Reclaiming Sodic Water for Irrigation through Gypsum Chamber

1. Introduction

The scheme aims at developing irrigation potential by providing financial assistance to farmers for reclaiming sodic ground water by Gypsum Chambers. In areas where ground water is sodic and where good quality surface water supplies are either inadequate or are not available at all and the farmers are left with no option but to use sodic ground water for irrigation purposes, which pose grave risks for soil health and environment, there is need to reclaim the sodic hazards by following specific system of management to achieve substantial increase in agricultural production, productivity and per capita income of farmers. Agricultural scientists have developed, perfected and tested technologies for safe use of brackish (sodic) water to sustain high level of agricultural production. There is need to disseminate the technology among the actual users, farmers, extension workers, bankers, administrators and development agencies etc.

The incidence of sodic water occurs mainly in semi-arid parts with annual rainfall of 500 mm to 700 mm. High Residual Sodium Carbonate (RSC) in water is common in central and South - West Punjab including parts of Amritsar (Khara Majha), Bhatinda, Mansa & Phul, Ferozepur (Zira and Dharamkot), Moga (Boghapurana, Nihalsinghwala), Ropar (Kharar), Sangrur (Malerkotla and Sangrur) and Southern Ludhiana covering about 25% of the total area of the state. In Haryana high RSC ground water constitute a considerable portion of the total ground water resources which is predominant in the southern districts of Mahendragarh, Rewari, Bhiwani, Rohtak, Faridabad, Gurgaon as also Jind (Rajaund, Narwana), Karnal, (Nilokheri, Nissing, Assandh), Kaithal, (Gulha Cheeka, Pundri, Dand, Kaithal), and parts of Sirsa covering 21% of the geographical area of the state. The sodic hazards of the water need to be mitigated for exploiting their irrigation potential. The common practice is the field mixing of powdered gypsum in a leveled field and then flooding it with good quality water. The powdering, bagging and proper storage of gypsum, the pre requisite for direct application to field, normally accounts for about 50% of the total cost of sodic water reclamation. For best results, good amount of fresh water is required, which is generally lacking in the arid and semi-arid regions. Further, field application needs to be done well before sowing of crops and it may not be uniform leading to improper mixing with the soil. In this case soil gets affected first and reclamation is done afterwards.

A relatively more economical and efficient method is the use of gypsum clods through a chamber which minimizes the need for leveled field and fresh water. In this method the sodic water is reclaimed before its application in the field without affecting soil and crops. Moreover, the amount of gypsum required to reclaim sodic water will be much less as compared to direct application in the field. Considering the encouraging results, this technology was tested and demonstrated at several locations in Haryana by the CCS Haryana Agricultural University, Hisar in Mahendragarh district and Central Soil Salinity Research Institute, Karnal in Kaithal/ Karnal districts.

2. Project Requirements

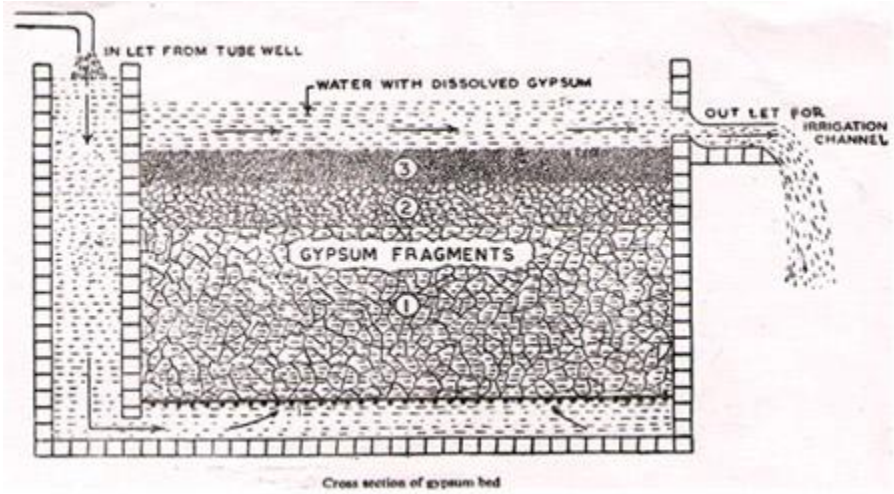
2.1 Gypsum

Gypsum, which is readily available from the mines near Hanumangarh (Rajasthan) in the form of lumps, has a purity of more than 85%. Bigger size clods are broken into smaller size of about 25 mm to 50 mm for better solubility. It contains 201 g Ca+ and 490 g SO4 per kg of gypsum used. It also contains some amount (100 g per kg) of Mg2+, K+, CO3 and Cr.

