JRAP (1997) 27, 2: 13-30

The Journal of Regional Analysis & Policy

A benefit-cost analysis of the Conservation Reserve Program in Ohio: Are trees part of a sustainable future in the Midwest?

Bibhakar S. Shakya and Fred J. Hitzhusen*
The Ohio State University

Abstract. Millions of acres of erodible land soon will be removed from the Conservation Reserve Program (CRP). Farmers may adopt different soil conservation measures on lands leaving CRP, or they may revert to erosive crop production. Our concern is the sustainable future use of the most erosive and downstream-damaging croplands. Planting trees on these lands could be one economically viable choice.

Benefit cost analyses of CRP, white pine plantation (WPP), and row crop production (RC) suggest that white pine plantation is a viable option for some CRP lands in the Midwest. Furthermore, federal expenditure could be minimized by reducing subsidies to a level where white pine plantation would maintain its attractiveness when compared to both CRP and row crops. Besides meeting all the goals of CRP, white pine plantation also ensures longer-term environmental protection and provides a marketable product.

1. Introduction

Soil erosion from farming has been a matter of concern for the past several decades. In the past reduced productivity and other on-site damage due to soil erosion were considered major issues for soil conservation policies and programs. Recent studies, however, have shown that the off-site damage of soil erosion such as sedimentation, water pollution, downstream impacts, and harmful effects to aquatic and terrestrial wildlife may be more serious and costly than on-site damage (Clark *et al.* 1985; Colacicco *et al.* 1989; Hitzhusen 1991; Napier and Camboni 1988; Ribaudo 1986; Ribaudo *et al.* 1989).

To reduce the high social costs of soil erosion and the aggregate supply of agricultural commodities, the federal government launched several conservation programs under the Food Security Act of 1985. The Conservation Reserve Program (CRP) is regarded as one of the most effective provisions of this act. In this program farmers

* Graduate student and professor, respectively at the department of agricultural economics, The Ohio State University, Columbus, Ohio 43210. An earlier version of this paper was presented at the 27th annual meeting of the Mid-Continent Regional Science Association, Madison, Wisconsin. The authors wish to thank the editor and the anonymous referees for helpful comments and suggestions.

contract for ten years to retire highly erodible lands from production to meet the following goals: sustain agricultural production capability; decrease off-site impacts of soil erosion such as environmental pollution; improve water quality and wildlife habitats; lessen the pressure on market prices of surplus farm commodities; and provide income support to participant farmers or land owners.

In 1990 CRP was modified as part of a larger program called the Agricultural Resources Program (U.S.D.A. 1990). The 1996 Federal Agricultural Improvement and Reform (FAIR) Act limited CRP enrollment to 36.4 million acres. In the future more funding will be needed to support the program because rental payments are increasing every year.

The cost of CRP contracts over ten years is $19.8 billion, including $1.8 billion in 1993. Due to this large budgetary requirement, extension or expansion of CRP contracts is not likely to be a viable option (Heimlich and Osborn 1993). In October 1995 the initial CRP contracts expired; these contracts included about 2 million acres that were retired from production. Contracts on more than 22 million acres terminated at the end of 1997 (ERS 1994). After the specified contract period, farmers are free to cultivate their lands. Although the 1996 FAIR Act has allowed up to 36.4 million CRP acres, it also has an early-out provision for CRP land judged to have low environmental value. The early buyout in the FAIR Act means farmers can revert CRP land to crop production before the contract period if those lands have low environmental impacts. This provision raises concerns about the loss of environmental benefits gained from CRP if any highly erodible acres are reverted to crop production. The policy that influences the use of CRP lands after contract expiration will be a critical issue for farmers, researchers, environmentalists, and other interested groups.

Predicted favorable future commodity markets will increase the possibility of a higher proportion of CRP-expired acres being converted to crop production. Some studies show that 40 percent to 60 percent of CRP lands will revert to crop production after the CRP contract period (Heimlich and Osborn 1993; Monson and Lenkner 1991; Sinner 1990). A study by Hopkins (1994) of the Indian Lake watershed in Ohio indicates that the soil erosion and associated off-site costs will increase for all post-CRP acres. The current concern, therefore, is identifying future use of CRP lands that will sustain the environmental benefits of the current program. Improving environmental quality is one of the major goals of CRP; some conservation tillage practices may be contrary to the goals of CRP (such as reducing pressure of surplus agricultural commodities or improving wildlife habitats).

In light of these problems, this paper focuses on both the on-site and off-site impacts of soil erosion and suggests that the erosive practices of row crop production on highly erodible land may be both nonsustainable and costly to society. Based on the results of Shakya (1992), the study suggests that planting trees, specifically white pine, may be one of the most ecologically sound and economically viable choices on the most environmentally valuable CRP lands in the Midwest. This study focuses on two main analyses:

- Economic: To estimate social costs and benefits including adjustments for federal subsidies, social time preference, and external or downstream water quality impacts; to evaluate the net social welfare of row crops (RC), CRP, and white pine plantations (WPP) from a societal accounting stance; and
- Financial: To estimate private opportunity costs and benefits of various alternatives from the farmer's perspective.

