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SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE

PRODUCTIVITY MAINTENANCE BENEFIT ANALYSIS

Shortcut Procedure

The following procedure illustrates a fast, simple, and easy-to-use method to approximate the average annual damages caused by soil depletion and the benefits obtained by adopting a conservation system. Only three items of information are needed from the physical science specialists: (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.

The shortcut procedure utilizes a table of Average Annual Reduction Factors (see appendix 1 for the procedure used to develop these factors).

Average Annual Reduction Factor
Interest Rate, Percent

YEARS	5	6	7	8	9	10	11
10	.41	.40	.39	.39	.38	.37	.37
15	.41	.40	.38	.37	.36	.35	.34
20	.40	.38	.37	.35	.34	.33	.33
25	.38	.36	.35	.33	.31	.30	.28
30	.37	.34	.32	.31	.29	.27	.26
40	.33	.31	.29	.26	.24	.23	.21
50	.30	.28	.25	.23	.21	.19	.18

Example Problem No. 1

The physical scientists have determined that if soil erosion continues, corn yields will decrease from the current yield of 130 bushels per acre to 100 bushels per acre in 25 years. 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 (Example 1) - Shortcut Procedure

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. Calculate the reduction in gross return: $260 - $200 = $60. From the above table, find the average annual reduction factor for 25 years at an interest rate of 10 percent. The factor is .30. Multiply the reduction in gross returns ($60) by the average annual reduction factor (.30) to arrive at the average annual reduction in gross returns per acre ($18). With the conservation system in place, the 130 bushel yield will be maintained, thus an approximation of the average annual benefits will be $18 per acre (see appendix 2 for the traditional procedure of calculating the average annual benefits).

This procedure is applicable to situations where the with treatment yield is no higher than the present yield, i.e. 130 bushels. If the with treatment yield will be higher than the present yield, the Productivity Enhancement Analysis should be used. An example of this analysis follows.

PRODUCTIVITY ENHANCEMENT BENEFIT ANALYSIS

Shortcut Procedure

This procedure is also a fast, simple, and easy-to-use way to approximate the average annual enhancement benefits resulting from an improved yield obtained by adopting a conservation system. As with the previous method, only three items of information are needed from the physical science specialists: (1) current yield, (2) future yield with treatment, and (3) the number of years it will take for the current yield to reach the future yield. Again, a knowledge of amortization and crop budgeting is not needed to calculate benefits.

The shortcut procedure utilizes a table of Average Annual Enhancement Factors:

Average Annual Enhancement Factor
Interest Rate, Percent

YEARS	5	6	7	8	9	10	11
10	.51	.50	.49	.49	.48	.47	.47
15	.47	.46	.45	.44	.43	.42	.41
20	.45	.43	.42	.40	.39	.38	.36
25	.42	.40	.39	.37	.35	.34	.32
30	.40	.38	.36	.34	.32	.31	.29
40	.36	.33	.31	.29	.27	.25	.24
50	.32	.30	.27	.25	.23	.21	.20

Example Problem No. 1A

(Continuation of problem 1)

The physical scientists have determined that the conservation system will improve the moisture holding capacity, increase the organic matter, improve tilth, etc., so that the yield is expected to increase to 140 bushels in 25 years. Using an interest rate of 10 percent, determine the average annual enhancement benefits.

Solution (Example 1A) - Shortcut Procedure

Assuming a $2/bushel price, the gross return for a 140 bushel yield is $280, and the gross return for a 130 bushel yield is $260 per acre. Calculate the increase in gross return ($280 - $260) is $20. From the above table, the average annual enhancement factor for 25 years at an interest rate of 10 percent is .34. Multiply the increase in gross returns ($20) by the average annual enhancement factor (.34) to arrive at the average annual increase in gross returns per acre ($6.80; rounded to $7). With the conservation system in place, the average annual enhancement benefits are $7 per acre.

Summary

The total average annual benefits from both the maintaining and the enhancing of productivity is $25 ($18 + $7) per acre.

REMEMBER: There are benefits, other than productivity maintenance and enhancement benefits, that must be considered when evaluating the effects of a conservation system. Other benefits may include; lower costs of production, water conservation, and offsite benefits including sediment deposition and water quality.

Example Problem No. 2

The physical scientists have determined that if soil erosion continues, corn yields will decrease from the current yield of 100 bushels per acre to 90 bushels per acre in 25 years. With a no-till system the 100 bushel yield will be maintained. Using an interest rate of 10 percent, determine the average annual benefits from the no-till system.

