ST famers respectively shown in table 4.

Table 3: Cost of various component required in installing solar pump sets

S. No.	Component	Cost (in ₹)	Percent (%)
1	Solar PV Module	80304.00	30.00
2	Structure	48182.40	18.00
3	Pump sets controller (VFD)	91011.20	34.00
4	Other necessary materials of system (BOS)	16060.80	6.00
5	Transportation and establishment charge	16060.80	6.00
6	Foundation (Civil Work)	16060.80	6.00
	Total	267680.00	100.00

Table 4: Subsidy of solar water pump sets to the farmers

S. No.	Particulars	GN category	OBC category	SC/ST category
1	MNRE & CREDA Contribution	249780.00 (93.27)	255680.00 (95.51)	260680.00 (97.38)
2	Farmer's share	18000.00 (6.72)	12000 (4.48)	7000.00 (2.61)

Note: Figure in parentheses indicate percentage of total

Impact of solar pump sets on production and income pattern of farmer:

Impact on cropping pattern of selected farmer,

Impact on cost and production of crop

Impact on cropping pattern of selected farmer: Before installing solar pump farmers are cultivating paddy, maize and urad in kharif season and paddy, wheat, chickpea, moong and lathyrus during rabi season. Summar season is fallow. Farmer are changed their cropping pattern after installing solar pump. Now cultivating area also increased and some new crop are taken like pea in rabi season and coriander in summar season. Before installing solar pump net cropped area was 2.99 ha, gross cropped area was 3.63 and cropping intensity was 121.63%. Now, after installing solar water pump sets gross cropped area and cropping intensity are increased to 5.43 ha and 181.60 % respectively are shown in table 5.

Table 5: Cropping pattern of the selected farmer

S. No.	Season/crop	Area (in ha)	
		Before using solar pump	After using solar pump
1	Kharif		
	1) Paddy	2.18	2.20
	2) Maize	0.37	0.35
	3) Urad	0.44	0.44
	Sub total	2.99	2.99
2	Rabi		
	1) Paddy	0.21	0.56
	2) Wheat	0.15	0.48
	3) Chickpea	0.13	0.52
	4) Pea	-	0.15
	5) Moong	0.03	0.03
	6) Lathyrus	0.12	0.12
	Sub total	0.64	1.86
3	Summar		
	1) Coriander	-	0.58
4	Gross cropped area	3.63	5.43
5	Net cropped area	2.99	2.99
6	Cropping intensity (%)	121.40	181.60

Impact on cost and production of crop: Crop cultivation costs are also dealt by adopting cost concepts, viz., used in farm management studies. CostA1, Cost A2, CostB1, CostB2, CostC1 costC2 and CostC3**.** The cost C2 covers both fixed and variable costs as the most detailed one. The cost of paddy, wheat, maize, chickpea, green pea and coriander cultivation was elaborated and described in table 6.

Yield and Value of yield: Before installation of solar pump the average yield of paddy, wheat, maize, chickpea are 56.00, 21.03, 19.30 and 7.22 respectively and after installation 57.27, 23.05, 20.01 and 7.69 quintals per hectare respectively. After installation of solar pump the average yield of pea and coriander are 90.03 and 15.03 quintals per ha respectively. Before installation of solar pump the value of yield of paddy, wheat, maize, chickpea are 91245.00 ₹, 34173.75 ₹, 26344.50 ₹, 28880.00 ₹ respectively. After installation of solar pump the value yield are 143175.00, 444371.25 ₹, 35217.60 ₹ and 37488.75 ₹ per ha respectively. After installation of solar pump the average yield of green pea and coriander are 90.03 and 15.03 quintal per ha and their value of yield are 184561.50 ₹ and 80150.00 ₹ per ha respectively shown in table 7.

Value of gross return, net return and benefit cost ratio: Before installation of solar pump the value of gross return, net return and benefit cost ratio of paddy, wheat, maize and chickpea are 91245.00 ₹, 36510.75 ₹, 26344.50 ₹ and 4025.27 ₹ per ha respectively. 31455.72 ₹, 9586.52 ₹**, 777.**15 ₹ and 4025.27 ₹ per ha respectively and B:C ratio is 1.52, 1.35, 1.03 and 1.16 respectively. After installation of solar pump the value of gross return, net return and benefit cost ratio of paddy, wheat, maize, chickpea, green pea and coriander are 152290.00 ₹, 46886.25 ₹, 35217.60 ₹, 37599.15, 184561.50 ₹ and 80150.00 ₹ per ha respectively**,** 92619.62 ₹, 20217.73 ₹, 9429.58 ₹, 12920.42 ₹, 95765.47 ₹ and 50674.39 ₹ per ha respectively and B:C ratio 2.55, 1.75, 1.36, 1.52, 2.07 and 2.72 shown in table 8.

