An area of reclaimed spoil in North Dakota.

Use of Soil Materials on Spoils— Effects of Thickness and Quality

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Both thickness and quality of soil material spread on spoils affect potential crop yields. On sodic spoils, as little as two inches of soil material is highly beneficial, but at least 30 inches seem to be required for maximum production.

North Dakota laws require that on land to be mined, up to 5 feet of soil material, if available, be removed, stockpiled, and respread on the surface of spoils after smoothing. Normally, an area proposed for mining is first mapped according to soil type, then the amount of soil material to be saved is determined and field stakes are set out accordingly. The dark topsoil (A horizon) is then removed and stockpiled followed by removal and stockpiling of the subsoil material (B and C horizons) to the depth indicated by the field stakes. After mining and levelling of spoils, the subsoil and then the topsoil are spread over the spoils before fertilizing and seeding.

In this sequence of operations, several key questions need to be answered. What effect does depth of topsoil and subsoil returned to spoils have on potential for crop production? Do different crops respond differently to soil thickness? Do the topsoil and subsoil need to be stripped, stockpiled, and respread separately or can they be mixed? What effect does quality of topsoil and subsoil materials have on potential crop growth (what criteria are used to determine suitability of soil material)? Do these requirements and responses change for different types of spoils? Will saline seeps develop along this interface between soil material and spoils? Will salt migrate from spoil into soil material and degrade it? Research is needed to provide data to answer all of these questions.

Research on the use of soil material spread over spoils was begun in 1970 by the USDA-ARS reclamation research team at the Northern Great Plains Research Center at Mandan. In this first work, done in cooperation with the SCS, Basin Electric Cooperative, and Consolidation Coal Company at the Glenharold Mine at Stanton, plots were established to study the effects of 2 inches of topsoil on grass establishment and growth, soil water characteristics, and various soil properties.

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Immediately, it became apparent that this thin layer of topsoil applied over impermeable, highly sodic spoils dramatically improved plant growth and production and reduced surface crusting and runoff (Table 1). Vegetation on plots with topsoil was mainly slender wheatgrass and foxtail barley the first few years, but this has been replaced by western wheatgrass and green needlegrass. Only a few grass, Kochia and foxtail barley plants are growing on plots without topsoil.

Table 1. Dry matter production by grass and water infiltration rate of spoils with and without 2 inches of topsoil.

		Without topsoil	With topsoil
		lbs./acre	
Dry weight of grass:	1973	410	1370
	1974	120	1530
	1975	210	1470
Infiltration rate during:		inches/hr.	
1st hour		2.88	6.47
2nd hour		0.42	1.93

Other plots established with 2 inches of topsoil in 1970 and 1971 showed that much of the effect of the topsoil was lost by mixing it into the upper few inches of spoil. The 2-inch topsoil treatment seemed to act primarily as a permanent mulch, preventing the surface of the spoils from sealing, thereby increasing infiltration and subsequent plant growth.

Additional experiments were begun in 1972, in which up to 1 foot of topsoil was added to sodic spoils. Also, experiments have been established at four mine sites (Stanton, Center, Zap, and Beulah), each with a different quality of spoil material, in which 1 foot of topsoil has been added. In 1974, the first of two wedge experiments was constructed in which good subsoil material was spread over impermeable sodic spoils to depths increasing from 0 to 7 1/2 feet. On top of this subsoil wedge, either 0, 8 or 24 inches of topsoil were spread. A fourth treatment involved mixing topsoil and subsoil in the wedge in a 1:3 ratio as the wedge was constructed. Each topsoil plot was then subdivided to accommodate four crops—spring wheat, crested wheatgrass, alfalfa, and a native grass mixture. The 40,000 yards of earth-moving involved in establishing this experiment was done by Consolidation Coal Company and Basin Electric Power Cooperative. Additional wedge experiments have since been established at North American Coal Corporation's Indianhead Mine at Zap.

Data are given in Table 2 on the yield of the first spring wheat crop harvested from the wedge at the Glenharold Mine in 1975. All crops were harvested in 1976, and generally the data from these crops followed the same trends as those shown in Table 2. Essentially, these data show that plant growth and yield increased as depth of soil material increased to about the 28-inch thickness—greater depths resulted in no further yield increase. However, for each of the types of soil material used, the yield curves levelled off at a different value—about 18 bushels/acre for the subsoil, 22 bushels for the mixed treatment, and 30 bushels for either 8 or 24 inches of topsoil over the subsoil.

Table 2. Spring wheat yield (1975) as affected by thickness of subsoil and topsoil over spoils (Glenharold Mine).

Total soil thickness (Subsoil and topsoil)	Topsoil thickness, inches 0	8	24	Mixed
inches	bu./acre			
4	11.9	—	—	15.7
12	15.8	23.9	—	20.0
20	17.8	28.5	—	21.9
28	19.2	29.1	29.2	22.4
36	18.8	28.9	30.0	23.2
44	18.6	29.5	30.5	22.0
52	19.6	29.0	30.5	22.5
60	18.6	30.2	28.8	21.6
68	18.8	28.6	29.9	21.6
76	18.7	30.1	30.9	22.9
84	—	28.8	31.7	—
92	—	—	29.6	—
100	—	—	30.4	—

If these trends continue in future years, these results mean that for the crops being studied and for the type of spoil used, about 30 inches of soil material is needed for maximum yield, regardless of quality of the soil material. However, maximum yield appears to increase as better soil material is used. Also, the beneficial effects of topsoil are considerably diluted when topsoil is mixed with subsoil material. Whether salt migration, waterlogging, erosion, or other factors will increase the soil depth required remains to be determined.

Several years of additional data from this and the other experiments established will provide the information needed to answer the questions listed in the first part of this paper. Conclusions presented here should be considered tentative until these additional data are collected. However, our data suggest that present North Dakota requirements for saving and respreading soil material after mining will meet the needs of most crops grown. Possibly, special attention will have to be given to stabilizing slopes to prevent the rapid erosion and loss of soil material applied to spoils. However, further research is needed on this and some of the other questions raised.