SOIL SALINITY IN ALBERTA

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ABSTRACT

Origins, extent and reclamation of saline soils in Alberta are described. Natural and man-induced salinity are addressed but the latter is emphasized. Major activities/structures responsible for causing man-induced salinization, roughly in order of decreasing extent, include dryland agriculture, irrigated agriculture, oil and gas development, lagoons/ reservoirs, ditches, and coal mining.

Methods for measuring salinity, its variability, and mapping requirements are discussed - expanding the use of EM-38's for groundtruthing is highly recommended.

Salinity management and prevention practices that are required to control salinization are explained. Joint efforts among industry, government, universities, and consultants have led to success in the non-renewable resource areas - the challenge for the 1990s is to bring about similar success in the renewable resource areas. Integrated, multidisciplinary, systems approaches at the watershed level involving farmers, researchers, policy makers and other key players are a must. Solutions to salinity problems will also ameliorate other important types of soil degradation.

INTRODUCTION

This paper focuses on soil salinity in Alberta based on experience gained on numerous consulting assignments, information gathered through discussions with colleagues, and literature reviewed. Items addressed include principal types and causes of salinity, salinity measurement, salinity management, salinity prevention, and finally, recommendations for action. Where possible, costs associated with damages, identification and reclamation are estimated.

SALINITY ISSUES

Types of Salinity: There are two major types of saline soils - those that exhibit "natural" salinity and have been broadly classified as Solonetzic soils; and, those that have been "man-induced". The latter are emphasized in this presentation.

Solonetzic soils are formed from geological materials high in sodium salts, due to intrinsic properties or to the influence of groundwater. Their most distinguishing feature is a subsurface hard-pan (Bnt horizon) which restricts water and root penetration and water availability. Crop yields are limited by poor physical conditions, high salt content, low fertility and associated surface acidity. In Alberta they are wide-spread from Vegreville to Taber and in the Peace River Area totalling nearly 5 million hectares (Toogood and Cairns 1973). Saline Gleysolic soils associated with wetlands and groundwater discharge areas also belong to the "naturally" saline soils.

Recently (<50 years) man-induced soil salinization has become a major concern in Alberta. It may occur as the spread of "naturally" saline soils or as the development of salinity where surface soils were previously not affected. Soil productivity is impaired by high salt content and in many locations associated excessive wetness or poor soil structure also reduces yields.

Causes of Man-Induced Salinity:

Soil salinization is caused by raising the watertable to less than about 2 m below ground surface in areas of saline subsurface materials thereby permitting capillary rise of salts into the root zone, by direct planned or accidental additions of salts to the soil (e.g. disposal of saline wastes, brine spills), or by land disturbances that result in saline parent materials being left at or near (<1 m $\pm$) the land surface. Responsibility for activities which contribute to salinization lies with both public and private sectors as discussed below.

1. **Dryland Agriculture**: A change from native perennial vegetation to arable agriculture, especially involving summerfallowing, is a major factor contributing to soil salinization (Coote 1983; Alberta Agriculture 1986). The change in vegetative cover permits increased downward percolation of water (**see Figures 1, 2, 3**). In recharge areas, the excess water will move down through the soil until it reaches a more/less permeable layer, then flow downslope within/above the layer, respectively, dissolving salts as it flows. If it reaches an area where the watertable is near the ground surface (about <2 m), the salt enriched water will rise by capillary action into the root zone. If the watertable is shallower than about 1 m the salts will rise to the soil surface forming a salt crust upon evaporation of the water. In discharge areas, rain water moving down through the profile will tend to leach any shallow salts downward but it will also raise the watertable and when dry conditions return, capillary rise will again bring salts upward. Salts may be removed from the root zone through downward flushing by heavy rainfall or irrigation, when the watertable is lowered naturally or by artificial subsurface drainage. The equilibrium concentration of the salts and depth of accumulation ultimately depends on rainfall; evapotranspiration; soil texture and permeability; watertable dynamics; chemistry of soil, geological deposits, and groundwater; and the complex interactions of these over time. For a more detailed explanation refer to the Dryland Saline Seep Control publication (Alberta Agriculture 1986).

