POSTMINING LAND USE: ECONOMIC COMPARISON OF FORESTRY AND PASTURELAND ALTERNATIVES[1]

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Abstract.--The influence of soil properties, legal requirements, and economics on postmining land use is described, and enterprise budgets are prepared to demonstrate procedures for evaluating forest and pastureland alternatives. A comparison of cow-calf operations with hybrid poplar and black walnut plantations suggests that a combination of pastureland and black walnut plantations will achieve the highest rates of return on investment.

INTRODUCTION

During the past three decades there have been important changes in surface mining laws that have had a strong influence on forestry's role as a postmining land use. Prior to the 1960's most state reclamation laws did not require the grading of spoil piles or the establishment of herbaceous ground cover. Strike-off grading was required in some states but this still resulted in rough topography that was not well suited to agriculture. Large acreages were planted in trees partly because early research by the U.S. Forest Service showed that trees, over time, could stabilize mine sites and eventually produce a timber crop.

This period was followed by laws in the early 1970's that required grading and the establishment of herbaceous ground cover to control erosion. Tree planting declined precipitously because seedlings could not successfully compete with the herbaceous species. Hayland and pastureland emerged as important postmining uses in many states.

The Surface Mining Control and Reclamation Act of 1977 may cause yet another shift in forestry's role. The Act and corresponding regulations require that specific criteria be met before the approval of changes in land use from those which existed prior to mining. How these new requirements will affect postmining land use decisions is uncertain; however, there is likely to be a tendency on the part of mining companies to avoid land use changes in order to simplify the permit application process and to eliminate potential delays in permit approval. The upshot could be that where forest land is the pre-mining land use it will receive greater consideration as a postmining land use. This could reverse the present trend of converting woodlands to other land uses.

The purpose of this paper is to briefly describe some of the factors that influence postmining land use and to explore by means of enterprise budgets the economics of forest and pasture land use alternatives. This latter objective will be met by analyzing the potential for cow-calf operations, hybrid poplar plantations and black walnut plantations on reclaimed land in southeastern Ohio.

FACTORS AFFECTING POSTMINING LAND USE

Most determinants of postmining land use can be categorized into one of three broad groups: (1) soil properties, (2) legal requirements and constraints, and (3) economic considerations. Climatic factors are also important but will not be discussed in this paper because they are largely beyond man's control. The chemical and physical properties

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of the reconstructed soil can be partially controlled by selectively mixing and placing soil horizons at the time of mining.

Properties of reconstructed soil that influence the selection of postmining land use include soil reaction (pH), stoniness, particle size and slope. For use as pasture, hayland, row crops, and other agricultural uses the reconstructed soil should have a Ph of 5.5 or higher, be free of stones at or near the surface which would interfere with tillage and harvesting operations, and have slopes that are less than 20 percent. Also, the particle size distribution should be adequate to provide aeration and moisture-retention. Stoniness and slope are usually not limiting factors when selecting land for forestry and wildlife use. Trees and shrubs can survive in reconstructed soils with a pH as low as 4.5, however, growth will be greatly reduced.

Surface mining can have a detrimental effect on soil properties resulting in diminished land capability. Mining destroys soil structure. Grading and redistribution of topsoil can and often does cause soil compaction. These problems can reduce yields below premining levels by reducing water infiltration and preventing effective root penetration. Another problem is that overburden material may settle unevenly and leave depressions that trap seasonal surface runoff. Microorganism populations may also be temporarily reduced by topsoil stockpiling. Some of these problems can be alleviated through careful planning of the mining operation, the proper choice of reclamation equipment, and the use of soil restoration plans.

In some situations, surface mining can improve the chemical and physical properties of the soil. For example, fragipans, claypans, and ironpans which reduce water infiltration and root penetration are broken and dispersed during overburden removal. Root penetration for trees is improved when consolidated rock near the surface is fractured. In the western states where saline conditions are found, it is possible during mining and reclamation to replace the surface horizons with more favorable overburden materials or to dilute sodium concentrations by soil mixing. Selective soil mixing also offers an opportunity to improve thin, acidic forest soils in the eastern coalfields. These procedures must be approved in advance by the regulatory authority.

