COLORADO DEPARTMENT OF AGRICULTURE

Agricultural Chemicals and Groundwater Protection

Economic Considerations of Nutrient Management BMPs

January 2011

Concern about nutrients from fertilizers and manure degrading water supplies has resulted in a search for nutrient management approaches that protect water quality. A number of practices (known as Best Management Practices or BMPs) have been identified which can help maximize nutrient efficiency while minimizing environmental problems.

Due to the economic risks inherent in agriculture, producers need incentives to change proven ways of doing business. These incentives may include increased profits, decreased costs, cost-share funding, enhanced water quality, or even improved public perception. Producers should evaluate the potential environmental benefits versus the costs and returns of BMPs as they determine which practices are most appropriate for their operation. Not all practices are equal in their environmental or economic benefit. This publication is intended to help producers think through some of the economic considerations associated with adopting BMPs.

The adoption of BMPs may require changes from existing management and cultural practices. Economic analysis of these changes involves calculation of the costs and benefits of the new system versus the old system. Consideration of new practices can be a complicated decision; there may not be a single factor by which to judge the appropriateness of any particular practice. The economic and financial considerations of BMPs are important parts of the decision process. The complexity of the economic analysis depends on the particular practice and situation being analyzed.

The basic partial budgeting framework can be adapted for any of the BMPs. The calculation of particular costs and returns will be specific to the BMP under consideration and the particular farming situation where it is to be applied. In all cases, only those costs and returns that will be impacted by the change will be relevant to the partial budget decision.

Categories of BMPs

For purposes of economic analysis, BMPs may be divided into four categories. While the basic economic principles of calculating additional costs and additional returns holds for each of the categories of BMPs, the application of these principles can be quite different. It could be as basic as calculating the cost and returns associated with changing fertilizer rate, or as complicated as calculating the costs and benefits associated with investing in secondary containment structures. Secondary containment structures have a considerable lifetime and involve the economics associated with investment analysis. Economic analysis for each of these categories will be discussed.

BMP Categories

Best Management Practices for nutrient management may be divided into four categories, depending on which types of changes are involved.

1. Changes in fertilizer usage or changes in soil management
2. Changes in cropping practices
3. Changes in tillage or fertilizer application practices
4. Changes in or additions of structures

Category 1: Changes in fertilizer usage or changes in soil management

The economic assessment of these types of changes is straightforward. The expected benefits for most of these BMPs will be realized fairly quickly, most often in the

Example Partial Budget for BMP: Fertilizing for optimum economic returns

Benefits		
1. Additional Income	$ -	
2. Reduced Expenses	$ 12.50 (25 lb less N/A)	
3. Benefits Subtotal (1 + 2)		$ 12.50/A
COSTS:		
4. Reduced Income	$ 10 (-2 bu/A)	
5. Additional Expenses	$ -	
6. Costs Subtotal (4 + 5)		$ -10.00
DIFFERENCE:		
(Benefits - Costs)		$ 2.50/A

first production year. Thus, benefits from this type of BMP will be easy for the farm operator to calculate.

Likewise, the costs of implementing BMPs in this category will also occur in the first production year. The economic analysis involves comparing the added costs with the expected benefits in a straightforward application of the partial budgeting process. For example, a wheat producer may be considering two alternative levels of nitrogen fertilizer applications. The first involves applying 80 pounds of nitrogen per acre. The yield associated with this level of fertilizer is expected to be 50 bushels per acre. As an alternative, the producer may apply 55 pounds of nitrogen per acre and expect a yield of 48 bushels per acre. If nitrogen fertilizer costs $0.50 per applied unit, the price of wheat is expected to be $5.00 per bushel, the partial budget format can be used to determine the economic consequences associated with reducing nitrogen fertilizer. In the benefits section, there is no additional income as yields are reduced. Expenses are reduced by $12.50 per acre [(80 pounds x $0.50 per pound) compared to (55 pounds x $0.50 per pound)]. Total benefits are $12.50 per acre. In the costs section, income is reduced by $10.00 per acre [(50 bushels x $5.00 per bushel) compared to (48 bushels x $5.00 per bushel)]. There are no additional expenses. Thus, the difference associated with reducing nitrogen fertilizer is a net benefit of $2.50 per acre.

