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USING ECONOMICS TO PROMOTE CONSERVATION PRACTICES: A Simplified Approach

This coversheet transmits a technical note originally released by the West National Technical Center (WNTC) in 1992.

The technical note provides examples of techniques available to NRCS planners to use as they assist farmers, ranchers, and other clients in evaluating conservation practices and systems of practices. Included in the technical note are one-page examples illustrating some of the most frequently used methods of economic analysis and a one-page worksheet designed to help in the use of these approaches.

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Technical Note

Using Economics to Promote Conservation Practices: A Simplified Approach

Economics Series No. W10

USING ECONOMICS TO PROMOTE CONSERVATION PRACTICES

A SIMPLIFIED APPROACH

This Technical Note was adapted from the Midwest National Technical Center Economics Technical Note 200-LI-6, Using Economics to Promote Water Quality, A Simplified Approach, September, 1992.

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INTRODUCTION

Throughout conservation planning the planner is working to motivate the client to adopt conservation. One way to persuade our clients to adopt conservation is to describe the benefits and costs of conservation to their operation. When the client understands it is to their advantage, conservation is more likely to be adopted. It is important to remember that the client will not always directly benefit from their conservation investment. For example, conservation practices/systems may protect ground and surface water resources which may benefit the general public more so than the client who bears the full cost. Studies have found that billions of dollars of damages to ground and surface water resources can be reduced through improving conservation management on rangeland and cropland. With such significant damage reductions, the tendency towards regulation gains strength. However, SCS is working to persuade farmers and ranchers to voluntarily change their methods of operation to maintain and enhance the management of their natural resources.

The purpose of this technical note is to give examples of techniques available to SCS conservationists to use as they assist farmers, ranchers, and other clients in evaluating conservation practices and systems of practices. These techniques pertain to the evaluation of onsite benefits and costs, that is, those benefits and costs directly incurred by the client. Included in this technical note are one-page examples illustrating some of the most frequently used methods of economic analysis and a one-page worksheet designed to help in the use of these approaches.

EXAMPLE 1

Maximizing Profit With Input Management (e.g., Fertilizer)

Background: In the past, the importance of "maximizing yields" has been promoted through friendly neighbor competition, college agronomy courses, Master Grower Contests, etc. This is justified if the extra yield is sufficient to pay for the extra fertilizer.* Maximum yield does not guarantee maximum profit. In fact, the higher the fertilizer/crop price ratio, the lower the fertilizer rates should be. A producer maximizes profit by adding fertilizer only to the point where extra yield will pay for the extra fertilizer. More is not always better.

Tools Needed: To convince a producer to add fertilizer only to the point where the extra yield will pay for the extra fertilizer, he/she must be shown to what degree extra increments of fertilizer increase yields. This yield "response" must then be compared to the price of the crop and the price of the fertilizer to estimate changes in net returns (profits).

Approach: Data must be obtained on fertilizer/yield response and fertilizer/crop prices.

Sources of Response Data
1. County Extension Agent
2. Local Producers
3. SCS State Economist
4. Experiment Station Bulletins

Sources of Cost Data
1. Market Reports
2. Local Dealers
3. Local Producers
4. SCS State Economist

Example:

Input (Nitrogen)	Increase in Input	Corresp. Yield (Corn)	Change in Yield	Increased Cost	Change in Income	Change in Net Returns
(lbs/ac)	(lbs/ac)	(bu/ac)	(bu/ac)	($.20/lb)	($2.00/bu)	(+/-$)
50	--	100	--	--	--	--
100	50	120	20	$10	+$40	+$30
150	50	130	10	$10	+$20	+$10
200	50	135	5	$10	+$10	$00
250	50	138	3	$10	+$ 6	-$ 4

Given the response and cost information, it is easy to calculate changes in net returns as fertilizer rates increase. In this case, the producer should not apply more than 200 pounds of nitrogen per acre. If he/she does, the increase yield will not pay for the increased nitrogen. Added nitrogen will also increase the chances of water quality degradation. This technique can be applied to any input (including pesticides) and any crop (including pasture and range).

