CHAPTER VIII

RECLAMATION OF SALINE ALKALI SOILS
A saline soil is one which contains less than 5 percent of sodium as salinity and more than 60 percent of sodium as the alkalinity. An alkali soil may also have high EC, the limits of salinity and alkalinity as given by USDA laboratory (1) are: conductivity above 4 mhos/cm, pH value 7.5 (or the saturation extract at 25°C) and exchangeable sodium percentage (ESP) above 15. A higher percentage of insoluble carbonates is another problem relating to soils in the arid and semi-arid zones. The level of CaCO₃ at which p-fixation becomes an agricultural problem may be the margin at which the soil can be considered calcareous. A limit of 8-10 percent of CaCO₃ is suggested by Hille et al (2) as the margin for defining a calcareous soil.

The conventional methods existing for the reclamation of such soils are: exhaustive tilling followed by drainage, mulching with plant materials to increase the organic matter content, mixing with sand, gypsum-vegetation etc.
and with chemical amendments containing sulfur such as pyrosulphuric, ferrous sulphate, aluminium sulphate and hydrochloric acid followed by irrigation. Various scientists have proposed different methods in this field to evolve an easy and economic reclamation. A review of the contemporary literature on the subject has attested here under.

Rissal and Samuel (3) covered the effect of various 3-containing amendments for soil reclamation and their treatment. They found that 3-compounds (CaSO₄), 3, H₂SO₄, H₂SO₃, CO₃, (NH₄)₂SO₃, Al₂(SO₄)₃ and Fe₂SO₄ increased the availability of plant nutrients such as P, K, Na, Zn and Fe. Jenkins studied (4) the reclamation of soda saline chalk solonetz with inorganic acids and Fe₂SO₄ 7H₂O. According to him, desalinization was highest when treated with Fe₂SO₄ 7H₂O and H₂SO₄. The exchangeable Na content decreased due to formation of finely divided and dispersed pyrosulphuric in the soil solution. Generally CaCO₃/H₂O was most effective reclaiming agent, which not only removed substantial amounts of salts especially toxic ones, but improved soil structure, filtration capacity and other soil physical properties. Poonic and Shusabla (5) while studying the Ca uptake of dhalinch observed that application of CaCO₃ and a line
subliming agent (H₂SO₄, HCl, Al₂(3O₄)₃ etc. to a some alkali soils, increased dry matter yield or tur. The effectiveness of the agents in increasing yields was in the order

$$\text{HCl} \quad > \quad \text{H₂SO₄} \quad > \quad \text{Al₂(3O₄)}_₃$$

They also increased Ca-content, H₂SO₄ being the most effective and HCl the least. The C-content in the plant was increased by H₂SO₄ and HCl, while Mn and N-content decreased. Mishra and Khen (6) studied leaching properties of solutions of CaSO₄, Al₂(3O₄)₃, FeSO₄ and H₂SO₄. Sertin (5) studied the leaching of Al and Fe sulphates gave highest leaching rates and water alone made the soils kill iron. The efficiency was in order:

$$\text{Ca·SO₄} \quad > \quad \text{Al₂(3O₄)}_₃ \quad > \quad \text{Fe}²⁺ \quad > \quad \text{H₂SO₄} \quad > \quad \text{Sertin}$$

Gutarchan et al. (7) and Petrov (8) studied the efficiency of FeSO₄ in improving soil aeration and tribution, and flocculation. However, effect of FeSO₄ decreased sharply after the first year.
Tiemurov et al. (4) suggested that HCl treatment followed by Na$_2$SO$_4$ (2 percent) and subsequent Na$_2$CO$_3$ and NaCl and Ca(NCO)$_3$$_2$ in the second the mineral in CaCO$_3$ and Na$_2$SO$_4$ contents. By this method 3 m depth of the soil is demineralized to 0.4 to 0.6 percent solid residue. Young et al. (10) successfully reclaimed saline alkali soils of Jerir and Fandra using HCl absorbed on clay. Cultivation of alfalfa for 2-3 year followed by Na$_2$CO$_3$ and NaCl contributed to the improvement of soil and recovery of soil for other plants.

