United States
Department of
Agriculture

**Natural
Resources
Conservation
Service**

Part 610 National Resources Economics Handbook

Part 610 Conservation Planning

Issued draft June 2001

Acknowledgments

This update of the Conservation Planning Handbook for Economics was prepared under the direction of Peter Smith, director, Renna Young Owens, economist of the Resource Economics and Social Services Division, Natural Resources Conservation Service. Karen Robinson provided excellent administrative support. Suzi Self of the National Production Services Center is commended for editing and formatting.

This document has been under revision since 1987. Therefore, numerous NRCS agricultural economists and others have made major contributions to this handbook. The following economists provided extraordinary review and comments of the draft:

Larry Edmunds, Salt Lake City, Utah
James Featherson, Temple, Texas
June Grabemeyer, East Lansing, Michigan
Aaron Hinkston, Alexandra, Louisiana
B. Ted Kuntz, Stillwater, OK
JoDean Nichols, Bismarck, North Dakota
Florence Swartz, Syracuse, New York
Letitia Toomer, Richmond, Virginia

Editing and formatting were completed by Mary Mattinson and Suzi Self of the National Production Services Center, Fort Worth, TX.

Part 610
National Economics Handbook

Contents

610.0102 Benefits of conservation **1–3**
(a) Onsite benefits 1–3
(b) Offsite benefits 1–4

Figures

Tables

Examples

Chapter 1 Benefit and Costs

Contents

Chapter 1 Benefits and Costs

610.0100 Introduction

(a) Purpose and scope

This chapter addresses the purpose and policy of carrying out the mission of NRCS with respect to economics for conservation planning. The purpose of this handbook is to document the use of economic tools and integrate economics into conservation planning. It provides guidance in identifying onsite and offsite benefits, costs of conservation, and how economics can fit into and influence the planning process.

As consumers, we weigh the benefits and costs of our decisions. Aspects that cannot be measured in dollars influence many of those decisions. However, most often we try to compare the benefits of a purchase or investment to its costs. For example, someone considering the purchase of a computer to help manage their business might compare the benefits of a more organized and efficient business to the cost of time required to learn how to use a computer system and incorporate business records.

Decisionmaking for the landowner in farming or ranching is the same as any other decisionmaking. Once a problem is identified, physical and monetary effects of alternatives can be compared. One of the landowners many concerns is whether potential benefits from installing new conservation measures would outweigh the costs.

(b) Conservation effects for decisionmaking

When assisting a landowner, the important effects, which are the basis for the decisionmaking process must be discerned. The Conservation Effects for Decisionmaking (CED) framework (chapter 5) provides general background information on how to organize concerns, effects, and other information to assist the landowner in making conservation decisions. The CED workbook provides a comprehensive training program for those individuals who wish to use the framework to help make effective conservation plans with the landowner.

610.0101 Economics and the planning process

(a) Objectives

The Natural Resources Conservation Service (NRCS) National Planning Procedures Handbook (NPPH) is used by NRCS to assist people in making informed decisions in the wise use and conservation of resources. The key is involving the landowner in the planning process. NRCS helps landowners to achieve both their objectives and those of society for sustained use of soil, water, air, plant, and animal resources (fig. 1–1). NRCS uses a planning and implementation process to:

- help landowners understand their resources and resource management needs, potentials, and problems;
- identify alternative solutions to these problems;
- determine effects of alternative solutions, including comparison of effects expected if the problems remain untreated;
- choose alternative solutions that are consistent with the landowner's objectives; and
- implement and maintain feasible solutions as rapidly as is practical.

(b) The nine step planning process

NRCS uses a three-phase, nine-step planning process that leads to implementation. This process is used in all instances where assistance is provided to landowners (client and landowner are interchangeable throughout this handbook) regardless of the expected outcome or scope of the planning effort, the type of conservation treatments involved, or the source of funding to be used for implementation. While the nine steps are shown in sequence, the process is very dynamic.

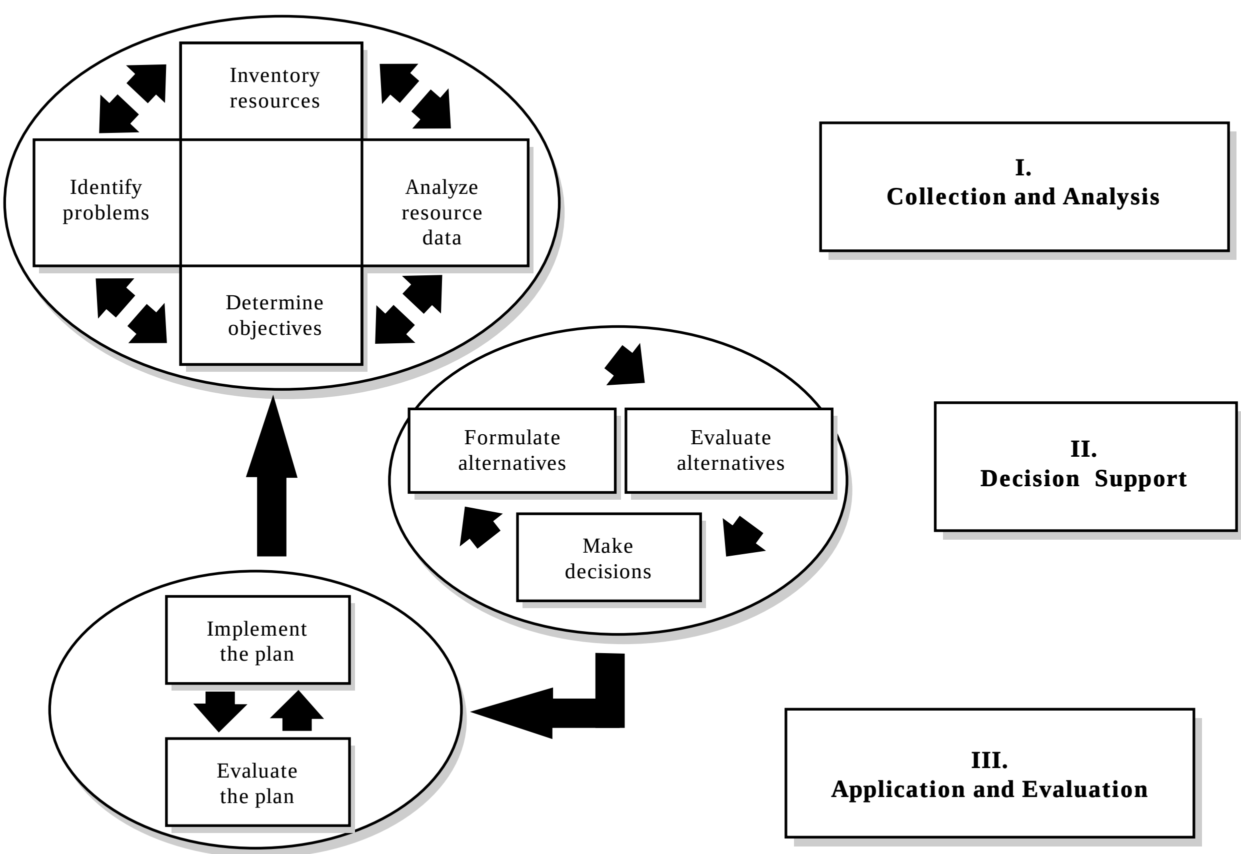
The degree of detail used in the planning process varies with the type, method, and scope of assistance; the complexity of the planning situation; and the recipient. Using the process creates a consistent method nationwide. The steps are:

Step 1 Identify problems and opportunities
Step 2 Determine objectives
Step 3 Inventory resources
Step 4 Analyze the resource data
Step 5 Formulate alternatives
Step 6 Evaluate alternatives
Step 7 Make decisions
Step 8 Implement the plan
Step 9 Evaluate the plan

This planning process requires the use of skills from many disciplines, such as economics, agronomy, soils, and engineering, to achieve the highest quality of assistance. Economics is one discipline that should play an important role throughout the planning process. It enters into the process most heavily during Phase II.

Alternative economic concepts and principles are applied to formulate the conservation plan (step 5). Considerations factor the relationship between the cost of the system and changes in resource conditions that will occur. Comparisons of the costs of practices to their effects on the resource lead to formulation of a cost-effective alternative. When more than one conservation plan alternative is evaluated (step 6), economics factors in.

Figure 1–1 Conservation planning



610.0102 Benefits of conservation

Benefits from conservation are numerous and occur offsite as well as onsite. Onsite benefits occur at or close to the location of the conservation activity, generally to the owner of the resource where the conservation activity was undertaken. These benefits can be divided into at least two types: maintaining or restoring productivity, and decreasing production costs. Offsite benefits occur in a different location than the conservation activity and may occur to different owners. A detailed record of conservation effects that can be expected in specific resource settings are in sections III and V of the Field Office Technical Guide.

(a) Onsite benefits

(1) Maintaining productivity
Maintaining productivity means maintaining crop yields by protecting the soil from erosion as well as conserving water. Crops need sufficient nutrients, water, and soil that has adequate tilth and organic matter for their passage, which allows adequate root growth.

Where erosion occurs, crops often cannot absorb basic needs. Through the removal of topsoil, wind erosion reduces the capacity of the soil to hold moisture and degrades the soil profile. Water erosion similarly removes topsoil, reducing the quality and quantity of the soil and causing nutrients to be lost. It can also cause onsite crop damage by forming gullies and depositing sediment. Both of these effects lower productivity by reducing and sometimes eliminating crop stands in certain areas.

Where conservation practices are used to reduce soil loss and conserve moisture, yields can be maintained and enhanced. These practices are designed to keep soil, nutrients, and water where they are needed.

(2) Decreasing production costs
Some conservation practices are beneficial to the landowner because the costs may be reduced. Practices, such as conservation tillage and no-till, reduce the number of trips over the field saving the landowner time, fuel, and machinery wear. However, weed and insect control costs may be increased. Other measures that convert row crops to other land uses permit the landowner to use less fertilizer and fewer chemical inputs in these areas. Examples are field borders and grassed waterways. These measures involve converting sometimes low yielding row crop areas, such as end rows and watercourses, to grass. The landowner saves production costs because these converted areas usually require less input than the row crops they displaced.

(b) Offsite benefits

Offsite damages, which may include sediment deposition and reduced water quality, result as eroded soil is transported and deposited by the actions of wind or water. The sediment can fill in ditches, plug culverts, reduce the useful life of reservoirs and ponds, destroy fences, destroy and damage crops, and transport farm pesticides and fertilizers.

Conservation practices can be installed to reduce offsite damages. This reduction is considered an economic benefit and should be considered in the decisionmaking process. Through conservation, the transport of material that pollutes the ecosystem, damaging wildlife and aquatic habitat, can be dramatically reduced.

The most effective way to avoid offsite pollution is to keep soils from eroding and chemicals on the fields where they are applied. Practices that reduce soil loss, sediment, and chemical pollutants may be useful in maintaining or improving water quality. This may not be true in all cases. For example, with a soil where the leaching of soluble phosphorus is a problem, no-till in some circumstances makes the problem worse.

610.0103 Costs of conservation

(a) Expenditures

(1) Up-front costs

Given the potential onsite and offsite benefits of conservation, possibly one reason it is not more widely adopted is that conservation involves up-front investment costs. The most obvious cost is installing the practice. This may include the material, land, labor, and equipment necessary to get the conservation practice on the ground according to NRCS specifications.

(2) Operation and maintenance

Operation and maintenance (O&M) are costs that occur throughout the lifetime of the practice, and ensure that it continues to function properly. Fertilizing a waterway, operating a pump, or reseeding a terrace backslope are examples of O&M.

Changing tillage practices may cause other costs to be incurred. For example, in some soils applications of fertilizers and pesticides must be increased when switching to conservation tillage or no-till. Increased production costs must be accounted for in these situations. These costs may be partly offset by fewer operations, better timing of operations, and lower equipment repair costs resulting from the elimination of gullies.

(b) Lost production

Another cost for some conservation practices is the cost of lost production. When certain practices are installed, previous production from the area is foregone. Waterways and certain types of terraces take land away from cropland. If the yields from these areas are initially low, then the loss will be small. However, if previous yields are high, then the cost of installing waterways will also be high in terms of lost production.

610.0104 Agricultural business environment effects on conservation purchases

Commonly accepted benefits and costs of conservation have been described. However, a decision that is economically sound (i.e., where the net benefits from all sources have been maximized) may not be a good decision for the farmer. A landowner's economic situation should be considered before recommendations are made. How the agricultural business environment (interest rates, the farm program, politics) affects a landowner's decision about applying conservation needs to be addressed.

(a) Economic prosperity

During times of prosperity, landowners usually can invest in long-term conservation. Installation of conservation practices is often a good way to reduce the tax burden in a year of high profits, making conservation an intelligent investment. However, benefits from conservation sometimes take time to materialize, while the costs are up-front. Therefore, liquidity, cash flow, or profitability can become a big problem for many landowners considering conservation investments (see appendix B).

(b) Economic stress

Practices with high installation costs and benefits that take time to materialize may be a good alternative from a conservation viewpoint, but not feasible for the landowner. In times of economic stress, applying part of a system that will yield some benefits may be better than not applying a practice at all. When the landowner's economic situation improves, the remaining practices of the long-term conservation plan could be applied, enabling the landowner to reap the full benefits of conservation.

Chapter 2 Basic Considerations and Economic Principles

Contents

Chapter 2 Basic Considerations and Economic Principles

610.0200 Introduction

(a) Purpose and scope

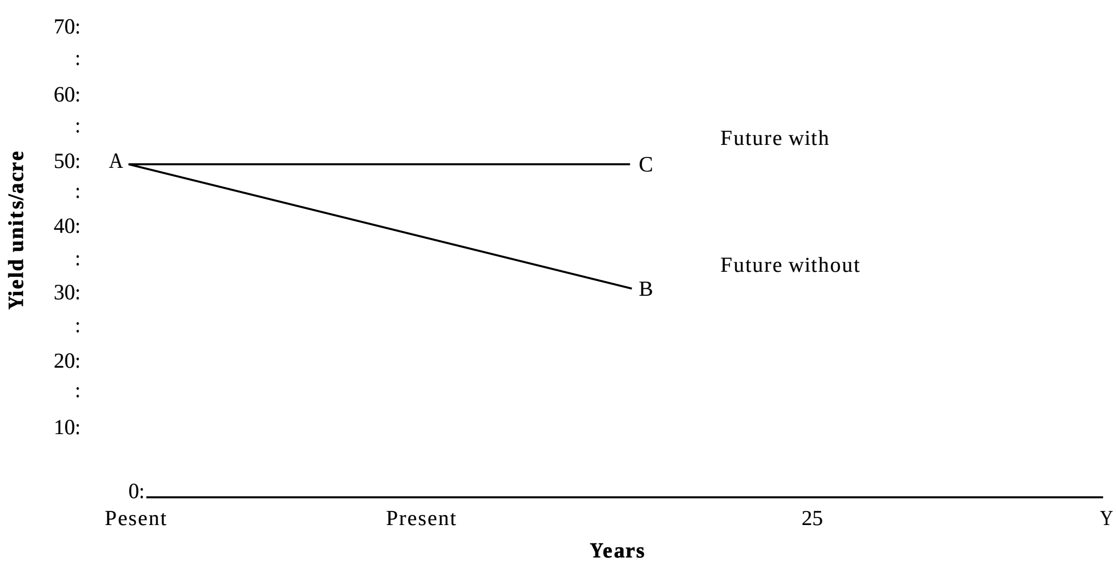
This chapter defines and illustrates economic principles and procedures that can contribute to effective conservation planning and decisionmaking. Major emphasis is placed on the identification and accounting of effects for purposes of comparison and selection. Economics is inseparable from planning and should be used to provide professionally responsible information that enables decisionmakers to comfortably make informed decisions about implementing conservation.

(b) Background

(1) Options with and without
Some physical situation, such as erosion or yield level, is currently, or expected to be, at a condition that is undesirable, unacceptable, or less than possible. Additionally, this situation can be corrected, if desired, by actions or activities called conservation practices. The estimated future situation without conservation practices should be compared to the situation expected with their implementation. The difference between the without and with options is the impact of conservation. The future without situation serves as a benchmark for the analysis. Identifying the benchmark situation is the first step in the conservation effects for decisionmaking framework.

(2) Example: Salts in the root zone
Estimating future effects is important. They should be stated objectively and must be made in reference to time. Consider an example where current management is causing an accumulation of salts in the root zone. Without treatment, continuing accumulations are expected to have a damaging effect on crop yield (see line AB in fig. 2–1). With adoption of a conservation system, salt accumulated in the root zone will be reduced and crop yields will be maintained (see line AC in fig. 2–1). The change in yield resulting from adoption of the conservation system is the area ABC, when evaluated over the 25-year period. If additional labor is the only cost of implementing the conservation system and yield change is the only gain, determination of the relative worth of adoption is made by comparing the value of the yield gain to the cost of additional labor.

Figure 2–1 Expected yield levels over time, with and without conservation



Estimates of future conditions without and with treatment are commonly made by using an inventory of the current situation as a starting point. Historical trends are then projected while current relationships and foreseeable developments are considered. Projections should reflect the views of the decisionmakers, research, and other published data, such as soil surveys. The expectations of the future without situation and the with treatment alternative must be tempered by local judgment.

610.0201 Decisionmaking

Effective conservation planning must involve both the landowner and the conservation planner. Together they need to identify the important physical and economic factors that are to be examined and look into the future to identify any changes in conditions without and with conservation. In addition, the landowner needs to identify the relevant time horizon. Ultimately, the landowner must also place relative values on gains and losses for the final analysis.

The process of decisionmaking is one of balancing the gains against the sacrifices of each option to determine which one produces the largest net gain or the smallest net loss. Once those options are identified, the process enables comparison to select the most desirable option.

(a) Relative weights

The landowner must place relative values on gains and losses to determine their individual weight in the decisionmaking process. Often the factors compared are not compatible in kind, place, or time. Some effects may have a common denominator, such as a market price, while others do not. Landscape appearance and the presence of endangered wildlife species are two examples where commonly held absolute values do not exist.

Actions taken in one place, or by one individual, may create change in another location, or to another individual. For example, a change in a feed crop resource may impact grazing resources, or the downstream/offsite impacts of erosion may affect water quality for recreation. Similarly, actions taken in one period create effects in another. The effect of current soil erosion on the ability of future generations to produce food and fiber and the impact of the current management regime on the options for future management of native plant communities are two examples.

The process of decisionmaking is not limited to factors that have common denominators, but allows the comparison of tradeoffs within and between alternatives. Ultimately, decisions are made that place relative weights on each consideration. The landowner, not the assisting professional, places value on the quantities identified in the planning process.

(b) Level of detail

Assistance is normally provided up to the point where landowners can comfortably make an informed decision about conservation actions. The kind and amount of information are different for every individual and every situation.

The simplest evaluation may consist of identifying the most obvious physical impacts stemming from the problem and estimating the costs of the conservation practices to address these problems. For example, upon learning that ephemeral gully erosion will be eliminated by a terrace system costing $40 per acre, some landowners would be ready to make a decision. Most of the questions posed by landowners can be answered with this approach.

An intermediate evaluation could be done for more specific resource questions that often require more detailed answers. Chapter 5, Evaluation Techniques, presents some useful ways to enable a more detailed evaluation of a particular option.

When the landowner requests a detailed analysis, the conservation planner may need to request direct assistance from a state office economist. In some cases the landowner may need financial or cash flow analysis. If NRCS does not have this type of assistance available, a farm management specialist may be required.

(c) Period of analysis

Two analytical concerns in decisionmaking are determining the length of time over which individual effects are to be considered and assuring that these effects are considered on a common time basis. The length of time over which effects are considered is called the period of analysis. The landowner is responsible for its identification. General factors affecting the landowner in the determination include sociological ones, such as age of the landowner and whether the children will farm.

Economic factors that constrain the period of analysis include the physical deterioration of capital investment (farm equipment and conservation practices) and obsolescence because of improvements in technology. The period of analysis should not exceed the shorter of the planning horizons, the repayment period or the physical life of the alternative. However, if the selected planning horizon is shorter than the physical life of the alternative, the benefits that accrue beyond the period analyzed must be carefully analyzed.

A period of analysis is established so that gains and losses may be compared on the same or equivalent time basis. The common time basis for comparison of effects can be any one year during the period of analysis or an average annual amount over the period. For example, all effects can be capitalized and compared at the end of the period or discounted and compared in present value terms. Frequently, gains and losses are calculated and stated in average annual terms. Further definitions and procedures for expressing values on a common time basis are provided in Chapter 4, Time and Money.

610.0202 Economic factors influencing private decisions

Thus far, the general description of analytical principles and the decisionmaking process has been within the context of comparing all gains and all losses over an identified period. The criteria used is that when gains exceed losses, the option is economic and that the selected best option tends toward the optimum economic option. However, several factors can significantly alter the judgment of whether an alternative is feasible and which alternative is best.

(a) Distributing costs and benefits

An important consideration is who pays the cost and receives the benefits. On the gains side of the situation, quantified effects must be recognized—to whom does the gain accrue. The conclusion should not be made that only personal gains have value to landowners.

On the losses side, who pays the costs must be considered. Monetary costs, considered a loss, may be greatly impacted by cost share or income tax treatment. Cost share and current provisions for investment tax credit on some conservation treatment components can directly reduce out-of-pocket costs to the individual.

(b) Balancing gains and losses

To balance gains against losses, individuals must give weights, or prices, to items considered. Such items as commodities are generally priced based upon future market expectations tempered by past and current conditions. However, such items as labor may not be readily priced even though a labor market may exist. Commitment of or savings in labor may not change out-of-pocket cash costs or add to cash revenue. Savings in labor have cash value only when cash payments to labor are reduced or cash revenue is generated from use of the saved labor in an alternative activity. However, saved labor may have physical value as leisure time. Similarly, commitment of labor has cash cost only when additional cash payment is made to labor or committed labor reduces cash revenue when taken out of employment in an alternative activity.

The example of labor value demonstrates the economic concept of opportunity cost, which relates the value of a good or service to the opportunities available for alternative employment. The landowner must place the values, or prices, on the items considered as gains or losses. Therefore, quantification of effects, gains, and losses should begin with physical measures, such as bushels, gallons, hours, and pounds, when possible.

(c) Timing

Proper accounting and valuation of effects anticipated over a period of analysis may lead to conclusions on economic feasibility and identification of the economically best alternative, but may not lead to implementation. A close examination of when gains are realized and when losses are required may reveal that short-term financial demands exceed short-term ability to pay. Comparing the timing of gains and losses defines the financial term cash flow. Options that require near term losses or expenditures to achieve benefits in a longer term are susceptible to financial unfeasibility even though total gain exceeds total loss.

Comparison of gains and losses on an equal time basis requires the use of concepts described in chapter 4. A framework for evaluating various options is provided in chapter 5.

(d) Interest rates

An aspect of the economic concepts presented in chapter 4 is the interest rate used to equate items in time. This rate can have a substantial effect on the judgment about economic feasibility and an individual's selection of the best option. As the interest rate used in evaluation is increased, effects occurring further into the future have relatively less value. Selection of the interest rate used in evaluation is the responsibility of the landowner. It should reflect what earning power is given up (the opportunity cost) or what must be paid.

When self-owned resources are committed to implementation of an option, the earnings of those resources in their alternative employment must be forfeited. That rate of earning power forfeited is the appropriate interest rate. Borrowed resources require rental payments to the owner of the resource because of its earning power. The rate of rental payment is the appropriate interest rate. It is important to recognize that in a situation where self-owned resources are committed, even though total gains exceed total losses, the cash position of the landowner would not be improved unless net gains exceeded the earnings that would have been realized from an alternative use of the resources.

(e) Depreciation

Depreciation is the anticipated reduction in the value of an asset over time, caused through physical use or obsolescence. In accounting, depreciation refers to the process of amortizing or allocating a portion of the original cost of a fixed asset, such as a tractor, to each accounting period. The value is gradually used up (written off) during the estimated useful life of the asset. Allowance may be made for the ultimate estimated resale value of the fixed asset (its residual value) to remain at the end of its useful life to the enterprise. The two principal types of depreciation methods are:

- Straight-line depreciation—allocates the cost of a fixed asset in equal amounts for each accounting period.
- Accelerated depreciation—allocates a larger proportion of the original cost to earlier accounting periods and a smaller proportion to later periods.

(f) Inflation

An increase in the general price level of an economy is inflation. Inflation occurs when the quantity of money in circulation rises relative to the quantity of goods and services available. The result is too much money chasing too few goods, and prices are bid up. At high rates of inflation, people begin to lose confidence in money. The quantity of money in circulation increases relative to expenditures in current prices, as people tend to hold (hoard) goods rather than money. Inflation is associated with a rise in gross national expenditure at current prices that is greater than the increase in the real supply of goods and services.

In watershed project analysis (PL-566 projects), the customary analytical approach is to work in constant prices rather than current prices and to assume that inflation will affect the prices of nearly all costs and benefits equally. Specified costs and benefits are varied in comparison with the others so that their relative prices change. Using constant prices allows the analyst to avoid making risky estimates of future inflation rates and to simplify the analytical procedures.

610.0203 Evaluating options

(a) Least cost option

(1) Comparing losses

In situations where defined objectives require the achievement of a minimum level of performance or output, the problem is reduced to searching out the option that requires the least amount of loss (least cost). Usually the question does not include determination of economic feasibility. However, implementation continues to be dependent upon the measurable monetary aspects of the option considered by the landowner. The problem can, therefore, be viewed as a comparison of the losses of one option against those of another, and a search for that option that costs the least. Again, the landowner must place a value on items considered in the balancing process and must be cognizant of factors described in the previous section. Analytical principles are employed that define effects by examining the future with and without situations and comparing them on an equal time basis.

(2) Example: water quality

Consider an example where plans and laws, such as the 1972 Clean Water Act as amended (Section 208), are used to enforce minimum standards for water quality and maximum standards for permissible discharge. For a landowner, such as a dairy owner, to continue in business, the choices faced may be reduced to compliance or jail. Assuming jail is not a desirable option, the problem is reduced to finding the least cost means of compliance.

(3) Considerations

From an economic viewpoint, any conservation practice selected for installation should not be more costly than any other reasonable means of accomplishing the same level of conservation. Comparison of costs for all alternatives considered is essential and should include the estimate of operation and maintenance expenditures and the average annual installation costs.

Any costs occurring in the future, monetary or nonmonetary, need to be identified and converted to a common time base. Some particular nonmonetary costs, such as the potential loss in water quality in a creek that would receive runoff from a grassed waterway, may not be easily expressed in dollars. This, however, does not mean that they are not important and certainly does not exclude them from the evaluation process.

(b) Maximization of net gains (income)

(1) The best option

In the decisionmaking process described, the best option is that alternative with the greatest net gain from the viewpoint of the individual landowner. The best alternative would be considered the economic optimum if selection were made from a very large number of alternatives. The selection process is one of replacing the benchmark situation only when another alternative is found with more net gain. Another view of the process is the comparison of the change in gains between alternatives to the change in losses between alternatives, using the criteria that as long as added gains exceed added costs (losses), additional net gain is realized. In other words, additional losses are made only to the point where they are offset by added gains. In the formulation of alternatives that are comprised of separate practices, each practice should be examined to determine if that practice adds more gain than loss.

(2) Example: animal waste

For example, consider the land disposal portion of an animal waste management alternative where application of manure on either or both of two field crops is possible (all other factors held constant). The nutrient value of the manure would be allocated where the most net gain could be expected. Optimum economic allocation would be achieved by allocating increments (tons or gallons) to the crops in order of highest value of crop response to the nutrients. This requires recognition of another important physical concept. Successive units of manure (crop nutrients) applied to a crop has smaller and smaller effects on crop yield until, finally, it has a negative effect on the crop if applied beyond a certain level. This diminishing response to inputs is called *diminishing returns*. It is important because at some level of allocation of manure to one of the crops, yield response and, therefore, value is reduced to the point where application should be shifted to the other crop. The final allocation may be determined after several successive shifts between crops, until either total manure is allocated or gains no longer exceed costs.