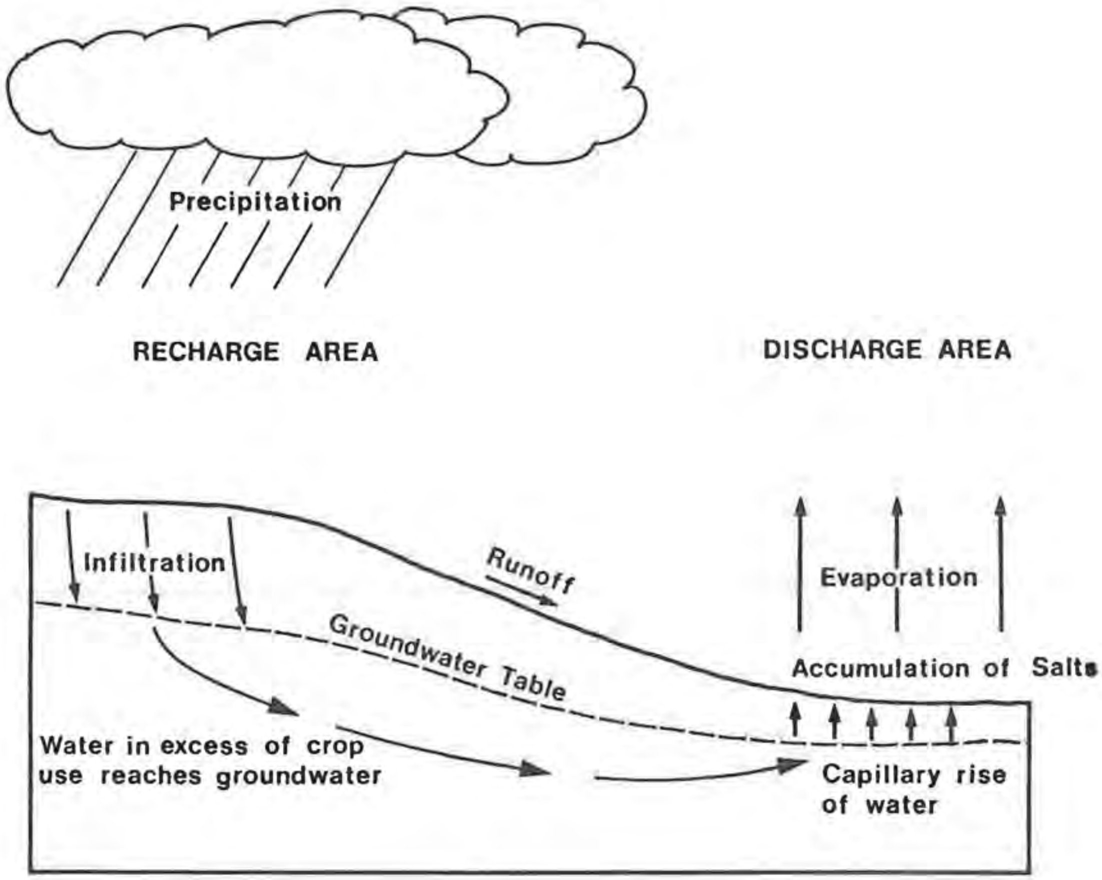

Figure 1. Development of Saline Soils.

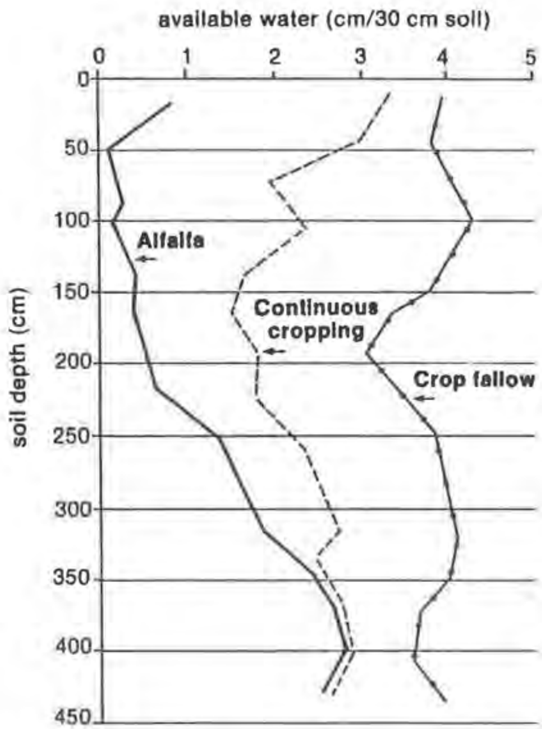

Figure 2. Available soil water under various crop systems, fall 1978 (Brown, USDA, Montana).