2.2 Gypsum Chamber/ Bed

2.2.1 Structure

It is a brick-cement-concrete chamber, the size of which depends primarily on tube well discharge and its sodicity, i.e., residual sodium carbonate (RSC). This chamber is connected to a waterfall chamber on one side and irrigation channel on the other. The partition wall between the waterfall chamber and gypsum bed is provided with a 10 cm slit at the bottom to allow the entry of water in the gypsum bed from below the iron bars. A net of iron bars covered with wire net (2 mm x 2 mm) is fitted at a height of 10 cm from the bottom of the bed to hold the gypsum fragments. Water from waterfall box enters into the bed from



Cross section of gypsum bed

below the iron net, comes vertically up and then flows out in the irrigation channel after dissolving gypsum. The bed is filled with gypsum fragments and regularly replenished at about 20 to 25% depletion of bed due to gypsum dissolution. With a little modification, farmers can easily convert waterfall chambers of their tube wells into gypsum chamber. The cross section of composite

gypsum bed is shown in the figure.

2.2.2 Size of gypsum chamber

Dimension of the chamber includes the effective (internal) area in which the gypsum clods are to be placed taking into account the length, breadth and vertical height. For the sake of simplicity and practical adaptability, the height of the chamber has been fixed at one metre with variable lengths and breadths depending upon tube well discharge and water sodicity. By constructing the chamber of the recommended size for a given discharge rate and Residual Sodium carbonate (RSC) of the tube well water to bring down the RSC of the reclaimed water within the permissible limit of around 2 me/l. To have the desired results, chamber has to be replenished with gypsum clods frequently i.e. after 40 - 50 hours of running the water through the chamber to bring the height to a fixed level of 70-75 cm. The dimensions of gypsum chamber for different tube well discharge and sodicity of water assuming a height of 1 m are given in Table 1.

Table 1. Approximate dimensions (length & breadth) of gypsum chambers (m3) for different tube well discharge and sodicity of water

Tube well discharge (l/s)	Residual Sodium Carbonate (RSC, me/1) of the tube well irrigation water						
	4	**6**	**8**	**10**	**12**	**14**	**16**
4	0.8	1.7	2.6	3.7	4.8	6.1	7.5
5	1.1	2.2	3.3	4.6	6.1	7.6	9.4
6	1.3	2.6	4.0	5.5	7.3	9.1	11.2
7	1.5	3.0	4.6	6.4	8.5	10.6	13.1
8	1.7	3.4	5.3	7.4	9.7	12.2	15.0
9	1.9	3.9	5.9	8.3	10.9	13.7	16.8
10	2.1	4.3	6.6	9.2	12.1	15.2	18.7
11	2.3	4.7	7.3	10.1	13.3	16.7	20.6
12	2.5	5.2	7.9	11.0	14.5	18.2	22.4
13	2.7	5.6	8.6	12.0	15.7	19.8	24.3
14	2.9	6.0	9.2	12.9	16.9	21.3	26.2
15	3.2	6.5	9.9	13.8	18.2	22.8	28.1
16	3.4	6.9	10.9	17.7	19.4	24.3	29.9

In the above table, dimension of the chamber for tube well discharge rate from 4 lps to 16 lps have been given. But in reality, it varies from 4 lps to 10 lps/12 lps in various areas of Haryana and Punjab where sodic groundwater exists.

As an example, for reclaiming the sodic tube well water having 10 me/l RSC with a discharge rate of 5 lps, the internal (effective) volume of the chamber will be 4.60 m3. Thus, keeping height constant at 1 m, length and breadth of the chamber can be adjusted as per the convenience of the farmer. The dimensions can be 4.6 m x 1.0 m or 3.07 m x 1.5 m or 2.3 m x 2.0 m and likewise.