Tonkonozhko et al. (11) while studying the salinized soils in the delta of the river Kuban observed that their properties during the reclimation observed that natural differentiation of soils was limited and often an increased solonetz and solonetz formation was observed. The removal of salinity of soils resulted in Na-incorporation into soil complex, increased the Na$_2$CO$_3$ content of the soils and increased solonetzicity. This occurred specially during denitrification of solonetzons which contained very high Na and relatively high Mg. They have also found that secondary salinization of the
upper soil layers after through washing and leaching out of the salts into the drainage system. As chlorides and carbonates were easily leached out, the relative carbonate and bicarbonate contents of the soil increased. For this they have suggested gypsum treatment and acid treatment.

Semendyery N.V. (12) while studying the effectiveness of the gypsum to low sodium solonetz soils observed that calculated amount of gypsum had improved the soil fertility and the crop yield. A decrease in gypsum doses led to lesser effects of its application. He has observed that application of 1 ton gypsum and 30 ton manure/bec gave the best results.

Bhambra, D.L. and Poonia, S.J. (13) while studying the effect of Esp on the availability of Ca from gypsum and CaCO₃ applied to barley, dhaicha and maize in a sandy loam soil observed that Ca-availability decreased with increasing Esp in the CaCO₃ treatment plot. In gypsum treatment also the Ca availability increased with Esp in case of a crop, as reported in case of Dhaichas and decreased in case of maize. The uptake of Ca from gypsum was always higher when CaCO₃ added. I.D. Bhambra, D.L. (14) observed that application of gypsum
the production of both barley and rye increased, and the
proved by about 30 percent.

Sharma, A.K. and Wechera-Haase, J.T. (15) gave the
following order for improvement of silt loam soil: Illinois:

- Slurry = gypsum hydrated lime and improved the rate of
  application was

\[ 2 \text{ percent} > 1 \text{ percent} > 0 \text{ percent} \]

Grieson, I.T. (16) observed that the use of gypsum resulted in the reduction in soil pH and surface runoff. He had also observed a significant increase in yield of the crop and dry matter.

Sidle, A.H. et al (17) while working to overcome
leaching of saline, alkaline saline soils in the arid low
land using chemical amendments observed that the salts cannot be leached with water alone. Addition of 

\[ 1.5 \text{ metric tons of } \text{HCl, 0.3 metric tons of } \text{NH}_4 \text{NO}_3, \]

130 metric tons of HCl, 0.3 metric tons of 

\[ \text{KCl, and 130 tons of nitric acid increased the } \] 

This treatment devalued and neutralized the soils retro-
of the soil with 1.3 percent of call and 135-265 chlorella
Na per 100 g of soil within 16-63 days by fixation. Allhina
V.K. and Sabneva M.A. (13) on studying the alteration of micro
flora of a heavy clayey coloacheck of broom starch during
reclamation observed that it was a hand and application of ferrocicic
acid, gypsum (alone) of mixture-dung or in combination by
product of the petrochemical industry, increased the number of fix-
izing micro-organisms. Washing with water together with the
application of gypsum at 15-20 tons/ha, dung at 40 tons/ha or
together with 20 tons/ha of oil product was reclamation by then.

Weiss, A. (14) while studying the rice yielding
chlorosis connection by Fe, Zn, and \( \text{H}_2\text{SO}_4 \) application observed
that rice has shown chlorosis due to deficiency of Fe and Zn.
Application of 5 or 10 kg of \( \text{Fe} \), 40 kg alone release of \( \text{Fe} \) and \( \text{Zn} \)
\( \text{FeSO}_4 \) were effective in increasing yield and combination of both
these were more effective. Application of \( \text{H}_2\text{SO}_4 \) also was result in
release of Zn and Fe from soil.

Miyazato and Kayan (20) suggests the use of \( \text{H}_2\text{SO}_4 \)
for the treatment of contaminated irrigation soil. Associated
water clear precipitation of Co\text{SO}_4 and increase in a changeable
Na and \text{CO}_3, thus ensuring low infiltration soil.
H$_2$SO$_4$ solution reduced Ca-sorption and exchangeable Na- by neutralizing Ca and Mg, consequently preventing scaling in infiltration tests. Leman et al. (21) also observed that in calcareous soil, infiltration is done with salty water (salts = 3 to 34 g/lit., Na = 1-5 g) H$_2$SO$_4$ applied at rates sufficient to prevent Ca-sorption (2.1 - 4.1 g/l.) maintained a slightly above neutral and reduced Na- and Mg in all the crops studied. Reduced hydraulic conductivity in some soils through dried water was greater than 1.0.

