The Appalachian Regional Reforestation Initiative and the Forestry Reclamation Approach

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Abstract

The Appalachian Regional Reforestation Initiative is a broad-based program that involves citizens, industry, academia, and government agencies to encourage the planting of productive trees on active and abandoned coal mine lands. Reforestation research conducted by various academic institutions has confirmed that highly productive forestland can be created on reclaimed mine land by using a five step Forestry Reclamation Approach (FRA): (1.) Create a suitable rooting medium for good tree growth that is no less than four feet deep and comprised of topsoil, weathered sandstone and/or the best available material; (2.) Loosely grade the topsoil or topsoil substitutes placed on the surface to create a non-compacted growth medium; (3.) Use native and non-competitive ground covers that are compatible with growing trees; (4.) Plant two types of trees – early succession species for wildlife and soil stability, and commercially valuable crop trees; and, (5.) Use proper tree planting techniques.

Keywords

Mining, trees, compaction, topsoil, revegetation

Introduction

The majority of the Appalachian region was originally covered with rich hardwood forest. Over the years, surface mining reclamation has resulted in forest fragmentation and a net loss of productive forestland. We cannot replace nature, but we can create an environment through the reclamation process that will enhance tree growth, increase survivability, accelerate the natural process of succession, and reestablish forest habitat. This is the focus of the Appalachian Regional Reforestation Initiative (ARRI).

With the advent of the Surface Mining Control and Reclamation Act of 1977 (SMCRA), special efforts were made to address land stability and sedimentation caused by past mining practices. Reclamation practices including high soil compaction rates and aggressive ground covers resulted in dense hay land and pastureland. This type of reclamation may be aesthetically pleasing and desirable in some cases, but it is not conducive to productive forestland.

Although implementation of the law has been largely successful in controlling erosion, many lost opportunities for reforestation of surface mines have occurred since SMCRA was implemented in 1978. Of particular concern is that mine land reclamation projects often produce excessively compacted soil, which makes successful tree growth difficult. In the early years of SMCRA, regulators focused on stability of landforms created by surface mines at the expense of creating diverse and productive forests. This attitude was brought about by a desire to move away from the excesses of pre-law surface mining where severe erosion, sedimentation, landslides, and mass instability were commonplace. As a result, excessive compaction of surface mines became the rule of thumb despite the warning of reforestation researchers.

Furthermore, regulators found that it was extremely difficult to implement SMCRA initially because of its technical complexities. This caused reforestation efforts to take a back seat until more basic regulatory requirements with higher priorities could be fine-tuned. Lastly, surface mine operators believed that other post-mining land uses, in particular hay and pasturelands, were easier and cheaper to achieve than forestry. These factors and others contributed to the industry-wide mindset that led to significant forest fragmentation across the coalfields of Appalachia. Much of the land mined since 1977 has been prepared for a post-mining use of hay or pasturelands. After bond release, most of these lands slowly revert to low quality shrub and forest cover with little or no commercial value. These lands are usually less productive and diverse than the original forest cover. These are the issues that led to the start of ARRI.

Appalachian Regional Reforestation Initiative - ARRI

ARRI is a broad-based citizen/industry/academic/government group working to encourage planting of productive trees on reclaimed coal mined lands and abandoned mine lands. Our vision is not only to plant more high value trees, but to ensure the survivability and growth potential of the planted trees. To do so, we will concentrate on promoting the use of the Forestry Reclamation Approach technology. By using a combination of private and governmental resources, the program will facilitate and coordinate the coal industry, university researchers, the environmental community, and state and federal government agencies that have an interest in creating productive forestland on reclaimed mined lands.

ARRI is guided by a Core Team that includes members from each Office of Surface Mining Reclamation and Enforcement (OSM) Field Office, and members from each State Regulatory Authority in the seven states of the Appalachian Region. This Core Team has the responsibility to develop reforestation partnerships and promote ARRI. In addition to the Core Team, reforestation researchers and experts from ten different Universities and the U.S. Forest Service have joined forces to create ARRI's Academic Team. Their primary goal is to provide current state-of-the-science guidance for practitioners of surface mine reforestation.

