

LAND RECLAMATION WITH TREES IN IOWA¹

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Abstract.--The most important considerations in revegetating reclaimed lands are soil pH, moisture availability, and the restoration of fertility and good nutrient cycling. Green ash, cottonwood, alder, Arnot bristly locust, and several conifers are used most in plantings. Emphasis is placed on the use of symbiotic nitrogen fixation and mycorrhizae to improve establishment and growth of trees.

INTRODUCTION

As an aid to reclamation efforts in Iowa and surrounding areas, this paper reviews the findings of revegetation studies done on old spoil areas, discusses current work being conducted on the Iowa State University demonstration mine site, and projects some of the techniques likely to be useful once the necessary developmental research is completed. Most of the results discussed are based on coal mine reclamation work, but they also should have general applicability to other reclamation efforts.

A total of about 12,000 acres of mined lands are in need of reclamation in Iowa. New mining activity has produced an average of only 400 additional acres to revegetate each year, but this figure could increase with changes that may occur in the Iowa coal industry. At present, only a small percentage of the land reclamation efforts in Iowa involves the planting of trees; most of the landowners have preferred to return the land to row crops or pasture. Recreation, aesthetics, and wildlife habitat improvement have been the major reasons for the tree planting that has been done. Future interest in fuelwood plantations might increase the percentage of reclaimed land to be reforested.

Although the surface mining of sand, gravel, limestone, gypsum, clay, and coal all contribute significantly to land reclamation needs in Iowa, coal mining has drawn the most attention. Iowa's coal deposits are confined to the south-central and southeastern portions of the state, areas characterized by a rolling topography and soils high in clay content.

The coal deposits are relatively high in sulfur content, a factor delaying current use of the resource. As the technology of sulfur removal improves and the price of coal imported to the state escalates, strip mining for Iowa coal could return to its former level of 400-500 acres per year (80-100 acres per year currently).

The high sulfur content in Iowa coal deposits has created other problems. It has been estimated that 38%, the highest percentage in the central states, of the old mine sites had toxic spoils with a pH of less than 4.0 (Lorio et al. 1964). New mining practices have eliminated most of that problem, but the "tight" nature of the soils in the area still makes tree establishment difficult. In addition, the more mechanical reclamation a site has received, the greater is the soil compaction and the greater the difficulty in revegetating with trees. A second potential problem on even the sites reclaimed by new mining technology is the reestablishment of good nutrient-cycling relationships. Newly reclaimed sites are likely to have poor internal drainage, low surface-soil organic-matter content, and reduced microbial activity to aid in the breakdown and availability of soil nutrients. There is likely to be some difficulty in getting good mycorrhizae established on tree roots, and those tree species capable of symbiotic nitrogen fixation may not encounter the necessary microbial symbionts in these

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reconstituted soils.

OLD MINE SITES

Spoil characterization and revegetation trials were started in 1952, and several general summaries of that work have appeared previously (Hansen et al. 1962; Lorio et al. 1964; Lorio and Gatherum 1965). On a few sites, there has been a natural reinvasion of cottonwood, boxelder, and American elm. However, on many sites natural revegetation is extremely slow because of a combination of low pH, steep topography, infertility, and insufficient seed source or germination conditions. A total of 15 tree species was tested in plantations on these spoils and the following conclusions were drawn (Lorio et al. 1964):

1. Green ash had the best survival across all conditions, but is best adapted to more moist sites with a pH near 7.
2. Cottonwood had good survival and the best growth rate on a variety of sites. It had double the height growth of green ash.
3. If evergreens are desired, only eastern redcedar should be used on calcareous sites. On dry, low-pH sites, jack and Virginia pine can be used. Red and eastern white pine should be used only on moist, well-drained sites with good fertility and slightly acid pH's.

One woody shrub species also has shown considerable potential for use. Arnot bristly locust, a cultivar of *Robinia fertilis*, can be established on low pH spoils (survival rate drops significantly only below a pH of 3.5), and it will subsequently spread as a ground cover by means of root sprouting (Helgersson and Gordon 1978).

Soil moisture and pH characteristics are the primary determinants of what tree species can be established on a site (Lorio and Gatherum 1965). Where these two characteristics are not extreme, the next most important limitations are nitrogen and phosphorus availability (Lorio and Gatherum 1966). Therefore, planting nitrogen-fixing tree species alone or in combination with other species is likely to increase growth rates. European alder (*Alnus glutinosa*) is a leading candidate for use as the nitrogen-fixing component of tree plantations (Dale 1963; Plass 1977), and a major research project on this species is in progress at Iowa State University (Hall et al. 1979; Maynard and Hall 1980). Black locust (*Robinia pseudo-acacia*) is another nitrogen-fixing tree species that might be used. The Arnot bristly locust previously discussed could be used

as a nitrogen-fixing shrub layer in tree plantations.

The phosphorus-deficiency problem should be reduced if trees can be planted with appropriate mycorrhizal fungi already established on their root systems (see article by Marx elsewhere in this proceedings). We also have evidence that at least one mycorrhizal fungus (*Pisolithus tinctorius*) offers a direct protective effect for root systems exposed to low pH soils where toxic levels of aluminum are in solution (Cochrane and McNabb 1979).

NEW MINE SITES

Less experience is available on establishing tree plantations on sites mined with the new technology. A few landowners have successfully planted walnut and white pine. The author has established a research planting of European alder and hybrid poplar (*Populus alba* X *P. grandidentata*) on a terrace at the Iowa State University Demonstration Coal Mine near Oskaloosa, Iowa. After three growing seasons, the survival is 37% for the alder and 87% for the hybrid poplar. Initial growth rate was best for the hybrid poplar, up to 3.6 ft. in the first year. Once the alder became established, rapid growth started, adding at least 3 ft. of growth during the third growing season. Root excavations have shown that the alder is capable of sending a "sinker-root" system down through the compacted, high-clay-content soil to a depth of approximately 3 ft., while the roots of the hybrid poplar are confined to a wide horizontal spread in the upper 6 in. of soil. Future evaluations of this study should provide insights on the ability of alder to improve a reclaimed site by breaking up compacted zones in the soil and supplying nitrogen through leaf fall and root decomposition.

Other studies are needed to gauge the suitability of a range of other tree species for use on reclaimed sites and to determine the best site preparation and planting techniques. The establishment of tree plantations that help to restore a nutrient balance to mined sites while providing fuelwood, wildlife, and recreational benefits may then become an alternative to the more costly reclamation of sites for row-crop production.

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