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NON RECLAIMABLE LANDS MADE TO BLOSSOM

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Lands in the arid and semi arid regions of the world are : Saline, Saline Sodic or Sodic in nature. The canal irrigated areas of Pakistan are mostly a part of them. Water losses from the canal systems which provide irrigation facilities for sustained agriculture, have raised the ground water level. It has been influenced by surface evaporation which has futher agravated the problems of salinity and sodicity in the top soil crust.

The magnitude of the problem has been assessed in Pakistan by the Planning Division of WAPDA (1979) in the irrigated area of 34.5 million acres. According to them 25% of the land is affected by salinity to varying degrees. The profile salinity on the other hand, has been assessed at 38% of the cultivated canal irrigated area. In the Punjab, on the visual basis of soil salinity survey, 12.6% of the C.C.A. is affected by salinity. A.most all saline lands show a sodic behaviour as well.

Methods now exist to tackle the problems of salinity and sodicity. In the recent past the techniques have been developed to reclaim these lands even with the use of poor quality water with or without the use of amendments (1988) and lands may be put under reclamation process at any time during the year.

Inspite of all these achievements there remains a class of degraded saline lands which is termed non-reclaimble. These poor lands have been posing a challenge to the scientists who have been struggling hard to develop new research processes for making them useable for crop production. However, no material success could be achieved.

The Pakistan Agricultural Research Council, with their eminent scientists have been busy since long to do research on thse lands. Finally they took up the matter with

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the Secretary, to Government of the Punjab, Irrigation and Power Department, Lahore who advised the author working as the Director Land Reclamation Punjab, to make his share of research contribution.

A joint project "Biotic and Chemical Reclamation of Saline Sodic Soils" was initiated by Pakistan Agricultural Research Council and Director Land Reclamation Punjab, in 1986. Since then substantial success has been achieved. The degraded non-reclaimable lndus have been made to blossam through our research efforts. Some of the results achieved therefrom are given here 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 exchaneable sodium was effectively removed to a depth of four feet and practically a highly sodic land was converted into a high productive land.

Haider (1959) reported that leaching with water alone was ineffective 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/l of Ca+Mg. They pointed out that with the use of only 4 feet of sea water in conjunction with 6 feet of Colrado river water, reduced the initial exchaneable sodium percentage of the soil from 39 to 5 and reduced the time of Reclamation from 120 days to 12 days.

Zaidi and Qayyum (1968) reported that the rate of reclamation increased considerably with the use of gypsum and farm yad 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 accelerate 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 insoluable 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

carbonats is known to be indicative of the minimum amount of amendments 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 reclamatin of the soil were highly dependent upon the quality of water used for leaching.

Altaf and Asghar (1985) found 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 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 amendments are used for this purpose. Sulphuric acid and gypsum are equally effective to increse the infiltration rate of the soil. Hydrochloric acid is also used but the infiltration rate produced in the soil is almost half of that with sulphuric acid and gypsum.

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

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

Altaf and Asghar (1988) achieved reclamation of saline and sodic lands within a month or so with the use of available ground water.

MATERIAL AND METHODS

The experiment was conducted at Sadhoki in the Sheikhupura district The land is situated at a distance of 36 Kilometers from Lahore and 34 Kilometres from Gujranwala along the G.T. Road. The area of the farm is 117 acres which has been divided in six blocks: A, B, C, D, E and F. The land is degraded saline and sodic in nature. It is impermeable. In case it is flooded, it wets only upto 6 to 7 cm. depth. On drying it produces wide cracks.

The survey of the area was conducted and the soil smples were tested in the laboratory. The results of the analysis are given in table: 1A, 1B, 1C, 1D and in Table 2.

Very low permeability of the soil, even after making it a calcium soil, confirms that its vertical drainage or leaching is not possible. Hence the concept of surface drainge/washing was initiated and applied to reclaim the land.

The following steps were kept in view : -

1. Control.
2. Surface drainge of the land and growing of sordon grass.
3. Surface drainage of the land and growing of Janter.
4. Surface drainage of the land and growing of Kallar Grass.
5. Surface drainage of the land with gypsum application to meet the requirements of : 3.75, 7.5 and 15 cm depths of the soil.

The study was carried out under the randamized complete block system. There were four replications of each treatment. Thus there were 28 plots in all. Due to shortage of time, out of these 28 plots, only 14 were managed to carry out the Reclamation Process.

