IMPLEMENTATION OF NEW CONSERVATION PROGRAMS AND THE NEED TO RESPOND TO CHANGING MARKET CONDITIONS

Clayton W. Ogg and Ralph E. Heimlich

Under new federal programs, soil and water conservation practices are relied upon to make a major contribution to the control of nonpoint sources of water pollution. Economic efficiency is to be considered in selecting these practices. Although only an experimental program funding of $50 million has been appropriated, $400 million of Rural Clean Water Program funds in 1980 were authorized. The program is to be administered by the Secretary of Agriculture with the concurrence of the Administrator of the Environmental Protection Agency. Because its implementation may eventually necessitate major land use changes and capital investments as part of 5- to 10-year contracts with farmers, we examine how soil conservation plans can incorporate potential changes in market prices of crops.

The analysis focuses on two sets of prices, both of which are important in agricultural programs. First, the Official Water Resource Council Prices, which were based on relatively high commodity prices for 1972-1976, are being used for short-term water resource planning up to 1990 and farther into the future. Second, support prices form the basis of a larger agricultural program which prevents prices from falling below these much lower levels.

We consider the consequences of basing conservation plans on Water Resource Council prices in the event that prices fall to support levels. One question addressed is whether conservation plans based on the higher prices are very different from those that would be optimal during years when prices are at support levels. Another question is whether conservation programs could be deliberately designed to complement the objectives of price support programs by allowing farmers flexibility within their plans to respond to price incentives.

RATIONALE FOR SELECTING AND COMPARING CONSERVATION PLANS

The selection of these prices and the research method are designed to represent closely an actual planning situation with options that could be implemented under the Rural Clean Water Program. The Chowan-Pasquotank river basin in eastern Virginia and North Carolina, encompassing most of 26 counties, is selected for study. A linear programming model allocates land uses to soil groups with similar erosion and yield characteristics, under the two contrasting market situations.[1] Profit-maximizing conservation strategies are thus developed and compared with each other, and they are considered in the larger context of how they affect food production needs.

MANAGEMENT ALTERNATIVES IN THE LINEAR PROGRAMMING MODEL

The basin's resource base is divided into eight Piedmont soil groups, with soils ranging from highly erosive to moderately erosive, and 15 Coastal Plain soil groups that are generally less erosive but also more productive than Piedmont soils, and used more intensively.

Erosion control practices used in the model are based on those appropriate for the areas that have been built into 322 rotations and practice combinations by the Soil Conservation Service in North Carolina. Average basin-wide yield increases were projected for 1990, using Spillman regressions with past yields as independent variables. Budgets were then combined into composite yearly costs and yields for crop rotations on appropriate soil groups.[2] Soil losses for LP model activities

Clayton W. Ogg is an agricultural economist and Ralph E. Heimlich is an economist with the Natural Resource Economics Division, Economics, Statistics, and Cooperatives Service, U.S. Department of Agriculture.

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[1]Although a national model by Wade and Heady assumes a fixed demand, Taylor and Frohberg were able to construct a large LP model of the Cornbelt which included a stepped demand curve. This study was useful, too, in showing very roughly how market participants might be affected by uniform sediment loss restrictions, but was still limited to only one world market demand situation. An earlier small area study in which perfectly elastic demand was assumed found that pollution controls shift much of the farm output — and pollution problems — to locations outside the study area (Casler and Jacobs, p. 185).

[2]Nitrogen use on each soil group was projected for 1990 by taking the corn yield times the following efficiency factor: $\frac{.8 \text{ lb./bu.}}{65\%}$ Fertilizer data were provided by J. W. Gilliam and other North Carolina State soil scientists.

SCS soil survey interpretations provide base yields for each soil. It is assumed that 1990 yields increase by the same proportion for each soil group. Yields for conventional tillage, no-till, and chisel plow systems are assumed to be equal. A composite yield for a 3-year rotation would, for example, be one-third of the 1990 yield of each crop in the rotation. Composite costs for 1990 are computed the same way in 1976 dollars and assume high levels of management. Costs of conservation investments are amortized over the typical life of each investment.

were computed by applying the crop management factors from recent revisions of the Universal Soil Loss Equation, by Wischmeier and Smith, to the average soil loss that would have resulted if each soil group had been left fallow.[3] Management practices in crop rotations are strip cropping, terracing, winter cover crops, residue management, no-till, chisel plowing, and contour plowing, and a large number of combinations of those activities. Wheat and soybean double cropping was included as a fall plow and no-till activity.

