

TREE PLANTING EXPERIENCES IN THE EASTERN INTERIOR COAL PROVINCE

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Abstract.--Fruit trees were planted successfully in 1918 and organized afforestation began in 1928. Professional foresters had a hand in some of the very earliest planting projects. Formal reclamation research played an important role in applying science to early reclamation technology; however, considerable work has preceded the scientists. Some success has been experienced with tree planting on coal waste slurry, a problem site with uniquely adverse conditions. Some indications were found showing early Chinese Chestnut tree plantings developing into timber form trees, under some conditions. It was also observed that Chinese Chestnut trees are reproducing naturally from trees planted on mine spoils as young as 12 to 15 years of age.

INTRODUCTION

Subject of this paper deals with the Eastern Interior Province (E.I.P.). Though the bulk of this region is in Illinois, the E.I.P. area extends over Southwestern Indiana and the northern part of Western Kentucky. All of the coal mining activity in Illinois and Indiana is within the E.I.P.; however, Kentucky occupies parts of two coal provinces of which only Western Kentucky is within the E.I.P.

Generally, the E.I.P. geographically is characterized by relatively low relief to level or nearly level land topography. Lesser portions of all three states within this province have commercial coal mining operations on steeper topography which occasionally also may include steep (over 37%) slopes. Unlike steep slope areas of Appalachia; however, steep slopes of the Eastern Interior Coal Province tend to be relatively short in slope length.

Bulk of the surface mining in Illinois and about half of that in Indiana occurs within the glaciated region, with relatively low relief topography. Another feature

common to this area is generally thick unconsolidated overburden materials lying above shale, sandstone, limestone, or a combination of the three, which form the balance of the overburden above coals in this area.

There is considerable similarity between surface mining conditions in the Illinois and Indiana unglaciated regions. Unconsolidated materials layers are generally thinner than in the glaciated region, with about three feet to ten or twelve feet of unconsolidated material commonly occurring.

The E.I.P. of Kentucky resembles the unglaciated coal region of Southern Illinois and Southern Indiana to some degree; however, topographic relief is somewhat greater and existing natural soils are part of the total unconsolidated materials layer which is significantly thinner. The more undulating topography and thinner soils of the unglaciated region stand as a striking contrast to the level to nearly level topography and thick soils (up to 16 inches of A-horizon soil) in the prairie region of West Central and Northern Illinois, which comprises some of the nation's most productive agricultural lands.

Rainfall generally is about 40 inches or more annually in the E.I.P., decreasing slightly as latitude increases northward. Climate in the entire province is favorable for a wide variety of commercial crop production and also favorable for commercial forest production.

RECLAMATION HISTORY

Some of the oldest, if not the oldest, land reclamation effort in the country occurred in the E.I.P. This would seem not too surprising, since the earliest commercial coal surface mining in the country is reported to have occurred near Danville, Illinois in 1866 (Illinois Blue Book 1971-1972).

Peach, apple and pear trees were successfully planted on mine spoils in Clay County, Indiana in 1918. Though some small forest plantings occurred earlier, an organized afforestation program on mine spoils in Indiana started in 1928 (Medvick 1973).

An interesting early influence in Illinois involved the tree nursery program developed in connection with the Civilian Conservation Corps program. Discontinuation of that program in the late 1930's made surplus trees available which were purchased by coal operators and planted on strip mine spoils (Illinois Blue Book 1971-1972).

A land reclamation law in Indiana came about in 1941 (the second one in the nation). Kentucky came out with a land reclamation act in 1954, and Illinois passed their first effective law in 1962, after an act passed many years earlier was declared unconstitutional.

There were numerous common traits among the early state land reclamation laws. Both pre-law and during early periods under these laws, land reclamation and tree planting were almost synonymous terms.

RECLAMATION TECHNOLOGY

Very little if anything was known initially about tree planting methodology on mine spoils. There was obviously a lot of guess work; however, it is known that professional foresters had a hand in some of the very earliest planting projects as early as 1928 (Medvick 1973).