* Other production costs may also increase slightly with a higher yield, however, experience indicates that fertilizer is the major cause of increased costs.

WORKSHEET 1

Maximizing Profit With Input Management

Data Needed: 1. Increasing input amounts (record below).
2. Corresponding yield response (record below).
3. Input price $.
4. Crop price $.

$ Change in Net Returns (Profit):

(1) Input (Nitrogen)	(2) Increase in Input	(3) Corresp. Yield (Corn)	(4) Change in Yield	(5) Increased Cost	(6) Change in Income	(7) Change in Net Returns
(lbs/ac)	(lbs/ac)	(yld/ac)	(yld/ac)	(Input price x col. 2)	(Crop price x Col. 4)	(Col. 6 - Col. 5)
	--		--	--	--	--
______	______	______	______	$______	$______	$______
______	______	______	______	$______	$______	$______
______	______	______	______	$______	$______	$______
______	______	______	______	$______	$______	$______
______	______	______	______	$______	$______	$______

Recommended Input Level: The last level with a positive change in net returns will maximize profit for the producer. Any level beyond that will not increase net profits and will increase the change of water degradation.

EXAMPLE 2

Cost Analysis (e.g. Brush Control)

Background: When a landuser is deciding whether or not to apply conservation to improve water quality, the outlay or cost of that system is important. The landuser needs this information to make sound economic and financial decisions. A conservationist should be able to supply the needed conservation cost information.

Tools Needed: The costs of conservation practices which improve water quality vary according to whether the practice is enduring (structural) or based on the landuser's improved management (nonstructural). Enduring practice costs include installation, operation, maintenance, and sometimes replacement. Costs of management include crop budget item costs like increased labor and management.

Approach: A landuser needs to amortize (spread out on an annual basis) installation costs of alternatives to reflect his/her annual production costs. The installation costs of each alternative should be amortized (spread out) over some logical time period, such as the life of the practice or loan period, so that total annual costs of each alternative can be developed.

Generally, annual operation and maintenance (O&M) costs are added to amortized installation costs to find total costs on an annual basis. Replacement costs should be considered when comparing alternatives with unequal life spans, and the method used here automatically accounts for replacement of short-lived alternatives.

Example: A rancher is trying to determine the annual costs of brush control under three alternative methods: (a) mechanical control, (b) aerial applied chemical control, and (c) basal applied chemical control. Assume he/she can borrow money at 9 percent interest. Use the amortization factor table that follows to estimate total average annual costs per acre.

The following format can be used to organize alternatives and their costs, and to annualize them using appropriate amortization factors.

Alternatives	Life	Installation Cost	Amortization Factor*	Annual Installation Cost**	Annual O&M	Total Average Annual Cost***
	(Yrs)	($/ac)	(life,9%)	($/ac/yr)	($/ac/yr)	($/ac/yr)
Mechanical	20	65	.11	7.15	.65	7.80
Aerial/chem.	5	25	.26	6.50	1.25	7.75
Basal/chem.	10	40	.16	6.40	.40	6.80

* From Amortization Factors Table on page 5
** Installation cost x amortization factor
*** Annual installation cost + annual O&M

The annual cost of the two alternatives least likely to degrade water quality (mechanical and basal/chemical) are essentially of equal or lesser cost than the aerial method. Thus, the rancher's goals of least cost conservation and maintaining water quality can be met simultaneously. If the aerial/chemical method was least expensive, the rancher would at least be able to see what degree the goals differed.