For surface drainge of the soil, 10 cm deep water was applied each time and the soil was puddled, planked. Water was allowed to stand over night, and the next day it was removed. In this way 40cm water was applied with four irrigations within 10 days and was removed by surface drainage.

The sodicity in the gympsum treatment was neutralized to the depth of 3.75, 7.50 and 15 cm of the soil. By each treatment, the salts in th soil were dissolved by the water applied and were removed when it was drained.

Finally, the electrical conductivity of the soil saturation extract of the top soil in all treatments was reduced to less than 4 dS/m and its pH was mostly lowered to 8.3 or less by gypsum treatment only.

In control and the gypsum treatments, rice was transplanted in the 3rd week of July, 1986. In the others Kallr Grass, Sordon Grass and janter were sown at th same time.

The tubewell water was used for reclaiming the land and to irrigate the crops. The analysis results of the water are given in Table 3.

The usual cultural and fertilizer application practices recommended by the Agriculture Department were adopted to raise the crops.

During the next year 12.5 acres of this land were selected further to apply the results achieved from this experiment. For this, plots of 1.25 acre size each were made. Water courses were kept on the outer sides of the fields and a 30 cm wide and 15 cm deep drainage channel was dug in between the two rows of the fields to remove the drainage water. It was joined to the main drain running along the G. T. Road.

These plots were treated with gypsum at the rate of 3 tons per acre to meet the requirements of the upper 15 cm depth of the soil. 40 cm irrigation water was applied with 4 irriations of equal depths to reclaim the land and was removed through the drainage channel. The rice crop was raised after completing this process which was followed by wheat and barley in 5 acres and 7.5 acres, respectively.

RESULTS AND DISCUSSIONS

The results of the soil analysis indicate that it is clay loam in texture and contains 5.2 % Calcium Carbonate (Table 1A). The electrical conductivity of the saturation extract is 9 dS/m and its sodium adsorption ratio is 55. The pH of the saturation extract is 8.9 (Table 1B). The pH on the basis of 1 : 5 soil water suspension is 9.3. The percentage of salts with 1 : 15 soil water suspension is 0.7 (Table 1C).

Calcium Sulphate requirement of the soil is 11 tons per acre per 30 cm depth of the soil. Its cation exchange capacity is 16.0 and the exchangeable sodium percentage is 40 (Table 1D).

The behaviour of the soil to water indicates (Table 2) that canal water did not penetrate into the soil mass.

Similar was the case when it was converted to a Calcium soil. In case it was treated with saline water having electrical conductivity 6.5 ds/m, it wetted the soil in the pot to its entire depth, but later on the flow of water was completely held up. It shows that the soil is not only dispersed, but also contains swelling type of clay due to which it becomes impermeable on wetting and developes wide cracks on drying.

The high salinity and pH of the soil show that it needs to be reclaimed prior to cropping (Table 4).

The analysis results of the tubewell water used for irrigation (Table 3) show that the water is fit for raising common crops.

It was expected that in all the treatments, where the salts were removed but

sodicity persisted the sodic resistant crops would grow successfully. In other treatments, where before removing the salts, calcium sulphate was added to neutralize the sodicity of the soil, the pH of the top soil saturation extract was also reduced to less than 8.5. This land could be used for growing common crops.

The results of the crops grown (Table 5) show that Sordon Grass germinated but being less tolerant to sodicity, it did not grow well, whereas Australian grass and Janter grew normally. Rice (Irri-6) almost failed in control plots. In gypsum treated plots, where sodicity had been neutralized to the depth of 15 cm of the soil, the growth of the crop was better than in those where it was neutralized to the depth of 7.5 cm.

In other plots where the sodicity was neutralized only upto the depth of 3.75 cm of the soil, the crop stand was poorer than the other two calcium sulphate treatments (Table-5).

The average yield of paddy in 1.25 are size plots of Irri 6 was 1460 Kg per acre and that of "Basmati 385" was 1020 Kg per acre: the average yield of wheat and barley were 1896 and 506 Kg per acre respectively.

CONCLUSIONS

The concept that some lands are totally non-reclaimable is not true as has been demonstrated by the latest research. These lands can also be made to blossom as has been done at Sadhoki. Such lands offer excellent challenges to the intellegence, skill and integrity of the scientists for their improvement and to the hard working farmers of Pakistan to make them highly productive. The reserch work could be crried further to reduce time and costs for improvement.

