CHAPTER 7

CHAPTER VII - EVALUATION TECHNIQUES

INTRODUCTION

This chapter contains a collection of various evaluation techniques and procedures. There is no particular order to this chapter so that you may easily add new material as it becomes available. This chapter contains evaluation techniques which will be helpful in integrating economics into your conservation planning activities.

When assisting a landuser in making conservation decisions it is important to recognize the reality of risk; price risk, interest rate risk, and climatic risk. While risk can not be eliminated, the landusers attitude towards risk and ability to accept risk will influence the evaluations and conservation decisions implemented.

If additional help is needed contact your state economist.

PROBLEMS - AVERAGE ANNUAL COST TABLE

DIRECTIONS: Calculate the Average Annual Cost for the following conservation practices. Use 13% interest rate. Round to the nearest $10.

1. Cover crop - What is the annual cost of flying on winter wheat for a cover crop at $20.00/acre for a 20 acre field?

2. Rock chute - A rock chute is installed to stop gully erosion. The cost of installation is $2500.00 - expected life is 20 years and 3% O&M cost. Calculate annual cost.

3. Grassed waterway with subsurface drinage. The total installation cost is $3,000.00. (Cost of waterway is $1,500.00 and cost of tile is $1,500) Expected life of waterway is 10 years and 3% O&M cost and expected life of tile is 25 years and 1% O&M cost. Calculate annual cost of total system.

4. Gradient terrace system - Installation cost - $7,000.00 - expected life is 15 years and 2% O&M. What is annual cost?

5. Water and sediment control basin system - Installation cost of system is $8,000.00 - expected life is 15 years and O&M is 4%. What is the annual cost?

6. Shaping for Critical Area Planting - Shaping of a critical area cost $3,200.00. Determine the annual cost assuming a life span of 20 years and 2% O&M.

7. Interseeding of a pasture (20 acres) with an appropriate grass-legume mixture is needed. It will cost $90.00/acre with an estimated 5 year life span and 5% annual maintenance cost. What is the annual cost of this operation.

8. A farmer would like a pond excavated at an estimated cost of $4,200.00. What will be the annual cost using an expected life of 25 years and 3% for O&M?

9. A diversion is installed at a cost of $4,000.00. What will be the annual cost of installing this measure with expected life span of 10 years and O&M of 4%?

10. A farmer wants to install a center pivot irrigation system at an estimated cost of $65,000.00 with a life span of 15 years and 10% O&M Cost. What will be the annual cost and cost/acre if the system irrigated 130 acres?

ANSWERS - AVERAGE ANNUAL COST TABLE

1. Cover crop - cost of $20.00/acre for 20 years

Answer: $20.00/acre x 20 acres = $400.00
$400.00 x 1.13 (Interest rate 13%) = $452.00 (round to $450)
$450.00 annual cost

2. Rock chute - Cost $2,500.00 - 20 years life - 3% O&M

Answer: $2,500.00 x .172 (.142 + .03) = $430.00

3. Waterway w/drain - Cost $3,000.00 (1,500.00 for waterway + 1,500.00 for subsurface drainage) Waterway - 10 year life - 3% L&M; subsurface drainage - 25 year life - 1% O&M

Answer: Grassed waterway -
$1,500.00 x .214 (.184 - .03) = $321.00 annual cost
Subsurface drainage -
$1,500.00 x .146 (.136 + .01) = $219.00 annual cost
Combined cost - waterway and subsurface drain
$321.00 - $219.00 = $540.00 annual cost

4 Gradient terrace system - Cost $7,000.00 - 15 year life - 2% O&M

Answer: $7,000.00 x .175 (.155 - .02) = $1225.00 annual cost

5. Water and sediment control basin system - Cost - $8,000 - 15 yr life - 4% O&M

Answer: $8,000.00 x .195 (.155 + .04) = $1560.00 annual cost

6. Critical Area Planting - Cost - $3,200.00 - 20 year life and 2% O&M

Answer: $3,200.00 x .162 (.142 + .02 = .162) = $518.40 (round to $520)

7. Interseeding a Pasture (20 acres) at a cost of $90/acre - 5 year life and 5% O&M

Answer: 20 acres x $90.00/acre = $1,800.00 x .334 (.284 + .05) = $601.20 (round to $600)

8. Excavate a pond at a cost of $4,200.00 with estimated 25 year life and 3% O&M

Answer: $4,200 x .166 (.136 + .03 = .166) = $697.20 (round to $700)

9. Diversion is installed at a cost of $4,000.00 - expected life 10 years - 4% O&M

Answer: $4,000 x .224 (.184 + .04 = .224) = $896.00 (round to $900)

10. A center pivot is installed at a cost of $65,000.00 life span of 15 years and 10% O&M

Answer: $65,000 x .255 (.155 + .10 = .255) = $16,575
cost per acre: $16,575 - 130 acres = $127.50/acre

Pasture Problem

Benefits from improved pasture conditions will eventually amount to $1,500 annually. It will take 5 years to reach this level of benefits. These benefits will then remain constant for the remainder of the 20-year evaluation period. Using a 10 percent interest rate, calculate the annual benefits.

