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Guest Column

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Land Reclamation Research

Land reclamation can assume several forms and have many objectives. As discussed here, land reclamation will be concerned with the establishment of permanent vegetation, or with creating soil conditions such that the establishment of grasses or annual crops can be achieved on drastically disturbed land. Reclamation research has as its primary broad objective the return of the land to some level of agricultural production such that its productivity is "equal to or better," as defined and required by law, than its premine level. At first this may appear easy, just return the topsoil, or root depth surface layers, to their original positions and productivity will be re-established. In practice the problem is more complex. By law only "suitable plant growth materials" may be returned to the surface. But what constitutes "suitable plant growth material" as defined by law is not always available and the choice becomes the "best available," if this is known. Land reclamation research in a broad sense is directed at re-establishing vegetation, evaluating overburdens as "suitable plant growth material," re-establishing water movements through and from the area, and producing a soil "equal to or better" than it was before mining. More briefly, land reclamation research is directed at learning how to make the land whole.

The North Dakota Agricultural Experiment Station and the Northern Great Plains Research Center, USDA-SEA-AR, started reclamation research in the early 1960's. These early studies were concerned primarily with the chemical and physical characterization of overburden and grassland establishment. In the early 1970's the North Dakota State University Departments of Soils, Botany, Chemistry and Bacteriology and USDA-SEA-AR were expanding their research interests, especially those related to soil salinity, grass adaptability, overburden evaluations and vegetation establishment on reclaimed land. In 1974 North Dakota State University's efforts were expanded greatly on a broad scale through a grant from the Old West Regional Commission. Some of these funds also went to the North Dakota State Geologic Survey for area hydrology studies.

Today a sizeable North Dakota Agricultural Experiment Station Department of Soils coal strip mine research program is located at the Northern Great Plains Research Center, Mandan, North Dakota, where NDSU researchers, with collaborators in research at NDSU in Fargo, North Dakota, cooperate and coordinate their research activities with USDA-SEA-AR research programs. Research facilities, equipment and office and laboratory space are provided to

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On the Cover: A representative of Knife River Coal Company and Dunn County Agent Laverne Linnell inspect an area of reclaimed land. Reclamation of mined land has been the subject of considerable research in North Dakota and is the emphasis of this issue of North Dakota Farm Research. Photo by James Berg.

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the NDSU Soils staff at the North Great Plains Research Center, Mandan, North Dakota. Currently the North Dakota State University research program is funded in part by Coal Impact funds to the North Dakota Agricultural Experiment Station, by North Dakota State University and by two grants, one from the Environmental Protection Agency and one by the Falkirk Mining Company. This early start and the continued support in land reclamation research have given North Dakota a regional leadership role in land reclamation and environmental protection.

In North Dakota approximately 1500 acres of land are stripped and by inference reclaimed annually. The stripping process is quite straightforward. The dark topsoil is removed and set aside in spoil piles for later return. Then a portion of the ashy gray horizon, the so-called "second lift" just below the topsoil, is removed to a depth of 5 feet and stored in separate spoil piles. Finally, the overburden, the material below the "second lift" down to the coal, is removed and piled along the edges of the first trench being opened or placed into an adjacent trench from which the coal has been removed. The top overburden is removed first so it is placed at the bottom of the pile, or trench, while the deepest overburden finally resides on the top. The overburden in any one cut can vary widely both in texture and in salts. Sometimes it is better "plant growth material" than the "second lift" or none of it may be "suitable plant growth material." In practice the bottom part of the overburden which is often the saltiest horizon, becomes the new base on which the "second lift" rests. The topsoil is then returned to its original dominant position. But this does not assure that the land is now "equal to or better" than before mining.

Many changes, usually adverse, can take place in the various materials during the mining operations that cannot be accurately evaluated by premine characterization. Examples are oxidation of materials during mining and storage, changes in overburden bulk densities and consequent reduction of water infiltration rates, compaction such that root impedence may occur, and mixing and stirring of the "second lift" to where, if salts were present in its lower layers, they are now mixed throughout, leaving the plant root zone too high in salts. Many of these adverse characteristics may ameliorate with time. Like a patient who has undergone radical surgery, the land requires a period of recuperation. Unlike the laws of medicine, strip mine reclamation laws require the coal mining companies to guarantee recovery, namely, that the land will be "equal to or better" in productivity than it was before mining. At the present time the legal requirements for reclamation exceed our proven technologies and basic knowledge.

