

An Economic Appraisal of Reclamation Practices on a Strip Coal Mine Site in Greene County, Indiana

R. MICHAEL DINKEL and LEE GUERNSEY, Indiana State University

Abstract

The main purpose of this study was to ascertain the impact of very adverse physical conditions on reclamation practices and to determine the costs involved in revegetating the toxic strip mine site. A number of experiments were carried out in order to obtain a comparison of selected factors of reclamation.

Four expenditures were analyzed in order to determine the total costs of reclaiming land which had developed a very harsh environment from strip coal mining operations. These were the costs of utilities for preparing media, the transportation expenses of delivering the media for field application, the labor costs of preparing the test sites and the planting of trees, and the costs of materials which included the media used, the plants, and the seed.

The total cost of reclaiming an acre of land to trees at the project site was 2.4¢ per ton of coal mined or about \$150 per acre. In contrast, the cost of reclaiming the test site to grass averaged 8.4¢ per ton of coal mined or about \$435 per acre. However, if the test site had more favorable characteristics, the costs would have been greatly reduced.

Throughout the Eastern Interior Coal fields of the United States, a significant percentage of productive land is undergoing strip coal mining operations. In this process, massive machinery is used to remove the overburden of soil and rocks from above the various seams of coal. The condition in which the areas are left after the mineral has been extracted is in need of reclamation.

This study was conducted to ascertain the significance of the physical and economic factors involved in the revegetation of a strip mined area was internal and runoff flows into strip mined ponds of the area and two spoil bank ridges at the Greene County site. One of these ridges was composed entirely of sandstone, whereas the second ridge was made up primarily of shaly material.

The slopes of the project area were not too steep for planted vegetation, but all the plantings were made upon the struck off surface on top of the two spoil bank ridges. The ridge tops had a width of nearly twenty feet between the shoulders of the banks. Most of the drainage in the area was internal and runoff flows into strip mined ponds of the area and remains stagnant after reaching these water bodies. This fact has been instrumental in the ponds having a high iron content and a very reddish color.

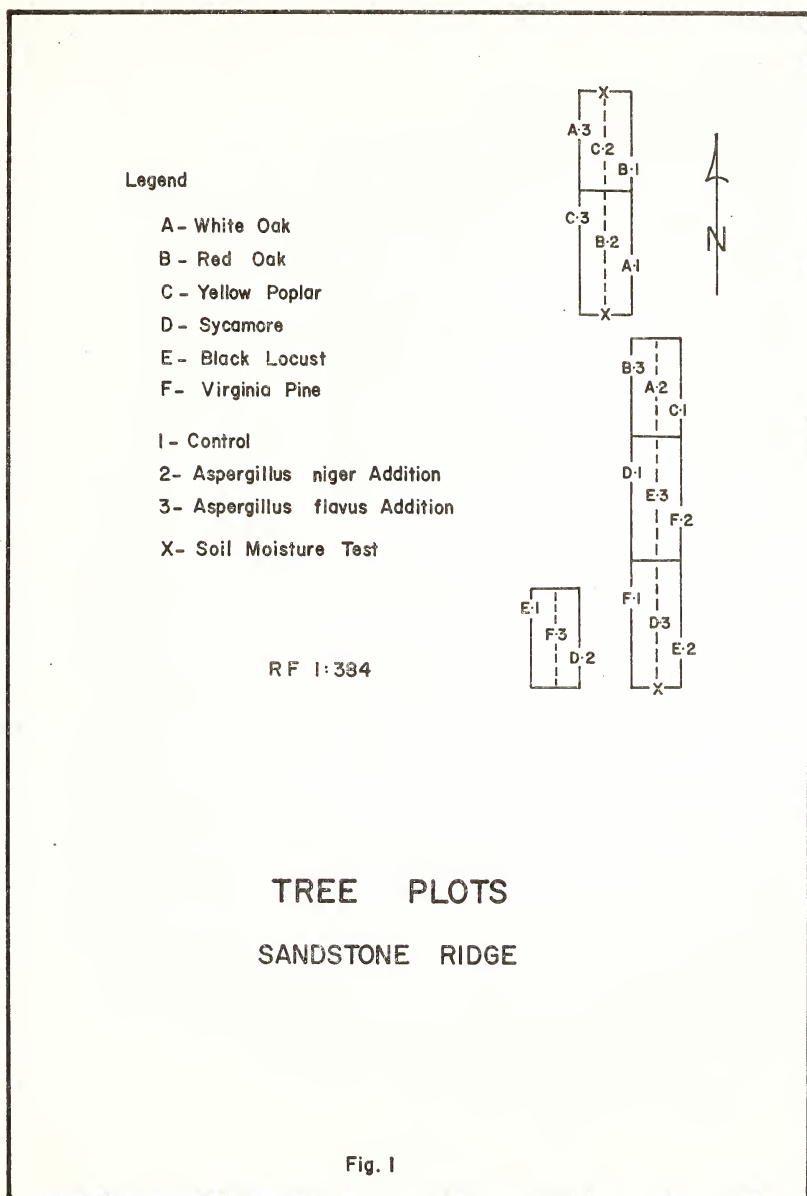
Another physical characteristic of primary importance is the soil texture of the project area. The character of materials making up the spoil surfaces has a direct effect on plant growth and ultimate soil development. Since the shale spoil bank had a much finer texture than the sandstone spoil bank, more compaction occurred on this spoil material and resulted in an impervious hardpan developing on the shale ridge.

