3. SALINE AND ALKALI SOILS

There is probably more excellent, reliable, useful information on saline and alkali soils than on any other phase of soil and plant nutrition. This is due mainly to the efforts of a dedicated band of USDA scientists who, in the nineteen forties and early fifties put out a wealth of solid information on the subject. Much of this in- formation is compiled in USDA Handbook 60, published in 1954 (see General Reference at end of chapter). A revised version of this publication is scheduled to be released by 1982 and this revised version should be part of every fieldman's library.

An excellent, concise, publication on the reclamation of saline and alkali soils was published by Stromberg in 1972 (see General Reference).

The classes of saline and alkali soils are given below:

CLASSIFICATION OF SALINE & ALKALI SOILS*

Soil Class	EC	ESP	Recommended Reclamation
Saline	Over 4	Under 15	Drainage and leaching
Saline-alkali	Over 4	Over 15	Leaching followed by amendment if ESP stays over 15
Nonsaline-alkali	Under 4	Over 15	Amendment + leaching
Normal	Under 4	Under 15	—

* EC given in mmhos/cm; ESP = exchangeable sodium percentage

It should be noted that pH is not a criterion used to designate alkali soils and that alkali soils can have an acid pH (below 7.0) although this is rare; soils can also have an alkaline pH (above 7.0) but not be alkali soils. Alkali soils would be more properly termed sodium soils or sodic soils, and in some cases they are. The confusion between alkaline, alkali and alkalinity will probably always be with us.

Soil pH values in excess of 8.5 almost invariably indicate an alkali soil (ESP over 15). This fact has been used for field classification of alkali soils. Phenolphtalein indicator changes color in the 8.5 to 9.0 range and a positive phenolphtalein test will therefore indicate an alkali soil Many soils in California have been mapped as alkali soils based on the phenolphtalein test.

Soils can be alkali, however, and have a pH less than 8.5. Saline- alkali soils usually have a pH reading below 8.5. Unfortunately some of the old soil maps classify some soils as non-alkali because they didn't give a positive phenolphtalein test; many of these soils are saline-alkali - the salts in the soil modify the pH to a lower range. Phenolphtalein essentially delineates only non- saline alkali soils.

Also useful when interpreting soil analysis data is that EC values of soils containing gypsum should be reduced by 2 mmhos/cm for interpretive purposes. On the other hand, EC levels of very sandy soils (SP below 30) should be multiplied by 2 before interpreting and EC values of moderately sandy soils (SP between 30 and 40) should be multiplied by 1.5 before interpreting. In other words, a given EC reading is more hazardous the sandier the soil.

The following reclamation schedule is modified from Stromberg (see Gen. Ref. 2) and can be used as a guide in reclaiming saline- alkali soils:

SAMPLE RECLAMATION SCHEDULE FOR SALINE-ALKALI GROUND

Summer Months (1st year)

1. Grade the land for surface irrigation.
2. Rip to a depth of 30" or more; shank spacing on crossbar should be no greater than the depth of ripping.
3. Disc to smooth surface and make some temporary irrigation borders.
4. Irrigate the ground at least once or twice until the soil seals up.
5. Test soil to determine need for amendments.
6. Apply 10 tons of 55% gypsum* per acre if necessary.
7. Disc and cross disc the gypsum (or other amendment) to mix it in the top 6 inches of soil.
8. Irrigate again.

*amendment choice is not limited to gypsum. 1 ton of elemental sulfur is equivalent to 10 tons of 55% gypsum and can be substituted for gypsum on most soils. Sulfuric acid has also proven to be an excellent amendment on some soils, (see separate chapter on amendments for further information).

Fall Months (1st year)

1. Work up a seedbed.
2. Apply 80 units of nitrogen per acre.
3. Seed a winter cereal, preferably barley.

Winter Months (1st year)

1. Irrigate during winter and early spring to keep crop growing and to leach soil.
2. Map alkali areas (poor growth; slick spots) for additional gypsum application.

Spring and early Summer Months (2nd year)

1. Harvest cereal.
2. Treat areas mapped (above) and any bare spots in the fields with another 10 tons of 55% gypsum per acre.
3. Apply 20 gals, of 10% zinc sulfate solution per acre if soil analysis shows low zinc levels.
4. Disc stubble and mix in the gypsum (and zinc, if applied).
5. Irrigate and work up a flat seedbed.

6. Apply 100 units of nitrogen per acre.

7. Seed to sudangrass or grain sorghum.

8. Irrigate by flooding between temporary borders. Avoid furrow irrigation because this concentrates the released salts in the tops of the beds.

Late Summer and Fall Months (2nd year)

1. Harvest the crop.

2. Use soil analysis to determine if additional gypsum should be applied.

3. Apply gypsum if soil tests show need, using twice as much on bare or weak spots.

4. Plant to irrigated pasture or alfalfa. If the process of reclamation has been good, an alternative may be to plant the land to a fall seeded row crop or to a spring seeded row crop such as corn or cotton. Once salinity levels have been lowered to a safe range, furrow irrigation can be used.

If it is known that a particular piece of ground is saline or saline- alkali (and it usually is) extensive soil sampling prior to the first irrigation is not warranted since once the first irrigation has been applied the entire chemical composition of the soil is drastically altered. For example, 1 acre foot of water will remove approx. 80% of the salts from a 1 foot depth of soil. Why spend a lot of money on initial soil sampling when the results will be meaningless after the first irrigation? Soil analysis of more value *after* the initial leaching; this is the analysis that can determine the amounts of amendments needed, if any.

As indicated in the preceding reclamation schedule, particular attention should be given to mapping and reclaiming the weak spots that will always occur in a parcel of any size. These spots can be mapped visually; there is no need in running extensive soil tests except to substantiate an opinion on a particular area. An aerial photo during the growing season can be much more useful than soil analysis in mapping these weak areas - I have made extensive use of such photos; nothing fancy is needed, a plain old black and white photo will suffice. It makes no sense to apply amendments to an entire field when only a relatively small portion will reap the benefits - in other words, put your money where it will do the most good.

General References

1. Richards, L.A. (ed.) **Diagnosis and improvement of saline and alkali soils.** USDA Handbook 60. 1954.

2. Stromberg, L.K. **Reclaiming saline and alkali soils.** 8 page mimeo from the Fresno County Ag Extension Service, 1720 S. Maple, Fresno, CA 93702. 1972.

3. See chapter on amendments, following.