SOIL SERIES 86

A REPORT ON FIELD RESEARCH IN SOILS

The 1970 edition of the "Bluebook" is a compilation of data collected and analyzed throughout Minnesota. Information was contributed by personnel of the Department of Soil Science, Extension Soil Specialists and Agronomists at St. Paul and the branch stations at Crookston, Grand Rapids, Lamberton, Morris, Rosemount and Waseca, and Soils and Crops agents.

Some of the results are from 1969 experiments only and should be regarded on this basis. The investigations are those of a more applied nature, and exclude some of the more theoretical laboratory, greenhouse and growth chamber studies. Since considerable amounts of data includes only one years study, it should not be considered as conclusive and not for further publication.

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SOME CLIMATOLOGICAL NOTES, FALL 1969

by Donald G. Baker

A. Summary of the 1969 Soil Water Survey.

The fall 1969 soil water results are shown in Table 1. Following the exceptionally high precipitation of fall 1968, which was centered over an area a bit west of Lamberton where a total of 18 inches was recorded in September and October, the 1969 soil water reservoirs are returning to normal. This is why most of the soils show a decrease in water content between fall of 1968 and 1969 (column 8 in table 1).

The return to normality of the water content in south-central and southwestern Minnesota was in part hastened by the departure of the April 1-August 31, 1969, precipitation from normal, Fig. 1. In all of central and southern Minnesota, except a relatively small area in the southwest and extreme south-central, the precipitation was below normal. The deviation reached a maximum departure of at least 8 inches below normal in a small area south of the Twin Cities.

The 1968 and 1969 soil water reservoirs during the growing season at Southwest Experiment Station, Lamberton, are shown in Fig. 3. By the end of the 1969 season the reservoir was about back to normal.

The 1968 and 1969 seasons at the Northwest Experiment Station, Crookston, are shown in Fig. 4. It is interesting to note the difference in water content due to plant cover.

In summary the soil water reservoir in the state seems to be as follows:

1. Average in the south-central and southwest. For the 1970 crop year only a normal seasonal precipitation is required.

2. The same is true for northeastern, north-central and northwestern (except the exterme northwestern tip) Minnesota.
3. Soil moisture reserves are probably somewhat below normal in the west-central and extreme southeastern parts of the state. Normal to somewhat above normal precipitation is required for the 1970 season.
4. Soil reserves are probably quite low in the extreme northwestern tip and in a relatively large area in central and east-central Minnesota. Well above normal precipitation will be necessary to sustain crops in the 1970 season.

Table 2 shows the average soil water content at a number of sites.

B. Average Winter Snow and Soil Conditions at St. Paul.

While the following data are derived only from the Twin Cities area they may be of general interest to those concerned with the winter climate. Table 3 shows that on the average the snow depth reached a maximum in February, although there was a slightly greater liklehood of snow cover in January (78.8% of the days) than in February (75.7% of the days). For the winter period of December-March the snow cover persisted about 82 days (67.6% of the days) with the daily snow depth averaging 4.3 inches.

The average progression of the 32°F isotherm into and out of the soil at the St. Paul campus weather station is shown in Fig. 4.

Also shown in Fig. 4 is what is believed to be typical patterns of frozen soil when a deep snow cover is present and when there is relatively little snow cover (a so-called "open" winter). Of particular importance

Table 3. Long-term mean monthly snow depth and percent of possible days with snow cover.*

	Nov	Dec	Jan	Feb	Mar	Apr	Mean (Dec-Mar)
Depth (In.)	0.67	2.95	4.90	5.71	3.64	.T	4.3
Possible Days (%)	25.7	65.1	78.8	75.7	51.5	1.5	67.6

*Based upon snow depth values on the 10th, 20th and 30th day of each month. Data from the Minneapolis-St. Paul Weather Bureau airport station. T signifies a trace.

with respect to early spring drainage problems is the fact that a frozen layer often persists at intermediate depths (centered between 60-80 cm, 24-31 in.) for about 10 days after thawing has occurred both above and below this level.

Table 1. Fall 1969 soil water survey results (soils sampled to a depth of 5 feet).