In addition to these there are other factors like soil type, cropping pattern, rainfall and other management practices which need consideration before taking up amelioration of sodic water through gypsum chambers. So, detailed analysis of water and soil samples have to be done from Soil Testing Laboratory.

3. Cost Estimate

The cost estimates for various dimensions of gypsum chambers are given in Table 2. These costs are indicative and actual cost may be financed depending upon site-specific conditions subject to economic viability.

Table 2. Cost of Construction of various dimensions of gypsum chambers

Size of gypsum chambers		Cost of construction (Rs.)			
Dimension (m) L x W x H	**Volume m3**	**Bricks**	**Sand, Cement, Gravels, Labour**	**Iron Bar and Mesh**	**Total**
1.5 x 1.0 x 1.0	1.5	2500	3850	3250	9600
2.0 x 1.0 x 1.0	2.0	2700	4200	4200	11100
2.0 x 1.5 x 1.0	3.0	3500	5250	6400	15150
3.0 x 1.5 x 1.0	4.5	4200	6270	9600	20070
4.0 x 1.5 x 1.0	6.0	4800	7200	12750	24750
5.0 x 1.5 x 1.0	7.5	5500	8400	15900	29800
5.0 x 2.0 x 1.0	10. 0	6000	9000	21300	36300
6.0 x 2.0 x 1.0	12. 0	6700	10050	25500	42250
7.0 x 2.0 x 1.0	14. 0	7400	11050	29700	48150
8.0 x 2.0 x 1.0	16. 0	8000	11700	34050	53750

4. Project Outlay

While the project outlay will vary according to the extent of sodicity of ground water and discharge of tube well, keeping in view the field level conditions prevailing in the States of Punjab and Haryana, a situation with higher range of sodicity level of 12 me/l and moderate tube well discharge of 8 to 9 lps is presumed for arriving at the total financial outlay of the model project. In most of the

cases actual cost is likely to be lower than this, and as such project viability will not be adversely affected. Under this assumption the recommended size of the gypsum bed will be 5m x2m x 1m i.e. 10 m3. The project cost will comprise following two items:

Cost of construction of chamber : Rs.36300.00
Cost of 1 truck gypsum including transportation : Rs.15000.00
Total project cost : Rs.51300.00

Bank loan : Bank loan is presumed at 85% of the project cost at Rs.43600.00

Margin : Margin is assumed at Rs.7700.00 @ 15% of the project cost. If subsidy towards this activity is available, margin may be net of subsidy.

Benefits :

The crop yields recorded at one of the demonstration field under both with and without project are given below which can form the basis for working out the economic viability. Diversification into high value crops may be encouraged, if recommended by State/ Central Government Institutions.

Crop Yields without and with use of gypsum chamber (Source : CCS HAU, Hisar).

Crops	***Yield (Kg/ha)***		
	Without Project	**With Project**	**Net increase in yield**
Wheat	1530	4000	2470
Raya	320	1250	930
Pearl Millet	880	2500	1620

Note: *The net increase in yields would be significantly higher over a period of 2 to 3 years*

The economics can be worked out from the incremental yields, prevailing cost of inputs and price of produce for a proposed cropping pattern for a given site.

Economics:-

With the investment as specified above and an additional recurring cost of about Rs.4000/ annum towards the cost of replenishment of gypsum, a farmer is expected to get a net incremental benefit of Rs.27500.00 per ha. Major benefit would be in the form of higher productivity of rabi crops, as the kharif paddy is less affected by the situation. The BC ratio of the project works out to 2.04 and IRR

40.07%. |

Repayment :
The entire loan along with interest @12% on term loan can be repaid in five years.

***Advantage of Gypsum chamber over field application of powdered Gypsum*.**

1. High crop yields, especially when higher sodicity irrigation water is used.
2. Cheaper, economically viable and practically feasible for the farmers.
3. Relatively less gypsum is required to reclaim as dissolution of gypsum is maximum in water.
4. Flooding with good quality water is not necessary.
5. No possibility of non-uniform application of gypsum in the field as the sodic water is reclaimed in the chamber itself before reaching the field.
6. No micro leveling of the field is essential.
7. Saving in cost and energy for powdering and bagging.

