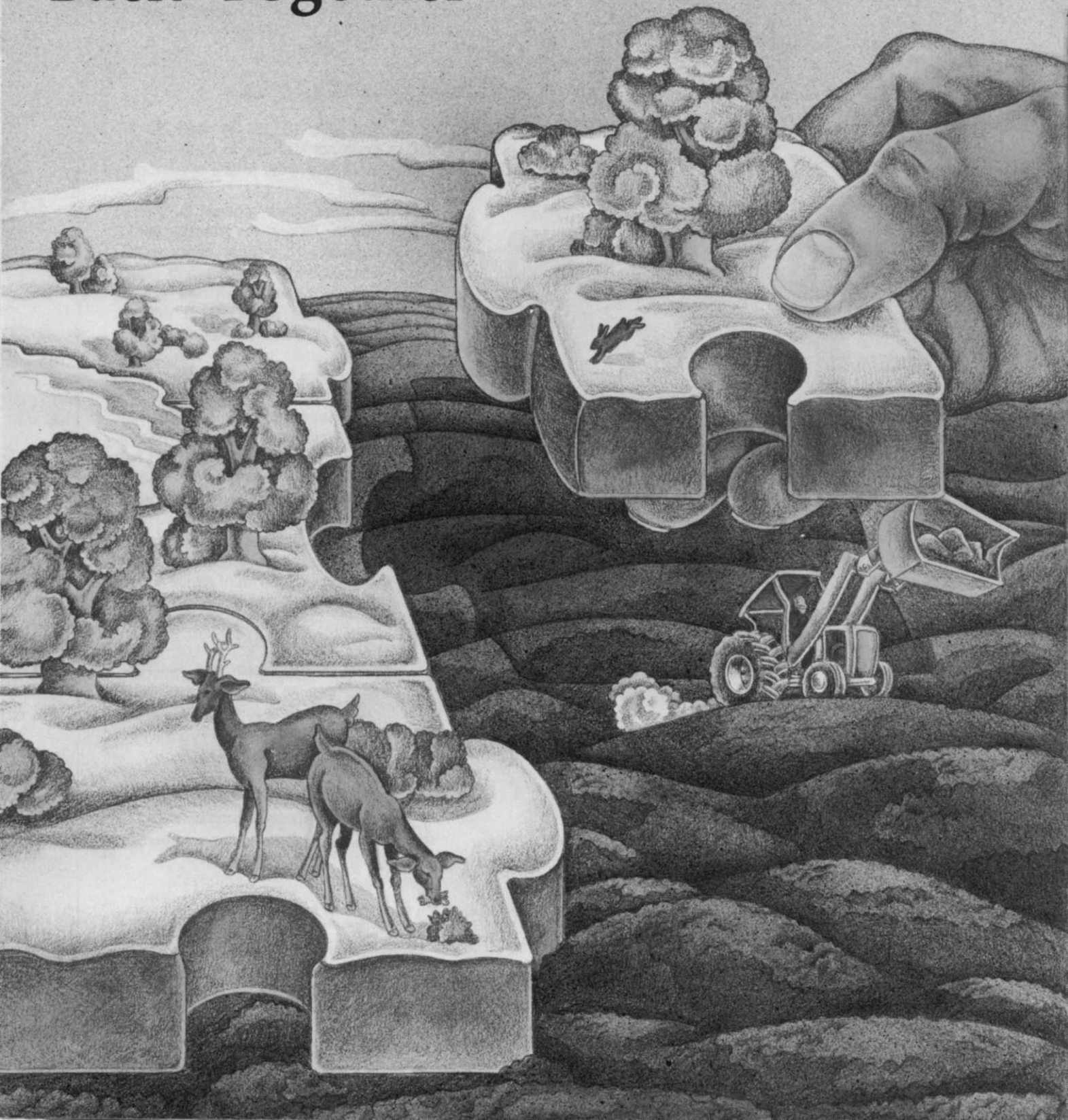


# REVEGETATION

Putting the Puzzle  
Back Together



**R**evegetation is more than putting the pieces of a puzzle back together. In the case of strip mining, land can rarely be restored to its original state. It is a compromise based on the extreme need for energy in the United States today.

