TECHNICAL NOTES

US DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

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GUIDANCE FOR USING TYPICAL COST/RETURN INFORMATION TO EVALUATE THE ECONOMICS OF SPECIFIC RESOURCE SITUATIONS

I. Introduction

Your specific planning needs for economic information are undoubtedly as diverse as the agricultural crop/resource situations of this state. Each planning situation involves comparisons of alternative treatments each with advantages and disadvantages. Individuals make decisions by comparing advantages and disadvantages of alternative actions. Farmers and ranchers usually measure advantages and disadvantages in terms of dollars, but non-monetary values (safety and health concerns, community pride, non-priced recreational and wildlife benefits, etc.) may also be important to them.

The role of the conservation planner is to aid the decision-making process by providing clear information and data about the pros and cons of contemplated changes. The farmer or rancher can then weigh expected results and select a plan that meets his or her needs. The level of detail required in an analysis of a conservation system depends on the needs of the person making the decisions. In some cases a farmer or rancher may be able to make decisions based solely on the physical and biological changes expected as a result of a conservation system. This information is always the first duty of sound conservation planning. Alternatively stated, an objective assessment of the present condition, future without any intervention (expected trend arising from the present condition) and future with alternative treatments is essential and is often all a grower needs for decision-making.

If additional information is needed regarding how the proposed conservation system will influence their costs or income, then typical farm studies and budgets, if available, can serve as the basis for more detailed analysis. The intent of this Technical Note is to provide guidance regarding the main economic concepts and terms that underpin typical farm studies and representative budgets in order to assist you to adapt these sources of information for specific planning efforts. The information presented could also be used to develop budgets, partial budgets and representative economic analyses for farming/natural resource situations in your area.

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Specifically, two categories of information will be presented: (1) Enterprise budgeting and cost accounting information; and (2) Economic analysis methodology information with examples of (a) Partial Budgeting Analysis (rowcrop production with conservation tillage); and (b) Least Cost or Cost Effectiveness Analysis (orchard production of pears and irrigation via a hose-pull vs. solid-set sprinkler systems). Given that time is a scarce commodity each section is written with the reader in mind to stand alone so that you don't have to read and digest the entire Technical Note to understand a particular section. However, you are of course encouraged to read and utilize the entire document as needed.

The information provided on partial budgeting (beginning on page 9/section II.H.) and least cost or cost effectiveness analysis (beginning on page 13/section II.K.) will most likely have greatest relevance (practicality) for field work. The degree of detail provided in the sections on cost accounting and enterprise budgeting will go beyond your most common needs for planning, but should serve as a detailed reference for the so inclined planner with occasional more in-depth analysis requirements.

II. Enterprise Budgeting and Cost Accounting

A. Background: Budgets provided in most studies are generally based on averages for a given area and are therefore considered "typical" or representative of cropping operations in that area. It is important to understand how such budgets were formulated in order to construct your own or to revise those available to fit your specific situations. Budgets generally include individual per acre charges for each operation. These charges contain estimates for both the fixed and variable costs associated with each operation and are based on ownership, operating and/or custom work rate estimates adopted from information collected locally or from surveys conducted by the extension service or reported by private information suppliers such as Doane's Agricultural Report (See Attachment A "Machinery Operating Costs, 1989" and "1989 Farm Machinery Custom Rates Guide"- used with permission from Dan Henley, Manager, Doane's Information Services, St. Luis, Missouri).

First, some clarification of terminology is in order to avoid confusion and clearly separate cost categories. Several terms and cost categories are commonly used to identify one type of cost from another, e.g., operating, variable, overhead, fixed, ownership, etc. All of these can

be grouped under two categories, fixed and variable costs. Operating costs are simply a type of variable costs, while overhead and ownership costs are only types of fixed costs. Specific definitions for these terms and a few others follow:

B.Depreciation: The annual cost that results as machinery and equipment are consumed via wear and tear, i.e., equipment physically wears out over time and must be replaced.

This is distinct from the original cost of a piece of machinery which is either the cash purchase price or the down payment plus dollar amount financed through a loan plus interest. Depreciation is a real, but often misunderstood cost due to confusion with terminology, methods of calculation and concern focused on depreciation allowances for tax purposes vs. "book depreciation" (reflects reductions in market value of an asset) vs. actual physical depreciation estimates and their translation into economic value estimates for replacement purposes (economic depreciation should be a mirror image of physical depreciation and also involves notions of obsolescence and salvage values if relevant).