1.1 White pine plantation

White pine plantation is an alternative for CRP-expired lands in the Midwest because of the wide adaptability and fast growth of white pines compared to most other species and because of the available market for pine pulp. White pine can grow well on coarse, sandy soils with low to medium productivity and resists diseases and pests so that chemical treatment is normally not required (Brown and Stires 1981; Lorimer 1982; Smith 1985). With proper management, the plantation of white pine for wood-chip products is feasible even on poorer or less fertile sites (Brown and Stires 1984).

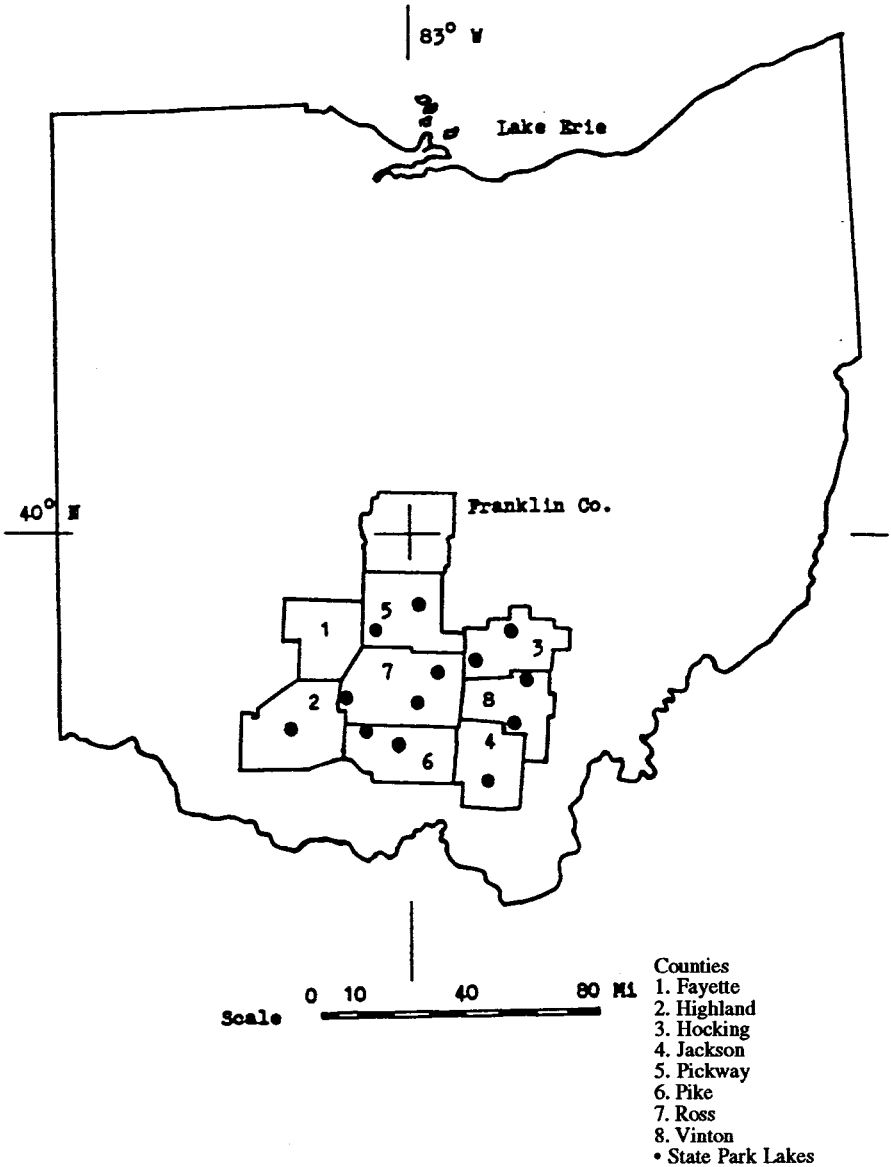
The future market for white pine fiber in the study area is assured by the Mead Paper Company of Chillicothe, Ohio, one of 13 member companies of the American Forest & Paper Association (AF&PA 1998). Mead has initiated land-leasing and cooperative seedling programs that encourage farmers to grow white pine. Since December 1985 Mead's annual demand for pine pulp has been 250,000 tons (Smith 1985). To meet this demand, Mead has imported pines from states as far south as Georgia, but currently is focusing on the procurement of standing pine timber within a 60 mile radius. This includes most of the southern Ohio counties neighboring Chillicothe in Ross County (Fayette, Pickaway, Hocking, Vinton, Jackson, Pike, and Highland counties) (Figure 1). The CRP-contracted lands (first through ninth sign-up period) in these eight counties cover 46,331.8 acres or about 18 percent of the total CRP land in the Ohio. Figure 1 also shows the state park lakes in the region because they are important impacted downstream receptors from soil erosion.

2. Benefit-cost methodology

Benefit-cost analysis is widely applicable in numerous developmental, natural resource, and environmental programs (Dasgupta and Pearce 1978; Hufschmidt *et al.* *1*988). Benefit-cost analysis provides important social economic efficiency information that can be helpful in the public decision-making process. Such analysis estimates benefits and costs from a societal accounting stance (Dasgupta and Pearce 1978; Hufschmidt *et al.* *1*988*;* Pearce 1983; Randall 1987). Based on its evaluative capability, benefit-cost analysis is selected as a method to make economic comparisons of various alternatives, and the net present value (NPV) is used as the benefit-cost criterion. The NPV of a project is defined as:

$$NPV = \sum_{t=0}^{T} \frac{b_t - c_t}{(1 + i)^t} \qquad (1)$$

Figure 1. Counties of Ohio included in this study



where:

b_t = Benefits in year t;
c_t = Costs in year t;
T = Total project period (30 years);
i = Discount rate.