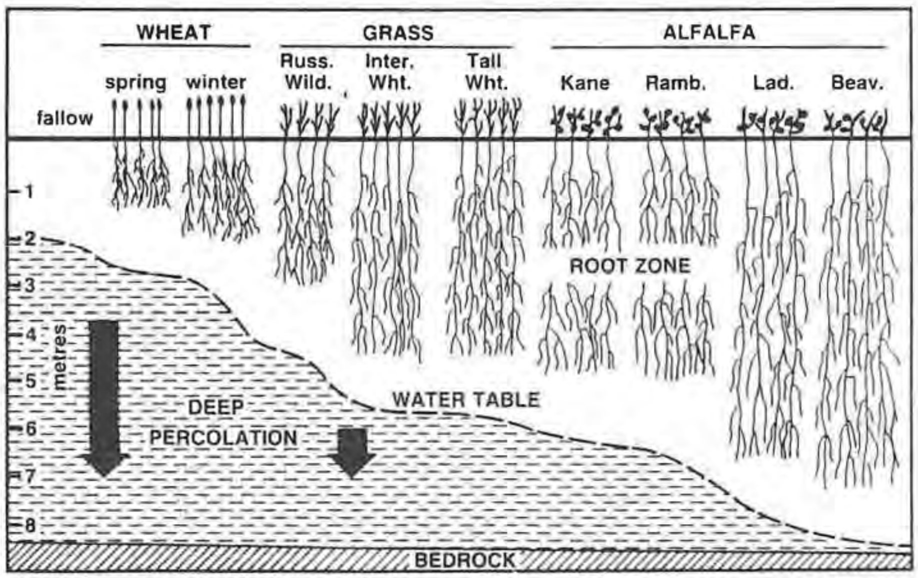

Figure 3. Rooting and Water Table Depths with Wheats, Grasses and Alfalfa.

Wetland drainage which is an increasing practice on the prairies should help to lower the watertable and in areas prone to salinization this should reduce soil salinization. However, careful planning, design, construction and maintenance of drainage systems are required to ensure that runoff waters do not cause erosion or ponding and salinization downstream. Also effects of drainage on groundwater for domestic supply should be considered. It is clear that to date agricultural practices on the prairies have shifted the natural balance in the direction of expanding salinization. A recent provincial survey at a scale of 1:1 million coordinated by the Land Resource Centre of Agriculture Canada (personal communication with W.W. Pettapiece) indicates that the main agricultural area affected lies roughly in the southeastern quarter of the province (bounded on the north by a line from Edmonton east to Saskatchewan and on the west by a line from Edmonton south to USA). A total of about 320 000 ha is affected by salinity (EC > 8 dS/m in upper 60 cm). Various estimates of rates of expansion have been made as high as 10 percent of the salt affected area per year in some areas (Vander Pluym 1982), but rates are judged to be much lower on a provincial basis. A lack of historic baseline salinity surveys makes it impossible to re-survey areas and determine changes in areas affected on that basis.

2. **Irrigated Agriculture:** Factors responsible for increased salinization in dryland areas are enhanced in irrigated areas. Application of irrigation water, containing small amounts of salt (<300 ppm), and percolation downward to the watertable resulting in raised groundwater levels more than offset increased evapotranspiration by higher yielding crops. If salts are not leached through, there could be some accumulation over years resulting from the additions by irrigation water. Caution is needed in generalizing in that differences in amounts and timing of irrigation, crops grown, and rotations followed also affect the final salt balance. In addition, there is leakage from unlined irrigation canals which is severe especially in coarse textured soils. Over the years various reports have estimated that from 10 to 30% of the irrigated land is affected (Harker et al. 1986). Some 340 000 ha of irrigated land was estimated to be affected by salinity (EC >4 dS/m in upper 60 cm) and/or wetness (Leskiw 1985). Note this salinity level is lower (EC>4) than indicated for dryland (EC > 8) extent, and it includes non-saline waterlogged areas. More critical limits for irrigated lands are justified since higher value and more sensitive crops are commonly grown.