(3) Nonquantified values

An important exception to diminishing returns is that gains are usually expressed only in dollars. Therefore, any nonquantified values would be excluded from net gains or net loss figures. Because of the presence of these nonquantified personal or societal values, landowners often seek to achieve a level of conservation that is different from the level that maximizes only monetary net gains.

(c) Types of analysis

(1) Sensitivity analysis

Sensitivity analysis can be used to systematically test what happens to the feasibility of a conservation plan if events differ from the estimates made in planning. It is a means of dealing with uncertainty about future events and values. A sensitivity analysis is done by varying one element or a combination of elements and determining the effect of that change on the outcome. With a conservation plan, testing for the effects on earning capacity of changes in prices, cost, delay in implementation, and changes in yield may be useful. Sensitivity tests need not be directed at the effect of a change on project worth. The test may be made, for example, to determine the effect of a delay in benefits on the cash position of a farmer who has borrowed for an irrigation pump. Variations on sensitivity analysis may also include evaluation risk, interest rates, and prices.

Risk is the probability or chance that something will or will not occur as planned. For example, what is the chance that yields will reach the prescribed level? What is the likelihood that the system will be more costly than expected? The impact of these occurrences can be tested using sensitivity analysis. They can also be evaluated using a formal procedure called *risk analysis*.

(2) Risk analysis

Risk analysis can be more narrowly described as an analytical technique in which probabilities of occurrence are determined for all critical conservation option elements. Then, by computer, repeated computations of a measure of option worth are made, each element entering in successive computations according to its probability of occurrence. The result is most commonly reported in the form of a cumulative probability curve, plotted on a graph in which the vertical axis represents the probability a measure of option worth will fall below a stated value and the horizontal axis represents the values of the measure of option worth.

Chapter 3 Why Landowners Adopt Conservation

Contents

Tables

610.0300 Introduction

Landowners adopt new conservation practices if the practices seem to be in their best interests. However, disagreements arise when the question, why don't landowners adopt new conservation practices, such as residue management systems, is asked. Strategies to promote the adoption of new conservation practices must take the answer into account to help landowners make decisions that are economically, agronomically, and environmentally sound. It can serve as the basis for increasing adoption. Understanding why landowners refuse to adopt new practices is central to developing appropriate information to help them make informed decisions.

610.0301 Reasons for non-adoption

Landowners do not adopt conservation technologies for two basic reasons: they are either unable or unwilling. These reasons are not always easily distinguishable from one another. Landowners can be able, yet unwilling; willing, but unable; and, of course, both unable and unwilling. These may sound like minor distinctions, but the difference between a landowner being unwilling or unable is crucial when designing the appropriate conservation adoption strategy.

(a) Unable to adopt

Being unable to adopt a new conservation practice implies that some obstacle or situation causes the decision not to adopt to be rational and correct. The landowner is making a sound decision in rejecting a conservation practice because of this obstacle. The important point is that the landowner may be willing to adopt the practices, but for one or more reasons is unable to make this decision. Among those reasons are:

- Information is lacking or scarce.
- Costs of obtaining information are too high.
- Complexity of the practice is too great.
- A conservation practice is too expensive.
- Labor requirements considered are excessive.
- Planning horizon is too short.
- Availability and accessibility of supporting resources are limited.
- Managerial skills are inadequate.
- Control over the adoption decision is limited or nonexistent.

Information is lacking or scarce—A landowner may be unable to adopt a practice because some of the basic information necessary for a sound economic and agronomic analysis is missing.

Costs of obtaining information are too high—The time, expense, and difficulty of obtaining site-specific information may be too high. Obtaining relevant information is not cost-free to the landowner.

Complexity of the practice is too great—An important characteristic of any new technology is its simplicity or ease of use. Extensive research literature is available showing that the complexity of a technology is inversely related to the rate and degree of adoption. Conservation practices that are too complex make some landowners unable to adopt this technology.

Conservation practice is too expensive—Investment costs and influence on net returns are major concerns of today's landowners. Designing a practice that is agronomically sound, but has too high of a price tag makes many landowners unable to adopt.

Labor requirements considered are excessive—Land, labor, and capital still determine the nature of the farm or ranch. If the labor requirements associated with a new conservation practice are thought to be too high or relative to the capabilities of the farm or ranch, then the farm or ranch manager will be unable to adopt the technology.

Planning horizon is too short—Conservation practices may be rejected by a landowner because of the current planning horizon relative to the time associated with recouping initial investments, learning costs, or depreciation of the present equipment line. Many of today's landowners may not be farming or ranching in a few years because of retirement or other transitional forces. Asking them to make a long-term investment within the context of a short planning horizon will result in them being unable to adopt.

Availability and accessibility of supporting resources are limited—Few landowners adopt innovative conservation management systems without significant support. This support can be in different forms.

- Local equipment or agrichemical dealers willing to take the risk of investing in products not currently being used in their trade areas.
- Other landowners using conservation practices who are willing to share both successes and failures.
- U.S. Department of Agriculture information and assistance network capable of answering landowners questions.

The lack of any one of these could be the obstacle that creates a situation where the landowner is unable to adopt.

Managerial skills are inadequate—As in the case of the physical resource base they manage, diversity among landowners is tremendous. A dimension of this diversity is managerial skill. Too often conservation practices are designed for the average or above average manager. Local assistance networks are also oriented to this group because of the performance and evaluation systems used in USDA. Either of these can create a situation where landowners with less than average management capabilities receive little or no assistance in building these skills. These landowners will then make the correct decision in rejecting the conservation practice because they lack the requisite managerial skills or the opportunity to develop them.

Control over the adoption decision is limited or nonexistent—Viewing the landowner as some independent decisionmaker who calls all the shots is common. The landowner, therefore, becomes the focal point of most efforts to transfer new technologies. In many situations, however, a decision cannot be made without the approval of a partner, source of financial credit, landlord, or some other third party. If these other interests are not convinced of the merits of a new conservation practice, then the landowner will be unable to adopt.

(b) Being unwilling to adopt

Landowners may be unwilling to adopt a new practice. This implies that they have not been persuaded that the technology will work or is appropriate for the farm or ranch operation. This persuasion does not occur for several reasons. As in the case of inability to adopt, many of these situations are beyond the landowners control; therefore, making a correct decision in rejecting the practice. Until the correct form of persuasion is offered, this will not change.

Landowners may be unwilling to adopt because:

- Information conflicts or inconsistency.
- Poor applicability and relevance of information.
- Conflicts between current conservation goals and the new technology.
- Lack of knowledge on the part of the landowner or promoter of the conservation practice.

- Practice is inappropriate for the physical setting.
- Practice increases risk of negative outcomes.
- Belief in traditional practices.

Information conflicts or inconsistency—Landowners may be unwilling to adopt a practice because of inconsistency or even outright conflicts in the information about the practice. Concerned about water quality in a vulnerable area, the landowners may hear that a particular conservation practice always requires more pesticides or that another local landowner claims it requires fewer pesticides. They will often remain unwilling to adopt until these divergent messages become more consistent.

Poor applicability and relevance of information—To make a sound decision, landowners need information that is applicable and relevant to their farm or ranch. Data from a neighboring state or even across the county line may be judged as not meeting local conditions. Until the data are adapted and made available relative to local situations, the landowner will remain unwilling to adopt.

Conflicts between current conservation goals and the new technology—New technologies do not always fit into existing conservation practices and the policy context in which they operate. In these cases the general expectation is that landowners will adapt the operation to meet the adoption requirements of the technology. This can be contrasted with a situation where a flexible technology is designed so that it can be adapted to fit into a landowner's operation. Landowners may be unwilling to adopt if they feel that too much adaptation is required.

Lack of knowledge on the part of the landowner or promoter of the conservation practice—An individual that has not had the opportunity to learn about a new practice and a planner that lacks sensitivity to the basic needs of a potential adopter can cause a landowner remain unwilling to adopt.

Practice is inappropriate for the physical setting—The landowners may be expected to adopt a practice that is inappropriate for the physical setting of the farm or ranch operation. Potential yield losses, inefficient use of inputs, or even negative environmental impacts can result from this situation. Some landowners, recognizing this incompatibility, remain unwilling to adopt.

Practice increases risk of negative outcomes—A conservation practice can increase the probability of a negative outcome in many ways. A relatively wet versus dry year can have many implications for pest control, nutrient amount and placement, and the timing of tillage operations. Relying on agrichemicals for pest control can make the landowner more dependent on weather patterns and increase the potential costs of rescue operations. The complexity of a practice, importance of the timeliness of operations, and the interdependence of inputs all can increase perceived or real uncertainty and risk. Some landowners are simply unwilling to make major decisions under conditions of uncertainty or where risk is significant.

Belief in traditional practices—Although traditional beliefs and practices in agriculture are often scorned, one should not forget that those traditional landowners continue to survive in today's competitive environment while thousands of their innovative or progressive neighbors have gone out of business. Some landowners are unwilling to change because those traditional practices present the least risk in dynamic agricultural markets.

(c) Using decisionmaking information

A way to use knowledge about landowner decisionmaking is to use a 2 x 2 matrix format (table 3-1). Landowners reasons for adopting or rejecting agricultural practices can be categorized into one of the four cells.

Initially the specific group of landowners (target groups) whose cooperation is required for a particular program or project needs to be identified. For each target group an assessment is made of the reasons they are able or unable and willing or unwilling to adopt the recommended conservation practices. Based on each group's reasons for adopting or rejecting a recommended practice, target groups are sorted into the cell that best represents their decisionmaking rationale. These reasons for adoption or rejection can be determined by interviews with key informants, focus group discussions, NRCS personnel, or other such methods. State social science coordinators and the Agency sociologists can assist with this task. Examples of different target populations and different conservation practices are provided in tables 3-1 through 3-3. Table 3-4 can be adapted for a particular situation.

Using the matrix to organize target group's reasons for adopting or rejecting NRCS recommendations can assist state office planners and field office personnel in determining the appropriate actions necessary to implement a successful program or project. Matrix provided by Tom Makowski, former sociologist with NRCS.

(d) Example: Matrices

The following matrices summarize all the various combinations of landowner's reasons for adoption and rejection of new practices and technologies. Three sample matrices are presented, and a blank matrix is provided. The table can be read across each row or down each column. For example, in the first table for Low Initial Cost Systems, if the landowner has never heard of a low initial cost system from NRCS, but has a history of adopting conservation innovations, then that landowner would fit into the category of being unable and willing.

Identifying the category an individual landowner falls into should help the conservation planner tailor a conservation adoption strategy to the needs and concerns of that particular landowner. Realization of the landowner's reasons for adoption or rejection should enable the conservation planner to avoid ignorance of and insensitivity to the landowner's needs, and help get more conservation on the land.

610.0302 Observations about adoption

(This section was adapted from an article titled "Farmer Adoption of Production Technologies" written by Pete Nowak, a professor in the Department of Rural Sociology, University of Wisconsin at Madison.)

At least three general observations can be made from the lists presented in this section about why landowners are unable or unwilling to adopt conservation practices. First, increasing the adoption of conservation practices or any other new technology depends upon addressing reasons why landowners are unable or unwilling to adopt, and then removing these impediments.

Second, many of the factors causing landowners to be unable or unwilling to adopt are beyond their control. In many cases it is not so much the landowners failure as it is a system failure.

Third, broad-scale use of any one or even several of the remedial strategies suggested is doomed to failure. A shotgun approach to using technical, financial, or educational assistance seldom is the answer. The specific type of assistance the landowner needs must be delivered in a format compatible with their capabilities.

The promotional strategies that worked for the early adopters generally are not as effective with late adopters. If accelerated rates of adoption for conservation systems are wanted, then NRCS personnel must be as willing to accept new ideas and methods as they expect potential adopters to be of new practices.

Table 3-1 Low initial cost systems (LICS)

Reasons for landowner adoption and rejection of new practices and technologies

Landowner is	Unable	Able
Willing	*Unable* 1 The landowner has never heard of a LICS from NRCS, but… *Willing* has a history of adopting conservation innovations	*Able* 2 The landowner was assisted by the NRCS field office in planning LICS *Willing* and a LICS will meet the landowner's needs on leased land
Unwilling	*Unable* 3 No one in the county who can help the landowner implement a LICS… *Unwilling* and, thus far, a LICS seems no better than doing nothing.	*Able* 4 A medium-sized, stable operation, the landowner has heard of LICS, but… *Unwilling* has heard conflicting inform-ation about the effectiveness of LICS.

Table 3-2 Crop residue management (CRM)

Reasons for landowner adoption and rejection of new practices and technologies

Landowner is	Unable	Able
Willing	*Unable* 1 Landowner cannot get information or assistance on CRM appropriate to his operation, but… *Willing* has a plan that requires CRM and continues to receive base payments.	*Able* 2 Landowner has tried CRM on a limited basis and... *Willing* can fit it into current cropping rotation.
Unwilling	*Unable* 3 First heard of CRM when plan was signed and never before used anything but a mold board plow. *Unwilling* The landowner is suspicious of government assistance and is relatively isolated from mainstream agriculture.	*Able* 4 NRCS district conservationist has offered to assist the landowner implement CRM on the land, but… *Unwilling* The landowner is afraid of changing the way the fields have always been prepare.

Table 3-3 Agroforestry—Windbreak technologies

Reasons for landowner adoption and rejection of new practices and technologies

Landowner is	Unable	Able
Willing	*Unable* 1 An eastern Colorado landuser has no local source from which to obtain stock, but… *Willing* the landuser grew up in Missouri and wants trees on his land.	*Able* 2 Field office staff has information and the ability to assist landusers plan a windbreak planting, and *Willing* several landusers recently req-tec a forest stewardship workshop in their county.
Unwilling	*Unable* 3 The landuser has never planted a tree in his life and... *Unwilling* conventional wisdom is that trees can't grow here; "Never have. Never will."	*Able* 4 The county has a total tree care program, but… *Unwilling* the landowner doesn't see how trees will improve either the efficiency or effectiveness of the operation.

Table 3-4 Worksheet

Reasons for landowner adoption and rejection of new practices and technologies

Landowner is	Unable	Able
Willing	*Unable* 1 *Willing*	*Able* 2 *Willing*
Unwilling	*Unable* 3 Unwilling	*Able* 4 Unwilling

Chapter 4 Time and Money

Contents

Figures

Chapter 4 Time and Money (Interest and Annuities)

610.0400 Introduction

(a) Purpose and scope

During the decisionmaking process, the landowner occasionally wants more detailed information than the first or second level of analysis provides. In cases where investment and return information is required, the conservationist needs a basic understanding of interest and annuities to perform an indepth analysis and comparison of alternatives available.

The intent of this chapter is to provide a basic understanding of more detailed concepts, such as interest and annuities, and to show how they can be used to compare and analyze alternatives. The interest and annuity factors needed for these calculations appear with the examples and in appendix A. The state economist can help locate the tables for other interest rates if needed. This chapter also gives formulas and examples for calculating the factors. For practice examples, consult appendix A. Finally, spreadsheet software programs have functions for many of the formulas.

(b) The time value of money

Money can be invested and used to make more money over time. Thus, $1 received today could be put in a bank or invested, where it would become worth more than $1 a year from now. This is known as the time value of money. Landowners may decide to purchase one piece of equipment versus another or to make no purchase at all, based upon the use of money over time.

(c) Opportunity costs

The time value of money can be thought of in two forms. First, if the landowner borrows money for a purchase, the time value of money is the interest paid on the loan. When landowners use their own money, the time value is the return they gave up from another investment (savings account, certificate of deposit, IRA) by making the purchase.

When a landowner considers purchasing conservation, the time value of money concept applies. A cost above and beyond the purchase of the conservation practice must be considered. If the landowner borrows to pay for the practice, that additional cost will be equal to the interest that must be paid on the loan. Otherwise, the additional cost is equal to the return that money would have earned on some other investment.

610.0401 Timing

(a) One-time values, annuities, and lags

The benefits and costs of conservation do not necessarily occur at the same time. Certain costs and benefits may occur at one point in time while others occur over a number of years.

Those values that occur at a single point in time, such as installation costs, are called *one-time values*. Values that occur over an extended period are called annual flows, or annuities. Annuities can be generalized as constant, decreasing, or increasing over time, depending on their characteristics. Many of the benefits from conservation occur as annuities. A one-time value can occur today or at some point in the future. If it occurs at some point in the future, it is delayed or lagged. Annuities can also be lagged. If benefits from a terrace do not start until a year after installation, then those benefits are said to be lagged 1 year. Deferred grazing following range seeding is another common example of a lagged annuity.

(b) Average annual values

To properly compare benefits and costs, the same timeframe must be considered. A standard form in which they can be considered is average annual values, which describes an annual flow that is not lagged. In table 4–1, the middle column gives four examples.

Table 4–1 Examples of one-time values, annuities, and lagged values

One-time values	Annuities (Avg. Annual Values)	Lagged values
Installation cost	Replacement costs	Conservation benefits, average returns, average costs
O&M costs	Replacement costs	Any value not starting this year

Average annual values are significant because the accounting system in most businesses, including farming and ranching, is based on them. Therefore, the costs and benefits of conservation, once converted to average annual values, can be added to the annual costs and returns of the farm or ranch business.

Useful tools for converting the benefits and costs of conservation into average annual values are the amortization key and the interest and annuity (I&A) tables. (See the NRCS Field Office Technical Guide (FOTG), section 1, appendix A, or the state economist.)

The conversion of costs and benefits into average annual values without the help of I&A tables would involve the use of many calculations and much time. The tables were constructed to simplify the process by presenting coefficients developed from the formulas, thus providing much simpler and faster calculations. Formulas and examples are provided.

The interest and annuity (I&A) tables are used in benefit-cost analysis when benefits are delayed for a significant period after costs are incurred; when benefits are not constant over the evaluation period; and when costs, expressed as capital or principal amounts, must be converted to an average annual cost. The conversion of costs and benefits of conservation to average annual equivalents without the help of I&A tables would involve the use of many difficult formulas and calculations. The tables were constructed to simplify the process by presenting coefficients developed from the formulas for use in much simpler calculations. A typical table that NRCS uses has nine columns:

- Periods
- Future value of 1
- Present value of 1
- Future value of annuity of 1
- Amount of annuity for future value
- Present value of an annuity of 1
- Amount of annuity for a present value
- Present value of an increasing annuity
- Present value of a decreasing annuity

Table 4–2 presents the interest and annuity table for the 10 percent interest rate used in the following examples.

Number of periods hence is the number of years in which calculations are considered. Several factors may influence this determination including conservation measures may have a short or long useful life or an individual may want to recover their costs in a certain period. Three items described in detail, but not found directly in the tables are simple interest, compound interest, and sinking fund (table 4–3).

Table 4–3 Annual loan payment activity during a 10-year period

Year	Amount of loan	Annual payment	Payment Principal	Payment Interest	Remaining Balance
1	$7000.00	$1139.25	$439.25	$700.00	$6560.75
2	6560.75	1139.25	483.17	656.08	6077.58
3	6077.58	1139.25	531.49	607.76	5546.09
4	5546.09	1139.25	584.64	554.61	4961.45
5	4961.45	1139.25	643.11	496.14	4318.34
6	4318.34	1139.25	707.42	431.83	3610.92
7	3610.92	1139.25	778.16	361.09	2832.76
8	2832.76	1139.25	855.97	283.28	1976.79
9	1976.79	1139.25	941.57	197.68	1035.22
10	1035.22	1139.25	1035.73	103.52	0
Total	—	$11392.50	$7000.00	$4392.50	—

610.0402 Interest

Interest is the earning power of money; what someone will pay you for the use of your money, or the rent you are willing to pay for the use of someone else's money. Interest is usually expressed as an annual percentage rate (APR) and is most often compounded.

(a) Simple interest

Simple interest is money paid or received for the use of money, generally calculated over a base period of 1 year at a set interest rate, but is not commonly used. Figure 4–1 graphs simple interest.

$$I = (p)(i)(n)$$

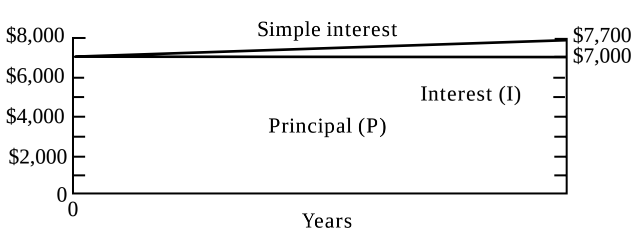
where:

I	=	interest
p	=	principal
i	=	rate of interest
n	=	number of periods (years)

Example: \$7,000 is borrowed at 10 percent interest (APR) for 1 year. Use the interest formula to compute how much money will be needed to pay off this loan when it is due.

$I = 7{,}000 \times .10 \times 1 = 700$	interest due
7,000	principal due
\$7,700	Total needed to pay the loan

Figure 4–1 Simple interest



Example: To determine how much interest is earned if \$3,000 is put into a savings account for 6 months at 10 percent interest, multiply the principal times the interest times the number of years.

$$I = 3{,}000 \times .10 \times .5 = \$150 \text{ will be earned}$$

(b) Compound interest

Compound interest is earned for one period and immediately added to the principal, thus resulting in a larger principal on which interest is computed for the subsequent period.

$$CI = (1+i)^n$$

where:

CI	=	compound interest
n	=	number of periods
i	=	periodic rate of interest
1	=	one dollar since the formula results in a factor that is multiplied by the principal dollar amount.

If the interest rate is 10 percent (APR) compounded quarterly for 5 years, then i = .10 divided by 4 (four payments in a year) or .025; n = 5 x 4 (four payments in a year) or 20. The factor to be multiplied by the principal amount is $(1 +. 025)^{20} = 1.63862$.

Example: At the end of 7 years, the depositor will have \$4,871.79 if \$2,500 is put into a savings account paying 10 percent interest compounded annually.

$$(1+.10)^7 = 1.94872$$
$$1.94872 \times 2{,}500 = \$4{,}871.80$$

If compounded semiannually:

$$(1+.05)^{14} = 1.97993$$
$$1.97993 \times 2{,}500 = \$4{,}949.83$$

If compounded quarterly:

$$(1+11.025)^{28} = 1.99650$$
$$1.99650 \times 2{,}500 = \$4{,}991.25$$

If compounded monthly:

$$(1+.00833)^{84} = 2.00791$$
$$2.00791 \times 2{,}500 = \$5{,}019.78$$

If compounded daily:

$$(1+.00027)^{2555} = 2.01370$$
$$2.01370 \times 2{,}500 = \$5{,}034.25$$

For comparative purposes, compounding gives these results: $2,500 invested for 7 years at 10 percent:

Compounded annually	$4,871.79
Compounded semiannually	$4,949.83
Compounded quarterly	$4,991.24
Compounded monthly	$5,019.79
Compounded daily	$5,034.25

Compound interest factors are not shown by column heading in the tables. However, the same answer can be obtained by dividing by the appropriate present value of 1 factor, since the present value of 1 factor is the reciprocal of the compound interest factor. Since these are annual tables, this method will work only if compounding on an annual basis.

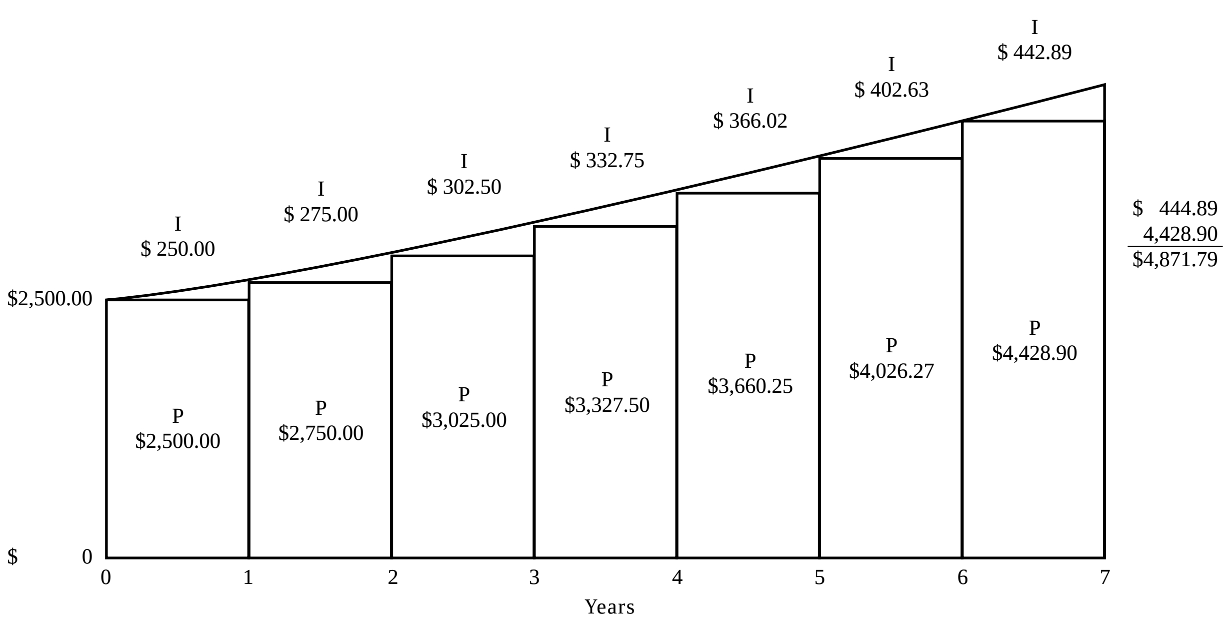
Example: $2,500 in 7 years will be worth $4,871.78 if it earns 10 percent interest compounded annually.

1/.51316 (from the interest tables, present value of 1, 7 years hence at 10 percent) = 1.94871 (the same factor was obtained by using the formula).

$$1.94871 \times \$2{,}500 = \$4{,}871.78$$

Compound interest is shown in graph form in figure 4–2.

Figure 4–2 Compound interest



610.0403 Calculating interest and annuities

(a) Present value of 1

The present value of 1 is the amount that must be invested now at compound interest to have a value of 1 at the end of a given period. Put another way, it is what $ 1.00 due in the future is worth today. It is also known as the present worth of one or discount factor.

$$PV = \frac{1}{(1+i)^n}$$

where:
PV = present value
i = interest rate
n = years

The present value of 1 factor is the reciprocal of the compound interest factor.

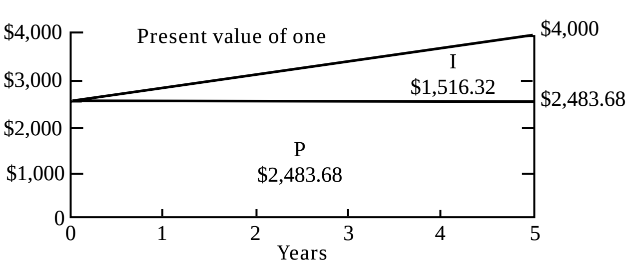
Example: $4,000 will be needed 5 years from now. You would need to invest $2,483.68 now at 10 percent interest compounded annually to be worth $4,000 in 5 years. The graph is shown in figure 4–3.

$$\frac{1}{(1+10)^5} = \frac{1}{1.61051} = .62092$$

$$.62092 \times 4{,}000 = \$2{,}483.68$$

The factor can also be found in the 10 percent interest table in the present value of 1 column for 5 years hence.

Figure 4–3 Value of 1



Example: If $923 is invested at 10 percent interest compounded annually and left alone for 25 years, it would have a value of $10,000 at the end of the 25 years (the power of compounding), or $10,000 to be received in 25 years is worth $923 today.

$$.09230 \text{ (from the table)} \times \$10{,}000 = \$923$$

(b) Amortization

Amortization is also called partial payment or the capital recovery factor. The amortization factor determines what annual payment must be made to pay off the principle and interest over a given number of years (average annual cost).

$$A = \frac{i(1+i)^n}{(1+i)^n - 1} \quad \text{or} \quad \frac{i}{1 - \frac{1}{(1+i)^n}}$$

The factor is also shown in the 10 percent interest table in the amortization column for 10 years hence.

