ADOPTION OF JAIN INTEGRATED MICRO IRRIGATION SYSTEMS BASED ON SOLAR PUMPING IN CANAL COMMAND AREAS OF BUNDELKHAND REGION OF CENTRAL INDIA TO OVERCOME WATER AND POWER SHORTAGES OF THE REGION

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ABSTRACT: (9 pt)
Bundelkhand region of Central India like the other parts of India receives erratic rainfall and has unfavorable geological and topographical conditions. This makes Bundelkhand a region prone to water shortages. Severe water shortage is experienced in the years of poor rainfall. There is a problem of power shortage also in the region. There are couple of dams and canal systems constructed in the region for surface irrigation. Most of these projects have experienced construction delays and cost overruns. Out of the net sown area in the region, about 18% is irrigated with canals, 3% with tanks, 26% with tube wells ,40% with other wells and 14% with other sources. Irrigated area as a percentage of total sown area in case of UP Budelkhand is 42.3% (as against UP average of 72.8%) and that of MP Bundelkhand is 39.9%. Hence there is scope for increasing area under irrigation in Bundelkhand region , but the adverse conditions such as draught and flood due to erratic rainfall, adverse geology and severe power shortages in the region do not allow that to happen. To fight against all these odds, Jain Irrigation Systems Ltd has come out with the most advanced and innovative model of Integrated Micro Irrigation Project based on Solar Pumping Systems, which will suit all the conditions in the region and will help to save the precious natural resources such as water and power etc. This paper describes such a model which would be a ray of hope to change the scenario of Bundelkhand region.

INTRODUCTION

Bundelkhand is a region of Central India, comprised of some districts of UP and some districts of MP. Generally UP Bundelkhand comprised of Jhansi, Lalitpur, Jalaun, Hamirpur,Mahoba, Banda and Chitrkoot districts and MP Bundelkhand is comprised of Datia, Chhatrapur,Tikamgarh, Panna,Damoh and Sagar districts. These districts are generally referred t as Bundelkhand region, even though sometimes other districts from UP and MP are also referred to be the areas of Bundelkhand region. Geographically Bundelkhand lies between Indo-Gangatic Plain to the north and the Vindhya Range to the south.

Bundelkhand is a dry area. The minimum temperature varies from around 6 deg C in Chhatrapur to 12 deg C in Sagar. Maximum temperature varies from 38 deg C in Sagar to 43 deg C in Banda.The highest temperature was recorded in Banda which is one of the hottest places in India, at 47.8 deg C in May 1960.

Bundelkhand gets moderate annual rainfall ranging between 750 mm in north west to 1250 mm in south west. But the precipitation is erratic. Bundelkhand receives most of its rains during June to September. Rain fall is often a high burst with an intensity of 30-40 mm/hr, hence rainwater has a very little time to penetrate the soil. It also has substrata of impermeable rock. Hence most of the bundelkhand area is drought prone area. Some times Bundelkhand also receives excessive rainfall resulting into floods.

Bundelkhand has mainly two rivers Ken and Betwa. There are a couple of dams and canal systems on these rivers. Ground water and tanks is another source of irrigation. Out of the net sown area in the region, about 18% is irrigated with canals, 3% with tanks, 26% with tube wells ,40% with other wells and 14% with other sources. Following table shows sources of irrigation in UP and MP

Bundelkhand districts.

Table 1 : Percentage of Net Irrigated Area and Sources of Irrigation in Bundekhand Region

District	Net Irrigated Area as % of Net Sown Area	% of net irrigated area by source				
		Canals	Tanks	Tube wells	Other wells	Other source
Jhansi	64	45	7	3	43	2
Lalitpur	79	33	21	11	33	1
Jalaun	54	76	2	17	5	Neg
Hamirpur	36	41	2	34	21	2
Mahoba	48	36	18	2	43	1
Banda	34	63	5	26	7	Neg
Chitrakoot	29	38	17	25	19	Neg
UP Bundelkhand	50	48	10	14	26	1
Datia	68	55	Neg	1	42	Neg
Chhatrapur	56	9	2	Neg	75	12
Tikamgarh	68	8	6	5	76	4
Panna	33	12	7	7	22	52
Damoh	36	9	Neg	26	24	41
Sagar	44	2	1	17	50	31
MP Bundelkhand	50	14	3	9	53	21

Thus the Irrigated area as a percentage of total sown area in case of UP Budelkhand is 42.3% (as against UP average of 72.8%) and that of MP Bundelkhand is 39.9%. Hence there is a scope for increasing area under irrigation in Bundelkhand region , but the adverse conditions such as drought and flood situation due to erratic rainfall, adverse geology and severe power shortages in the region do not allow that to happen. To fight against all these odds, Jain Irrigation Systems Ltd has come out with the most advance and innovative model of Integrated Micro Irrigation Project based on Solar Pumping Systems, that should be suitable for all the adverse conditions in the region and will help to save the precious natural resources such as water and power etc.