Amortization Factors

Years	5%	7%	9%	11%	13%
	Borrowing/Savings Interest Rate				
2	.54	.55	.57	.58	.60
3	.37	.38	.40	.41	.42
4	.28	.30	.31	.32	.34
5	.23	.24	.26	.27	.28
10	.13	.14	.16	.17	.18
15	.10	.11	.12	.14	.15
20	.08	.09	.11	.13	.14
25	.07	.09	.10	.12	.14

WORKSHEET 2

Cost Analysis of Alternatives

Alternatives	Life	Installation Cost	Amortization Factor	Annual Installation Cost*	Annual O&M	Total Average Annual Cost**
	(Yrs)	($/ac)	(life,__%)	($/ac/yr)	($/ac/yr)	($/ac/yr)
1.						
2.						
3.						
4.						
5.						

* Installation cost x amortization factor
** Annual installation cost + annual O&M

NOTE: Total annual costs of each alternative, as calculated here, incorporate installation and O&M costs while only approximating replacement costs (through the use of amortization factors based on varied lifespans). A precise measure of annual replacement costs involves detailed use of amortization techniques including numerous lagging procedures.

Amortization Factors

	Borrowing/Savings Interest Rate				
Years	5%	7%	9%	11%	13%
2	.54	.55	.57	.58	.60
3	.37	.38	.40	.41	.42
4	.28	.30	.31	.32	.34
5	.23	.24	.26	.27	.28
10	.13	.14	.16	.17	.18
15	.10	.11	.12	.14	.15
20	.08	.09	.11	.13	.14
25	.07	.09	.10	.12	.14

EXAMPLE 3

Partial Budgeting (e.g., Conservation Cropping Systems)

Background: The partial budget is an powerful tool for SCS conservationists to use as they assist farmers, ranchers, and other landusers in evaluating conservation practices and systems of practices. The partial budgeting technique is basically a weighing of the benefits and costs which change as alternatives are considered. This technique simplifies data collection while examining how benefits and costs change.

Tools Needed: Two main tools are needed to employ the partial budgeting technique. First, the conservationist and the producer must estimate the operational changes that the proposed conservation practice(s) will cause and any changes in yield that might occur. Second, a format by which to compare these changes must be used, i.e., a partial budgeting form.

Approach: Any change caused by the adoption of a conservation practice(s) can be classified into one of four categories: (a) Added returns, (b) added costs, (c) reduced returns, or (d) reduced costs. Once the changes are classified on the partial budget form, they can be estimated in dollar terms and then analyzed in total to develop the net effects.

Example: The employment of a conservation cropping system any result in a number of changes in the way a farmer operates. Examples of the changes for a particular situation might include: (1) an increase in hay production worth $55/acre, (2) an increase in water quality (complex evaluation procedures could be used to evaluate the monetary effects; however, in this example the monetary benefits of improved water quality were not evaluated), (3) reductions in herbicides and pesticides worth $5/acre, (4) a decrease in fertilizer usage worth $25/acre, (5) an incentive payment worth $5/acre, (6) an increase in labor costing $4/acre, and (7) a decrease in corn production worth $75/acre.

Categorizing these changes in a partial budgeting format yields the following:

Part A	Value ($/acre)
1. Added return	
(a) Increase in hay production	$55
(b) Increase in water quality	not evaluated
2. Reduced Costs	
(a) Less herbicide and pesticide	$ 5
(b) Less fertilizer	$25
(c) Incentive payments (cost share)	$ 5
Subtotal A (gains to the landuser)	$90

Part B	Value ($/acre)
1. Added costs	
(a) Increased labor costs	$ 4
2. Reduced returns	
(b) Decrease in corn production	$75
Subtotal B (losses to the landuser)	$79
Estimated change in income (A minus B)	$11/acre gain

Without estimating the benefits from the increased water quality, net income rises $11/acre. Even if net income fell, that amount could be offset by the increased water quality benefits which were not measured.