If NPV > 0 at the discount rate i, the project is acceptable. NPV gives the present value of the income stream for the individual or private entrepreneur i.e., farmer and/or land owner in financial analysis. In economic analysis NPV provides the present value of all net benefits or gains to the whole society or nation. The following variables are incorporated in equation (1) to estimate NPV of row crops, CRP, and white pine plantation which are considered benefits (+) and costs (-) depending on either the economic or financial analysis:

Alternatives:

RC	Economic:	$B_r - C_r - C_{op} - C_{on} - C_{of}$
	Financial:	$B_r - C_r + F_{sr} - C_{on}$
CRP	Economic:	$B_{of} + B_{on} - C_{op} - C_{cc} - C_{ec} - C_{mc}$
	Financial:	$F_s + B_{on} - \frac{1}{2}C_{ec} - C_{mc}$
WPP	Economic:	$B_{of} + B_{on} + B_w - C_{op} - C_{cc} - C_{ew} - C_{mw}$
	Financial:	$F_s + B_{on} + B_w - \frac{1}{2}C_{ew} - C_{mw}$

where:

B_{of} = Off-site annual benefits from reduced soil erosion for CRP and white pine plantation;
B_{on} = On-site annual benefits from reduced soil erosion for CRP and white pine plantation;
B_r = Gross return from row crops (without federal payment) per year;
B_w = Return from the sale of white pine products;
C_{cc} = Increase in consumers' cost due to the increase in market price of food commodities;
C_{ec} = One time establishment costs for CRP cover crops, including grasses, legumes, trees, windbreaks, filter-strips, or wildlife covers;
C_{ew} = One time establishment costs for white pine, including cost for site preparation, tree saplings, and planting;
C_{mc} = Annual maintenance costs for CRP land to assure complete vegetative coverage and freedom from unwanted weeds;
C_{mw} = Annual maintenance costs for white pine plantation to suppress weeds in first four years of white pine growth;
C_{of} = Off-site costs of soil erosion under row crops per year;
C_{on} = On-site costs of soil erosion under row crops per year;
C_{op} = Social opportunity cost of land, includes annual rental value of land without considering federal subsidy;

C_r = Costs for row crop per year, includes costs for various inputs such as seed, fertilizers, labor (does not include land rents);
F_s = Annual federal subsidies (land rents) for CRP and white pine plantation;
F_{sr} = Annual federal subsidies to row crops (government payment).

2.1 Row crop

Row crop production is assumed to be the status quo alternative in this study because without federal programs such as CRP or the proposed white pine plantation, farmers will continue to grow row crops. The estimated costs and returns of major crops on per acre basis from the *Ohio Crop Enterprise Budgets* are used to derive an average net return from land in southern Ohio (OSU 1991). The federal subsidy (F_{sr}) for row crops on a per acre basis is derived from the *Ohio Longitudinal Farm Survey*. This survey is representative of the state of Ohio employing data from 1986 through 1988.

The annual damage from soil erosion on a per ton basis is used for estimations of C_{of}, based on a study done by Ribaudo (1986). Such estimates previously have been established for different regions of the U.S. Because the southern area of Ohio lies on the borders of three regions (the Corn Belt, Appalachia, and the Northeast), Ribaudo's estimates for these three regions are taken for the calculation of C_{of}. The average values of C_{of} derived from these three regions are used as medium and low level soil erosion off-site costs in this study.

Estimations of C_{on} are based on the amount of soil loss per acre per year (Colacicco *et. al* 1989). These values of C_{on} also have been established for the various regions. Although the variation in on-site erosion costs is not as great as off-site costs (C_{of}), the average values of the Corn Belt, Appalachia, and the Northeast regions are used as medium and low level on-site costs.

2.2 Conservation Reserve Program

The benefits of the Conservation Reserve Program are the savings in commodity payments and the reduced erosion damage. Off-site and on-site erosion control benefits of CRP total $9.1 billion or 24.6 percent of aggregate CRP benefits of $37 billion (Ribaudo *et al.*1989). The value of erosion control is still a conservative estimate, as all of the environmental benefits such as biodiversity are not accounted for in the estimate. CRP will reduce soil erosion to a sustainable level, also called T-level which is defined as soil erosion of less than five tons of soil loss per acre per year for midwestern U.S. soils (S.S.S.A. 1987). The off-site benefit from reduced erosion is calculated by subtracting off-site cost of CRP from off-site cost of row crops:

$$B_{of} = C_{of}\,(RC) - C_{of}\,(CRP).$$

Similarly, on-site benefits for CRP is based on:

$$B_{on} = C_{on} (RC) - C_{on} (CRP).$$

The consumers' cost is a social cost generated by CRP. The increase in consumers' costs (C_{cc}) is due to the increase in market price of food commodities (Young and Osborn 1989). The market price is assumed to increase as the supply of commodities decreases as a result of the retirement of erodible croplands from production under CRP.

2.3 White pine plantation

Soil type and topography may play important roles in defining an economical project period for white pine plantation. Depending on the significance of site and slope aspects, more than one scenario can be developed by varying the project period T. In this study a 30 year period is chosen for white pine plantation based on the current practices in the area. The price of pine pulp is a function of distance from the farmer's farm to the industry or market. The distance is limited to a 60 mile radius from Mead Industry to ensure a market for pine pulp. The price of pine pulp is estimated to be an average of $4.00 per ton; however, sensitivity analysis on this pulp price also is performed. The data for the analyses of white pine (for both costs and revenues) are collected primarily from Mead.