Soil Sampling

Soil sampling of fields used for crop production can provide valuable information regarding nutrients, soil texture, salinity, pH, and organic matter. Sampling protocol indicates that each sample should contain about 20 cores of soil from a reasonably uniform area of each field. Fields without uniform soil types should be divided into separate sampling units. Costs associated with soil testing include taking the sample and submitting it to a laboratory for analysis. One person can collect 20 cores of surface soil from a uniform field and mail the sample to a laboratory in about one hour.

Partial Budget: Soil Testing & Reduced Phosphorus Rates

	40 Acre Field	*130 Acre Field*
Benefits		
Additional Income	$ 0.00	$ 0.00
Reduced Expenses (3lbs P_2O_5/ac @ $0.55)	$ 66.00	$214.50
Total Benefits	$ 66.00	$214.50
Costs		
Reduced Income	$ 0.00	$ 0.00
Additional Expenses (soil test)	$ 25.00	$ 75.00
Total Costs	$ 25.00	$ 75.00
Difference (Benefits - Costs)	$ 41.00	$139.50

Labor costs would be $20.00 and postage would be $3.00. Some crop consultants include soil sampling with their per acre charge for all provided services.

A routine soil test averages $20.00 with a range of $9.50 to $60.00 according to a CSU Extension Factsheet No. 0.520. If a soil analysis costs $20.00, total soil sampling costs would total $35.00 per field or $0.88 per acre (40 acre field).

Soil testing can result in better fertilizer management, higher yields, and improved profits. A savings of about 2-3 pounds of nitrogen or phosphorus per acre would pay for the costs of soil sampling a 40-acre field.

Deep soil sampling (2 - 4 ft. deep) is important to determining proper fertilizer application levels. Residual soil NO_3-N that leaches below the root zone is not available for plant growth and increases the potential for ground water contamination. Deep soil sampling usually results in reduced application levels of N fertilizer due to additional N credits. Research at Akron, Colorado found that the nitrogen application rate could be reduced by as much as 50 percent in one year as a result of crediting subsoil nitrate.

Costs of deep soil sampling on a 40-acre field will be an additional $25.00 for collection of the samples (if surface soil is being sampled at the same time) and $10 for the additional test. The total of $35 can be offset by a savings of 1.75 pounds less nitrogen per acre applied to a 40-acre field.

Category 2: Changes in cropping practices

Crop rotation can enhance nutrient utilization, particularly when deep rooted crops are included in the rotation. Corn following plow-down of a full stand of alfalfa rarely responds to N fertilizer. Winter cover crops can also be useful in the rotation to scavenge excess nutrients in a vegetable crop system or following any shallow-rooted crop. Changes in the mix of crops grown on the farm or the rotation of crops grown will involve a more detailed economic analysis. If new crops are to be grown on the farm, a detailed enterprise budget that allows for the determination of net income from the crop will be required. Enterprise budgeting, while not difficult, can be tedious. CSU Extension has procedures available to assist producers with enterprise budgeting. The farm manager will need to know very specific information about the production process and practices required for the new crop. The results of the enterprise budgeting activity would then be used in the partial budgeting format to determine the economic impact of the BMP under consideration. Enterprise budgeting spreadsheets are available from the Department of Agricultural and Natural Resources http://dare.colostate.edu/pubs/extension.aspx#agricultural_mgmt.

Changes in crop rotations may also involve a two-step economic analysis. The first step would determine the impact on net income of changing rotations. Because rotations occur over time, the analysis needs to make the appropriate adjustments in costs and returns for different years so that they may be compared at the same point in time. The adjusting of time differences is usually referred to as compounding or discounting.

An important consideration in this process is the selection of the appropriate interest rate. The appropriate rate will be a "real" rate of interest rather than a "nominal" rate.