County	Nearby Town	Operator	Soil Type	Crop	Total Available Water, Inches	% of Possible Water	Inches Difference Fall '69-Fall '68	Water Used In Season, Inches	
Big Stone	Ortonville	H. Dimberg	Barnes c.l.	Alf-brome	1.9	13.9	-0.7	21.4 4/25-11/10	OG
Big Stone	Beardsley	Wright	Barnes si.l.	Soybeans	4.7	40.1	+4.2	11.6 4/25-11/10	OG
Chippewa	Milan	H. Olson	Rothsay si.l.	Soybeans	5.1	38.3	-2.2	21.9 5/6-11/10	OG
Chippewa	Montevideo	Sederstrom	Barnes si.l.	Corn	2.8	21.2	-3.2	20.0 5/6-11/10	OG
Grant	Barrett	H. Hubbard	---	Wheat	2.0	15.2	----	14.1 5/12-11/10	OG
Jackson	Lakefield	Pietz	Primghar si.l.	Alfalfa	8.9	93.6	*	5/26-10/27	GH
Kandiyohi	Pennock	G. Geise	Clarion si.l.	Alf-brome	1.9	13.9	-5.9	M-11/10	GH
Lac Qui Parle	Bellingham	Glasser	Aastad si.c.l.	Corn	9.9	61.8	+0.2	M-11/10	OG
Lac Qui Parle	Lac Qui Parle	Heimdahl	Rothsay si.l.	Small grain	1.5	11.0	-3.8	21.6 5/6-11/10	OG
Lac Qui Parle	Marietta	Aebli	Rothsay si.l.	Small grain	8.0	59.7	-1.3	22.0 5/6-11/10	OG

Table 1. (Continued)

Lac Qui Parle	Dawson	M. Nelson	Aastad si.c.l.	Soybeans	5.6	51.8	-4.2	21.4 5/6-11/10	OG
Lincoln	Porter	R. Boulton	Barnes si.l.	Corn	3.7	47.4	-5.2	22.1 5/23-10/28	GH
Lyon	Marshall	Boerboom	Vallers c.l.	Corn	15.6	125.8	*	5/24-10/29	GH
Murray	Slayton	A. Larson	Barnes si.c.l.	Alfalfa	3.3	25.8	*	16.5 5/26-10/27	GH
Murray	Fulda	R. Horn	Primghar si.l.	Oats	5.3	30.6	*	18.0 5/26-10/27	GH
Polk	Crookston	U. of M.	Hegne si.c.l.	Barley (#1)	11.3	66.4	+1.5	15.2 6/8-10/31	OS
Polk	Crookston	U. of M.	Hegne si.c.l.	Wheat (#5)	7.1	41.7	-0.8	16.2 5/30-11/4	OS
Polk	Crookston	U. of M.	Hegne si.c.l.	Sugarbeets (#6)	5.0	29.4	----	15.4 6/3-10/31	OS
Pipestone	Pipestone	Bucher	Kranzburg si.l.	Corn	8.4	61.7	-1.5	20.1 5/23-10/27	GH
Ramsey	St. Paul	U. of M.	Waukegan si.l.	Sod	1.4	17.3	-3.5	14.1 5/4-10/23	DB
Ramsey	St. Paul	U. of M.	Waukegan si.l.	Soybeans	1.5	18.5	-4.7	15.3 5/4-10/23	DB
Ramsey	St. Paul	U. of M.	Waukegan si.l.	Bare soil	1.1	13.6	-3.7	14.3 5/4-10/23	DB

Table 1. (Continued)

Redwood	Belview	V. Anderson	Nicollet c.l.	Corn	8.4	67.2	*	12.6 5/20-10/29	GH
Redwood	Lamberton	U. of M.	Webster c.l.	Corn	4.8	48.9	**	14.9 6/20-10/18	WN
Redwood	Morgan	N. Prokosch	Nicollet c.l.	Alfalfa	1.5***	33.3***	*	17.4 5/24-10/29	GH
Redwood	Wabasso	D. Kuehn	Nicollet	Corn	4.1	31.3	-2.9	5/24-10/29	GH
Rock	Hardwick	Hengeveld	Kranzburg si.l.	Corn	4.8	44.8	-8.2	M-10/27	GH
Stevens	Alberta	R. Cook	---	Alfalfa	2.5	17.5	---	14.9 5/12-11/10	OG
Stevens	Morris	U. of M.	Aastad si.c.l.	Corn	3.0	23.8	-0.4	16.8 5/12-11/10	OG
Swift	Danvers	Stubbs	Barnes c.l.	Corn	2.7	18.8	-2.1	22.2 5/6-11/10	OG
Swift	Murdock	Tucker	Vallers si.c.	Corn	12.1	79.0	-3.3	M-11/10	OG

*Too wet for fall samples in 1968.
**Compared to 9/13/68 sample; too wet for later sampling in fall, 1968.
***Includes only first 3 feet.
NOTE: S.C.S. sites not sampled because sampling materials not sent out.