ARRI has identified several barriers to successful reforestation that must be eliminated:

- Cultural Barriers – We will work to change the perception that tree planting is more expensive and risky than reclamation to pastureland. This will require re-education of mining companies and regulatory authorities from the top management all the way down to the inspectors and equipment operators in the field. We must change the perception of what good forestry reclamation should look like.
- Technical Barriers – We will work to promote the use of FRA technology, and to encourage additional research as needed.
- Perceived Regulatory Barriers – OSM and the Appalachian region states have determined that the FRA technology can be implemented under the current State and Federal regulations. However, we will continue to review State and Federal regulations to identify and resolve impediments to reforestation. We will work to change the perception that the regulations impede effective reforestation techniques.

The goals of ARRI are to:

- Plant more high-value hardwood trees on reclaimed coal mined lands in Appalachia
- Increase the survival rates and growth rates of planted trees
- Expedite the establishment of forest habitat through natural succession

The Core Team has recognized that the way for ARRI to achieve these goals is through implementing the Forestry Reclamation Approach.

Forestry Reclamation Approach

Researchers began to notice that tree productivity on some pre-SMCRA sites actually had superior growth rates to those planted under the law. Most of these sites were on areas with low compaction rates. Forestry researchers at Southern Illinois University conducted studies during the 1970's and 80's to examine 30-year-old tree plantations on low compaction spoil piles in the mid-west region. They found very high survival rates and growth rates for many hardwood species. They also documented far greater natural succession of native forest tree species in the areas planted to trees, than on adjacent unplanted areas.

Current forestry research conducted by the University of Kentucky, Virginia Polytechnic and State University, and West Virginia University has confirmed that highly productive forestland can be created on reclaimed mine land by using a Forestry Reclamation Approach (FRA). The FRA will increase forest productivity and timber value, increase plant diversity through natural succession, increase soil and water conservation, provide critical wildlife habitat, and carbon

sequestration. It is for these reasons that the Appalachian Regional Reforestation Initiative (ARRI) was formed.

The FRA has taken lessons learned from past mining practices and modified current mining practices to create more productive forestland. The FRA discussed here is a general guideline. Each State will be encouraged to develop a FRA that fits the unique environmental conditions within that State.

The five steps of FRA are:

1. **Create a suitable rooting medium for good tree growth that is no less than 4 feet deep and comprised of topsoil, weathered sandstone, and/or the best available material**

The selection of the best growth medium will depend on the local environmental conditions and the best available soil material. In Ohio and parts of Pennsylvania, large deposits of topsoil are available. This is a valuable resource and it should be conserved and replaced.

In most of the other States in the Appalachian Region, sandstone with a moderately low pH has been shown by research to be the preferred growth medium. Shale may be used in combination with sandstone; however, high concentrations of shale and other fine-grained spoil materials should be avoided. Many times these materials have higher pH values, which encourages heavy ground cover and inhibits tree growth. On remining sites, topsoil/sandstone may not be available in sufficient quantities. In these cases, a combination of spoil materials will be required to create the best available growth medium.

2. **Loosely grade the topsoil or topsoil substitutes established in step one to create a non-compacted soil growth medium**