3. **Oil and Gas Industry:** The oil and gas industry is a minor contributor to soil salinization, in terms of area affected, however, damage can be severe (EC >20 dS/m) in localized areas. Principal sources of salts include:

   - brine spills/leakage from ruptured pipelines and from storage lagoons at battery sites (significant problem in some of the older oil fields),

- disposal of drilling wastes where saline water muds are used or where saline formations are encountered (main concern in Cold Lake region),

- bringing saline subsurface materials to the surface during pipeline construction (main concern in areas of Solonetzic soils).

4. **Sewage Lagoons and Water Reservoirs/Small Dams:** Any artificially constructed water reservoirs that can leak and raise the surrounding waterable to within 1 to 2 m below ground surface are potential contributors to soil salinization. It is common to observe salt crusts, in areas of saline geologic materials, covering less than 1 to 2 ha around village/town sewage lagoons throughout Alberta.

   Where sewage is disposed through irrigation, conditions as described under irrigated agriculture are generally applicable but because sewage disposal occurs on a much smaller scale and in isolated areas, negative impacts are less likely. Also, where buried pipelines are installed comments given under the oil and gas industry apply.

5. **Road and Drainage Ditches:** Ditches which alter natural water flow and either drain or create ponding areas have affected soil salinity. Effects may be positive or negative depending on whether the local watertable is lowered or raised, respectively. The extent of changes in salinity is impossible to estimate but these are clearly localized and the acreages affected are included under dryland agriculture.

6. **Mined Land:** Coal mining in areas of Solonetzic soils and/or saline geological materials has the potential for altering pre-mine soil salinity status by placement of saline materials at the surface and by redistribution of salts by groundwater in the post-mine landscape. Depending on materials handling practices, landscape design, land use, etc. net effects may be positive, negative or unchanged. The extent of possible impact is restricted to mined areas - a few thousand hectares.

SALINITY MEASUREMENT

Spatial and Temporal Variation: Soil salinity levels (natural or man-induced) may be relatively uniform over sizeable tracts or they may vary considerably (EC 5 to 20 dS/m) over a few metres, depending on topography, soils, hydrogeological regime, and sources of salinity. Salts are soluble and readily move with soil water, thus, at any given time salinity levels are the result of a balance between upward, downward and lateral saturated and unsaturated water flow. Significant changes (say EC 2 to 3 dS/cm) may occur in a few days in response to a heavy rainfall or a high evaporation period or on a seasonal basis reflecting different climatic conditions and crop growth stages. Over a period of years even greater shifts may occur reflecting climatic cycles, changes in groundwater regime, land use, etc.

Methods of Measurement: McKenzie (1986) has prepared a summary of the most common methods of measuring salinity, comparative costs and relationship to crop yields. The same paper outlines procedures and charts for determining EC using an electromagnetic conductivity meter (EM-38).

In my opinion, the EM-38 is an extremely useful instrument for determining soil salinity at a fraction of the cost (1/30±) of conventional laboratory procedures. This represents a major break-through in soil salinity measurement. Main factors affecting the readings include soil temperature, moisture content and texture. Moist soil conditions result in better readings than dry conditions and the ground should not be frozen. Calibration of the instrument can be accomplished by sampling 10 or more profiles representing a range of salinity levels and relating instrument readings to mean profile EC. Examples of resultant linear relationships developed for different projects are given in **Figure 4**. Higher r^2 values indicating better readings have been observed when readings were taken on moist soils and also when a wide range of salinities (e.g., EC 1 to 20) were encountered. Low r^2 values correspond to dry conditions and a narrow range of readings (e.g., EC 2 to 8). Equivalent EC values may also be determined directly using procedures described by McKenzie.

Classification: Over the years, various salinity classification systems have been employed differing mainly with respect to descriptive terminology, EC limits for categories, depths considered, and percentage of areas (map units) affected. **Tables 1 and 2** outline classes defined in Soil Erosion and Salinity Surveys: A Procedures Manual (Alberta Agriculture 1986).