Table 2. Average fall soil water reserves in inches of available water in a 5 foot column of soil.

County	Nearby Town	Ave. Water Content (in.)	Years of Data
Big Stone	Ortonville	1.7	4 (1966-69)
"	Beardsley	1.4	4 (1966-69)
Chippewa	Milan (Big Bend)	6.3	7(1962-69) '65 msg
"	Montevideo	3.5	5 (1965-69)
Dodge	Dodge Center	4.8	9 (1960-69) '69 msg
Grant	Barrett	2.0	1 (1969)
Jackson	Lakefield	6.3	2 (1967-69) '68 msg
Kandiyohi	Pennock	2.2	6 (1963-69) '65 msg
"	Kandiyohi	1.4	4 (1963-68) '65 msg
Lac Qui Parle	Bellingham	9.21	7 (1962-68) '65 msg
"	Lac Qui Parle	2.8	5 (1965-69)
"	Marietta	6.5	7 (1962-69) '65 msg
"	Dawson	6.6	6 (1963-69) '65 msg
Lincoln	Arco	3.3	6 (1963-69) '69 msg
"	Porter	4.9	7 (1963-69)
Lyon	Marshall	7.7	5 (1963-69) '66,'68 msg
Murray	Slayton	2.2	2 (1967-69) '68 msg
Mille Lacs	Milaca	6.7	8 (1961-69) '69 msg
Nobles	Fulda	3.2	2 (1967-69) '68 msg
Polk	Crookston	6.2 (Plot 1)	9 (1961-69)
"	"	3.7 (Plot 4)	3 (1964-69) '66,'69 msg
"	"	7.7 (Plot 5)	5 (1964-69) '66 msg
"	"	5.6 (Plot 6)	4 (1964-69) '67,'68 msg
"	"	2.9 (Plot 7)	2 (1966-67) '68,'69 msg

Table 2. (Continued)

County	Nearby Town	Ave. Water Content (in.)	Years of Data
Pipestone	Pipestone	6.5	3 (1967-69)
Ramsey	St. Paul	6.9 (Sod Plot)	4 (1965-68)
"	"	6.4 (Soy Plot)	6 (1962-68) '64,'67 msg
"	"	8.3 (Base Plot)	3 (1965-68) '67 msg
Redwood	Belview	5.9	7 (1962-69) '68 msg
"	Lamberton	5.1	8 (1961-69) '68 msg
"	Morgan	7.6	3 (1965-68) '68,'69 msg
"	Wabasso	5.0	6 (1963-69)
Rock	Hardwick	8.3	3 (1967-69)
Sibley	Winthrop	8.5	7 (1961-69) '68,'69 msg
Stevens	Alberta	2.5	1 (1969)
"	Morris	2.5	3 (1967-69)
Swift	Danvers	4.3	6 (1963-69)
"	Murdock	1.0	6 (1963-69)
Todd	Long Prairie	8.3	1 (1968) '69 msg
Watonwan	Butterfield	7.4	7 (1961-69) '68,'69 msg
"	Lewisville (Mad)	7.6	3 (1966-68)
"	Lewisville (King)	8.1	3 (1966-68)
Wabasha	Kellogg	9.5	8 (1961-69) '69 msg
Yellow Medicine	Granite Falls	9.3	6 (1963-68)