Principles:

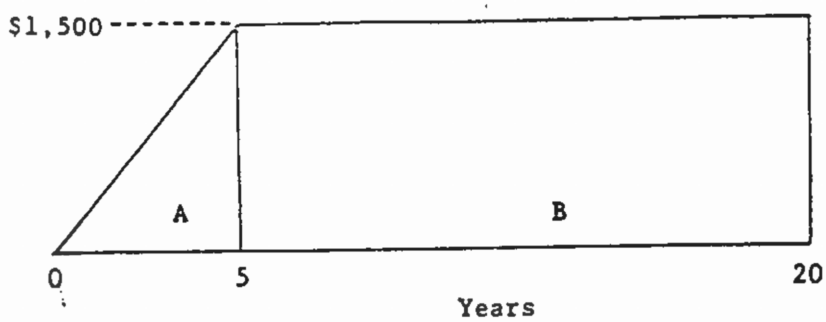
a. Present value of an increasing annuity. (This will tell us the capital value that will produce an annuity that increases from 0 to $1,500 in 5 years, or $300 annually).

b. Present value of an annuity of 1 per year. (This will tell us the capital value that will produce a constant annuity of $1,500 annually for 15 years from the 5th to 20th year.)

c. Present value of 1. (Discount--the present value which will produce the constant annuity is not worth as much now as in 5 years so this is brought back to present value.)

d. Amortization.

Solution:



a. $300 x 10.65259[1] = $3,196 (present capital value of A)

b. $1,500 x 7.60608[2] = $11,409

c. $11,409 x 0.62092[3] = $7,084 (present capital value of B)

$3,196 + $7,084 = $10,280 (total present capital value of all benefits)

d. $10,280 x 0.11746[4] = $1,207 (annual benefits)

1 Present value of an increasing annuity 5 years.

2 Present value of an annuity of 1 per year for 15 years.

3 Present value of 1-5 years hence.

4 Amortization factor for 20 years @ 10 percent interest.

PROFESSIONAL KNOWLEDGE

Understanding the Inflation Index

The value of the dollar is constantly changing. The primary reason for this, in our time, is inflation. Although economists might like to be more technical about it, inflation can be generally described as what happens when the volume of money and credit in an economy increases faster than the supply of goods, driving up the price of the goods that are available for purchase. Even though there is more money, in other words, everything costs more too, so nobody really gets ahead. Or do they?

The answer to *that* depends on whether increases in income (and expense) keep pace with the rate of inflation, exceed it, or trail along behind it. And the calculation of those relative increases has been complicated enough—until recently—to confuse and discourage nearly everyone who isn't a trained economist or accountant.

Now, however, there is a much simpler way to calculate the impact of inflation during the last twenty years. Martin Lefkowitz, Director of Special Projects for the National Chamber Foundation, has developed an inflation factor formula for the years between 1966 and 1988 that makes it easy to compare costs or income in equal dollars throughout that period. This formula, expressed in the Inflation Index Table (Figure 1), can be used to make reliable comparisons between dollar figures in any of the years covered.

For instance, using the following table and your own expense records, you can compute whether the price of office supplies is going up faster or more slowly than the rate of inflation. Or, if you like, apply the multipliers to your own salary. You will probably be pleased to discover that your salary increases have outpaced inflation. In recent years, national surveys have shown that support staff salaries generally have risen faster than inflation.

How to use the table: If you paid $5.00 for a box of a certain type of stationery in 1977, multiply $5.00 times 1.95 (the multiplier for 1977 prices) to find our what the equivalent price would have been in 1988 You will find that a 1988 price of $9.75 was equal to the $5.00 price in 1977. Between 1977 and 1988, that is, inflation added $4.75 to the cost of your stationery If you can buy the stationery for less than $9.75, therefore, the cost has actually come down since 1977. you have to pay more than $9.75, on the other hand, the price has increased faster than inflation—the cost of the stationery has truly gone up.

Or suppose you want to apply the numbers in the table to your own paycheck. If your entry level position in 1982 paid $4.50 an hour, the same position today—if paid on the same basis—would pay $5.49 an hour Any additional pay you are receiving is due to advancement, not inflation. Similarly, if an executive secretary in your firm earned $21,000 in 1980, the same position might be expected to pay $30,030 today. As you can see, this type of inflation-factor analysis quickly reveals real increases in income.

To get a sense of how your costs have grown over the years, apply the figures in this table to your expense records. Although complaints about increases in the cost of living are often justified, consumers and homeowners sometimes object to rising food price and property taxes without considering the impact on inflation. Some prices that seem high may actually have come down.

The changing value of the dollar influences every financial transaction and every working American. Find out where you really stand—apply the multipliers to the figures that affect your office and your own finance. The more you know about business and economics, the more valuable you will be to your employer and the more knowledge you can bring to bear on your personal decision making.

Inflation Index Table

YEAR	MULTIPLIER	YEAR	MULTIPLIER	YEAR	MULTIPLIER
1966	3.64	1974	2.40	1982	1.22
1967	3.54	1975	2.20	1983	1.19
1968	3.40	1976	2.08	1984	1.14
1969	3.22	1977	1.95	1985	1.10
1970	3.04	1978	1.81	1986	1.08
1971	2.92	1979	1.63	1987	1.04
1972	2.82	1980	1.43	1988	1.00
1973	2.66	1981	1.30		

ECONOMICS OF SOIL AND WATER CONSERVATION

"Amortization"

A farmer is considering a terrace system costing $3,000. The terrace system will permit him to use his land more intensively. Cost-return budgets indicate he can increase his net returns, excluding the cost of the terraces, by $600 annually. He can obtain a loan for 10 years at 10 percent interest. He wants to evaluate the feasibility of installing the terrace system.

