1961

Fertilizing Corn in Eastern South Dakota

Cooperative Extension, South Dakota State University

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Fertilizing Corn

Commercial fertilizers are another tool to help increase farm income. Although we often speak of soils needing fertilizer, the basic interest of the manager is net returns or profits.

The practical question is, "how much fertilizer pays best?" To answer this question let's consider nitrogen application on corn. We need to know three things: (1) the cost per pound of the nitrogen, (2) the extra bushels to expect as more fertilizer is added, and (3) what the extra bushels will be worth.

THE COST OF NITROGEN

Nitrogen fertilizer may be purchased in different forms. To get the best bargain you should compare the cost per pound of nitrogen in different fertilizers. High analysis fertilizer is usually more economical because you are purchasing and hauling more units of plant food per pound.

Suppose your dealer has ammonium nitrate (33-0-0) containing 33% nitrogen and costing $90 per ton. The cost per pound of nitrogen can easily be determined. Each 100 pounds of fertilizer contains 33 pounds of nitrogen. Multiply 33 by 20. This gives 660 pounds of available nitrogen per ton. Then the cost per pound of nitrogen is $90 divided by 660 or 13.6 cents. Cost of application will increase this to about 15 cents per pound.

Let's assume the lowest priced nitrogen including the cost of application is 15 cents per pound. Then the cost per acre of nitrogen would be: 20 pounds, $3; 40 pounds, $6; and 60 pounds, $9. These costs are shown in figure 1. The more you apply the more it costs as shown by the line OA.

EXPECTED RESPONSE FROM NITROGEN

Fertilizer experiments and demonstrations show that as more and more nitrogen is added, corn yields increase, but at a diminishing rate. Agronomists have estimated that, under average conditions in eastern South Dakota, corn will yield about 30 bushels per acre as an average without commercial nitrogen. Corn yields may be somewhat higher than average in the southeastern section, and somewhat lower in the northeast. Adding 20 pounds of nitrogen can be expected to increase total corn yields to 39 bushels or 9 extra bushels of corn as shown in figure 2. The second 20 pounds will add approximately 5 bushels more and the third 20 pounds will yield 2 additional bushels.

By Joshua Robinson, associate Extension farm management specialist; and Russell L. Berry, associate professor of economics
These responses can be expected only under average conditions where no legumes or manure have been added recently, and where phosphate is not a limiting factor. Yield response for your farm may be different depending on your soil, your location, and your management. In any given year, weather may greatly increase or decrease the yields you can expect. What we are talking about here are average moisture conditions.

**WHAT THE EXTRA CORN WILL BE WORTH**

The price that can reasonably be expected for corn at harvest determines the most profitable rate of application. To see this, let’s assume that corn will be worth $1 at harvest time.

Now that we have made estimates of (1) fertilizer costs, (2) yield responses, and (3) corn prices, we are ready to answer the question: "How much does nitrogen pay?" The answer is presented in table I and figure 3. The most profitable nitrogen application appears to be 40 pounds per acre.

Forty pounds of nitrogen increases gross returns by $14 per acre at a cost of $6 (Column 3 and 7). Net returns for fertilizer are $8 per acre (Column 9). Adding another 10 pounds (50 pounds of nitrogen) will reduce the total net return to $7.50 (Column 9). The additional 1 bushel of corn, worth $1 (Column 8), failed to cover the additional $1.50 cost of 10 pounds of nitrogen by 50 cents (Column 10).

You may note that other rates of nitrogen application are also profitable. This may tempt you to apply 60 pounds per acre which will return a net of $6.50 (Column 9) over and above the cost of nitrogen (Column 3). But why apply 60 pounds for only $6.50 when 40 pounds will net you $8. Rather, the extra 20 pounds should be put on another acre. This will give you $6 more, which together with the net for the first acre, will total $14.

Still better would be to buy an additional 20 pounds for the second acre and make $8 on each or a total of $16. If funds are not available to purchase the full 40 pounds of fertilizer, then applying 30 pounds to each acre is the most profitable. As shown in table 1, this would give $7.50 per acre or $15 total net returns under the conditions assumed.