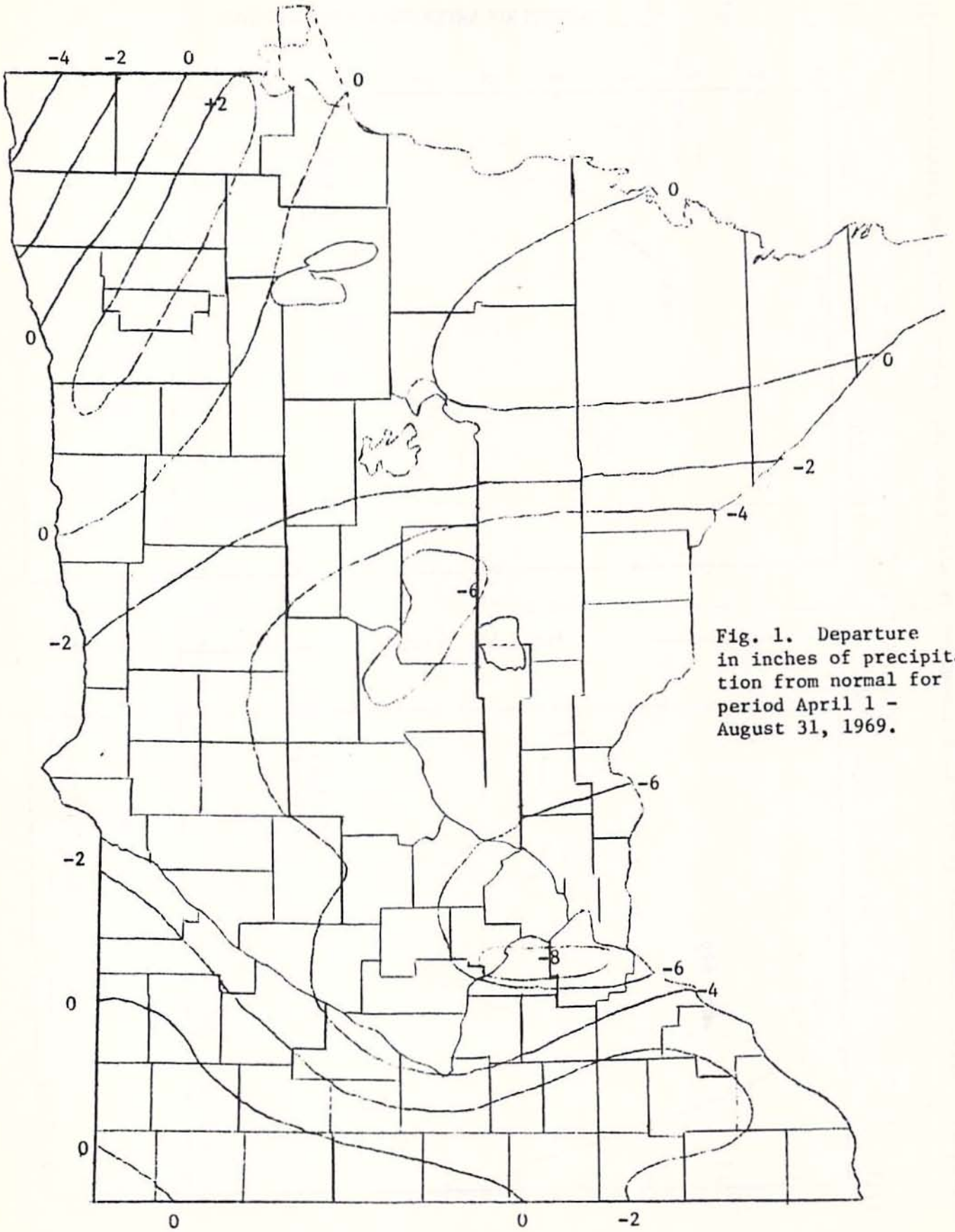

Fig. 1. Departure in inches of precipitation from normal for period April 1 - August 31, 1969.