The advantage of using H$_2$SO$_4$ solution in its relative merits over other methods was observed by all authors. The USDA laboratory had suggested the use of sulfuric acid or soil amendment long before.

Lesham and Allain (22) in 1965 observed the relative advantage of using sulfuric acid for soils rich in calcium carbonate. Kulench et al. (23) observed that in neutral soils, best results were obtained by use of 1 percent sulfuric acid solution as lixiviant instead of toxic ions, in use of 1 liter (50-100 ton/bac) and used for washing.
with water at 4500 m³/hec). Similar observations were also
Korsban (23) observed that soil washing the treat with sulphuric acid (5.6 ton/hec) worsened the filtration and cationic
of weekly and highly saline alkali soils. However strongly saline soils was increased by 10 fold. In the treat
(0.2 ton/hec) under similar condition the permeability of weekly saline alkali soils while that of strongly
saline alkali soils increased only 2 fold, that means that sulphuric acid was more suited to weekly saline alkali soils.

Lehstrae C.L. (23) while studying the effectiveness
of sulphuric acid at 30 percent of the theoretical require
requirement (10.6 ton/hec) and gypsum at 20, 40, 60 or 30
percent of the theoretical requirement (34 ton/hec) in reclaim-
ing saline alkali soil observed that sulphuric acid almost
completely reclaimed the soil in the first year and resulted in
a marked increase in paddy field. The phytotoxic effect of
gypsum was also as evidenced by the gradual increase in yield.
Prather et al. (30) selected some active and efficient scavengers used in alkaline medium by using CaSO₄, CaCl₂, and H₂SO₄ singly or in combination. The amount of scavenger, time on, and temperature were fixed that as a single scavenger calcium carbonate was used in a solution of CaSO₄ and resulted in a more desirable sorbent in a CaCl₂.

Assstadt and Halden (31) on the conclusion of diluted sulfuric acid (1st time 3 percent solution) followed by a 3 percent solution (or 12,000; 11,350; and 2150 µg/ml) would result in exchangeable Ca to 40 to 45 percent at 40% and year with reaction. After cooling, CaSO₄, H₂SO₄, and water were removed to the extent of Cu²⁺, CaSO₄, and Ca²⁺ were reduced by 35-40, 65-30, and 35-50 percent respectively. The Ca and Mg content in 1-24 was increased by 35 and 212 percent respectively.

Different other methods have been tried by many workers in reclaiming the calcite alkaline salt. Y. S. S. and Torreeka reported Fe₂CO₃ containing solid with H₂ solution followed by several collisions and uptake from. The best
rates were 450 - 500 m$^3$ NaCl soln/hac cont iri: 15-33 tons NaCl and 40 tons gypsum/hac and 6000 - 8000 m$^3$ in tr/hac. after treatment almost all carbonates were removed. the content above, e.g. trc: 3000 to 1.2 ec/ta... be completely removed by this method.

Alberovich and Sheinberg suggested the use of concentrated NaCl$_2$ solutions for the reclamation of a saline soil. However, it was observed that water cannot

Salt water dilution method for reclamation has been successfully carried out by many workers. It was noticed that tunnel drainage can be used for the nutrition of saline soils. Velyan et al. (35) studied the saline effect on c.d.e. or 0.01 m/c$^2$. They found it to be equivalent to the use of 30 tons of 40% H$_2$SO$_4$/ha. With current density of 0.1 - 0.5 m/c$^2$, no the soil structure and permeability and reduce the soil water 10 to 7.5 kJ/m$^2$/h. (36) observed that c.d.e. (0.5 m/c$^2$) occurred (60 tons/hac) and combination of gypsum (30 tons/hac) with c.d.e.
increases soil reaction from near 6.5 to
approximately 7.0. Application of 30 tons/hoe to 60 tons/hoe is effective.

John Jones (37) observed the influence of chloride and relative compounds (betaine hydrochloride, octylcholine, chlorocholine, chloride) and found that if applied at the root medium with presence of Cl, and without decreasing the uptake of P, it is beneficial.

Patarek J. Habbo K. observed that excessive leaching of saline alkali soils increases the application of industrial by-product such as coke or sugar mill ashes give high yield of rice or corn with the use of pyroxs.