Legal requirements and constraints are the second major category of factors which affect postmining land use selections. Section 515 of The Surface Mining Control and Reclamation Act of 1977 requires all surface coal mining operations to " . . . restore the land affected to a condition capable of supporting the uses which it was capable of supporting prior to any mining, or higher or better uses of which there is a reasonable likelihood . . ." Furthermore, proposed land uses following reclamation cannot be impractical or unreasonable, inconsistent with land use policies and plans, or involve unreasonable dealys in reclamation.

The language contained in the Federal Act poses the question of what constitutes a "higher or better" land use. In his widely recognized land economics textbook, Barlowe (1958) defines highest and best use as that land use which provides an optimum return to its operators or to society. Returns may be measured in strictly monetary terms, in intangible social values, or in some combination of these values. Highest and best use also embodies the concept of comparative advantage which includes consideration of both the ability of land to produce a net return above production costs and the relative demand for uses to which it might be put. Usually land is in its highest and best use when it is used for the purpose or combination of purposes of which it has the highest comparative advantage.

The land use provisions of the Federal Act have been the subject of much discussion and debate, especially when they are operationally defined in the form of specific regulations. The Federal Rules list ten land use categories which are defined in terms of specific uses or management-related activities rather than vegetative cover. These categories include forestry, pastureland or land occasionally cut for hay, recreation, cropland, and fish and wildlife habitat. Changes of land use from one category to another are considered a change to an alternative land use and subject to approval by the state regulatory authority.

To gain approval, the landowner must be consulted and several criteria must be met (see 30 CFR 816.133 and 817.133). These criteria include but are not limited to (1) the determination that the proposed use is compatible with adjacent land use and any existing land use policies and plans, (2) the submission of plans showing the feasibility of the use, (3) evidence that public facilities will be provided if necessary, and (4) adequate plans to prevent or mitigate any adverse effects on fish, wildlife, and related environmental values. These requirements are not intended to discourge land use changes.

However, they may place an additional, but legally necessary, burden on mining companies who seek a land use change.

The final category of factors that influence postmining land use is economic in nature. As a general rule, most landowners tend to use their land for those purposes that promise the highest economic return. Sometimes surface mining can be conducted in a manner that will leave the land in a condition likely to yield greater financial rewards than were possible before mining. For example, from the forestry standpoint, mining improves accessibility by leaving a road network from which to manage and harvest timber crops. It also leaves the site free of uncommercial trees and undesirable vegetation that normally must be cleared before plantations can be established. Upon the approval of the regulatory authority, topography can be altered to provide more gently sloping landforms that permit the use of mechanized equipment needed for intensive forest management. The condition of the land can be improved for pasture, wildlife, and recreation by the creation of watering ponds and lakes where none previously existed. There must also be approval by the regulatory authority.

Thus, surface mining can improve the potential of land for a variety of uses -- recreation, forestry, livestock pastures, hayland, wildlife and cropland. The selection of the most appropriate postmining land use is often complex. The remainder of this paper concerns the financial dimension of the postmining land use decision for two competing land uses--forestry and pastureland--for coalfields in southeastern Ohio. The intent of this exercise is to demonstrate the types of economic analyses that should be undertaken when making postmining land use decisions.

FORESTRY VS PASTURELAND

In 1979, an estimated 31,600,000 tons of coal were surface mined in southeastern Ohio (U.S. Department of Energy, 1980). The forest industry of Ohio is also centered in this part of the state. There are three pulpmills and numerous small primary and secondary wood manufacturing plants that provide markets for locally grown timber. This part of the state is also a significant livestock producing area. Accordingly, forestry and pasture are both realistic postmining land uses.