D. G. Baker, Soil Science
E. L. Kuehnast, ESSA
9/24/69

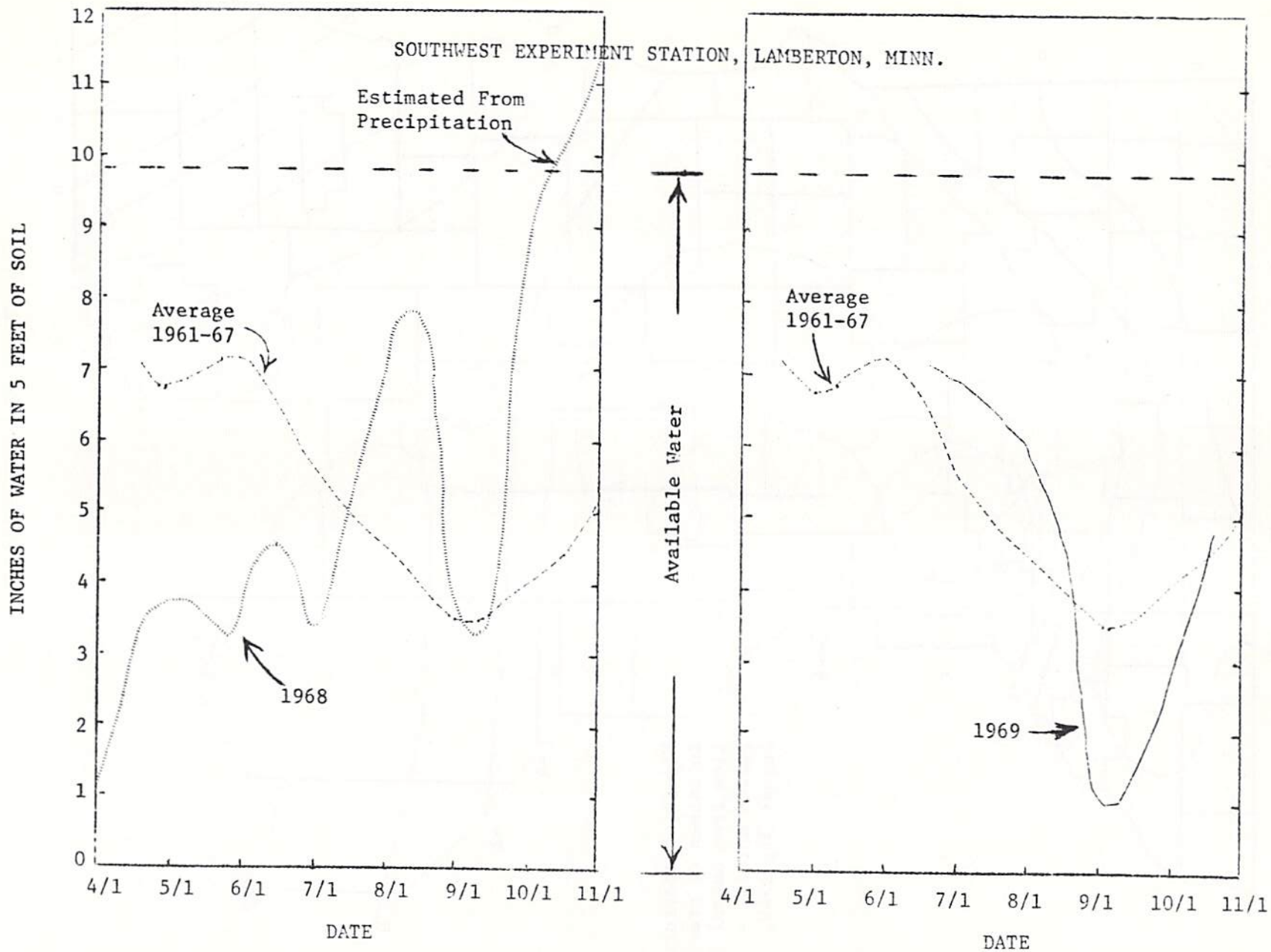

Fig. 2. Soil water conditions under continuous corn at Southwest Agricultural Experiment Station, Lamberton, Minn.