Tree "wildlings" were used prior to availability of nursery grown planting stock. Walnuts were direct seeded possibly because there was no tree nursery growing such

planting stock. Tree planting stock was shipped by rail from eastern tree nurseries, prior to the time tree nurseries were established locally.

Under these conditions, both planting success and planting failures were experienced. To those who came along on the scene later, these early successes and failures became laboratories from which to learn. As such, results preceded the science.

Eventually individual state coal operator associations enlisted the aid of forestry researchers from the U.S. Forest Service and from the various university agricultural experiment stations. The science of land reclamation began to take shape. Some tree species selection began to emerge and some recognition of different spoil conditions permitted some unsophisticated -- yet real effort to include or exclude certain species on some generally specific sites (Limstrom and Deitschman 1951).

By around 1950, afforestation was no longer a hit and miss situation. Trying to establish a "preferred" type forest on varying sites became the major objective. Technically, afforestation on mine spoils, in a rough fashion, at least, was a known practice and this fledgling science preceded statutory requirements calling for mandatory planting of disturbed lands in all three states of the Eastern Interior Coal Province (Arnott 1950).¹

Probably the 1950's and 1960's were the big "growth years" in surface mining land reclamation -- just as it was in surface mining afforestation. Following are some highlights of this period:

(1) There were about a handful of "experts" across the country and these people all knew each other and, by keeping in close communication, they learned from each other's mistakes -- and successes.

(2) Development of technology on strip mine forage establishment brought about opportunity to choose another land use option. It was this fact which caused a sharp decline in afforestation in Illinois (Grandt and Lang 1958).

¹Arnott, Donovan, Jr. 1950. Initial survival of planted hardwoods on strip mine spoil banks of Indiana. Purdue University, Dept. of For. Unpublished Thesis.

(3) Exposure to repeated failures helped discerning land reclamationists to learn where options were real and where they were just imaginary. The trend from afforestation to forage reclamation in Illinois was followed in Indiana; however, in Indiana, this did not come about until the late 1960's.

(4) Many thousands of acres of productive strip mine forests in the E.I.P. stand today as silent monuments to the success of phenomenal growth of strip mine afforestation of this period. Afforestation continued as a major land reclamation practice in Kentucky even beyond the period of extensive grading work which, by law, eliminated the ridge and valley topography on mine spoils areas.

(5) During this time period, the science of land reclamation changed a great deal; however, field conditions -- the spoils being planted -- changed very little, until the late 1960's.

(6) Early land reclamation laws in the E.I.P. required some minor grading work -- but not enough to change site conditions. This fact helped a great deal to perfect afforestation practices with minimal confounding.

ARRIVAL OF THE BULLDOZER

In the late 1960's, Kentucky, followed by Indiana, enacted legislation calling for elimination of spoil ridges and valleys. Illinois followed suit in 1971.

In addition to changing the topography, bulldozers have a way of affecting other parameters also -- the site itself becomes "something different". There might be a better expression for it; but, soil compaction surely comes close, until a better expression is found.

One need only review a modest sampling of land reclamation literature to discover that effects of soil compaction on mine spoil afforestation has a wide following among both proponents and protagonists. As a result, any serious student of land reclamation is entitled to be, at least somewhat, confused.

If we refer back to our discussion of the "big growth" years in surface mining reclamation, it should be noted that, over a significant period of years, spoil conditions remained generally unchanged and only the techniques employed changed. Thus, it was easier to evaluate cause and effect. It is a fairly safe prediction to state that anyone who tries to duplicate results of

afforestation on ungraded mine spoils by application on graded mine spoils, is in for a few surprises.

Most perplexing of all is the fact that one can establish an excellent stand one year and a complete fizzle the very next year on what appears to be and might really be identical spoil.