Nominal Interest Rate - Inflation Rate = Real Interest Rate

The nominal rate is typically considered to be the rate that lenders charge borrowers. A real interest rate of approximately 5 to 7.5 percent is often used in these calculations. These results would then be used in the partial budgeting analysis to determine the economic impact of BMPs.

Category 3: Changes in tillage or fertilizer application practices

The economic assessment of BMPs in this category may involve the analysis of changes in equipment. Both economic and financial considerations will need to be included in this analysis. The economic analysis will include the consideration of the investment requirements if a change in machinery will be necessary. The financial analysis will include an evaluation of the cash flow impacts of changes in the machinery complement. Farm managers will want to weigh both of these analyses in their decision regarding the adoption of BMPs in this category. In many cases, changes in tillage practices will also result in changes in inputs such as nutrients and pesticides.

Machinery investment analysis involves the use of compounding and discounting principles in a manner similar to crop rotation decisions. The major difference is that with machinery investment decisions, there are often subsequent replacement decisions that must be considered. The costs associated with the new machinery will be a major portion of the partial budget analysis for these BMPs. Farm managers can still use the partial budget framework for this analysis, but must carefully consider the benefits and the timing of those benefits.

It is essential to examine all inputs that may change when analyzing alternative tillage systems. Input changes may relate to purchased inputs within an enterprise, the addition or deletion of an entire enterprise, or a change in equipment that will impact all crop enterprises on the farm.

Fertilizer Application Methods

Proper timing of fertilizer application can enhance

Costs of Nitrogen and Phosphorus Fertilizer Applications (for irrigated corn)

	Nitrogen Application		Phosphorus Application	
	Single	Split (2)	Broadcast	Band
Revenue Increases (per acre)	$ 0.00	$ 0.00	$ 0.00	$ 0.00
Fertilizer Costs (per acre)	$ 90.00	$ 90.00	$ 44.00	$ 22.00
Application Costs	$ 6.00	$ 12.00	$ 4.00	$ 6.50
Total Costs	$ 96.00	$102.00	$ 48.00	$ 28.50

plant uptake of nitrogen and other nutrients necessary for plant growth. Split applications of fertilizer can reduce the amount of nutrients lost to the environment and ensure that nutrients are available at those times critical to maximum plant growth.

Split application of nitrogen requires an additional trip over the field unless it is applied through irrigation.

The actual application cost would increase from $6.00/A (liquid) or $10.00/A (anhydrous) to $12.00 or $20.00 per acre. The cost of nitrogen would probably not change, because 50 percent of the fertilizer would be applied in each of the two applications. However, in some cases, producers can actually decrease total N applied in splits.

Band application of phosphorus typically involves application of only 50% of the fertilizer that would be applied on a broadcast basis. In the example below, there would be a savings in fertilizer costs of $22.00 per acre with band application of P fertilizer compared to broadcast application. This analysis does not include net benefits from increased crop yields for either split applications of nitrogen or band application of phosphorus. In some cases, there may be crop yield increases. However, the amount of increase varies due to management, tillage systems, climatic conditions, and soil productivity.

Category 4: Changes in or addition of structures

This category includes those BMPs that involve physical changes to the farm's land base. By their very nature, these are long-term changes and need to be analyzed in that context. There may be both direct and indirect costs associated with these BMPs. For example, the planting of grass buffer strips involves the cost of the seed, planting, and long term maintenance. If these strips are planted on ground that was previously cropped, the foregone crop revenue is also a "cost" of grass filter strips and needs to be considered.

Partial budgeting analysis should include this lost income from ground taken out of production. Again, for those changes that are expected to have long lifetimes, the principles of discounting and compounding need to be incorporated and the costs of these BMPs should be considered on an annual basis. Any yield increase or loss will need to be taken into account. Cost-share programs are often available for structural practices. Check with your local USDA Natural Resources Conservation Service office to determine cost-share availability for practices you are considering.