Tax allowances for depreciation are deductions allowed which reduce taxable income and explicitly recognize part of the real cost of using up machinery and equipment. These tax code provisions are commonly referred to as cost or capital recovery allowances and generally will differ from depreciation charged by a firm in its accounts. The basic concept of depreciation allowances is for the same purpose as the notion of a "sinking fund". A sinking fund is an amount of money set aside each year from the productive employment of capital equipment, which is accounted for as a "book expense" and ultimately goes towards the replacement of the actual piece of machinery, i.e., it is charged to earnings so that funds will be available to replace assets as they wear out.

C.Fixed Costs: Over a short term time period some factors of production cannot be varied. Charges for those factors of production that can't be easily varied are termed fixed costs. Fixed costs do not vary with output and would be incurred even if no output were produced.

1. <u>Ownership costs</u> are an example of fixed costs. They represent expenditures for ownership of the farm and all assets and include (a) depreciation; (b) local real estate taxes; (c) principal and interest on investment (payments to retire loans for land, machinery and equipment, and all capital improvements, i.e., buildings and structures on the

farm); (d) mortgage and personal property insurance and life/health insurance for the owner (crop and livestock insurance are considered variable costs and are thus excluded) and housing for the owner (employee and machinery housing fit under item (c) above).

2. **Overhead costs** are another example of fixed costs and include expenditures associated with the farm organization that are in general not influenced by levels of production nor types of enterprises undertaken. Items included in this group are (a) basic service fees for utility bills such as telephone and electricity; (b) machine shop and related farm tool expenditures; (c) accountant or management service fees; (d) farm office costs, etc. It should be noted that in the long run all costs are variable, e.g., more land can be acquired, a mortgage can be paid off,etc.

D.Variable Costs: Those expenditures which occur only when production takes place are termed variable costs. They are variable in the sense that they vary with the level of output achieved. Increasing (variable) use of inputs such as fertilizer results in output increases up to the point where additional use of inputs does not result in added product. Added (variable) use beyond this point results in detrimental effects (output reductions).

1. **Operating costs** are an example of variable costs to utilize farm machinery and include expenditures for lubricants, maintenance, repairs, and, in general, fuel (not applicable to all machines, e.g., an offset disk does not use fuel).

2. **Material costs** are another category of variable costs and include expenditures for any material or consumable supplies used in the production process, e.g., agricultural chemicals, seeds, irrigation water, etc.

3. **Labor** is generally considered a variable cost, but could be defined as a fixed cost as in the situation where an owner of a farm, who may or may not also be the operator, accrues certain costs which are charged against the farm regardless of output levels. Mortgage payments for land are fixed costs as noted above, but rental payments for land are variable costs. Custom fieldwork costs are also considered as variable costs.

4. **Management** could be defined as either a fixed or variable cost depending on the situation. For most owner/operators management and labor charges for their own efforts are irrelevant academic definitions. If they are

able to cover their costs of production, in a very broad sense including the cost of the lifestyle that they live and the farm supports, then it doesn't matter to them if there are or aren't any returns to management and labor.

E.Cost Accounting: A number of assumptions, which may or may not be explicitly mentioned, are behind each of the per acre charges used in representative budgets. Per acre charges usually include fixed and variable cost estimates for operating new equipment based on some assumed annual number of hours of usage.

For example fixed costs are typically calculated as follows: Depreciation is typically taken over 10-15 years with salvage values ranging between 15 and 30 percent of the purchase price depending on the machine used. Original machinery costs are often discounted 10 to 20 percent from list prices quoted by the major manufacturing firms. Interest charges on the average investment/machine are based on current interest rates, or approximately 11-12 percent on the original purchase price. Insurance for machinery is based on 50-75 percent of the original cost of the item and housing is charged at $0.75-$1.00 per square foot of space required.

Variable costs are often calculated based on: repair costs estimated from formulas provided by the American Society of Agricultural Engineers; with lubrication assumed to be 10 percent of fuel costs; and fuel consumption calculated based in general on 0.06 gallons per horsepower hour.

F.Specific Guidance: Given that each individual grower's resource situation and farming practices vary to one degree or another from the typical budget situation mentioned above, modifications should be made as needed. For example, fixed costs, excepting insurance, for a given piece of equipment would be irrelevant for the farmer who had completed paying for it and if sufficient funds for replacement had already been put aside, i.e., it is completely depreciated in an accounting sense. In this situation only cash variable costs and property insurance (a fixed cost) would be relevant for the machine.