PROPOSED JAIN INTEGRATED MICRO IRRIGATION MODEL

These models have been proposed for Bundelkhand region where there are severe problems of water shortages and power shortages. The proposed model is suitable for a particular site in Bundelkhand region, however can be easily replicated in other parts of Bundelkhand with some modifications in the systems depending upon the local conditions.

The proposed model includes main HDPE line which can be a Gravity main from the dam or Rising main depending up on the topography, Distribution System(mainly gravity based) , Storage Sumps, Solar Pumping Systems, Micro Irrigation Systems (Sprinkler or drip irrigation systems depending up on the cropping pattern) and CD works such as road crossing, river crossing or railway crossing.
In this model the entire command area can be divided in to a number of *chaks* having average area of each *chak* as 40 Ha. Each chak has been provided with one storage sump having suitable capacity. Water would be delivered to the sumps through a combination of Gravity Main with Gravity Distribution or Pumping Main with Gravity Distribution to the storage sumps. Then the water would be delivered to the Micro Irrigation systems through Solar Pumping Systems under required pressure and will be delivered to the crops/plants directly near to the root zone of the plants. In this model as far as possible one can use the available gravity and solar pumping. No electrical pump sets are required.

After receiving the water at storage sump through gravity, farmers will have a choice of irrigating their fields with the help of piped flow irrigation OR sprinkler irrigation OR Drip irrigation using Solar

Pumping Systems. The maximum chak size considered here is 40 ha and the size of solar pump set is 10, 25 and 13 HP in case of piped flow, sprinkler and drip irrigation respectively considering the market limitations/ availability of solar pump sets of higher capacity.

In these models length of the Gravity main from the water source to the field is considered at 27 km approx.. The flow in each model differs and therefore the diameter and pressure class of pipe also differs. The pipes are considered to be of High Density Polyethylene (HDPE)

CROPPING PATTERN

Following cropping pattern has been considered while working out these models: Soyabeans (Kharif), Wheat, Gram and Mustard. The area of each crop and cropping intensity would differ depending upon the model of piped flow irrigation, sprinkler irrigation or drip irrigation.

ESTIMATED COSTS

Following are the tentative costs of each model considering piped flow, sprinkler and drip irrigation using solar pumping systems:

Table 2 : Estimated Costs Model 1: Piped Flow Irrigation

Sr	Item	Cost, Rs lacs	Cost per ha, Rs.
1	Gravity Main Line	8375.65	158720.00
2	CD Structures	2090.25	39615.00
3	Panel Rooms	420.00	7960.00
4	Storage Tanks	1705.20	32314.00
5	Solar Pumps	2380	45102
6	Pipe Distribution Network	1384.07	26229.00
7	Automation	1991.62	37742.00
8	On-field Irrigation System	1319.25	25000
9	Contingencies 10 %	1966.60	37268.00
10	Total Cost for Project	21632.64	409950.00

Table 3: Estimated Costs Model 2: Sprinkler Irrigation Model

Sr	Item	Cost, Rs lacs	Cost per ha, Rs.
1	Gravity Main Line	8312.39	157522.00
2	CD Structures	2090.25	39611.00
3	Panel Rooms	420.00	7960.00
4	Storage Tanks	1568.00	29714.00
5	Solar Pumps	5950.00	112754.00
6	Pipe Distribution Network	1323.60	25083.00
7	Automation	1991.62	37742.00
8	On-field Irrigation System	3302.52	62584.00
9	Contingencies 10 %	2495.84	47297.00
10	Total Cost for Project	27454.22	520267.00

Table 4: Estimated Costs Model 3 : Drip Irrigation Model

Sr	Item	Cost, Rs lacs	Cost per ha, Rs.
1	Gravity Main Line	6567.39	124454.00
2	CD Structures	2090.25	39611.00

3	Panel Rooms	420.00	7960.00
4	Storage Tanks	1120.00	21225.00
5	Solar Pumps	3094.00	58632.00
6	Pipe Distribution Network	1027.33	19469.00
7	Automation	1991.62	37742.00
8	On-field Irrigation System	9394.44	178027
9	Contingencies 10 %	2570.50	48712.00
10	Total Cost for Project	28275.53	535832.00

Total costs in case of traditional canal based systems have been worked out as Rs 214.81 Crore which is equivalent to Rs 413111.00 per Ha. Considering the same cropping pattern, the above costs for different models have been worked out. Thus the total costs of the systems in case of model 1 i.e. piped flow irrigation is marginally lower than the traditional canal irrigation and the total cost in case of sprinkler and drip irrigation models is slightly higher than canal and piped flow models. However in terms of benefits Sprinkler and Drip irrigation models are better than the other two. This is because of the inherent benefits of sprinkler and drip irrigation systems with respect to water savings, yield increase, input savings and other benefits.