BASE SOLUTIONS FOR TWO MARKET CONDITIONS

Table 1 shows the Water Resource Council prices and support prices. Table 2 indicates the corresponding base output projections for crops and soil erosion for 1990 and compares crop output with projections based on the OBERS national shift-share analysis of regional trends. An apparent limitation of both base solutions is that they are based largely on an assumed profit-maximizing behavior and ignore planting and harvesting time constraints at the farm level, which historically have encouraged more soybeans to be grown in rotation with corn (see Table 2).[4] The base solutions are also abstractions that do not fully recognize the farmer's ongoing concern with erosion; thus there is hay production in the OBERS analysis on land which this model finds is more profitable for wheat and row crops. The base solutions do, however, include a requirement for 14,000 acres of contouring which is based on a very rough projection by conservation experts. Although wheat acreages have increased dramatically in recent years, the model may also be overestimating the speed with which farmers will continue to expand wheat acreages.

TABLE 1. PRICES FOR PROFIT MAXIMIZATION OF THE CHOWAN-PASQUOTANK LP MODEL, 1990

Commodity	Unit	WRC[a] Current Normalized	Loan[c] Level
Corn Grain	Bu	$ 2.54	$ 2.00
Corn Silage	Ton	16.09[b]	10.95[d]
Wheat	Bu	2.46	2.25
Soybeans	Bu	6.10	3.50
Sorghum	Bu	2.03	1.90
F-C Tobacco	Lb	1.04	1.04
Peanuts	Lb	.19	.19
Hay	Ton	52.68	35.85[d]

[a]Average of NC and VA current normalized prices for 1972-1976, developed by the Water Resources Council.
[b]Estimated.
[c]Represents surplus crop prices.
[d]Decreased by 31.9% = average decline in corn and soybean prices from WRC to loan level.

TABLE 2. BASIN OUTPUT FOR 1990 BASE SOLUTIONS COMPARED TO TREND ANALYSIS

Crop	Unit	Model using WRC prices	Model using support price levels	OBERS projections
		thousands		
Hay	Ton	38	0	65
Corn for Grain	Bu	68,897	91,828	36,149
Peanuts[a]	Lb	904,119	904,119	904,120
Soybeans	Bu	18,113	7,836	25,051
Silage	Ton	162	0	162
Tobacco[a]	Lb	67,256	67,256	67,256
Wheat	Bu	23,439	13,078	3,324
Grain Sorghum	Bu	0	205	847
Erosion	Ton	15,347 (10 tons/acre)	15,523 (10 tons/acre)	

[a]Peanuts and tobacco are grown under quotas and were therefore constrained to the anticipated trend levels. At prices for both model solutions these crops would otherwise have occupied a much larger portion of the cropland in the Basin.

In each price situation, cropland use is assumed to be dependent on crop prices, and potential impacts of livestock price cycles are disregarded. Providing for a livestock sector that is not in the model therefore requires the additional simplifying assumption that pastureland would not be converted to crop production. This assumption tends to understate the hypothesized impacts of crop prices on conservation programs. However, hay and silage are allowed to increase or decrease their share of available cropland in response to price changes. Feed rations therefore may be affected by market price changes, but pasture acreages are not.

For the base projections and throughout the analysis, it is also assumed that benefits of conservation are external to the firm. This assumption is necessary because there are no accurate data about yield increases resulting from soil conservation.

[3]This average fallow-ground soil loss is constructed as the product of the rainfall, slope, and erodibility factors for each of several thousand Conservation Needs Inventory sample points which were assigned to the 23 soil resource groups. The slope length factors are from a much smaller SCS sample. Minor soils in each soil group are assigned the average soil loss estimated for soils which make up more than two-thirds of the soil groups. Wischmeier's caution against averaging Universal Soil Loss Equation coefficients instead of soil losses at sample points is therefore heeded.

[4]All solutions, however, require a fraction (⅔) of the soybeans and corn to remain on soil groups where they are grown. The cropland base includes land that has grown crops in recent years and land that is projected to be cleared for crop production in the base solution. The base solution remains largely an abstraction with its assumption of short-term profit maximization. This is necessary because there are not enough data about conservation practices under present programs to project how farmers will respond to either price situation.