Example: A farmer borrows $7,000 to install a conservation system. The interest rate is 10 percent, and the repayment schedule is set up for 10 years. The farmer must pay $1,139.25 each year for 10 years to pay off the $7,000 loan and interest. A total of $11,392.50 will have been paid to close out this loan ($7,000 of principal and $4,392.50 of interest).

$$1^{.10} - \frac{1}{(1+10)^{10}} = \frac{.10}{1-.38554} = \frac{.10}{.61443} = .16275$$

$$.16275 \times \$7{,}000 = \$1{,}139.25$$

Table 4–2 displays annual loan payment activity during the 10-year period.

Figure 4–4 illustrates amortization. The amortization factor is the reciprocal of the present value of an annuity of 1 per year factor, which means that the same answer can be obtained by dividing by the present value of an annuity of 1 per year factor. Using the above problem, the solution is:

$$\frac{7{,}000}{.614457} = \$1{,}139.22$$

(c) Amortization key

Many plant sciences or botany courses use a tool called a key to identify plant species. This key helps the observer to answer a series of question. It is useful because it allows nonexperts to identify species of plants that are unknown to them. By answering a series of questions, the amortization key serves as a guide for using the interest and annuity tables to convert benefits and costs of conservation to average annual values. The amortization key is illustrated in figure 4–5.

The first question on the key is whether the value is an annuity, such as benefits from a terrace that occur regularly over time, or a one-time value, such as terrace installation costs. If it happens to be a one-time value, follow down the key to the question: Is it lagged? A value that will be realized sometime in the future is considered lagged because there is a lag period between now and the time the value will occur. Assuming the value is not lagged, only the value over the life of the project or evaluation period needs to be amortize.

A one-time value is amortized when it is multiplied by the amortization factor (see the I&A tables in appendix A). The result of this multiplication is an average annual value. Had the value been lagged, the one-time value would first be multiplied by the present value of 1 factor for the lag period and then multiplied by the amortization factor.

To convert an annuity to an average annual value, first determine if it is constant, increasing, or decreasing. If the annuity is a constant flow of value, then it should be multiplied by the present value of a constant annuity factor for the period (number of years) of the annuity. This factor is in the I&A tables under the column called Present value of an annuity of 1 per year.

The result would then be multiplied by the amortization factor if the annuity was not lagged. If the annuity period were lagged, it would be multiplied by the present value of 1 factor for the lag period before being amortized.

Figure 4–4 Amortization

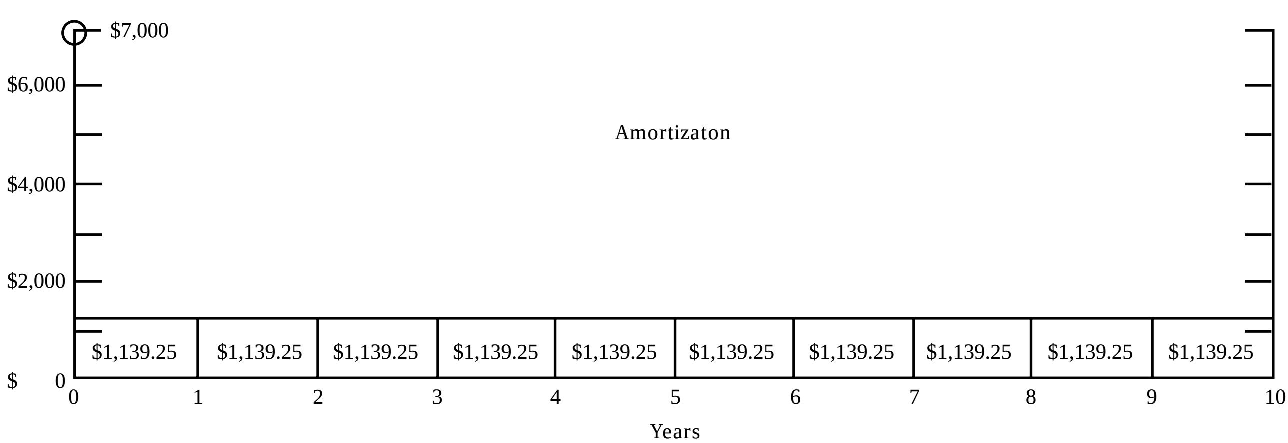
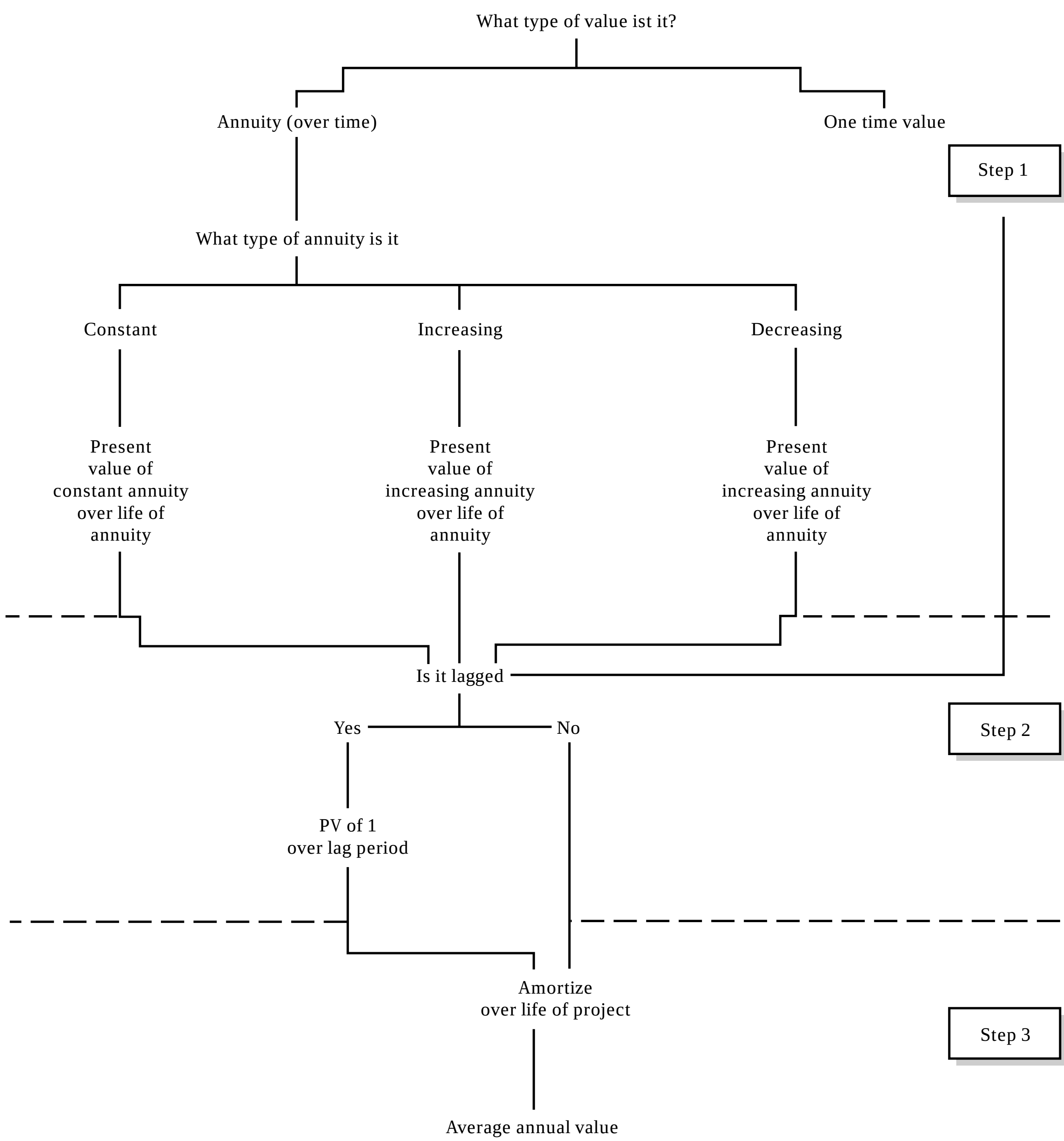


Figure 4–5 Amortization key



For an increasing or decreasing annuity, the value multiplied by the factor is the yearly average increase or decrease. For example, with an increasing annuity that begins at zero and rises to $500 after 5 years, the yearly average increase would be 500 divided by 5, or 100. That value would be multiplied by the present value of an increasing annuity factor for 5 years. To do so, locate the factor in the 5-year row under the Present value of an increasing annuity column and multiply it by 100. If the annuity is lagged, that answer is multiplied by the present value of 1 factor over the lag period. It is simply amortized if the annuity begins in the first year. The same steps would be taken for a decreasing annuity using the appropriate factors.

The three basic steps in the process are:

Step 1 Convert annuities to one-time values
Step 2 Adjust for lags
Step 3 Amortize

Not all the steps are used each time. The key guides you through the proper process. For example, if a one-time value is considered, the key moves you past step 1. If the annuity or one time value is not lagged, the key moves you past step 2. This process is necessary to convert benefits and costs of conservation into values that can be easily incorporated into a landowner's records and decisionmaking system.

(d) Present value of an annuity of 1 per year

Present value of an annuity (PV of A) of 1 per year is also referred to as a constant annuity, present worth of an annuity, or capitalization factor.

This factor represents the present value or worth of a series of equal payments or deposits over a period shows what an annual deposit of $1 is worth today. If a fixed sum is to be deposited or earned annually for n years, this factor will determine the present worth of those deposits or earnings.

$$\text{PV of A} = \frac{(1+i)^n - 1}{i(1+i)^n}$$

Example: You want to provide someone with $1,200 each year for 10 years. The interest rate is 10 percent. You must deposit $7,373.48 now to produce an annuity of $1,200 for 10 years, and a total of $12,000 will be received. The interest amounts to $4,626.52.

$$\frac{(1+10)^{10} - 1}{.10(1+10)^{10}} = \frac{(1+10)^{10} - 1}{.10(2.59374)} = \frac{1.59374}{.259374} = 6.14457$$

$$6.14457 \times 1,200 = \$7,373.48$$

The factor is also in the 10 percent interest table in the Present value of an annuity of 1 per year column for 10 years hence.

The present value of an annuity factor is the reciprocal of the amortization factor. Therefore, the same answer can be obtained by dividing by the amortization factor as follows:

$$\frac{1,200}{.16275} = 7,373.27$$

(e) Amount of an annuity of 1 per year

The amount of an annuity of one per year (A of $1) is the amount that an investment of $1 per year will accumulate over a certain period at compound interest.

$$\text{A of \$1 per year} = \frac{(1+i)^n - 1}{i}$$

Example: $2,000 per year will be invested for 30 years in an individual retirement account (IRA) paying 10 percent interest compounded annually. The value of the IRA account at the end of 30 years is $328,988.04.

$$\frac{(1+.10)^{30} - 1}{.1} = \frac{16.44940}{.10} = 164.49402$$

$$164.49402 \times 2,000 = \$328,988.04$$

The factor is also in the 10 percent interest table in the Amount of an annuity of 1 per year column for 30 years hence.

(f) Sinking fund

The sinking fund (SF) factor is used to determine what size annual deposit is necessary for accumulation of a certain amount of money in a certain number of years at various rates of compound interest.

$$\text{SF} = \frac{i}{(1+i)^n - 1}$$

Example: $6,300 will be needed in 4 years. The amount, $1,357.46, must be deposited annually for 4 years at 10 percent interest compounded annually to accumulate the $6,300.

$$\frac{.10}{(1+.10)^4 - 1} = \frac{.10}{.4641} = .21547$$

$$.21547 \times 6,300 = \$1,357.46$$

The sinking fund factor is not shown in the tables, but the same answer can be obtained by dividing by the appropriate amount of an annuity of 1 per year factor. This is because the amount of an annuity of 1 per year factor is the reciprocal of the sinking fund factor.

$$\frac{6,300}{4.64100} = \$1,357.46$$

The sinking fund factor is also equal to the amortization factor minus the interest rate.

$$.31547 - .10 = .21547$$

$$.21547 \times \$6,300 = \$1,357.46$$

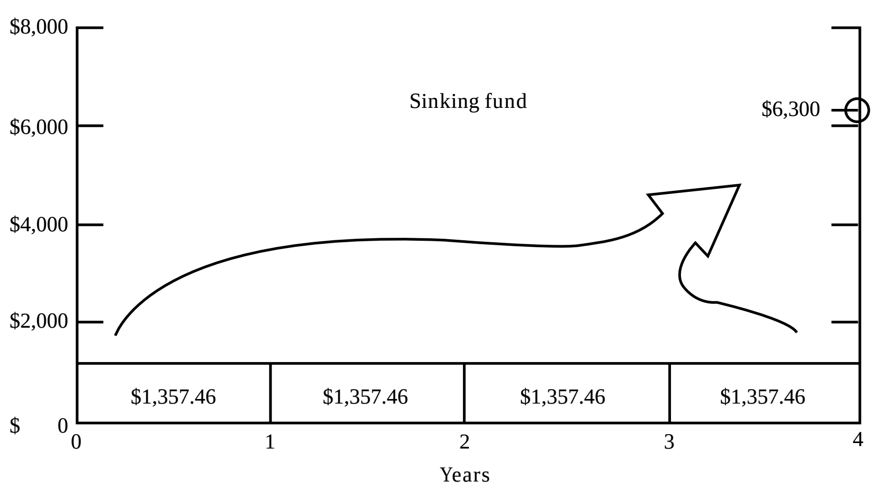
Figure 4–6 depicts the annual deposit required to realize $6,300 within 4 years.

(g) Present value of an increasing annuity

The present value (PV of IA) of an increasing annuity is a measure of present value of an annuity that is not constant, but increases uniformly over a period. When using this factor, note that the value of $1 (which is multiplied by the factor) is the annual rate of increase and not the total increase during the period. This is shown in figure 4–7.

$$\text{PV of IA} = \frac{(1+i)^{n+1} - (1+i) - n(i)}{(1+i)^n (i)^2}$$

Figure 4–6 Sinking fund



Example: A farmer renovates a pasture and estimates that it will reach full production in 4 years. Tbe improvement will increase uniformly over the 4-year period and at full production will improve net income $20 per year per acre. Using an interest rate of 10 percent, the present value of this increasing annuity is 7.54798.

$$\frac{(1+.10)^5-(1+.10)-4(.10)}{(1+.10)^4(.10)^2}=\frac{1.61050-1.1-4}{1.46410\times .01}$$

$$\frac{.11051}{.014641}=7.54798$$

The annual rate of increase needs to be determined. The annual rate of increase is $20 divided by 4 or $5. This is not to say that the annuity is constant or the same each year, but that the landowner will receive income of $5 the first year, $10 the second, $15 the third, and $20 the fourth (uniform increases of $5 per year). The present value of this increasing annuity or income stream is 7.54798 x $5 or $37.74. If you deposited $37.74 in an account paying 10 percent interest compounded annually, you could withdraw $5 at the end of year one, $10 at the end of year two, $15 at the end of year three, and $20 at the end of year four, and there would then be a balance of $0.00.

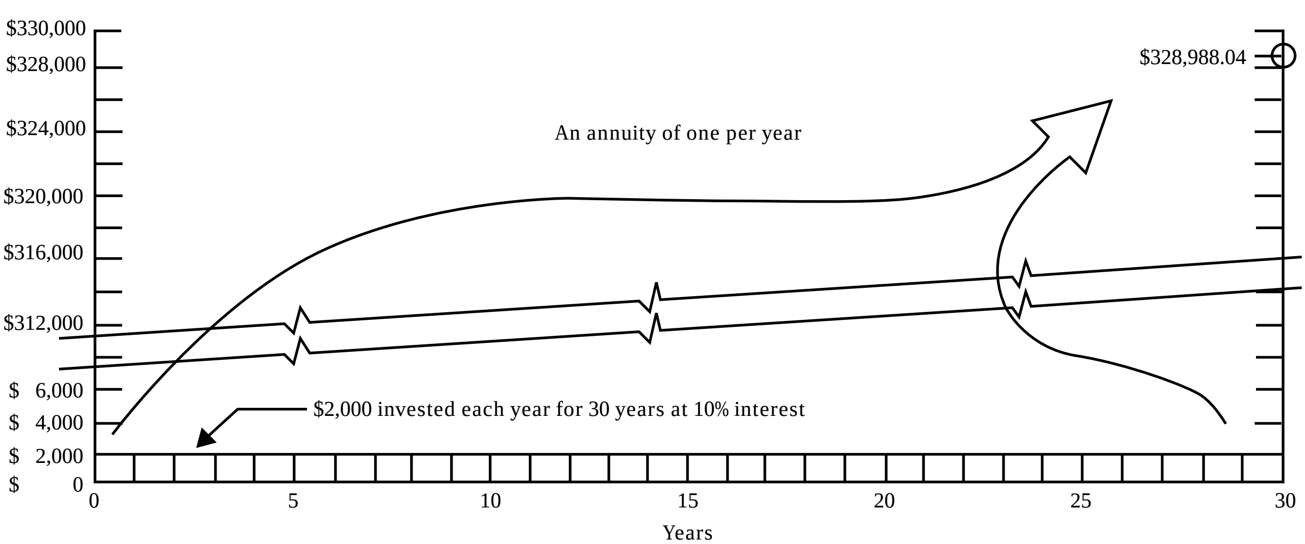
This factor is also in the 10 percent interest tables in the Present value of an increasing annuity column for 4 years hence.

(h) Present value of a decreasing annuity

The present value of a decreasing annuity (PV of DI) factor is used to determine how much something is presently worth that will provide an annuity that decreases uniformly each year. Note that the value of $1 (which is multiplied by the factor) is the annual rate of decrease and not the total decrease during the period.

$$\text{PV of DI}=\frac{n(i)-1+\dfrac{1}{(1+i)^n}}{(i)^2}$$

Figure 4–7 Present value of an increasing annuity



Example: A gravel pit is producing $28,000 income annually. Because of a decreasing supply that is more costly to remove, income will drop at a steady rate until it equals zero in 7 years. At 10 percent interest, the present value of the gravel is determined by using the factor 21.31581. Calculate the factor as follows:

$$\frac{7(.10)-1+\frac{1}{(1+.10)^7}}{(.10)^2}=\frac{-.3+\frac{1}{1.1^7}}{.01}$$

$$\frac{.3+.51316}{.01}=\frac{.213158}{.01}=21.31581$$

The factor is in the 10 percent interest table in the Present value of a decreasing annuity column for 7 years hence. See appendix A.

The next step is to determine the annual rate of decrease, which equals $28,000 divided by 7, or $4,000.00. The annuity is not constant or the same each year. The landowner will receive income of $28,000 the first year, $24,000 the second, $20,000 the third, until the supply runs out on the seventh year and becomes $0.00. Finally, the present value of this decreasing annuity is the factor times the annual rate of decrease (21.31581 x $4,000) or $85,263.24. This is the amount that would need to be deposited now to produce the identified decreasing annuity.

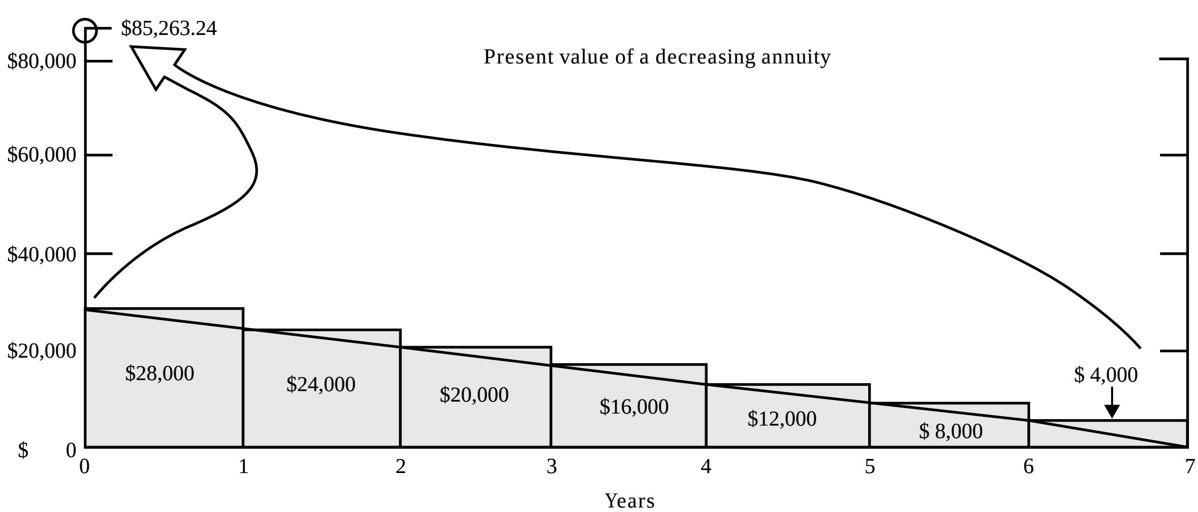
(i) Rule of 72

This shortcut method allows you perform several interest and annuity calculations. The rule of 72 states that 72 divided by the interest rate received will result in the number of years it will take to double your money at compound interest.

Example: To compute how long it takes to double an investment of $150 at 8 percent compound interest, divide 72 by 8.

$$\frac{72}{8}=9 \text{ years}$$

Figure 4–8 Present value of a decreasing annuity



Using the I&A tables, you can check the calculation. If you want to determine the PV of one, 9 years hence, at 8 percent, the factor to use is .50025.

$$.50025 \times \$300 = \$150$$

$$\frac{150}{.50025} = 300$$

Dividing 72 by the number of years you want to double your money gives you the interest rate you need.

Example: To compute the interest rate needed to double $150 in 9 years, divide 72 by 9.

$$\frac{72}{9} = 8\%$$

Compound interest factors are not shown by column heading in the I&A tables. Calculate such factors by dividing by the appropriate present value of 1 factor (.50025 in the example) since the present value of 1 factor is the reciprocal of the compound interest factor. Note that this method works only if compounding on an annual basis, because the I&A tables are annual tables.

$$\frac{150}{.50025} = 300$$

Chapter 5 Evaluation Techniques

Contents

Figures

Tables

Chapter 5 Evaluation Techniques

610.0500 Introduction

In this chapter evaluation techniques and procedures, such as partial budgeting, break-even analysis, and using an index are described. Evaluation techniques that help in integrating economics, into conservation planning activities are described at a more detailed level. This includes cost effectiveness, marginal analysis, conservation effects for decisionmaking, and economic thresholds.

A useful technical note to consult is The Economics of Nutrient and Pest Management, September 1990: Series 614. If additional help is needed, contact your state economist.

610.0501 Partial budgeting

(a) Method

A partial budget is an orderly and logical method of estimating what will happen if small changes are made in farm operations. Examples of changes include adding another crop, switching from alfalfa to potatoes, or investing in farm storage. Since the change affects only certain components, only the cost and income changes for the affected crops need to be considered. Partial budgeting will helps to answer such questions as:

- How much will the changes cost?
- Will income increase as a result of the change?
- Will net income change?

(b) Example

The example form (fig. 5–1) shows how to display the information. A short example of partial budgeting used to answer a buy or rent problem is shown in example 5–1. A series of questions in appendix B helps in conducting a complex partial budget evaluation. It provides the resulting net change in profits, an analysis of the answer and how it was estimated, and a basis for deciding about operational changes.

Figure 5-1 Partial budget worksheet

Partial budget

Problem:

Additional costs:	$__________	Additional revenue:	$__________
Reduced revenue:		Reduced costs:	
______________________	$__________	______________________	$__________
______________________	$__________	______________________	$__________
______________________	$__________	______________________	$__________
______________________	$__________	______________________	$__________
A. Total additional costs and reduced revenue	$__________	B. Total additional revenue and reduced costs	$__________
			$__________
		Net change in prof`it (B minus A)	$__________

610.0502 Break-even analysis

(a) Method

Break-even analysis provides useful information when small changes in specific conservation situations are being evaluated. This technique can be used to determine how much of an investment can be made based on the expected returns. Examples of break-even questions include:

- How much can I afford to spend?
- How long will it take to get my money back?
- What rate of return will I receive?
- How much net gain do I need?

Each of these questions involve an unknown variable, such as cost, time, interest rate, and change in net returns, respectively. Each question can be answered if the other three variables are known. Generally, three of the following four pieces of information must be available to solve for the other:

- Cost—cost of applying the conservation
- Time—system life, loan period
- Interest rate—producers' borrowing or saving interest rate
- Change in yield or net returns—the difference created by applying conservation

(b) Example

The problems and solutions in figure 5–2 illustrates the break-even analysis process. The examples in figure 5–3 provides a better idea of how break-even analysis can be used. In this example, an opportunity exists to develop a water source (a spring) and improve grazing distribution. This will allow the harvest of 30 AUMS in an area where only 10 are harvested at present.

Figure 5-1 Partial budgeting example

Partial budget—Buy or Rent

Problem: A farmer has made a decision to no-till 600 acres. Now the choice is to rent a drill for $7.50 per acre or purchase a new drill. A new drill would cost $24,000, have a salvage value of $4,000, and a useful life of 10 years. The same tractor would be used to pull either drill so there will be no change in tractor costs. Annual repairs on the drill are estimated at $300, and taxes and insurance will be about $50 per year. Should the farmer purchase the new drill? (Purchasing would be the change.)

Solution:

Additional costs:	$__________	Additional revenue:	$__________
Capital recovery (purchase drill) ($24,000 - 4,000) x (amort. factor 10 yr. @ 10%)	$3,255	None	
Interest on salvage value $4000 @ 10%/year	$400		
Taxes and insurance	$50		
Repairs	$300		
Reduced revenue:		Reduced costs:	
None		Machine rent 600 x $7.50	$4,500
A. Total additional costs and reduced revenue	$4,005	B. Total additional revenue and reduced costs	$4,500
		Less A	$4,005
		Net change in profit (4,500 – 4,005)	**$495**

Buying the new drill is a beneficial change.

Figure 5-2 Break-even analysis example

Break-even cost:

Change in yield x value of yield/unit x proper annuity factor, given years and interest rate = break-even cost

At any cost lower than break-even cost plus cost sharing, the producer will profit from the conservation investment

Break-even time:

$$\frac{\text{Conservation cost after cost sharing}}{\text{Value of change in yield}} = \text{Calculated cost, annuity factor}$$

Using the appropriate interest rate column, find the time period row which approaches the calculated annuity factor. This time period is the break-even rate of return; that is, the rate of return needed to break-even on the conservation investment.

Break-even interest rate:

$$\frac{\text{Conservation cost after cost sharing}}{\text{Value of change in yield}} = \text{Calculated cost, annuity factor}$$

Using the appropriate time row, find the interest rate that approaches the calculated annuity factor. This interest rate is the break-even rate of return; that is, the rate of return needed to break-even on the conservation investment.

Break-even value per unit of yield:

$$\text{Conservation cost after cost sharing} \times \frac{\text{amortization factor for given years and interest rate}}{\text{change in yield (i.e., 30 bushels, 20 AUMs)}}$$

The conservation investment will pay for itself at any price received greater than the break-even value.

Figure 5-3 Sample problems and solutions

Example 1: Break-even cost

Problem: How much can the cooperator afford to spend for the stock water development if the system life is 20 years, the interest rate is 12 percent, and an AUM is valued at $7?

Solution: 20 AUMS (change in yield) x $7 per AUM = $140. $140 x 7.46944 (present value of an annuity of 1 per year for 20 years at 12% interest) = $1,045.72.
The cooperator's breakeven point is a capital cost of $1,045.72. The cooperator will profit from stock water development at any cost below the break-even point.

Example 2: Break-even time

Problem: What is the period of capital recovery or minimum life expectancy for the proposal if the capital cost is $1,000, an 8 percent interest rate is used, and the value of the change in AUMs produced is $120 per year?