3. A framework for analysis and data sources

From a financial or private accounting stance, costs and returns are measured from the farmers' perspective: market or administered prices are used; externalities are not usually fully internalized; taxes are treated as a cost; and subsidies are considered a benefit. From a societal or economic accounting stance, taxes and subsidies are considered as transfer of payments from individuals to the public at large and vice versa (Gregory 1987; Mishan 1972). In the economic analysis, subsidies are replaced by the actual opportunity costs of the resources involved (e.g., land). Producer and consumer surplus losses or gains are included, and a social time preference rather than the private opportunity cost of capital is used.

The social opportunity cost of land is regarded as a cost in the economic analysis of both CRP and white pine plantation because the retirement of lands will forfeit production of commodities which is considered a loss to society. This social opportunity cost of land only includes the land rental value net of federal subsidies and is different from private opportunity cost which is the land rental value including federal subsidies. The annual land rental value of marginal land (erodible and less productive) in Ohio is $35.00 per acre (OSU 1991). Land tax is common to all alternatives and is a fixed cost to farmers because farmers have to pay land taxes under all of these alternatives. The average land tax in the eight counties based on current agricultural use value and millage rate for the years 1988 and 1990 is $3.37 per acre per year.

Determining a social discount rate for the economic analysis is arguable and difficult. For financial analysis the discount rate usually is assumed to be the marginal or opportunity cost of money to the farm or firm (Gittinger 1984). Hence, in this study the market interest rate will be used for the discount rate in the financial analysis. A study done by Irwin, Forster, and Sherrick shows that the mean return to farm assets is 10.63 and the Consumer Price Index is 4.58 (over the period 1947 to 1984). The real interest rate is estimated at 6 percent for the financial analysis in this study.

In the economic analysis it may be justifiable to use a social discount rate r because white pine plantation has a long project life (30 years) and products available only at the end of project period; farsighted objectives of sustainability; and an intertemporal allocation. The Forest Service recommends the use of a 4 percent discount rate for long-term land and resource planning (Gregory 1987). The use of different discount rates (r) in a sensitivity analysis by Shakya (1992) shows the influence of r in the comparison of row crops, CRP, and white pine plantation.

The off-site and on-site costs of soil erosion are important factors in this analysis. For the off-site costs of soil erosion the average cost value (dollars per acre) from Ribaudo's analysis of the Appalachian, Corn Belt, and Northeast regions is used. Southern Ohio, while in the Corn Belt, lies adjacent to the other two regions and has characteristics of all three regions. On-site costs of soil erosion do not differ much among these regions due to similarities in soils and crops (land use). Off-site costs, on the other hand, vary more, with the Northeast region having the highest costs.

Several factors are responsible for higher off-site costs versus on-site costs (Hitzhusen 1992). One major factor is population density, which has a positive relationship with off-site costs. A high population density, such as in the Northeast region, results in a high demand for water quality, recreation, and aesthetic values of water bodies (lakes, rivers and reservoirs). Although the population density of these counties is in the low range, the density of state parks and lakes and the population within a 25 mile to 50 mile radius of state parks and lakes in these counties is higher than other counties. Therefore, a sensitivity analysis of on-site and off-site costs of soil erosion is done using low and medium values (Shakya 1992). The low values are averages of the Appalachia and Corn Belt regions, while the medium values are averages of all three regions.

Various scenarios of CRP and white pine plantation along with row crops (the three main alternatives of the study) are developed considering possible trends in farmers' choices for future use of CRP-expired lands. For example, a farmer may wish to revert to row crop production after ten years of CRP or 30 years of white pine plantation, denoted as CRP/RC and WPP/RC, respectively. Such scenarios enable one to make contingencies for the uncertainty of land-use programs. CRP may not continue for a 30 year period. Modifications, such as the recent CRP easement program, are also likely to change the focus of the program, depending upon the impact of current progress and response. Similarly, the land-leasing program of Mead Paper Corporation in Ohio, in which Mead bears all plantation and maintenance costs for white pine (WPP/MEAD), also may not continue beyond the initial period of 30 years. Therefore, white pine plantation is compared with several possible combinations of row crops, CRP, and some options of white pine plantation.

4. Analysis of tree plantation in CRP land: Is it sustainable?

Both CRP and white pine plantation reduce soil erosion, thereby alleviating costs of off-site and on-site erosion impacts. On the other hand, among the alternatives considered, row crop production with its potentially high external costs of soil erosion is likely to have higher social costs. Under CRP and white pine plantation the supply of agricultural commodities decreases due to retirement of erodible lands from production which makes the aggregate price of commodities rise from p' to p* representing consumers' loss under CRP/WPP of p*abp' (Figure 2). Part of the federal expenditures would be saved in surplus commodity payments under CRP and white pine plantation, however, due to the retirement of erodible lands (Figure 3).