TABLE 3. OPTIMAL LAND USE AND CONSERVATION PRACTICES UNDER ALTERNATIVE MARKET CONDITIONS

Model Erosion Constraints	Prices	Net Dollar Returns	Row Crop Acres	Hay (tons)	Strip Crop (acres)	Contour acres	Terraced acres	Chisel Plow Acres	No Till Acres
		---thousands---							
Base solution[a] (15,352 thousand tons)	WRC	301,355	1,528	38	0	14	0	0	498
	Support	224,405	1,414	0	0	14	0	0	57
	Twice Support	715,372	1,528	38	0	14	0	0	171
11,513 thousand ton limit	WRC	301,202	1,528	38	0	298	28	166	504
	Support	224,068	1,414	0	0	342	0	84	94
	Twice Support	714,962	1,528	38	0	368	26	72	206
7,675 thousand ton limit	WRC	269,755	1,513	57	0	323	71	85	914
	Support	214,834	1,408	7	9	307	222	58	328
	Twice Support	704,180	1,531	38	0	244	412	66	404
3,838 thousand ton limit	WRC	263,965	1,484	43	16	297	614	82	1,189
	Support	168,305	960	482	455	281	460	72	174
	Twice Support	600,654	1,296	321	265	75	892	25	809

[a]Based on interviews with SCS technicians, the minimum constraint for chisel plow, strip crop, and terracing was very low for 1990 and contouring had a minimum constraint set at indicated level.

IMPACT OF MARKET CONDITIONS IN DETERMINING OPTIMAL CONSERVATION STRATEGIES

Characteristics of the base solutions and of solutions for the WRC and support price levels under successively more restrictive erosion constraints are shown in Table 3. As can be seen, net returns and row crop acreage are reduced and acreages treated with conservation practices increase as erosion constraints become more restrictive.

Output prices primarily affect the selection of conservation strategies by causing land to shift out of row crops during crop surplus years. This change is most evident when total basin erosion is limited to only 3,838,000 tons, or one-fourth of the base solutions in Table 3. For WRC prices, considerably more land is being terraced, whereas the support prices bring very large acreages of strip cropping into the solution. These differences imply that anticipating possible price changes would be very important in designing conservation plans if extensive erosion reductions were required.

To estimate the seriousness of employing the optimal support price strategy during a higher price year, the same 3,838,000 ton limit was applied with WRC prices, but under the additional assumption that farmers were committed to raise the 482,000 tons of hay that appeared in the support price solution. Under this scenario, net returns fall 11 percent more than in the original WRC price solution, when they dropped from the base of $301 million to $263 million. Depending on the subsidy allowed in their cost share contracts under the Clean Water Act, farmers and taxpayers would share this additional loss. These price differences and losses are clearly smaller than they would have been if the much higher prices for 1974, for instance, had been chosen for comparison (Cory and Timmons).

For the base solution and the two lower environmental restraints, the prices of wheat and soybeans become key variables. Erosion rates are similar for the two base solutions, even with 114 thousand more row-cropped acres under WRC prices. This is because in the WRC solution 498 thousand no-till acres, more than 95 percent of which are double-cropped wheat and soybeans, compensate for the larger row crop acreage. There are 914 thousand no-till acres in the WRC solution under the 7,675,000-ton erosion restraints, again mostly with double-cropped wheat and soybeans. The support price solution for both the 11,513,000 and

7,675,000-ton erosion constraints has much less no-till double cropping than the WRC price solutions. Raising wheat during the winter months is encouraged by conservationists because it protects the soil during winter rains; with favorable prices, results support this strategy.

Because WRC prices are relatively higher for soybeans than for corn and wheat, Table 3 also shows the effects of simply doubling all prices over support levels. These solutions include a lot of no-till and terracing as does the solution for WRC prices, but terracing, strip cropping, and shifts to hay are more important in this higher price situation whereas no-till and contouring are used more widely under WRC prices.

THE CASE FOR FLEXIBLE CONSERVATION PLANS

Reducing erosion to 25 percent of the base solution causes a loss of about one-third of the row crop acreage in the basin under support prices, but there is little change under WRC prices. Although the model may overestimate the loss of production from conservation constraints during low price years because of its assumption of perfectly elastic demand, matching conservation strategies to market conditions substantially reduces basin output under support prices. This complements set-aside programs and is another compelling argument for encouraging flexible conservation plans.

