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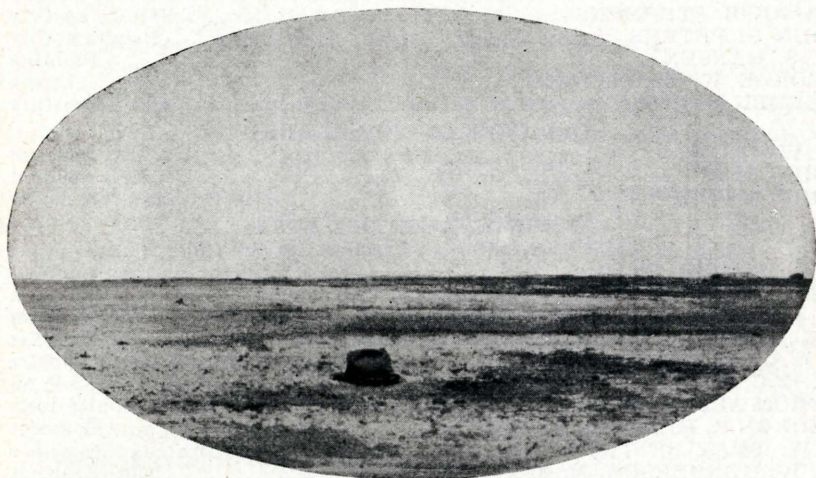
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SOIL ALKALI

By

F. S. HARRIS



CIRCULAR NO. 41

Utah Agricultural College
EXPERIMENT STATION

Logan, Utah

January, 1920

UTAH AGRICULTURAL EXPERIMENT STATION

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SOIL ALKALI

By

F. S. HARRIS

The farmer of the West is likely to be very much upset at the mention of alkali, mineral, or salt, in connection with his land. These various names are applied to a condition which he usually knows little about except that it is bad. The exact nature of the substances called by these names and the character of the injury caused by them are very vague in his mind; but he knows that he wants nothing to do with alkali if he can help it.

The prevalence of alkali throughout the arid parts of the world makes it impossible for farmers in these regions to be entirely unaffected. The only alternative is to learn as much as possible about the condition and prepare to meet it squarely. All sections are not equally affected by alkali, but the soils of no large irrigated area are entirely free from it.

The fact that the better lands have been taken makes it necessary next to use some of the soils that are to an extent affected by alkali if the farm products of the arid parts of the world are to be increased.

What is Alkali.—Any soluble salt that is present in the soil in quantities sufficient to injure crops may, in a rough way, be called alkali. This definition does not hold in a strictly chemical sense, but it will do for practical purposes. The word alkali is only one of the many names applied to soluble salts, but it is probably used more than any other.

Of the numerous soil materials that are soluble in water, only a few are likely to be present in anything like injurious quantities. For that reason alkali is usually rather simple in its composition. It is made up of any one, or a mixture, of the following salts: sodium chloride (common salt) sodium carbonate (washing soda), sodium sulphate (Glauber's salt), sodium nitrate (Chili saltpeter), and magnesium sulphate (Epsom salt). A number of other salts are found in a few places, but the ones mentioned above are more common than any others.

Generally no single salt is found alone but the soil contains a mixture of the substances mentioned above. As a rule one group such as the chlorides, the carbonates, or the sulphates predominates in a given region. The nature of the salt will, of course, determine the best method to be employed to eliminate the trouble.

Alkali is often classified as black and white. All of the salts are themselves white, but sodium carbonate dissolves organic matter from the soil. This produces a black color, hence the

name "black alkali". In a similar manner the nitrates produce a brown color. The carbonates and nitrates also cause a hard surface crust to be formed on the soil. This makes the passage of water difficult and interferes with the growth of crops. For this reason black alkali is more to be dreaded than white.