Principles:

1. Number of years hence. (This is the period of evaluation - 10 years.)

2. Amortization. (Convert a capital cost to annual cost of equal payments over time.)

Solution:

$3,000 x .16275 (amortization factor, 10 years at 10 percent) = $488.25

Annual benefits	=	$600.00
Annual cost	=	488.25
Net benefits	=	$111.75

In addition to the cost of installing the terrace system, it will require $60 annually to properly maintain them over their expected life. Is the system still feasible?

Annual installation cost	=	$488.25
Annual O&M cost	=	60.00
Total annual cost	=	$548.25
Annual benefits	=	$600.00
Total annual cost	=	548.25
Net benefits	=	$ 51.75

BREAKEVEN ANALYSIS

BACKGROUND - Breakeven analysis provides useful information in a variety of conservation situations. It will determine how much of an investment can be made based on the expected returns. Consider the following questions: (1) How much can I afford to spend? (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? All four questions are "breakeven" questions.

TOOLS NEEDED - Each of the questions involve an unknown variable, i.e. (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.

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

1. Cost - Cost of applying the conservation
2. Time - System life, loan period, etc.
3. Interest rate - Producers' borrowing or savings interest rate.
4. Change in yield or net return - Resulting from applying conservation.

Breakeven Problems and Their Solutions

An opportunity exists to develop a water source (spring) and improve grazing distribution. This will allow the harvest of 30 AUMS in an area where only 10 are harvested at present.

Example 1: (Breakeven Cost)
How much can the cooperator afford to spend (capital cost) for the stockwater development if the life is 20 years, the interest rate is 12% and an AUM is valued at $7?

Solution: 20 AUMS (change in yield) x $7 per AUM = $140. $140 x 7.46944 (p.v. of annuity of 1 per year, 20 yr, 12%) = $1,045.72. The cooperator's breakeven point is a capital cost of $1,045.72. At any cost below the breakeven point the cooperator will profit from stockwater development.

Example 2: (Breakeven time)
What is the period of capital recovery or minimum life expectancy for the proposal if the capital cost is $1,000, an 8% interest rate is used, and the value of the change in AUMs produced is $120 per year.

Solution: $1,000 (Capital Cost) / 120 = 8.333. Using the 8% compound interest and annuity table, read down the column labeled PV of an annuity of 1 per year until a factor close to 8.333 is found. Then read left to No. of years hence column. The factor of 8.333 occurs between 14 and 15 years. Conclusion is that the period of capital recovery, or breakeven time is about 15 years.

Example 3: (Breakeven interest rate)
What is the breakeven interest rate or internal rate of return when capital cost is $1,000, effects are evaluated over a 20 year time period and the value of the change in AUMs produced is $180 per year.

Solution: The PV of an annuity of 1 per year factor for the breakeven interest rate is $1,000/180 = 5.555. Reading across interest tables we find that the PV of an Annuity of 1 per year factor for 20 years at 16% = 5.92884, 17% = 5.62777, and 18% = 5.35275. Since the factor for 17% is closest to but not less than the breakeven factor of 5.55556 we conclude that the breakeven interest rate is slightly greater than 17%.

Example 4: (Breakeven value)
What must an AUM be worth to break even when capital cost is $1,400, evaluation is 20 years, and benefits are discounted at 11%?

Solution: $1.400 x .12558 (amortization factor, 20 years, 11%) = $175.81. 175.81/20 = $8.79 per AUM.
Given the level of the other variables an AUM must be worth $8.79 to break even.

Note: Farmers may not adopt practices at breakeven levels because of risk and other factors.

WORKSHEET

BREAKEVEN COST?

__________ x __________ x __________ = $ __________

(change in yield) (value of yield/unit) (proper annuity factor, given years & interest rate) (breakeven cost)

At any cost lower than $__________ (breakeven cost) plus cost sharing, the producer will profit from the conservation investment.

BREAKEVEN TIME?

$__________ / $__________ = __________

(conservation cost, after cost sharing) (value of change in yield) (calculated annuity factor)

Using the appropriate 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.

BREAKEVEN INTEREST RATE?

$__________ / $__________ = __________

(conservation cost, after cost sharing) (value of change in yield) (calculated annuity factor)

Using the appropriate 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.

BREAKEVEN VALUE?

$__________ x __________ / __________ = $ __________

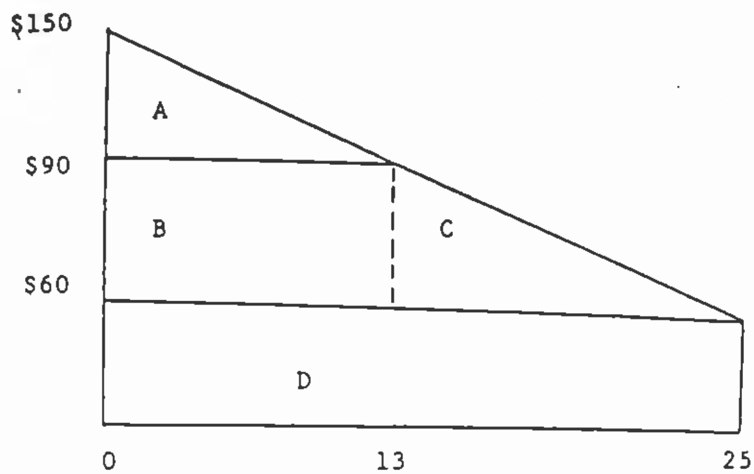
(conservation cost, after cost sharing) (amortization factor for given years and interest rate) (change in yield, i.e., 30 bushels, 20 AUMs, etc.) (breakeven value per unit of yield)

SOIL RESOURCE DETERIORATION ANALYSIS

Without condition--continuous corn, conventional tillage, current yield, 130 bu. per acre, current net return = 150 per acre

20T soil loss, at this rate of erosion, the yield will drop to 110 bu. in 13 years and the net income will drop to $90 per acre.

