FINANCIAL COST TO LANDOWNERS ASSOCIATED WITH FORESTLAND CONVERSION TO NON-PRODUCTIVE USES IN THE PROCESS OF SURFACE MINING[1]

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Abstract. Public Law 95-87, the Surface Mining Control and Reclamation Act of 1977 (SMCRA), mandates that mined land be reclaimed to its pre-mining use, and in a fashion that renders the land at least as productive after mining as it was before mining. According to SMCRA requirements, mine operators are responsible for reclaiming mined land. Until recently, mine operators commonly reclaimed previously forested land to hayland/pasture or wildlife habitat. Most of these lands have been abandoned from management and rendered non-productive. This left the landowner with the option or necessity of converting these reclaimed mined lands to forests at a later stage, in order to make them economically viable. Such a land-use conversion, however, comes at a substantial cost to the landowner, which makes the financial feasibility of such a conversion a questionable issue. This paper examines the economic implications of this shift in reforestation burden from the landowner to the mine operator. Results suggest that the reforestation of mined lands as part of the mining operation creates a viable and profitable forest enterprise for landowners.

Additional Key Words: mine reclamation, land-use conversion, reforestation

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Introduction

Public Law 95-87, the Surface Mining Control and Reclamation Act of 1977 (SMCRA), mandates that mined land be returned to its pre-mined use or one of higher value, and that the land be reclaimed in a fashion that renders the land at least as productive after mining as it was before mining. In the central Appalachian region, where prime farmland and economic development opportunities for mined land are scarce, the most practical land use choices are forestland, hayland/pasture, or wildlife habitat. Since 1977, the majority of mined land has been reclaimed as hayland/pasture or wildlife habitat, which is less expensive to reclaim than forest land, since there are no tree planting costs. However, because there is no livestock industry, and because most wildlife lands are abandoned after bond release, there are now hundreds of thousands of hectares of grasslands and scrublands in various stages of natural succession located throughout otherwise forested mountains in the eastern U.S.

Until recently, it was common for mine operators to reclaim previously forested land to hayland/pasture or wildlife habitat. This left the landowner with the option or necessity of converting these reclaimed mined lands to forests at a later stage in order to make them economically useful. Such a land-use conversion comes at a substantial cost to the landowner, which makes the financial feasibility of such a conversion questionable. However, because the law requires the mine operator to reforest the land if it was forested prior to mining, in actual fact, the mine operator is responsible for the costs of reforestation unless alternative land uses result in higher value. Were mine operators to comply with the law, therefore, after bond release, the landowner would be handed an established forest, for which he/she has not incurred any establishment costs.

The purpose of this paper is to address the economic implications of the coal company assuming the costs of reclaiming mined lands to forests versus the landowner assuming these costs. This analysis will be conducted by comparing Land Expectation Values (LEV) for a range of land use conversion scenarios, in which the landowner assumes the costs of site preparation and tree planting versus similar scenarios in which the coal company assumes the costs.

Methods

Growth and yield

Two forest stand types are considered for reforestation purposes: 1) mixed Appalachian hardwoods and 2) white pine. Multiple linear regression was used to estimate per hectare stand volume, with volume (V) as the dependent variable, and site index (S), stand density (N) and Age (A^{-1}) as the independent variables (Table 1). Forest inventory data for this estimation were collected on reclaimed mined sites in a study by Rodrigue (2001). These data were gathered from fourteen planted forest sites across seven states, located on reclaimed mined lands in the midwestern and eastern coalfields. The fourteen sites, each with an average size of 2.5 ha of uniform and contiguous forest cover, ranged from 20 to 55 years old, and covered a broad spectrum of spoil types.