Because conservation goals will be implemented through short-term measures planned for 1 to 10 years, flexible strategies based on market prices could contribute to maintaining a balance between meeting food needs and protecting soil and water resources. This flexibility could be built into 5-10-year Clean Water Act contracts with farmers which would allow them to change practices as long as the desired level of protection is achieved.[5]

In the Chowan basin, no-till double cropping is a popular conservation practice that increases farm output even during high price years, and farmers' preference for hay rotations under the more restrictive restraints during lower price years complements land retirement programs. During a 10-year contract period, farmers could be encouraged to alternate between these two practices in response to price incentives. Terracing, which is a longer term measure, enters both solutions in limited areas under the more restrictive case, and would be appropriate for such areas even if price changes were anticipated. However, row crop acreage would presumably be further reduced under support prices if there were no terracing option in the solutions for 50 and 75 percent gross erosion reductions.

POTENTIAL FOR MAKING WATER QUALITY PLANS RESPONSIVE TO CHANGING PRICE CONDITIONS

There is considerable evidence that farmers have responded to price changes in ways that affect erosion and sediment problems (Cory and Timmons). Even some long-term investments, such as terraces and "permanent" pastures, were rapidly plowed out during the high price years in the early seventies. Potential price changes undoubtedly complicate water quality and conservation planning at all levels.

Models such as the one used in this analysis are designed primarily to assist planners, first in the selection of practical erosion-reduction goals for the planning area or in designated subareas and second in identifying practices that need to be encouraged, and their costs, for each soil situation.

Our analysis focuses on the way price changes affect this selection of efficient practices. Long-term conservation investments, such as terraces, should probably be encouraged only on those soils where they are included in detailed model outputs under both the high and low price situations. The model provides this information for each soil group in the basin.

For shorter term practices, such as use of winter cover crops and no-till double-cropping systems, plans can be designed with the built-in flexibility to change to less intensive rotations when prices fall.[6] Over the 10-year period of Clean Water Act contracts strip cropping may also be temporarily replaced by other conservation practices in response to price incentives. Detailed model outputs from each solution identify for each soil group the potential changes that may be expected during the contract period.

Allowing this kind of flexibility is expected to make farmers more willing to participate in the Rural Clean Water Program. However, because individual skills and preferences vary

[5]Although this article shows how flexibility in carrying out conservation programs can help to stabilize farm prices, conceivably farmers might over-respond to a previous price change. In this situation the flexibility that appears to be so beneficial in this analysis could actually lead them to further destabilize prices. Despite this possibility, farmers are expected usually to anticipate price levels correctly because price changes generally are not so frequent or unpredictable.

One way to ensure that conservation programs have a stabilizing effect on prices would be to incorporate conservation practices into the set-aside programs currently used to support prices. For example, acres set aside to meet a price support objective could be acres selected from conservation plans for areas with steep slopes. Combining programs appears to be consistent with some of our analysis, but it would involve changes in current legislation which are beyond the scope of this article.

[6]Whether cost sharing should be allowed to vary on the basis of price levels is a question that may be raised as detailed model outputs anticipate cost share needs. These vary not only by soil but by price conditions. Currently, cost share programs are not very sensitive even to the needs that differ among farms according to their soils; it would be a major change to tie cost sharing to price conditions. However, both are feasible with the soil detail from LP model outputs.

among farmers, a basin model obviously cannot anticipate the response of every individual. Instead it identifies several practices that are appropriate for each soil group under both price situations and suggests how net returns may be expected to change in going from each base solution to the selected erosion control plans. Model results therefore indicate the need for plans that are capable of adapting to price changes, and they provide a starting place for designing plans and anticipating assistance needs for individual farmers.

Planning for more than one price situation admittedly could complicate the process of developing plans with individual farmers, especially if the planner attempts to change the amount of cost sharing as prices change. Perhaps the simplest approach is to allow the farmer to select several appropriate options in the cost share contract, and then to alternate among them as he sees conditions changing.

ADDITIONAL RESEARCH NEEDS

Soil conservation measures solve pollution problems only to the extent that targeted pollutants, such as sediment and phosphorus, are not carried to streams or lakes. Although phosphorus associated with erosion can contribute to the severe eutrophication problems in the Albemarle Sound, losses vary greatly among soils for both dissolved phosphorus and sediment-associated phosphorus. Erosion reduction thus must be related to reduction in delivered sediment and to other water quality goals so that erosion control costs are incurred where they are most efficient in improving water quality.

In a recent article Karr and Schlosser warn of the fallacy of equating erosion control with pollution control while advocating natural stream buffers to focus control measures more directly on water problem areas. The economic impacts would, again, depend on market prices. Further research is therefore needed both to allow conservation models to better represent impacts on water quality and to consider economic impacts of new approaches to water quality improvement (Pionke, Schneider).

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