This would be a soil loss of 260 ton or 1.73 inches. From year 13 to 25, the yield will drop to 90 bu. and the net income will drop to $60 per acre. This will be an additional loss of 240 tons or 1.6 inches.



Average annual net return--future without (F/WO) condition

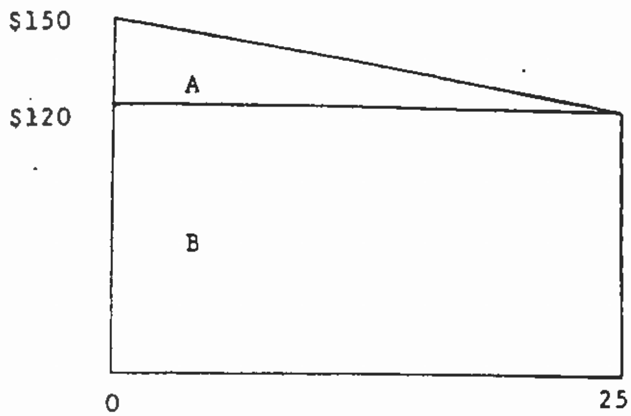
A:	150-90=60÷13= 4.62x58.96644 =	$272.42(PV)
B:	90-60=30x7.10336=	213.10(PV)
C:	90-60=30÷12=2.50x51.86308=	
	129.66x.28966=	37.56(PV)
D:	60x9.07704=	544.62(PV)

Total present value $1,067.70

Average annual net return (.11017) = $117.63 per acre

With condition, chisel till--continuous corn, yield, 130 bu. per acre, current net return = $150 per acre

10 ton soil loss, at this rate of erosion the yield will decrease to 115 bu. per acre in 25 years and net income will decrease to $120 per acre.



Average annual net return--future with (F/W)

A: 150-120=30÷25=1.20x159.22960 = $191.08(PV)
B: 120x9.07704= 1,089.24(PV)

Total present value	$1,280.32
Average annual net return (.11017)	$141.05

(F/W) Average annual net return per acre with chisel till	$141
(F/WO) Average annual net return per acre, conventional till	118
Net benefits per acre =	$ 23

NOTE: 10% interest rate
Soil density, 150 ton/in.
25 year evaluation

ECONOMICS OF SOIL AND WATER CONSERVATION

"Amortization"

A cooperator desires to build a farm pond to store water for livestock. The fill will require 6,700 cu yd of earth. Current cost for earth work is $0.62 per cu yd. Ninety-five feet of corrugated metal pipe at $11.30 per lineal foot (installed) is also required.

1. What is the installation cost of the dam?

   6,700 cu ft x $0.62 = $4,150
   95 ft x $11.30 = 1,075
   Installation cost = $5,225

2. If the cooperator borrows money at 9 percent and the expected life of the dam is 25 years, what is the annual installation cost?

   $5,225 x .10181 (25 yr @ 9%)
   Annual installation cost = $532

3. Annual O&M is estimated to be 2 percent of the installation cost. What is the total estimate of annual costs?

   $5,225 x .02 = $105
   Amortized cost = 532
   Total annual cost = $637

4. If the cooperator receives 60 percent ACP cost sharing on the dam, how does this affect the estimate of annual costs to the farmer?

   $532 x .40 (100%-60%) = $213
   O&M = 105
   Revised annual cost to farmer = $318
   (Reduces his costs by $319 per year)

MIDWEST
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TECHNICAL NOTE

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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.

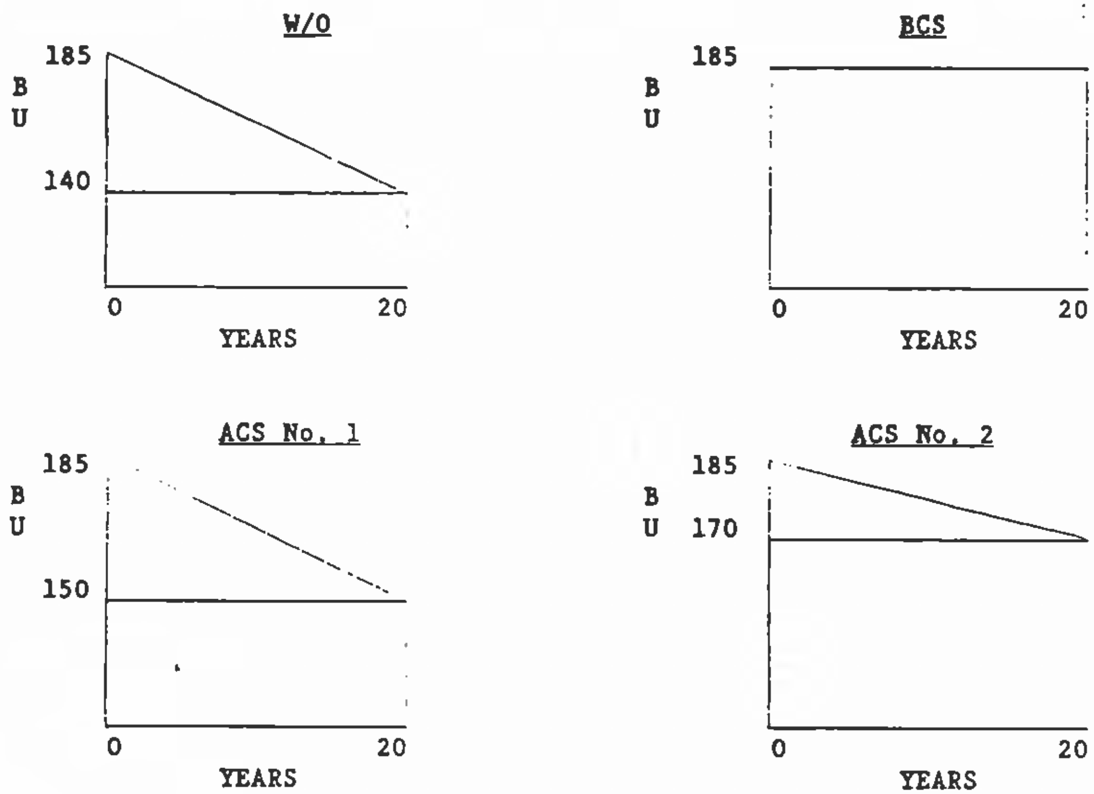
The rate of soil depletion can be slowed with the installation of alternative conservation systems (ACS's) No. 1 or No. 2. The yield estimate in 20 years for system No. 1 is 150 bushels per acre and for system No. 2, 170 bushels per acre.