COST ECONOMICS

Following table gives the comparison of different models with the conventional canal based flow irrigation models.

Table 5: Comparison of Different Models

Sr No	Item	Canal Based Flow Irrigation	Piped Flow Irrigation	Sprinkler Irrigation	Drip Irrigation
1	Water Allocation, Mm3	17.29	17.29	17.29	17.29
2	Water Utilized, Mm3	17.29	17.29	17.29	13.03
3	Water Saving, Mm3	0	0	0	4.26
4	Area, Ha	5277	5277	5277	5277
5	Cropping Intensity,%	98	115	200	200
6	Irrigation Efficiency %	35	40	71	86
7	Weight of Produce, MT	13974	16675	36145	45181
8	Water Productivity, MT/Mm3	808	964	2091	3467
9	Capital Cost, Rs Cr	214.81	216.32	274.54	282.75
10	Cost of Cultivation, Rs Cr	8.98	10.64	18.9	20.79
11	Variable Costs, Rs Cr	24.63	25.88	37.75	39.94
12	Total Costs, Rs Cr	33.61	36.52	56.65	60.73
13	Income, Rs Cr	32.12	37.28	81.91	102.38
14	Net Income, Rs Cr	-1.49	0.76	25.26	41.65

The basic assumption while working out these models is that the area and water allocation is same in all the three models.

In all the three models, the cropping intensity can be increased to 115% in case of piped flow model, 200% in case of sprinkler model and 200 % in case of drip irrigation model from 98% in case of Conventional Canal Based Flow Irrigation model. In case of Drip Irrigation model, apart from increasing the cropping intensity, one can also save water up to 4.26 Mm3 (more than 25%).

In all the three proposed models, there will be an increase in yield and therefore Water Productivity will be much higher than the conventional canal based flow irrigation model. Water productivity can be increased to more than 400% in case of Drip Irrigation .

In case of net benefits, Conventional Canal Based Flow Irrigation model shows negative cash flow. This is primarily because of the interest burden of capital investments. However in case of piped flow model, sprinkler model and drip irrigation model, the cash flow is positive and net returns in case of drip irrigation systems are as high as Rs 39400 per ha in one season. This shows that the overall income of the farmers would definitely increase if they adopt micro irrigation systems.

ADVANTAGES OF THE PROPOSED MODELS

1. Judicious use of water, energy, fertilizers and other inputs.
2. Increased yields and profitability due to micro irrigation to the extent of 50%
3. Increased productivity will ensure increased income level of the farmers.
4. No power costs /reduced recurring expenses due to introduction of eco- friendly solar pumping systems
5. Reduced carbon emissions and pollution due to introduction of environment friendly solar pumping systems
6. Availability of reliable power and irrigation due to solar systems.
7. The project will create huge direct and indirect employment generation and will stop migration of rural youth to urban areas.

JAIN"S EXPERIENCE IN EXECUTION OF INTEGRATED MICRO IRRIGATION PROJECTS

During last three-four years Jain Irrigation Systems Ltd have executed number of such integrated micro irrigation projects in India, few of them and their approximate area covered are given below :

1. Shiggaon Lift cum Sprinkler Irrigation project in Karnataka – 9900 Ha
2. Balh Valley Medium Irrigation project in Himachal Pradesh – 2400 Ha
3. Indira Gandhi Nahar Pariyojana, Rajasthan – 15000 ha
4. Purna and Chandrabhaga Irrigation Project in Maharashtra – 10000 Ha
5. Narmada Canal Project, Rajasthan – 140000 Ha(Under Execution)

C**ONCLUSION**

Different models of micro irrigation systems can be adopted successfully in the command areas of Bundelkhand region to improve the water productivity and ultimately to increase the income levels of the farmers of this region. Even though there cannot be a single model which will suit all the requirements/conditions in the command area, the models suggested in this paper are extendable to large size areas with minor modifications according to the site conditions, land extent, topography and cropping patterns.