For. and alined (38) observed that nitrate deficient limiting the performance of oil rich soils can be improved by application of synthetic ferrous pictures (latex styrene granules). It increases more since water availability to plants. Jostini and Josted suggested the use of oil rich or baux matrix in petroleum industry for the production of non-colorful cellulose. The high yield increases the formation of oil.
Islamic (4) observed that shallow stone (deionization process) can be used for deionization and its ability to absorb, considerable amount of water in the soil. Jaded (42) showed that sewage sludge can be assimilated by combined treatment with 5 (1 percent) of thiobacillus aeruvivus and/or T-thiooxidans culture. After 56 days the thioscrillae + 3 treatment soil pH increased from 3.4 to 7 - 7.5 and ESP decreased from control values: 54.63 - 55.06 to 10.55 - 11.56 with the combined treatment or thio-
basillus alone was effective.

Another important lead in the reclamation of saline alkali soils is the utilization of industrial wastes for the reclamation purposes. Skaterius et al. (43) observed that industrial wastes containing CaSO₄, Fe-oxide, and trace metals was found to be better than even gypsum treatment, and in soil increased, while Na and Cl decreased. Calcium carbonate in soil properties and crop yield. Vasiliave (44) found that addition of 0.5 percent gypsum + super basic material waste or 0.2 - 0.5 percent of the latter alone cause the highest evolu-
tion of Cu₂O from the soil. Addition of Cu and is combined to
such plots increased soil respiration activity, soil nitrate reduction, microbial count and accumulation of soil nitrogen.

Yehla et al. (45) used sulfuric acid waste from copper smelters and found that the rate of water infiltration into Na-affected soils could be increased considerably. Petrosyan (46) showed that waste sulfuric acid containing sulfates were the most efficient amendment for improving saline soils. The increase desalinization improved infiltration rates and resulted in high yields. He also showed that desalinization of saline water can be accomplished by mixing waste sulfuric acid with irrigation water. Srinath and Roy (47) suggested that sulfuric acid from petrochemical industrial wastes can be used as a substitute for monoammonium phosphate for the salinization of solonetz soils. In field experiments 50 percent sulfuric acid waste (5.0 tons/ha) increased the yield by 22-54 percent. The acid waste may contain toxic hydrocarbon substances, but they are microbially degraded and do not affect plant growth.

Such (48) and co-workers suggested first the use of sulfuric acid from dairy industry for the reduction of saline
and alkali soils. In the first successful experiments, in the field of Patra and Hill (North and South), waste sulphuric acid from a battery factory, waste acid waste from fertilizer industry waste was used. The percentage composition of the acid waste from the former sources was:

1. Sulphuric acid 50 - 55 percent
2. Salt solids 5 - 10 percent
3. Remaining

While that from the latter was:

1. Sulphuric acid 60 - 70 percent
2. Allylbenzene sulphinate 6 - 9 percent
3. Remainder

A systematic process of reclamation of saline or saline alkali soil may involve the following operations.

1. Prevention of inundation and spread of water by constructing bunds or walls (near coast).
2. Pick out suitable amendments such as sulphur, iron, Fe\textsubscript{3}O\textsubscript{4} or \textsubscript{H}\textsubscript{2}SO\textsubscript{4} depending on the soil structure and requirement so as to make the soil more cie.

3. Infiltration of an efficient leaching and drainage system which may prevent the seepation of high water table and hence water logging and

4. Choice of crops according to salt and alkali resist not power e.g. growing of alfalfa, Dhainch etc. First crop after reclamation.

In addition to the waste sulphuric acid treatment based on the results of hydraulic conductivity. It was decided to use Iron-sulphate prepared by using waste sulphuric acid, waste sulphur from industries and pyrites were taken as a combined treatment. The application of such an acid powder treatment was taken up simultaneously with the waste sulphuric acid treatment on different plots.

The waste soil treatment was given on fields at Boratoda and Patan samples given in table No. VIII A. These samples are saline soil, and this salinity is due to old sea
water intrusion on the site. This soil mixture was
containing 33 percent sulphur and 33 percent lime. It was
on site at Amba Adhanna. Close to this area, some
soils were spoiled due to the use of alkali type well water in the area.
### TABLE 10. VIII A
STUDY OF SOIL SAMPLES BEFORE AND AFTER LECHMATIC TREATMENT