Due to reduced social costs of soil erosion, both CRP and white pine plantation are hypothesized to have more net social gains in comparison with row crops. Furthermore, white pine plantation is hypothesized to be more beneficial to society than CRP as white pine plantation has two major advantages: a lower maintenance cost and a final pine pulp product generated by the end of the project period (Figure 4). Although the environmental benefits are assumed to be equal for both CRP and white pine plantation, white pine plantation is proposed as a more attractive option as compared to CRP or row crops both economically and financially. In addition, white pine plantation ensures longer-term environmental protection of highly erodible lands.

5. Results and discussions

The results of the financial and economic analyses for each of the alternatives using medium values of soil erosion costs are presented in Table 1. The sensitivity analysis using the low values of soil erosion costs does not change the ranking of the various alternatives considered in this study. The discount rate has significant impact in the ranking of different options. The sensitivity analysis on the various discount rates is presented in Tables 2 and 3. Sensitivity analysis for pulp price is also performed to see the impact of price changes on white pine plantation ranking as compared to CRP and row crops (Table 4). These alternatives are compared on the basis of NPV.

5.1 Economic analysis

The economic analysis considers the overall economic contribution of the proposed project to society as a whole. The data in Table 1 for all alternatives under economic analysis show row crops as having a negative NPV, which implies that row crops generate more aggregate costs than benefits from a societal standpoint. This outcome results mainly from the off-site soil erosion costs that are internalized in the analysis. In this analysis CRP is assumed to extend into the future for three ten year cycles to make it comparable with white pine plantation which requires 30 years.

From a societal standpoint CRP and the CRP easement program are almost the same. The difference between the two is that the latter provides a federal subsidy on

Figure 2. Loss in consumers' surplus due to retirement of highly erodible land

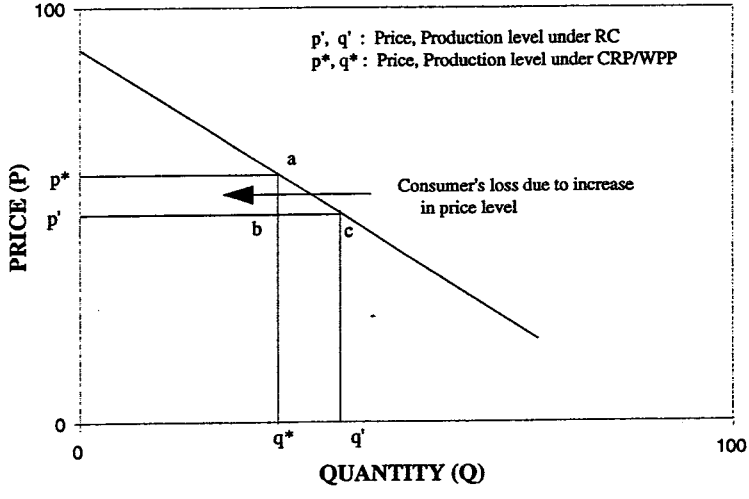


Figure 3. Cost saving in surplus commodity payments

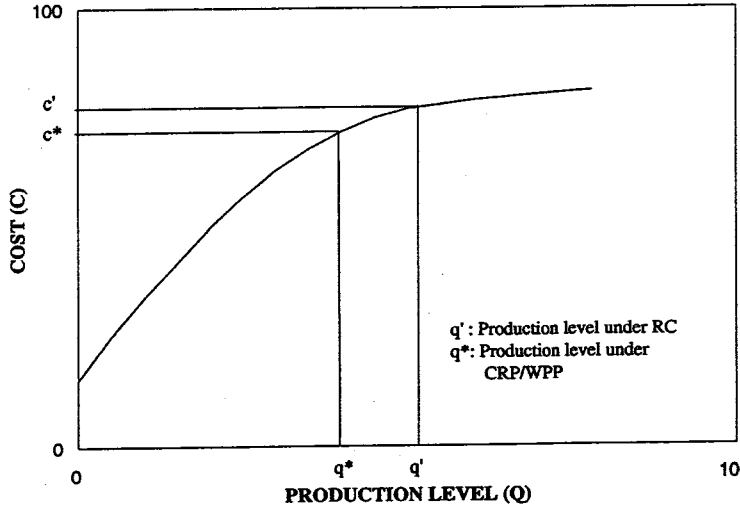
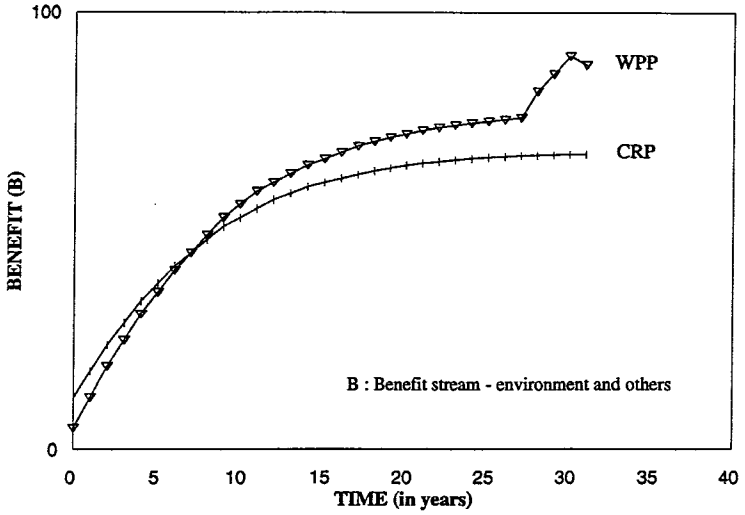


Figure 4. Benefit stream under white pine plantation and CRP



reserve land for only half (15 years) of the 30 year project period. This difference, however, will have an impact on the financial analysis; naturally, the 30 year alternative providing subsidies throughout the project period will be more attractive to farmers. The higher NPV of CRP in comparison to the CRP easement program is presented in Table 1 under the financial analysis.