Depreciation (capital recovery), as a component of fixed costs, is often excluded from analyses for loans to finance long-term investments in many productive assets. This occurs because capital recovery for lenders ends with loan repayment and from a farmers perspective replacement, if needed, will presumably occur in the future from retained profits. Retained profits would in part be made up from the cost reduction/profit enhancing aspects of tax allowances

for depreciation. Depreciation is something neither farmers nor lenders usually have to deal with immediately, excepting times when tax law changes result in accelerated cost recovery allowances and indeed have a significant effect on investment decisions. The main interest of both the lender and farmer is to simply see that the expected cashflow is sufficient to recover/pay the loan.

However, it may be in the interest of an individual grower to analyze whether or not a financed investment in some productive resource will allow him/her to employ the capital asset so as to generate funds for replacement. This would allow the individual to avoid having to finance replacement in the future and would presumably increase profit margins by reducing interest costs (assuming that his/her opportunity cost of capital is lower than his/her financial cost to borrow capital, i.e., assuming that the potential earnings rate for other uses of his/her available dollars is lower than the interest cost of borrowed money).

The following approaches can be followed to estimate and allocate the fixed and variable costs particular to a specific grower for a given piece of equipment, farm improvement or set of machinery and materials used in crop and livestock production. The information pertaining to fixed costs has greatest relevance for growers contemplating a change requiring a significant investment in some longer-term productive asset such as machinery, buildings, additional land, irrigation system hardware, drainage systems and evaporation ponds, grade stabilization structures, etc.

G.Enterprise Budgeting Procedures: **1.** Determine the relevant fixed cost components which may be wholly or partially allocated to the enterprise to be budgeted. Make a list indicating which resource items, equipment, buildings, land, etc., are solely or partially used for the crop or livestock activities being budgeted. Given that the productive employment of resources varies from year to year it is important that fixed costs be established first. Once these costs are known then charges may be made to each productive enterprise which employs a given resource based on expected use. For example, expected use of a specialized implement may be for only one type of crop production. Therefore, the entire capital (fixed) costs would be charged to that activity. Alternatively, a tractor is usually employed in many enterprises. Therefore, it's fixed costs would be allocated to individual activities based on a general per acre charge or an hourly use fee.

2. Directly estimate those fixed costs which are simply a per acre charge (real estate taxes) or a function of the cost to the farm divided by the number of acres farmed, e.g., insurance, accountant services, etc.

3. Then compute <u>average annual investment cost/acre</u> (principal and interest) for each piece of equipment or capital improvement by taking the original purchase price (cost including sales tax) and multiplying this figure by the applicable amortization factor which can be found in the Economics of Conservation Handbook or in abbreviated form in the attached Interest and Annuity Tables (See Attachment B). The amortization factors are based on specific interest rates and periods of time. They convert original cost to average annual. The appropriate interest rate would be the same as for common loans used to finance equipment purchases, buildings, etc. The appropriate period would be the same as for common loans for purchasing the item, e.g., 20-30 years for land and some buildings, 5-20 years for other buildings, 3-15 years for most equipment/machinery, etc.

An alternative method for calculating average annual investment cost for a given set of equipment is to take one half of the item's original purchase price/acre and multiply it by the applicable loan percentage rate (one half of the purchase price is an assumed average value of the equipment during its useful life). Average annual estimates of this type will differ from the more accurate actual interest costs and from average annual principal and interest costs estimated with compound interest and annuity tables. This is especially true if only a small proportion of the item's original cost was actually financed, but this method will provide a "ballpark" estimate.

4. Then, if relevant, compute <u>average annual depreciation costs/acre</u> by taking the original equipment cost (including sales tax) minus anticipated salvage values for all items used in the enterprise and divide these amounts by the expected years of useful life. Divide the resultant dollar cost/year by the number of acres the item is annually used on. These calculations will result in an estimate of the annualized cost/acre for capital recovery of a given piece of equipment. This method is termed the straight line method of depreciation.

In times of high inflation or rapid technological change the replacement-cost depreciation method should be employed. Replacement-cost depreciation uses periodic revaluation of an asset by an index of capital costs (See USDA/Statistical Reporting Service "Agricultural Prices") to adjust depreciation charges accordingly. The declining balance method of depreciation is one other widely used method for calculating depreciation. This method uses a

constant proportion of the value of an asset over its life. Thus, the amount of depreciation charged each year results in a declining amount.

5. Then make a list of all variable cost items relevant for the enterprise being evaluated and calculate the per acre cost for each piece of equipment, labor and management (if relevant) employed and material input. Material costs/acre are simply the price paid multiplied by the quantity used/acre. You may also want to charge for miscellaneous expenses (generally 8% to 10% of all other variable costs) to serve as a contingency or catch-all for unexpected expenses and the odd job details that escape many cost accounting efforts.