Mapping: Salinity of a pedon can be characterized by different individuals, using various techniques, with samples analyzed by different labs and comparable results would be expected. Mapping of salinity, however, is much more difficult to standardize and to reproduce by different mappers. Characteristics of the landscape, skill of mappers, mapping scale, mapping objectives, quality of aerial photos, amount of ground truthing, methods and intensity of salinity measurements, spatial and temporal variations, and salinity patterns all contribute to making salinity mapping an art rather than a science (see Harker et al. 1986). Areas with strong salinity (EC >8) are generally clearly visible in the field or on aerial photographs because of presence of bare spots, salt crusts, or vegetation indicators. Weak and moderate salinity is best measured by ground truthing, and the EM-38 is an ideal instrument for this purpose.

Good quality salinity surveys at a scale of 1:20 000 (suitable for individual problem/management application) using suitable aerial photographs, an EM-38, minimal laboratory analysis, and ground truthing of most apparently saline areas, can be produced for about \$1500 to \$3000 per township (16 to 32 cents per ha) depending mainly on extent of salinity, intensity of ground truthing, access and size of survey area. Costs can be reduced substantially if this is done in conjunction with a soil survey, farm assessment, or any survey that requires ground coverage. Larger scale mapping can of course be prepared at lower costs, but such maps are limited to planning uses - they are not detailed enough for salinity management purposes.

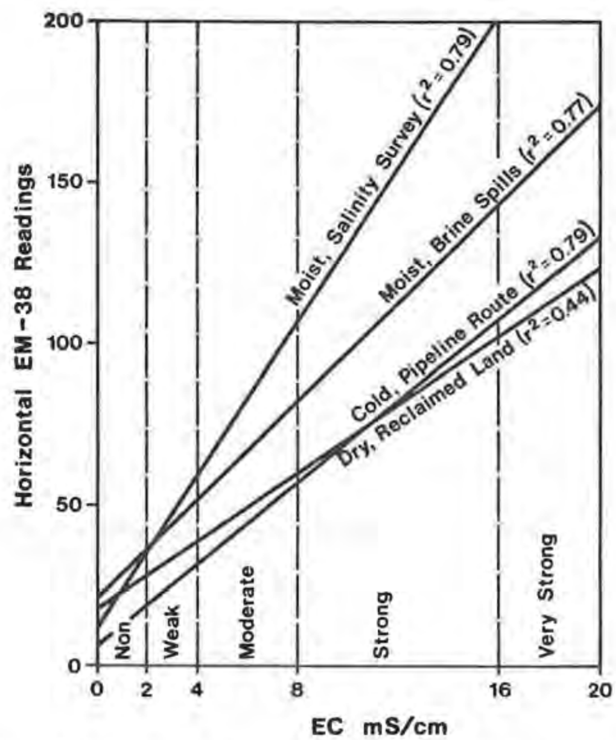

Figure 4. Project linear relationships relation EM-38 readings to mean profile EC.

Table 1. Salinity Classification.

EC (mS/cm)	Degree	Class	Effects
0 to 2	None	1S	Salinity effects negligible
2 to 4	Weak	2S	Yields of sensitive plants reduced
4 to 8	Moderate	3S	Yields of most crops reduced
8 to 16	Strong	4S	Only tolerant crops productive
>16	Very Strong	5S	Only tolerant plants survive

Table 2. Salt Tolerance of Agricultural Crops.

Tolerance	Field Crop	Forage Crop
High	Barley	Tall Wheatgrass
	Winter Wheat	Russian Wild Ryegrass
	Rye	Slender Wheatgrass
		Sweet Clover
Moderate	Oats	Bromerass
	Spring Wheat	Reed Canarygrass
	Rape	
	Corn	Alfalfa
	Flax	
Low	Peas	Clover
	Beans	

Salinity Management: Salts are soluble and move with the soil water, therefore, salt management is also soil water management. Practices which lead to an increase or decrease in levels of saline groundwater above or below a critical depth (about 2 m, depending on soil type) will correspondingly tend to increase or decrease salinity in the root zone. Additions to groundwater occur because of increased rainfall, irrigation, leakage from reservoirs, downward percolation in ponding areas, practices such as snow trapping and summerfallowing or growing crops that result in lower evapotranspiration which all contribute to increased soil moisture content. The key to controlling the spread of salinity is to manage the crops, soil, and water in a way that maintains groundwater levels below critical levels. Recommendations to achieve optimum conditions in this respect depend on many factors and differ from one locality to another, but in all cases the key components to understanding and managing salinity are the same. They include: climate, surface hydrology, hydrogeological regime, soils, topography, soil and water chemistry, vegetation/land use, and economics. It is essential to study the land in three dimensions, preferably on a watershed basis, and to gain an appreciation for the variations over time. To properly diagnose salinity problems in order to make sound recommendations for reclamation multidisciplinary and integrated analyses are a must!