The white pine plantation option is the most favorable alternative because of its lower maintenance costs and the additional pine product, which contributes to higher NPV when compared to CRP. While providing environmental benefits equal to CRP, white pine plantation offers overall greater economic gains to society as a whole, assuming white pine plantation and CRP rental payments are equal throughout the project period.

As with CRP/RC option, the WPP/RC scenario (conversion of land to row crops after 30 years of white pine plantation) yields a lower NPV than continuous white pine plantation because the cost of land clearing in converting the established forest into farmland once again at the end of the project period. Based upon the economic analysis, however, the WPP/RC alternative is still better than CRP, CRP/RC, and row crops.

5.2 Financial analysis

The financial analysis provides the costs and revenues of the land use alternatives from the farmer's accounting standpoint. Based on the reasoning of direct returns/gains, a farmer would rank the CRP easement program as the least attractive.

Table 1. Results of economic and financial analyses*

Analysis	NPV ($/acre)
Panel A: Economic (r = 4%)	
RC	-864.12
CRP	386.04
CRP (easement)	386.04
CRP/RC	-364.13
WPP	557.03
WPP/MEAD	557.03
WPP/RC	460.84
Panel B: Financial (r = 6%)	
RC	951.75
CRP	885.32
CRP (easement)	594.07
CRP/RC	901.45
WPP	993.88
WPP/MEAD	1210.53
WPP/RC	938.51

* Average of Appalachia, Corn Belt, and Northeast regions (medium values for soil erosion costs)

The row crops option has a higher (but not much greater) NPV than CRP, which raises the question of why farmers would enroll in CRP. Although there are some possibilities of over- or under-estimation of NPVs, two lines of reasoning may be used to explain the seeming contradiction. The first involves a risk-averse behavior of the farmer: that is, a farmer would prefer to enroll in CRP because of the guaranteed, although somewhat lower, income. The second reason may be the awareness and benevolent characteristics of farmers that motivate them to retire their erodible land from production.

Contrary to the economic analysis, in the financial analysis the CRP/RC scenario is more attractive to farmers than CRP alone. This result is consistent with many other studies that indicate that in the absence of CRP more than 50 percent of CRP acres (after contracts expire) would revert to erosive crop production. White pine plantation is the most appealing alternative, however, because it not only achieves the objectives of soil erosion (environmental pollution) control, but also offers a means of effectively using lands of high erosion hazard (i.e., a pine pulp product at the end of project period).

The WPP/RC option has a lower NPV than row crops alone, implying that it is not profitable for farmers to grow white pine if they intend to revert the land to row crops after 30 years. The WPP/MEAD scenario has a higher NPV than white pine plantation has. In this case MEAD bears all costs of establishment and maintenance of white pine plantation. Although white pine plantation has proved to be more appealing to farmers than other alternatives analyzed in this study, farmers could be hesitant to establish a white pine plantation because it requires a long-term commitment.

Table 2. Sensitivity analysis of the discount rate (medium values* of soil erosion costs)

Analysis	NPV ($/acre) 2%	4%	6%	8%
Panel A: Economic				
RC	-1097.67	-864.12	-701.08	-584.21
CRP	507.71	386.04	310.12	240.23
CRP (easement)	507.71	386.04	310.12	240.23
CRP/RC	-548.42	-346.13	-215.79	-130.92
WPP	819.38	557.03	391.47	283.63
WPP/MEAD	819.38	557.03	391.47	283.63
WPP/RC	650.45	460.84	336.10	251.43
Panel B: Financial				
RC	1490.14	1173.08	951.75	793.09
CRP	1410.83	1101.35	885.32	730.46
CRP (easement)	750.59	666.04	594.07	532.88
CRP/RC	1440.31	1122.95	901.45	742.71
WPP	1815.88	1320.87	993.88	771.18
WPP/MEAD	2043.07	1542.63	1210.53	983.03
WPP/RC	1646.95	1224.68	938.51	738.98

* Average of Appalachia, Corn Belt, and Northeast regions.

5.3 Sensitivity analysis

Sensitivity analyses are performed both on the discount rate and the pulp price. The discount rate plays an important role in the project analysis especially when it has a relatively long time horizon such as white pine plantation. The sensitivity analysis on pulp price provides its impact on the ranking of white pine plantation as compared to other alternatives discussed in this paper. The pulp price is subject to change in the future, and there are market possibilities for pulp/tree product from industries other than paper that may result in different prices.

5.3.1 The discount rate

A sensitivity analysis shows the effect of the discount rate on the expected outcome (NPV) of different scenarios in both the economic and financial analyses using medium and low soil erosion costs. Tables 2 and 3 show that the discount rates have more significant impact on NPVs of the white pine plantation alternatives than CRP and row crops in both economic and financial analyses. It is partly due to generation of pine pulp from white pine plantation at the end of 30 year period. The ranking of the alternatives is not affected by the discount rate in the economic analysis. In the financial analysis, however, the ranking of those alternatives is affected due to change in the discount rate. The results of the sensitivity analysis indicate that the discount rate is an important consideration and may be critical from a societal as well as financial (farmer's) viewpoint because an increase may alter the ranking of the project alternatives.