Equipment operation charges (variable costs) may be estimated using the following formulas:

(a) acres/hour = tractor speed in mph * 5,280'/mile * width in feet of the implement being used divided by 43,560 square feet/acre * field efficiency (field efficiencies in California typically range from 70% to 90% for most operations and tend to be reduced by increasing the width of a machine or by increasing the speed of operation);or an alternate method for acres/hour = (tractor speed in mph * implement width * field efficiency)/825;

(b) hours/acre = 1 divided by the number of acres covered/hr);

(c) fuel use in gallons/acre = gallons/horsepower hour multiplied times the equipment's horse power divided by the number of acres covered/hour (use 0.06 gallons/Hp-Hour for diesel engines and 0.08 gallons/HP-Hour for gasoline powered motors if you don't know the specific consumption rate);

(d) tractor and implement maintenance and repair costs typically run over their useful lives from 80% to 120% of the individual item's original cost (harvest equipment repair costs generally range from 60% to 80%). Thus, a fair estimate of the cost/hour of use can be made by taking the appropriate percentage of the machine's original cost and divide it by the hours of useful life.

(e) lubrication costs typically average around 10 percent of fuel costs;

Once all costs have been accounted for, returns or gross receipts are utilized to estimate before income tax profits. Don't forget to include deficiency payment rates for those individuals who participate in the Federal Feed Grain, Wheat, Upland Cotton and Rice programs. Deficiency payments are estimated by the USDA/ASCS before the crop season for advance loan payments and the general planning

needs of farmers. They are later calculated for final payment at the end of the growing season based on a formula that takes in to consideration the difference between average market price for a given year and the target price established through the USDA.

Cooperative extension service enterprise budgets are excellent examples of complete enterprise budgets.

H. Partial Budgeting: Partial budgeting is an alternative approach for customizing typical farm information. This method is a simplified way of examining the economic consequences of alternative practices and systems of production and is therefore preferable to complete enterprise budgeting. The partial budget technique is comparable to the common use of pro vs. con method of weighing the pluses and minuses associated with any contemplated change. The analysis focuses solely on the physical and biological variables that change, then translates them into economic values using the same techniques discussed in the section on enterprise budgeting. A simple listing of the advantages and disadvantages of a given change in operations is a good way to begin.

The desired result is an assessment of the net effect, in dollars, of all positive and negative change. All changes may be expressed in one of the following partial budget analysis categories: (a) added costs; (b) added returns; (c) reduced costs; (d) reduced returns; and (e) changes in the environment which may or may not be monetized. The following partial budget analysis form may be used as a guide:

Partial Budget Analysis Worksheet

	$/Acre/Yr
1. Added Costs:	
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
Sub Total	_____
2. Added Returns:	
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
Sub Total	_____
3. Reduced Costs:	
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
Sub Total	_____
4. Reduced Returns:	
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
Sub Total	_____
5. Changes in the Environment:*	
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
Sub Total	_____

Net Effect = (2. + 3. + 5.) - (1. + 4. + 5.)

Cost/Return Summary

		($)
Added Costs	-	_____
Added Returns	+	_____
Reduced Costs	+	_____
Reduced Returns	-	_____
Net Envir.Change	+/-	_____
Net Effect		_____

* Use monetary estimates when practical, zero if there aren't any known, and at least note any environmental changes in narrative form as either detrimental, positive or neutral for both on-farm and offsite impacts.

I. Partial Budgeting Example: Conventional tillage (moldboard plow) corn for grain followed by cotton is currently being grown (furrow irrigated) on 200 acres of Windswept, Washaway and Nowuseeitnowudont soils in Passing Wind County, Drafty Valley, USA. Soil loss from wind erosion is estimated to be 7 tons per acre per year. Irrigation induced erosion is estimated to result in an additional 30 tons/acre/year.

Current practices along with the present rates of erosion are having a significant enough impact to depress yields (wind damage and irrigation induced seedling losses due to voiding and sedimentation), slowly impair long-term productivity and increase annual operating costs (replane fields, lowered field efficiency and inefficient use of water and fertilizer). In addition, tailwater runoff enters Repugnant Creek and is carried downstream to Aseperatereality city water supply reservoir. Sediment associated with the runoff is reducing the reservoir's storage capacity, and nutrients and other agricultural chemicals are associated with water quality degradation.