Reclamation of surface mined land is not new, but the number of acres entailed, their location, and how the spoils affect revegetation efforts are.

In North Dakota an estimated 20,000 acres per year will be disturbed by surface mining. It is predicted that more than a tenth of western North Dakota will be mined. Most of this land (50-60 percent) is now used as range for cattle, vegetation consisting primarily of cool and warm season grasses.

The states of Montana, Wyoming, New Mexico and North Dakota have become the preferred areas for strip mining because coal is in thick veins not far from the surface, the coal is relatively low in sulfur, there are fewer natural and man-made obstacles, and fewer people are affected. Data from the Department of Interior show a savings of 30-50 percent over eastern strip mining.

These western states have written laws to prevent abuse of natural resources by mining companies. Regulations in general require that the productivity of the land be restored, the contour of the land be preserved, and erosion and water pollution avoided. It is not known at this time whether these requirements can be met. Research has been taking place since 1970 to determine this.

Perhaps most perplexing at this point is the difference how mine spoils respond to revegetation efforts in the west as opposed to in the Appalachians and the midwest. The extra pressure from regulations is forcing mining companies to develop permanent, not just temporary, measures for revegetation.

The grasses present in the west apparently cannot get reestablished by mere chemical alteration of spoils. Research is showing that a layer of soil must be placed over the spoils to provide adequate water absorption (infiltration), prevent salty spoils from sealing out moisture, and to avoid runoff problems. Limited rainfall, roughly 15 to 20 inches per year, with little in sum-

mer months, may create the need for irrigation for the first two to five years after reseeding.

Surface soil must be stockpiled during mining operations and replaced over spoils after the coal is removed. Continuous fertilization is required due to a general lack of phosphorus and nitrogen in range soil. In the east, woody material cleared during mining could be chipped into a suitable mulch. Very little woody material is available in the west and soil is the only mulch available.

Researchers have been experimenting with different depths of soil over spoils. Optimum depth seems to be in the neighborhood of 30 inches. However, with time the high salt content of the spoils appears to migrate upward into the soil layer making water uptake by roots difficult.

Gypsum has been mixed with both spoils and soil to reduce the sodium content. Leaching the sodium out by natural rainfall is unlikely and leaching by irrigation is expensive.

Reclamation and revegetation consequently have become major cost considerations of mining firms in the west. Years of time and hundreds of dollars per acre are required to do the job properly.

### **History of U.S. Revegetation Efforts**

The Forest Service was the first Federal agency to perform research into reclamation of surface-mined land in the 30s. Initial research centered around reforestation of spoils in southeastern Ohio. Most revegetation theories today stem from this research.

Following World War II surface mining increased in the midwest. It was then discovered that similar revegetation techniques could not be applied with consistent results throughout the U.S. Regional differences in weather, topography, geology, geography, and laws made alterations necessary.

Appalachian mining efforts brought new insight into erosion and runoff. Spoils there tended to be more acid than in the midwest.

In the 60s interest grew in the west toward surface mining. Today surface mining of coal in western states doubles nearly every year. Whereas in 1947 only ten percent of

coal mined came from surface mines, today the figure approaches 50 percent. Furthermore, the National Energy Program, still under consideration in Congress, calls for an additional one billion tons of coal production per year by 1985.

Certainly surface mining will play a greater and greater role in energy production in the near future.

### **Revegetation Technology**

Research on revegetation in western states has centered around reclaiming spoils, thickness of soil above spoils, moisture holding characteristics, soil chemistry and fertility, and irrigation.

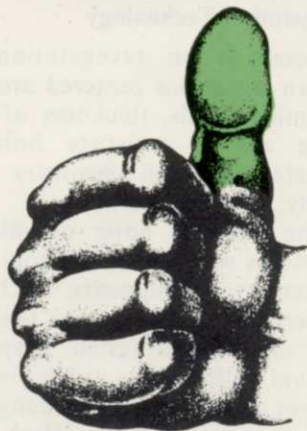
The original hope of mining companies was that spoils could be restored by amendments, leaching, and fertilizer. Gypsum was the primary amendment tested. Gypsum (calcium sulfate) was applied at 20 tons per acre to replace exchangeable sodium with calcium. High exchangeable sodium reduces the infiltration rate of spoils. The effect of high exchangeable sodium is lessened in sandy soil or soil with high organic matter content. Results showed that gypsum treatment reduced the exchangeable sodium content 30-50 percent in the top foot of spoils after three years.