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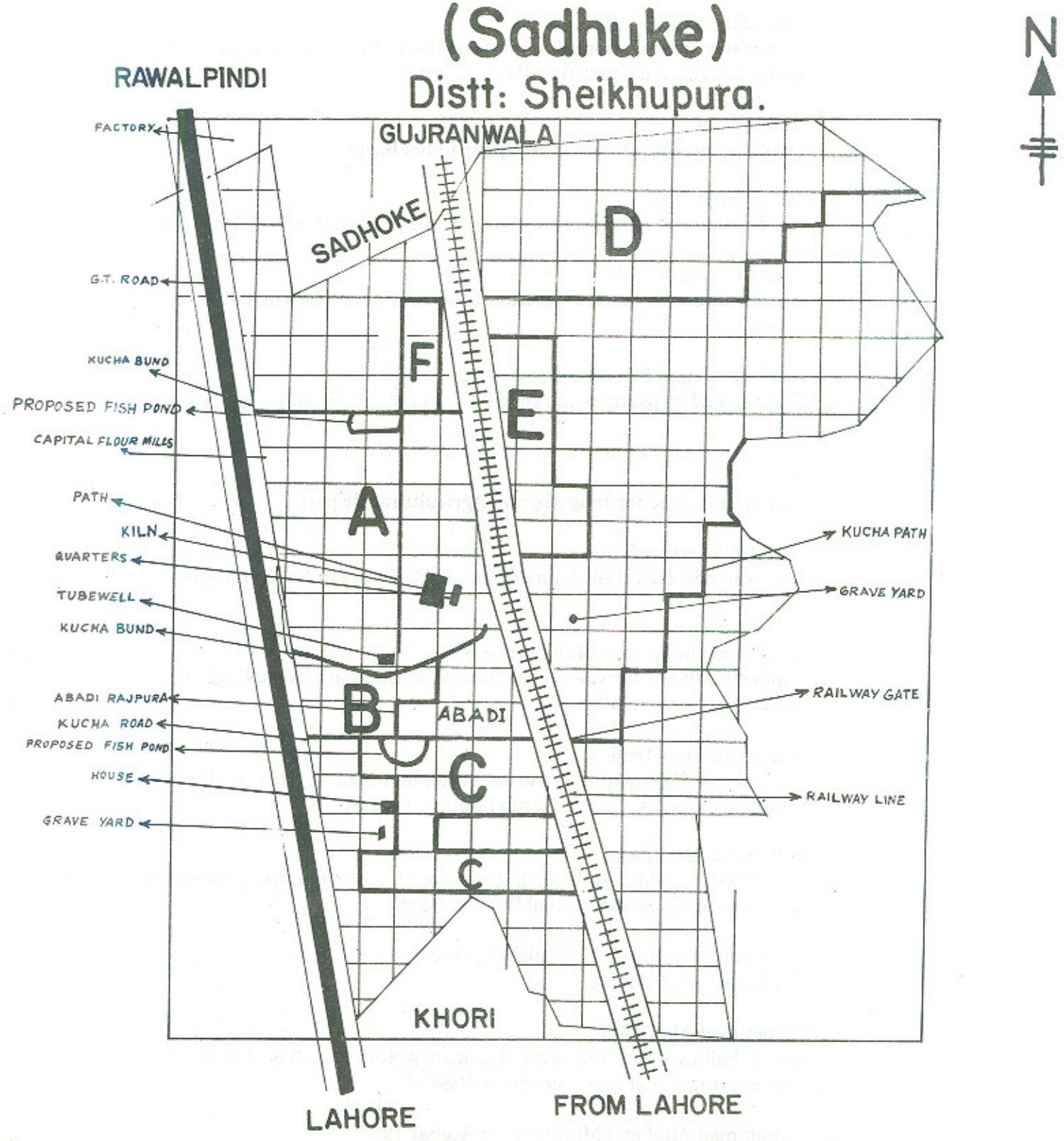

Table - 1A

Analysis Results of the Soil

Mechanical Composition:

PERCENTAGE OF:				
Sand	Silt	Clay	Texture	Calcium Carbonate
15.60	52.0	32.4	Clay loam	5.2

Table - 1B

Soil Saturation Extract Analysis

			Milliequivalents per litree						
Sp	pH	$ECx10^3$	(Ca+Mg)	Na	CO_3	HCO_3	Cl	SO_4	SAR
51	8.5	9.0	4.5	82.5	--	4.5	14.0	68.5	55.0

Table - 1C

Chemical Analysis of the soil

pH 1:5 Soil Water Suspension	9.3
Percentage of Salts.	0.70
(1:15) Soil Water Suspension	

Table - 1D

Gypsum Requirement of the Soil/Tons per acre fool.	CEC/100 Grams	Exchangeable Sodium per	Exchangeable Sodium percentage
11.0	16	6.5	40.0

Table - 2

Water Penteration in the soil

POTS

1	2	3
--	--	The water soaked thesoil to raise as moisture content to the filed capacity level, but later on the water penetration through the soil was stuck up completely.