The sandstone ridge in the project area had a pH range of from 3.0 to 4.9 and was a marginal spoil bank. This is in contrast to the shale ridge, which has an average pH of 2.7 and was classified as being toxic. The non-toxic portions of the marginal spoils were plantable, but were usually small in size and randomly scattered. The pH readings were taken at various depths in the spoil banks. This was done since leaching processes often cause the surface spoil to be less acidic than that found at a depth of a few inches. Qualitative chemical tests were made on the spoil from both strip mine ridges within the experimental area. Both the shale and the sandstone ridge were found to be very rich in phosphorus. Traces of potassium, magnesium, and calcium were also found in the area. Iron was present in samples from both ridges, but was more abundant from the sandstone area. Both ridges had a very high sulfate content, which reduced the viability of the various plants in this reclamation project.

The adjacent farm land has been severely damaged by the toxic material which has been washed down from the spoil banks. Loose material has been carried down onto the field which will undoubtedly decrease the productive capabilities of the land. This problem might be alleviated if drainage ditches were maintained near the boundary of these two adjacent areas. The simple construction of ditches would not eliminate the problem because these ditches would fill with sediment very rapidly.

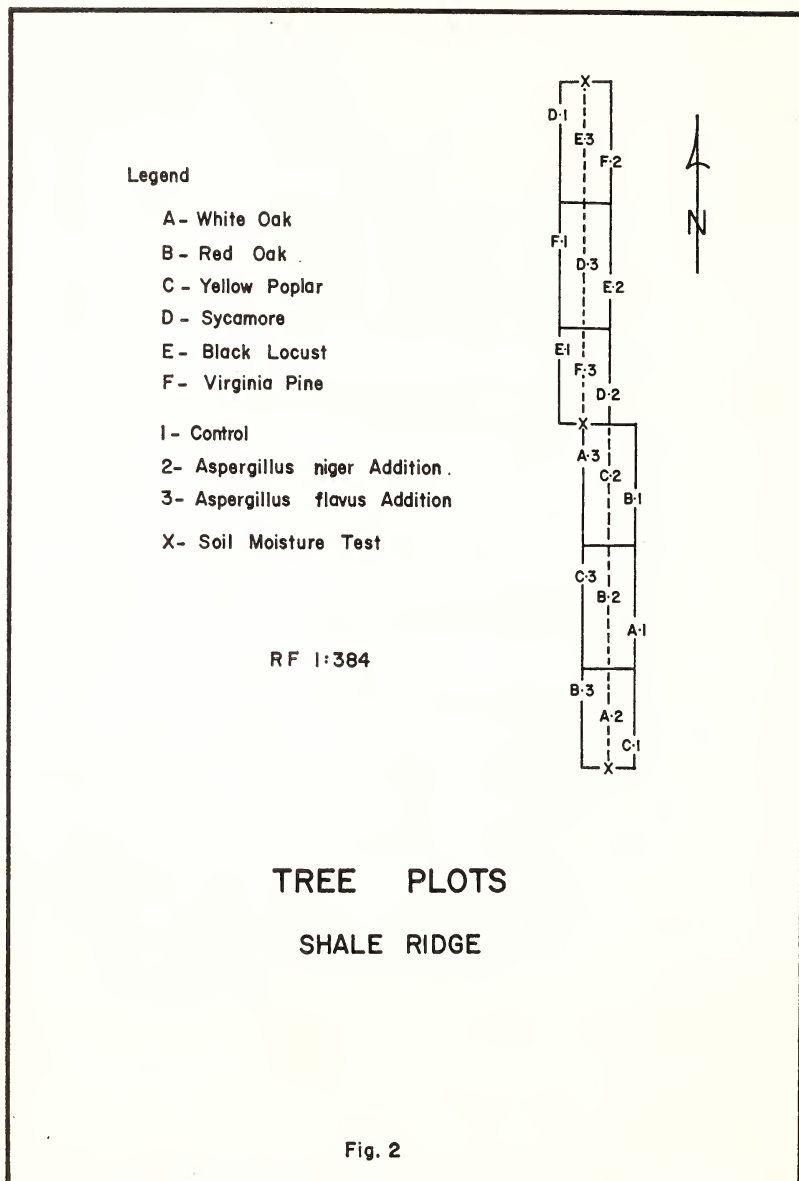
