TECHNICAL NOTES

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THE ECONOMICS OF NUTRIENT AND PEST MANAGEMENT

Like every other industry, production agriculture is increasingly moving toward the use of computers and high-tech, sophisticated pieces of equipment. Producers are purchasing machinery equipped with GIS/GPS technology that is being employed to monitor crop yields, control the application of chemicals, count seeds being planted, etc.

More and more producers are relying upon agronomic consultants for assistance in making production decisions (scouting for pest, fertilization recommendations, herbicide use, varieties, etc.)

These producers will be the first to become acutely aware of the benefits (economic/environmental) of nutrient and pest management. However, there are still many producers (for a variety of reasons) who have not progressed to this stage in their production activities. Many of them still need to be encouraged to adopt the use of nutrient and pest management practices.

Because of the significant national emphasis being placed on nutrient management plans, and the use of chemicals for pest control; field offices are going to be increasingly required to communicate the benefits of utilization of NRCS's nutrient and pest management practices.

With the above facts in mind, NRCS planners are going to have to fully understand both the ECONOMIC and ENVIRONMENTAL consequences of their technical assistance to producers. The information included in this technical note is intended to make available two simple ECONOMIC TOOLS that can be utilized by field offices in their discussions with producers concerned with nutrient and pest management.

INTRODUCTION

In the Natural Resources Conservation Service, economics can play a major role in implementing our Nutrient and Pest Management Standards and Specifications. Economic principles and tools can be used together with other tools to develop specific nutrient management plans or pest management plans. This is important because farmers and ranchers will need to increasingly rely on economic principles and methodologies to help them make sound management decisions.

The two main principles examined here include optimization and economic thresholds. Specifically, this technical note will explain the "what" and "how" of fertilizer optimization and economic thresholds in herbicide and insecticide applications.

Optimization is a term that can relate to various production situations. However, in the context of nutrient management, optimization means adding fertilizer up to the point where it no longer pays to do so. IT NO LONGER PAYS WHEN THE INCOME FROM THE INCREASE IN YIELD GENERATED BY THE LAST UNIT OF FERTILIZATION DOES NOT COVER THE COST OF THAT FERTILIZER.

"Economic threshold" IS THE POINT AT WHICH AN INPUT STARTS TO PAY FOR ITSELF. Farmers and ranchers must make decisions about pesticide applications. Weeds and insects can cause injury to a crop. A little injury may be acceptable if it does not significantly affect profits. However, if injuries worsen, decisions about using pesticides must be made. The key becomes whether or not the cost of treating the pest is less than the cost of the problem itself.

NUTRIENT MANAGEMENT

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

Studies have shown that many farmers continue to over-fertilize by 20 to 25 percent. In addition to potential environmental problems, over-fertilization leads to loss of profit. These losses occur because many farmers have not incorporated economics into their nutrient management decisions. The equation must include yield response, the price of fertilizer, or the price of their crop.

So, how is the principle of optimization used in making fertilizer-use recommendations? The following data is needed:

1. Target yield (3-5 year average) obtained from farmer's records.
2. Yield responses obtained from the Land Grant University.
3. Fertilizer prices obtained from NRCS "Louisiana Statewide Average Cost List FY-2007"
4. Crop prices obtained from local markets

Using the above-mentioned data, a "revised target yield" can be calculated. The following table reflects the simplicity of the computations involved.

Table 1. Calculating a revised target yield:

Fertilizer (N in lbs) $0.41/lb	Crop Yield (Corn in bu) $2.50/bu	Change in Costs ($)	Change in Total Returns ($)	Net Returns ($)	Change in Net Returns ($)
50	70	--	--	154.5	--
75	95	10.25	62.5	206.75	52.25
100	105	10.25	25.0	221.5	14.75
125	113 (Rev. Target Yield)	10.25	20.0	231.25	9.75
150	116	10.25	7.5	228.5	-2.75
175	118	10.25	5	223.25	-5.25
200	119	10.25	2.5	215.5	-7.75
225	120 (3 yr Target Yield)	10.25	2.5	207.95	-7.75

Columns 1 and 2 reflect estimates of the relationship that exist between fertilization levels and corn yield increases.

Using this information and assuming the only cost change associated with increasing fertilizer application is the cost of the additional fertilizer (Column 3), the remainder of Table 1 can be constructed when you move from one level of fertilizer to the next higher level. Columns 4 and 6 indicate the change in "Total Returns and Net Returns."

The revised target yield was determined through the use of economics in the optimization process. It was isolated by increasing fertilizer applications to a point where the Last Addition of Fertilizer Results in a Positive Change in Net Income.

In this example, it occurred at a yield of 113 bu of corn at an application of 125 lbs/ac of N. If the data was more refined, it would be possible to show that the optimal N application would be somewhere between 125 and 150 lbs/ac of N and 113 and 116 bu/ac of corn.

For purposes of this example, 113 bu was selected as the revised target yield.