Table 1 – Estimated yield coefficients for mixed hardwood and white pine plantations (based on data from study by Rodrigue (2001))

	Data set	
	Mixed HDWDS	**White pine**
Site index (S)		
Coefficient	**0.0145****	**0.01604****
t-stat	2.90857	3.13600
P-value	0.00529	0.00448
Stand density (N)		
Coefficient	**-0.00023**	**-0.00038**
t-stat	-0.86142	-1.50392
P-value	0.39289	0.14565
Age (1/A)		
Coefficient	**-11.22905**	**-34.13108****
t-stat	-1.03875	-3.81126
P-value	0.30364	0.00085
Observations	57	28

* indicates coefficient is significant at $\alpha = 0.10$ level

** indicates coefficient is significant at $\alpha = 0.01$ level

<u>Silvicultural treatments and site classes</u>

All financial feasibility calculations for this study are based on three levels of site preparation intensity and five different site classes. Silivicultural treatment costs increase with increasing levels of site preparation intensity. The three proposed silvicultural treatments for this study are aimed at sequentially addressing the three major factors limiting reforestation success on reclaimed mined land:

- incompatible ground cover
- soil compaction
- incompatible soil chemical properties and low fertility

Silviculture treatment 1 (low intensity) - This treatment addresses only the existing incompatible ground cover. The following silvicultural activities are assumed: Herbicides will be used to kill the existing groundcover, trees will be planted, and herbicides will be used twice in year one and twice in year two to control competing vegetation adjacent to the planted trees.

Silviculture treatment 2 (medium intensity) - This treatment will address the existing incompatible groundcover and soil compaction problems The following silvicultural activities are assumed: Herbicides will be used to kill the existing groundcover, the site will be tilled to a depth of 0.7m in one direction to ameliorate soil compaction problems, trees will be planted, and herbicides will be used twice in year one and twice in year two to control competing vegetation adjacent to the planted trees.

Silviculture treatment 3 (high intensity) – This treatment will address the existing incompatible groundcover, soil compaction and soil chemical and fertility problems. The following silvicultural activities are assumed: herbicides will be used to kill the existing groundcover, the site will be tilled to a depth of 0.7m in one direction to ameliorate soil compaction problems, soil chemical and fertility problems will be corrected/improved through liming and fertilization, trees will be planted, and herbicides will be used twice in year one and twice in year two to control competing vegetation adjacent to the planted trees.

The activities and costs associated with each of the three site preparation intensities are reported in Table 2. A number of these costs are average costs from the literature, while some of them were collected via personal communication. The total costs incurred per site preparation intensity for the mixed hardwood and white pine scenarios, are summarized in Table 3. Tables 4 and 5 show the site class delineations used for mixed hardwood and white pine sites, respectively.

Table 2 – Estimated costs of various site preparation activities in given year

	Activity	**Cost ($/ha)**	Site preparation intensity
Year 0	Weed control (herbicide + application)	262.54[1]	High, medium, low
	Ripping (D8 bulldozer)	296.52[2]	High, medium
	Fertilize (6oz/tree: materials + application)	197.16[3]	High
	Lime (2.47 tons/ha: materials + application)	97.23[4]	High
	Seedlings ($0.25/tree: mixed hardwoods)	369.66*[5]	High, medium, low
	Hand planting	672.11[6]	High, medium, low
Year 1	Weed control 1 (herbicide + application)	90.19[7]	High, medium, low
	Weed control 2 (herbicide + application)	90.19	High, medium, low
Year 2	Weed control 1 (herbicide + application)	90.19	High, medium, low
	Weed control 2 (herbicide + application)	90.19	High, medium, low
	Fertilize (12 oz/tree)	237.49	High

* $0.20/tree for White pine = $268.84/ha

Table 3 – Total costs incurred by site preparation intensity

Site preparation intensity	**Total cost ($/ha – not discounted)**	
	Hardwoods	*White pine*
Low	1665.08	1591.15
Medium	1961.60	1887.67
High	2493.48	2419.55

[1] 1.25 gal/ac @ $45/gal + application @ $50/ac (tractor sprayer)
[2] D8 bulldozer @ $120/ac
[3] Walmart (2003): $4/50lbs bag of 10:10:10 + application @ $7/hr (labor wage)
[4] Sisson & Ryan Quarry (2003): $4.35/ton of lime + application @ $35/ac (farm tractor)
[5] Forest Landowner 2001-2001 Seedling Nursery Directory
[6] 1344 trees/ha @ $0.5/tree
[7] 0.5gal/ac @ $45/gal + application @ $14/ac (hand spray)

Table 4 - Site index classes for mixed hardwoods (ft at base age 50)

