SOIL SALINITY INVESTIGATIONS*

Introduction

Soil salinity is perceived as one of the major threats to future productivity of prairie soil resources. Over the past decade increases in extent of soil salinity have been noted at the farm level and attempts to introduce remedial practices have been initiated. Almost all the remedial practices have been based on the now well known Montana model of soil salinity. Several visits to Montana and North Dakota by the senior author had suggested that perhaps this model did not fit all of the situations in Saskatchewan and that there was a need to conduct more detailed investigation into the fundamental causes. As well, extension programs with thousands of Saskatchewan farmers convinced us that specific recommendations for individual situations could not be made on general information. These two factors lead to the establishment of the soil salinity investigation team.

Objectives

The objectives of this program are:

1. To determine the cause of soil salinity on individual farm situations.

2. To develop and document models for the various types of soil salinization.

3. To discover the surface characteristics which will allow diagnosis of the various models of soil salinization.

4. To devise management or reclamation practices based on a thorough knowledge of the causes.

Methods of Investigation

Sites for investigation are selected from applications for assistance that originate on individual farms and come to us through agricultural representatives. In many cases the local knowledge of the agricultural representative is instrumental in bringing forward a representative "sample" of the various types of soil salinity that occur in a local area.

Site selection in the first year was dictated largely by a desire and requirement to achieve a cross-section of sites across all areas in Saskatchewan where soil salinity is a problem. The commitment was to conduct at least one investigation in each of the six agricultural extension regions of Saskatchewan Agriculture.

Once a site has been selected for investigation the first step is to order all available black and white aerial photography for the affected areas. When this is available a "site conference" is held.

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*J.L. Henry, P.R. Bullock, T.J. Hogg and L. Luba. Prepared for the 1983 Soils and Crops Workshop, Feb. 15, 1983, Saskatoon.

At this conference the aerial photographs, soil maps of all available kinds, geologic maps, topographic maps, water well information, and any other pertinent information is studied. With this information and the description of the problem by the farmer and agricultural representative, a theory of soil salinization mechanisms is formed. This theory forms the basis of the investigation strategy.

At the site the first step is an interview with the farmer and in some cases the agricultural representative and/or soils and crops specialist. In this interview the history of the problem is determined and the historical aerial photographs are reviewed with the farmer. Following this, field traverses of the problem are conducted so that the farmer can point out problem areas and any changes that may have occurred over time.

While the interview and field traverses are being conducted, other members of the team conduct preliminary EM38 surveys. This usually involves corner to corner transects on each affected quarter section, but the exact transect may vary according to the individual site.

When this background information is all available a strategy for drilling is established. The objective of the drilling program is to determine the near surface (upper 15 meters) stratigraphy and ground water occurrence. Soil samples are procured from the first hole and the laboratory is set up. The field laboratory allows on site measurement of 1:1, pH and conductivity. By the time the second test hole has been drilled and sampled the results are usually available for the first. Shallow soil samples with a hand probe may also be taken as required to provide individual site calibration of EM38 units.

From this point on no two investigations are alike. The strategy from this point depends on the results obtained to that point in time.

An important part of the investigation is on site measurement of any water table that has occurred in the drilling program. In addition, wells, streams, springs, sloughs, dugouts and any other surface or ground water source are analyzed. The conductivity of water is one of the most crucial measurements and is extremely valuable in interpreting flow relationships.

In some situations shallow (15 meters) drilling does not provide definitive information on salinization processes. This is true primarily where artesian pressure from deeper aquifers is the cause of the problem. In these situations it is necessary to carry out rotary drilling operations to trace the entire stratigraphy and to determine any artesian pressure and to establish the piezometric surface. This type of drilling operation was carried out by contract water well drillers for our first year of operation and we would anticipate continuing to carry it out in this manner.

The investigation process continues until the solution to the problem is found. In some cases this can be in one trip and one investigation series, but in more complex situations it may require return visits with different equipment and procedures.

Summary of First Year Results

Reporting of detailed results is beyond the scope of this presentation and paper. A detailed report which includes almost all of the measurements made plus the interpretations is prepared for each site. What follows is a summary of the types of soil salinity encountered.

Of the ten sites investigated only one exhibited characteristics of the classical saline seep process. In this case, we encountered approximately 7 meters of lacustro-till material overlying 1-2 meters of a gravel lens and all of this was underlain by dense till interpreted as a deposit of the second last glaciation (Floral till). In the upper slope positions, moderately leached sloughs were encountered and in lower slope positions saline soils were present. Based on stratigraphy, water conductivity analyses, and relative topographic positions, this was interpreted as a classical saline seep situation.

In six of the sites, artesian pressure was the dominant mechanism resulting in soil salinization. In some of these sites, it was found that the water present in the aquifer, at the source of the acquifer at depth, was of reasonable quality. Electrical conductivity of from 1,000 to 2,000 umhos/cm was found. In these situations if sufficient quantity of water were available, irrigation and subsequent leaching of surface salts could be a possible reclamation practice. Further work will be required to document the quantity and quality of the water before embarking on experimental irrigation projects.

At the remaining sites the dominant process was slough focussed evaporitive ring salinization. In this model the water enters the slough by overland flow and creates a ground water mound. In the capillary fringe surrounding the slough salinization results. In some cases the specific configuration can result in "plateaus" being suspended between several sloughs and a high degree of salinization can result. It was also found that many of the sloughs are very highly leached. At one site the soil conductivity was traced from the surface down to the bedrock at a depth of approximately 60 meters and the overlying till was found to be leached of salts for its entire depth. Some of these leached sloughs are slightly acid.

Conclusions

Based on one year of experience, we conclude that it will be feasible to describe and document the various models of salinization and to design management and/or reclamation processes based on this documentation. We also conclude that the classical Montana saline seep model accounts for a relatively small percentage of salt affected land in Saskatchewan. This has very far reaching implications for the kinds of management recommendations that we are making and that we

should make in the future. For example, there is little point in recommending that the upper slope positions be cropped to remove a water table if in fact a water table does not exist.

We also conclude that detailed examination of the pedology of a situation will, with sufficient background research, allow reasonable predictions as to salinization processes. At this point in time, the real need in soil salinity is to rapidly document as many sites as possible to determine the relative contribution of the various salinization processes.