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RAPID RECLAMATION OF UNBROKEN SALINE - SODIC LANDS WITH GROUND WATER

BY

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ABSTRACT

The study: Rapid Reclamation of unbroken Saline/Saline sodic Lands, with or without gypsum use, was carried out at the field level at different sites. 50 Cm of the available ground water was applied in 5 successive irrigations which were followed by a 10 cm canal irrigation. The active rootzone of crops was reclaimed to give reasonable yield of the wheat crop.

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Canal irrigated areas of Pakistan are a part of the arid to semi arid regions of the world. It is due to the scanty rainfall and high rate of surface evaporation. The seepage and perculation losses of water from the canal system developed to manage crop production, have caused to raise the water-table, which has further aggravated the situation in respect to these problems.

At present in the Punjab alone 2.68 million acres of land (11.57% of the C.C.A) are in the grip of salinity. This is on the basis of the visual soil salinity survey (1985-86). The magnitude of the problem has been assessed in Pakistan by the Planning Division of WAPDA (1979) in the irrigated areas of 34.5 million acres. According to them 25% of the irrigated land is affected by salinity to varying degrees. The profile salinity has, on the other hand, been assessed at 38% of the cultivated canal irrigated area. Almost all the saline lands show sodic behaviour. To ensure the prosperity of the people in the Country, the Reclamation of these diseased lands is a pre-requisite.

In the Punjab so far an area of 5,38,398 acres is unbroken due to non availability of irrigation water.

Reclamation of a saline sodic land requires the removal of the salts and elimination of the sodic character, for which ample water is required to get rid of the salts. For sodicity equivalent Calcium ion is needed to replace the soil sodium as well.

Saline sodic soils are mostly calcareous in nature, but the solubility of Calcium Carbonate is hardly 100 ppm. It is very low. With its use it takes years to get rid of sodicity to make the soil productive. Recently new technology to utilize chemical amendments has been made use of and the process of reclamation of saline sodic and sodic lands has been completed within a short period of time.

The prevalent Reclamation Process includes the supply of additional canal water at the rate of one cusec for 45 acres on perrenial canals and 60 acres on non perrenial canals. In the Punjab during the last five years about 850 cusecs of water has been utilized annually for this

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purpose, whereas about 60,000 cusecs are needed for a period of 3-5 years to tackle the problem in a realistic way. The availability of this much water through our present canal system is not possible.

The research work was carried out to handle the situation with the use of ground water and it yielded useful results. The results achieved are applied at the farmers' field level at 4 sites in the Punjab on unbroken saline/saline-sodic soils. The ground waters, available there, were put to use for their rapid reclamation. The results achieved therefrom are presented in this paper.

REVIEW OF LITERATURE

Kelly(1951) applied gypsum to an alkali soil at the rate of 10 to 12 and 15 tons per acre. The plots were flooded continuously for three weeks. He found that the exchangeable sodium was effectively removed to a depth of four feet and practically a barren land was converted into a high productive land.

Haider (1959) reported that leaching with water alone was in-effective while gypsum in combination with leaching effectively reclaimed a "BARA" soil.

R.C.Renord and C.A. Bower (1960) used sea water for reclaiming a sodic soil. The sea water contained 11.6 meq/1 of Ca+Mg. They pointed out that with the use of only 4 feet of sea water combined with 6 feet of colrade, River water, reduced the initial exchangeable sodium percentage of the soil from 39 to 5 and reduced the time of Reclamation from 120 days to 12 days.

Bower(1962) recommended that for soils having Gypsum requirement upto 5 meq/1 100 gms of soil, growing of rice and green manure crops could be depended upon for reclamation of a saline sodic soil in a reasonable period of time.

Zaidi and Qayyum (1968) reported that the rate of reclamation increased considerably with the use of Gypsum and farm-yard manure and the income obtained with the use of amendments for reclamation is more than that with leaching without amendments.

Hussain Muhammad (1968) reported that it takes 6 to 8 years for reclaiming a saline sodic soil by rice culture and that application of gypsum accelerates the replacement of exchangeable sodium.