Table 3. Sensitivity analysis of the discount rate (low values* of soil erosion costs)

Analysis	NPV ($/acre)			
	2%	4%	6%	8%
Panel A: Economic				
RC	-565.40	-445.10	-361.12	-300.92
CRP	34.34	18.01	6.60	-1.57
CRP (easement)	34.34	18.01	6.60	-1.57
CRP/RC	-425.62	-300.52	-218.01	-162.65
WPP	346.45	189.34	97.23	42.05
WPP/MEAD	346.45	189.34	97.23	42.05
WPP/RC	177.08	92.80	41.59	9.63
Panel B: Financial				
RC	1515.73	1193.22	968.09	806.71
CRP	1387.90	1083.52	871.05	718.74
CRP (easement)	727.63	648.20	579.80	521.16
CRP/RC	1446.15	1125.08	901.29	714.14
WPP	1792.94	1303.04	979.61	759.46
WPP/MEAD	2020.14	1524.79	1196.26	971.31
WPP/RC	1624.01	1206.84	924.24	727.26

* Average of Appalachia and Corn Belt regions

5.3.2 The pulp price

We also conduct sensitivity analysis on pine pulp price (Table 4). The change in pine pulp price affects the ranking of white pine plantation more significantly under financial analysis than under the economic analysis. This is mainly because the off-site benefits are included in the economic analysis and pine product itself does not have the major impact on the ranking of white pine plantation. From the farmer's accounting stance under financial analysis, the decrease in pine pulp price affects the ranking of white pine plantation more notably as the return from pine product is a direct benefit to farmers while the off-site benefits of white pine plantation are not directly incorporated in the farmer's accounting stance.

When comparing white pine plantation with CRP under economic analysis, the pulp price needs to decrease close to 50 percent before the NPV of white pine plantation becomes equal to that of CRP. The reason for such a price margin is also due to the lower maintenance cost of white pine plantation as compared to CRP. Under financial analysis, however, farmers will find white pine plantation and CRP equivalent in terms of NPV even if the pulp price decreases 25 percent. Hence, these results also can be extended in the areas where similar market opportunities, not necessarily a paper industry, for tree product are available as long as the price falls within this range.

Table 4. Sensitivity analysis of the pulp price*

Analysis	NPV ($/acre) with different pulp prices		
	Base case	25% less	50% less
Panel A: Economic (r = 4%)			
RC	-864.12	-864.12	-864.12
CRP	386.04	386.04	386.04
CRP (easement)	386.04	386.04	386.04
CRP/RC	-364.13	-364.13	-364.13
WPP	557.03	472.59	387.87
WPP/MEAD	557.03	472.59	387.87
WPP/RC	460.84	375.39	290.52
Panel B: Financial (r = 6%)			
RC	951.75	951.75	951.75
CRP	885.32	885.32	885.32
CRP (easement)	594.07	594.07	594.07
CRP/RC	901.45	901.45	901.45
WPP	993.88	883.71	773.09
WPP/MEAD	1210.53	1100.34	990.56
WPP/RC	938.51	828.27	718.19

* Average of Appalachia, Corn Belt, and Northeast regions (medium values for soil erosion costs)

6. Summary and policy implications

The 1996 FAIR Act limits CRP lands to 36.4 million acres; however, it also provides an early-out provision under which farmers can remove their land from CRP contracts and grow crops under favorable situations. This may jeopardize the environmental benefits from those CRP lands, but FAIR also gradually reduces subsidies to some conventional crops, e.g., corn and wheat. Various studies suggest that some alternative farming systems are more competitive than conventional farming; however, favorable federal policy changes are needed to enhance the profitability and wider adoptability by farmers. Alternatively, some tillage practices that require a higher application rate of chemicals could exacerbate the problems associated with groundwater contamination. As improving water quality is one of the important objectives of CRP, such conservation tillage approaches may not contribute to environmental and other goals of CRP such as the reduction of surplus agricultural commodity production or the improvement of wildlife habitats. In the case of CRP-expired lands, tree plantations, specifically white pine, could be one of the ecologically and economically feasible options.

The study assumes the availability of a market for pine pulp from Mead Paper Company in the study region. This is not a unique situation, as there are twelve other such paper industries located in this and other regions from Maine to Georgia to Wisconsin. Furthermore, there are also market possibilities of tree products from other industries. The sensitivity analysis on the pulp price indicates that the pulp price can fluctuate from 25 percent to 50 percent and still make white pine plantation a viable option for farmers and society.

Based on the benefit cost analyses of CRP, white pine plantation, and row crops, this study suggests that white pine plantation is a viable option for the most environmentally valuable CRP lands. Because white pine plantation generates more net present value than CRP in both the financial and economic analyses, white pine plantation will benefit both individual farmers and society. Furthermore, federal payments could be minimized by reducing subsidies to a level where white pine plantation would maintain its attractiveness when compared to both CRP and row crops. Reduced subsidies of row crops will facilitate this process. Besides meeting all the goals of CRP, white pine plantation also ensures longer-term environmental protection and provides a marketable product at the end of the project period. Farmers may be reluctant to adopt white pine plantation because of the long-term commitment required. Farmers' willingness to undertake long-term commitments needs more research for validation of this proposal.