#### BEFORE TREATMENT

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Location</th>
<th>Depth</th>
<th>pH</th>
<th>TEC mer/100 gm</th>
<th>Ca+Mg</th>
<th>K</th>
<th>La</th>
<th>TEC (ESP)</th>
<th>Alkali Texture</th>
<th>S.P.</th>
<th>Co2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>Boratwada</td>
<td>0-6&quot;</td>
<td>8.4</td>
<td>32.0</td>
<td>19.0</td>
<td>0.8</td>
<td>12.2</td>
<td>39.0</td>
<td>12.5</td>
<td>Sanday</td>
<td>51.0</td>
</tr>
<tr>
<td>A-2</td>
<td>Boratwada</td>
<td>6-15&quot;</td>
<td>8.3</td>
<td>30.5</td>
<td>16.9</td>
<td>1.0</td>
<td>12.6</td>
<td>41.4</td>
<td>13.4</td>
<td>Sandy</td>
<td>55.0</td>
</tr>
<tr>
<td>B-1</td>
<td>Peter</td>
<td>0-6&quot;</td>
<td>8.1</td>
<td>41.7</td>
<td>21.0</td>
<td>1.3</td>
<td>19.4</td>
<td>45.0</td>
<td>8.2</td>
<td>Sandy</td>
<td>60.0</td>
</tr>
<tr>
<td>B-2</td>
<td>Peter</td>
<td>6-15&quot;</td>
<td>7.9</td>
<td>41.5</td>
<td>9.8</td>
<td>1.5</td>
<td>20.0</td>
<td>46.5</td>
<td>10.0</td>
<td>Sanday</td>
<td>59.0</td>
</tr>
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#### AFTER TREATMENT

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Location</th>
<th>Depth</th>
<th>pH</th>
<th>TEC mer/100 gm</th>
<th>Ca+Mg</th>
<th>K</th>
<th>La</th>
<th>TEC (ESP)</th>
<th>Alkali Texture</th>
<th>S.P.</th>
<th>Co2</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>Boratwada</td>
<td>0-6&quot;</td>
<td>7.4</td>
<td>28.5</td>
<td>24.4</td>
<td>0.3</td>
<td>3.8</td>
<td>12.0</td>
<td>6.9</td>
<td>Sandy</td>
<td>46.0</td>
</tr>
<tr>
<td>A-2</td>
<td>Boratwada</td>
<td>6-15&quot;</td>
<td>7.5</td>
<td>34.1</td>
<td>29.8</td>
<td>0.3</td>
<td>4.0</td>
<td>14.2</td>
<td>9.3</td>
<td>Sandy</td>
<td>52.0</td>
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<tr>
<td>B-1</td>
<td>Peter</td>
<td>0-6&quot;</td>
<td>7.3</td>
<td>41.0</td>
<td>35.6</td>
<td>0.3</td>
<td>5.0</td>
<td>12.4</td>
<td>6.2</td>
<td>Sandy</td>
<td>57.0</td>
</tr>
<tr>
<td>B-2</td>
<td>Peter</td>
<td>6-15&quot;</td>
<td>7.4</td>
<td>39.7</td>
<td>35.9</td>
<td>0.5</td>
<td>4.0</td>
<td>11.1</td>
<td>5.9</td>
<td>Sandy</td>
<td>54.0</td>
</tr>
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### TABLE A. VIII A (contd)

**STUDY OF SOIL SAMPLES BEFORE AND AFTER RECLAMATION TREATMENT**

<table>
<thead>
<tr>
<th>S.No. Location</th>
<th>Depth</th>
<th>EC x 10^(-2) at 25°C mmhos/cm</th>
<th>Saturation Extract Analysis</th>
<th>SAR (Satd. Extract)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ca^2+ Mg^2+ Na^+ K^+ HCO_3^-</td>
<td>SO_4^2- Cl^-</td>
<td></td>
</tr>
<tr>
<td>A-1 Boratwada</td>
<td>0 - 6&quot;</td>
<td>9.22</td>
<td>6.4 2.2 34.2 1.0 4.5 5.4  85.2</td>
<td>41</td>
</tr>
<tr>
<td>A-2 Boratwada</td>
<td>6 - 15&quot;</td>
<td>7.52</td>
<td>5.2 1.0 64.0 0.4 4.5 7.4 52.0</td>
<td>36</td>
</tr>
<tr>
<td>B-1 Petan</td>
<td>0 - 6&quot;</td>
<td>18.84</td>
<td>8.2 14.1 184.2 1.5 4.3 20.0 190.4</td>
<td>55</td>
</tr>
<tr>
<td>E-2 Petan</td>
<td>6 - 15&quot;</td>
<td>18.44</td>
<td>10.8 19.2 202.0 1.2 4.2 32.0 194.6</td>
<td>52</td>
</tr>
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</table>