Solution: Using the 8 percent compound interest and annuity table, read down the column labeled PV of an annuity of 1 per year to a factor close to 8.333. Read left to the Number of years hence column. The factor of 8.333 occurs between 14 and 15 years. The conclusion is that the period of capital recovery, or break-even time, is about 15 years.

$$\frac{\$1,000}{120} = 8.333$$

Example 3: Break-even interest rate

Problem: What is the break-even interest rate or internal rate of return when capital cost is $1,000, effects are evaluated over a 20-year period, and the value of the change in AUMs produced is $180 per year?

Solution: The PV of an annuity of one per year factor for the break-even interest rate is

$$\frac{\$1,000}{180} = 5.555$$

Reading across interest tables we find that the PV of an annuity of one per year factor for 20 years at 16% interest = 5.92884, 17% interest = 5.62777, and 18% interest = 5.35275. Since the factor for 17 percent interest is closest to, but not less than the break-even factor of 5.55556, we conclude that the break-even interest rate is slightly greater than 17 percent interest.

Example 4: Break-even value

Problem: 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 percent interest?

Solution: Given the level of the other variables, an AUM must be worth $8.79 to break even.

$$\$1,400 \times .12558 \text{ (amortization factor, 20 years, 11\% interest)} = \$175.81$$

$$\frac{175.81}{20} = \$8.79 \text{ per AUM}$$

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

610.0503 Cost and Price Indexes

(a) Inflation

One reason the value of the dollar has constantly changed in recent history is inflation. Inflation occurs when the volume of money and credit in an economy increases faster than the supply of goods, thus driving up the price of the goods that are available for purchase. Even though there is more money, everything costs more, so no one really gains. Or do they?

The answer depends on whether increases in income (and expenses) keep pace with the rate of inflation, exceed it, or trail along behind it.

(b) Commonly used indexes

Four of the most commonly used indexes in agricultural analyses are Prices Received by Farmers (table 5-1), Prices Paid by Farmers (table 5-2), the Consumer Price Index (CPI) (table 5-3), and the Engineering News Record (ENR) construction cost index (table 5-4). The choice of which index to use depends upon the nature of the numbers you are trying to update. In general, the indexes for Prices Paid and Prices Received by Farmers are more specific to agriculture than the CPI or ENR indexes.

(1) Prices paid and prices received by farmers
Figure 5-4 uses the Prices Paid by Farmers index in to illustrate the procedure for using an index. This procedure can be applied to any index. Indexing is a method of quickly adjusting cost and return information for inflation or deflation over time. Prices Paid by Farmers and Prices Received by Farmers indexes are calculated monthly by the National Agricultural Statistics Service (NASS). These indexes are published monthly and annually in the Agricultural Prices Report by NASS and many State crop and livestock Reporting Boards. The indexes are also published annually in the United States Department of Agriculture's Annual Statistics. The reports that contain the annual summary of indexes of prices received and paid by farmers; prices received for farm commodities by states and prices paid for production items by region and the U.S. Past year and earlier years can be viewed at *http://usda/mannlib.cornell.edu/imports/nassr/price/zap-bb/*.

The indexes published in the Agricultural Statistics for 1977 use 1977 for the base year. The base year is expressed in the index tables as "1977= 100" and is changed periodically. Indexes are adjusted to a new base by dividing the prices for all other years into the prices for the selected base year.

Enterprise cost and returns, or crop budgets, may be adjusted over time or updated using price indexes. The index of items used in production (all commodities), Prices Paid by Farmers, is the commonly used index for total costs in a budget (table 5-1). Total costs may be broken down, for example, into seed, fertilizer, and machinery, and the respective individual indexes applied. The total change in costs resulting from use of the aggregate index will be the same as the change in costs resulting from use of the individual indexes, within rounding differences.

Prices Received by Farmer's index (table 5-2) may also be used to adjust total returns in crop budgets. However, current prices of the commodity preferable because they are usually readily available.

The Consumer Price Index and the Engineering News Record Index can be used in an identical fashion to that of the Prices Received and Prices Paid indexes.

Figure 5–4 Soybean budget

Given: A soybean budget dated 1987 is available. Current price for soybeans is $5.95.

Soybean budget, 1986.

35 bushels $\times$ $5.20	=	$182
Production cost	=	170
Net returns	=	12

Index of items used in production, from table 5-1:

1987	147
1988	157
1989	165

Problem: Cost and returns for soybeans are needed for 1989.

Solution: To obtain the factor for adjusting 1987 costs to 1989, divide the 1989 index by the 1987 index:

$$\frac{165}{147} = 1.1224$$

The 1987 costs are then multiplied by the adjustment factor to get the 1989 adjusted costs:

$$\$170 \times 1.1224 = \$190.80$$

A 1989 adjusted budget is then constructed, using the current price of soybeans as follows:

35 bushels $\times$ $5.95	=	$208
Adj. production cost	=	191
Net returns	=	17

To obtain an average index for 1987-89 (3 years) average Prices Paid index is:

$$147 + 157 + 165 = \frac{469}{3} = 156$$

(This average index may then be used to adjust a base year cost to an average cost for 1987-89. Indexes may also be used to adjust budgets for current years to previous years. Except in rare cases, it is recommended that the adjustment periods be kept to no more than 5 years, because using indexes to adjust budget costs assumes technology is constant. Indexes measure how much it costs to purchase this hypothetical package of goods and services compared to what it was in the base year.)

(2) Consumer price index

A number of indexes can be used to convert costs and other numerical figures from different periods to dollars of constant purchasing power. The CPI (table 5-3) is commonly used and is appropriate for most applications. The conversion process is best explained with an example.

Average monthly earnings of a farm laborer in 1909 were $21.30. How much would it have taken in 1988 to equal the same purchasing power? Multiply $21.30 by the CPI for 1988 (118.3), and divide by the CPI for 1909 (9.0).

$$21.30 \times \frac{118.3}{9} = \$279.97$$

(3) Engineering news record index

The ENR index (table 5-4) can be used to convert cost information from different periods to dollars of constant purchasing power. This index is commonly used to update cost information in watershed plans and similar types of projects. Use of this index is identical to that described for the CPI. Although monthly data are printed on this table, only annual averages should normally be used in NRCS work. Indexes measure how much it costs to purchase a hypothetical package of goods and services, compared to what it was iin the base year.

Table 5-1 Prices received by farmers: index numbers by groups of commodities and ratio, United States 1975-87 (1977=100) and 1988-1998 (1990-1992=100) 1/ 2/

Year	Food grains	Feed grains/ hay	Cotton	Tobac- co	Oil bear. crops	Fruit and nuts	Fruit for fresh mkt. 3/	Com/ veg.	Com./ veg. for fresh mkt.	Pot., swt. pot./ dry edible beans	All	Meat	Dairy	Poul- try/ eggs	Live- stk/ prod.	All farm prod.	Ratio 4/
1975	155	127	68	93	81	85	84	92	88	108	105	100	90	103	98	101	113
1976	129	120	99	93	85	80	80	91	88	104	102	101	100	102	101	102	107
1977	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1978	122	101	91	109	93	137	144	105	106	104	105	134	109	106	124	115	106
1979	147	114	96	118	103	144	151	110	109	92	116	166	124	111	147	132	107
1980	165	132	114	124	102	124	128	113	110	129	125	156	135	112	144	134	97
1981	166	141	111	140	110	130	132	136	135	177	134	150	142	116	143	139	92
1982	146	120	92	153	88	175	186	126	120	125	121	155	140	110	145	133	84
1983	148	143	104	155	102	128	131	130	129	123	128	147	140	118	141	135	84
1984	144	145	108	153	109	202	220	133	133	157	138	151	139	135	146	142	87
1985	133	122	93	153	84	180	192	129	122	124	120	142	131	119	136	128	79
1986	109	98	91	138	77	169	177	130	123	114	107	145	129	128	138	123	77
1987	103	85	99	129	79	181	194	144	147	126	106	163	129	107	146	126	78
1988 5/	113	102	95	86	126	96		104		88	96	91	93	98		99	108
1989 6/	127	109	98	96	118	99		103		131	99	94	104	111		104	108
1990	100	105	107	97	105	97		102		133	101	105	105	105		104	105
1991	94	101	108	102	99	112		100		99	97	101	94	99		99	99
1992	113	98	88	101	100	99		111		88	102	96	100	97		99	97
1993	105	99	89	101	108	91		116		107	103	100	98	105		102	98
1994	119	106	109	101	110	89		109		110	105	90	99	106		98	94
1995	134	112	128	103	104	97		119		106	106	85	98	107		99	92
1996	157	146	122	105	128	118		111		114	108	87	114	120		108	98
1997	128	117	112	104	131	108		122		90	108	114	102	113		105	90
1998	103	100	107	104	107	110		119		99	108	120	119	117		100	87

1 Source: United States Department of Agriculture, Agricultural Statistics, 1990, page 386.
2 The National Agricultural Statistics Service indexes are computed uses the price estimates of averages for all classes and grades for individual commodities being sold in local farm markets. In computing the group indexes, prices of individual commodities have been weighted by average quantities sold during 1971-73.
3 Fresh market for noncitrus, and fresh market and processing for citrus.
4 Ratio of Index of Prices Received (1977=100) to Index of Prices Paid (1977=100).
5 1980-1998 Base weight period 1990-1992=100.
6 Numbers changed slightly in versions of data printed as year 94 and year 98 reports.

Table 5-2 Prices paid by farmers: Index numbers by groups of commodities, United States, 1975-89 (1977=100) and 1988-98 (1990-92=100) 1/ 2/ 3/

Year	Production indexes: Prod. (all com.)	Feed	Livestk. & poul.	Seed	Fert.	Ag. chem.	Fuels/ energy 4/	Farm/ sup. rep.	Auto/ trucks	Trac./ self-prop. mach.	Other mach 7/	Build/ fenc.	Farm serv./ cash rent 4/	Rent 8/	Int.	Taxes	Wage rates 5/	Prod., int., tax, wage rates	Com., int., tax, wage rates 6/
1975	91	100	85	94	120	102	88	102	82	82	80	90	86		77	87	85	89	89
1976	97	103	97	92	102	111	93	100	94	94	95	94	92		88	94	93	95	95
1977	100	100	100	100	100	100	100	100	100	100	100	100	100		100	100	100	100	100
1978	108	98	140	105	100	94	105	104	106	109	108	108	107		117	100	107	109	108
1979	125	110	185	110	108	96	137	115	117	122	119	118	117		143	107	117	125	123
1980	138	123	177	118	134	102	188	134	123	136	132	128	144		174	115	127	139	138
1981	148	134	164	138	144	111	213	147	143	152	146	134	157		211	123	138	151	150
1982	153	122	164	141	144	119	210	152	159	165	160	135	169		242	124	144	157	159
1983	152	134	160	141	137	125	202	152	174	174	171	138	145		250	129	148	159	161
1984	155	135	154	151	143	128	201	147	182	181	180	138	152		248	133	151	161	164
1985	151	116	154	153	135	128	201	146	193	178	183	136	150		228	136	154	156	162
1986	144	108	153	148	124	127	162	144	198	174	182	136	145		211	138	152	150	159
1987	147	103	179	148	118	124	161	145	208	174	185	137	147		189	144	166	151	162
1988 5/	90	104	91	94	94	89	77	90	90		89	94	85		100	89	87	92	91
1989	95	110	93	104	99	93	83	94	93		94	96	91		106	91	95	97	96
1990	99	103	102	102	97	95	100	96	97		96	99	96	96	107	95	96	99	99
1991	100	98	102	99	103	101	104	100	100		100	100	99	100	100	101	100	100	100
1992	101	99	96	99	100	103	96	104	102		104	101	103	104	93	104	105	101	101
1993	103	99	104	105	97	107	92	107	109		106	105	108	100	88	107	108	102	104
1994	106	105	95	109	106	110	88	110	115		113	109	113	108	92	112	111	107	106
1995	109	104	82	110	122	115	91	112	121		121	114	118	116	103	117	113	109	110
1996	115	129	75	115	125	119	102	115	118		125	115	116	128	106	112	117	115	115
1997	119	125	94	119	121	121	106	118	119		128	118	116	136	106	115	123	118	118
1998	115	110	88	122	112	122	88	119	119		133	118	117	134	109	119	129	116	117

1 Source: United States Department of Agriculture, Agricultural Statistics, 1990, page 386. (http://usda.mannlib.cornell.edu/reports/nassr/price/zap-bb/
2 The National Agricultural Statistics Service indexes are computed using the price estimates of averages for all classes and grades for individual commodities being sold in local farm markets. In computing the group indexes, prices of individual commodities have been weighted by average quantities sold during 1971-73.
3 Index values for 1973 through 1975 were revised and published in May 1976 using 1971-73 weights. Indexes were reordered and several new indexes introduced.
4 New indexes; values for years prior to 1973 are not available.
5 Simple average of seasonally adjusted quarterly indexes.
6 Family living component included.
7 Other machinery heading dropped beginning on the 1988 report.
8 Farm and rent reported separately.

Table 5-3 Consumer price index, 1982-84=100 [1/]

Year	CPI	Year	CPI	Year	CPI	Year	CPI
1900	8.3	1925	17.5	1950	24.1	1975	53.8
1901	8.3	1926	17.7	1951	26.0	1976	59.9
1902	8.7	1927	17.3	1952	26.5	1977	60.6
1903	9.0	1928	17.1	1953	26.7	1978	65.2
1904	9.0	1929	17.1	1954	26.9	1979	72.6
1905	9.0	1930	16.7	1955	26.8	1980	82.4
1906	9.0	1931	15.2	1956	27.2	1981	90.3
1907	9.3	1932	13.6	1957	28.1	1982	96.5
1908	9.0	1933	12.9	1958	28.9	1983	99.6
1909	9.0	1934	13.4	1959	29.1	1984	103.9
1910	9.3	1935	13.7	1960	29.6	1985	107.6
1911	9.3	1936	13.8	1961	29.9	1986	109.6
1912	9.7	1937	14.3	1963	30.2	1987	113.6
1913	9.9	1938	14.1	1963	30.6	1988	118.3
1914	10.0	1939	13.9	1964	31.0	1989	124.0
1915	10.0	1940	14.0	1965	31.5	1990	130.7
1916	10.9	1941	14.7	1966	32.4	1991	136.2
1917	12.8	1942	16.3	1967	33.4	1992	140.3
1918	15.0	1943	17.3	1968	34.8	1993	144.5
1919	17.3	1944	17.6	1969	36.7	1994	148.2
1920	20.0	1945	18.0	1970	38.8	1995	152.4
1921	17.9	1946	19.5	1971	40.5	1996	156.85
1922	16.7	1947	22.3	1972	41.8	1997	160.52
1923	17.0	1948	24.1	1973	44.4	1998	163.01
1924	17.1	1949	23.8	1974	49.3	1999	166.1
						2000	169.7 [2/]

1 Source: Financial Trend Forecaster Homepage (http://www.fintrend.com/html/historical.html).
2 February 2000

Table 5-4 Construction cost index history, 1906-2000 (Source: Engineering News Record) 1/

Annual average 2/							Monthly construction cost												
Yr.	AA	Yr.	AA	Yr.	AA	Yr	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual avg
1906	95	1929	207	1952	569	1975	2103	2128	2128	2135	2164	2205	2248	2274	2275	2293	2292	2297	2212
1907	101	1930	203	1953	600	1976	2305	2314	2322	2327	2357	2410	2414	2445	2465	2478	2486	2490	2401
1908	97	1931	181	1954	628	1977	2494	2505	2513	2514	2515	2541	2579	2611	2644	2675	2659	2660	2576
1909	91	1932	157	1955	660	1978	2672	2681	2693	2698	2733	2753	2821	2829	2851	2851	2861	2869	2776
1910	96	1933	170	1956	692	1979	2872	2877	2886	2886	2889	2984	3052	3071	3120	3122	3131	3140	3003
1911	93	1934	198	1957	724														
1912	91	1935	196	1958	759	1980	3132	3134	3159	3143	3139	3198	3260	3304	3319	3327	3355	3376	3237
1914	89	1937	235	1960	824	1982	3707	3728	3721	3731	3734	3815	3899	3899	3902	3901	3917	3950	3825
1915	93	1938	236	1961	847	1983	3960	4001	4006	4001	4003	4073	4108	4132	4142	4127	4133	4110	4066
1916	130	1939	236	1962	872	1984	4109	4113	4118	4132	4142	4161	4166	4169	4176	4161	4158	4144	4146
1917	181	1940	242	1963	901														
1918	189	1941	258	1964	936	1985	4145	4153	4151	4150	4171	4201	4220	4230	4229	4228	4231	4228	4195
1919	198	1942	276	1965	974	1986	4218	4230	4231	4242	4275	4303	4332	4334	4335	4344	4342	4351	4295
1920	251	1943	290	1966	1019	1987	4345	4352	4359	4363	4369	4387	4404	4443	4456	4459	4453	4478	4406
1921	202	1944	299	1967	1074	1988	4470	4473	4484	4489	4493	4525	4532	4542	4535	4555	4567	4568	4519
1922	174	1945	308	1968	1155	1989	4580	4573	4574	4577	4578	4599	4608	4618	4658	4658	4668	4685	4615
1923	214	1946	346	1969	1269														
1924	215	1947	413	1970	1381	1990	4680	4685	4691	4693	4707	4732	4734	4752	4774	4771	4787	4777	4732
1925	207	1948	461	1971	1581	1991	4777	4773	4772	4766	4801	4818	4854	4892	4891	4892	4896	4889	4835
1926	208	1949	477	1972	1753	1992	4888	4884	4927	4946	4965	4973	4992	5032	5042	5052	5058	5059	4985
1927	206	1950	510	1973	1895	1993	5071	5070	5106	5167	5262	5260	5252	5230	5255	5264	5278	5310	5210
1928	207	1951	543	1974	2020	1994	5336	5371	5381	5405	5405	5408	5409	5424	5437	5437	5439	5439	5408
						1995	5443	5444	5435	5432	5433	5432	5484	5506	5491	5511	5519	5524	5471
						1996	5523	5532	5537	5550	5572	5597	5617	5652	5683	5719	5740	5744	5620
						1997	5765	5769	5759	5799	5837	5860	5863	5854	5851	5848	5838	5858	5825
						1998	5852	5874	5875	5883	5881	5895	5921	5929	5963	5986	5995	5991	5920
						1999	6000	5992	5986	6008	6006	6039	6076	6091	6128	6134	6127	6127	6060
						2000	6130	6160	6201	6198									

1 How ENR builds the index: 200 hours of common labor at the 20-city average of common labor rates, plus 25 cwt of standard structural steel shapes at the mill price, plus 22.56 cwt (1. 128 tons) of portland cement at the 20-city price, plus 1,0888 board-feet of 2 x 6 lumber at the 20-city price.

2 Base: 1913=100. Indexes revised from September 1996 through January 1998 (http://www.enr.com/cost/costcci.asp).

610.0504 Cost effectiveness

(a) Method

Cost effectiveness analysis is an appraisal technique used when benefits cannot be reasonably measured in monetary terms. It can be used in two forms:

- The constant effects method, which uses least-cost analysis to determine the alternative for meeting a stated level of benefits, including intangible ones. (See fig. 5–4.)
- The constant cost method, which calculates the cost per unit of benefit, or the cost effectiveness ratio, and requires that means exist for quantifying benefits (but not necessarily for attaching a monetary price or economic value to the benefits).

If analysis is used to determine the most cost-effective means of production among option technologies, it is most often in the form of the constant effects method and called least-cost analysis. A measure of product worth is impossible to obtain from cost-effectiveness analysis because the analysis is done without reference to user value.

610.0505 Marginal analysis

(a) Method

Marginal analysis is the analysis of the change in one variable when a small change is made in another. An example of its application is the marginal value product. This is the amount that production is changed when a small change is made in input, all other inputs being held constant. For instance, one could measure how different amounts of fertilizer affect wheat production.

Marginal analysis is an important concept underlying most economic analyses. On (or at) the margin refers to a small change in the total of some input or in production.

Figure 5-5 Computing average annual cost life cycle cost analysis example

Problem: Determine least costly alternative.

Situation: Two alternatives are being considered to provide pressurized water at a given point: a pump and motor or a gravity pressurized pipeline, each with a 20-year life expectancy. The installation cost (capital cost) of the pump and motor is estimated to be $5,000, and of the gravity pipeline, $10,000. Average annual operation and maintenance cost for the pump and motor is estimated to be $1,000, and for the gravity pipeline, $300. The installation and annual operation and maintenance costs between alternatives are:

Pump and motor:	$5,000 + $ 1,000=$6,000
Gravity pipeline:	$10,000 + $300=$10,300

Questions: When compared over a 20-year life at 20 percent interest, which is the least costly alternative? If the interest rate used is 5 percent, which is least costly? What general conclusions can we draw from this example?

Solutions: Compute average annual cost life cycle cost analysis to determining least cost alternative

To determine which option, pump or motor or gravity pipeline, is least costly, the installation and average annual operation and maintenance (O&M) costs of each must be considered on a single common time base that is frequently used is average annual total cost. An average annual equivalent of the installation cost can be derived by amortizing the one-time installation cost at the evaluation interest rate over the evaluation period, which is the life expectancy in this problem. O&M costs are already calculated on an annual basis. Hence, the total average annual cost can be determined by adding together the average annual equivalent of installation costs and the O&M costs. When average annual total cost at a given interest rate has been determined for each option, comparison will reveal which is the least costly means of providing equal service. It is important to realize and understand that economic comparison of costs to determine the least costly option is only valid when each option provides the same level of service or output.

Comparison over 20 years at 20 percent interest

Average Annual	Pump and motor	Gravity pipeline
installation cost	$1,027	2,054
(Factor = 0.20536)		
Average annual O&M	$1,000	300
Average annual total cost	**$2,027**	**2,354**

Conclusion: When compared over 20 years at 20 percent interest, the pump and motor option is less costly than the gravity pipeline option.

Comparison over 20 years at 5 percent interest

Average Annual	Pump and motor	Gravity pipeline
installation cost	$401	802
(Factor = 0.08024)		
Average annual O&M	$1,000	300
Average annual total cost	**$1,401**	**$1,102**

Figure 5-5 Compute average annual cost life-cycle cost analysis—Continued

Conclusion: When compared over 20 years at 5 percent interest, the gravity pipeline is less costly than the pump and motor option.

General conclusions: High interest rates tend to push decisionmakers away from higher installation costs in favor of higher operation and maintenance costs. Low interest rates tend to do the opposite, by making one-time installation costs look relatively more favorable than recurring annual operation and maintenance costs. Viewed from another perspective, high interest rates tend to move decisionmakers away from options that require large and relatively irreversible commitments and toward operations with low initial commitment and high flexibility for change. Low interest rates indicate more expected stability in future economic conditions, and therefore make initial commitment more comfortable for decisionmakers.

An important factor that confounds and partially negates the above conclusions is inflationary impact on recurring annual costs. Inflation is one factor that influences the market rate of interest. Generally, when high interest rates prevail, higher prices for most goods and services are expected in the future. If all goods and services increase at the same rate, the stated general conclusions remain valid. However, above average increases in price may occur. The market for a particular good adjusts to expected increases in demand or shortages in supply. When high interest rates reflect a differential price increase of a good, that increase is considered price escalation. Expected price escalation must be considered separately from inflation, and partially negates the general conclusions as well. Expected price escalation effects on decision making are considered in the next section.

610.0506 Conservation Effects for Decisionmaking

(a) Introduction

(i) Purpose and scope

Conservation Effects for Decisionmaking (CED) enables NRCS planners to display and evaluate the effects of various conservation options available to the land user.

The CED process can be used to assist land users with their conservation decisions by:

- Providing a framework in which to organize and present information that facilitates comparison of the positive (gains) and negative (losses) effects of a conservation option.
- Permitting consideration of all physical, sociological, and economic values pertinent to the evaluation.
- Encouraging the employment of analytical tools at appropriate levels of sophistication to provide information.
- Capitalizing on the knowledge and experience of our agency professionals and clients to foster interaction throughout the decisionmaking process.

(ii) The planning process

The CED process is completely consistent with the planning process outlined in the National Planning Procedures Handbook. CED is not a new system, but a method of thought organization. It provides a way to evaluate the continuum of all alternatives available to the land user, and is intended to make conservation planning and application easier and more efficient.

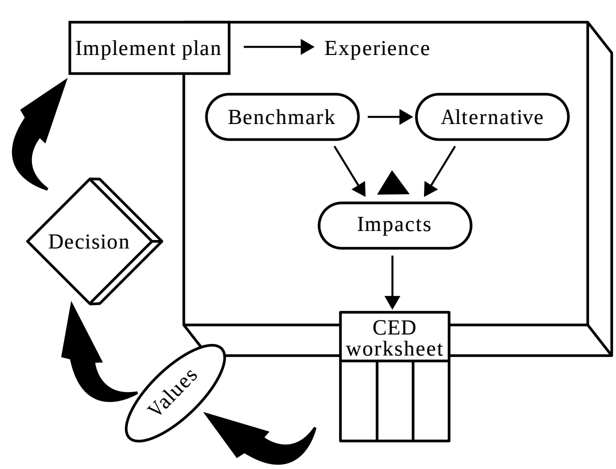
(iii) Collecting and recording information

The collecting and recording of effects information for the CED process is not a new approach; it has been the major thrust of conservation management systems (CMS), and of planning in general. The CED idea emerged from a national economic application work group. It links the planning process with economic input and emphasizes the end objective. The identification of the expected effects from applied conservation allows decisions to be made and actions to be taken. The CED framework is applicable to all NRCS programs and planning situations. Consequently, it is also the theme and organizational tool for this handbook, which has an explanation of the steps in the process of evaluation, a diagram of the decisionmaking process, and examples of evaluation approaches. Subsequent chapters explain the various economic principles, tools, and techniques available for use if one wishes to carry evaluations to a more detailed level of analysis.

(iv) The framework

The CED framework has information from many disciplines combined, so that a comprehensive and effective evaluation can be made. For more guidance on how to carry out a CED analysis, consult with your state office about CED training, the CED Training Manual, and the CED Workbook. The workbook contains step-by-step instructions and explanation of each step of the process. Lessons and questions are provided for self-study. Always keep in mind that economics is just one of the many tools available to help NRCS do a better job and to help the land user make more informed decisions. Figure 5-6 is a chart presented to graphically explain the CED decisionmaking process.

Figure 5–6a CED decisionmaking process



(b) Steps in the CED process

(i) Benchmark

Field office level planning efforts should always first identify the benchmark condition. The planner and land user work together to develop a picture of existing conditions, trends, problems, opportunities, and objectives. The assistance provided is based upon soil, water, and other natural and cultural resource information. The description of benchmark conditions could include:

- Other inventories and evaluations
- Description of current crops, farming practices, livestock type and condition, and available equipment
- Consideration of sociological and economic characteristics

Planning objectives and the complexity of each situation determine the level of detail necessary for inventories and evaluations.

The objectives of the land user will usually affect the kind and amount of information gathered and evaluated. However, the formulation of planning objectives requires that the objectives of society as well as those of the land user be considered. The planning process should also identify opportunities. This creates a broader view that goes beyond the search for resource problems to recognize where resource enhancements may be achieved. For example, if a given area does not have a significant soil resource problem onsite, opportunities may still exist to make on-farm improvements that could increase efficiency and profitability, while at the same time reducing negative water or air quality effects offsite.

(ii) Alternatives

Alternatives that meet both individual and societal objectives need to be considered after a picture of the benchmark situation and expected future trends are developed. The CMS (Conservation Management System) formulation process will normally be used to develop alternatives that provide a desirable view of the future.

Proposed alternatives enable planners to develop a picture of the conditions that could exist on the farm or ranch with conservation treatment. Alternatives represent the world of possibilities, a vision of what could be, based on predictive models, professional judgment, and experience with the expected effects of each action or set of actions considered. They are the different options that are proposed to deal with current and future problems or issues arising from the existing situation.

An alternative is generally a Resource Management System (RMS), but could also be an Acceptable Management System (AMS), or Alternative Conservation System (ACS) for plans developed for the 1985 Food Security Act. It could be a single practice or simply an adjustment to present farming operations. Proposed alternatives must be consistent with Sections III and IV of the Field Office Technical Guide (FOTG), and must also be within the approval authority of the planner. Apart from the FOTG, the experience and knowledge of the planner and decisionmaker are the main sources of information used for selection.