A "hidden" problem in dealing with graded mine spoils is the fact that we are dealing with both cuts and fills and, in any given spot, we don't know which is the case. One need not be a soils specialist to know that amount of site compaction, soil air space and surface water insoak rate may not be the same on cuts as it is on fills. How much confounding such factors cause, one can only speculate about. For those who propose to do research on graded spoils, in order to overcome confounding caused by cut and fill differences, this writer advises designing plots and rows long enough to overlap both site types and to orient rows at right angles to original spoil ridges. This would avoid, for example, comparing a row planted on a fill with a row planted on a cut.

Graded spoils, if not too rocky, can be planted with a specially adapted tree planting machine; however, use of the planting machine might justify change of tree species.

Conifers seem to tolerate graded spoils; however, in the hardwood region, the idea of having to abandon hardwoods carries a negative image among many reclamationists. Both silver maple and red maple seem to be out-performing other hardwoods and may prove to be exceptions. Black locust can be established, if cover alone is the objective.

TREES VS FORAGE

It is some indication of advance in the state of the art which permits one to be able to choose between establishing either trees or forage on graded mine spoil. In many situations, either is possible. Except for climatic limitations (not a problem in the E.I.P.) any spoil which will grow forage also will grow trees. However, some sites may be too sandy, too coarse in texture, or too acidic for forage and yet support acceptable and maybe even excellent afforestation possibilities.

Heretofore, it has been the presumption that the existing site, in general, must be dealt with under the conviction this is a fixed condition and the only options available had to do with finding a species that will tolerate or adapt to the given site.

For many years, about the only site improvement considered practical would have been fertilization.

During the past decade or so, it has been established that site can, in fact, be changed and changed drastically. Not only that it can be done, it has been done on a significant scale. In some cases, toxic spoils have been ameliorated by application of neutralizing agents (this has been widely practiced in West Kentucky). More drastically, toxic spoils have been simply covered over by applying a suitable mantle of neutral earth.

Successful site correction, of course, brings one back to the pleasant dilemma of being able to deliberately choose between vegetating with whatever is desired, for whatever land use one might prefer. In such circumstances, afforestation may or may not prevail.

TOPSOILED SPOILS -- A NEW DAY

On the presumption that present federal requirements for coal surface mining reclamation survives the U.S. Supreme Court, both present and future reclamation on coal surface mined areas involves something approaching "original land" conditions. As a result, it must be readily apparent that one engaged in revegetation of such areas need be not necessarily a land reclamationist. If we refer back to former problems of having to plant raw spoils, by comparison, past experience may be of only limited benefit.

If we can agree that we are now working in a "new day", we must also recognize that we have at hand an opportunity to create, by deliberate plan, almost precisely that which we envision should be established. We should be able to reclaim to row crops where that is desired and to forest where such is desired. Each should have their rightful place. We may have finally circumnavigated the circle.

It should be a real pleasure to be a land reclamationist now and to exert one's efforts toward establishing, for example, not just a forest, but the very best forest. The fact that there are no existing large scale good examples to follow for reclaiming fully restored and topsoiled mine spoils should be a disadvantage only to the unimaginative.

Although the new land reclamationist might be able to ignore the site problems which plagued his predecessors, it should be pointed out emphatically that trees of the type preferred have a way of not planting

themselves where we want them. Consequently, there is no escape from strict adherence to proper tree planting methodology. If this sounds a bit trite, it is pointed out that this writer has already observed complete tree planting failures on fully restored and topsoiled coal surface mined spoil areas. Problems do still abound and they have only shifted to new dimensions.

Unfortunately, legal constraints require that herbaceous cover must accompany tree planting and there must be effective erosion control measures applied. Under such circumstances, tree planting failure cannot be corrected by simple replanting or interplanting, unless effective herbicide or comparable treatment also is used.

Much more research is needed to determine, for the different geographic regions, acceptable companion herbaceous species and to develop acceptable timing sequences with actual tree planting. Can selection of proper herbaceous species allow tree survival and growth; or, will it be unavoidable to use herbicides? If herbicides are to be used, chemical choice and technique of application, for large scale plantings, will likely become new areas of specialization for the new land reclamationist.