Reclamation approaches can be grouped into three main categories: engineering approach, agronomic approach, and combination of these. The engineering approaches involve surface drainage to reduce recharge or subsurface drainage to lower the watertable and flush the salts out of the profile, with or without irrigation. In natural saline seepage areas installation of subsurface drains costs in the order of \$1000 to \$2000 per hectare. Surface drainage is generally much cheaper. However, the availability of outlets for drainage waters is another major factor in determining total drainage costs and this could be a few hundred to thousands of dollars per hectare. Under dryland conditions reclamation time may be several years. If irrigation is applied, reclamation success can be greatly enhanced. As a guide, it takes several sequential applications totalling 1 m of water to reclaim a 1 m depth of soil.

The agronomic approach involves lowering the watertable by practicing the following:

- in the recharge area - high moisture use crops
  - continuous cropping
- in the discharge area - growth of salt tolerant crops
  - continuous cropping
  - manuring

While reclamation may take several years, and is best suited to "man-induced" salinity control, costs are minimal in comparison to those for the engineering approach. In areas of natural seepage, subsurface drainage is required for successful reclamation. An operator must therefore choose the optimum reclamation approach, or combination, for a given type of operation and salinity problem.

What are the costs of salinization to agriculture? Table 3 shows expected yields (bushels/acre) and corresponding values for barley, wheat and oats grown on soils within different salinity classes. Losses, assuming constant inputs, range from about $30 to $120 per acre ($75 to $300 per hectare) per cropping season.

An issue that is gaining attention is drainage water quality and its impact downstream. At current rates of drainage no significant problems have arisen, except perhaps in isolated small basins. But if drainage activity increases to the extent needed to reclaim, for example, salinity within irrigation districts water quality degradation could become serious (Stanley SLN Consulting 1978).

At industrial problem sites, for example, brine spill and drilling wastes reclamation, drainage waters cannot simply be discharged into natural courses. Water must be hauled/piped from the site and if irrigation water must also be hauled/piped in for leaching purposes, reclamation costs could skyrocket ($50,000/ha?).

Salinity Prevention: Agronomic practices that are recommended for salinity reclamation may be "relaxed" somewhat to be effective for prevention in dryland regions. On irrigated lands subsurface drainage in affected areas is recommended. Implementation of control or reclamation procedures is probably slower, on an acreage basis, than the spread of salinity. Salinity control on farmlands needs much more attention and action than it has been receiving.

The oil and gas industry has historic salinity problems in many locations that require clean-up. In the future accidental leakage from ruptured lines will continue to be a problem and reclamation will be required. Efforts and research that are underway to improve drilling waste disposal practices, including fluids and solids, will help to minimize associated soil salinization (Leskiw et al. 1986). Pipeline installation guidelines and techniques developed over the past few years should eliminate the associated soil salinization problem, except, perhaps on unregulated lines (Tera Environmental Consultants and Pedology Consultants, 1985). In this case, regulation of all lines would be beneficial.

Reservoirs, lagoons, dams, canals and ditches that leak will continue to contribute to salinization where saline subsoils/groundwaters occur. Techniques to reduce leakage, installation of barrier curtains around reservoirs, and subsurface drainage to maintain salt levels within acceptable limits are suitable control measures. Careful grading of road ditches is needed to eliminate ponding sites which contribute to salinization. In many of these instances, government departments must become more concerned with soil-water-salinity management.