WORKSHEET 3

Partial Budget Form

Part A	Value ($/acre)
1. Added returns	
____________________	$________
____________________	$________
____________________	$________
Plus	
2. Reduced Costs	
____________________	$________
____________________	$________
____________________	$________
Subtotal A (gains to the landuser)	$90

Part B	Value ($/acre)
1. Added costs	
____________________	$________
____________________	$________
____________________	$________
Plus	
2. Reduced returns	
____________________	$________
____________________	$________
____________________	$________
Subtotal B (losses to the landuser)	$________
Estimated change in income (A minus B)	$________

EXAMPLE 4

Breakeven Analysis (e.g., Improve Grazing Distribution)

Background: Breakeven analysis provides useful information in a variety of conservation situations. Consider the following questions: (1) How much can I afford to spend on a conservation practice(s)? (2) How long will it take to get my money back? (3) What rate of return will I get? and (4) How much net gain do I need to pay for the conservation required? All four questions are "breakeven" questions.

Tools needed: Each of the previous questions involve an unknown variable: (1) cost, (2) time, (3) interest rate, and (4) change in net returns. Each question can be answered if the other three variables are known. A table of interest and annuity factors, like the one included at the end of this example, will be needed to solve for the unknown variable.

Approach: Three of the following four pieces of data must be known in order to solve the other.

1. Cost - Cost of applying conservation practice(s).
2. Time - System life, loan period, etc.
3. Interest rate - Producers' borrowing or savings interest rate.
4. Change in Net Returns - Gain or loss from applying conservation.

Example: An opportunity exists to develop an additional water source (spring) and improve grazing distribution, thereby reducing the concentration of animal water. This will also allow the harvest of 30 AUMs in an area where only 10 are harvested at present.

Example A (Breakeven Cost): How much can the rancher afford to spend for the stockwater development, if the life is 20 years, his borrowing interest rate is 11 percent, and an AUM is valued at $7?

Solution A: 20 AUMs (change in yield) x $7 per AUM = $140. $140 x 7.96 (annuity factor for 20 years and 11 percent) = $1,114. The rancher's breakeven costs is $1,114 and at any lower cost, he/she will profit from stockwater development over the 20-year period.

Example B (Breakeven Time): How long will it take the rancher to get his/her money back if the capital cost is $1,000, at a 7 percent interest rate and the value of the change in AUMs produced is $120 per year?

Solution B: $1,000 (capital cost)/$120 = 8.33. Read down the 7 percent column of the annuity table until a factor close to 8.33 is found, in this case 8.36. Then read left to the time period (years) column. The factor of 8.36 occurs at 13 years. Thus the breakeven time is about 13 years.

Example C (Breakeven Rate of Return): What is the breakeven rate of return when the rancher's costs is $1,300, effects are evaluated over a 20-year time period, and the value of the change in AUMs produced is $180/year?

Solution C: The factor for the breakeven rate of return is $1,300/180 = 7.22. Read across the 20-year row of the annuity table until a factor close to 7.22 is found. Since the factor is between 11 percent and 13 percent, we conclude that the rancher will need about a 12 percent rate of return on the conservation investment to breakeven.

Example D (Breakeven Value): What must an AUM be worth to breakeven when the rancher's share of the conservation cost is $1,400, evaluation is 20 years, and the bank charges 11 percent on borrowed money?

Solution D: $1,400 x .125 (reciprocal of the annuity factor for 20 years, 11 percent (1/7.96)) = $175. $175 / 20 (change in yield) = $8.75 per AUM. Given the level of the other variables an AUM must be worth $8.75 to breakeven.

Present Value of Constant Annuity Factors

	Borrowing/Savings Interest Rate					
Years	5%	7%	9%	11%	13%	15%
2	1.86	1.81	1.76	1.71	1.67	1.63
3	2.72	2.62	2.53	2.44	2.36	2.28
4	3.54	3.39	3.24	3.10	2.97	2.85
5	4.33	4.10	3.89	3.70	3.52	3.35
10	7.72	7.02	6.42	5.89	5.43	5.02
11	8.31	7.50	6.81	6.21	5.69	5.23
12	8.86	7.94	7.16	6.49	5.92	5.42
13	9.39	8.36	7.49	6.75	6.12	5.58
14	9.90	8.75	7.79	6.98	6.30	5.72
15	10.38	9.11	8.06	7.19	6.46	5.85
20	12.46	10.59	9.13	7.96	7.02	6.26
25	14.09	11.65	9.82	8.42	7.33	6.46