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.

<u>Solution (Example 3) - Shortcut Procedure</u>



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

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

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

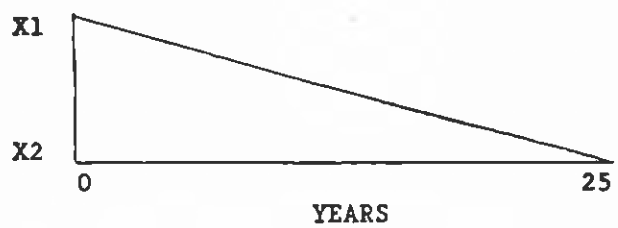
4. Incremental benefits of ACS No. 2 over ACS No. 1
   170 - 150 = 20: 20 x .33 = <u>6.60</u> bushels of corn per acre.

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:

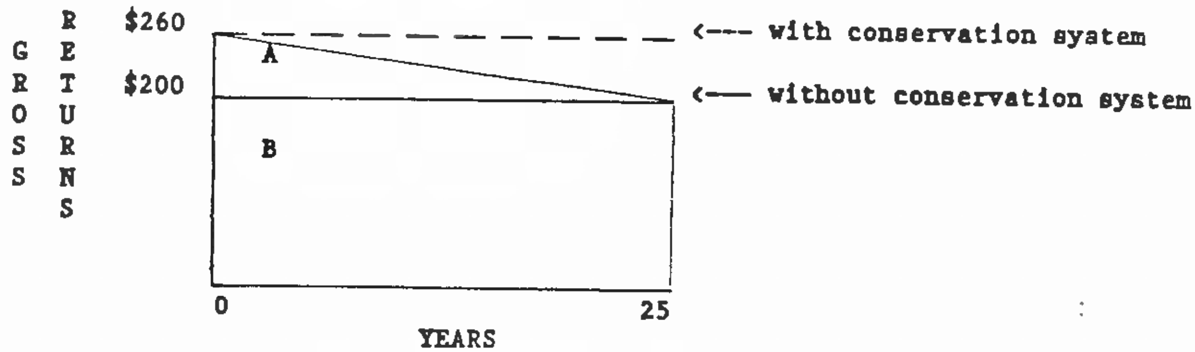


X1 - X2 = 1
1/25 = .04
.04 x 159.22960 (present value of a decreasing annuity for 25 years at 10%) = 6.37
6.37 x .11017 (amortization factor for 25 years at 10%) = .7017
1 - .7017 = .2983, rounded to .30

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.

Problems

You have $10,670 in your IRA, you want to take out $2,000 per year. Your funds are earning 10 percent interest. How long will your funds last?

$2,000 ÷ $10,670 = .18744

In the 10 percent table look down the amortization column until you find .18744 and go to the left column and read off the number and years. In this case the funds will last 8 years.

Proof

Start With	One Year Later With 10% interest	End of Year	Annual Withdrawal	Balance
$10,670	$11,737	1	$2,000	$9,737
9,737	10,711	2	2,000	8,711
8,711	9,582	3	2,000	7,582
7,582	8,340	4	2,000	6,340
6,340	6,974	5	2,000	4,974
4,974	5,471	6	2,000	3,471
3,471	3,818	7	2,000	1,818
1,818	2,000	8	2,000	0

At 7 percent interest how long would the funds last? Between 6 and 7 years.
At 15 percent interest how long would the funds last? Between 11 and 12 years.

If your IRA had $85,537 and with a 10 percent return and an annual withdrawal of $12,000, how long will the funds last? $12,000 ÷ 85,537 = .14029, from the tables, between 13 and 14 years.

If $8,000 taken out annually how long will it last? $8,000 ÷ 85,537 = .09353, from the tables, it would last forever and then some!

