Soil and Water

Canada-Saskatchewan Irrigation Diversification Centre

Reclamation of a Saline Irrigated Field using Subsurface Drainage

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Introduction

Most Saskatchewan soils contain natural salts that can reduce crop productivity if the salts become concentrated in the root zone by upward water movement. Restricted drainage conditions may also cause salinization by raising the water table.

Such a problem occurred at the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) on a 9-ha (23-ac) parcel of land (Field 11) that had been flood irrigated since 1949. A fine-textured soil layer beneath an otherwise well-drained loam to silty loam soil restricts drainage of excess water. By 1986, the salinity had become so severe that only a salt tolerant grass-legume mix could be grown on the field. CSIDC decided to undertake a reclamation program that would include installation of a subsoil drainage system and careful management of irrigation to leach excess salt from the soil.

Procedure

The first step was to improve control of water application by replacing surface flood irrigation with a linear move sprinkler system. Improvements to surface drainage provided better control of surface runoff and prevented ponding.

A subsurface drainage system was installed in 1986. The system was based on drainage system design equations using site-specific soil properties. Perforated 100 mm (4 in) polypropylene pipes fitted with a polyester filter sock were installed at 15 m (50 ft) and 30 m (100 ft) spacings. A laser-controlled trencher was used to place the pipes on a gradient sloping from a depth of 1.2 m (4 ft) to 1.6 m (5.25 ft) where pipes connect with a main drainage conduit. The main conduits slope to a 2.6 m (8.5 ft) depth where they drain into an effluent collector in the southwest corner of the field.

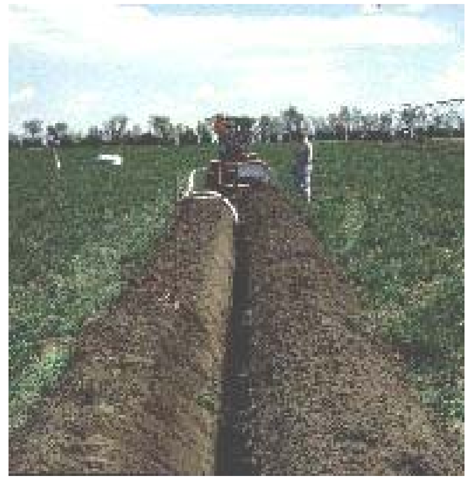
Once the drainage system was in place, salts were removed from the soil by flushing with water (i.e. leaching). Water was applied for six years after harvest when evaporation was low. A high percentage of irrigation water was able to move through the soil (Table 1). This irrigation produced a large flush of effluent water passing through the drainage and collection system (Figure 1). The volume of total dissolved salts (TDS) leached from

Severely saline field.

EM38 salinity meter.

the soil was measured in the effluent from 1986 to 1993 (Figure 2).

A permanent 15 m x 15 m (50 ft x 50 ft) grid was established for monitoring changes in soil salinity. Salinity was measured using an EM38 conductivity meter each fall after leaching had been completed. The EM38 measurements were then used to classify each portion of the field as non-, slightly, moderately, and severely saline.



Drain installation.

Geostatistical software was used to calculate the total area that fell within each salinity class.

Table 1. Total fall leaching water applied.

Year	Leaching Water (mm)	Leaching Water (in)
1988	475	18.7
1989	355	14.0
1990	270	10.6
1991	297	11.7
1992	222	8.7
1993	135	5.3
1994	50	2.0
1995	0	0
1996	0	0
1997	0	0

Fall leaching on saline field.

Salt Removal Results

This carefully planned and implemented reclamation program was effective in removing salts and restoring the cropping potential of the land. The fall leaching program removed a large volume of dissolved salts as measured in the drainage effluent (Figures 1 and 2). Theoretically, soil salinity is reduced by 50% when the ratio of the depth of water applied (Dw) to the depth of soil leached (Ds) is equal to 0.5 (Dw/Ds = 0.5); 80% of the salts are removed when the depth of water applied is equal to the depth of soil leached (Dw/Ds = 1.0). Based on soil analyses, the results of this study are consistent with the predicted values. Enough water had been applied to remove 50% of the salt to a depth of 1.0 m after leaching in 1988, and 80% of the salt had been removed after leaching in 1989.

Figure 1. Water (effluent) flow rates from drains.

Figure 2. Salinity levels of drain water (Total Dissolved Solids (TDS)).

Soil Monitoring and Crop Yield

EM38 readings to a 0.75 m (30 in) depth indicate a dramatic decline in soil salinity. Before the reclamation program started in 1987, more than 60% of the land area was classified as moderately or severely saline (Table 2). After the first leaching season in 1988, less than 30% of the land was moderately or severely saline, with a further reduction to 3% after leaching in 1989. The benefits of reclamation were demonstrated by a rapid improvement in barley yields (Table 3). In 1988, the crop grew in strips over the drains where soil mixing had occurred; by 1990, barley yields had more than doubled.

Table 2. Percentage of field area in each salinity class using EM38 horizontal readings.

Year	Salinity Class (dS/m) Non- (0-2)	Slight (2-4)	Mod. (4-8)	Sev. (8-16)
	--- % field area ---			
1986	20	18	34	28
1988	17	54	26	3
1989	69	28	3	0
1991	89	11	0	0
1993	93	8	0	0
1995	70	28	2	0
1997	83	16	1	0
2000	83	16	1	0

A demonstration plot was established in 1990 in the most severely affected area of the field to evaluate the response of crops sensitive to salinity.

Successful reclamation of saline field evident from crop yield.

No adverse effects were observed in the growth of faba bean, pea, lentil, dry bean, or hard red spring wheat. Reclamation of this field using subsurface drainage had been achieved.

Table 3. Crop yield after subsurface drainage installation and reclamation.

Year	Crop	Yield (kg/ha)	(bu/ac)
1988	Heartland Barley	3225	60
1989	Bonanza Barley	4470	83
1990	Duke Barley	6990	129
1991	Duke Barley	5900	109
1992	Duke Barley	6505	120
1993	Manley Barley	4838	89
1994	Duke Barley	5240	97
1995	Othello Pinto Bean	2477	2205*
1997	Sceptre Durum	4720	70

* lb/ac

The Bottom Line...

Reclamation of a severely saline field can be achieved using a well-planned, site-specific subsurface drainage system coupled with a proper leaching program.

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