AREAS WITHOUT TOPSOIL

Some areas do not have topsoil present due to natural conditions, neglectful erosion, or, the area may have been previously surface mined. Thus, restoration of such area unavoidably may have raw spoil as the best available surface material. Revegetation problems on such areas, of course, should generally resemble those immediately preceding federal interim standards, except that herbaceous, companion cover becomes a factor.

Although specially adapted tree planting machines are available and most graded spoils are amenable to such machine planting, greater selectivity in species choice seems to be called for. In general, conifers seem to be adapted to machine planting; whereas, only a limited number of hardwood species seem to be so adapted.

In general, this writer's experience and observations suggest machine planting requires tree species choice be those with root system displaying generally high fibrosity (numerous small rootlets). Conifers generally meet this criteria. Among the hardwoods, soft maples and, to some degree, European Alder, give some indication of promise. Among non-arborescent species, autumn olive has shown good survival and growth.

Hand planting, by the use of a planting bar, seems to have achieved more consistent tree planting survival than has machine planting on graded spoils. Erratic success; however, suggests there is still more to be learned before we can expect "routine success" from graded spoils afforestation. Some suggestions for improving survival include the following:

(1) Planting as early in the planting season as possible makes planting work easier because freeze and thaw soil conditions seem to somewhat ameliorate compacted spoil conditions and workmen tend to do better work and plant deeper under less difficult planting conditions. Early planting also helps improve survival due to longer growth and development period, allowing better root development, prior to dry, hot weather stress period arrival.

(2) The later in the season planting is done, the more care and supervision becomes critical to success. Planting stock care is essential and merely keeping seedling roots wet is not adequate. A seedling can be just as dead from root mold as it is from desiccation. This writer observed a fairly large scale tree planting failure during the spring of 1980 where hardwood seedlings did not even open their buds to begin spring growth. It seems fair speculation that the seedlings planted probably were not viable plants at the time of planting.

(3) A tractor with a ripper can be used to rip a furrow at the spacing planned for tree planting on graded spoils. This treatment not only should ameliorate grading compaction and make planting work easier, increased rainwater insoak also would be expected and both factors should improve tree survival. Using a tractor with ripper in this fashion has long been a standard practice for eucalyptus planting on tin mine spoils in Nigeria. Timing of ripping work should be in the fall or early winter for area to be planted the following spring (Onosode, A. T., et al. 1973).

(4) Planting graded spoils with a commercial tree planting bar becomes progressively more difficult as spring planting season advances and drier weather renders compacted, graded spoil harder and more difficult for the planting bar to penetrate. Conditions do develop where one just cannot force a commercial planting bar into the ground. With such conditions, tree planters have a tendency to "J" root the tree seedlings and planting failure is almost assured.

One solution to compacted spoil planting conditions, assuming ripping with a

tractor is not available, is to have planting bars fabricated at a local blacksmith shop. A piece of large truck spring can be welded to the end of a piece of 3/4-inch pipe. Length of truck spring piece about 10 inches would be adequate and overall length, after being welded to the piece of pipe, should be about 49 inches. The blade (end of truck spring piece) should be heated and hammered to be sharp. No foot step, as is found on the commercial planting bar, is needed. Such a tool has enough heft that it can be jabbed into the ground like a post digging spud and, even if repeated jabbing is required for hard soil conditions, eventually, a proper depth tree planting hole can be dug with this tool.

(5) It is never desirable to plant trees on freshly graded spoil. Ideal conditions are for grading work to be completed in the fall or early winter and undergo winter weathering conditions prior to planting early the following spring.

(6) Where herbicides are to be used, if pre-emergent type is chosen, significant advantage is available if ripping with a tractor is done because treatment along the tree rows (ripped furrows) can be done efficiently where one plans to allow herbaceous cover to develop in the strip between rows.