How much could be taken out annually and never touch the principal? $8,553.70

COMPOUND INTEREST AND ANNUITY TABLES FOR
10.0000 PERCENT

NO. OF YRS. HENCE	PRESENT VALUE OF 1	AMORTI-ZATION	PRESENT VALUE OF AN ANNUITY OF 1 PER YEAR	AMOUNT OF AN ANNUITY OF 1 PER YEAR	PRESENT VALUE OF AN INCREASING ANNUITY	PRESENT VALUE OF A DECREASING ANNUITY
1	.90909	1.10000	.90909	1.00000	.90909	.90909
2	.82645	.57619	1.73554	2.10000	2.56198	2.64463
3	.75131	.40211	2.48685	3.31000	4.81593	5.13148
4	.68301	.31547	3.16987	4.64100	7.54798	8.30135
5	.62092	.26380	3.79079	6.10510	10.65259	12.09213
6	.56447	.22961	4.35526	7.71561	14.03943	16.44739
7	.51316	.20541	4.86842	9.48717	17.63154	21.31581
8	.46651	.18744	5.33493	11.43589	21.36360	26.65074
9	.42410	.17364	5.75902	13.57948	25.18048	32.40976
10	.38554	.16275	6.14457	15.93742	29.03591	38.55433
11	.35049	.15396	6.49506	18.53117	32.89134	45.04939
12	.31863	.14676	6.81369	21.38428	36.71491	51.86308
13	.28966	.14078	7.10336	24.52271	40.48055	58.96644
14	.26333	.13575	7.36669	27.97498	44.16719	66.33313
15	.23939	.13147	7.60608	31.77248	47.75807	73.93920
16	.21763	.12782	7.82371	35.94973	51.24013	81.76291
17	.19784	.12466	8.02155	40.54470	54.60349	89.78447
18	.17986	.12193	8.20141	45.59917	57.84095	97.98588
19	.16351	.11955	8.36492	51.15909	60.94760	106.35080
20	.14864	.11746	8.51356	57.27500	63.92048	114.86436
21	.13513	.11562	8.64869	64.00250	66.75822	123.51306
22	.12285	.11401	8.77154	71.40275	69.46083	132.28460
23	.11168	.11257	8.88322	79.54302	72.02943	141.16782
24	.10153	.11130	8.98474	88.49733	74.46604	150.15256
25	.09230	.11017	9.07704	98.34706	76.77344	159.22960
26	.08391	.10916	9.16095	109.18177	78.95498	168.39055
27	.07628	.10826	9.23722	121.09994	81.01448	177.62777
28	.06934	.10745	9.30657	134.20994	82.95609	186.93433
29	.06304	.10673	9.36961	148.63093	84.78424	196.30394
30	.05731	.10608	9.42691	164.49402	86.50349	205.73086
31	.05210	.10550	9.47901	181.94342	88.11855	215.20987
32	.04736	.10497	9.52638	201.13777	89.63415	224.73624
33	.04306	.10450	9.56943	222.25154	91.05502	234.30568
34	.03914	.10407	9.60857	245.47670	92.38587	243.91425
35	.03558	.10369	9.64416	271.02437	93.63131	253.55841
36	.03235	.10334	9.67651	299.12681	94.79588	263.23492
37	.02941	.10303	9.70592	330.03949	95.88399	272.94083
38	.02673	.10275	9.73265	364.04343	96.89992	282.67349
39	.02430	.10249	9.75696	401.44778	97.84779	292.43044
40	.02209	.10226	9.77905	442.59256	98.73159	302.20949
41	.02009	.10205	9.79914	487.85181	99.55512	312.00863
42	.01826	.10186	9.81740	537.63699	100.32206	321.82603
43	.01660	.10169	9.83400	592.40069	101.03587	331.66002
44	.01509	.10153	9.84909	652.64076	101.69988	341.50911
45	.01372	.10139	9.86281	718.90484	102.31724	351.37192
46	.01247	.10126	9.87528	791.79532	102.89095	361.24720
47	.01134	.10115	9.88662	871.97485	103.42385	371.13382
48	.01031	.10104	9.89693	960.17234	103.91861	381.03074
49	.00937	.10095	9.90630	1057.18957	104.37776	390.93704
50	.00852	.10086	9.91481	1163.90853	104.80368	400.85186

IRA - PROBLEMS

Use 10 percent interest factors

1. HOW MUCH WILL ACCUMULATE?
   $2,000 invested each year for 20 years

2. HOW LONG WILL ____________* LAST?
   Withdraw $16,000 a year

3. HOW LONG TO ACCUMULATE ____________* IF $2,000 INVESTED ANNUALLY?

4. HOW MUCH TO SAVE EACH YEAR FOR 20 YEARS TO ACCUMULATE ____________* IN 20 YEARS?

* Insert in this space the answer calculated in part 1.

IRA - SOLUTIONS

Use 10 percent interest factors

1. HOW MUCH WILL ACCUMULATE?
   $2,000 invested each year for 20 years

   A. $2,000 x 57.27500 (amount of an annuity of 1 per year) = $114,550

2. HOW LONG WILL ($114,550)* LAST?
   Withdraw $16,000 a year

   A. $16,000 / $114,550 = .139677
   Look in the amortization column for .139677 and read across the line to the number of years hence. In this case the funds will last between 13 - 14 years.

3. HOW LONG TO ACCUMULATE ($114,550)* IF $2,000 INVESTED ANNUALLY?

   A. $114,550 / $2,000 = 57.27500
   Look in the amount of an annuity of 1 per year column until you find 57.27500 and read across the line to the number of years hence, in this case it will take 20 years to reach your goal.

4. HOW MUCH TO SAVE EACH YEAR FOR 20 YEARS TO ACCUMULATE ($114,550)* IN 20 YEARS?

   A. $114,550 / 57.27500 (amount of an annuity of 1 per year) = $2,000.

* Insert in this space the answer calculated in part 1.