One of the initial steps in planning this study was to determine a site layout for the experimental plots. Preliminary field work was conducted during March, 1968, to determine the specific areas in which the experiments would be conducted upon the various woody species to be used. Two herbaceous species were planted in October of 1967, and similar preliminary work was done prior to that time. Upon evaluating the slopes of the two ridges, considering the exposure of the different species to the sunlight and the drainage of the plots, it was decided that the top of the two ridges would be used for the plantings of both trees and grasses. Since the sides were not equal in degree of slope, it was felt that the flattened area on the ridge tops should be utilized, thus giving a more accurate means of equating the actual potential of each of the two ridges. These tops were struck off in 1966, six years after the strip mining had taken place.

Definite plots were then staked out on the ridges. A total of twelve separate plots were arranged, with six being located on each ridge, and trees were planted at six foot intervals within these plots (Figures 1 and 2). It was decided to use six different species of trees and to divide these various species into three groupings. Two of the groups were treated with different fungal culture filtrates, an organic matter to be utilized by the plants in their growth, and the third was a control group. In the site layout of experimental plots for the herbaceous species, less subdividing of the plots was necessary. In this phase of the experiment, only the sandstone ridge was utilized. Prior to the actual sowing of the grasses, the region was staked out into three separate plots (Figure 3). In comparing the general physical background of the two spoil bank