Solution (Problem No. 2) - Shortcut Procedure

From the above table find the average annual reduction factor for 25 years at an interest rate of 10 percent. The factor is .30. Calculate the reduction in yield; 100 - 90 = 10 bushel yield reduction. The average annual yield reduction is 3 bushel (.30 x 10) per acre. The average annual yield without the no-till system is 97 bushel, (100 - 3). The average annual yield with no-till is 100 bushel. The average annual benefits are thus 3 bushels per acre per year.

The next step then is to assign a value to the 3 bushels of corn. Crop budgets show the value of corn to be $1.50 per bushel and variable harvesting costs of $.15 per bushel. The marginal net benefit of a bushel of corn is then $1.35 per bushel, ($1.50 - $.15), or $4.05 per acre per year for the no-till system. Crop budgets also show an increase in net return, caused by a reduction in production costs, of $10 per acre with no-till.

Total Benefits Are:

Increase yield benefits	$4.05
Reduced production costs	$10.00
Total annual benefits per acre	$14.05

Example Problem No. 3

Physical scientists have determined that if soil erosion is allowed to continue at the current rate, corn yields will decrease from 185 bushels per acre to 140 bushels per acre in a 20 year period. The installation of a basic conservation system (BCS) will maintain yields at 185 bushels per acre.

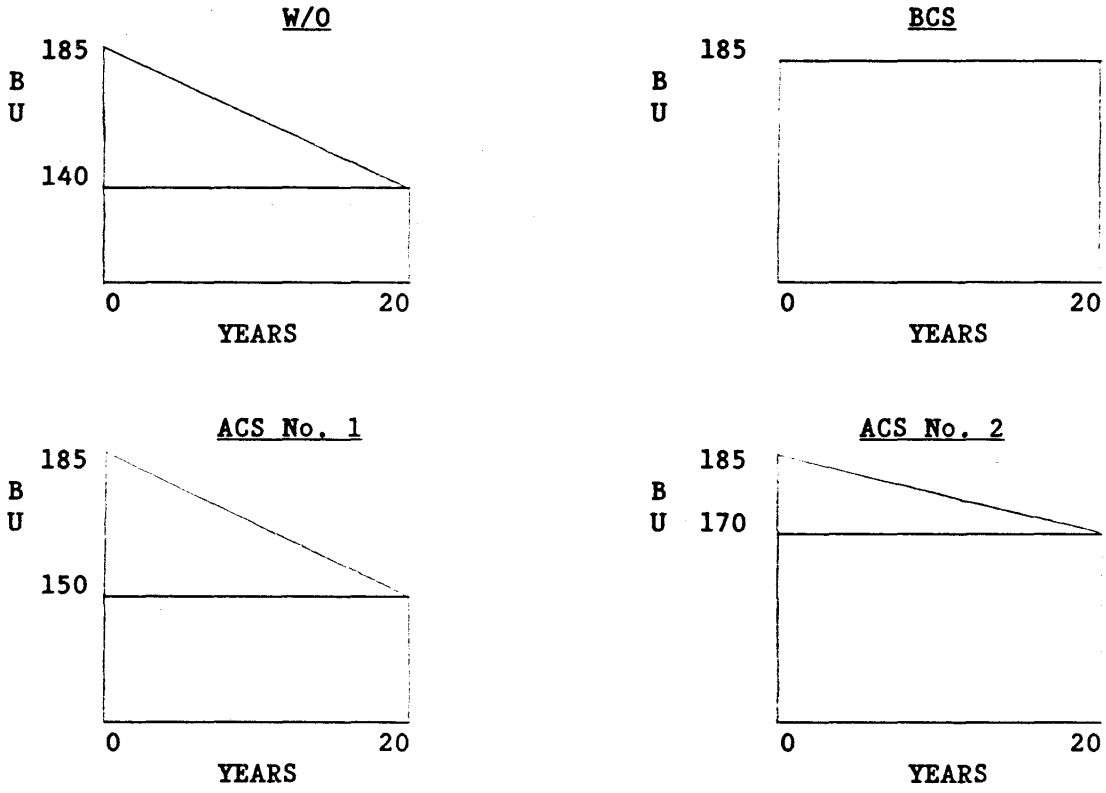
The rate of soil depletion can be slowed with the installation of alternative conservation systems (ACS's) No. 1 or No. 2. The yield estimate in 20 years for system No. 1 is 150 bushels per acre and for system No. 2, 170 bushels per acre.