MIDWEST
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CENTER

TECHNICAL NOTE

Subject: ECN - ECONOMICS

Series No.: 200-LI-5

Reference: THE ECONOMICS OF NUTRIENT AND PEST MANAGEMENT

Date: JULY 1990

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SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE

THE ECONOMICS OF NUTRIENT AND PESTICIDE MANAGEMENT

INTRODUCTION

Background

In the Soil Conservation Service, economics can play a major role in implementing our Nutrient Management and Pest Management standards. Economic principles and tools can be used together with other tools such as soil testing, nutrient source analysis, water budgets, leaching indices, site vulnerability assessments and pesticide solubility ratings, etc., to develop specific nutrient management plans or pest management plans. That is indeed fortunate as farmers and ranchers will need to rely more and more on economic principles and methodologies to help them make chemical application decisions. This paper is meant to serve as a catalyst towards more involvement by SCS economists in this area.

The two main principles examined here include optimization and economic thresholds. Specifically, this paper will explain the "what" and "how" of fertilizer optimization and economic thresholds in herbicide and insecticide application. It is hoped that from the methods described in this paper, a basis for technology transfer to the field can be established. With simple "spreadsheet" automation, these techniques can be made even more useful.

Optimization

Optimization is a term that can relate to various production situations. However, in the context of nutrient management, optimization means adding fertilizer up to the point where it no longer pays to do so. Why does it no longer pay? Because the income from the increase in yield caused by the last unit of fertilizer does not cover the cost of that fertilizer. It is as simple as that. However, the concept of optimization is sometimes ignored.

Economic Threshold

Farmers and ranchers must make decisions about pesticide application. Weeds and insects can cause injury to a crop. A little injury may be acceptable if it does not significantly affect profits. However, if injuries worsen, decisions about using pesticides must be made. The key becomes whether or not the cost of treating the crop problem is less than the cost of the problem itself.

The point at which an input starts to pay for itself is called the "economic threshold." This paper will discuss methods to estimate the economic threshold for two agricultural inputs, herbicide and insecticide.

NUTRIENT MANAGEMENT

Fertilizer Recommendations

Soil testing is being used more and more as a benchmark in fertilizer recommendations. A yield goal or "target yield" sometimes supplied by the farmer, is compared to the soil test benchmark to estimate fertilizer needs. This is superior to previous "trial and error" fertilization and new, more accurate soil testing methods are being developed all the time. However, if the estimated target yield is too high, over application will result and the crop will not be able to utilize all the available nutrients, leaving them as potential pollutants.

Hallberg (1986) reports that half of all farmers in Iowa and Nebraska over fertilize by 20 to 25 percent. In the Pacific Northwest, winter wheat in many locations shows little response to additional nitrogen because of previous over-fertilization (Papendick, et al, 1984). Another study shows that irrigated corn producers over-apply nitrogen at an average rate of 78 lbs/ac. (Schepus, 1982).

In addition to potential environmental problems, over-fertilization leads to loss of profit. Some farmers are applying fertilizer at a rate that simply does not pay. Why? They have not incorporated economics into their nutrient management decisions. Their equation does not include yield response, the price of fertilizer, nor the price of their crop. In fact, we in SCS have not included yield response sufficiently into our standards and assistance. Prices of fertilizer and crops are not considered at all. We flatly do not consider optimization in our nutrient management technical assistance.

As Iowa Attorney General Tom Miller explained at the Midwest Soil Testing Conference held in Des Moines last fall, "If fertilizers were applied only in the best economic interests of farmers, then the environmental problems would probably be eliminated."

Fertilizer Optimization

So how does one incorporate the principle of optimization? By developing a way to incorporate economics into the target yield estimation. Most noneconomists recommend a three- to five-year historical average. This is a good first step but can be improved upon by applying some simple economic logic, a few prices, and yield response data from the Extension Service - - - all readily available:

Data needed	Source
Target yield (3-5 year average)	Farmer's records
Yield response	Extension Service
Fertilizer price	Fertilizer Dealer
Crop price	
Realistic estimate	Hedged Price
Conservative estimate	Target Price

With this data, the following table can be filled out by hand, automated quite quickly in a spreadsheet, or compiled in an executable form. The result of the process is a "revised target yield," one which incorporates economics, specifically optimization, Table 1.

Table 1. Calculating A Revised Target Yield

Fertilizer (N in lbs.) (Price = $.25/lb.)	Crop Yield (corn in bu.) (Price = $1.80/bu.)	Change in Cost ($)	Change in Return ($)	Net Change ($)
50	70	-	-	-
75	95	6.25	27.00	20.75
100	105	6.25	18.00	11.75
125	113 (Revised Target Yield)	6.25	14.40	8.15
150	116	6.25	5.40	-.85
175	118	6.25	3.60	-2.65
200	119	6.25	1.80	-4.45
225	120 (3-year Target Yield)	6.25	1.80	-4.45

If the farmer had used the three-year average target yield, he would have over-applied by 100 pounds causing increased hazard to the environment as well as lost profit. In fact, the over-application cost the farmer $12.40/ac which is the sum of the negative net change between the three-year average target yield and the revised target yield.

HERBICIDE THRESHOLD

What Is It?

The herbicide threshold is the point where weed density is high enough, that herbicide control costs equal the cost of the lost yield due to the weeds. That is, the point where applying herbicide is economically justified. If herbicide is applied on a field where the threshold is not reached, profits are lost. For example, if the lost yield due to weeds is $12 per acre, herbicide costs are $18 per acre, and herbicide is applied; $6 per acre lost profit results.

How Is It Calculated?