**AFTER TREATMENT**

<table>
<thead>
<tr>
<th>S.No. Location</th>
<th>Depth</th>
<th>EC x 10^(-2) at 25°C mmhos/cm</th>
<th>Saturation Extract Analysis</th>
<th>SAR (Satd. Extract)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ca^2+ Mg^2+ Na^+ K^+ HCO_3^-</td>
<td>SO_4^2- Cl^-</td>
<td></td>
</tr>
<tr>
<td>A-1 Boratwada</td>
<td>0 - 6&quot;</td>
<td>5.36</td>
<td>12.4 2.4 41.6 0.4 2.0 6.2 40.0</td>
<td>15</td>
</tr>
<tr>
<td>A-2 Boratwada</td>
<td>6 - 15&quot;</td>
<td>4.18</td>
<td>11.8 2.2 30.2 6.2 2.2 8.0 32.0</td>
<td>11</td>
</tr>
<tr>
<td>B-1 Petan</td>
<td>0 - 6&quot;</td>
<td>4.52</td>
<td>16.4 5.1 20.2 Tr 1.2 22.4 18.0</td>
<td>6</td>
</tr>
<tr>
<td>E-2 Petan</td>
<td>6 - 15&quot;</td>
<td>4.76</td>
<td>18.6 7.2 24.7 0.6 1.4 34.6 24.2</td>
<td>7</td>
</tr>
<tr>
<td>S.No.</td>
<td>Location</td>
<td>Depth</td>
<td>S.P</td>
<td>pH(Satd)</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>--------</td>
<td>-----</td>
<td>----------</td>
</tr>
<tr>
<td>C-1</td>
<td>Kocharia</td>
<td>0-6&quot;</td>
<td>50</td>
<td>8.1</td>
</tr>
<tr>
<td>C-2</td>
<td>Kocharia</td>
<td>6-15&quot;</td>
<td>46</td>
<td>8.0</td>
</tr>
<tr>
<td>D-1</td>
<td>Bavla</td>
<td>0-6&quot;</td>
<td>48</td>
<td>8.4</td>
</tr>
<tr>
<td>D-2</td>
<td>Bavla</td>
<td>6-15&quot;</td>
<td>48</td>
<td>8.4</td>
</tr>
</tbody>
</table>

| C-1   | Kocharia | 0-6"   | 46  | 7.1      | 25.0            | 21.2       | 0.4                 | 3.3          | 18.0| 6.0 | 6.0      | 15.0          | Sandy loam   |
| C-2   | Kocharia | 6-15"  | 44  | 7.7      | 26.2            | 26.2       | 0.3                 | 3.3          | 18.0| 6.0 | 6.0      | 15.0          | Sandy loam   |
| D-1   | Bavla   | 0-6"   | 44  | 7.9      | 26.2            | 25.2       | Tr                  | 3.2          | 22.0| 7.1 | 15.0    | 15.0          | Sandy loam   |
| D-2   | Bavla   | 6-15"  | 42  | 7.5      | 26.2            | 23.3       | Tr                  | 2.9          | 23.0| 6.8 | 15.0    | 15.0          | Sandy loam   |
### Table 10. VIII B (Contd)

#### Study of Soil Samples Before and After Reclamation Treatment

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Location</th>
<th>Depth</th>
<th>EC $\times 10^{-3}$ at 25°C</th>
<th>Saturation Extract Analysis (meg/litre)</th>
<th>SAR (Satd. Extract)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>C$^2_2$</td>
<td>Mg$^{+2}$</td>
<td>Na$^+$</td>
</tr>
<tr>
<td>C-1</td>
<td>Kocharia</td>
<td>0 - 6&quot;</td>
<td>6.87</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td>C-2</td>
<td>Kocharia</td>
<td>6 - 15&quot;</td>
<td>6.13</td>
<td>2.8</td>
<td>2.1</td>
</tr>
<tr>
<td>D-1</td>
<td>Bevda</td>
<td>0 - 6&quot;</td>
<td>11.79</td>
<td>2.3</td>
<td>1.5</td>
</tr>
<tr>
<td>D-2</td>
<td>Bevda</td>
<td>6 - 15&quot;</td>
<td>12.28</td>
<td>2.4</td>
<td>1.7</td>
</tr>
</tbody>
</table>