How Alkali Injures Crops.—Alkali causes injury to crops by preventing them from absorbing moisture and also by a direct corrosive action. Plants absorb water from the soil whenever the cell sap in the roots contains a higher concentration of dissolved material than is contained in the soil solution. If, on the other hand, the dissolved material in the soil becomes more concentrated than the cell sap, the plant is unable to take up moisture and consequently dies. It appears to be burned the same as if it had been subjected to drouth.

If the soluble salt content of the soil is slightly less than that of the plant, the plant may not be killed, but it will be prevented from making a rapid growth. Seeds planted in a strongly alkali soil fail to germinate because they are unable to absorb water. Soils puddled by alkali are not favorable to crop growth. They do not allow a free movement of moisture and they are so hard that the plant is hindered from making its normal development.

Indicators of Alkali.—It is impossible to tell how seriously a soil is affected with alkali by merely looking at it. A chemical analysis must be made. Of course a superficial examination will help to tell many things about the soil, but such information may be misleading. For example, gypsum may be dissolved from the soil and brought to the surface where it is deposited as a white layer. This might lead a person to think the soil highly alkaline, while as a matter of fact, it is impossible to dissolve sufficient gypsum to cause injury to crops. On the other hand, sodium chloride may give but little evidence of its presence even though there may be sufficient to cause decided injury to plants.

The native vegetation is one of the best indicators of the presence of alkali. For instance, if sagebrush is growing vigorously it may be assumed that the alkali content is not excessive. On the other hand shadescale, greasewood, salt weed, and salt grass, all indicate the presence of dangerous quantities of alkali. The native vegetation and a chemical analysis of the soil to a depth of at least six feet make an excellent combination in determining the degree of contamination of alkali land.

Toxic Limits of Alkali.—It is difficult to place any very definite limit of toxicity on alkali soil since toxicity is limited by several factors. The presence of abundant moisture and organic matter as well as a desirable soil texture help to reduce harmful effects.

The combination of salts must also be considered. For example, the sulphates are much less harmful than the carbonates, the nitrates, and the chlorides. If the alkali of a particular region is made up largely of sulphates it can be present in much larger quantities without causing injury than if the other salts predominate.

In general it may be said that soils containing more than 0.5 per cent of soluble salts where the larger part is chlorides, carbonates, or nitrates and 1 per cent where sulphates predominate are unsuitable for crop production without reclamation. Of course, these figures are modified by many conditions.

Crops for Alkali Land.—The crops to raise on alkali land depend on the degree of salinity of the soil, the uses that can be made of the crops, the markets, and other economic conditions as well as the climatic factors which determine what crops can be grown.

Date palms are very resistant to alkali and are profitable where climatic conditions are favorable, but the high temperature required for this crop removes it from consideration for most alkali lands. Likewise several salt weeds will grow on land highly charged with salt, but the use for these plants is limited. Salt grass is probably the most useful plant to grow on strong alkali land, but it is not nearly so good as many other forages and cannot be recommended where better crops can be made to grow.

Among the ordinary farm crops the smaller grains can usually be raised to about the best advantage on alkali land. They are fairly resistant, and since they are not expensive to raise, the loss is not great in case of a failure. There is not a great difference in the resistance of barley, oats, rye, and wheat, although the order in which they are named probably is the order of their resistance. All varieties of any one of these crops do not have the same resistance. These crops are surer to succeed as a hay crop than for the grain.

Root crops such as sugar-beets, while not resistant in the seedling stage, are fairly good crops for land where the alkali does not give trouble till late in the season.

The legumes as a class do not do well in the presence of much alkali, particularly is this true of peas and beans. Sweet clover and alkali make fairly satisfactory crops for land of medium alkali content when a stand is once secured. As a type of cropping for Utah alkali land, three crops that may be used in a rotation on damp medium alkali land are sweet clover, sugar-beets, and barley.