Site Class	**V**	**IV**	**III**	**II**	**I**
Range	< 51	52-61	62-71	72-80	80 +
Average	46	56	66	75	85

Table 5 - Site index classes for white pine (ft at base age 50)

Site Class	**V**	**IV**	**III**	**II**	**I**
Range	< 64	65-77	78-88	89-99	100 +
Average	58	71	83	94	106

Land expectation value (LEV) calculations

All results in this study are presented in terms of LEV. LEV is the Net Present Value (NPV) for an infinite time horizon. Whereas NPV takes into account the opportunity cost of money that is tied up in the investment in forestry over a single rotation, LEV also takes into account the opportunity cost of land by considering subsequent rotations. The general formula used in calculating LEV values for this study is as follows:

$$\text{LEV} = [\sum_{t=0}^{T} R_t/(1+i)^t - \sum_{t=0}^{T} C_t/(1+i)^t]/(1-(1+i)^T)$$

Where:

R_t = revenue received at time t ($/ha)

C_t = cost incurred at time t ($/ha)

i = alternative rate of return

t = time since project initiation (years)

T = harvest age (years)

All LEV calculations are based on 1st quarter 2003 Timber Mart-South standing timber average prices for mixed hardwoods and pine in Virginia (Table 6). Scenarios were developed, using 3.5%, 5%, and 7.5% as alternative rates of return. This range of alternative rates of return covers a broad spectrum of interest rates, and is consistent with other studies. Product classes (sawtimber or pulpwood) were determined by site class. On higher quality sites, the proportion of sawtimber tends to be higher and vice versa on poorer sites (Amacher et al., 1997). In this study, site classes I and II were classified as high quality sites, and site classes III, IV and V were classified as poor quality sites (Table 7).

Table 6 - 1st Quarter 2003 Timber Mart-South standing timber average stumpage prices for Virginia ($/ton)

	Hardwoods	Pine
Sawtimber	20.07	29.68
Pulpwood	4.65	8.51

Table 7 - Proportions of sawtimber and pulpwood for various site classes by species (Amacher et al., 1997)

Site Class	Sawtimber	Pulpwood
I & II (HDWDS & Pine)	75%	25%
III, IV & V (HDWDS)	66.7%	33.4%
III, IV & V (Pine)	50%	50%

A wide variety of decision parameters must be considered when examining the financial feasibility of reforesting mined lands, including planting stand density and rotation age. All LEV calculations were conducted under the assumption of an initial planting density of 1344 stems/ha. This is a standard 10 x 8 ft stocking for plantations. Hardwood rotation ages were varied, in increments of 10 years, from 40 – 80 years. Pine rotation ages were varied, in increments of 5 years, from 20 – 40 years. These rotation age ranges cover a spectrum of typical rotation ages for hardwoods and softwoods, respectively.

The case in which the landowner pays the costs of site preparation versus when the coal company pays these costs differs somewhat between hardwood and pine forests. It is assumed that the mixed hardwood stands will regenerate naturally, and thus, there will be no further establishment costs subsequent to the initial establishment costs. It is assumed, however, that the pine stands will be harvested at rotation age, and replanted, and thus there will be associated establishment costs at the beginning of each new rotation. The landowner will pay these costs, subsequent to the first rotation.

Summary

All the above-mentioned components were combined into an Excel spreadsheet. This spreadsheet was set up, so as to allow for the estimation of the financial implications of a broad range of land use conversion scenarios, in terms of LEV, through the varying of all the variables involved in this calculation: site class, site preparation intensity (and associated costs), alternative rate of return and rotation age. LEV calculations were made for both scenarios in which the landowner assumed the costs of site preparation and planting, and scenarios in which the coal company assumed the costs of site preparation and planting. Within the range of data and parameter variations used in this study, three particular scenarios were selected for comparison, from both the mixed hardwood and the white pine LEV results: 1) High LEV - for the scenario that produced the highest LEV, 2) Middle LEV - for the scenario which comprised more or less average values of parameters used, and 3) Low LEV - for the scenario that produced the lowest LEV.