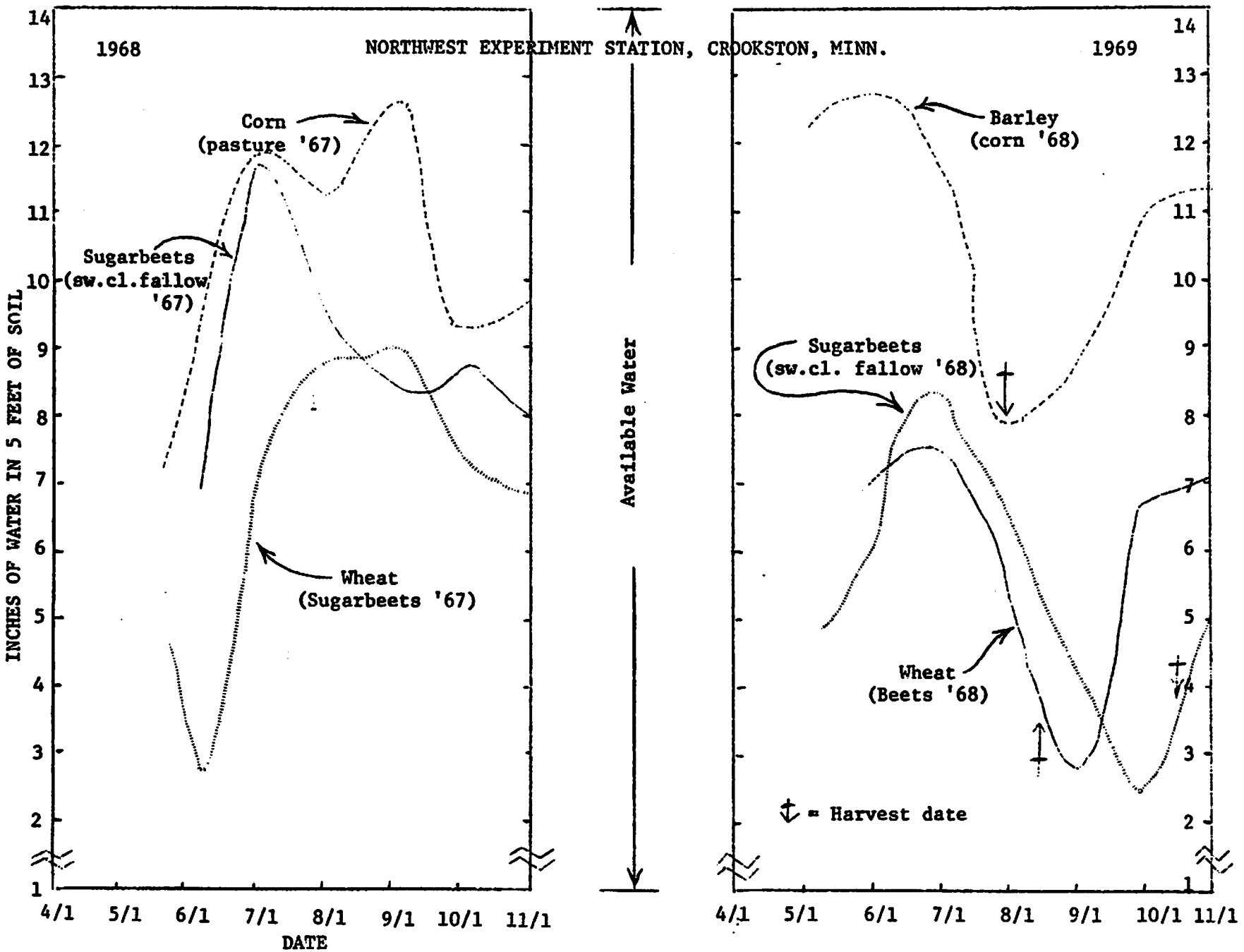

Fig. 3. Soil Water Conditions at the Northwest Agricultural Experiment Station, Crookston.