Table 6: Impact on cost of cultivation of crops (total cost in Rs per hectare)

S. No.	Crops		Cost C2 (Total cost)
1	Paddy	Before installation of solar pump	59789.28
		After installation of solar pump	59670.38
2	Wheat	Before installation of solar pump	26924.23
		After installation of solar pump	26668.52
4	Maize	Before installation of solar pump	25567.35
		After installation of solar pump	25788.02
5	Chickpea	Before installation of solar pump	24949.13
		After installation of solar pump	24678.73
6	Green pea	After installation of solar pump	88796.03
7	Coriander	After installation of solar pump	29475.61

Table 7: Impact on yield and value of yield

S. No.	Crop		Yield (Quintal per ha.)		Value of yield (Rupees per ha.)	
			Main product	By product	Main product	By product
1	Paddy	Before installation of solar pump	56.00	59.50	91245.00	8925.00
		After installation of solar pump	57.27	61.10	143175.00	9165.00
2	Wheat	Before installation of solar pump	21.03	23.37	34173.75	2337.00
		After installation of solar pump	23.05	25.15	444371.25	2515.00
4	Maize	Before installation of solar pump	19.30	-	26344.50	
		After installation of solar pump	20.01	-	35217.60	
5	Chickpea	Before installation of solar pump	7.22	1.18	28880.00	94.4
		After installation of solar pump	7.69	1.38	37488.75	110.4
6	Green pea	After installation of solar pump	90.03	-	184561.50	
7	Coriander	After installation of solar pump	15.03	-	80150.00	

Table 8: Value of gross return, net return and benefit cost ratio

S. No.	Crop		Value of gross return	Net return	Benefit cost ratio
1	Paddy	Before installation of solar pump	91245.00	31455.72	1.52
		After installation of solar pump	152290.00	92619.62	2.55
2	Wheat	Before installation of solar pump	36510.75	9586.52	1.35
		After installation of solar pump	46886.25	20217.73	1.75
4	Maize	Before installation of solar pump	26344.50	777.15	1.03
		After installation of solar pump	35217.60	9429.58	1.36
5	Chickpea	Before installation of solar pump	28974.4	4025.27	1.16
		After installation of solar pump	37599.15	12920.42	1.52
6	Green pea	After installation of solar pump	184561.50	95765.47	2.07
7	Coriander	After installation of solar pump	80150.00	50674.39	2.72

Conclusion

In India total number of solar pump sets installed is 181521. Chhattisgarh state has the highest number of solar pump installation i.e. 56362. Followed by Andhra Pradesh with 28267 installation. It is need to promote the use of solar pump by the government. The investment required for solar pump was 267680.00 ₹ and above. Pump set controller (VFD) takes largest share 34% followed by solar PV modules 30%. Structure component take 18% of the total cost and other necessary materials of system, transportation and establishment charge and foundation (civil works) charge contributed 6,6,and 6 per cent respectively. Solar pump is very costly. It is need to discover the less cost material. The contribution of MNRE and CREDA to solar water pump sets was 93.27% for GN category farmers. For OBC category farmers the contribution was 95.51%. And 97.38% contribution of MNRE and CREDA to solar water pump sets for the SC and ST category famers. Farmer's share for installation of solar water pump sets was 6.72%, 4.48% and 2.61% for GN, OBC, and SC/ST famers respectively. Before installation of solar pump the value of gross return, net return and benefit cost ratio of paddy, wheat, maize and chickpea are 91245.00 ₹, 36510.75 ₹, 26344.50 ₹ and 4025.27 ₹ per ha respectively. 31455.72 ₹, 9586.52 ₹**, 777.**15 ₹ and 4025.27 ₹ per ha respectively and B:C ratio is 1.52, 1.35, 1.03 and 1.16 respectively. After installation of solar pump the value of gross return, net return and benefit cost ratio of paddy, wheat, maize, chickpea, green pea and coriander are 152290.00 ₹, 46886.25 ₹, 35217.60 ₹, 37599.15, 184561.50 ₹ and 80150.00 ₹ per ha respectively**,** 92619.62 ₹, 20217.73 ₹, 9429.58 ₹, 12920.42 ₹, 95765.47 ₹ and 50674.39 ₹ per ha respectively and B:C ratio 2.55, 1.75, 1.36, 1.52, 2.07 and 2.72. Before and

after installation of solar pump the change of value of gross return, net return and B:C ratio is not only by the use of solar pump but also price changes of product.

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