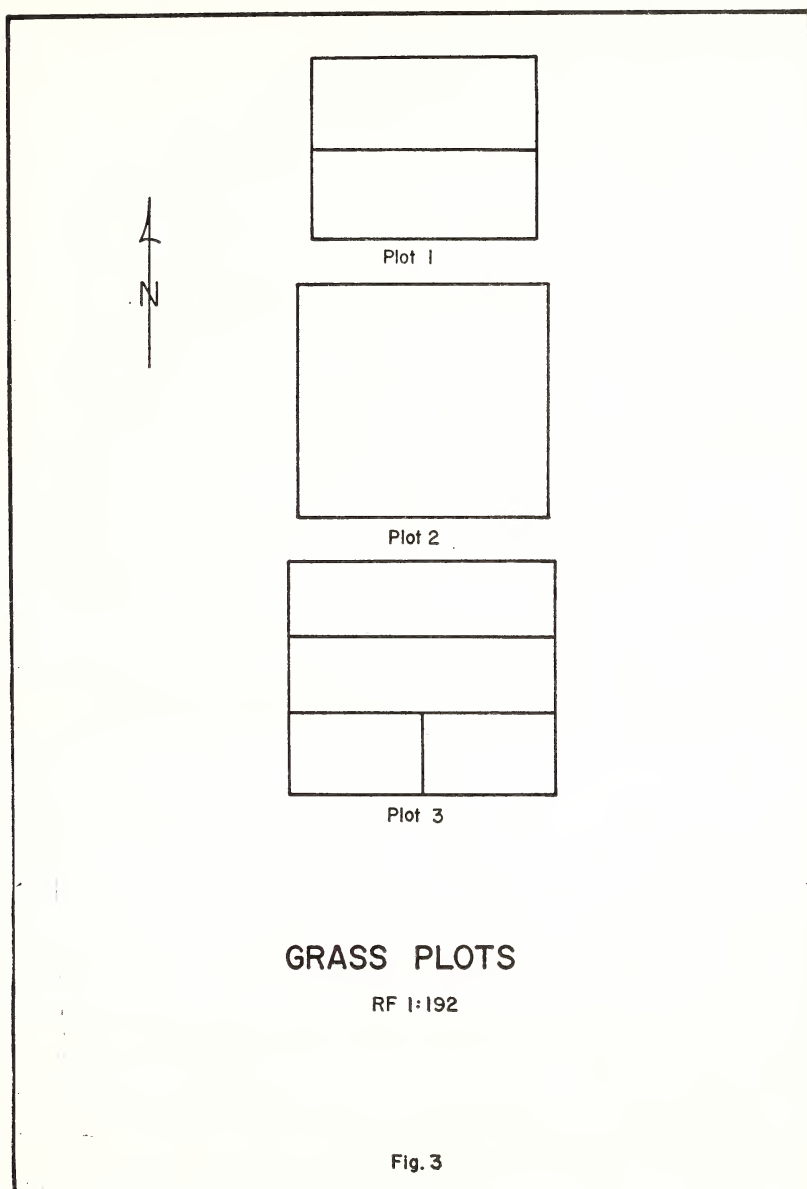


ridges, it was apparent that the greatest differences were in the acidity and the chemical composition of the ridge itself. Most of the other physical properties were quite similar.

There was a great difference in the natural vegetation found on each of the two spoil bank ridges within the experimental area. Numerous



cottonwood trees and trumpet vines were located on the sides of the sandstone ridge, near the site where the experimental trees were planted. These cottonwood trees, as well as a number of pine trees, were planted by the Indiana Coal Producers and appear to be growing very slowly. The trumpet vines and other weeds were not planted here, but have



grown on a volunteer basis. But there was absolutely no natural vegetation to be found surrounding the test plots on the shale ridge.

Three separate expenditures were analyzed in order to determine the total costs of reclaiming land that had undergone strip mining operations. These were the costs of utilities, labor, and materials which were utilized in the various aspects of the reclamation experiment. The shake

machine, the device in which the fungal culture filtrates were formed, cost one-half cent per hour to operate. It operated for 72 continuous hours, which was the total time required for the run to be completed. A total of twelve runs were made with the shake machine for an accumulated cost of \$4.32. On a larger scale, the utilities would run \$43.20 to treat one acre of land in a similar manner. The utility costs for the operation of the 100 gallon fermenter, with 96 hours of operation time per batch, amounted to \$9.85. The utility cost would be \$197.20 for one acre. The labor cost of planting and treating one acre of such land with trees would be approximately \$71, based on the present minimum wage of \$1.60 per hour.