Drawback

1. In case where a farmer uses sprinkler set for irrigation, an additional booster needs to be installed for lifting the reclaimed water from the chamber/storage tank.
2. Presently there is no subsidy on lump/clod gypsum, whereas, the powdered gypsum is supplied at a highly subsidised rate to the farmers.

Suggestions

3. Since this is an innovative scheme it will require promotional efforts and workshop for the banks, Govt. agencies and farmers may be conducted to create awareness.
4. State Government may provide subsidy for gypsum clods/lump on par with powdered gypsum, it will encourage the farmers to use gypsum through chambers, which reclaims the sodic groundwater to be used for irrigation and other domestic consumption.

ANNEXURE
Model scheme for Reclaiming sodic ground water for irrigation through Gypsum Chamber

Unit cost :

Considering the average field condition with saline ground water tracts in the States of Punjab and Haryana, the model unit cost is assessed under following conditions. However, actual cost incurred may be based on sodicity level of the ground water.

Sodicity :12 me/l
Tube well discharge assumed : 8-9 lps
Thus the size of gypsum bed will be about 5m x 2m x 1m i.e. 10 m3
Cost of construction of chamber :Rs.36300.00
Cost of gypsum including transportation :Rs.15000.00
Total capital investment : Rs.51300.00

Particulars	**Year 1**	**Year 2**	**Year 3 - 10**
With Project Situation Cost			
Investment cost	51300.00	0.00	0.00
Recurring cost (Cost of cultivation + gypsum)	26500.00	30500.00	30500.00
Total cost	77800.00	30500.00	30500.00
Without Project cost	22500.00	22500.00	22500.00
Incremental cost	55300.00	8000.00	8000.00
Incremental cost at 15% DF	47676.00	2646.00	11875.50
With Project benefit	64650.00	78500.00	78500.00
Without Project benefit	43000.00	43000.00	43000.00
Incremental benefit	21650.00	35500.00	35500.00
Incremental benefit at 15% DF	18835.50	26649.00	119603.25
Net incremental benefit	-33650.00	27500.00	27500.00
NPV	Rs. 84822/-		
BCR	2.04		
IRR	40.07%		

Model Project for reclaiming Sodic ground water through Gypsum Chambers : Repayment schedule

Project Cost : Rs.51,300/-
Margin (15%) : Rs.7700/-

Bank loan : Rs.43,600/-
Rate of interest : 12%

Year	Loan O/s	Int. accrued	Gross surplus	Repayment			Net surplus
				Interest	Principal	Total	
1	43600	5232	17650	5232	1600	6832	10818
2	42000	5040	27500	5040	9000	14040	13460
3	33000	3960	27500	3960	10000	13960	13540
4	23000	2760	27500	2760	11000	13760	13740
5	12000	1440	27500	1440	12000	13440	14060

Farm Model for reclamation of saline water through Gypsum chambers

Season	Crops	Area	Cost of cultivation	Yield per ha (q)		Production (q)		Saleprice (Rs./q)	Gross income		Net income	
				1st yr.	2nd yr.	1st yr.	2nd yr.		1st yr.	2nd yr.	1st yr.	2nd yr.
Predevelopment												
Kharif	Paddy	1	15000.00	40	40	40.0	40.0	850.00	34000.00	34000.00	19000.00	19000.00
Rabi	Wheat	0.6	7500.00	15	15	9.0	9.0	1000.00	9000.00	9000.00	1500.00	1500.00
Total						49.0	49.0		43000.00	43000.00	20500.00	20500.00
Post Developmental												
Kharif	Paddy	1.0	15000.00	45	50	45.0	50.0	850.00	38250.00	42500.00	23250.00	27500.00
Rabi	Wheat	0.6	7500.00	30	40	18.0	24.0	1000.00	18000.00	24000.00	10500.00	16500.00
	Mustard	0.40	4000.00	7	10	2.8	4.0	3000.00	8400.00	12000.00	4400.00	8000.00
Total		2.00									38150.00	52000.00
Less recurring cost on gypsum from 2nd year onwards			4000.00									48000.00
Incremental Income											17650.00	27500.00