B.K. Khosla and I.P. Abral (1972) studied the effect of gypsum of varying finess on the composition of saturation extract of a saline sodic soil. They reported that much of the gypsum is utilized in precipitating the soluble carbonates to form relatively insoluble calcium carbonate. Gypsum of a slightly finer than 0.59 mesh would be more effective than that of the coarse grades. The amount of gypsum needed to neutralize the soluble carbonates is knwon to be indicative to the minimum amount of amendements required to start the reclamation of a saline sodic soil high in carbonates.

G.R.Dutt: Terkeltoul and Roa Shkool R.S. (1972) pointed out that the amounts of water and gypsum required for reclamation the soil were highly dependent upon the quality of

water used for leaching.

Muhammad and Khaliq (1975) reported that gypsum sulpher combination with manure were quite efficient in reclaiming a saline sodic soil.

Hussain and Asghar (1985) found out that with the application of Gypsum even though it is applied to the extent of 1/2 or 1/4th of the total requirement of the soil, the reclamation of a saline sodic soil is accelerated and can be achieved within a limited period of time. The increase in infiltration rate of the soil is almost equal with 1/2 and 1/4th of the gypsum requirement applications. They further concluded that rice is a highly sodic resistant crop.

Altaf (1985-86) reported that the reclamation of saline/sodic calcareous lands can be achieved within a short period of time, when the chemical amendements are used for this purpose. Sulphuric acid and Gypsum are equally effective to increase the infiltration rate of the soil. Hydrochloric acid is also useful but the ilfiltration rate produced in the soil is almost half of that with Sulphuric acid and gypsum.

Altaf (1986) pointed out that 1/2 and 1/4th gypsum is almost equally useful to facilitate the leaching process of a saline sodic soil.

Altaf (1987) achieved successful reclamation of a saline sodic soil at the field level, with the use of brackish water.

MATERIAL AND METHODS

Study was carried out at Chak No.387 G.B., L.C.C. East Circle, Chak No.276 G.B. , L.C.C. West Circle District Faisalabad, Chak No.112/15L Reclamation Research Station Mianchannu District Khanewal and Chak No.187/9L District Sahiwal.

The selected unbroken pieces of land of one acre each were of highly saline and sodic type. In each case soil sampling was done from the whole field to find out its texture and salinity/solidicity status upto 60 cm depth. Each plot was divided into four Sub-Plots before starting the experiment; Calcium Sulphate (CaSO4.2H2) was added at the rate of full requirement of the upper 15 cm of the soil. When the ground water contained Residual Sodium Carbonate, consideration was given to that as well. Calcium Sulphate was applied in addition to the one already added to off set its hazarduous affect on the soil.

The ground waters used for Reclamation were also analysed (Table-5).

To accomplish the Reclamation work 5 irrigations of ground water were given successively. Each irrigation was of 10 cm depth. After that one irrigation of canal water (Table-5) of the same depth was applied to ensure the removal of salts from the rootzone of the crop to the extent that the land was practically reclaimed.

The Reclamation process was carried out in the month of November 1987 at all sites except in Chak No.187/9L, where it was taken in hand in the month of March, 198.

The first crop grown at all the sites was wheat except in Chak No. 187/9L at Sahiwal, where it was Janter (Susbania Aculeta).

Nitrogen and Phosphorus were applied at the rate of 100 Lbs and 44 Lbs. per acre as Urea and Superphosphat respectively, 50 Lbs. K20 was also added as Patassium Sulphate. All these fertilizers were put in before sowing the crop.

The crops were raised with canal water irrigation applications.

RESULTS AND DISCUSSION

Results of the soil analysis! L.C.C. East) before starting the study (Table-1) show that the soil is silty clay loam to clay loam in texture. The results achieved therefrom may be applied any where safely.

The chemical results of this soil Table-1) show that the soil was in the worst condition from salinity/sodicity point of view.

The quality of water(Table - 5) indicates that the water is un-fit for irrigation due to its very high Electrical Conductivity and Residual Sodium Carbonate contents.