To achieve a specific alternative, certain steps or actions need to be taken. Examples of actions include a change in cropping sequence, land use, time of seeding, tillage or timing of cultivation, structural improvements to the farm, or simply lowering the speed of a single tillage operation. Each individual has a different experience base that can be increased by on-the-job training, specialized training courses, field trials, or the use of models. A useful learning experience for planners is to visit land users with successful conservation treatments already applied. Technology transfer through exposure in this manner rapidly broadens an employee's perspective and improves their expertise and confidence. If successful on-farm experiences are documented and shared as case studies, the knowledge base of others within and outside the agency could also be easily enhanced. Such experiences should be recorded first in physical and biological terms rather than monetary ones, because monetary values are simply a translation of the former and can be expressed in current dollars at any time.

(iii) Impacts

The completed alternative is compared with the benchmark condition to estimate the impacts of the actions. The impacts of applied conservation options are the differences between the benchmark or current condition and trends and the proposed alternative situation. Quantification of the impacts is dependent upon the degree of detail used to describe or measure the benchmark and expected alternative conditions.

The impacts should be described in narrative form at a minimum, and in quantitative terms to the extent possible. They should also be recorded in an easy to understand manner for consideration by the decision-maker.

Conservation Effects or Impacts Worksheets can be used to record this information. Differences in erosion rates, habitat values, water quality, acres farmed, bushels harvested, labor and fuel requirements, pesticides used, etc., should all be documented to the extent that such information is needed by the land user or is required by the agency. The time frame when the impacts occur might also be identified, because certain actions such as pasture improvements can result in immediate costs, but the resulting yield increases may be delayed and then occur for an extended period of time.

(iv) Values

Each individual's values will affect the relative merits of an impact. Ten additional quail may be a positive impact to one person and a negative one to another. An individual's set of values may be in harmony with society's best interest or it may be in direct conflict. Once it has been applied to the impacts, the positive and negative points may be listed. This listing can start out generally and be expanded to increasingly detailed levels. The procedure may involve traveling completely back through the decisionmaking process, or it may involve increasingly sophisticated levels of detail on the same impacts. The process is continued until the land user has enough detail to make an informed decision. In most cases, the planner will identify the costs and describe necessary maintenance for each of the options. Often a limited amount of detailed information will be enough. Occasionally, however, a more complex analysis will be necessary, and the concepts presented in this handbook may help.

610.0507 Economic Thresholds

Integrated pest management (IPM) is an approach to pest control that combines biological, cultural and other alternatives to chemical control with the judicious use of pesticides. The objective of IPM is to reduce pest infestation below a level that can cause economical damage while minimizing harmful effects of pest control on human health and environmental resources.

A key principle of IPM is that pesticides should only be used when field examination or "scouting" shows that infestations exceed economic thresholds. The economic threshold occurs when the levels of pest population that, if left untreated, would result in reductions in revenue that exceed treatment costs.

The point at which input starts to "pay" for itself is called the economic threshold. Economic thresholds can assist farmers and ranchers make decisions about pesticide application. Undesirable weeds and insects can cause major injury to a crop. A small amount of injury may be tolerable if it does not significantly affect crop yield and, consequently, does not significantly affect revenue gained from selling the crop. Nevertheless, if the presence of pests is considered to affect crop yield, decisions about using pesticides must be based on whether the cost of treating with pesticides is less than the value of expected crop yield loss.

(a) Economic Threshold - Insecticides

The insecticide economic threshold is the point where expected crop damage from insects is high enough so that insecticide control costs equal the value of expected yield loss due to the insects.

The following represents a method that can be used to assess the need to apply insecticide (economic threshold) in corn where the European corn borer is the target species.

Needed Information:

- Expected crop yield (without presence of corn bores).
- Expected crop market price.
- Estimated population density of borers and expected yield loss (sources of yield loss information include USDA Extension Service, agricultural research institutes, and producer's experience).
- Cost of insecticide treatment (chemical and application).

Example: An average of one borer per plant is estimated to cause a 5 percent yield loss. Scouting the field results in about 2 worms per plant. Application of an insecticide would provide 75% control. Chemical and application costs are $12 per acre. Expected yield is 125 bushels per acre, with an expected market price of $2.20 per bushel.

Potential Yield Loss/Acre =
125 bushels x 10% (2 borers/plant) = 12.5 bushels

Expected Value of Loss/Acre =
12.5 bushels x $2.20 = $27.50

Preventable Value of Loss/Acre =
75% x $27.50 = $20.63

In this example, the net gain from insecticide treatment would be $8.63 ($20.63 - $12). Therefore, it would be advantageous to treat the field. Had the treatment costs exceeded $20.63 per acre, then further losses could be prevented by not treating the field at the time.

According to surveys conducted by the USDA Economic Research Service, scouting and threshold use are widespread in specialty crop production. Chemical dealers, crop consultants, and other professionals scouted nearly two-thirds of the U.S. fruit and nut acreage and nearly three-quarters of the vegetable acres in the surveyed states for insects. Growers reported using economic thresholds as the basis for making pesticide treatment decisions on virtually all of these scouted acres. Potato growers reported that 85 percent of their acreage was scouted in 1993, and economic thresholds were used in making nearly three-quarters of their insecticide application decisions. Growers of two-thirds to three-fourths of corn and soybeans reported using scouting, mostly by themselves or a family member. Most of these growers reported using economic thresholds as well. Nearly 90 percent of the cotton acreage was scouted, including commercial scouting services on 40 percent of this acreage. Insect pests cause large economic losses in cotton production, and entomologists have been developing economic thresholds for these pests for several decades.

Why manage pesticides?

Concerns about the side effects of synthetic pesticides began emerging in scientific and agricultural communities in the late 1940's, after the problems with insect resistance to DDT. Many unintentional effects of pesticide exposure on nontarget species have been reported since then, including acute pesticide poisonings of humans (especially during occupational exposure) and damage to fish and wildlife, including species that are beneficial in agricultural ecosystems. Since the 1960's, especially after the publication of Silent Spring by Rachel Carson in 1962, and the establishment of US Environmental Protection Agency in 1970, some pesticides have been banned, others restricted in use, and others' formulations changed to lessen undesirable effects.

Human health impacts

The American Association of Poison Control Centers estimates that approximately 67,000 nonfatal acute pesticide poisonings occurs annually in the United States. However, the extent of chronic illness resulting from pesticide exposure is much less documented. Direct exposure to pesticides by those workers who handle and work around these materials is believed to pose the greatest risk, but indirect exposure through trace residues in food and water is also a source of concern.

Environmental quality

Documented environmental impacts of pesticides include:

- poisonings of commercial honeybees and wild pollinators of fruits and vegetables
- destruction of natural enemies of pests in natural and agricultural ecosystems
- ground and surface water contamination by pesticide residues which cause severe damage to fish and other aquatic organisms, birds, mammals, invertebrates, and microorganisms
- population shifts among plants and animals within ecosystems toward more tolerant species.

Pesticide resistance

After repeated exposure to pesticides, insect, weed, and other pest populations in agricultural cropping systems may develop resistance to pesticides through a variety of mechanisms. In the United States, over 183 insect and arachnid pests are resistant to 1 or more insecticides, and 18 weed species are resistant to herbicides. Cross-resistance to multiple families of pesticides, along with the need for higher doses and new pesticide formulations is a growing concern among entomologists, weed ecologists, and other pest management specialists.

Recent laws and initiatives have committed USDA to reduce risk and use of pesticides and promote sustainable agriculture that reduces contamination of the nation's natural resources. Projects, programs, and initiatives are also ongoing at the regional level for resource management and protection. The goal of NRCS is the adoption of integrated pest management on all private lands. In meeting the requirements of the Food Quality Protection Act (1996), NRCS is committed to apply the integrated pest management that promotes both economic and environmental benefits, and encourages research and extension of information throughout strategic alliance with other agencies and organizations in the nation.

(b) Economic Threshold - Herbicides

The herbicide economic threshold is the point where weed density is high enough so that herbicide control costs equal the value of the expected lost yield due to weed density. If a specific herbicide is applied on a field where the threshold is not reached, then excess costs are incurred. For example, if the expected yield loss due to weeds is $12 per acre and herbicide costs are $18 per acre, then this could result in a $6 per acre in unnecessary costs.

The following suggests a method that can be used to evaluate the need to apply herbicide (economic threshold) in corn.

Needed Information:

- Expected crop yield.
- Expected crop market price.
- Densities of weeds in the field by species and expected yield loss (sources of yield loss information include Extension Service, agricultural research institutes, producer's experience, etc.).
- Cost of herbicide treatment (chemical and application).

Example: A corn field has an average of 6 giant ragweed, 24 pigweed, and 10 giant foxtail plants per 100 feet of row. Using the chart below, expected yield losses as the result of the weeds are 1.5% (interpolated), 2%, and 1% respectively, or a total of 4.5%. If the expected yield is 120 bushels per acre and the expected price is $2.00/bushel, then the potential yield loss would be $10.80 per acre (4.5% x 120 bushels x $2 = $10.80). If herbicide treatment costs were less than $10.80 per acre, then treatment would be justified. If herbicide treatment costs are greater than $10.80 per acre, then additional costs could be reduced if the herbicide were not applied at this time.

	Percent corn yield loss						Percent soybean yield loss					
	1	2	4	6	8	10	1	2	4	6	8	10
	——Number of weed clumps per 100 ft of row——											
Weed												
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
Lambsquarter	12	25	50	100	125	150	2	4	6	10	15	20
Velvetgrass	-	-	-	-	-	-	8	16	24	32	40	50
Morning glory	-	-	-	-	-	-	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

Source: Nebraska Cooperative Extension Service, 1989

Chapter 6 Evaluation Techniques

Contents

Chapter 6 Computer Tools

610.0600 Introduction

This chapter describes selected computer programs (tools) that have been useful for economic analysis and evaluation. Information on additional computer programs will be added as it becomes available and distributed via a technical note until incorporated in this handbook. These tools and related economic data are on the NRCS Resource Economics and Social Sciences Homepage in Economics and Related Social Sciences Issues & Information. The site address is http://www.nhq.nrcs.usda.gov/RESS/econ/ressd.htm.

Detailed information and instructions for use of these computer tools can be found in the associated user manual.

Numerous economic computer tools have been developed and used by NRCS, but will not be referenced in this document. However, technology and Agency policy have led to more user friendly models or better tools. Technical notes documenting those models may be obtained from the state economist or national economics staff. Some of these include:

- Conservation Option Procedure
- The Economics - Floodwater damage computer application program (ECON2)
- Economic Module for FOCS
- Land Damage Analysis Program (LDAMG)
- Value of Agriculture Production (VAGPR)

610.0601 Cost and return estimator (CARE)

The CARE program is designed to generate costs and returns for crop enterprises or operations. CARE consists of a complete budget generator and a full-screen editor called Quick Budget. The budget generator uses data bases that store information on farming activities. It allows the user to assemble farming activities to encompass variations in ownership, usage patterns, and machinery complements to prepare complete cost and return estimates for various form enterprises. Quick Budget allows the user to select a previously prepared generator budget summary and edit only the summary on the screen. The revised budget summary can then be saved, printed, or both.

The CARE User Manual has instructions on use of the program.

The budget output formats available in the CARE program are:

- Quick Budget Report
- Quick Budget Comparison Report
- Summary Budget Report
- Detailed Budget Report

Selection of a budget output format should be based upon the need for a particular degree of detail. A simple, yet quite detailed format that would meet the needs in most field office applications is the Quick Budget Report.

Quick Budget provides an easy way to interactively modify the summary results of the CARE Budget Analysis Report. It starts by creating a budget from data bases maintained in the main CARE system or by loading a Quick Budget saved from a previous session. CARE converts the budget into a spreadsheet that can be edited, allowing the user to make changes to the operations, materials, yields, and prices. The effect on costs and returns can then be assessed. Quick Budget also allows the user to construct a budget from scratch without going through the full CARE budget construction.

Quick Budget Comparison Report enables comparison between two budgets and displays the changes that could occur when one system is switched to another; for example, conventional tillage to no-tillage.

610.0602 Erosion productivity impact calculator (EPIC)

EPIC is a comprehensive computer model developed to determine the relationship between soil erosion and soil productivity. It stimulates the erosion processes by using a daily time step and uses readily available inputs. Since erosion can be a relatively slow process, the model is capable of simulating hundreds of years if necessary.

EPIC is capable of computing the effects of management changes on outputs. This program is composed of physically based components for simulating erosion, plant growth, and related processes, and economic components for assessing the cost of erosion, and determining optimal management strategies. The EPIC physical components include hydrology, weather simulation, erosion-sedimentation, nutrient cycling, plant growth, tillage or tilth, and soil temperature.

610.0603 Grazing lands application software (GLA)

GLA, version 2.0.4, July 1995, is a user-friendly grazing land decision support software package created by the Ranching Systems Group, Department of Rangeland Ecology and Management at Texas A&M University, College Station, Texas. GLA is also supported by the NRCS Grazing Lands Technology Institute.

GLA was developed for the grazing land planner/operator to aid in the inventory of land units, calculate stocking rates, calculate multiple species stocking rates (livestock and wildlife), determine nutritional requirements for grazing livestock, and analyze the economic value of treatment alternatives. Each data base in the program requires population of information which is localized to the area in where it will be used. For example, plant species, growth curves, and production may be specific to a state or adjusted to a field office location.

The program contains two data base modules used to localize specific information for an area and client. These modules include animal resources data base and plant/soil resources data bases. They include animal specific information, feedstuff information, soils, plant species, preferences, and production levels. The client module calculates stocking rates by selecting from data bases to customize and include information on soils, land use, species, and production levels specific to an individual's operation.

The decision support module includes a management evaluation program, multi-species calculator, and a nutritional balancing analyzer. The management evaluation offers the planner an opportunity to analyze a client's potential to successfully complete a management system. The multi-species calculator determines the ratio between kinds of livestock and wildlife and the stocking rate. The nutritional balancer determines the animal's requirements based on environment, breed characteristics and animal demands during the evaluation period.

The economics module compares the present carrying capacity to the future capacity based on a conservation management system. GLA considers information, such as discount rate, planning horizon, animal demand, and variation in rainfall from the average. Specific data, such as variable costs, percent offspring, animal selling price, and weight, are also included in the evaluation. Cost of improvement practices and increases from additional animal units, improved weights and selling price are compared to calculate net present value and the internal rate of return. This allows different conservation systems to be compared for decisionmaking purposes.

610.0604 Interactive conservation evaluation (ICE)

The ICE program provides a computerized evaluation process to assist land users in evaluating and comparing alternative conservation management systems. For instructions on use of the ICE program, see the ICE User Manual.

Although ICE is not widely used, it was designed to analyze and compare the without condition with up to nine additional conservation options. Soil loss, future yields with soil depletion, and average annual costs of conservation practices are all calculated. Using crop budget data, ICE calculates gross returns, costs of production, and net returns. Other effects, such as impacts on wildlife and water quality, may also be recorded.

An ICE Preevaluation Worksheet has been developed to facilitate use of the ICE program. The worksheet is useful when gathering and organizing input data needed for the program, especially if the district conservationist is visiting farmers or does not have immediate access to a computer. The worksheet is also extremely useful as a training aid since it shows what information is needed and organizes it into the proper sequence for entry. Contact your state economist if worksheets are required.

References

Barlowe, Raleigh. 1958. Land resource economics. Prentice-Hall.

Carlson, Gerald A., David Zilberman, and John A. Miranowski. 1993. Agicultural and environment resource economics.

United States Department of Agriculture, Natural Resources Conservation Service. 1993. National Planning Procedures Handbook.

United States Department of Agriculture, Natural Resources Conservation Service. 1996. Water quality. National Resoures Economics Handbook, part 612.

United States Department of Agriculture, Natural Resources Conservation Service. Economic evaluations. National Engineering Handbook, part 652, Irrigation Guide, chapter 11.

United States Department of Agriculture, Natural Resources Conservation Service. 1997. Grazinglands economics. National Range and Pasture Handbook, chapter 10.

United States Department of Agriculture, Natural Resources Conservation Service. 1997. General Manual, Part 400, Economics policy.

United States Department of Agriculture, Natural Resources Conservation Service. Field Office Technical Guide. Sections I and V.

United States Department of Agriculture, Natural Resources Conservation Service. 1998. National Resources Economics Handbook, Water resources, part 611.

United States Department of Agriculture, Natural Resources Conservation Service. 1999. CORE4 Manual.

United States Water Resources Council. 1983. Economic and environmental principles and guidelines for water and related land resources implementation studies (P&G).

Glossary

Alternative cost Expenditures for achieving a goal or objective similar to one previously evaluated.

Amortization Converting capital or initial cost to annual cost by determining the size of annual payments needed to pay off a debt over a given time period at a given interest rate. (i interest rate, n = number of time periods)

$$\frac{i(1+i)^n}{(1+i)^n - 1}$$

Amount of an annuity of $1 per year How much an annuity invested each year will grow over a period of years. (i = interest rate, n = number of time periods)

$$\frac{(1+i)^n - 1}{i}$$

Annuity A series of equal payments made at equal intervals of time over time. An annuity may be a benefit or a cost.

Assessed value The estimated worth of property for general property tax purposes.

Average annual benefits The difference between the without project average annual damages and the with project average annual damage. Quantifiable benefits for an evaluation period.
See average annual ?

Average annual cost Initial cost of capital amortized to an annual cost plus the necessary operation and maintenance costs.

Average annual equivalent (annualized) The present value (at a given interest rate) of benefits and costs that occur at subsequent intervals over the period of analysis. Present values are then annualized by amortizing over the period of analysis at the given interest rate. Intervals are identified by the schedule of obligations.

Average product The ratio of total output (a total product) to the quantity of input used in producing that output.

Base period A point in time where other index numbers are compared, for example, the year 1967 = the base index 100.

Benchmark The resource setting from which options are evaluated. A benchmark is commonly thought of as representing the current resource setting.

Benefit-cost ratio A mathematical computation where benefits accruing from some action are divided by the cost of the action.

Breakeven point The point where the proceeds from total output of an alternative plan equal the costs of all inputs associated with that alternative.

Capital One of four traditional factors of production used to produce goods and services. Capital is generally defined to include machinery, livestock, buildings, and/or cash that can be used to purchase or trade for ohter resources. Capital does not include land and labor contributed toward the production of goods and services.

Capital-investment Monetary expenditures necessary for initial installation of a practice or system.

Capital-recovery period The length of time an individual or group may choose to retire (pay-off) a debt. See evaluation period.

Cash-outlay Direct cash expenditures for purchase of items such as farm supplies, hired labor, and services.

Competitive enterprise A business entity which increases its own production in order to capture a greater share of the market, thus causing other competing entities to decrease their production.

Complementarity Where an increase in the production of one good or service will cause an increase in production of another.

Composite acre A weighted unit showing the percentage or proportion that each crop is of the total cropland acreage.

Compound interest Interest that is earned for one period and immediately added to the principal, thus resulting in a larger principal on which interest is computed for the following period. (i = interest rate, n = number of time periods)

$$(1+i)^n$$

Compound interest and annuity tables A collection of factors used to express the functions of interest rate and time.

Cost-effectiveness analysis An appraisal technique especially useful where benefits cannot be reasonably measured in only money terms. It is the only method used to any extent to deal with intangible benefits. On a present value basis, the least expensive alternative combination of tangible costs that will realize essentially the same intangible benefits, needs to be identified. This combination is often referred to as “least cost” or “cost-effectiveness”. Once it is determined that the least expensive alternative has been identified and its costs valued, then the subjective question, is it worth it, can be more meadily addressed.

Cost and Return Estimator (CARE) A software program designed for use on a microcomputer to create and/or adjust cost and return estimates (crop budgets).

Crop budget A systematic listing of resources used, their cost for specified yield levels, and the value of the output by individual crops or enterprises.

Crop budget system A computerized system designed to create and adjust cost and return estimates.

Cropping pattern The crops that are cuurrently grown in an evaluation period. Project the most probable cropping patterns expected to exist with and without project.

Current normalized prices The weighted average of prices recived for a commodity over the preceeding 3- to 5-year period.

Custom rate The usual fee for farm services rendered; generally for machine hire.

Demand The quantity of a good (or service) which consumers will purchase at a certain price.

Deposition Soil movement (erosion) from one location to another resulting in the covering of fertile soil sediment, which results in a less productive soil.

Depreciation A decrease in the value of property through wear, deterioration, or obsolescence.

Diminishing returns A condition where each successive unit of input adds less to total output than the previous unit.

Economic analysis An analysis done using economic values. In general, economic analysis omits payments such as credit transactions, and values all items at their “value in use” or their opportunity cost to the society.

Economics The science of allocating limited resources among competing ends so as to maximize some desired quality or benefit.

Economies of scale Ability of business firms to spread their fixed costs over larger quantities of output.

Effective economic life The point where the present worth of expenditures for extending the life of a facility exceeds the present worth of its benefits.

Efficiency A measuring stick for evaluating choices. In general, efficiency refers to the ratio of output to input.

Evaluation period Time period beginning at the end of the installation period, with the time period based on the expected useful economic life.

Factors of production Resources, either human (labor) or nonhuman (capital) used for producing goods and/or services. The four factors of production commonly identified are land, labor, capital, and management.

Fair market value The price at which an owner of an asset would sell that asset to a willing buyer.

Family labor Non-hired labor inputs from an individual or from their household.

Financial analysis An analysis done to determine effects of a particular action or plan on the liquidity, cash flow, or profitability of a business or enterprise.

Fixed costs Expenditures an enterprise would incur even if no output were produced.

Gross returns Total production in units multiplied by the price per unit.

Interactive Conservation Evaluation (ICE) A software program designed for use on a microcomputer to make economic analyses of the costs and benefits of conservation.

Interest The earning power of money or the price for the use of money, otherwise known as the time value of money or return of capital.

Interest rate (i) The cost of using borrowed capital or the value placed on using owned capital, either of which are determined by demand, time, or risk.

Internal rate of return The interest rate money will earn as the total investment of an enterprise is repaid to that enterprise by its revenues.

Lagged A value which occurs sometime in the future is referred to as lagged when discounted to present value.

Land voiding A stage of land deterioration, generally through gully erosion, where the remaining productive capacity of the land is for all practical purposes zero.

Least cost alternative The lowest expenditure for installing, operating, and maintaining a system or systems of conservation measures to achieve a specified objective. The objective could be minimum soil erosion, maximum water quality, and optimal wildlife habitat.

Linear programming A technique sometimes useful for predicting an optimum level of production. The best combination of production activities is determined for this optimal production level through application of specific, linear, physical, or monetary constraints to a maximum level of production.

Management A decision making process of determining how land, labor, and capital will be combined in an enterprise or organization for the purpose of obtaining a specific objective. One of four factors of production

Marginal analysis Determining the level of production where marginal costs are equal to marginal benefits and net benefits are maximized.

Marginal benefits The additional benefit of producing one more unit of output.

Marginal costs The additional cost of producing one more unit of output.

Marginal rate of substitution The amount of one commodity or product a consumer is willing to give up in order to get an additional unit of another commodity or product.

Maximum net benefit The level of development where the value of total output minus the value of total required input is the greatest.

Mean Mathematical average, obtained by dividing the sum of two or more quantities by the number of these quantities.

Median Designating the middle number or the middle between two numbers in a long series of ordered numbers or values.

Net returns The residual value of production after total costs of production are subtracted from the gross returns.

Number of years (or periods) hence Number of years (or periods) into the future for which the calculations are being made.

Objective Qualified goals or achievements to answer or solve projected needs as expressed by a person or group of persons.

Off-site benefits Benefits accruing to areas or persons outside the problem-controlled area.

On-site benefits Benefits accruing at the general location of the control practice.

Operating cost Expenditures for machine operation which generally include lubrication, repairs, and fuel (not applicable to all machines).

Operation and maintenance and replacement (1) Actual expenditures and services performed to insure proper functioning of the facility or measure throughout its intended life. (2) Capital outlay required ot maintain the benefit stream and planned mitigation measures.

Opportunity costs The earning capabilities of money for use in alternative investments having similar risk and time frames.

Overhead costs Expenditures associated with the farm organization, not generally influenced by levels of production or kinds of crops grown such as most utilities, machine shop and related shop tools, and accountant or management fees.

Ownership costs Costs unrelated to rate of annual use, such as expenditures for depreciation, taxes, interest on investment, insurance and housing.

Partial budgeting A technique where only the relevant changes in income and production are identified, listed, and used in the analysis.

Perennial crops Those having a life cycle of more than two years.

Performance rate Rate of accomplishment based on machine width, tractor speed, and the percent efficiency.

Perpetuity An indefinite or extremely long period of time.

Planning horizon The time period within which a business personal farmer, or rancher formulates their activities.

Present value (or present worth) Future costs or benefits discounted or lagged to show their current value.

Present value of a decreasing annuity Today's value of an annuity that is not constant but decreases uniformly over a period of time.

Present value of an annuity of $1 per year The discounted or lagged value of a series of equal payments to be covered over a period of years.

Present value of an increasing annuity Today's value of an annuity that is not constant but increases uniformly over a period of time.

Present value of 1 The amount that must be invested now at compound interest to have a value of one in a given length of time, or what one dollar due in the future is worth today. This is also known as the discount factor or the reciprocal of the compound interest factor.

Price The exchange value for commodities usually determined through the market system.

Price base A common level of prices generally adjusted through the use of price indexes.

Price index A procedure to reflect changes in prices relative to prices in some base period.

Principal The initial investment (exclusive of interest) and the ensuing amounts as payments are periodically made on that principal.

Private cost or benefit Those accruing to identified individuals.

Production costs Expenditures, both fixed and variable, for all items required for specified levels of crop or livestock production.

Projections Best estimates of future development, based upon historical trends, analysis of current relationships and an evaluation of foreseeable conditions.

Public cost or benefit Those accruing to groups of people and remaining inseparable to individuals.

Quantity differential Changes achieved through resource improvement in the per acre yield (or output) for har vested crops.

Redevelopment benefits Benefits derived in areas having chronic underemployment or unemployment problems by providing employment opportunities through construction, operation and maintenance of resource improvements.

Relocation costs Expenditures for replacement housing, moving and related needs, advisory services, or movement of business operations, brought about by installation of project measures.

Rent (pure economic) The residue left for the fixed resource (land) after all other production costs are deducted from total gross returns. .

Salvage value The monetary value of an investment at the end of its economic life. Usually the trade-in value as new equipment is purchased.

Secondary benefits The values added over and above the immediate products or services of the project as a result of new demands on the transporting, processing, and marketing industries, supplying of additional materials and services required to make possible the increased net returns and the provisions of maintaining and operating the project features.

Sectors The various categories of business enterprises, each having specific characteristics, i. e ., agriculture, mining, manufacturing, etc.

Separable cost For each purpose, the difference between the cost of a multipurpose structure and the cost of the structure with that purpose omitted.

Short run A time period long enough to permit desired changes in output without altering the size of the farm unit or organization.

Simple interest Money earned on the principal only and not on accumulated interest.

Simulation studies A highly sophisticated computerized technique generally used to examine regional economic problems. The model -embodies relevant parameters and relationships of the economic sectors to characterize over time the behavior of a real economic system.

Sinking fund A program for capital accumulation over a period of years. The factor indicates how much needs to be invested per year at a given interest rate to accumulate $1 by a given date.

Social cost Adverse conditions, either monetary or non-monetary, that are liabilities of society as a whole.

Specific costs The cost of facilities that exclusively serve only one project purpose.

Standard of living The necessary amenities of personal consumption which can be provided by the current estimated disposable family income.

Streambank erosion The removal of soil from the streambank by water movement. This is considered a permanent resource damage.

Substitution of capital The continuing application of new technological innovations to improve production efficiencies over what can be provided with manual efforts.