The use of pans and other rubber tire equipment must be eliminated during final grading. The practice of tracking-in with dozers to create a smooth and compacted final grade is not advisable, and is an unnecessary expense. The majority of the backfill should be placed and compacted using the currently accepted practices. The difference is only during the replacement of the growth medium in the last 4-6 feet. In area mining, haul trucks are used to dump the growth medium in a tight arrangement, and final grading is accomplished with one or two light passes with a dozer to strike off the tops of the dump piles. Likewise, in a dragline operation, the growth medium is placed in piles and a dozer lightly grades the area leaving a rough, non-compacted growth medium. In steep slope mining areas, the majority of the backfill is placed and compacted as usual, but the final 4-6 feet of growth medium is dumped and lightly graded to achieve the required final grade. This low compaction technique will actually reduce erosion, provide enhanced water infiltration and restore the hydrologic balance, and allow trees to achieve good root penetration. Research conducted by the University of Kentucky, at the Starfire Reforestation Project, has shown that reduced compaction rates result in superior tree survival and growth rates. Ripping can alleviate compaction, and research has shown that this will increase tree growth. However, this unnecessary expense can be avoided by limiting compaction during final grading.

3. **Use native and non-competitive ground covers that are compatible with growing trees**

Tall Fescue including Kentucky-31, Sericea Lespedeza, and all clovers except Ladino should be avoided. Seeding rates and fertilizer rates should be reduced in order to limit ground cover competition to planted tree seedlings. Competitive ground cover will inhibit both tree survival and productivity. Tree compatible grasses include Foxtail Millet, Rye, Red Top, Perennial Ryegrass, and Orchard Grass. Tree compatible legumes include Kobe Lespedeza, Birdsfoot Trefoil, and Appalow lespedeza. These species will provide sufficient ground cover, but will not aggressively compete with tree seedlings for rooting space, sunlight, and soil moisture.

4. Plant two types of trees – early succession species for wildlife and soil stability, and commercially valuable crop trees

Early succession trees and shrubs act as nurse plants for the higher quality hardwoods and provide wildlife food and cover. Good nurse plants include Redbud, Dogwood, Black Locust, Bicolor Lespedeza and Black Alder. Crop trees should be selected according to the soil and environmental conditions. Research has shown that commercially valuable hardwoods can be successfully grown including Red Oak, White Oak, Green Ash, White Ash, Black Walnut, Sugar Maple and Yellow Poplar. Conifers such as White Pine and Loblolly Pine have also been shown to thrive on FRA sites. Using the FRA also encourages natural succession of native forest plants. By planting both early succession and late succession tree species and accelerating natural succession, a shorter amount of time is required to reach a mature forest.

5. Use proper tree planting techniques

The importance of proper tree planting cannot be over stressed. The best planting stock available should be selected and maintained in cold storage until actual planting. Tree seedling roots exposed to air for as little as 15 minutes can significantly increase the mortality rate. Care should be taken to separate seedlings and prune roots only when necessary. The seedlings must be kept moist and immediately placed in the planting bag. The planting hole must be made as deep as possible, to accommodate the entire root system. The planting hole must be completely closed leaving no air pocket, and tamped in with the heel. In most cases, the extra cost of hiring professional tree planters will be well worth the investment.

Both environmental and economic benefits occur with reclamation using FRA. The environmental benefits include:

- Increased plant diversity through natural succession of native forest plants
- Endangered species habitat and enhanced wildlife habitat for managed game
- Soil and water conservation
- Recovery of the hydrologic balance
- Carbon sequestration (refers to the ability of forestland to remove carbon from the atmosphere, and store it as biomass and soil organic matter)

Reforestation also provides a wide range of economic benefits to landowners, the local community, and coal mining companies including:

<u>Landowner</u>

- Increased timber value
- Tax incentives

- Leasing for recreational areas
- Carbon sequestration credits

Community
- Jobs for the local economy
- Local sales tax revenue

Coal Mining Companies
- Reduced grading costs
- Reduced fertilizer and seeding costs
- Reduced maintenance costs
- Reforestation using FRA provides an economically viable post mining land use option that will result in timely bond release

Evaluating Site Productivity

The likely productivity of a particular area for growing trees can be expressed as the "Site Index" (SI). The SI is the total height to which dominant trees of a given species will grow on a given site by some index age (usually 25 years for conifers or 50 years for hardwoods). For example, if the site index for a specific soil within a forest is 70 at 25 years for White Pine, White Pine seedlings that are planted today are expected to be 70 feet tall in 25 years. Thus, once a forester determines the site index, future timber yields can be predicted (Hamilton, 1995).