Previous studies by Baker et.al. (1976) and Higgins (1973) show that satisfactory forage yields and beef calf gains can be obtained on surface mined land. Baker et.al. (1976) reports forage yields of 2.71 tons per acre for grass and legume mixtures that had been fertilized with 40 lbs of N, 80 lbs of P_2O_5 and 120 lbs of K_2O per acre. Grazing trails indicated that about three acres of a vigorous stand of Kentucky 31 fescue and sericea lespedeza are required per cow-calf unit. Higgins (1973) reported that four acres of reclaimed land were needed per cow-calf unit. The higher acreage per cow-calf unit which Higgins reported probably reflects reclaimed land that had not been topsoiled and lower fertilizer application rates.

Sutton provides the most recent forage yield data for surface mine sites in southeastern Ohio which had been reclaimed to meet current topsoiling standards.[3/] In his experimental work, which involved nine different fertilizer treatments at three sites, Sutton found nitrogen to be the limiting factor in forage production. The most appropriate fertilizer treatment--100 lbs N, 50 lbs P_2O_5, 50 lbs K_2O--produce an average yield of three tons per acre from three cuttings. Sutton also observed that reconstructed mine soils are more droughty than natural soils and that this reduces forage yields.

Hybrid poplar plantations are a second possible land use. Davidson (1979) reports that a 16 year old hybrid poplar plantation on mine spoil in Pennsylvania yielded 90 tons of pulpwood and 9,400 board feet of lumber. This is equal to a growth of about two cords per acre per year. Stone Container Corporation contends that on abandoned field sites growers in Ohio can expect survival rates of 90 to 100 percent with annual height growth rates for the first five to six years of three to five feet and diameter growth of one-half to one inch per year.

In addition to its rapid growth, hybrid poplar is a desirable species because it can be propagated from cuttings and regenerated from stump sprouts after harvesting. Poplars grow best on sites with a pH of 5.5 or above.[4/] The trees will not tolerate shade

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[3/] Personal communications with Dr. Paul Sutton, Ohio Agricultural Research and Development Center dated August 18, 1980

[4/] Davidson, W. H. 1980. Hybrid poplars for spoil reforestation. Unpublished paper presented at the spring meeting of the American Council for Reclamation Research. May 6-7, 1980. Wheeling, W.Va., 11 p.

and can only be successfully established where competing vegetation is controlled.

Black walnut provides a reforestation opportunity which might yield significantly higher economic returns than hybrid poplar. This species develops best on deep, well drained, nearly neutral soils which are generally moist and fertile (Schlesinger and Funk 1977). Because of its site requirements, black walnut should only be considered for planting on the better reclaimed surface mine soils. Previous research indicates that walnut has good survival and growth on reclaimed land if planting sites are carefully chosen.[5/]

Cow - calf enterprises

In order to develop a cow-calf enterprise budget for reclaimed surface mined land it was necessary to make several assumptions. These assumptions were derived after reviewing published and unpublished studies and consulting with a Soil Conservation Service Agronomist, Ohio Cooperative Entension Service personnel, and lease holders operating a large cow-calf operation on reclaimed land. The data that are presented represent 1980 costs and product prices which the typical investor might experience when developing reclaimed lands and marketing cattle.

The first assumption was that with the proper fertilization program, annual forage yield would be three tons per acre and that 40 lbs of forage would be needed per animal unit day (AUD). The 40 lbs per AUD may seem conservative, however it includes losses resulting from trampling and a safety factor to ensure adequate forage during dry years. During the five month period lasting from December through April the cattle would be fed baled hay. An area of 2.4 acres would be needed to support one animal unit. Beef gain was estimated to be 1.5 lbs per AUD. Calves and cows were assumed to have an average weight of 500 and 1100 pounds and to bring market prices of $81 and $44 per hundred weight, respectively.

There was no charge for planting the pasture and hayland because this expense would normally be borne by the mining operator. Also, it was assumed that the necessary watering ponds would be constructed during reclamation and not require further expenditures for use by the livestock enterprise. Other assumptions are largely self explanatory (Table 1).