Information on Best Management Practices

BMPs for nutrient management have been developed by CSU Extension with help from Colorado producers. Some of these practices and the economic considerations associated with their adoption are listed on the following page. More information on BMPs for irrigation, fertilizer, manure, and pesticide management is available through the CSU Extension Resource Center at (970) 491-6198. This fact sheet and the BMPs are also available online at www.csuwater.info

Available BMP Booklets:

1. Nitrogen Fertilizer (Bulletin #XCM-172)
2. Irrigation Management (Bulletin #XCM-173)
3. Manure Utilization (Bulletin #XCM-568A)
4. Phosphorus Fertilization (Bulletin #XCM-175)
5. Pest Management (Bulletin #XCM-176)
6. Agricultural Pesticide Use to Protect Water Quality (Bulletin #XCM-177)
7. Pesticide and Fertilizer Storage and Handling (Bulletin #XCM-178)
8. Protecting Your Private Well (Bulletin #XCM-179)

Economic Considerations of Best Management Practices for Nutrient Management	Additional Costs				Potential Returns*
	Management	Labor	Land	Capital	
Test soil annually		✓			+, *0*
Set realistic yield expectations	✓				+
Analyze & credit irrigation water nitrate	✓				+, *0*
Test subsoil for residual nitrate & credit	✓	✓			+, *0*
Analyze and credit manure, compost, and biosolids	✓				+, *0*
Develop a nutrient management plan	✓				+, *0*
Split N applications		✓			+, *0*
Avoid fall fertilizer applications	✓				*0*
Utilize nitrification and urease inhibitors				✓	+, -
Apply P fertilizer in sub-surface bands	✓				+, *0*
Calibrate manure and fertilizer application equipment		✓			+, *0*
Incorporate manure after spreading		✓			+
Establish buffer zones around water supplies	✓		✓	✓	-
Install vegetative filter strips		✓	✓	✓	-
Implement no-till or conservation tillage systems	✓				+, *0*, -
Strip crop erosive fields	✓	✓			*0*
Manage irrigation to minimize leaching and runoff	✓	✓			*0*
Mix, load, and store fertilizers 100 ft. from any water supply	✓				*0*
Avoid N fertilizer applications through ditch water unless tailwater recovery is used	✓		✓		*0*, -

* Returns will vary by site, crop, management, and year.

+ = potential positive return

0 = no additional return expected

- = additional costs with no additional returns expected

Partial Budget Form

Benefits:

1. Additional Income:
   List the items of increased or additional income from the BMP plan $ _____

2. Reduced Expenses:
   List the expenses that will be avoided by implementing BMPs $ _____

3. Benefits Subtotal (1 + 2) $ _____

Costs:

4. Reduced Income:
   List the lost income that will not be received from the BMP plan $ _____

5. Additional Expenses:
   List the additional items of expense from the BMP plan that are not required with the base plan. Cost-share or incentive programs may reduce some of these expenses $ _____

6. Costs Subtotal (4 + 5) $ _____

7. DIFFERENCE (Benefits - Costs) $ _____

A positive difference indicates that the net income from the BMP plan exceeds the net income of the base plan by the amount shown. A negative difference indicates that the net income from the BMP plan is less than the net income of the base plan by the amount shown. Net returns in the partial budget analysis should not be confused with a full economic analysis. A negative difference does not necessarily mean the operation is not profitable, but rather the BMP plan is less profitable than the base plan.

In using the partial budgeting approach, it is not necessary to have entries in each of the partial budgeting categories. For example, some BMPs may only affect expenses, not gross income levels. Producers should not expect that all BMPs will have a positive effect on net returns, especially short-term returns. Economic considerations are among the many criteria in the decision to adopt any particular BMP. Thus, some BMPs that reduce income may be implemented if producers decide that other factors are "worth the cost."

For questions or comments on this report please contact Troy Bauder, Colorado State University, (970) 491-4923, troy.bauder@colostate.edu

Original factsheet written by Reagan M. Waskom, Director, Colorado Water Institute