Table - 3

Analysis Results of Tubewell water at Sabhoki

S.No.	EC	T.C.	Ca+Mg	Na	CO_3	HCO_3	Cl	SO_4	SAR
1.	800	8.0	4.4	3.6	--	4.6	1.4	2.0	3.5

Table - 4

Analysis Results of the Original soil

Sr. No.	Treatment.	Rep.	Plot No.	Depth (Cm)	Stura-tion per	pH Paste	ECx10^3 of Extract at 25 C	SOLUBLE CATIONS/ANIONS MILLIEQUIVALENTS PER LITRE							SAR
								(Ca+Mg)	Na	CO_3	HCO_3	Cl	SO_4	Total	
T^1	Control	1	4		43	8.2	6.0	8.5	51.5	–	4.0	8.0	48.0	60	24.98
		2	11		44	8.7	4.2	2.5	39.5	2.0	3.5	8.5	28.0	42	35.33
		3	21		43	9.4	2.8	2.0	26.0	4.0	5.0	6.5	12.5	28	26.00
		4	28		44	9.9	5.0	2.0	48.0	5.0	7.5	8.5	29.0	50	48.00
T_2	Sordon	1	7		44	8.3	3.8	5.5	32.5	T	5.5	8.0	24.5	36	19.60
	Grass.	2	13		43	8.2	6.2	8.0	54.0	–	7.5	11.5	43.0	62	27.00
		3	19		43	9.5	9.0	2.0	88.0	7.0	11.5	20.5	51.0	90	88.00
		4	24		43	9.9	9.5	1.5	93.5	11.0	17.5	11.5	60.0	95	107.99
T_3	Australian	1	2		43	8.5	4.2	2.5	39.5	3.0	3.5	10.5	25.0	42	35.33
	grass	2	14		43	8.4	9.0	8.5	81.5	–	5.5	18.0	66.5	90	39.50
		3	16		44	8.8	5.0	2.5	42.5	3.0	6.5	12.5	28.0	50	38.01
		4	27		44	8.9	9.0	2.5	87.5	7.0	8.5	22.5	52.0	90	78.26
T_4	Jantar	1	5		42	8.4	2.8	3.0	25.0	–	4.5	6.5	17.0	28	20.40
	Berseem	2	12		42	8.1	6.5	18.5	46.5	–	6.5	9.5	49.0	65	15.29
		3	18		44	9.0	7.0	2.5	67.5	3.0	5.0	12.5	49.5	70	62.30
		4	25		43	9.1	6.5	2.5	62.5	8.0	9.5	15.5	32.0	65	55.90

Table - 4

Analysis Results of the Original soil

Sr. No.	Treatment.	Rep.	Plot No.	Depth (Cm)	Stura-tion per	pH Paste	ECx10^3 of Extract at 25 C	SOLUBLE CATIONS/ANIONS MILLIEQUIVALENTS PER LITRE							SAR
								(Ca+Mg)	Na	CO_3	HCO_3	C1	SO_4	Total	
T_5	Gypsum	1	3		43	7.3	5.5	15.5	39.5	--	4.0	5.5	45.5	55	14.12
	requirement.	2	9		43	8.3	6.4	11.5	52.5	--	4.0	7.5	52.5	64	21.89
		3	20		43	8.1	8.5	15.5	69.5	--	4.0	10.0	71.0	85	24.96
		4	23		44	8.4	4.5	6.0	39.0	--	3.5	5.5	36.0	45	22.50
T_6	Gypsum th	1	6		44	8.1	3.5	4.5	30.5	--	3.5	6.0	25.5	35	20.3
	Requirement	2	8		44	8.6	4.2	6.5	35.5	T	5.0	11.5	25.5	42	19.69
		3	17		44	8.5	7.5	7.0	68.0	--	3.0	7.5	64.5	75	36.35
		4	26		43	8.7	7.0	4.0	66.0	3.0	5.5	12.5	49.0	70	46.67
T_7	Gypsum $^1/_8$th	1	1		43	8.5	3.6	2.5	33.5	2.0	3.0	7.5	23.5	36	29.96
	requirements	2	10		43	8.1	4.2	6.5	33.5	T	5.0	11.5	25.5	42	19.69
		3	15		43	8.5	6.5	2.0	63.0	2.0	4.5	9.5	50.0	65	63.00
		4	22		44	9.1	5.0	2.0	48.0	4.0	5.0	7.5	33.5	50	48.00