TABLE 1. *Cost of Reclaiming one Acre of Strip Mined Land*

Trees		Grass	
Raw Material for Media	---\$19.20	Raw Material for Media	---\$ 40.00
Seedlings	----- 16.00	Seed	----- 170.00
Labor	----- 70.95	Labor	-----
Utilities	----- 43.20	Utilities	----- 197.20
TOTAL		TOTAL	
----- \$149.35		----- \$407.20	
		(plus labor)	

The three key materials required for this research project were media used in treating the experimental groups, the plants, and the seed. The costs of these materials were considered in order to determine a detailed cost analysis (Table 1). The cost of the raw materials for media used in the tree planting experiment was \$1.92. From these costs, it can be extrapolated that it would cost approximately \$19.20 to treat an entire acre of strip mine land with tree plantings in a similar manner. It was necessary to acquire the tree seedlings for this study in multiples of one hundred. Although only part of the tree seedlings were planted, one hundred of each of the six different species of trees were acquired and only the more healthy specimens were used in the actual planting on the spoil banks.

By planting a total of only 180 trees on the two strip mine sites, the actual cost of plants used in the study was about \$1.60. These were planted in an area which was approximately 4,000 square feet in size. In extrapolating this to a scale of acreage, the cost of plants necessary to reclaim an acre of similar land would be nearly \$16. Two grasses were used in this study, Kentucky 31 Fescue and perennial rye. A seed mixture containing 2½ lb. of each was sown on the experimental plots. The cost of seeding the plots was \$3 and the sum of all grass seed utilized in the project totaled \$9. The cost of seeding an acre of strip mined land in a similar manner would cost about \$170. Since the experiments were conducted on a comparatively small area, the total cost of reclaiming this type of land would be much less if the practices were conducted on a

larger scale, as most certainly would be the case in state-wide reclamation endeavors.

Another way of expressing the cost analysis of reclamation for a larger area in this vicinity is on a tonage basis. This figure was arrived at by using the average depth and thickness of the number III coal seam, which is presently being mined in this portion of Greene County. This seam, which averages two to three feet in thickness, is approximately sixty feet beneath the surface of the earth. If these figures remain uniform throughout the project area, a total of nearly 6,000 tons of coal would be mined from one acre of ground. In 1968, the average cost of recovering this coal was about \$4 per ton. It would cost an additional \$.017 per ton of coal mined to reclaim the stripped land in trees. To this, one would need to add the cost of labor, which would amount to approximately \$.007 per ton. Therefore, the total cost of reclaiming one acre of land to trees at the project site would amount to \$149.35, which would average 2.4c per ton of coal mined.

The cost of reclaiming the test site to grass land is more expensive. The materials and utilities needed in this operation would add an additional 8.4c to the cost of extracting one ton of coal in the stripping methods now in use. Labor costs would vary significantly, even on the local scale and, therefore, would be almost impossible to estimate with any degree of accuracy. However, without the labor costs being taken into consideration, it would cost \$407 to reclaim an area of 1.0 acres to grasslands.

Conclusions

Although the survival rates of the experimental plantings in this reclamation study were not outstanding, a great deal of information was acquired concerning the importance of the physical environment on various herbaceous and woody species. This strip mine site was undoubtedly one of the most adverse areas in this coal mining region. Very few spoil banks in Greene County, Indiana had such a low pH reading and such a high sulphur content. By simple observing the project area, one was able to note the dramatic contrast between the experimental planting site and the other nearby stripped land, which had been naturally revegetated. Before any major steps are taken in the reclamation of a stripped area, considerable time should be spent to thoroughly analyze the physical characteristics of the region. Although some of the physical characteristics may be favorable, one poor characteristic may cause the project to be unsuccessful.

In addition, economic factors must also be considered. The overall cost of reclaiming spoil banks has been a major concern of the private coal companies. Many of these organizations feel that the initial expense of reclaiming the stripped land far outweighs any possible economic return in the near future. This concept has been diminishing rapidly, however, due to many successful operations in the past few years.

On most strip mined areas in this portion of Indiana, favorable results would be achieved by utilizing the methods practiced in this study.

As previously shown in this study, it would be possible to reforest an acre of land for less than \$150. This figure would include the cost of all plants, culture filtrate, and labor for the project. The economic returns from this endeavor would be a definite asset to the entire region. From the cost figures arrived at in this study, it may be too expensive to plant grasses on this particular strip mine site in Greene County. However, if the area possessed more favorable physical characteristics, this operation would not be uneconomic, since income from the grass lands would eventually exceed the initial investment.