Total receipts per acre were estimated to be $154.87 from which pasture cost ($50.95), livestock cost ($56.92) and hay harvest cost ($37.50) must be deducted. The return after these deductions was $9.50 per acre, excluding land and management charges. Major cost items were fencing, fertilization, interest on cow herd investment, and hay harvesting.

At present, reclaimed unimproved surface mine land in southeastern Ohio can be leased for cow-calf grazing at about $5.00 per acre. Eight thousand acres of reclaimed land owned by Ohio Power Company has recently been leased by an Iowa based cattle company for a base price of $5.00 per acre plus an additional fee which is determined by prices at feeder calf sales in the state. The 1980 rental fee for this property was $9.95 per acre, which is slightly over our estimate of the return above livestock, pasture, and hay costs. The leasee plans to invest $3.2 million in land improvements and livestock during the 20 year lease period. The cow-calf operation is not expected to show any profit for at least three years.

Hybrid poplar plantations

Woodlands personnel from Stone Container Corporation provided establishment cost and yield estimates for a hybrid poplar pulpwood enterprise (Table 2). It was assumed that poplar plantations with an eight by eight spacing would be established in herbaceous cover using two herbicide applications. Three clearcuts yielding 49 tons per acre each were planned at 14, 12 and 10 year intervals. The declining rotation age is possible because successive rotations can be established from stump sprouts. After the third cutting, the area would be replanted. The stumpage price was assumed to be $2.00 per ton which is the 1980 price for well stocked hardwood stands with good access.

Total plantation establishment cost was estimated to be $143 per acre while stumpage sales for the three cuttings produced revenue of $294 per acre. The average

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[5/] Vogel, Willis G. 1979. Are trees neglected plants for reclaiming surface mines? Unpublished paper submitted to the West Virginia Academy of Sciences, November 29, 1979, 27 p.

Table 1. -- Cow-calf enterprise budget for reclaimed surface mines in southeastern Ohio, 1980

Item/explanation	Value per acre
Receipts	$154.87
225 lbs beef/ac. @ $68.80 cwt.	
Pasture costs	
Fence installation	
$55/ac., 20 year life, i=8%	5.60
Fence maintenance	
5% of installation costs	2.75
Clipping	3.00
Annual fertilizer & lime application	
100 lbs. N @ .25/lb	25.00
30 lbs. P_2O_5 @ .22/lb.	6.60
30 lbs. K_2O @ .10/lb.	3.00
.5 tons lime @ $10/T	5.00
pasture cost =	$50.95
Livestock costs	
Building charge	1.00
Interest on investment	
$500/cow x 8% x 5/12	16.67
Death loss: $500 x 1% x 5/12	2.10
Replacement costs: $500 cow sold @ $400	
$100 ÷ 7 yrs. x 5/12	5.95
Veterinary, salt, & minerals	8.75
Breeding charge: $10 x 5/12	4.10
Livestock taxes & insurance	2.25
Labor: $4.50/hr. x .4 hr./cow x 5	9.00
Marketing cost	2.50
Miscellaneous charges	4.60
livestock costs =	$56.92
Hay harvest costs	
Mow, rake & bale @ $30/ton	37.50
5/12 of forage baled	
Return above pasture & livestock costs [a/]	47.00
Return above pasture, livestock & hay costs [a/]	9.50

[a/] Excludes land and management charges.

Table 2. -- Hybrid poplar plantation for reclaimed surface mines in southeastern Ohio, 14 - 12 - 10 year rotations, 1980

Item/explanation	Year	Value per acre
Planting stock 8 x 8 spacing 640 trees/acre unrooted cuttings	1	$68
Planting combination machine & hand	1	40
First herbicide application simazine: pre-emergent spray round-up: post-emergent spray 3 foot wide strips	1	20
Second herbicide application	2	15
	Total establishment cost =	$143
First harvest 49 tons/ac 3.5 tons/ac./yr. $2.00/ton stumpage	14	98
Second harvest [a] 49 tons/ac. 4.1 tons/ac./yr. $2.00/ton stumpage	26	98
Third harvest [a] 49 tons/ac. 4.9 tons/ac./yr. $2.00/ton stumpage	36	98
	Total stumpage income =	$294
Average annual net revenue [b]		4.19
Internal rate of return [b]		3.06%

[a] Second and third rotations established using coppice silvicultural system.