(7) Perennial herbaceous cover, as a tree planting, companion cover, should not be established ahead of tree planting. By establishing trees and herbaceous cover at the same time, it may be possible for the trees and herbaceous growth to survive; whereas, planting trees in established cover invites tree planting failure, unless herbicide treatment is applied. This writer is of the opinion that much more needs to be learned about dealing with companion herbaceous vegetation and, hopefully, other competent researchers will join in on the type of research being done by Vogel, whose paper on this subject appears on another part of this program.

TREES ON COAL WASTE SLURRY

A number of coal waste slurry lagoons have been planted with trees. Some stands are now over ten years of age. Out of nine sites planted, all showed some degree of success, with only one complete failure. The single failure had surface pH below 4.0. The other sites had pH above 4.0.

The highest success was achieved with cypress planted in a strip around a water area and extending into the water-covered slurry as far as tree planters wearing rubber boots could walk and successfully

anchor trees into the slurry. Appearance of the ten year old stand shows very few trees failed to survive and growth rate appears to be satisfactory.

On dry slurry areas, some fair stands of trees are now growing and results indicate that successful species are pitch pine, jack pine, Virginia pine, cypress, red oak and river birch. White pine proved a failure, although, in places, it survived a few years.

Although some success has been achieved, no entire slurry lagoons were completely, successfully afforested. Just why this is so still remains to be explored and elucidated. This writer's speculation is that the answer lies in variations of slurry material which are not superficially noticeable. To the naked eye, slurry areas appear to be level; however, they actually slope at about 0.7% (precise composition of different particle sizes will affect the slope and probably no two slurry lagoons are precisely similar).

It is not necessarily suggested here that slurry areas cannot be completely afforested -- just that this writer has not personally observed such. Efforts to replant failed areas would definitely seem to be worth trying; however, this writer does not know of such being done. If attempts at replanting result in failure, it may result in delineating areas which may require treatment such as possibly liming and/or fertilizing or soil covering.

Those attempting tree planting in slurry are cautioned to observe there is a special problem in planting during dry weather because the slurry surface may become extremely dry and powdery. Digging a hole through the dry surface commonly will cause dry slurry material to fall down in the hole because, when dry, slurry material is "structureless". Placing a tree seedling in a hole partially filled with dry slurry would seem to invite planting failure. To deal with this problem, it has been found that one can use a tree planting bar to rake back and forth a couple of times to scrape dry slurry aside and expose moist slurry found below. If one then digs a planting hole in the moist slurry, the hole will retain its shaped opening to allow insertion of a tree seedling and normal planting procedure can then be observed.

A LOST SPECIES RE-ESTABLISHED

A half century of surface mining afforestation experience in the E.I.P. has taught us many things and has had some significant impact in other ways. As often occurs, results other than those sought sometimes come

about in a way that exceeds all expectations. Such is the case with Chinese Chestnut.

As is well known, the native American Chestnut is a thing of the past, due to the chestnut blight. A once very valuable component of the midwest and eastern hardwood forest has not been among the numerous hardwood species planted on strip mine spoils, for obvious reasons. However, in approximately 1949, it was decided to try a substitute variety -- Chinese Chestnut. This species has been regularly planted in Indiana ever since that time and, for many years, this species has been producing chestnuts for the enjoyment of local citizenry and, of course, for wild-life food.

Because typical Chinese Chestnut tree growth behavior tends to be, more or less, that associated with fruit trees (orchard form), these trees have taken on the image of being desirable nut producer components of a stand and no one is known to have given much attention to possibilities beyond that.

It is now possible to report that some chestnut trees are developing under closed canopy stand conditions in a way that original orchard form is giving way to developing a timber form character. It is still too early to determine final outcome; however, some pole size trees with fair timber form can now be found.

Something this writer has not found appearing in the literature involves reproducing capability of Chinese Chestnut -- especially on surface mine spoil areas. This writer has now observed enough instances in different stands to conclude that this species is reproducing naturally. Stands where natural regeneration was found generally are about 12 to 15 years of age or older. Thus, it soon may be possible to conclude that we have successfully re-established a lost species.

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