After application of 50 cm. tubeweel water in five successive irrigations followed by one canal water irrigation of 10 cm; 50% of the soil was rendered fit for crop production (Table-1). Wheat: the first crop gave average performance(Table-6).

In this case the land could not be properly levelled, consequently even distribution of water in all the sub plots could not be managerd due to which parts, distall from the channel, remained un-reclaimed.

In L.C.C.(West) the soil was clay loam in texture (Table-2). The analysis results (Table-2) indicate that the soil was highly saline but non-sodic in character. It did not require Calcium Sulphate application. The tubewell water used for irrigation was also highly saline(Table-5); 50 cm of this water and 10 cm canal water were applied for its reclamation. After completing the reclamation process it was observed that the salinity in the top 15 cm. soil had been cleared to render this soil fit for crop growth (Table-2). The wheat crop gave good yield (Table-6).

At Chak 112/15L Reclamation Research Station Mianchannu the soil was highly saline sodic (Table-3) The water used for reclamation was unfit for crop use (Table-5). The reclamation process was accomplished in the similar way as mentioned above. The wheat crop was raised which gave average yield (Table-6).

In Sahiwal also the selected soil was highly saline sodic (Table-4). The ground water used for Reclamation was fit for irrigation (Table-5). At first 50 cm. of this water was applied in the month of February, 1988 followed by 10 cm. of canal water. The process was completed within 25 days and the first crop grown was Janter(Sesbania Aculeata). It was green manured and was followed by rice. The rice crop is of the normal type.

SUMMARY AND CONCLUSIONS

Ground water was used to achieve the initial rapid reclamation of saline/saline-sodic lands with or without the use of Calcium Sulphate. The land was reclaimed even when the availability of canal water supply could not be thought of. Tangible results of the crop yield were obtained (Table-5).

From this study it is concluded that:-

1) The water quality is not a limiting factor for the initial reclamation of the diseased saline/saline-sodic lands.

2) Gypsum application is not always a necessity to reclaim the salt affected lands.

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TABLE - 1

ANALYSIS RESULTS OF THE SOIL

L.C.C.(EAST)

A - Mechanical

Depth (Cms)	Sand %age	Silt %age	Clay %age	Texture
00 - 15	54.8	23.2	22.0	Clay loam to sandy clay loam
15 - 30	56.8	22.2	21.0	Sand Clay Loam
30 - 45	50.8	27.2	22.0	Clay Loam
45 - 60	52.8	26.2	24.0	Clay Loam

B - Chemical Before

	SP	pHs	ECe ds Cm^{-1}	Ca+Mg	Na	CO_3	HCO_3	Cl	SO_4	S.A.R.
00 - 15	32	9.7	22.5	1.5	293.5	27.0	11.0	97.0	160.0	339.0
15 - 30	32	8.9	6.5	2.0	74.0	3.0	8.5	27.5	37.0	74.0
30 - 45	33	8.7	3.7	2.0	39.0	3.0	3.0	12.5	22.5	39.0
45 - 60	38	8.4	3.7	2.5	38.5	1.0	2.5	12.5	35.0	34.0

Chemical After

00 - 15	32	8.1	7.0	3.0	78.0	-	3.0	36.0	45.0	45.2
15 - 30	32	8.7	7.0	2.0	81.0	1.0	5.5	30.5	47.0	66.4
30 - 45	35	9.0	6.0	1.0	66.0	2.0	4.5	22.0	40.5	54.1
45 - 60	35	8.4	6.2	2.5	65.5	-	4.5	23.0	42.5	43.9

Note :- Cations and Anions are given as milliequivalents per litre.

ECe Electrical conductivity of soil saturation extract.

SAR Sodium Adsorption Ratio.