The following is one method to estimate the need to apply herbicide, (herbicide threshold), in corn or soybeans. Similar methods are available for small grain crops as well. To estimate, use the following steps:

1. Determine the expected yield.

2. Determine the crop price.

3. Determine densities of weeds by species and expected yield loss.

    a. Count weeds in 100 feet of row.

    b. Use following table to determine weed density and expected yield loss.

Economic Thresholds for Weeds

WEED	% corn yield loss						% soybean yield loss					
	1	2	4	6	8	10	1	2	4	6	8	10
	----------number of weed clumps per 100 feet of row----------											
Cocklebur	4	8	16	28	34	40	1	2	4	6	8	10
Giant ragweed	4	8	16	28	34	40	1	2	4	6	8	10
Pigweed	12	25	50	100	125	150	2	4	6	10	15	20
Lambsquarters	12	25	50	100	125	150	2	4	6	10	15	20
Velvetleaf	--	--	--	---	---	---	8	16	24	32	40	50
Morningglory	--	--	--	---	---	---	8	16	24	32	40	50
Jimsonweed	--	--	--	---	---	---	8	16	24	32	40	50
Smartweed	--	--	--	---	---	---	8	16	24	32	40	50
Giant foxtail*	10	20	50	100	150	200	5	10	17	25	32	44
Shattercane**	6	12	25	50	75	100	2	5	8	11	14	18
Volunteer corn	--	--	--	---	---	---	1	2	3	4	5	6

*5 to 8 stems per clump **2 to 3 stems per clump
Source.--University of Illinois - Field Crop Scouting Manual, 1990

4. Add up the percentage of yield loss for all weeds and multiply by the expected yield to get yield loss in bushels per acre.

5. Multiply bushels per acre yield loss times expected price.

This results in the expected dollar damage caused by weeds which can be compare to the cost of treatment. If the damage is higher than the cost of treatment, the herbicide threshold has been reached and application is economically justified. If not, profits will be higher if herbicide is not applied at this time.

Example: A soybean field has an average of six giant ragweed, 24 velvetleaf, and 10 giant foxtail clumps per 100 feet of row. According to the chart, yield losses for the weeds are 6 percent, 4 percent, and 2 percent, respectively, making total yield loss 12 percent. If the expected yield is 40 bushels per acre and beans are valued at $5 per bushel, the yield loss would be 4.8 bushel or $24 per acre. If the cost of treatment is $26 per acre, the net gain of treatment would be -$2 per acre. In this case, treatment would not be economically justified.

INSECTICIDE THRESHOLD

What Is It?*

Consistent with the herbicide threshold definition, the insecticide threshold is the point where insect density is high enough that insecticide control costs equal the cost of lost yield due to the insects.

*Integrated pest management (IPM) is one approach to lessen the application of insecticides through use of scouting and other monitoring techniques to more accurately estimate the insect problem. In fact, IPM was one of the first developments to popularize the use of economic threshold as an efficiency tool.

How Is It Calculated?

Insect scouting methods vary, but normally information is needed on many of the same factors as with weed scouting. Using the European Corn Borer as an example, the following steps are taken to determine the need for insecticide:

1. Determine the expected yield.

2. Determine the crop price.

3. Determine density of borers.

 a. Sample 25 plants in each of four locations counting the number of corn borers per stalk (borers are found in whorls on the stalk).

 b. Divide this number by 100 to get an average number of borers per stalk.

 c. Multiply the number of borers per stalk by 5 (percent damage caused by one borer per stalk) to get percent of yield damage to the crop.

4. Multiply crop price x expected yield x .75 x percent yield damage to get the dollar damage to the corn per acre from corn borers (75 percent control is assumed with corn borer insecticides).

If this amount is more than the cost of treatment, treatment is economically justified.

Example: An average of one borer cavity per plant is capable of causing an approximate 5 percent yield loss. In the example shown, from scouting you know that there are 2 worms per plant. Assume 75 percent control and $1.75 per bushel with a yield expectation of 125 bushels per acre.

	Example Field	Your Estimates
1. Yield potential for this field.	125 Bu/A	______ Bu/A
2. Potential yield loss (2 larvae/plant x 5% = 10% loss in yield, 10% x 125 Bu = 12.5 Bu loss/A).	12.5 Bu/A	______ Bu/A
3. Dollar loss/A (12.5 Bu/A x $1.75 per Bu = $21.87 loss/A).	$ 21.87	$ ______
4. Preventable loss (if chemical is 75% effective $21.87 x 75% = $16.41/A).	$ 16.41	$ ______
5. Chemical ($8.00/A) and application cost ($4.00/A). (Estimate your own cost or call dealer/applicator.) TOTAL = $12/A.	$ 12.00	$ ______

6. Compare preventable loss ($16.41/A) with treatment cost ($12.00): $16.41/A - $12.00/A = $4.41/A (dollars saved by treatment/A). $ 4.41 $________

Source: Nebraska Cooperative Extension Service, 1989

In this case, the net gain from treatment would be $4.41 per acre and treatment would be economically justified.

SUMMARY

In order for farmers/ranchers to adequately analyze the nutrient and pesticide application decisions of today, they must understand the economic and environmental implications. This Technical Note discusses techniques that consider economics, which if adopted by overappliers, would go a long way in solving the negative environmental implications as well.

For we in SCS, the need to understand and be able to relate the economic implications of nutrient and pesticide management would be very complimentary to our environmental technical assistance. The use of the optimization concept for nutrient management and the concept of economic thresholds in pesticide management would increase our credibility at the field level.

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