Data courtesy of Dr. O. C. Soine

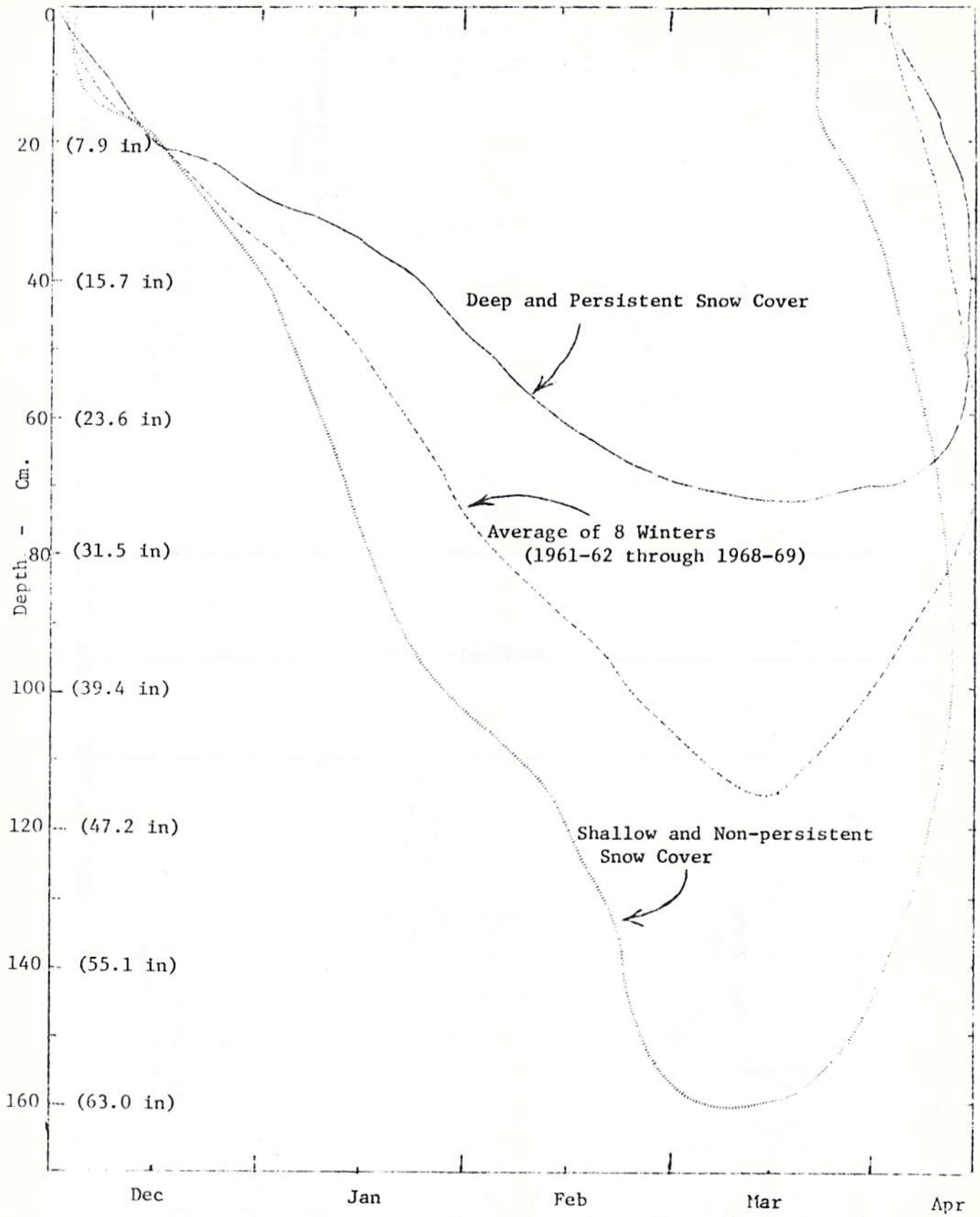

Fig. 4. Average soil freezing depth at St. Paul, Minn., 1961-62 through 1968-69. Freezing depth under deep and shallow snow cover is also shown.

Those to whom I am indebted for obtaining the soil samples or supplying soil water data are the following:

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EFFECT OF ZINC ON THE YIELD AND QUALITY OF SUGARBEETS, 1969

Northwest Experiment Station, Crookston

Olaf C. Soine, Soil Scientist

This is the second year for this trial and in 1969 there were plots at four locations throughout the Red River Valley. Table 1 gives the location of these plots, the previous crops, and the fertilizer treatments prior to planting. Two rates of zinc, 10 and 40 lbs. per acre, were broadcast prior to planting and placed in a band after planting.

Table 1. Location, 1968 crop and fertilizer treatment.

Location	1968 Crop	Fertilizer Applied
Sabin	Durum wheat	100 lb. N, 160 lb. P_2O_5 broadcast prior to planting
Crookston	Sw. cl. fallow	250 lb. P_2O_5 fall applied, 100 lb. 5-42-0 applied at planting
E. Grand Forks	Sw. cl. fallow	200 lb. 5-42-0 applied at planting
Auburn, North Dakota	Potato	50 lb. N, 160 lb. P_2O_5 broadcast prior to planting

Table 2 gives the soil analysis for the four locations. These samples were taken prior to the fertilizer application and planting. The soil at all sites was alkaline, high in organic matter, and high in potash. The phosphorus tested very high at Crookston, high at Auburn and Sabin, but low at East Grand Forks. The zinc content of the soil was medium at all locations.

Table 2. Soil analysis for each location, 1969.

Soil texture	pH	Organic matter	P lbs/A	K lbs/A	Zn P.P.M.	S P.P.M.
Auburn, No. Dak. Sil	7.9	H	40	410	1.9	40
E. Grand Forks, Minn. Sil	8.0	H	13	450	1.9	21
N.W. Experiment Station, Crookston L	8.1	H	92	540	2.0	28
Sabin, Minn. SiCl	7.9	H	37	600	1.6	14

Table 3 gives the treatment, yield, percent sugar, impurity index, and sugar per acre. Yields at Sabin and Auburn were low because of poor stands and insufficient rainfall during the growing season. Yields at Crookston and E. Grand Forks were good. Although there were no significant yield increases at any of the locations, there were increases of 1.41 tons at Crookston, 1.20 tons at Sabin, and 0.90 tons at Auburn. There were no significant differences between rates or methods of application, impurity index, percent sugar, and sugar per acre.