TABLE - 2

ANALYSIS RESULTS OF THE SOIL

L.C.C.(West)

A - Mechanical

Depth (Cms)	Sand %age	Silt %age	Clay %age	Texture
00 - 15	46.8	30.2	23.0	Clay Loam
15 - 30	50.8	26.2	23.0	Clay Loam
30 - 45	42.8	32.2	20.3	Clay Loam to Loamy Clay.
45 - 60	40.8	35.2	24.0	Clay Loam

B - Chemical (Before)

	S.P	pHs	ECe ds Cm^{-1}	Ca	Mg	Na	CO^3	HCO^3	Cl	SO^4	S.A.R.
00 - 15	34	7.8	34.0	56.0	19.0	385.0	-	2.5	342.5	115.0	62.9
15 - 30	37	8.0	10.5	33.0	12.0	85.0	-	2.0	70.0	51.0	17.9
30 - 45	34	7.8	8.0	24.5	14.0	56.5	-	2.0	52.0	41.0	13.0
45 - 60	34	8.0	6.5	22.5	15.5	32.0	-	2.0	32.0	36.0	7.4

Chemical (After)

00 - 15	37	8.0	6.5	22.0	15.0	39.5	-	2.0	20.0	54.5	9.2
15 - 30	37	8.0	6.5	22.0	11.0	43.6	-	1.5	16.5	58.5	10.6
30 - 45	36	7.9	7.0	22.0	15.0	47.5	-	1.5	18.5	64.0	10.9
45 - 60	36	7.9	7.5	20.5	14.5	54.5	-	1.5	21.5	66.5	13.0

Note :- Cations and Anions are given as milliequivalents per litre.

ECe: Electrical conductivity of soil saturation extract.

SAR: Sodium Adsorption Ratio.

TABLE - 3

ANALYSIS RESULTS OF SOIL:

Site

112/15-L Mianchannu

A-Mechanical

Depth (Cm)	Sand %	Silt %	Clay %	Textural Class
0 - 15	48.6	29.0	22.4	Clay Loam
15 - 30	47.6	30.0	22.4	Clay Loam
30 - 45	44.6	32.6	23.4	Clay Loam
45 - 60	48.6	29.0	22.4	Clay Loam

B - Chemical (Before)

	SP	pHs	ECe ds Cm^{-1}	Ca	Mg	Na	CO_3	HCO_3	Cl	SO_4	S.A.R.
0 - 15	35.0	8.8	14.0	2.0	1.0	174.0	1.0	1.5	95.0	79.5	142.7
15 - 30	35.0	9.5	26.0	2.0	0.5	342.5	8.0	2.5	167.0	167.5	304.8
30 - 45	36.0	9.1	30.0	2.5	0.5	407.0	4.0	7.0	156.0	156.0	333.7
45 - 60	36.0	9.5	20.0	2.0	1.0	257.0	6.0	7.5	107.5	107.5	210.7

Chemical (After)

0 - 15	39.0	8.1	3.8	0.5	2.5	35.0	-	1.0	11.0	26.0	28.3
15 - 30	38.0	8.5	3.1	1.0	2.0	28.7	1.0	5.5	10.0	15.2	23.2
30 - 45	39.0	9.0	4.0	1.5	0.5	38.5	2.0	6.0	18.5	16.0	38.5
45 - 60	39.0	9.2	5.0	1.0	1.0	48.8	3.0	5.0	27.0	18.8	48.8

Note:- Cations and Anions are given as milliequivalent per litre.

ECe: Electrical conductivity of Soil saturation extract.

SAR: Sodium Adsórption Ratio.

TABLE - 4

ANALYSIS RESULTS OF SOIL:

Site

187/9-L Sahiwal

A-Mechanical

Depth (Cms)	Sand %	Silt %	Clay %	Texture
0 - 15	52.0	26.20	21.80	Clay Loam
15 - 30	43.0	32.20	24.80	Clay Loam/Loamy Clay
30 - 45	36.0	37.30	26.80	Loamy Clay
45 - 60	29.0	46.20	24.80	Silt Clay/Silt Clay Loam

B - Chemical (Before)