Using the Shortcut Procedure for a 20 year evaluation period and an interest rate of 10 percent, calculate the average annual yield benefits from the installation of:

1. The BCS
2. ACS No. 1
3. ACS No. 2
4. The incremental benefits of ACS No. 2 over ACS No. 1

HINT: It is not necessary to calculate the average annual yield for each alternative to arrive at the average annual benefits. Simply calculate the future yield difference (yield in 20 years) of the alternatives being analyzed and multiply by the appropriate average annual reduction factor. It is also helpful to draw a sketch of each alternative.

Solution (Example 3) - Shortcut Procedure



1. Average annual benefits from the BCS:
   185 - 140 = 45; 45 x .33 = 14.85 bushels of corn per acre.

2. Average annual benefits from ACS No. 1:
   150 - 140 = .10; 10 x .33 = 3.30 bushels of corn per acre.

3. Average annual benefits from ACS No. 2:
   170 - 140 = 30: 30 x .33 = 9.90 bushels of corn per acre.

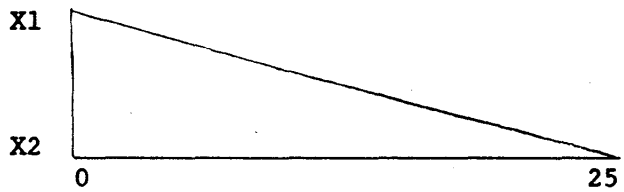
4. Incremental benefits of ACS No. 2 over ACS No. 1
   170 - 150 = 20: 20 x .33 = 6.60 bushels of corn per acre.

Appendix 1

Calculating Average Annual Reduction Factors

The average annual reduction factor is dependent on two variables; (1) the interest rate, and (2) the evaluation period. The factors are based on a one unit change in output. The units may express a measurement of value or yield; dollar, rupee, pound, mark, yen, bushel, lug, ton, pound, bale, hogshed, etc., and be used for any crop; corn, cotton, wheat, tobacco, soybeans, avocados, alfalfa, cranberries, etc.

The average annual reduction factor for a 25 year evaluation at 10 percent interest is calculated as follows:

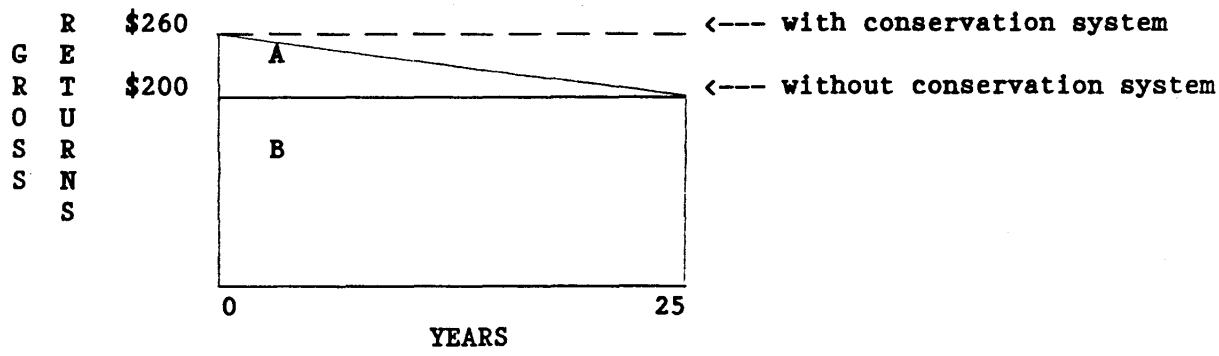


X1 - X2 = 1
1/25 = .04
.04 x 159.22960 (present value of a decreasing annuity for 25 years at 10%) = 6.37
6.37 x .11017 (amortization factor for 25 years at 10%) = .7017
1 - .7017 = .2983, rounded to .30

For every 1 unit decrease in output there will be a .30 unit average annual reduction in output. The .30 factor is true only when using a 25 year evaluation period and an interest rate of 10 percent.

Appendix 2

Solution (Example 1) - Traditional Procedure



A. Annual rate of decrease; 260 - 200 = 60, 60/25 = 2.4, 2.4 x 159.22960 (present value of decreasing annuity for 25 years at 10%) = 382.15. Present value of area A is $382.15.

B. 200 x 9.07704 (present value of an annuity of 1 per year for 25 years at 10%) = 1,815.41. Present value of area B is $1,815.41.

Total present value; $382.15 + $1,815.41 = $2,197.56. Average annual return without conservation system: 2,197.56 x .11017 (amortization factor for 25 years at 10%) = $242.11 (rounded to $242).

Average annual returns with conservation system	$260
Average annual returns without conservation system	$242
Average annual benefit	$18

The same $18 average annual benefit was obtained by using the shortcut method. This verifies that the shortcut method is valid.