Restoring Fertility to Land Where Levelling Operations Have Removed All the Top Soil and Left Raw Subsoil Exposed

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In the past few years with the advent of suitable power machinery, considerable levelling of irrigated land has been undertaken. Much of this levelling removes all of the surface soil and in some cases penetrates deeply into the subsoil in the areas "cut" and may leave this subsoil on top in the areas of "fill". The object of this levelling process is to increase the efficiency and distribution of irrigation water.

Previous work *(1)*[2] has shown that a high percentage of our subsoils are deficient in available phosphate and nitrogen. This brings up the question of what is the easiest and most economical way of raising the yielding ability of the soils exposed by levelling to somewhere near that of the original surface soil.

In the spring of 1945 on a block of land on the Experiment Station Farm, levelling was done by the Soil Conservation Service. In part of this area the surface soil and some of the subsoil was removed, leaving the subsoil exposed. The soil was transported to other parts of the field not included in the experimental area. On this area a fertility experiment was laid out and seeded to alfalfa with a companion crop of Colsses barley. The range in depth of "cut" was from 1.2 feet in plot 6 to 0.2 foot in part of plot 24. With the exception of this latter depth, all the "cut" area used for plots had 0.5 foot or more of the surface removed. The soil treatments were as follows: No treatment, manure, manure plus 125 pounds of treble superphosphate (43 percent P_2O_5), manure plus 500 pounds treble superphosphate, manure plus 1000 pounds treble superphosphate, and manure plus 125 pounds treble superphosphate and 125 pounds potassium sulphate (40 percent K_2O).

The heavy applications were used because previous experiments *(2)* had shown that heavy applications of treble superphosphate on the Station soil (Fort Collins loam) showed a residual effect on beets after the complete cycle of an 8-year rotation. All the experimental area with the exception of the no-treatment plots was manured at the

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[2]Italic numbers in parentheses refer to literature cited.

rate of 10 loads of feed-lot manure from the cattle feeding pens after the land was levelled. After the land was manured it was plowed, packed, harrowed, and floated. After this treatment, commercial fertilizer was applied, as outlined, with a grain drill having a fertilizer attachment. The plots were then harrowed and drilled to alfalfa and barley. One irrigation was applied during the growing season and one to the alfalfa after the grain had been threshed. Because of unfavorable weather the lateness of starting the levelling process, seeding was delayed until May 2.

During the entire season the effect of the treatments could be easily seen. Table 1 gives the grain and total yields and the bushel weights obtained with the different treatments. While the yields on the treated plots were low, they were in line with similar yields on adjacent plots which were planted about the same date (table 2).

Table 1.—Fertility treatments to increase yields on land levelled to remove surface soil.

Series 4600	Planted May 2		Emerged May 12		
	1945				
	Yield per plot in pounds		Yield per acre in pounds		Test weight
Treatment No.	Grain	Total	Grain	Total	Pounds
No	20.75	46.25	405	629	40.25
Manure—10 loads per acre	64.02.1	113.0	879	1,537	42.25
Manure + 125 pounds phosphate	82.0	144.25	1,115	1,002	43.15
Manure+500 pounds phosphate	74.375	142.25	1.012	1,035	43.425
Manure+1000 pounds phosphate	89.25	171.25	1,214	2,329	43.3
Manure+125 pounds phosphate 125 pounds potassium sulphate	88.375	171.75	1,202	2,336	42.75
Mean yield			971	1,788	
Difference to be significant			181	535	

Table 2.—Date of planting Spring barley on fallow, 1045.

Variety	Date planted	Date emerged	Date ripe	Yield Bushels per acre	Yield Pounds per acre
Thebi	3-21	4-9	7-27	24.0	1,181
Lico	3-21	4.0	7-28	73.8	3,542
Trebi	3-31	4-23	7-27	56.5	2,712
Lico	3-31	4-23	7-31	71.6	3,442
Trebi	4-9	4-30	7-29	69.4	3,331
Lico	4-9	4-30	8-1	80.4	3,859
Trebi	4-30	5-9	8-2	54.5	2,616*
Lico	4-30	5-0	8-3	46.6	2,237*
Trebi	5-11	5-24	8-7	35.5	1,694*
Lico	5-11	5-24	8-7	48.8	2,342*
Trebi	5-19	5-29	8-16	14.5	696
Lico	5-19	5-29	8-16	23.6	1,133

*Comparative dates.

The analysis of variance indicates there is a significent difference in yield. The application of manure increased the yield from 405 pounds grain to 879 pounds grain or 117 percent. The quality of the grain as indicated by the test weight also shows an improvement for the application of manure and fertilizer. Little difference is shown between the different plots receiving fertilizer in addition to manure. The carry-over effect of the heavy applications will be determined on the succeeding crops of the 8-year rotation: Alfalfa, alfalfa, alfalfa, corn, beets, wheat, beets, and barley seeded to alfalfa.

Chemical analyses of the plant material from the experiment showed a large and significant increase in the soluble phosphate content of the fertilized green plants when compared with the untreated plants. The increase in phosphate was accompanied, by a significant decrease in potassium and an apparent decrease in soluble nitrogen, though the nitrogen decrease was not significant.

There were slight and not significant differences between the total phosphorus and total nitrogen of the fertilized mature grain when compared with the unfertilized grain. There was, however, a significant difference in kernel weights.

Table 3.—Chemical analyses of green plants and mature grain.

Treatment	Soluble P in green plants (6/25/45)	Soluble K in green plants (6/25/45)	Soluble N in green plants (6/25/45)	Total P2O5 in grain	Total N in grain
	ppm	p/10,000	ppm	Pct.	Pct.
1 No fertilizer	125	110	500	.76	2.04
2 Manure (10 loads)	225*	110	305	.87	1.88
3 Manure+125 pounds phosphate	200*	97*	335	.81	1.73
4 Manure+500 pounds phosphate	301*	99*	265	.84	1.86
5 Manure+1000 pounds phosphate	305*	94*	355	.79	2.02
6 Manure+125 pounds phosphate + 125 pounds potassium suphate	176	95*	290	.78	2.03
S. E.	48.7	7.3	22.9	.075	.121
Difference for significance	69.5	10.3	32.3	.102	.172

*Significant by 5 percent point from no treatment (No. 1)

Literature Cited

1. Gardner, R. Why Is Subsoil Unproductive. Colo. Agr. Exp. Sta. Bul. 464. 1941.
2. Gardner, R., and Robertson, D. W. A Comparison of the Effect of Manures and Commercial, Fertilizers on Sugar Beet Yields. Proc. Amer. Sci. of Sug. Beet Tech. 1946