[b] Excludes land charge, property tax, fire protection costs and management charge.

annual net revenue was $4.19 per year. The internal rate of return was equal to 3.06 percent--a rate that is far too low to attract investors.

Hardwood stumage prices for pulpwood are relatively low in Ohio because the supply of poletimber exceeds demand. This depresses oportunities for commercial forest plantations. Nevertheless, Stone Container Corporation in Coshocton, Ohio has established an eight acre nursery with the capability to produce 300,000 poplar cuttings per year. The company is currently leasing small acreages of old fields for poplar plantations and is cooperating with Peabody Coal Company in the establishment of experimental plantings on reclaimed land.

Black walnut plantations

In evaluating the financial possibilities of establishing black walnut plantations, it was assumed that only the best sites would be planted. Walnut seedlings would be planted on an 11 x 11 spacing and interplanted with autumn-olive or European black alder. Both of these species fix nitrogen which will increase the growth of the walnut. They also reduce the need for pruning and provide wildlife food and cover. Because walnut is intolerant of shade, three herbicide applications and three mowings were believed necessary. Several prunings and thinnings were included in the budget to produce high quality veneer logs and sawlogs. It was assumed that the plantation would yield 2,500 board feet of sawlogs and 5,000 board feet of veneer logs in 50 years.

Current prices for black walnut stumpage were estimated to be $.50 per board foot for sawlogs and $5.00 per board foot for veneer logs. Hoover (1978) has shown that the price of black walnut stumpage has increased historically at a rate of 1.5 percent per year above the cost of other goods and services in the economy. If we apply this rate of increase in real value to 1980 prices, black walnut stumpage at rotation age will be worth $1.05 per board foot for sawlogs and $10.53 per board foot for veneer logs. These assumptions and accompanying cost and yield data reflect the experience of Pierson-Hollowell Company, a veneer manufacturing firm that is establishing and managing walnut plantations in Indiana. During the past year this company established plantations on reclaimed land for AMAX Coal Company.

Given these assumptions, the plantation was capable of earning an annual net revenue of $1,091 per acre and an internal rate of return of 9.34 percent (Table 3). This rate of return is much higher than for the hybrid poplar plantation and is likely to attract some investors.

Comparison of alternatives

To compare the black walnut and hybrid poplar plantations to the cow-calf operation, the net present value of an infinite number of income streams was calculated for each alternative land use at eight percent compound interest.[6/]

Land Use	Net Present Value
Pasture	$119
Hybrid poplar plantation	-94
Black walnut plantation	581

The hybrid poplar plantation had a negative land value indicating that from solely a financial standpoint, hybrid poplar plantations would not be a desirable land use. Pasture had a positive land value, but not nearly as high as the black walnut plantation. These results suggest that the best land use strategy would be to plant black walnut on the most favorable sites and to use the remaining reclaimed land for a cow-calf enterprise.

ADDITIONAL CONSIDERATIONS

In addition to return on investment, there are other considerations which will influence the postmining land use choice as related to forestry and pasture alternative. Landowners tend to select those land uses which are compatible with or complement their other business ventures. For example, wood-using industries that own coal bearing land usually return these lands to forest in order to protect their investments in secondary manufacturing. They already have the technical skills to establish and manage plantations and can provide their own market for the wood that is produced.

[6/] An eight percent interest rate was suggested by Samuel M. Brock as appropriate for evaluating postmining land use alternatives when current prices are used. Unpublished paper. Selecting a higher and better postmining land use for surface mined land through budgeting. June 30, 1980. 22p.