#### After Treatment

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Location</th>
<th>Depth</th>
<th>EC $\times 10^{-3}$ at 25°C</th>
<th>Saturation Extract Analysis (meg/litre)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>C$^2_2$</td>
<td>Mg$^{+2}$</td>
</tr>
<tr>
<td>C-1</td>
<td>Kocharia</td>
<td>0 - 6&quot;</td>
<td>3.54</td>
<td>6.4</td>
</tr>
<tr>
<td>C-2</td>
<td>Kocharia</td>
<td>6 - 15&quot;</td>
<td>3.67</td>
<td>6.2</td>
</tr>
<tr>
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<td>Bevda</td>
<td>0 - 6&quot;</td>
<td>7.90</td>
<td>4.8</td>
</tr>
<tr>
<td>D-2</td>
<td>Bevda</td>
<td>6 - 15&quot;</td>
<td>6.00</td>
<td>4.4</td>
</tr>
</tbody>
</table>

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232
DISCUSSION

Table No. VIII A, presents the data for reclamation of two sites viz. Baratwada and Patan, which are saline soils. Before the reclamation the growth of the crops were uneven and very poor yields were obtained. The sites were in very bad conditions because they are very hard to till and poor water permeability was there.

Addition of 2 tons of industrial waste sulphuric acid (adjusted to 50 percent strength) plus 3 percent organic matter per acre reclaimed the soils within a period of ten days. 6 inch water layer was kept for 'washing out' the salts for a period of seven days. A ditch of 2.5' depth and 2.0' width was made covering the total length of the plot so as to lead the salts away from the plot.

In Baratwada soils the acid treatment showed a quick reclamation and the salinity level decreased from 9.2 to 5.6 in the 0.6 inch layer, and from 7.5 to 4.2 in the 6.15 inch layer. The presence of CaCO$_3$ to the extent of 12-13 percent
is a source of Ca-supply and we find that there is increase in salinity and increase in the Ca content in the saline soils. Similarly in Patan excreta the salinity has been decreased from 13.6 to 4.5 in the 0.6 inch layer and from 13.4 to 4.3 in 6.15 inch layer. Here also the saturated extract shows a significant amount of Ca which raises from 134.2 to 20.7. The pH also decreases from 7.4 to 7.5 showing reduction in ESP measurement. There is decrease in CaCO3 content which also supports formation of fresh gypsum which will be useful in subsequent years.

Again a very important result of reclamation is the availability of the higher amount of yields from the crops at both the sites. The farmers who were getting cumin worth Rs.600/- in the untreated plots used to get cumin worth 6000/- by this treatment indicating a ten fold increase in the crop yield of cumin. There has been an economical revolution in this area of North Gujarat. After this 1st successful experiments about 150 acres of land has been improved by this acid treatment in this area.
Table No. VIII - B presents the data in the selection of Kochariya and Basla soils by the acid powder method. Here also 1 ton of soil powder per acre was used to recei the salty soils which are due to the old river before the port in that area about 300 years ago.

In case of Kochariya soil, the soluble salts have decreased from $6.8 \times 10^3$ mmhos/cm to $3.5 \times 10^3$ mmhos/cm to $3.8 \times 10^3$ mmhos/cm in 5-15 inch layer. The pH changes from 3.1 to 7.5 in the 1st layer and from 0.0 to 7.1 in the second layer. As compared to Kochariya the soil condition is not improved to the same extent, consider the electrical conductivity level. However, increase in Ca content and decrease in Na content as well as increase in $SO_4$ content indicate that we have direct evidence for taking a bold conclusion that acid powder treatment can turn a saline Na-soil into a supported Ca soil which can support better plant growth. At Kochariya 1st crop of paddy increased from 35 monds/acre to 83 monds/acre and the subsequent crop of wheat also increased from 21 monds/acre to 43 monds/acre. In fact, the acid powder method is convenient to use and it works on the basic principle that $H_2SO_4$ in relation on the hydrolysis of Iron Sulph to and also
H$_2$SO$_4$ is formed by oxidation of sulphur and interaction of $\text{SO}_3$ with soil moisture.

In fact the superiority of acid method over acid powder method can be proved very easily even to see. The quickness of acid method is comparatively much higher than acid powder method. One point to note is that the treated and controlled plots should be kept far away because the laches from the treated plots can affect the untreated plots which has been observed fact at other sites.
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