Supplementary enterprise Production from one enterprise is increased without increasing or decreasing production of another enterprise.

Supply The quantity of a good or service a firm is willing to produce to sell at a given price.

Synthetic analysis Using unit values based on historical information and relating to estimated characteristics of future storm events

.

Technological advancement Gains in production efficiencies through new innovations of the scientific and industrial arts.

Time frame Number of years between intervals of study, as in OBERS projection’s 10 year timeframes, i.e., 1980, 1990, 2000, etc.

Turnover The average number of times a dollar changes hands as it is spent.

Unit cost Monetary value or charge per some uniform amount, i.e., cost per cubic yard of concrete, cost per hour for owning an 18-foot self-propelled combine, etc.

Value added The increase in value resulting from doing something to or with the product.

Variable costs Costs relevant to production or those occurring only as production takes place.

With condition The anticipated situation which is projected to occur in the future if the proposed project measures are installed.

Without condition The anticipated situation which is projected to occur in the future, if the proposed project measures are not installed.

Appendix A Interest and Annuity Sample Problems and Solutions

Introduction

Interest and annuity (I&A) tables are a simple and easy to use tool that can be used when you need a specific factor to solve a specific type of economic analysis. A commonly used reference for these factors is the "Compound Interest and Annuity Tables" book, which can be found in your State office. These same tables are also contained in any hand held financial calculator. For demonstration purposes, specific pages from the "Compound Interest and Annuity Tables" book are included in the following sample problems and solutions. Formulas for computation of each of the columns can be found in chapter 5 or the Glossary of this handbook. If you have a need for interest and annuity factors not covered by these tables or do not have access to your states' "Compound Interest and Annuity Tables" book, contact your State economist.

Of all the interest and annuity factors, the one you are most likely to use is the amortization factor. For this reason, a small wallet sized card has been prepared with amortization factors for the most commonly used interest rates and time spans. Evaluation examples are on the back of the card. Additional copies of this Average Annual Cost Table Card may be obtained from your State economist. The front and back of the wallet size card is illustrated below.

Effective use of interest and annuity tables

What follows are interest and annuity examples which illustrate the principles and procedures discussed in this handbook. These examples will provide a good understanding of how to approach and carry out an economic evaluation for conservation decisionmaking.

Interest and annuity tables supporting the examples are included. Detailed listings of interest and annuity tables can be found in the "Compound Interest and Annuity Tables" book located in your State office, or any handheld financial calculator.

If you need help solving these sample problems contact your State economist.

NRCS

AVERAGE ANNUAL COST TABLE
(Per Dollar of Installation Cost)

INTEREST RATE — PERCENT

Life span in years	9	10	11	12	13	14	15	16	17	18	19	20	21	22
2	.568	.576	.584	.592	.599	.607	.615	.623	.631	.639	.647	.655	.662	.670
3	.395	.402	.409	.416	.424	.431	.438	.445	.453	.460	.467	.475	.482	.490
4	.309	.315	.322	.329	.336	.343	.350	.357	.365	.372	.379	.386	.394	.401
5	.257	.264	.271	.277	.284	.291	.298	.305	.313	.320	.327	.334	.342	.349
6	.223	.230	.236	.243	.250	.257	.264	.271	.279	.286	.293	.301	.308	.316
7	.199	.205	.212	.219	.226	.233	.240	.248	.255	.262	.270	.277	.285	.293
8	.181	.187	.194	.201	.208	.216	.223	.230	.238	.245	.253	.261	.268	.276
9	.167	.174	.181	.188	.195	.202	.210	.217	.225	.232	.240	.248	.256	.264
10	.156	.163	.170	.177	.184	.192	.199	.207	.215	.223	.230	.239	.247	.255
11	.147	.154	.161	.168	.176	.183	.191	.199	.207	.215	.223	.231	.239	.248
12	.140	.147	.154	.161	.169	.177	.184	.192	.200	.209	.217	.225	.234	.242
13	.134	.141	.148	.156	.163	.171	.179	.187	.195	.204	.212	.221	.229	.238
14	.128	.136	.143	.151	.159	.167	.175	.183	.191	.200	.208	.217	.226	.234
15	.124	.131	.139	.147	.155	.163	.171	.179	.188	.196	.205	.214	.223	.232
20	.110	.117	.126	.134	.142	.151	.160	.169	.178	.187	.196	.205	.215	.224
25	.102	.110	.119	.128	.136	.146	.155	.164	.173	.183	.192	.202	.212	.222
50	.091	.101	.111	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220
100	.090	.100	.110	.120	.130	.140	.150	.160	.170	.180	.190	.200	.210	.220

IMPORTANT: Include O&M by (1) adding dollar amount to annual installation cost or (2) adding a percentage of installation cost to the selected factor from the table. See examples on reverse side.

COMPUTING AVERAGE ANNUAL COSTS

Average Annual Cost = Installation Cost X appropriate factor + O&M (include O&M by one of the two methods).

EXAMPLES

1. Terrace system will cost $400 per acre to install, interest rate is 10 percent and life span 25 years. O&M is estimated to be 5 percent of the installation cost.

SOLUTION: .110 + .05 = .160 x $400 = $64 average annual cost per acre.

2. Same as above except farmer qualifies for 75 percent cost sharing on installation cost. Farmer wants to know his annual cost.

SOLUTION: $400 x .25 (farmer's cost share) = $100 x .110 + $400 x .05 = $11 + $20 = $31 average annual cost per acre.

3. Waste management system will cost $27,000, interest rate is 14 percent and farmer wants to use a 12-year life span. O&M is estimated to be $1,900 a year.

SOLUTION: $27,000 x .177 = $4,779 + $1,900 = $6,679 average annual cost.

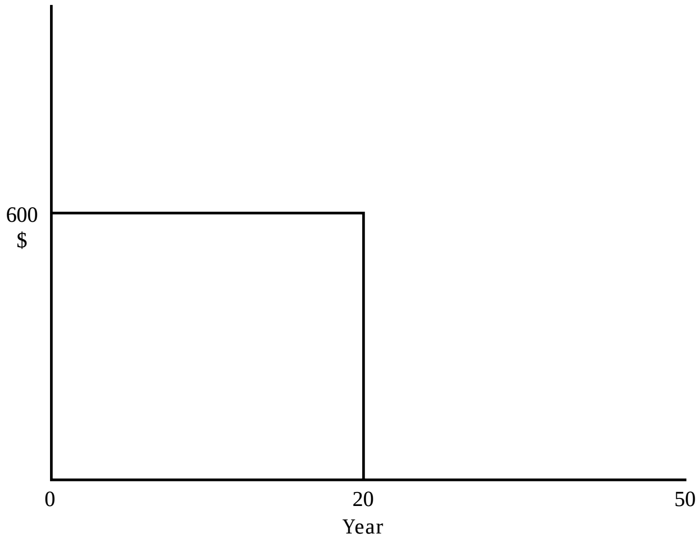
4. Farmer qualifies for a maximum cost share payment of $3,500 on above system. Farmer wants to know his annual cost.

SOLUTION: $27,000 − $3,500 x .177 = $4,160 + $1,900 = $6,060 average annual cost.

NRCS Natural Resources Conservation Service

Example 1

Receive $600 per year for 20 years. What is the average annual value over a 50-year evaluation period at 8%?



Principles

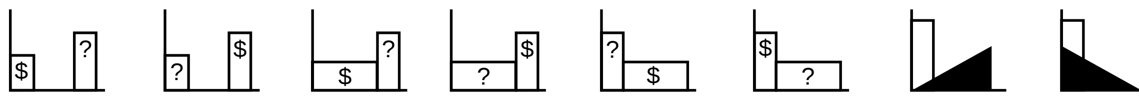
1. Present value of an annuity
2. Average annual value (amortization)

(Present value of annuity of $1, 20 years at 8%) (600) = (9.8181) (600) = 5,890.89
(Amortized factor 50 years at 8%) (5,890.89) = (.08174) (5890.89) = $481.52 year

Because of rounding, calculations may appear sightly off.

Name	Compounding	Discounting	Amount of annuity of 1	Sinking fund	Amortization			
Description	Future value of one	Present value of one	Future value of annuity of 1	Amount of annuity for a future value	Present value of annuity of 1	Amount of annuity for a present value	Present value of increase annuity	Present value of decrease annuity

Graphic



Formula

Periods								
1	1.0800	0.9259	1.0000	1.0000	0.9259	1.0800	0.9259	0.9259
2	1.1664	0.8573	2.0800	0.4808	1.7833	0.5608	2.6406	2.7092
3	1.2597	0.7938	3.264	0.3080	2.5771	0.3880	5.0221	5.2863
4	1.3605	0.7350	4.5061	0.2219	3.3121	0.3019	7.9622	8.5984
5	1.4693	0.6806	5.8666	0.1705	3.9927	0.2505	11.3651	12.5911
6	1.5869	0.6302	7.3359	0.1363	4.6229	0.2163	15.1462	17.2140
7	1.7138	0.5835	8.9228	0.1121	5.2064	0.1921	19.2306	22.4204
8	1.8509	0.5403	10.6366	0.0940	5.7466	0.1740	23.5527	28.1670
9	1.9990	0.5002	12.4876	0.0801	6.2469	0.1601	28.0550	34.4139
10	2.1589	0.4632	14.4866	0.0690	6.7101	0.1490	32.6869	41.1240
11	2.3316	0.4289	16.6455	0.0601	7.1390	0.1401	37.4046	48.2629
12	2.5182	0.3971	18.9771	0.527	7.5361	0.1327	42.1700	55.7990
13	2.7196	0.3677	21.4953	0.0465	7.9038	0.1265	46.9501	63.7028
14	2.9372	0.3405	24.2149	0.0413	8.2442	0.1213	51.7165	71.9470
15	3.1722	0.3152	27.1521	0.0368	8.5595	0.1168	56.4451	80.5056
16	3.4259	0.2929	30.3243	0.0330	8.8514	0.1130	61.1154	89.3579
17	3.7000	0.2703	33.7502	0.0296	9.1216	0.1096	65.7100	98.4795
18	3.9960	0.2502	37.4502	0.0267	9.3719	1.1067	70.2144	107.8514
19	4.3157	0.2317	41.4463	0.0241	9.6036	0.1041	74.6170	117.4550
20	4.6610	0.2145	45.7620	0.0219	9.8181	0.1019	78.9079	127.2732
21	5.0338	0.1987	50.4229	0.0198	10.0168	0.0998	83.0797	137.2900
22	5.4365	0.1839	55.4568	0.0180	10.2007	0.0980	87.1264	147.4907
23	5.8715	0.1703	60.8933	0.0164	10.3711	0.0964	91.0437	157.8618
24	6.3412	0.1577	66.7648	0.0150	10.5288	0.0950	94.8284	168.3905
25	6.8485	0.1460	73.1059	0.137	10.6748	0.0937	98.4789	179.0653
26	7.3964	0.1352	79.9544	0.0125	10.8100	0.0925	101.9941	189.8753
27	7.98881	0.1252	87.3508	0.0114	10.9352	0.0914	105.3742	200.8104
28	8.6271	0.1159	95.3388	0.0105	11.0511	0.0905	108.6198	211.8615
29	9.3173	0.1073	103.9659	0.0096	11.1584	0.0896	111.7323	223.0199
30	10.0627	0.0994	113.2832	0.0088	11.2578	0.0888	114.7136	234.2777
31	10.8677	0.0920	123.3459	0.0081	11.3498	0.0881	117.5661	245.6275
32	11.7371	0.0852	134.2135	0.0075	11.4350	0.0875	120.2925	257.0625
33	12.6760	0.0789	145.9506	0.0069	11.5139	0.0869	122.8958	268.5764
34	13.6901	0.0730	158.6267	0.0063	11.5869	0.0863	125.3793	280.1633
35	14.7853	0.0676	172.3168	0.0058	11.6546	0.0858	127.7466	291.8179
36	15.9682	0.0626	187.1021	0.0053	11.71.72	0.0853	130.0010	303.5351
37	17.2436	0.0580	203.0703	0.0049	11.7752	0.0849	132.1465	315.3103
38	18.6253	0.0537	220.3159	0.0045	11.8289	0.0845	134.1868	327.1391
39	20.1153	0.0497	238.9412	0.0042	11.8786	0.0842	136.1256	339.0177
40	21.7245	0.0460	259.0565	0.0039	11.9246	0.0839	137.9668	350.9423
50	46.9016	0.0213	573.7702	0.0017	12.2335	0.0817	151.8263	472.0814
60	101.2571	0.0099	1253.2133	0.0008	12.3766	0.0808	159.6766	595.2931
70	218.6064	0.0046	2720.0801	0.0004	12.4428	0.0804	163.9754	719.4648
80	471.9548	0.0021	5886.9354	0.0002	12.4735	0.0802	166.2736	844.0811
90	1018.9151	0.0010	12723.9386	0.0001	12.4877	0.0801	167.4803	968.9033
100	2199.7613	0.0005	27484.5157	.0000	12.4943	0.0800	168.1050	$$$$$$$$

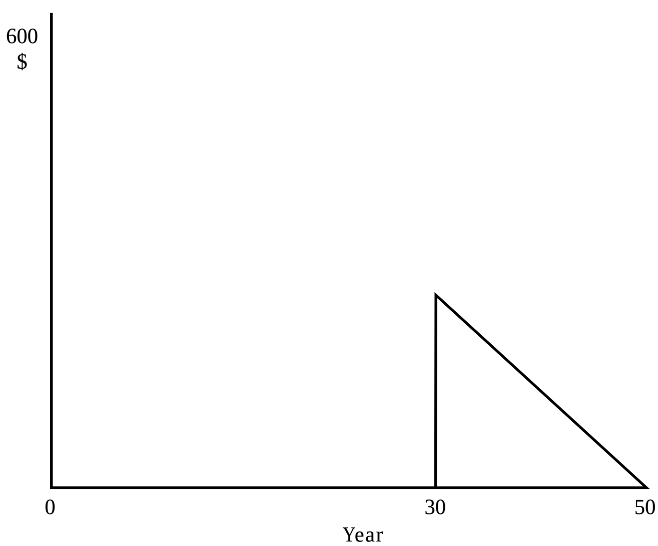
Example 2
After year 30, a return of $600 will decrease to 0 in year 50. Find the average annual value for a 50-year evaluation period at 8%.

Principles
1. Present value of a decreasing annuity
2. Present value of 1
3. Amortization

(Present value of decreasing annuity factor 20 years at 8%)($600/20) = (127.2732) (30) = 3,818.19

(Present value of 1, 30 years at 8%) (3,818.19)
(.0994)(3818.19) = 379.45

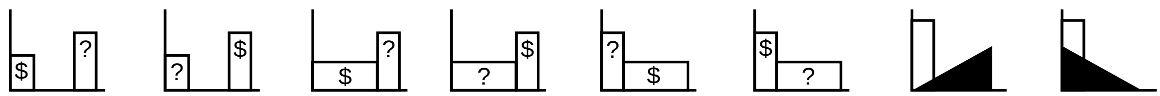
(Amortization factor 50 years at 8%) (379.45)
(.08174) (379.45) = 31.02



Because of rounding, calculations may appear sightly off.

Name	Compounding	Discounting	Amount of annuity of 1	Sinking fund	Amortization			
Description	Future value of one	Present value of one	Future value of annuity of 1	Amount of annuity for a future value	Present value of annuity of 1	Amount of annuity for a present value	Present value of increase annuity	Present value of decrease annuity

Graphic



Formula

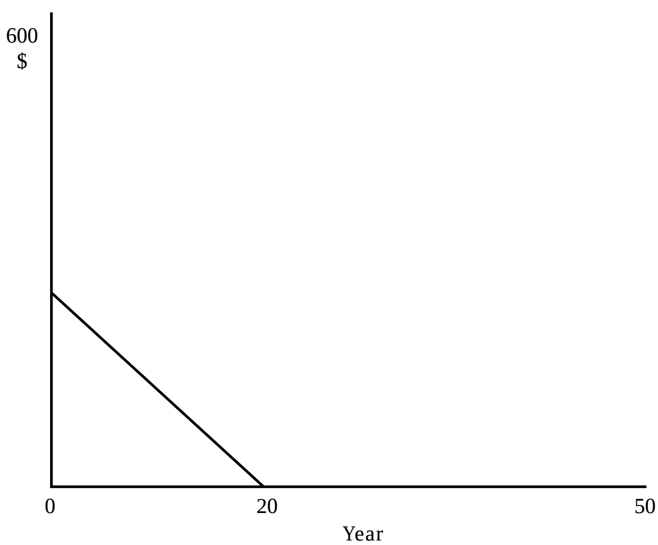
Periods								
1	1.0800	0.9259	1.0000	1.0000	0.9259	1.0800	0.9259	0.9259
2	1.1664	0.8573	2.0800	0.4808	1.7833	0.5608	2.6406	2.7092
3	1.2597	0.7938	3.264	0.3080	2.5771	0.3880	5.0221	5.2863
4	1.3605	0.7350	4.5061	0.2219	3.3121	0.3019	7.9622	8.5984
5	1.4693	0.6806	5.8666	0.1705	3.9927	0.2505	11.3651	12.5911
6	1.5869	0.6302	7.3359	0.1363	4.6229	0.2163	15.1462	17.2140
7	1.7138	0.5835	8.9228	0.1121	5.2064	0.1921	19.2306	22.4204
8	1.8509	0.5403	10.6366	0.0940	5.7466	0.1740	23.5527	28.1670
9	1.9990	0.5002	12.4876	0.0801	6.2469	0.1601	28.0550	34.4139
10	2.1589	0.4632	14.4866	0.0690	6.7101	0.1490	32.6869	41.1240
11	2.3316	0.4289	16.6455	0.0601	7.1390	0.1401	37.4046	48.2629
12	2.5182	0.3971	18.9771	0.527	7.5361	0.1327	42.1700	55.7990
13	2.7196	0.3677	21.4953	0.0465	7.9038	0.1265	46.9501	63.7028
14	2.9372	0.3405	24.2149	0.0413	8.2442	0.1213	51.7165	71.9470
15	3.1722	0.3152	27.1521	0.0368	8.5595	0.1168	56.4451	80.5056
16	3.4259	0.2929	30.3243	0.0330	8.8514	0.1130	61.1154	89.3579
17	3.7000	0.2703	33.7502	0.0296	9.1216	0.1096	65.7100	98.4795
18	3.9960	0.2502	37.4502	0.0267	9.3719	1.1067	70.2144	107.8514
19	4.3157	0.2317	41.4463	0.0241	9.6036	0.1041	74.6170	117.4550
20	4.6610	0.2145	45.7620	0.0219	9.8181	0.1019	78.9079	127.2732
21	5.0338	0.1987	50.4229	0.0198	10.0168	0.0998	83.0797	137.2900
22	5.4365	0.1839	55.4568	0.0180	10.2007	0.0980	87.1264	147.4907
23	5.8715	0.1703	60.8933	0.0164	10.3711	0.0964	91.0437	157.8618
24	6.3412	0.1577	66.7648	0.0150	10.5288	0.0950	94.8284	168.3905
25	6.8485	0.1460	73.1059	0.137	10.6748	0.0937	98.4789	179.0653
26	7.3964	0.1352	79.9544	0.0125	10.8100	0.0925	101.9941	189.8753
27	7.98881	0.1252	87.3508	0.0114	10.9352	0.0914	105.3742	200.8104
28	8.6271	0.1159	95.3388	0.0105	11.0511	0.0905	108.6198	211.8615
29	9.3173	0.1073	103.9659	0.0096	11.1584	0.0896	111.7323	223.0199
30	10.0627	0.0994	113.2832	0.0088	11.2578	0.0888	114.7136	234.2777
31	10.8677	0.0920	123.3459	0.0081	11.3498	0.0881	117.5661	245.6275
32	11.7371	0.0852	134.2135	0.0075	11.4350	0.0875	120.2925	257.0625
33	12.6760	0.0789	145.9506	0.0069	11.5139	0.0869	122.8958	268.5764
34	13.6901	0.0730	158.6267	0.0063	11.5869	0.0863	125.3793	280.1633
35	14.7853	0.0676	172.3168	0.0058	11.6546	0.0858	127.7466	291.8179
36	15.9682	0.0626	187.1021	0.0053	11.71.72	0.0853	130.0010	303.5351
37	17.2436	0.0580	203.0703	0.0049	11.7752	0.0849	132.1465	315.3103
38	18.6253	0.0537	220.3159	0.0045	11.8289	0.0845	134.1868	327.1391
39	20.1153	0.0497	238.9412	0.0042	11.8786	0.0842	136.1256	339.0177
40	21.7245	0.0460	259.0565	0.0039	11.9246	0.0839	137.9668	350.9423
50	46.9016	0.0213	573.7702	0.0017	12.2335	0.0817	151.8263	472.0814
60	101.2571	0.0099	1253.2133	0.0008	12.3766	0.0808	159.6766	595.2931
70	218.6064	0.0046	2720.0801	0.0004	12.4428	0.0804	163.9754	719.4648
80	471.9548	0.0021	5886.9354	0.0002	12.4735	0.0802	166.2736	844.0811
90	1018.9151	0.0010	12723.9386	0.0001	12.4877	0.0801	167.4803	968.9033
100	2199.7613	0.0005	27484.5157	.0000	12.4943	0.0800	168.1050	$$$$$$$$

Example 3
A present return will decrease from $600 to 0 in year 20. Find the average annual value for a 50-year evaluation period at 8%.

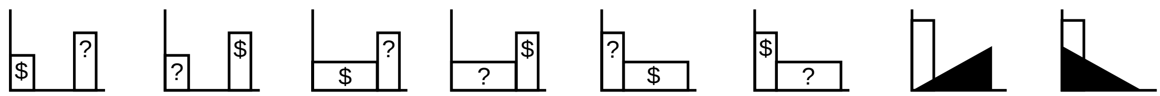
Principles
1. Present value of decreasing annuity
2. Amortization

(Present value of decreasing annuity 20 years at 8%) ($600/20)
(127.2732)(30) = 3,818.19

(Amortize over 50 years at 8%) (3,818.19)
(.08174)(3818.19) = 312.10



Because of rounding, calculations may appear sightly off.

Name	Compounding	Discounting	Amount of annuity of 1	Sinking fund	Amortization			
Description	Future value of one	Present value of one	Future value of annuity of 1	Amount of annuity for a future value	Present value of annuity of 1	Amount of annuity for a present value	Present value of increase annuity	Present value of decrease annuity
Graphic								
Formula								
Periods								
1	1.0800	0.9259	1.0000	1.0000	0.9259	1.0800	0.9259	0.9259
2	1.1664	0.8573	2.0800	0.4808	1.7833	0.5608	2.6406	2.7092
3	1.2597	0.7938	3.264	0.3080	2.5771	0.3880	5.0221	5.2863
4	1.3605	0.7350	4.5061	0.2219	3.3121	0.3019	7.9622	8.5984
5	1.4693	0.6806	5.8666	0.1705	3.9927	0.2505	11.3651	12.5911
6	1.5869	0.6302	7.3359	0.1363	4.6229	0.2163	15.1462	17.2140
7	1.7138	0.5835	8.9228	0.1121	5.2064	0.1921	19.2306	22.4204
8	1.8509	0.5403	10.6366	0.0940	5.7466	0.1740	23.5527	28.1670
9	1.9990	0.5002	12.4876	0.0801	6.2469	0.1601	28.0550	34.4139
10	2.1589	0.4632	14.4866	0.0690	6.7101	0.1490	32.6869	41.1240
11	2.3316	0.4289	16.6455	0.0601	7.1390	0.1401	37.4046	48.2629
12	2.5182	0.3971	18.9771	0.527	7.5361	0.1327	42.1700	55.7990
13	2.7196	0.3677	21.4953	0.0465	7.9038	0.1265	46.9501	63.7028
14	2.9372	0.3405	24.2149	0.0413	8.2442	0.1213	51.7165	71.9470
15	3.1722	0.3152	27.1521	0.0368	8.5595	0.1168	56.4451	80.5056
16	3.4259	0.2929	30.3243	0.0330	8.8514	0.1130	61.1154	89.3579
17	3.7000	0.2703	33.7502	0.0296	9.1216	0.1096	65.7100	98.4795
18	3.9960	0.2502	37.4502	0.0267	9.3719	1.1067	70.2144	107.8514
19	4.3157	0.2317	41.4463	0.0241	9.6036	0.1041	74.6170	117.4550
20	4.6610	0.2145	45.7620	0.0219	9.8181	0.1019	78.9079	127.2732
21	5.0338	0.1987	50.4229	0.0198	10.0168	0.0998	83.0797	137.2900
22	5.4365	0.1839	55.4568	0.0180	10.2007	0.0980	87.1264	147.4907
23	5.8715	0.1703	60.8933	0.0164	10.3711	0.0964	91.0437	157.8618
24	6.3412	0.1577	66.7648	0.0150	10.5288	0.0950	94.8284	168.3905
25	6.8485	0.1460	73.1059	0.137	10.6748	0.0937	98.4789	179.0653
26	7.3964	0.1352	79.9544	0.0125	10.8100	0.0925	101.9941	189.8753
27	7.98881	0.1252	87.3508	0.0114	10.9352	0.0914	105.3742	200.8104
28	8.6271	0.1159	95.3388	0.0105	11.0511	0.0905	108.6198	211.8615
29	9.3173	0.1073	103.9659	0.0096	11.1584	0.0896	111.7323	223.0199
30	10.0627	0.0994	113.2832	0.0088	11.2578	0.0888	114.7136	234.2777
31	10.8677	0.0920	123.3459	0.0081	11.3498	0.0881	117.5661	245.6275
32	11.7371	0.0852	134.2135	0.0075	11.4350	0.0875	120.2925	257.0625
33	12.6760	0.0789	145.9506	0.0069	11.5139	0.0869	122.8958	268.5764
34	13.6901	0.0730	158.6267	0.0063	11.5869	0.0863	125.3793	280.1633
35	14.7853	0.0676	172.3168	0.0058	11.6546	0.0858	127.7466	291.8179
36	15.9682	0.0626	187.1021	0.0053	11.71.72	0.0853	130.0010	303.5351
37	17.2436	0.0580	203.0703	0.0049	11.7752	0.0849	132.1465	315.3103
38	18.6253	0.0537	220.3159	0.0045	11.8289	0.0845	134.1868	327.1391
39	20.1153	0.0497	238.9412	0.0042	11.8786	0.0842	136.1256	339.0177
40	21.7245	0.0460	259.0565	0.0039	11.9246	0.0839	137.9668	350.9423
50	46.9016	0.0213	573.7702	0.0017	12.2335	0.0817	151.8263	472.0814
60	101.2571	0.0099	1253.2133	0.0008	12.3766	0.0808	159.6766	595.2931
70	218.6064	0.0046	2720.0801	0.0004	12.4428	0.0804	163.9754	719.4648
80	471.9548	0.0021	5886.9354	0.0002	12.4735	0.0802	166.2736	844.0811
90	1018.9151	0.0010	12723.9386	0.0001	12.4877	0.0801	167.4803	968.9033
100	2199.7613	0.0005	27484.5157	.0000	12.4943	0.0800	168.1050	$$$$$$$$

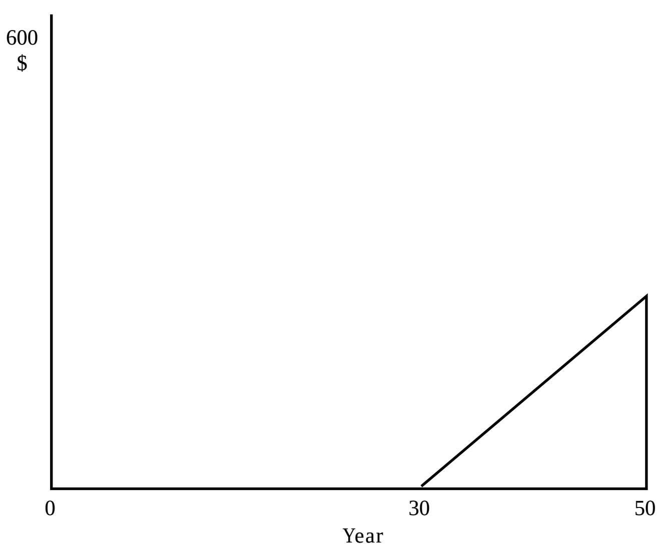
Example 4

A return will build from 0 in year 30 to $600 by year 50. Find the average annual value at 8% for a 50-year evaluation period.