What is the effect of a cost share payment when determining the breakeven values? From the operator's perspective cost share payments can be seen in two ways:

(1) The cost share payments reduce the effective cost of conservation, i.e., the cost of the system to the operator is reduced by the amount of the cost share payment. In Examples B, C and D the cost share payment is accounted for by subtracting it from the cost of the conservation practice/system and

(2) The breakeven cost that the operator can incur increases by the amount of the cost share payment. This is because the breakeven cost as calculated in Example A depends on the value of the conservation benefits gained by the operator. A cost share payment is a benefit received by the operator contingent on installing the practice/system. Therefore, referring to Example A, the operator's breakeven cost with cost sharing equals $1,144 plus the cost share payment. At any lower cost the operator will profit from stockwater development over the 20 year period.

WORKSHEET 4

Breakeven Analysis
(Always refer to present value of constant annuity factor table on previous page)

a. Breakeven Cost

__________ X $ __________ X __________ = $ __________
(change in yield) (per unit price of yield) (PV of constant annuity at given r and t)* (breakeven cost)

At any cost lower than $ __________ (the breakeven cost), the producer will profit by adopting the conservation.

b. Breakeven Time

$__________ / $__________ = __________
(conservation cost minus cost sharing) (value of change in yield) (calculated PV of constant annuity factor)

Using the given interest rate column, find the time period row which approaches the calculated annuity factor. This time period is the breakeven time, i.e., the time it will take the conservation investment to pay for itself.

c. Breakeven Rate of Return

$__________ / $__________ = __________
(conservation cost minus cost sharing) (value of change in yield) (PV of constant annuity factor)

Using the given time period row, find the interest rate column which approaches the calculated annuity factor. This interest rate is the breakeven rate of return, i.e., the rate of return needed to breakeven on the conservation investment.

d. Breakeven Value

$__________ X $__________ / __________ = $__________
(conservation cost minus cost sharing) (reciprocal of the PV of constant annuity at given r & t)* (change in yield, i.e., 30 bushels 20 AUMS, etc.) (breakeven value per unit of yield)

Each additional unit of yield caused by the conservation investment must be worth __________ (breakeven value/unit of yield) to pay for that investment.

* r = interest rate, t = system life or loan period

EXAMPLE 5

Benefit Analysis (e.g., Erosion Control)

Background: Benefits from erosion control occur offsite (e.g., improved water quality) as well as onsite (e.g., sustained yields). Unfortunately, offsite effects are extremely difficult to measure; and even if measurable, are somewhat unconvincing evidence to the landuser who has to pay for the conservation. To sell conservation for water quality, the measurable onsite benefits should be stressed as they relate directly to the landuser.

Tools Needed: The following method is a fast, simple, and easy-to-use way to approximate the average annual damages caused by soil depletion and the benefits obtained by adopting a conservation system. Information that is needed includes: (1) current yield, (2) future yield without treatment, and (3) the number of years it will take for the current yield to reach the future yield. A knowledge of amortization and crop budgeting is not needed to calculate benefits.

Approach: Onsite benefits from erosion control due to conservation and technology may accrue over time as yields rise. If one assumes, for measurement sake, the absence of new technology for increasing yields, the effects of conservation alone on sustaining yields can be isolated. The term "productivity maintenance" was derived from the concept of isolating conservation effects on yield.

Example: Soil scientists have determined that if soil erosion continues on the example soil, corn yields will decrease from the current yield of 130 bushels per acre to 100 bushels per acre in 25 years assuming other input technology is held constant. With a conservation system, the 130-bushel yield will be maintained. Using an interest rate of 10 percent, determine the average annual dollar benefits from the conservation system.