On mined lands special soil handling procedures and reclamation practices have been developed, implemented and are being continually monitored and researched to minimize potential for salinization of reclaimed lands. This

Table 3. **Expected Yields (bushels/acre) and Corresponding Values for Barley, Wheat, and Oats Grown on Soils Within Different Salinity Classes.**

	Salinity Range (mS/cm)							
	0 to 4		4 to 8		8 to 12		12 to 16	
	Typical Yield	Value	Typical Yield	Value	Typical Yield	Value	Typical Yield	Value
Barley	55	$137.50	43	$107.50	32	$80.00	17	$42.50
Wheat	30	$135.00	22	$ 99.00	10	$45.00	3	$13.50
Oats	60	$ 90.00	29	$ 43.50	21	$31.50	5	$ 7.50

* The yield values given are for illustrative purposes only. Many factors in addition to salinity will affect crop yield.

** Crop prices: Barley ($2.50/bushel); Wheat ($4.50/bushel); Oats ($1.50/bush) subject has been given a great deal of attention in the last 10 years by industry and government and progress has been excellent. At this rate, in the next few years soil reclamation guidelines that ensure sustained soil quality should be in place.

WHAT ABOUT THE 1990s?

An overview of current salinity indicates that, in terms of extent, agricultural lands affected by agricultural activities are the most serious salinity problem area. Industry has had and continues to have problems, for example, oil industry has brine spills, but effective regulations and procedures have been developed for clean-up. The same applies to pipeline installation and land reclamation. Steps are underway to deal with drilling wastes and, if progress is as rapid as in mined land and pipeline reclamation, major problems will be under control within ten years. The coal mining and oil sands industries have joined with government to undertake extensive, expensive research on land reclamation. Results have been truly enlightening and have provided important insights into management of undisturbed soils.

What has led to industries' success? Is it the ability to simply add to the price of the resource product to cover reclamation costs, is it response to government regulations, is it public pressure/attitude, is it the ability of specific government and industry agencies to harness forces to deal with "concentrated" site-specific problems. Likely it is a combination of these and the results in terms of solving serious problems have been very encouraging. Experience in salinity control should and no doubt will be applied to other environmental pollutants.

A major problem remains, however, in the agricultural arena. Policies, programs and practices developed over the years have not adequately addressed conservation issues - salinity, erosion, organic matter depletion, etc. The result has been very serious soil degradation. Interestingly, solutions to salinization also help reduce other forms of degradation. Hopefully, the 1990's will bring a new ethic in renewable resource management - leading to sustained or increased production levels, in concert with improved soil and water quality. To accomplish this goal, I believe we will require strong political will, redirection of policies/programs to ensure compatibility with conservation a more effective extension effort that includes the private sector, more active involvement of farmers, researchers, and extension people especially at the watershed/community level, and willingness of the non-farm population to support, socially and economically, the required changes. In the long term, this approach will lead to cheaper food and better food security than will the current one of expanding soil degradation. To keep costs of such a conservation oriented approach under control while maintaining high levels of productivity/efficiency, I believe that much more effort must be put into "agronomic" solutions to degradation problems.

Resource industries, consultants and government agencies have demonstrated an ability to work towards effective environmental protection in non-renewable resource areas. A main challenge for our society is to become more conservation oriented in the renewable resource areas, and this is a must in the next decade. Recent studies as exemplified by the Alberta Wetlands Inventory directed by an interdepartmental steering committee and conducted by consultants representing key disciplines are a positive first step in this direction.

REFERENCES

Alberta Agriculture. 1986. Dryland Saline Seep Control. Agdex 518-11.

Coote, D.R. 1983. Stresses on Land Under Intensive Agricultural Use. Stress on Land in Canada. Folio No. 6, Policy Research and Development Branch, Lands Directorate, Environment Canada. Ottawa.

Harker, D.B., F. Hecker, T.G. Sommerfeldt, C. Chang, L.A. Leskiw, W.W. Pettapiece, and H. Regier. 1986. Extent of Saline/Waterlogged Lands Within Irrigated Alberta: Phase 1 - Inventory and Preliminary Evaluation of Existing Mapping Data. CSRS Paper #54.

Leskiw, L.A. 1985. Application of Soils Information to Irrigation Planning and Management. IN: Fourth Annual Western Provincial Conference Rationalization of Water and Soil Research and Management "Irrigation on the Prairies". Saskatoon. 1985.

Leskiw, L.A., E. Reinl-Dwyer, T.L. Dabrowski, and B.J. Dabrowski (Piteau Engineering Ltd.), and H. Hamilton (HydroQual Consultants Inc.). 1986. Disposal of Wastes from Drilling Systems on the Public Lands of Alberta. Final Report and Field Manual prepared for Alberta Land Conservation and Reclamation Council, Reclamation Research Technical Advisory Committee. Edmonton.