	SP	pHs	ECe ds Cm^{-1}	Ca	Mg	Na	CO_3	HCO_3	Cl	SO_4	S.A.R.
0 - 15	35	9.2	30.0	2.0	1.0	407.0	6.0	5.0	176.0	220.0	325.6
15 - 30	36	10.0	22.0	2.0	1.0	287.0	14.0	5.0	222.5	145.5	229.6
30 - 45	36	10.2	15.0	1.0	1.0	189.0	20.0	5.0	92.5	71.5	189.0
45 - 60	37	10.4	12.0	1.5	1.0	147.5	23.0	8.5	73.0	42.5	131.3

Chemical (After)

0 - 15	41	7.9	8.0	6.0	13.0	76.0	-	3.0	13.0	79.0	24.3
15 - 30	39	8.4	8.7	3.5	0.5	105.0	1.0	2.0	13.0	93.0	74.6
30 - 45	40	9.0	8.3	2.0	1.0	92.0	2.0	5.5	60.0	27.5	75.4
45 - 60	42	9.3	8.5	2.0	0.5	100.0	4.0	7.5	54.5	36.5	89.0

Note:- Cations and Anions are given as milliequivalent per litre.

ECe: Electrical Conductivity of Soil saturation extract.

SAR: Sodium Adsorption Ratio.

TABLE - 5

ANALYSIS OF WATER USED FOR RECLAMATION

	Ca	Mg	Na	CO_3	HCO_3	Cl	SO_4	EC ds Cm^{-1}	pH	R.S.C.	S.A.R.
A. Canal Water											
	1.5	0.6	0.1	-	1.8	0.2	0.2	0.22	7.5	-	0.1
B.Ground Water Site											
L.C.C.(East) Faisalabad.	1.0	2.1	28.8	-	9.8	6.6	15.6	2.9	7.5	6.7	22.7
L.C.C.(West) Faisalabad.	3.6	4.4	42.0	-	10.4	25.5	14.1	4.4	7.4	2.4	21.0
112/15-L Mianchannu.	4.3	2.2	17.5	-	4.1	6.4	13.5	2.4	8.1	-	9.6
L.B.D.C. Sahiwal.	2.4	1.0	3.1	-	3.0	1.4	2.1	0.65	7.3	-	2.38

Note: Cations and Anions are given as milliequivalent per litre.

EC. Electrical conductivity of water.

R.S.C. (Residual Sodium carbonate)

S.A.R. Sodium Adsorption Ratio.

TABLE - 6

YIELD OF WHEAT CROPA:-

Site	Yield (Kgs)
1-L.C.C.(East)Faisalabad.	680
2-L.C.C.(West)Faisalabad.	1520
3-112/15-L Mianchannu.	680
4-L.B.D.C. Sahiwal.	Jantar.

TABLE - 7

GYPSUM REQUIREMENT OF THE SOIL:-

Site	Gypsum Requirement tons per acre 30 Cm
1-L.C.C.(East) Faisalabad.	8.94
2-L.C.C.(West) Faisalabad.	-
3-112/15-L Mianchannu.	6.8
4-L.B.D.C. Sahiwal.	9.94

TABLE - 8

ECONOMICS OF SOIL RECLAMATION

Site	L.C.C.(East) Faisalabad	L.C.C.(West) Faisalabad	112/15-L Farm Mianchannu	L.B.D.C. Sahiwal
A - COST				
:- Gypsum quantity	4.47 Tons	--	3.45 Tons	4.97 Tons
:- Value @360/ton	Rs. 1609.20	--	Rs. 1242.00	Rs. 1789.20
:- Water application	5	5	5	5
:- Value @ Rs. 60/-per irrigation.	Rs. 300.00	Rs. 300.00	Rs. 300.00	Rs. 300.00
Total Cost:	Rs. 1909.20	Rs. 300.00	Rs. 1542.00	Rs. 2089.20
B - INCOME				
:- Yield of the crop in Kgs.	680	1520	680	Janter.
:- Value @ 80/- per 40 Kgs.	Rs. 1360.00	Rs. 3040.00	Rs. 1360.00	--
Total Income:	Rs. 1360.00	Rs. 3040.00	Rs. 1360.00	--