Forestry Reclamation Approach Increases Site Index and Timber Value

Research has shown that by using the Forestry Reclamation Approach, the SI and resulting value of the timber resource can be significantly increased beyond that which existed prior to mining. For example, an average quality undisturbed Appalachian White Pine forest site has a SI of 55 (base age 25), which would yield small sawtimber at a value of $1,755 per acre (Doolittle 1958). The actual quality of a White Pine stand on an Appalachian mine site using the Forestry Reclamation Approach would have a SI of 70 (base age 25), which would yield large sawtimber at a value of $3,480 per acre (Burger et al., 1998). The increased value can be even more dramatic if commercially valuable hardwoods are planted.

Reforestation Costs

The costs associated with a reforestation project must be known to determine if the project is feasible. On Title IV sites these costs vary greatly from site to site, ranging from $200 to $2,000 per acre for optimal tree growth, depending primarily on the site conditions and the physical and chemical nature of the soil. This is because soils often need physical and nutritional enhancement, and the cost of soil improvements can vary significantly.

Most of the costs associated with reclamation of Title V sites are the same regardless of the post-mining land use. The differences in cost are found in the final grading, site preparation, and planting costs. In the past, reclamation to hay and pastureland has been perceived to be less costly than reclamation to forestland. However, by using the Forestry Reclamation Approach,

actual reclamation costs can be less for forestland. Low compaction final grading, which is encouraged for forestland reduces the hours of required dozer time. Surface rocks, small mounds, and depressions, are encouraged because this more closely matches natural forestland conditions. There are reduced costs for seed and fertilizer; because dense aggressive ground covers are not encouraged.

Reforestation also eliminates the cost of liming because trees generally perform well in slightly acidic soil conditions and native acid-tolerant ground-cover species are naturally more compatible with trees. These cost savings can be considerably more than the cost of tree planting. Maintenance of the site through the bond liability period can also be less for forestland. In most cases, pastureland will require maintenance throughout the bond liability period to maintain site productivity and to eliminate rills and gullies. Forestland requires very little maintenance and formation of stabilized gullies can be allowed to remain because they are compatible with forestry land uses and are not prohibited by federal regulations.

Reforestation as a Marketing Tool

Mining companies can increase their ability to compete for coal leases by providing the landowner with a valuable post-mining forestland resource. In addition, many states provide tax incentives for forestland that can significantly reduce the landowners' property taxes. Mining companies can also gain a marketing edge with coal consumers by providing carbon credits and other ecological assets derived from forestland.

Conclusion

In working toward the goals of ARRI, the Core Team has developed a Statement of Mutual Intent (SMI). Those groups and individuals signing the SMI pledge to promote ARRI and FRA. To date 161 signatories representing 77 different organizations have signed the SMI.

The work to promote ARRI has been invaluable, but there is much to be done. The real success of ARRI will be measured in on-the-ground results. The States in the Appalachian Region will be leaders in implementing FRA in the field. Putting FRA requirements as part of mining permits will likely be a key to ensuring that the provisions are implemented. To get to that point, mine operators, consultants, permit reviewers, inspectors, and land owners must be convinced of the benefits of ARRI. We are developing training programs aimed at these groups to demonstrate these benefits. We are also investigating the economic benefits of reforestation vs. conventional reclamation to prove that reclamation using FRA is not only cost effective but will lead to future economic benefits that will not occur in conventional reclamation.

Forestland enriches us all by providing numerous environmental and economic benefits. Forestland is also a renewable resource. By working together, State and Federal government agencies, the coal industry, landowners, university researchers, and local citizens, can indeed create highly productive forestland on reclaimed mine land by using the Forestry Reclamation Approach. We invite any and all interested parties to join the Appalachian Regional Reforestation Initiative and become Reforestation Champions.

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