Solution: Assuming a $2/bushel price, the gross return for a 130-bushel yield is $260, and the gross return for a 100-bushel yield is $200 per acre. From the Average Annual Reduction Factor table supplied in Worksheet 5, find the average annual reduction factor for 25 years at an interest rate of 10 percent. The factor is .30. Calculate the reduction in gross return: $260 - $200 = $60. $60 x .30 = 418 average annual gross return per acre reduction. With the conservation system in place, the 130-bushel yield will be maintained, thus an approximation of the average benefits will be $18 per acre per year.

Remember: There are other possible benefits from conservation practices that should be reviewed with the landuser besides productivity maintenance and water quality, e.g., lower costs of production, water conservation benefits, improved wildlife habitat, etc.

EXAMPLE 6

Benefit/Cost Analysis (e.g., Irrigation Water Management)

Background: In some cases, estimates of both costs and benefits can be made when considering the economic viability of a water quality/(quantity) conservation alternative. For those instances, a fairly clear economic picture can be drawn for the landuser.

Tools Needed: Benefit/cost analysis requires the estimate of both the costs and benefits of the conservation alternative. The physical effects must first be defined and then valued in dollar terms.

Approach: Combining cost analysis (Example 2) and benefit analysis (Example 5) involves the organized weighing of the positive and negative effects of adopting an alternative. The most important and difficult step is laying out the physical effects. The effects could include a change in yield, change in the use of an input, or the inherent value of a saved resource. Once the physical effects are outlined, it may not be necessary to value the effects, especially in simple alternatives. But, in more complex alternatives where physical units vary and comparison of negative and positive effects becomes difficult, "valuing" or putting a dollar value on the physical effects may be required.

Example: A landuser is considering a change from a sloping to a basin irrigation system. Assuming the system has a life of 20 years, and the landuser will have to borrow the money for the system at 11 percent interest, analyze the benefits and costs on an annual, per acre basis.

Benefit Analysis (See Example 5)

Item	Physical Effects (units/acre)	Price ($)	Value ($/ac/yr)
Increased Cotton Yield	400 lbs.	$70/cwt	$280
Decreased Water Use	22 ac. in.	$ 5/ac. in.	110
Decreased Labor	5 hrs.	$ 5/hrs.	25
	Total		$415

Cost Analysis (See Example 2)

Alternatives	Life	Instal-lation Cost	Amorti-zation Factor	Annual Instal-lation Cost	Annual O&M	Total Average Annual Cost
	(Yrs)	($/ac)	(life,11%)	($/ac/yr)		($/ac/yr)
Basin Irrigation	20	1,850	.13	240	72	312

Benefits - Costs

$415/acre/year - $312/acre/year = $103/acre/year

WORKSHEET 6

Benefit Analysis

Item	Physical Effects (units/acre)	Price ($)	Value ($/ac/yr)
1.			
2.			
3.			
4.			
5.			

Benefit/Cost Analysis

Cost Analysis

Alternatives	Life (Yrs)	Installation Cost ($/ac)	Amortization Factor* (life,__%)	Annual Installation Cost** ($/ac/yr)	Annual O&M ($/ac/yr)	Total Average Annual Cost*** ($/ac/yr)
1.						
2.						
3.						
4.						
5.						

* From Amortization Factors Table below.
** Installation cost x amortization factor.
*** Annual installation cost + annual O&M.

Benefits - Costs

$ ________ - $ ________ = +/- $ ________

Amortization Factors

	Borrowing/Savings Interest Rate				
Years	5%	7%	9%	11%	13%
2	.54	.55	.57	.58	.60
3	.37	.38	.40	.41	.42
4	.28	.30	.31	.32	.34
5	.23	.24	.26	.27	.28
10	.13	.14	.16	.17	.18
15	.10	.11	.12	.14	.15
20	.08	.09	.11	.13	.14
25	.07	.09	.10	.12	.14