Table - 4A

Analysis Results of the soil after Kharif 1987.

Sr. No.	Treatment.	Repli-cation	Plot No.	Depth (Cm)	Stura-tion Per:	pH Paste	ECx10^3 of Extract at 25^0C	SOLUBLE CATIONS/ANIONS MILLIEQUIVALENTS PER LITRE							SAR
								(Ca+Mg)	Na	CO_3	HCO_3	Cl	SO_4	Total	
T_1	Control	1	11	0-15	30	9.2	1.2	2.0	10.00	2.0	3.0	2.5	4.5	10.0	10.00
		2	11	-do-	32	8.4	0.7	2.5	4.50	T	2.0	2.5	2.5	7.0	4.02
		3	21	-do-	32	9.2	0.7	2.0	5.00	1.0	3.5	2.0	0.5	7.0	5.00
		4	28	-do-	32	9.4	0.9	2.0	7.00	1.0	4.0	3.5	0.9	9.0	7.00
T_2	Sordan	1	7	-do-	31	9.2	1.3	2.0	11.00	T	3.5	3.5	6.0	13.0	11.00
	Grass	2	14	-do-	31	8.4	2.6	3.5	22.50	--	2.5	4.5	19.0	26.0	17.01
		3	19	-do-	32	9.6	2.7	2.0	25.00	3.0	7.5	7.0	9.5	27.0	25.00
		4	24	-do-	33	9.4	1.7	2.0	15.00	1.5	3.0	2.5	10.0	17.0	15.00
T_3	Australain	1	2	-do-	29	9.3	1.8	1.0	17.0	2.5	4.0	4.0	7.5	18.0	24.04
	grass.	2	14	-do-	31	8.3	2.2	5.5	16.5	--	2.5	4.0	15.5	22.0	9.90
		3	16	-do-	30	9.5	1.5	1.5	13.5	2.0	3.5	3.0	6.5	15.0	15.60
		4	27	-do-	33	9.4	1.4	2.0	12.0	1.0	4.5	4.5	4.0	14.0	12.00
T_4	Jantar	1	5	-do-	31	9.0	1.1	1.0	10.0	2.5	4.0	2.5	2.0	11.0	14.14
	Berseem	2	12	-do-	31	8.8	1.0	2.0	8.0	1.5	3.0	2.0	3.5	10.0	8.00
		3		-do-	32	9.5	1.9	2.0	17.0	2.0	4.0	4.5	8.5	19.0	17.00
		4	25	-do-	32	8.7	1.0	2.0	8.0	T	3.5	3.0	3.5	10.0	8.00

Table - 4A

Analysis Results of the soil after Kharif 1987.

Sr. No.	Treatment.	Repli-cation	Plot No.	Depth (Cm)	Stura-tion Per:	pH Paste	ECx10^3 of Extract at 25°C	SOLUBLE CATIONS/ANIONS MILLIEQUIVALENTS PER LITRE							SAR
								(Ca+Mg)	Na	CO_3	HCO_3	Cl	SO_4	Total	
T_5	Cypsum	1	3	0-15	30	8.4	1.4	2.0	12.0	T	5.0	2.0	7.0	14.0	12.00
	Dose	2	9	-do-	32	8.5	1.3	2.0	11.0	2.0	3.0	2.5	5.5	13.0	11.00
		3	20	-do-	32	9.0	0.7	2.0	35.0	1.0	2.0	2.0	2.0	7.0	5.00
		4	23	-do-	33	9.1	0.7	2.0	5.0	2.0	2.5	2.5	7.0	7.0	5.00
T_6	Gypsum th	1	6	-do-	32	8.4	0.9	4.5	4.5	--	2.0	2.5	4.5	9.0	3.00
	Dose.	2	8	-do-	32	8.5	1.0	2.0	8.0	2.0	3.0	2.5	2.5	10.0	8.00
		3	17	-do-	32	9.3	1.6	2.0	14.0	2.0	4.0	4.0	6.0	16.0	14.00
		4	26	-do-	32	9.3	1.0	1.5	8.5	1.0	3.5	3.5	2.0	10.0	9.80
T_7	Gypsum $^1/_8$	1	1	-do-	29	8.9	0.9	1.5	7.5	2.0	2.5	2.0	3.5	10.0	8.66
	Dose.	2	10	-do-	32	8.9	0.7	2.5	4.5	T	2.0	2.5	2.5	7.0	4.42
		3	15	-do-	31	9.5	1.5	2.0	13.0	1.5	4.0	2.5	7.0	15.0	13.00
		4	22	-do-	32	9.4	1.3	1.5	11.5	1.0	3.5	3.5	5.0	13.0	13.28