Leaching in the west is difficult due to a lack of rainfall. Leaching is used to reduce the content of soluble salts and exchangeable sodium in the root zone. Soluble salts increase the osmotic potential of the soil layer making it more difficult for the plant to extract moisture from the soil.

Almost all spoils in the west lack adequate phosphorus and nitrogen. Potassium and minor element levels appear to be sufficient. Annual fertilization of nitrogen and phosphorus is necessary to revegetate most western mine areas.

Despite all their efforts, researchers found the sodium problem too great for gypsum to correct. The only effective way they found to correct the problem was to use more soluble calcium salts such as calcium chloride and calcium nitrate. However, these solutions require leaching out and are too expensive for large scale use. Costs for calcium chloride treatment would run \$1,300 per foot per acre.

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Consequently, tests have shown that chemical reclamation of strip mine spoils is not practical in large scale. A more practical method of reclamation is to apply a layer of soil over the spoils.

The Northern Great Plains Research Center, Mandan, ND, is the source of most information regarding soil thickness over spoils. Dramatic improvements in erosion control, infiltration, and plant growth have been found with as little as two inches of topsoil over spoils. Mixing topsoil with the top few inches of spoils proved less effective.

The center tested thicknesses of soil over spoils from 2-100 inches. Results show a topsoil depth of 8 inches, and a total soil depth of 28 inches, to provide the most efficient improvement. This combination provided the maximum yield per acre of spring wheat. Mixing the topsoil into the subsoil considerably reduced the benefit of the topsoil.

Research has not conclusively determined the relationship between soil thickness and the upward migration of sodium into the soil layer. Two-year studies have shown that sodium does migrate upward but that this migration is largely restricted to the first four inches above spoils.

Moisture retention and erosion are directly related. The more moisture taken into the soil the less there

is to erode poorly compacted soil or spoils. Western precipitation characteristics cause a new twist to infiltration and erosion problems. Most of the approximately 15 to 20 inches of precipitation falls during the growing season when temperatures are high and evaporation potential is highest. Most of this rain takes place during storms, each storm producing less than ½-inch of rain in a 24-hour period. Consequently, very little moisture is retained in the root zone between rainfalls. Vegetation can get established on undisturbed land during normal rainfall conditions. In periods of less than normal precipitation new seedlings often suffer water stress and fail. Also, precipitation is insufficient to leach sodium, salts, and other undesirable chemicals beneath the root zone.

Irrigation is a way to overcome a number of moisture problems of mine spoils. However, researchers have discovered that changes from standard agricultural irrigation practices are needed. Too much water can have the same effect as too little. A change from normal precipitation patterns can also influence the types of vegetation established. If irrigation is used only to establish normal range vegetation and then stopped, then it must be used in such a way to insure standard moisture conditions and not to create artificial ones.



In irrigation for establishment less water is needed therefore water of lower quality can be used. A number of universities are studying the use of effluent for irrigation on spoils.

#### Conclusion

The demand for coal for energy is enormous. The desire to mine coal in western states is just as great. However, most of the research needed to guarantee the proper re-establishment of natural vegetation is incomplete. Political and economic pressure could easily overpower the need for delay for more complete data. State laws set standards which aren't clearly understood, such as the degree of restoration of vegetation or for what period of time. The United States Department of Agriculture is performing most of the research with cooperation from mining companies.

Irrigation studies are incomplete, sodium uptake studies are incomplete, soil thickness studies are incomplete, as are other studies. It almost seems that the research has raised more questions than it has answered.

Any national policy for expansion of coal production must also include provisions for support of research to answer important questions as soon as possible. An energy program must not neglect the residual effects of production. *Bruce F. Shank, Editor.*

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