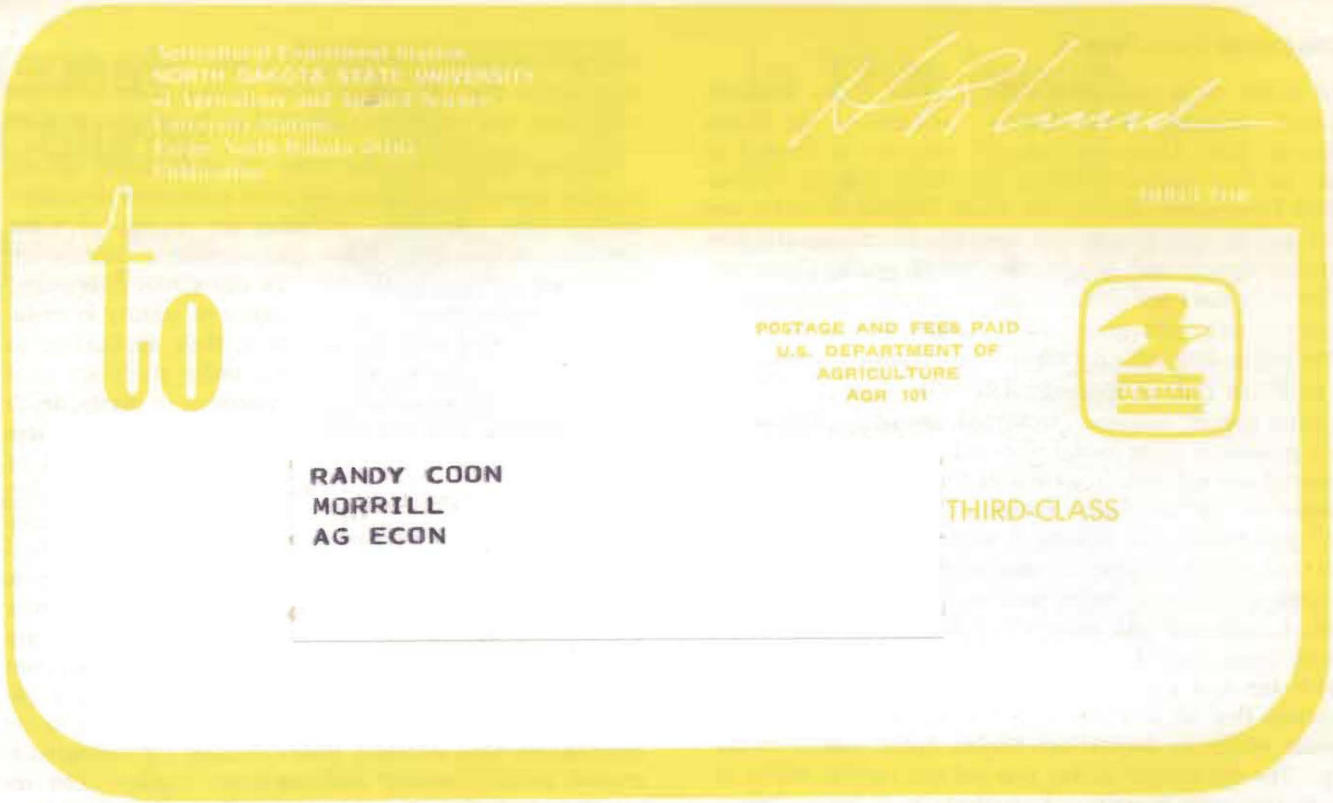
Several factors will influence the success of any reclamation effort with low rainfall and high salinity ranking at the top. Generally, in central North Dakota, high salinity and high sodium in overburden increases from east to west with the least in the Underwood, North Dakota, area and highest levels around Zap, North Dakota. What this means is that reclamation strategies become site specific with respect to salts. Low rainfall is common to the region. These two variables, rain and salts, require much time and effort to research because there is little that can be done about them in a practical sense. Variations in amount and distribution of rainfall can make a management practice that was successful one year be a total disaster the next. Research in this area requires field plots that are both time consuming and costly, but essential in reclamation studies.

Salinity affects a wide range of reclamation factors. Salinity interaction studies are being conducted at a number of field locations. Included are studies of water regimes, evapotranspiration measurements, infiltration, and water movement through the plant root zone. The research clearly shows the importance of salinity in evaluating the results and, by extension, their application to reclamation programs. Other areas under study are spoil characterization, saline and sodic tolerance of plants, depth of topsoil, the need for returning the "second lift" where the overburden is relatively free of salts, the effect of texture on compaction of all materials during mining and reclamation operations, subsidence, erosion, tillage practices, water movement in the plant root zone, infiltration, fertility needs, and greenhouse studies. These research areas represent factors that may play a role in developing a site specific reclamation program. Most of the factors are interrelated. For example, increased compaction increases soil water holding capacity but may produce root impedence and decreased yields. Or increased salinity in the overburden may decrease yields directly or through decreased infiltration and available water supply. Our research attempts to provide the information needed to balance the adverse crop production characteristics, and their intensity against desirable factors in such a way that the land will in time return to its original productivity.

Distinctions are made in both State and Federal laws in regard to the handling of "prime land." The prime soil standards are stricter and no mixing of "second lift" or topsoil from prime and nonprime land is permitted. The reclamation strategy is essentially fixed. These regulations were probably written for highly productive soils in high rainfall areas such as the cornbelt and are not well suited to the semiarid midwest. In North Dakota the soils mapped as prime are located at the bottom of gentle slopes such as foot slopes, upland swales, and valley fans. They are usually fairly flat and range in area from 40 to less than 10 acres, the smaller areas being the more common. Since soil type boundaries are usually diffuse just the identification of boundaries can be a problem. The higher productivity of the prime land is probably more the result of its physiographic location as recipient of runoff water than due to any particular chemical or physical characteristic of the soil itself.

Research is now underway attempting to evaluate the significance of the legal identifying characteristics of prime land as they apply to North Dakota conditions. It should be pointed out that in any reclaimed land there are areas at the base of drainage slopes that potentially can develop into the equivalent of prime land. Similarly both prime and nonprime land must, after reclamation, be "equal to or better" than they were before mining. Perhaps the only requirement really necessary for mining and reclamation of North Dakota prime land is that the total area be "equal to or better" in productivity after mining. Our research should resolve the issue.

A research program such as described here requires cooperation and support from many sources. The Public Service Commission personnel have been most cooperative in discussing our proposed research programs. Similarly



the cooperation of the coal mining companies and their personnel in giving permission to enter and conduct experiments on their properties has been outstanding. Baukol Noonan Incorporated, Consolidation Coal Company, Knife River Coal Mining Company, The Falkirk Mining Company and The North American Coal Corporation have been most interested and cooperative in providing areas for research plots and supplying blueprints and data of the research areas. This cooperation is greatly appreciated.