McKenzie, R.C. 1986. Methods of Measuring Soil Salinity. Unpublished Bulletin, Alberta Agriculture, Brooks.

Stanley SLN Consulting Ltd. 1978. Seepage and Salinization in Irrigation Studies: Efficiencies, Seepage and Salinization, Expansion Priorities. Consultant's report to Study Management Committee. Oldman River Basin; Lethbridge, Alberta.

Tera Environmental Consultants and Pedology Consultants. 1985. A Manual on Soil Conservation and Pipeline Construction in Alberta. Prep. for Alberta Environment, Land Reclamation Division.

Toogood, J.A. and R.R. Cairns. 1973. Solonetzic Soils Technology and Management. University of Alberta and Agriculture Canada. Bulletin B-73-1, First Edition.

VanderPluym, H. 1982. Salinity in Western Canada. IN: First Annual Western Provincial Conference Rationalization of Water and Soil Research and Management "Soil Salinity". Lethbridge, Alberta.

USEFUL CONVERSIONS

The conversion of EC mS/cm to mg/l or ppm of salts depends on the prevalent ions in the solution. For Alberta, the following relationships are recommended:

Salt (mg/l) = 850 x EC mS/cm;
if sulphates are dominant in the soil solution.

or

Salt (mg/l) = 640 x EC mS/cm;
if chlorides are dominant in the soil solution.

Salt ppm or mg/l x saturation % x soil bulk density g/cc x soil depth cm x $10^8 cm^2$/ha x 1 kg/1000 g = salt kg/ha

To calculate meq/l in saturation extract from kg/ha of ion applied, the equation is:

$$\text{ion meq/l} = \text{ion kg/ha} \times \frac{1\text{ eq}}{(\text{ion eq.wt})\text{g}} \times \frac{1000\text{ meq}}{1\text{ eq}} \times \frac{1000\text{ g}}{1\text{ L}} \times \frac{1000\text{ g}}{1\text{ kg}} \times$$

$$\frac{1\text{ ha}}{10^8\text{cm}^2} \times \frac{1}{\text{b.d. g/cm}} \times \frac{1}{(\text{soil depth})\text{ cm}} \times \frac{1}{\text{Sat.\%}}$$

RECOMMENDATIONS FOR FUTURE ACTION

Salinity is a serious and expanding soil degradation problem in Alberta, especially on agricultural lands. Joint government-industry efforts have proven to be successful in reclaming salinity caused by past industrial activity and new problem areas will no doubt be addressed as they arise. Reclamation of agricultural lands needs much more attention. Requirements for success include:

1. detailed multidisciplinary inventories (salinity, soils, groundwater regime, cropping practice, economics) that provide a sound basis for clean-up,
2. watershed based approaches (research, pilot projects, cooperative effort among farmers),
3. stronger extension effort focussing on a systems approach that is technically, environmentally and economically sound and socially desirable,
4. policies and programs to be tailored to be in harmony with the foregoing.

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MESSAGE FROM THE ORGANIZING COMMITTEE

Reclamation practitioners and researchers have gone a long way to solving the problems posed by such disturbances as mining, drilling and pipeline construction. The future challenge for reclamation lies in applying our expertise in other areas such as industrial site decommissioning, habitat creation and restoration, and urban design.

The Symposium was designed to expose participants to a wide variety of "new" areas where reclamation science could be applied. These were the "targets" referred to in the Symposium title. The speakers did an excellent job in meeting this goal. Some of the participants felt the Symposium had not provided enough information on new methods to be employed in reclaiming these new disturbance types. While this was not the goal of the Symposium it remains a valid concern that should be addressed in a future symposium.

Finally, the Hon. Ken Kowalski, Minister of Environment, encouraged all participants to get out and preach the need for, and successes of, reclamation, and indeed all environmental programs. Telling ourselves in conferences how wonderful we are is preaching to the converted. We need to let those who benefit from our labours, that amorphous group known as the public, know what we have done for them. This, too, should be the topic of a future symposium.

The papers in this proceedings have been edited and retyped into a common format. The contents of the papers are essentially unchanged from the submitted manuscripts of the authors.

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