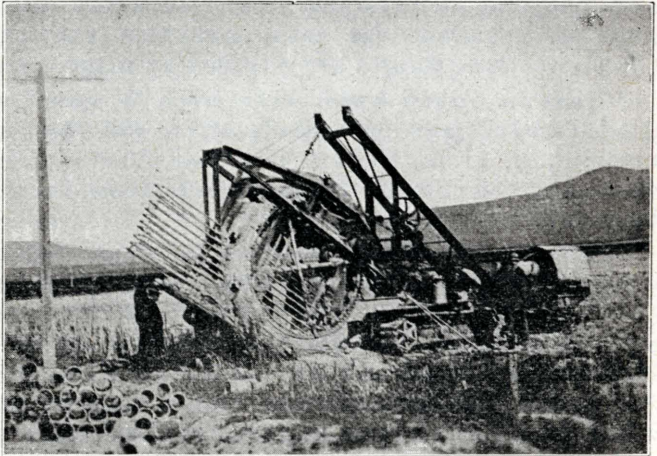
There are numerous crops having a resistance about equal to

the three mentioned which might be substituted where conditions would justify. For example, sweet clover might be replaced by alfalfa, sugar beets by mangels, and barley by oats or wheat.

Corn and potatoes are not usually successful on alkali land.

Reclamation of Alkali Land.—The uncertainty of securing a crop, together with the fact that a crop failure costs about as much as a success, makes it undesirable to farm land containing

large quantities of alkali. The profits in farming are none too large even under the most favorable conditions, and if an additional handicap in the shape of an unproductive soil is added, success is almost impos-



Machine for digging drainage ditches

sible. If a farmer finds himself in possession of alkali land he should investigate the possibilities of reclamation.

Nothing will destroy alkali. The only way to get it out of the land is to remove it by drainage or washing with water. Usually a covered tile drain system is the most successful method of reclaiming land. This, taken with the proper use of irrigation water, offers the quickest means of getting rid of the alkali. Open drains are used in some cases, but they have a number of disadvantages.

A number of means of preventing alkali from becoming more serious on a piece of land may be adopted. Among these are: (1) The cutting off of seepage water from higher land, (2) Cultivation to reduce evaporataion of water from the surface of the land and a consequent rise of salts from lower depths, (3) keep-ning the land constantly cropped, (4) The use of manure and organic matter to reduce surface evaporation, and (5) The proper use of irrigation water.

During the early stages of reclamation it is usually necessary to use the most resistant crops; but as the salt content is

reduced, other crops that may be more profitable can be introduced. While alkali in the soil is to be dreaded, it does not necessarily render the land valueless. Reclamation is not expensive when the improvement which it makes in the land is considered.

PUBLICATIONS RELATING TO SOIL ALKALI ISSUED BY THE
UTAH AGRICULTURAL EXPERIMENT STATION

These will be helpful to persons wishing a more detailed discussion.

Bulletin
Number

72. A Soil Survey of Salt Lake Valley, Utah.—Gardner, F. D., and Stewart, J.
111. The Reclamation of Seeped and Alkali Lands.—Brown, C. F., and Hart, R. A.
114. The Movement of Nitric Nitrogen in the Soil and Its Relation to Nitrogen Fixation.—Stewart, R., and Greaves, J. E.
121. The Soil of the Southern Utah Experiment Station.—Widtsoe, J. A., and Stewart, R.
123. Farm Drainage.—Brown, C. F.
134. The Nitric Nitrogen Content of the Country Rock.—Stewart, R., and Peterson, Wm.
139. The Movement of Soluble Salts with the Soil Moisture.—Harris, F. S.
145. Alkali Content of Irrigation Waters.—Stewart, R., and Hirst, C. T.
150. Further Studies on the Nitric Nitrogen Content of the Country Roads.—Stewart, R., and Peterson, Wm.
168. Relative Resistance of Various Crops to Alkali.—Harris, F. S., and Pittman, D. W.
169. Use of Alkali Water for Irrigation.—Harris, F. S., and Butt, N. I.
170. A Study of Methods of Determining Soil Alkali.—Pittman, D. W.

(College Series No. 140)