Table - 5

Yield Results of Kharif Crops 1987

Sr. No.	Treatment	R_1 Kg.	R_2 Kg.	R_3 Kg.	R_4 Kg.	Total Kg.	Average yield Kg/per acre. Kg.
1.	Control.	-	116	-	-	116	29
2.	Sordon Grass	495	160	-	-	655	164
3.	Austalian grass	5120	5440	5000	4800	20360	5090
4.	Jantar.	1600	2200	-	-	3800	950
5.	Gypsum half dose (Rice)	1272	857	327	771	3227	807
6.	Gypsum dose (Rice).	980	287	58	143	1468	367
7.	Gypsum $^1/_8$th dose (Rice).	28	266	6	5	305	76

Table - 5-A

Yield Results of Rabi Crops 1987 - 88

Sr. No.	Treatment	R_1 Kg.	R_2 Kg.	R_3 Kg.	R_4 Kg.	Total Kg.	Average yield Kg/per acre. Kg.
T_1.	Control.	-	-	-	-	-	-
T_2	Sordon Grss	-	-	-	-	-	-
T_3	Janatar-Berseem	102	78	43	53	276	2760
T_4	Australian grass	144	98	48	74	364	3640
T_5	Gypsum half dose (Berseem)	206	166	144	104	620	6200
T_6	Gypsum th dose (Berseem)	188	198	108	78	572	5720
T_7	Gypsum $^1/_8$th dose (Berseem)	138	102	62	54	356	3560

Table - 6

Yield Results of Rice Paddy (Verifiction of the Experimental Truth)

S.No.	Variety	Av. yield per acre.	Size of plot	Remarks.
1.	Irri: - 6	1460 Kg.	1.25 acre	Full levelling.
2.	Irri: - 6	860 Kg.	1.25 acre	No levelling.
3.	Basmati - 385.	1020 Kg.	1.25 acre	Full levelling.
4.	Basmati - 385	740 Kg.	1.25 acre	No levelling.

Table - 6-A

Yield Results of Wheat after Rice.

Field	Area in acre.	Total produce in Kg.	Av. yield acres in Kg.	Levelling
17.	1.25	890	712	Conventional
18	1.25	880	704	Conventional
24	1.25	1100	880	Presize.
25	1.25	1140	912	Presize.

Table - 7

Economic of Reclamation

Expenditure @ Rs.	Control	Sordon Grass	Australian Grass.	Janter	Gypsum 15 cm Require-ment.	Gypsum 7.5 cm Require-ment.	Gypsum 3.75 cm Require-ment.
1. Expedniture 4 Irrigations @ Rs. 60/- each.	240.00	240.00	240.00	240.00	240.00	240.00	240.00
2. Gypsum @ Rs. 360/- Ten.	--	--	--	--	1980.00	990.00	495.00
3. Fuddling (3 No.) @ Rs. 50/- each.	150.00	150.00	150.00	150.00	150.00	150.00	150.00
Total Expd:	390.00	390.00	390.00	390.00	2370.00	1380.00	885.00
INCOME							
1. Yield of Rice	58 Kg	328 Kg	5090 Kg	1900 Kg	1064 Kg	634 Kg	226 Kg
2. Rate	3.40 Kg	20/- 40 Kg	800/- per acre	20/- per 40 Kg	3.40 Kg	3.40 Kg	3.40 Kg
3. Amount Rs.	197.00	164.00	300.00	950.00	3618.00	2156.00	904.00
Net Income : Rs.	(-193)	(-226)	(-410)	(-560/-)	(1248/-)	(776/-)	(19/-)