Results

Hardwoods

Our results indicate that indeed there are significant economic implications associated with changing the assumption that the landowner assumes the costs of forest establishment to the assumption that the coal company assumes these costs, for mixed hardwood scenarios. For example, for the "middle" scenario, mixed hardwood LEV increases by $2045.76/ha in favor of the landowner, when the assumption changes from the landowner assuming the costs of forest establishment to the coal company assuming these costs (Table 8). It is also evident from our results that all of the proposed land use conversion scenarios for mixed hardwoods become financially profitable when the coal company pays the costs of forest establishment, whereas, under the assumption that the landowner pays these costs, none of the scenarios are financially profitable.

Table 8 – Comparison of mixed hardwood LEV ranges for scenarios where landowner pays reforestation costs vs. where coal company pays reforestation costs

LEV		Mixed hardwoods (landowner pays costs)	Mixed hardwoods (coal company pays costs)
Low	*LEV ($/ha)*	**-2416.71**	**15.38**
	Rotation	80 years	80 years
	Site class	V	V
	Site preparation	High	High
	ARR	7.5%	7.5%
Middle	*LEV ($/ha)*	**-1710.16**	**335.60**
	Rotation	60 years	60 years
	Site class	III	III
	Site preparation	Medium	Medium
	ARR	**5%**	**5%**
High	*LEV ($/ha)*	**-145.58**	**2057.96**
	Rotation	40 years	40 years
	Site class	I	I
	Site preparation	Low	Low
	ARR	3.5%	3.5%

<u>White pine</u>

Our results also indicate that there are significant economic implications associated with changing the assumption that the landowner assumes the costs of forest establishment to the assumption that the coal company assumes these costs, for white pine scenarios. For example, for the “middle” scenario, white pine LEV increases by $1951.57/ha in favor of the landowner, when the assumption changes from the landowner assuming the costs of forest establishment to the coal company assuming these costs (Table 9). Under the assumption that the landowner pays the costs of forest establishment, our results indicate that land-use conversion to white pine only becomes financially profitable under the most favorable environmental and economic conditions, e.g. best sites and low alternative rate of return. However, when the costs of forest establishment are paid by the coal company, it appears that land-use conversion to white pine becomes profitable even under the most unfavorable environmental and economic conditions.

Table 9 – Comparison of white pine LEV ranges for scenarios where landowner pays reforestation costs vs. where coal company pays reforestation costs

LEV		White pine (landowner pays costs)	White pine (coal company pays costs)
Low	*LEV ($/ha)*	**-2330.53**	**220.93**
	Rotation	20 years	20 years
	Site class	V	V
	Site preparation	High	High
	ARR	5%	5%
Middle	*LEV ($/ha)*	**-316.06**	**1635.51**
	Rotation	30 years	30 years
	Site class	III	III
	Site preparation	Medium	Medium
	ARR	5%	5%
High	*LEV ($/ha)*	**2697.98**	**4731.66**
	Rotation	30 years	30 years
	Site class	I	I
	Site preparation	Medium	Medium
	ARR	3.5%	3.5%

Conclusions

For a landowner, it would obviously be preferable, from a financial point of view, to leave initial site preparation and reforestation up to the coal company, and in so doing, spare him/her - self the initial costs of reclaiming the mined land. Were the coal company to assume the costs of reclaiming the mined lands, from a landowner's perspective, it would be most profitable to invest in high intensity site preparation on the best quality sites. However, in reality, the coal company would seek to reclaim the mined land in such a way that bond release is achieved at the least cost possible. This least cost option would most likely entail low intensity site preparation, regardless of site quality or other market factors. As an example of how this least cost reforestation scenario (coal company assumes costs) would impact the landowner economically, mixed hardwood LEV on a site class I site, under low intensity site preparation (rotation age 60 years, 5% ARR) would increase by approximately 164% from the corresponding scenario in which the landowner assumed the costs of reforestation. Thus, under this least cost reforestation scenario, the landowner (who assumes no costs) would still benefit.

This study shows that converting reclaimed mined lands back to their original forested state, as part of the coal mining enterprise, and in compliance with the law, is needed to ensure an economically viable forestry land use. If the costs of site preparation and planting are borne by the forestry enterprise after mining and bond release, and these costs are carried for decades until harvest, the forest land use is usually not profitable given current price and cost assumptions.

Literature cited

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