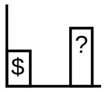
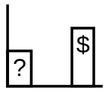
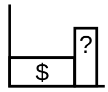
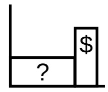
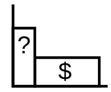
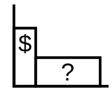
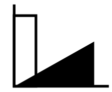
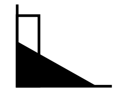
Principles

1. Present value of an increasing annuity
2. Present value of 1
3. Amortization

Present value of an increasing annuity factor: 20 years at 8%) ($600/20)
(78.9079) (30) = 2,367.24
(Present value of 1: 30 years at 8%) (2,367.24)
(.0994) (2367.24) = 235.26
(Amortization factor: 50 years at 8%) (235.26)
(.0817) (235.26) = 19.23



Because of rounding, calculations may appear sightly off.

Name	Compounding	Discounting	Amount of annuity of 1	Sinking fund	Amortization			
Description	Future value of one	Present value of one	Future value of annuity of 1	Amount of annuity for a future value	Present value of annuity of 1	Amount of annuity for a present value	Present value of increase annuity	Present value of decrease annuity
Graphic								
Formula								
Periods								
1	1.0800	0.9259	1.0000	1.0000	0.9259	1.0800	0.9259	0.9259
2	1.1664	0.8573	2.0800	0.4808	1.7833	0.5608	2.6406	2.7092
3	1.2597	0.7938	3.264	0.3080	2.5771	0.3880	5.0221	5.2863
4	1.3605	0.7350	4.5061	0.2219	3.3121	0.3019	7.9622	8.5984
5	1.4693	0.6806	5.8666	0.1705	3.9927	0.2505	11.3651	12.5911
6	1.5869	0.6302	7.3359	0.1363	4.6229	0.2163	15.1462	17.2140
7	1.7138	0.5835	8.9228	0.1121	5.2064	0.1921	19.2306	22.4204
8	1.8509	0.5403	10.6366	0.0940	5.7466	0.1740	23.5527	28.1670
9	1.9990	0.5002	12.4876	0.0801	6.2469	0.1601	28.0550	34.4139
10	2.1589	0.4632	14.4866	0.0690	6.7101	0.1490	32.6869	41.1240
11	2.3316	0.4289	16.6455	0.0601	7.1390	0.1401	37.4046	48.2629
12	2.5182	0.3971	18.9771	0.527	7.5361	0.1327	42.1700	55.7990
13	2.7196	0.3677	21.4953	0.0465	7.9038	0.1265	46.9501	63.7028
14	2.9372	0.3405	24.2149	0.0413	8.2442	0.1213	51.7165	71.9470
15	3.1722	0.3152	27.1521	0.0368	8.5595	0.1168	56.4451	80.5056
16	3.4259	0.2929	30.3243	0.0330	8.8514	0.1130	61.1154	89.3579
17	3.7000	0.2703	33.7502	0.0296	9.1216	0.1096	65.7100	98.4795
18	3.9960	0.2502	37.4502	0.0267	9.3719	1.1067	70.2144	107.8514
19	4.3157	0.2317	41.4463	0.0241	9.6036	0.1041	74.6170	117.4550
20	4.6610	0.2145	45.7620	0.0219	9.8181	0.1019	78.9079	127.2732
21	5.0338	0.1987	50.4229	0.0198	10.0168	0.0998	83.0797	137.2900
22	5.4365	0.1839	55.4568	0.0180	10.2007	0.0980	87.1264	147.4907
23	5.8715	0.1703	60.8933	0.0164	10.3711	0.0964	91.0437	157.8618
24	6.3412	0.1577	66.7648	0.0150	10.5288	0.0950	94.8284	168.3905
25	6.8485	0.1460	73.1059	0.137	10.6748	0.0937	98.4789	179.0653
26	7.3964	0.1352	79.9544	0.0125	10.8100	0.0925	101.9941	189.8753
27	7.98881	0.1252	87.3508	0.0114	10.9352	0.0914	105.3742	200.8104
28	8.6271	0.1159	95.3388	0.0105	11.0511	0.0905	108.6198	211.8615
29	9.3173	0.1073	103.9659	0.0096	11.1584	0.0896	111.7323	223.0199
30	10.0627	0.0994	113.2832	0.0088	11.2578	0.0888	114.7136	234.2777
31	10.8677	0.0920	123.3459	0.0081	11.3498	0.0881	117.5661	245.6275
32	11.7371	0.0852	134.2135	0.0075	11.4350	0.0875	120.2925	257.0625
33	12.6760	0.0789	145.9506	0.0069	11.5139	0.0869	122.8958	268.5764
34	13.6901	0.0730	158.6267	0.0063	11.5869	0.0863	125.3793	280.1633
35	14.7853	0.0676	172.3168	0.0058	11.6546	0.0858	127.7466	291.8179
36	15.9682	0.0626	187.1021	0.0053	11.71.72	0.0853	130.0010	303.5351
37	17.2436	0.0580	203.0703	0.0049	11.7752	0.0849	132.1465	315.3103
38	18.6253	0.0537	220.3159	0.0045	11.8289	0.0845	134.1868	327.1391
39	20.1153	0.0497	238.9412	0.0042	11.8786	0.0842	136.1256	339.0177
40	21.7245	0.0460	259.0565	0.0039	11.9246	0.0839	137.9668	350.9423
50	46.9016	0.0213	573.7702	0.0017	12.2335	0.0817	151.8263	472.0814
60	101.2571	0.0099	1253.2133	0.0008	12.3766	0.0808	159.6766	595.2931
70	218.6064	0.0046	2720.0801	0.0004	12.4428	0.0804	163.9754	719.4648
80	471.9548	0.0021	5886.9354	0.0002	12.4735	0.0802	166.2736	844.0811
90	1018.9151	0.0010	12723.9386	0.0001	12.4877	0.0801	167.4803	968.9033
100	2199.7613	0.0005	27484.5157	.0000	12.4943	0.0800	168.1050	$$$$$$$$

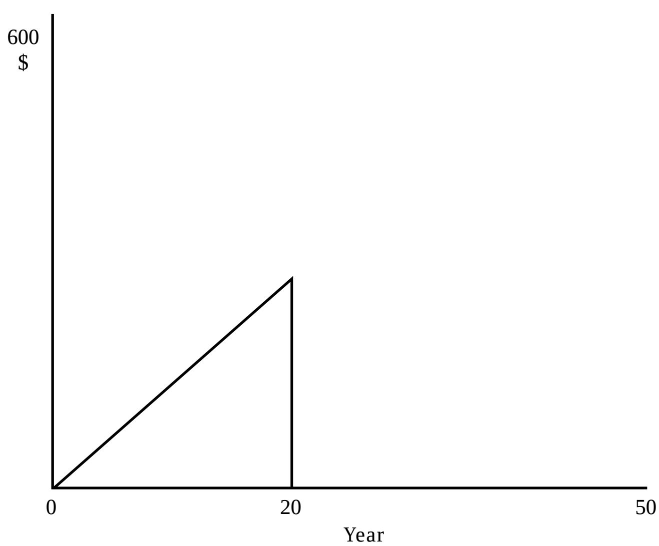
Example 5
A return will build from 0 to $600 in 20 years, then cease. Find the average annual value for a 50-year evaluation period at 8%.

Principles

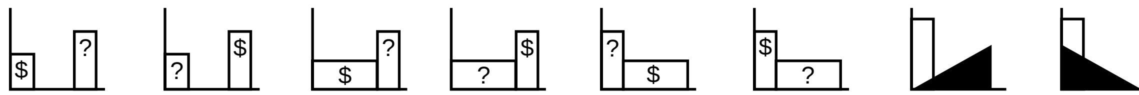
1. Present value of an increasing annuity
2. Amortization

(Present value of an increasing annuity: 20 years at 8%) (600/20)
(78.9079) (30) = 2367.24

Amortize: 50 years at 8%) (2367.24)
(.0817) (2,367.24) = 193.50



Because of rounding, calculations may appear sightly off.

Name	Compounding	Discounting	Amount of annuity of 1	Sinking fund	Amortization			
Description	Future value of one	Present value of one	Future value of annuity of 1	Amount of annuity for a future value	Present value of annuity of 1	Amount of annuity for a present value	Present value of increase annuity	Present value of decrease annuity
Graphic								
Formula								
Periods								
1	1.0800	0.9259	1.0000	1.0000	0.9259	1.0800	0.9259	0.9259
2	1.1664	0.8573	2.0800	0.4808	1.7833	0.5608	2.6406	2.7092
3	1.2597	0.7938	3.264	0.3080	2.5771	0.3880	5.0221	5.2863
4	1.3605	0.7350	4.5061	0.2219	3.3121	0.3019	7.9622	8.5984
5	1.4693	0.6806	5.8666	0.1705	3.9927	0.2505	11.3651	12.5911
6	1.5869	0.6302	7.3359	0.1363	4.6229	0.2163	15.1462	17.2140
7	1.7138	0.5835	8.9228	0.1121	5.2064	0.1921	19.2306	22.4204
8	1.8509	0.5403	10.6366	0.0940	5.7466	0.1740	23.5527	28.1670
9	1.9990	0.5002	12.4876	0.0801	6.2469	0.1601	28.0550	34.4139
10	2.1589	0.4632	14.4866	0.0690	6.7101	0.1490	32.6869	41.1240
11	2.3316	0.4289	16.6455	0.0601	7.1390	0.1401	37.4046	48.2629
12	2.5182	0.3971	18.9771	0.527	7.5361	0.1327	42.1700	55.7990
13	2.7196	0.3677	21.4953	0.0465	7.9038	0.1265	46.9501	63.7028
14	2.9372	0.3405	24.2149	0.0413	8.2442	0.1213	51.7165	71.9470
15	3.1722	0.3152	27.1521	0.0368	8.5595	0.1168	56.4451	80.5056
16	3.4259	0.2929	30.3243	0.0330	8.8514	0.1130	61.1154	89.3579
17	3.7000	0.2703	33.7502	0.0296	9.1216	0.1096	65.7100	98.4795
18	3.9960	0.2502	37.4502	0.0267	9.3719	1.1067	70.2144	107.8514
19	4.3157	0.2317	41.4463	0.0241	9.6036	0.1041	74.6170	117.4550
20	4.6610	0.2145	45.7620	0.0219	9.8181	0.1019	78.9079	127.2732
21	5.0338	0.1987	50.4229	0.0198	10.0168	0.0998	83.0797	137.2900
22	5.4365	0.1839	55.4568	0.0180	10.2007	0.0980	87.1264	147.4907
23	5.8715	0.1703	60.8933	0.0164	10.3711	0.0964	91.0437	157.8618
24	6.3412	0.1577	66.7648	0.0150	10.5288	0.0950	94.8284	168.3905
25	6.8485	0.1460	73.1059	0.137	10.6748	0.0937	98.4789	179.0653
26	7.3964	0.1352	79.9544	0.0125	10.8100	0.0925	101.9941	189.8753
27	7.98881	0.1252	87.3508	0.0114	10.9352	0.0914	105.3742	200.8104
28	8.6271	0.1159	95.3388	0.0105	11.0511	0.0905	108.6198	211.8615
29	9.3173	0.1073	103.9659	0.0096	11.1584	0.0896	111.7323	223.0199
30	10.0627	0.0994	113.2832	0.0088	11.2578	0.0888	114.7136	234.2777
31	10.8677	0.0920	123.3459	0.0081	11.3498	0.0881	117.5661	245.6275
32	11.7371	0.0852	134.2135	0.0075	11.4350	0.0875	120.2925	257.0625
33	12.6760	0.0789	145.9506	0.0069	11.5139	0.0869	122.8958	268.5764
34	13.6901	0.0730	158.6267	0.0063	11.5869	0.0863	125.3793	280.1633
35	14.7853	0.0676	172.3168	0.0058	11.6546	0.0858	127.7466	291.8179
36	15.9682	0.0626	187.1021	0.0053	11.71.72	0.0853	130.0010	303.5351
37	17.2436	0.0580	203.0703	0.0049	11.7752	0.0849	132.1465	315.3103
38	18.6253	0.0537	220.3159	0.0045	11.8289	0.0845	134.1868	327.1391
39	20.1153	0.0497	238.9412	0.0042	11.8786	0.0842	136.1256	339.0177
40	21.7245	0.0460	259.0565	0.0039	11.9246	0.0839	137.9668	350.9423
50	46.9016	0.0213	573.7702	0.0017	12.2335	0.0817	151.8263	472.0814
60	101.2571	0.0099	1253.2133	0.0008	12.3766	0.0808	159.6766	595.2931
70	218.6064	0.0046	2720.0801	0.0004	12.4428	0.0804	163.9754	719.4648
80	471.9548	0.0021	5886.9354	0.0002	12.4735	0.0802	166.2736	844.0811
90	1018.9151	0.0010	12723.9386	0.0001	12.4877	0.0801	167.4803	968.9033
100	2199.7613	0.0005	27484.5157	.0000	12.4943	0.0800	168.1050	$$$$$$$$

Example 6

Receive $600 per year for 20 years beginning in year 30. Find average annual value over a 50-year evaluation period at 8%.

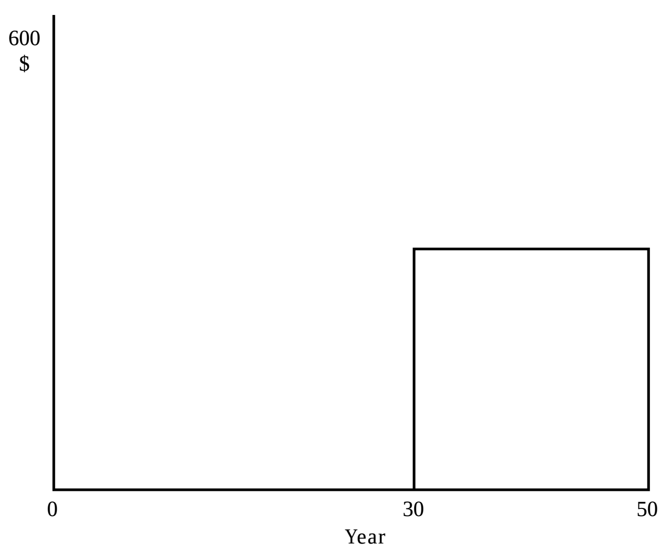
Principles

1. Present value of an annuity
2. Present value of 1
3. Amortization

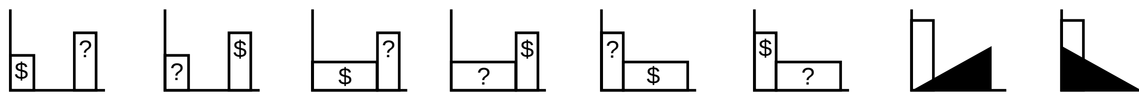
(Present value of an annuity: 20 years at 8%) (600)
(9.818) (600) = 5,890.89

(Present value of 1: 30 years at 8%) (5,890.89)
(.0994) (5,890.89) = 585.44

(Amortize: 50 years at 8%) (585.44)
(.0817) (585.44) = 47.85



Because of rounding, calculations may appear sightly off.

Name	Compounding	Discounting	Amount of annuity of 1	Sinking fund	Amortization			
Description	Future value of one	Present value of one	Future value of annuity of 1	Amount of annuity for a future value	Present value of annuity of 1	Amount of annuity for a present value	Present value of increase annuity	Present value of decrease annuity
Graphic								
Formula								
Periods								
1	1.0800	0.9259	1.0000	1.0000	0.9259	1.0800	0.9259	0.9259
2	1.1664	0.8573	2.0800	0.4808	1.7833	0.5608	2.6406	2.7092
3	1.2597	0.7938	3.264	0.3080	2.5771	0.3880	5.0221	5.2863
4	1.3605	0.7350	4.5061	0.2219	3.3121	0.3019	7.9622	8.5984
5	1.4693	0.6806	5.8666	0.1705	3.9927	0.2505	11.3651	12.5911
6	1.5869	0.6302	7.3359	0.1363	4.6229	0.2163	15.1462	17.2140
7	1.7138	0.5835	8.9228	0.1121	5.2064	0.1921	19.2306	22.4204
8	1.8509	0.5403	10.6366	0.0940	5.7466	0.1740	23.5527	28.1670
9	1.9990	0.5002	12.4876	0.0801	6.2469	0.1601	28.0550	34.4139
10	2.1589	0.4632	14.4866	0.0690	6.7101	0.1490	32.6869	41.1240
11	2.3316	0.4289	16.6455	0.0601	7.1390	0.1401	37.4046	48.2629
12	2.5182	0.3971	18.9771	0.527	7.5361	0.1327	42.1700	55.7990
13	2.7196	0.3677	21.4953	0.0465	7.9038	0.1265	46.9501	63.7028
14	2.9372	0.3405	24.2149	0.0413	8.2442	0.1213	51.7165	71.9470
15	3.1722	0.3152	27.1521	0.0368	8.5595	0.1168	56.4451	80.5056
16	3.4259	0.2929	30.3243	0.0330	8.8514	0.1130	61.1154	89.3579
17	3.7000	0.2703	33.7502	0.0296	9.1216	0.1096	65.7100	98.4795
18	3.9960	0.2502	37.4502	0.0267	9.3719	1.1067	70.2144	107.8514
19	4.3157	0.2317	41.4463	0.0241	9.6036	0.1041	74.6170	117.4550
20	4.6610	0.2145	45.7620	0.0219	9.8181	0.1019	78.9079	127.2732
21	5.0338	0.1987	50.4229	0.0198	10.0168	0.0998	83.0797	137.2900
22	5.4365	0.1839	55.4568	0.0180	10.2007	0.0980	87.1264	147.4907
23	5.8715	0.1703	60.8933	0.0164	10.3711	0.0964	91.0437	157.8618
24	6.3412	0.1577	66.7648	0.0150	10.5288	0.0950	94.8284	168.3905
25	6.8485	0.1460	73.1059	0.137	10.6748	0.0937	98.4789	179.0653
26	7.3964	0.1352	79.9544	0.0125	10.8100	0.0925	101.9941	189.8753
27	7.98881	0.1252	87.3508	0.0114	10.9352	0.0914	105.3742	200.8104
28	8.6271	0.1159	95.3388	0.0105	11.0511	0.0905	108.6198	211.8615
29	9.3173	0.1073	103.9659	0.0096	11.1584	0.0896	111.7323	223.0199
30	10.0627	0.0994	113.2832	0.0088	11.2578	0.0888	114.7136	234.2777
31	10.8677	0.0920	123.3459	0.0081	11.3498	0.0881	117.5661	245.6275
32	11.7371	0.0852	134.2135	0.0075	11.4350	0.0875	120.2925	257.0625
33	12.6760	0.0789	145.9506	0.0069	11.5139	0.0869	122.8958	268.5764
34	13.6901	0.0730	158.6267	0.0063	11.5869	0.0863	125.3793	280.1633
35	14.7853	0.0676	172.3168	0.0058	11.6546	0.0858	127.7466	291.8179
36	15.9682	0.0626	187.1021	0.0053	11.71.72	0.0853	130.0010	303.5351
37	17.2436	0.0580	203.0703	0.0049	11.7752	0.0849	132.1465	315.3103
38	18.6253	0.0537	220.3159	0.0045	11.8289	0.0845	134.1868	327.1391
39	20.1153	0.0497	238.9412	0.0042	11.8786	0.0842	136.1256	339.0177
40	21.7245	0.0460	259.0565	0.0039	11.9246	0.0839	137.9668	350.9423
50	46.9016	0.0213	573.7702	0.0017	12.2335	0.0817	151.8263	472.0814
60	101.2571	0.0099	1253.2133	0.0008	12.3766	0.0808	159.6766	595.2931
70	218.6064	0.0046	2720.0801	0.0004	12.4428	0.0804	163.9754	719.4648
80	471.9548	0.0021	5886.9354	0.0002	12.4735	0.0802	166.2736	844.0811
90	1018.9151	0.0010	12723.9386	0.0001	12.4877	0.0801	167.4803	968.9033
100	2199.7613	0.0005	27484.5157	.0000	12.4943	0.0800	168.1050	$$$$$$$$

Example 7

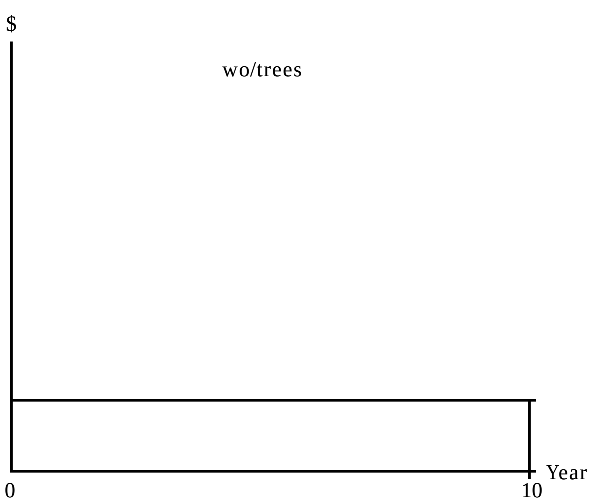
A farmer considers planting an acre of trees to sale as Christmas trees. It will take 10 years before the trees will be of marketable value. At that time a net return of $500 per acre can be expected. The present net return on this land is $30 per acre. How can these two alternatives be evaluated so the farmer can make his decision? It is assumed 10% interest will be applicable.

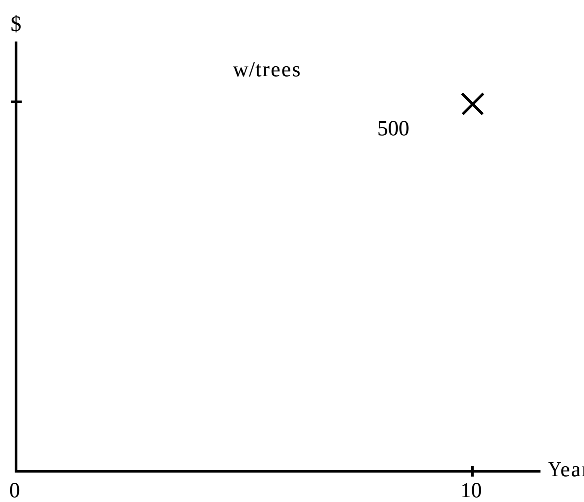
Return without trees

(Present value of an annuity of 1, 10 years at 10%) (30)
(6.1446) (30) = 184.34

Return with trees
(Present value of 1, 10 years, at 10 %) (500)
(.3855) (500) = 192.77

Difference (or expected change in return)
192.77–- 184.34 = 8.43

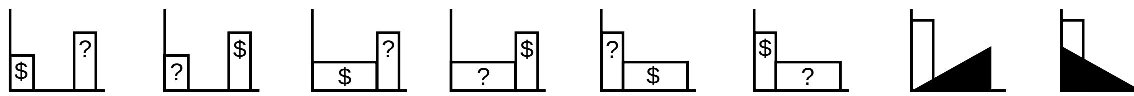




Because of rounding, calculations may appear sightly off.

Name	Compounding	Discounting	Amount of annuity of 1	Sinking fund	Amortization			
Description	Future value of one	Present value of one	Future value of annuity of 1	Amount of annuity for a future value	Present value of annuity of 1	Amount of annuity for a present value	Present value of increase annuity	Present value of decrease annuity

Graphic



Formula

Periods

1	1.1000	0.9091	1.0000	1.0000	0.9091	1.1000	0.9091	0.9091
2	1.2100	0.8264	2.1000	0.4762	1.7355	0.5762	2.5620	2.6446
3	1.3310	0.7513	3.3100	0.3021	2.4869	0.4021	4.8159	5.1315
4	1.4641	0.6830	4.6410	0.2155	3.1699	0.3155	7.5480	8.3013
5	1.6105	0.6209	6.1051	0.1638	3.7908	0.2638	10.6526	12.0921
6	1.7716	0.5645	7.7156	0.1296	4.3553	0.2296	14.0394	16.4474
7	1.9487	0.5132	9.4872	0.1054	4.8684	0.2054	17.6315	21.3158
8	2.1436	0.4665	11.4359	0.0874	5.3349	0.1874	21.3636	26.6507
9	2.3579	0.4241	13.5795	0.0736	5.1590	0.1736	25.1805	32.4098
10	2.5937	0.3855	15.9374	0.0627	6.1446	0.1627	29.0359	38.5543
11	2.8531	0.3505	18.5312	0.0540	6.4951	0.1540	32.8913	45.0494
12	3.1384	0.3186	21.3843	0.0468	6.8137	0.1468	36.7149	51.8631
13	3.4523	0.2897	24.5227	0.0408	7.1034	0.1408	40.4805	58.9664
14	3.7975	0.2633	27.9750	0.0357	7.3667	0.1357	44.1672	66.3331
15	4.17772	0.2394	31.7725	0.0315	7.6061	0.1315	47.7581	73.9392
16	4.5950	0.2176	35.9497	0.0278	7.8237	0.1278	51.2401	81.7629
17	5.0545	0.1978	40.5447	0.0247	8.0216	0.1247	54.6035	89.7845
18	5.5599	0.1799	45.5992	0.0219	8.2014	0.1219	57.8410	97.9859
19	6.1159	0.1635	51.1591	0.0195	8.3649	0.1195	60.9476	106.3508
20	6.7275	0.1486	57.2750	0.0175	8.5136	0.1175	63.9205	114.8644
21	7.4002	0.1351	64.0025	0.0156	8.6487	0.1156	66.7582	123.5131
22	8.1403	0.1228	71.4027	0.0140	8.7715	0.1140	69.4608	132.2846
23	8.9543	0.1117	79.5430	0.0126	8.8832	0.1126	72.0294	141.1678
24	9.8497	0.1015	88.4973	0.0113	8.9847	0.1113	74.4660	150.1526
25	10.8347	0.0923	98.3471	0.0102	9.0770	0.1102	76.7734	159.2296
26	11.9182	0.0839	109.1818	0.0092	9.1609	0.1092	78.9550	168.3905
27	13.1100	0.0763	121.0999	0.0083	9.2372	1.1083	81.0145	177.6278
28	14.4210	0.0693	134.2099	0.0075	9.3066	0.1075	82.9561	186.9343
29	15.8631	0.0630	148.6309	0.0067	9.3696	0.1067	84.7842	196.3039
30	17.4494	0.0573	164.4940	0.0061	9.4269	0.1061	86.5035	205.7309
31	19.1943	0.0521	181.9434	0.0055	9.4790	0.1055	88.1186	215.2099
32	21.1138	0.0474	201.1378	0.0050	9.5264	0.1050	89.6342	224.7362
33	23.2252	0.0431	222.2515	0.0045	9.5694	0.1045	91.0550	234.3057
34	25.5477	0.0391	245.4767	0.0041	9.6086	0.1041	92.3859	243.9143
35	28.1024	0.0356	271.0244	0.0037	9.6442	0.14037	93.6313	253.5584
36	30.9127	0.0323	299.1268	0.0033	9.6765	0.1033	94.7959	263.2349
37	34.0039	0.0294	330.0395	0.0030	9.7059	0.1030	95.8840	272.9408
38	37.4043	0.0267	364.0434	0.0027	9.7327	.0.1027	96.8999	282.6735
39	41.1448	0.0243	401.4478	0.0025	9.7570	0.1025	97.8478	292.4304
40	45.2593	0.0221	442.5926	0.0023	9.7791	0.1023	98.7316	302.2095
50	117.3909	0.0085	1163.9085	0.0009	9.9148	1.1009	104.8037	400.8519
60	304.4816	0.0033	3034.8164	0.0003	9.9672	0.1003	107.6682	500.3284
70	789.7470	0.0013	7887.4696	0.0001	9.9873	0.1001	108.9744	600.1266
80	2048.4002	0.0005	20474.0021	.0000	9.9951	0.1000	109.5558	700.0488
90	5313.0226	0.0002	53120.2261	.0000	9.9981	0.1000	109.8099	800.0188
100	$$$$$$$$$	0.0001	$$$$$$$$$	.0000	9.9993	0.1000	109.9195	900.0073

Example 8

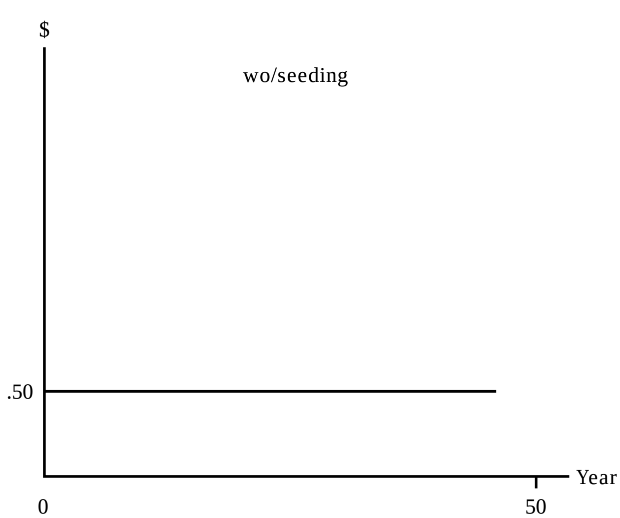
A farmer's deteriorating pasture yields a net return of $0.50 per acre. It will cost $10 per acre to reseed the pasture. The newly seeded acre will be out of production two years to permit the grass to become established. It will take an additional eight years for the pasture to reach its full productivity. At this time a net return of $6 per acre can be expected. Once established, the pasture under good management will have a permanent life. Can this cost be justified? A 10% interest rate is used. Use an evaluation period of 50 years.