If the farmer had used the 3 yr average target yield, he would have over-applied fertilizer by approximately 100 lbs/ac of N, causing potential increased hazard to the environment as well as lost profit. In fact the over-application cost the farmer $23.50/ac, which is the sum of the negative net changes between the 3 yr average target yield and the revised target yield.

HERBICIDE THRESHOLD

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

The following is one method to estimate the need to apply herbicide, in corn or soybeans. To estimate, use the following steps:

1. Determine the expected yield.
2. Determine the crop price.
3. Determine the densities of weeds by species and expected loss.
    a. Count weed clumps in 100 feet of a typical row in the field.
    b. Use the following table (Table 2) to determine weed density and expected yield loss.
4. Add up the percentage of yield loss for all weeds and multiply by the expected yield to get yield loss in bushels per acre.
5. Multiply bushels per acre yield losses times expected price.

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

Example: A soybean field has an average of 6 giant ragweed, 24 velvetleaf, and 10 giant foxtail clumps per 100 feet of a typical row. According to Table 2, yield losses for the weeds are 6%, 4%, and 2%. If the expected yield is 30 bushels per acre and beans are valued at $5.50/bu, the yield loss (12%) would be 3.6 bu/ac or $19.80/ac. If the cost of treatment were $29.25/ac, the net gain of treatment would be ECONOMICALLY UNJUSTIFIED.

Table 2. Economic thresholds for weeds:

	% Corn Yield Loss						% Soybean Yield Loss					
	1	2	4	6	8	10	1	2	4	6	8	10
Weeds	----Number of Weed Clumps Per 100 ft of Row----											
Cocklebur	4	8	16	28	34	40	1	2	4	6	8	10
Giant Ragweed	4	8	16	28	34	40	1	2	4	6	8	10
Pigweed	12	25	50	100	125	150	2	4	6	10	15	20
Lambs-quarters	12	25	50	100	125	150	2	4	6	10	15	20
Velvet Leaf	--	--	--	--	--	--	8	16	24	32	40	50
Morning-glory	--	--	--	--	--	--	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
Johnson-grass	6	12	25	50	75	100	2	5	8	11	14	18
Volunteer Corn	--	--	--	--	--	--	1	2	3	4	5	6

INSECTICIDE THRESHOLD

The insecticide threshold **is the point where insect density is high enough that insecticide control costs equal the cost of the lost yield due to insect damage.**

Integrated Pest Management (IPM) is one approach to lessen the application of insecticide through use of scouting and other monitoring techniques to more accurately estimate the insect problem.

Using the European Corn Borer, the insecticide threshold will be estimated. Insect scouting methods vary, for purposes of this discussion; the following steps are taken to determine the need for insecticide application.

1. Determine the expected yield
2. Determine the crop price
3. Determine the density of borers
    a. Sample 25 plants in each of four locations, counting the number of borers per stalk (borers are found in whorls on the stalk)
    b. Divide this number by 100 to get an average number of borers per stalk
    c. Multiply the number of borers per stalk by 5 (percent damage caused by one borer per stalk) to get the percent of yield damage to the crop
4. Multiply crop price X expected yield X 0.75 X percent yield damage to get the dollar damage to the corn per acre from corn borers (75% control is assumed with corn borer insecticide)

If this amount is more than the cost of treatment, the treatment is ECONOMICALLY JUSTIFIED.

Example: An average of one borer cavity per plant is capable of causing an approximate five percent yield loss. In this example, from scouting it is known that there are two worms per plant. Assume 75% control, a price of $2.50/bu, with a yield expectation of 120 bu/ac.

Table 3.

	Example Field	Your Estimate
1. Potential yield for this field	**120 bu/ac**	
2. Potential yield loss (2 larvae/plt) X 5% - 10% loss in yield, (10% X 120 bu/ac = 12 bu/ac loss)	**12 bu/ac**	
3. Dollar loss/ac (12 bu/ac X $2.50/bu = $30.00/ac loss)	**$30.00/ac**	
4. Preventable loss (if chemical is 75% effective = $30.00/ac X 0.75 = $22.50/ac)	**$22.50/ac**	
5. Chemical cost ($13.00/ac) Application cost ($7.01/ac) = $20.01/ac	**20.01/ac**	
6. Compare preventable loss ($22.50/ac) with treatment cost ($20.01/ac); $22.50/ac - $20.01/ac = $2.49/ac (potential profit saved by treatment)	**$2.49/ac**	

In this case, the net gain from treatment would by $2.49/ac, thereby making the treatment ECONOMICALLY JUSTIFIED.

SUMMARY

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

For NRCS, understanding and being able to relate the economic implications of nutrient and pesticide management decisions, would be very complimentary to our conservation technical assistance. The use of the optimization concept for nutrient management and the concept of economic threshold in pesticide management can increase our credibility at the field level.

Bill Waits
Agricultural Economist

REFERENCES

Technical Note: The Economics of Nutrient and Pest Management, Economics Series No.W-9. September 1990. United States Dept. of Agric., Soil Conservation Service, West National Technical Center: Portland, Oregon.