Samples of the blade, petiole, and roots were taken in mid-July and September for zinc analysis from the Crookston and E. Grand Forks plots. These two plots had the same land preparation and previous crop management. The data is given in Tables 4 and 5.

Table 3. Effect of zinc on yield, percent sugar, purity, and sugar at four locations, 1969.

Auburn, N. Dakota

Treatment	Rate lbs/A	Yield t/A	Sugar %	Impurity index	Sugar lbs/A
Check	0	14.61	14.30	1145	4,160
Zn broadcast	10	15.10	14.30	1089	4,320
Zn broadcast	40	14.67	14.92	936	4,380

E. Grand Forks, the zinc content of the roots was higher at the first sampling date than at Crookston, but not at the later date.

Table 4. Zinc content of blade, petiole and root in parts per million (ppm), 1969.

Treatment	Rate	Crookston			E. Grand Forks		
	lbs/A	blade	petiole	root	blade	petiole	root
Check	--	30.4b[1]	11.1a	11.6a	36.5a	14.5a	15.2c
Broadcast	10	34.4ab	14.5a	13.4a	37.6a	15.0a	17.8b
Broadcast	40	39.2a	13.9a	13.5a	40.9a	18.6a	19.9a
Band	10	31.8b	12.8a	13.0a	37.4a	16.5a	17.4b
Band	40	37.2ab	15.8a	13.5a	40.3a	16.6a	17.2b

Plots sampled July 7 and 17 at Crookston and E. Grand Forks, respectively.

[1]Any two averages followed by the same letter do not differ at the 5% level of significance according to Duncan's New Multiple Range Test.

Table 5. Zinc content of blade, petiole and root in parts per million (ppm), 1969

Treatment	Rate	Crookston			E. Grand Forks		
	lbs/A	blade	petiole	root	blade	petiole	root
Check	--	28.3b[1]	18.9a	9.3b	32.2a	13.6a	8.2b
Broadcast	10	36.8a	14.7a	13.6a	39.0a	16.5a	12.2a
Broadcast	40	39.1a	14.9a	12.9ab	37.7a	11.3a	11.9ab
Band	10	33.1ab	19.2a	10.9ab	35.8a	17.5a	9.6ab
Band	40	37.9a	15.8a	11.8ab	39.5a	15.9a	8.8ab

Plots sampled September 18 and 22 at Crookston and E. Grand Forks, respectively.

[1]See footnote Table 4.

LAND FORMING EXPERIMENT

Northwest Experiment Station, Crookston - 1969

Olaf C. Soine, Soil Scientist

This experiment was laid out in the fall of 1965 to study the effect of 5 different methods of land forming on crop yields in a rotation of corn, wheat, barley, and alfalfa. A fertilizer trial was included in the experiment.

There were variations in the yields of all crops on the various land forming treatments. The lowest yields occurred on the 0.2% and 0.1% slopes, especially on the lower half of these plots because most of the top soil was removed from this area during construction. The least soil movement took place on the Level and Land Smoothing plots, and here the yields were more indicative of the fertilizer treatments. On the check plot, there were two low areas where water tended to accumulate, which caused some crop damage.

The corn yields in 1969 were good but no definite results from the fertilizer applications were noted on the check, 0.2%, and 0.1% slope plots. On the Level and Land Smoothing plots, the 40+40+20 fertilizer application gave the highest yields. Although there were some variations in the 4-year averages, the 40+40+20 increased the yields on three of the land treatment plots.

Wheat production in 1969 was good and yields were above those in 1968 and the 4-year averages. The 40+40+20 fertilizer gave the most consistent and largest yield increase on each land treatment.

The barley yields on the 0.2% and 0.1% slope treatments were very low because of the soil disturbance on these plots during construction. The

best yield increases came from the 40+40+20 fertilizer application in 1969 and also for the 4-year averages.

The alfalfa yields in 1969 were variable and no definite trends were established. The best yields were on the 0.1% slope treatment, and the highest increase came from the 40+40+20 fertilizer application.

This study will be summarized and prepared for publication.