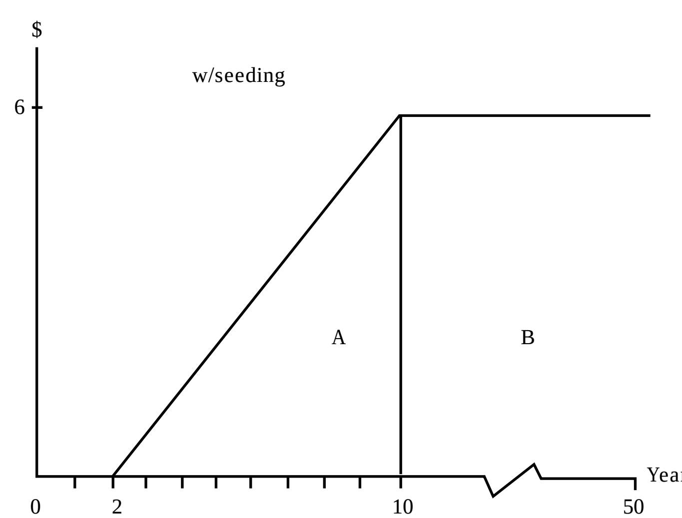
A. Underestablishment
(present value of increasing annuity: 8 years at 10%) (618 years) = 16.02
(present value of 12 years at 10%) (16.02)
(.8264)(16.02) = 13.24
Expected return is $13.34 per acre

B. Fully established
(present value of an annuity: 40 years at 10%)($6)
(9.7791)(6) = 58.67
(present value of 1: 10 years at 10%) (58.67)
(.3855) (58.67) = 22.62
Expected return is $22.62

Once established return is 13.34 + 22.62 = $35.86
Current return
(present value of an annuity: 50 years at 10%)(.50)
(9.91481)(.50) =4.96

Difference or change in return is 35.86 - 4.96 = $30.90
Net Benefit = 30.90 -10 = 20.90 with seeding

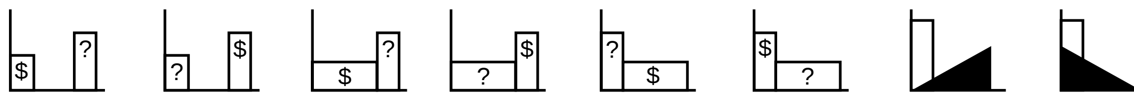




Because of rounding, calculations may appear sightly off.

Name	Compounding	Discounting	Amount of annuity of 1	Sinking fund	Amortization			
Description	Future value of one	Present value of one	Future value of annuity of 1	Amount of annuity for a future value	Present value of annuity of 1	Amount of annuity for a present value	Present value of increase annuity	Present value of decrease annuity

Graphic



Formula

Periods								
1	1.1000	0.9091	1.0000	1.0000	0.9091	1.1000	0.9091	0.9091
2	1.2100	0.8264	2.1000	0.4762	1.7355	0.5762	2.5620	2.6446
3	1.3310	0.7513	3.3100	0.3021	2.4869	0.4021	4.8159	5.1315
4	1.4641	0.6830	4.6410	0.2155	3.1699	0.3155	7.5480	8.3013
5	1.6105	0.6209	6.1051	0.1638	3.7908	0.2638	10.6526	12.0921
6	1.7716	0.5645	7.7156	0.1296	4.3553	0.2296	14.0394	16.4474
7	1.9487	0.5132	9.4872	0.1054	4.8684	0.2054	17.6315	21.3158
8	2.1436	0.4665	11.4359	0.0874	5.3349	0.1874	21.3636	26.6507
9	2.3579	0.4241	13.5795	0.0736	5.1590	0.1736	25.1805	32.4098
10	2.5937	0.3855	15.9374	0.0627	6.1446	0.1627	29.0359	38.5543
11	2.8531	0.3505	18.5312	0.0540	6.4951	0.1540	32.8913	45.0494
12	3.1384	0.3186	21.3843	0.0468	6.8137	0.1468	36.7149	51.8631
13	3.4523	0.2897	24.5227	0.0408	7.1034	0.1408	40.4805	58.9664
14	3.7975	0.2633	27.9750	0.0357	7.3667	0.1357	44.1672	66.3331
15	4.17772	0.2394	31.7725	0.0315	7.6061	0.1315	47.7581	73.9392
16	4.5950	0.2176	35.9497	0.0278	7.8237	0.1278	51.2401	81.7629
17	5.0545	0.1978	40.5447	0.0247	8.0216	0.1247	54.6035	89.7845
18	5.5599	0.1799	45.5992	0.0219	8.2014	0.1219	57.8410	97.9859
19	6.1159	0.1635	51.1591	0.0195	8.3649	0.1195	60.9476	106.3508
20	6.7275	0.1486	57.2750	0.0175	8.5136	0.1175	63.9205	114.8644
21	7.4002	0.1351	64.0025	0.0156	8.6487	0.1156	66.7582	123.5131
22	8.1403	0.1228	71.4027	0.0140	8.7715	0.1140	69.4608	132.2846
23	8.9543	0.1117	79.5430	0.0126	8.8832	0.1126	72.0294	141.1678
24	9.8497	0.1015	88.4973	0.0113	8.9847	0.1113	74.4660	150.1526
25	10.8347	0.0923	98.3471	0.0102	9.0770	0.1102	76.7734	159.2296
26	11.9182	0.0839	109.1818	0.0092	9.1609	0.1092	78.9550	168.3905
27	13.1100	0.0763	121.0999	0.0083	9.2372	1.1083	81.0145	177.6278
28	14.4210	0.0693	134.2099	0.0075	9.3066	0.1075	82.9561	186.9343
29	15.8631	0.0630	148.6309	0.0067	9.3696	0.1067	84.7842	196.3039
30	17.4494	0.0573	164.4940	0.0061	9.4269	0.1061	86.5035	205.7309
31	19.1943	0.0521	181.9434	0.0055	9.4790	0.1055	88.1186	215.2099
32	21.1138	0.0474	201.1378	0.0050	9.5264	0.1050	89.6342	224.7362
33	23.2252	0.0431	222.2515	0.0045	9.5694	0.1045	91.0550	234.3057
34	25.5477	0.0391	245.4767	0.0041	9.6086	0.1041	92.3859	243.9143
35	28.1024	0.0356	271.0244	0.0037	9.6442	0.14037	93.6313	253.5584
36	30.9127	0.0323	299.1268	0.0033	9.6765	0.1033	94.7959	263.2349
37	34.0039	0.0294	330.0395	0.0030	9.7059	0.1030	95.8840	272.9408
38	37.4043	0.0267	364.0434	0.0027	9.7327	.0.1027	96.8999	282.6735
39	41.1448	0.0243	401.4478	0.0025	9.7570	0.1025	97.8478	292.4304
40	45.2593	0.0221	442.5926	0.0023	9.7791	0.1023	98.7316	302.2095
50	117.3909	0.0085	1163.9085	0.0009	9.9148	1.1009	104.8037	400.8519
60	304.4816	0.0033	3034.8164	0.0003	9.9672	0.1003	107.6682	500.3284
70	789.7470	0.0013	7887.4696	0.0001	9.9873	0.1001	108.9744	600.1266
80	2048.4002	0.0005	20474.0021	.0000	9.9951	0.1000	109.5558	700.0488
90	5313.0226	0.0002	53120.2261	.0000	9.9981	0.1000	109.8099	800.0188
100	$$$$$$$$$	0.0001	$$$$$$$$$	.0000	9.9993	0.1000	109.9195	900.0073

Appendix B Breakeven Analysis

Economic evaluation of alternatives produce information that can be used by decisionmakers to determine feasibility and /or the most desirable alternative. In any evaluation, four variables must be considered:

- Cost of installation, including operation and maintenance
- The time period which the alternative will be evaluated
- Interest rate used for the evaluation
- Benefits from the alternative

If all four variables are known, the benefits from the alternative can be compared to the cost of installing the alternative. If three variables are known the fourth variable can be calculated. This is called breakeven analysis. If cost is unknown you are solving the question, how much can I afford to spend? If the time period is unknown you are answering the question, how long will it take to get my money back? If the interest rate is unknown you are asking the question, what rate of return will I get on my money if I install the alternative? Lastly, if the benefits are unknown, you are asking the question, how much net gain do I need to justify spending the money to install the alternative?

Problem 1 Nutrient Management

Breakeven costs—How much can a rancher afford to spend on stock water development if the trough life is 20 years, the interest rate is 8 percent and the value of the increase in animal units produced each year is $140?

Solution—Breakeven cost is the value of benefit times the present value of an annuity of 1

$140 x 9.81815 = $1,375

Breakeven time—How long will it take to recover the cost of an nutrient management system costing $90,000 with an 8 percent interest rate, and fertilizer savings of $50 per acre on 200 acres?

Solution—The value of the alternative is $50 per acre times 200 acres or $10,000 per year. The cost is $90,000. Divide the cost by the value or $90,000/ $10,000 = 9. Solve for the present value of an annuity of 1 per year factor and read down the list of factors for 8 percent to find a factor of 9 and read across to the number of years. The answer is between 16 to 17 years, so the breakeven time is 17 years.

Breakeven interest rate—What is the return on an investment for an alternative that costs $ 1,000, over 20 years, and the reduced operating costs are $180 per year?

Solution—Solve for the present value of an annuity of 1 per year factor and read across the interest tables to find the interest rate. The annuity value is $180 per year and the cost is $1,000. Therefore, the present value of an annuity of 1 per year factor for the break even interest rate is $1,000 divided by $180 or 5.555. Reading across interest tables we find that factor for 20 years the closest to but not less that 5.555 is 5.62777 for 17 percent.

Breakeven Value—What must a 14 ton load of manure be worth in fertilizer value in order to haul it five miles, if the cost of hauling is $30 per mile for 5 years at 8 percent interest?

Solution—Cost times amortization factor of 5 years at 8 percent divided by years. Five miles times $30 per mile is $150 cost.
($150 x .25046)/5 = $7.51 per load

Problem 2 Farm Management

Breakeven analysis provides useful information when small changes in specific conservation situations are being evaluated. Breakeven techniques can be used to determine how much of an investment is economically justified. It can also help producers answer questions like:

- How much can I afford to spend?
- How long will it take to get my money back?
- What rate of return will I get?
- How much net gain do I need?

Each of the above questions involves solving for an unknown variable, cost, time, interest rate, and benefits, respectively. Each question can be answered if the other three variables are known. Three of the following four pieces of information must be known in order to solve for the other:

- Cost – cost of applying the conservation
- Time – the life span or useful life of the practice
- Interest rate – producer's borrowing rate or rate of return desired
- Benefits – the change in yield or net returns created by conservation

Breakeven value (benefit) needed to replace an acre of production with another alternative or practice.

First solve for value of production per acre = income - expenses. Then solve for the portion of that crop in the rotation and sum the values for all crops to get the average value of production per acre. The alternative use needs to have net returns equal to or greater than the current use.

***Calculations*–**Crop rotation over 6 years is 4 years haylage and 2 years of corn silage (1/3 of time in com and 2/3 of time in hay).

Haylage is 6.3 tons per acre times $37 per ton less $200 operating expense times two-thirds of rotation time

$233.10–$200 x .67 = $22.17 per acre return

Corn silage is 17.5 tons per acre per year times $25.50 per ton less $240 per acre times a third of rotation time

$446.25–$240 x .33 = $68.06

Average per acre value of production is $22.17 plus $68.06 or $90.23 per year

The alternative for that acre needs to provide returns or benefits of $90.23 or more per acre for the producer to profit from the change.

If an acre of land on the farm was used for a wastewater treatment facility, the income would be lost from that land to install the filter area. The benefits from the filter would need to be filter greater than the loss of production. For a dairy farm, they might go into a further level of analysis with the details to convert the crop to feed on a dry matter basis to calculate the milk production per acre of land to determine the milk income per acre.

All prices and yields are state averages from the Pennsylvania Agricultural Statistics. The operating expenses per acre are from Pennsylvania State University enterprise budgets.

Problem 3 Forested Buffer

A farm is considering a forested buffer that would take part of a field. The time value of money needs to be considered, so look at a 7 percent rate of return over 20 years.

First solve for value of production per acre, which is income less expenses. Then solve for the portion of that crop in the rotation and sum the values for all crops to get the average value of production per acre. The alternative use needs to have net returns equal to or greater than the current use.

Calculations—Crop rotation over 6 years is 4 years hay and 2 years of corn grain (1/3 of time in corn and 2/3 of time in hay).

Hay is 2.44 tons per acre times $109 per ton less $200 operating expense times two-thirds of rotation time.

$265.96 – $200 x .67= $44.19 per acre return

Corn grain is 119 bushels per acre per year times $2.65 per bushel less $240 per acre times one-third of rotation time

$315.35 – $240 x .33 = $24.87

Total per acre value of production is $44.19 plus $24.87, which is $69.06 per year

The alternative for that acre needs to provide returns or benefits of $69.06 or more per acre for the producer to profit from the change. The present value of an annuity at 7 percent for 20 years is 10.594, so this factor times the average annual net returns can be use to calculate the total returns needed over the 20 year timeframe.

$69.06 x 10.594 = $731.62

If we want to harvest timber off the buffer in year 20 we need a net return (income less expenses for the timber) of $731.62 or more to make the buffer economically justified.

What breakeven yield do I need?
If operating expenses for corn grain are $240 per acre and the corn price is $2.65 per bushel, then $240 divided by $2.65 equals 90 bushels per acre breakeven yield. At yields below breakeven, there are net losses and the farmer needs to reduce expenses or look for another alternative use for that land.

For example if yield is 80 bushels per acre, then income is $2.65 times 80, which is $212 less $240 expenses equals a $28 net loss per acre. The forested buffer would save $28 per acre.

Example 4 Detail conversion of crop to milk value per acre

Dairy farm with corn and hay rotation, 4 years Haylage and 2 years of corn silage (1/3 of time in corn and 2/3 of time in hay) with 10 year timeframe at 7 percent. Fanner wants to use the milk value per acre to make a decision. To do this you need to convert the feed value to milk value.

	Feed requirements per cow are:	your farm
a Corn silage (CS) percent of ration	55 %	______________
b Corn silage moisture	65 %	______________
c Cows fed total lb dry matter	60 lb	______________
d lb of CS fed moisture (c) divided by (b)	60/.65 = 92.3	______________
e lb/cow/day (d) x (a)	92.3 x .55 = 50.8	______________
f (e) x 305 days in milk	50.8 x 305 = 15,494 lb	______________
g Dry cow fed at 1/3 amt x (e)	50.8 x .33 = 17 lb	______________
h Dry 60 days x (g)	60 x 17 = 1,020	______________
i lb/cow/yr CS (g) + (h)	15,494 + 1,020 =16,514 lb	______________
j lb/cow/yr divided by tons/cow/yr	16,514 / 2000 = 8.3	______________
Haylage:		______________
k haylage percent of ration	45%	______________
1 haylage moisture	65%	______________
m Cows fed total lb dry matter	60	______________
n Pounds of haylage fed moisture		______________
m divided by l	60/.65 = 92.3	______________
o lb/cow/day = (n) x percent ration	92.3 x .45 = 41.5	______________
p (o) x 365 days	41.5 x 365 = 15,147 lb/cow/yr	______________
q lb/cow/yr to tons/cow/yr	15,147/2000 = 7.5	______________

At 20 tons per acre per year of corn silage 1 acre will support 2.4 cows.
At 6 tons per acre per year of haylage 1 acre will support .95 cows.

Your farm divide yield by feed needs:
Corn silage ____ tons per year yield / line j (tons/cow/year) = ______________
Haylage _____ tons per year yield / line q (tons/cow/year) = ______________

Milk production per cow	20,000 lb
Milk production per cow times (a) milk attributed to CS	20,000 x .55 = 11,000
Milk production per cow times (k) attributed to haylage	20,000 x .45 = 9,000
Milk production attributed to CS times cows 1 acre of CS will support	11,000 x 2.4 = 26,400 lb/ac of CS
Milk production attributed to haylage times number of cows 1 acre of haylage will support	9,000 x .95 = 8,550 lb milk value/ac
At 2/3 from hay and 1/3 from corn silage	.67 x 8,550 +.33 x 26,400 = 14,440 lb milk at $13 per cwt $1,877

The benefits from the conservation needs to be $1,877 or more per acre to justify giving up the production.

Appendix C Buffers

Economic Impacts of Riparian Forest Buffers

The cost impacts of riparian buffers are site specific and determined by a variety of factors. Such considerations as dominant-land use, landowner objectives, and opportunity costs or foregone production, dictate the total cost that retaining or restoring riparian forest will impose. Following are three hypothetical scenarios that are intended to illustrate economic impacts for typical situations in the Chesapeake Bay Watershed - a coastal plain agricultural field, a forestry site, and a tract of new subdivision development near an urban center. Thanks goes to Dr. Ian Hardie, University of Maryland; John Long and Patty Engler, NRCS; and Scott Crafton, Virginia Chesapeake Bay Local Assistance Department for their assistance and review of these scenarios.

This example occurs in the Coastal Plain area of Maryland and is a hypothetical farm. The costs of riparian forest buffers on agricultural lands include buffer establishment, maintenance, and the opportunity cost of installing a buffer - foregone income from lost production in the riparian area.

Riparian Forest Buffer Installation Estimated Costs

Component	Materials	Unit	Estimated cost
	Establishment		
Preparation	- mow, disking	acre	$12.00
Light site prep			
Planting	8x8 spacing; 430 trees/acre	acre	$495.00
Tree Seedlings	(Hardwoods - $1.15/seedling)		
	12-18' seedling with labor included		
Subtotal			$507.00
	Maintenance		
Reinforcement	Seedlings 50/acre	acre	$58.00
Planting	Year 2 after establishment		$58.00
Total cost	Planting and Establishment	acre	**$565.00**
	Optional Costs		
Establishment	Shelters ($5.00/tree installed)	acre	$2,150.00
	Fencing (1 acre=282 linear feet)	acre	$564.00
Maintenance	- Herbicide treatment	acre	$54.00
Competition control	- mowing	acre	$12.00

Labor cost included in estimates could be saved with help by volunteers for establishment.

Scenario:
A 140-acre farm field located on the eastern shore of Maryland. The landowner manages the field in a two-crop (corn, soybeans), 2-year rotation. The field has 1,307 feet of perennial and intermittent streams running through it. The farmer has agreed to establish a 50-foot-wide forest buffer on both sides of the stream on the advice of his NRCS district conservationist. The result will be a 3-acre riparian buffer.

Assumptions:

- Yield over the entire field—In many cases the area adjacent to a stream or river is considered marginal land because of erosion or drought-prone soils, steep or rolling slopes, poor drainage, and low soil fertility. However, in some cases this area is influenced by the flood plain and can be highly productive. Therefore, we assume a consistent yield.
- No-existing buffer—The buffer to be established is calculated for both sides of stream at 50 feet.
- Land Capability Class—IIe or IIIe (few to moderate limitations).
- Production costs represent variable and fixed costs.

Income to the farmer
This amount represents the cost to the producer in lost crop income. Installing a forest buffer changes the land use for a long period of time. Therefore, total net income is the net present value (NPV), of crop income for 20 years, with a discount rate of 4 percent, the length of time before one may see a return from the new timber resource. Net income above variable and fixed costs is 1996 Crop Budgets of $84.00 per acre and assumes crop price/yields for corn ($3.60/100) and soybeans ($7.95/35) from MD Cooperative Extension Service. Net income is $1,141.00.

Cost of buffer establishment and maintenance
Installing a forest buffer involves site preparation, tree planting, and some second year reinforcement planting. Additional maintenance is sometimes employed to reduce competition and promote tree growth. Refer to preceding cost sheet for itemized costs.

Cost of forest buffer	$565.00
Total cost of riparian forest buffer to the landowner	$1,706.00

Incentive programs that reduce costs of forest buffers to landowners
State and federal programs exist which cost-share best management practices (BMP) and the establishment of riparian forest buffers on agricultural lands. These programs can frequently be combined, or *piggy-backed*, into a financial assistance package. An examination of programs and incentives available for buffers in the Bay states appears later in this chapter. Below are examples of program combinations for each state and the bottom-line cost over a 20-year period to the private landowner if these programs are used. These figures are net present values for direct comparison to landowner costs.

Maryland:

• Conservation Reserve Program (CRP)	
- 50% cost-share reduces buffer installation cost (one time)	$283.00
- Annual rental payments - $81 /acre (15 years)	901.00
- Riparian Forest Buffer 200/6 incentive and $5 maintenance (15 years)	235.00
• MD Buffer Incentive Program - $300/acre (one time)	300.00
Cost to Maryland landowner per acre	0.00

The Maryland landowner makes $13.00 per acre.

Virginia:

- CRP package	$1,419.0O
- Woodland Buffer Filter Area $100/acre (one time)	100.00
Cost to Virginia landowner per acre	187.00

The Virginia landowner loses income per acre over a 20-year period.

Pennsylvania:

• CRP package	$1,419.00
• Streambank Fencing Program (if >12-foot buffer, then fencing provided for free)	00.00
Cost to Pennsylvania landowner per acre	$287.00

The Pennsylvania landowner loses income per acre over a 20-year period.

Discussion

- State and Federal conservation programs can reduce or eliminate landowner costs for restoring riparian buffers an their land. This scenario shows that cost-share and incentive programs can lead to break even or better over a 20-year period. However, crop income opportunity is still lost as time continues.
- Riparian forests can provide additional and diversified economic returns to the agricultural producer. For example, timber that is selectively harvested can still provide annual equivalent of $8.00/acre (red oak - 60-year rotation) to $34.00 per acre (loblolly pine - 35-year rotation). Also, allowing hunting access can return $3.00 to $5.00 in lease fees per acre every year

This example occurs in the Coastal Plains area of Virginia's western shore. It was selected because it is based on an actual situation encountered by a leading forest products company in the region working with a private landowner. The costs, or in this case the foregone income, to retain the forest buffer are from the private landowner perspective.

Scenario

A 54-acre land parcel in private non-industrial land ownership located in the Middle Neck region of Virginia. It is a mixed pine/hardwood site with 3,920 feet of perennial stream running through the area scheduled for timber harvesting. A local ordinance requires a 50-foot wide buffer or streamside management zone to protect water quality. The result is a 4.5 acre total area impacted by retaining the buffer.

Income from Timber Production:

Income figures are shown per acre. Reforestation is optional in this region because natural regeneration occurs well on these sites. The reforestation cost is included to show potential costs to the landowner, and it assumes that they may choose selected species management.

Gross Timber Income (per acre)	$1,268.00
Production Costs to Landowner (per acre) Harvest - payment to logger (estimate of labor, equipment maintenance, hauling, insurance, FOB)	– 634.00
Reforestation - species enhancement/management (optional)	– 200.00
Net income to landowner	$434.00

Cost of a buffer to the landowner

The figures below show the income potential of the entire 54-acre land parcel and the impact of lost income for using alternative harvesting techniques within the 4.5-acre forest buffer. The preferred management approach is to clear cut the entire parcel. Each alternative harvesting technique reflects the adjusted total return, the exact dollar change (loss), and percentage change in return to the landowner. Total returns were calculated at $634.00 per acre to reflect the impact of the buffer on the timber sale only.

Cost of Buffer to Landowner

Harvesting alternatives	Total return	Changes	% Change
Total clearcut of the entire parcel	$34,250		
Selective cut All saw timber in buffer (>50% ba)	33,991	$259	1.00%
Selective Cut High quality in buffer (<50% ba)	31,602	2,649	7.70%
No harvest in buffer	$28,531	$5,719	16.70%

Comments on "Economic Impacts of Riparian Forest Buffers on Agricultural Lands"

Simplify crop production section by eliminating gross annual income and annual production cost figures; simply show net annual income per acre. Reference University of MD crop budgets for average income per acre. As we discussed, cropland entered into retirement programs will probably be the marginal, less productive acres, so the $127 per acre net income figure may be slightly high, although it seems to be in the right ballpark.

With an example of installing a forest buffer through CRP, suggest using a 15-year contract, with 15 annual payments ranging from $23 to 102 per acre. Suggest discounting all annual, dollars per acre values to a lump-sum NPV, so a comparison with the one-time, lump-sum BIP payment or other one-time payments can be made. Use a 30-year time period for discounting the lost crop income because there is a 30-year life requirement for the forest buffer.

Example: CRP in Talbot County

- $81/acre for 15 years = $797/acre NPV (at 6%).
- Discount net annual income as well ($127/acre for 30 years = $1,748/acre NPV).
- Factor in 20 percent incentive payment for buffers through CRP, and $5/acre maintenance fee: $5/acre+$16,20/acre = $21.20/acre. $21.20/acre for l5 years =$206/acre NPV.
- Hunting lease income: $5/acre for 30 years = $69/acre NPV

Under this scenario:

	Total NPV
Lost income (30 yrs)	($1,748)
Buffer installment (one-time)	200
(50% cost-shared from CRP)	
CRP annual rental payments (15 yrs)	$797
CRP maint. and inc. payments (15 yrs)	$206
BIP payment (one-time)	$300
Hunting lease income (30 yrs)	$69
	($586)

This analysis shows that there would be a net loss to the producer. However, a producer receiving $127 per acre in income from planting crops probably wouldn't enroll in CRP for only $81 an acre. The producer would probably only accept as much from CRP as they could get otherwise. Suggest setting up the scenario so that the crop income and the CRP rental rate were equal to $81 per acre.

	NPV
Lost income (30 yrs)	($1,115)
Buffer installment (one-time)	(200)
(50% cost-shared from CRP)	
CRP annual rental payments (15 yrs)	787
CRP maint. and inc. payments (15 yrs)	206
BIP payment (one-time)	300
Hunting lease income (30 yrs)	92
Net	$47

This scenario is also in line with the above comment that the majority of cropland enrolled in CXP or other retirement programs will be marginally productive.

General comments

Round all dollars per acre figures to whole dollar amounts. Specify in a column header that these figures are dollars per acre. Only show numbers in dollars per acre NPV so all numbers within the column can be easily compared. Have entire analysis on one page to facilitate cast of review.