References

American Forest and Paper Association (AF&PA), "List of AF&PA Member Companies," 1998.

Brown, James H., and James L. Stires, "Growth of White Pine in Relation to Soils and Topography in Southern Ohio," *OSU/OARDC Research Bulletin 1164* (November 1984).

Brown, James H., and James L. Stires, "Growth Intercept Methods for Predicting Site Index in White Pine Plantations," *Ohio Agricultural Research and Development Center Research Circulation 265* (March 1981).

Clark, E.H., J.A. Haverkamp, and W. Chapman. *Eroding Soils: The Off-Farm Impacts* (Washington, D.C.: The Conservation Foundation, 1985).

Colacicco, D., T. Osborn, and K. Alt, "Economic Damage From Soil Erosion," *Journal of Soil and Water Conservation*, 44, no. 1 (1989), pp. 35-39.

Dasgupta, A.K., and D.W. Pearce, *Cost-Benefit Analysis: The Theory and Practice* (London, England: MacMillan Press Ltd., 1978).

Economic Research Service (ERS), *RTD Updates: Conservation Reserve Program*, (Resources and Technology Division, U.S.D.A., January 1994).

Gittinger, J.P., *Economic Analysis of Agricultural Projects* (Baltimore and London: The Johns Hopkins University Press, 1984).

Gregory, G.R., *Resource Economics for Foresters* (New York: John Wiley and Sons, 1987).

Heimlich, R.E., and C.T. Osborn, "The Conservation Reserve Program: What Happens When Contracts Expire?" *Choice* (Third Quarter 1993), pp. 9-14.

Hitzhusen, F.J., "Off-Site Costs of Soil Erosion Property Rights and Conservation Policy: Some Ohio Evidence and Implications," working paper, Ohio State University (February 1991).

Hitzhusen, F.J., "The Economics of Sustainable Agriculture: Adding a Downstream Perspective," *Journal of Sustainable Agriculture*, 2, no. 2 (1992).

Hopkins, Jeff, "Indian Lake Watershed CRP Contract-Holder Land Use and Tillage Intention Survey," unpublished paper, OSUE (August 1994).

Hufschmidt, M.M., D.E. James, A.D. Meister, B.T. Bower, and J.A. Dixon, *Environment, Natural Systems, and Development: An Economic Valuation Guide* (Baltimore and London: John Hopkins University Press, 1988).

Irwin, S.H., D.L. Forster, and B.J. Sherrick, "Returns to Farm Real Estate Revisited," *American Journal of Agricultural Economics*, 70 (1988), pp. 580-587.

Lorimer, C.G., "Silviculture," in R.A. Young (ed.), *Introduction to Forest Science* (New York: John Wiley and Sons, 1982), pp. 209-34.

Mishan, E.J., *Elements of Cost-Benefit Analysis* (London: George Allen and Unwin Ltd, 1972).

Monson, M., and R. Lenkner, "A Sample of CRP Contract Holders on Future Land Use," paper presented at AAEA annual meeting, Kansas State University (August 4-7, 1991).

Napier, T.L., and S.M. Camboni, "A Social Science Perspective of Conservation of Soil Resources," in H.A. Henderson and T.K. Meeks (eds.), *Alternative Uses of Highly Erodible Agricultural Land* (Muscle Shoals, Alabama: Tennessee Valley Authority, 1988) pp. 165-177.

Ohio State University, *Ohio Crop Enterprise Budgets Grains—Forages* (Ohio Cooperative Extension Service, 1991).

Pearce, D.W., *Cost-Benefit Analysis* (London and Basingstoke: MacMillan Press Ltd., 1983).

Randall, Alan, *Resource Economics: An Economic Approach to Natural Resource and Environmental Policy* (New York: John Wiley and Son, 1987).

Ribaudo, M.O., "Consideration of Off-Site Impacts in Targeting Soil Conservation Programs," *Land Economics*, 62, no. 4 (1986), pp. 402-411.

Ribaudo, M.O., D. Colacicco, A. Barbarika, and C.E. Young. "The Economic Efficiency of Voluntary Soil Conservation Programs," *Journal of Soil and Water Conservation*, 44, no. 1 (1989), pp. 40-43.

Shakya, B.S. "Financial and Economic Analysis of White Pine vs. CRP and Row Crop Production on Erodible Lands of Southern Ohio," unpublished M.S. thesis. Ohio State University (1992).

Sinner, Jim, "Soil Conservation: We Can Get More for Our Tax Dollars," *Choices* (Second Quarter 1990).

Smith, Walter D., "If the Price is Right: Ohio White Pine to Supply Mead Paper's Long-Fiber Pulp Requirements," *Eastern White Pine: Today and Tomorrow: G.T. Report WO 51* (New Hampshire: U.S.D.A., 1985): 99-101.

Soil Science Society of America (S.S.S.A.), *Glossary of Soil Science Terms* (Madison, WI: S.S.S.A., July 1987).

U.S.D.A. (U.S. Department of Agriculture), "1990 Farm Bill Passed," *Agricultural Outlook* (December 1990).

U.S.D.A. (U.S. Department of Agriculture), "CRP Data of Ohio," unpublished data from Columbus, Ohio SCS (1990).

Young, C.E., and C.T. Osborn, "An Economic Evaluation of the Conservation Reserve Program," *Agricultural Economic Report No. 620* (Economic Resource Service, U.S.D.A., November 1989).