The field office conservation planner reviews the present situation with the landowner and discusses possible treatment options. The landowner is particularly interested in a Resource Management System (RMS) presented by the SCS involving conservation tillage (reduced-till corn and cotton), conservation cropping sequence (adding 3 years of alfalfa after 1 year of corn and 2 years of cotton), shortened length of irrigation runs, water and sediment control basins, tail-water return systems and sod filter strips adjacent to Repugnant Creek. This RMS reduces the wind erosion problem, essentially eliminates the irrigation induced erosion and sediment and agricultural chemical delivery problems from surface water flows.

The partial budget analysis provides the land user with information on the kinds, amounts and timing of actions necessary to implement the RMS. A listing of the expected advantages and disadvantages of changing from conventional tillage corn and cotton to reduced till corn, cotton and alfalfa with erosion control follows:

Advantages	Disadvantages
Reduced tractor fuel;	Shortened runs require $1.75/ acre added irrigation labor;
Reduced seedling mortality;	Purchase chisel plow @ $2,800 ($0.60/acre/year);
Reduced tractor repair;	Land removed from production for sediment basin;
Reduced machine repairs;	Sediment pond installation cost of $10,000 ($5/ac/yr);
Reduced machinery labor;	Longer rotation disrupts CU and ACR set-aside plans;
Reduced pesticide, sediment and nutrient runoff;	Shortened runs reduce field efficiency during cultiv.;
Maintenance of soil structure and productivity;	Tailwater recov. sys. cost of $1800($240/yr or $1.20/ac/yr);
Improved moisture holding capacity;	
Longer rotation disrupts pest and disease cycles;	
Less water and fertilizer needed;	
Less need to replane fields;	
Shortened runs result in improved IWM & better yields;	

In some cases, the client would be able to place his or her own values on the quantitative and qualitative expectations presented above and make decisions and take action. In other cases additional information would be needed or desirable. The partial budget format provided above could then be used in the next step for more detailed planning. Specific dollar values could be developed with the grower for each item leading to a bottom-line estimation of the net economic effects of the RMS.

The rest of the story in Drafty Valley, USA: Over time a majority of the growers in the area recognized the economic and urban relations advantages of such systems as detailed above. They adopted, to one degree or another, similar systems and the Community decided to rename Repugnant Creek, Fishable/Swimable Brook.

J.Cost Effectiveness or Least Cost Analysis: Cost effectiveness analysis is the same as cost minimization. This evaluation methodology can be used whenever a given objective is to be achieved without specific reference to benefits. Thus such evaluations provide an incomplete picture, i.e., no judgement is made as to whether or not a contemplated investment is worth doing. The decision to do something has already been made, now the evaluators role is to determine the least cost alternative that fits the landusers system and objectives. The basic comparison made in cost effectiveness analysis is between investment, operation, maintenance and sometimes replacement costs for various alternatives. Unlike partial budgeting, operational impacts on existing farm operations are not considered.

All future costs for each alternative are placed on a common time basis with annual operation and maintenance (O&M) costs via discounting (if needed) using present valuefactors (See Attachment B). All costs are then amortized over the relevant period of analysis and converted to per acre values if useful for comparison. The alternative which acceptably achieves the stated objective at least cost is deemed the recommended alternative.

K.Cost Effectiveness Example: A grower has decided to invest in a new irrigation system for a 145 acre pear orchard. With some initial planning assistance the grower has already narrowed his/her choice to two alternatives, a hose-pull system or a solid-set sprinkler system. The hose-pull system (alternative 1) has an initial investment cost of $793/acre ($115,000 total cost) with an expected life of 20 years. The average annual cost (AAC) of the investment would be $15,396 at a 12 percent discount rate. Annual operation and maintenance are expected to run approximately $12,216. Thus the total AAC of alternative 1 would be $27,612.

The solid set sprinkler system (alternative 2) has a significantly higher initial cost ($1,500/acre or $217,500 total), but will require significantly less for annual O&M ($4,590). This alternative is also expected to last 20 years and therefore the initial investment cost will result in an annual cost of $29,123. Thus the total AAC of alternative 2 would be around $33,713. This represents $6,101 more than alternative 1. However, alternative one might be the preferable alternative if we were to look at irrigation efficiencies, resulting crop yields, i.e., benefits in general. Once again, cost effectiveness analysis will indicate which alternative will achieve the objective at least cost, but may or may not lead you to the best choice.

L.Other References: "The Economics of Conservation Handbook" may be referred to for additional information on how to prepare enterprise budgets and conduct partial budgeting evaluations. Section V. of the FOTG (revised June, 1988) may be used for added assistance which includes Conservation Impacts Worksheets for collecting field data and carrying out partial budget analyses. Economics Technical Note No. CA-1, dated September, 1985 is a related reference regarding "Techniques for Evaluating Conservation Practice Costs".