**THE RULE FOR MAXIMUM PROFIT**

In order to get the greatest return on fertilizer investment, farmers should add additional fertilizer as long as the added yield multiplied by the price per bushel (Column 8) is equal to or greater than the cost of the additional amount of fertilizer multiplied by its price (Column 4); or as long as the net from addi-

![Figure 3. Rule for Greatest Profit.](image)

*Figure corn at $1 per bushel, fertilizer at 15c per pound of pure nitrogen.*

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**Table 1. Estimated Effects of Nitrogen on Corn Yields and Net Returns per Acre, Eastern South Dakota**

<table>
<thead>
<tr>
<th>Pure nitrogen pounds</th>
<th>Ammonium nitrate pounds</th>
<th>Total cost of fertilizer*</th>
<th>Cost increase</th>
<th>Total yield bu.</th>
<th>Increase from all nitrogen* value</th>
<th>Increase due to last dollar of nitrogen</th>
<th>Total (7) less (3)</th>
<th>Due to last addition of nitrogen (8) less (4)</th>
</tr>
</thead>
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<tr>
<td>Col. 1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>$3.00</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>$6.00</td>
</tr>
<tr>
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<td>3.00</td>
<td>1.50</td>
<td>39</td>
<td>9</td>
<td>9.00</td>
<td>3.00</td>
<td>1.50</td>
</tr>
<tr>
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<td>1.50</td>
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<tr>
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<tr>
<td>50</td>
<td>150</td>
<td>7.50</td>
<td>1.50</td>
<td>45</td>
<td>15</td>
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<td>-1.00</td>
</tr>
<tr>
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<td>15.5</td>
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<td>6.50</td>
<td></td>
</tr>
</tbody>
</table>

*Figure corn at $1 per bushel, fertilizer at 15c per pound of pure nitrogen.*
tional increases in fertilizer application is greater than zero (Column 10).

Table 1 and figure 3 demonstrate the rule for greatest profit on corn in Eastern South Dakota. This rule may be applied to other fertilizers, other crops, and other regions to determine the point of most profitable operation. It may be applied to practically any other farm enterprise decision to determine the most profitable level of inputs.

PHOSPHATE AND POTASSIUM

Remember that the yield estimates in figure 4 assume that plenty of phosphate is available. This means that in many cases phosphate as well as nitrogen needs to be applied. If in doubt, soil tests may be made. The cost per pound of phosphorus is calculated in the same way the cost of nitrogen was calculated.

Potassium (or potash) is not generally needed in South Dakota. However, soil fertility tests may also be made to determine potassium needs.

WEATHER MAKES PREDICTION DIFFICULT

While the rule for maximum profit is certain and never fails the same cannot be said for the weather. As a result the 40 pounds of commercial nitrogen that increases corn yields by 14 bushels may not increase yields at all in a year of drought. Fortunately when this happens most of the nitrogen remains in the soil and will be used by next year’s crop if moisture is available.

When weather conditions are favorable, higher yields can also be expected. Under such conditions more nitrogen would be profitable. Unfortunately no way has been found to determine whether the year ahead will be dry or wet. Hence, you should use these figures as only a guide in planning your fertilizer program.

Due to the differences in soils and management practices, fertilizer response, and therefore the most profitable rate of fertilization, usually varies even under average weather conditions. The most profitable rate of application may well vary from 20 to 60 pounds and even more on irrigated land. Unfortunately in the low rainfall areas of South Dakota, fertilizer application will bring a net return only in years with above average rainfall. For more information ask your county agent about experimental results pertaining to your soils and conditions.

USE OF LIMITED RESOURCES

Where operating capital is in short supply, the question often arises how best to invest the money that can be spared for the purchase of fertilizer, if the money is not enough to apply the most profitable rate to all the acres to be planted in corn.

Let’s take for example a farmer who plans to grow 100 acres of corn. He has calculated the most profitable rate of fertilization to be 40 pounds of pure nitrogen per acre, the same as in our data. Due to limited funds he can buy only $300 worth of ammonium nitrate which contains 2,000 pounds of pure nitrogen.

There are two choices:

Plan 1: Put 40 pounds each (the most profitable rate per acre) on part of the acreage.

Plan 2: Put as much as possible, but less than the best rate, on all of the corn acreage.

WHICH IS MORE PROFITABLE?

Step 1. The acreage that 2,000 pounds applied at 40 pounds to the acre will cover must be determined, as well as the amount that may be applied per acre if all the acreage is to be covered.

Plan 1: 2,000 pounds ÷ 40 pounds per acre will cover 50 acres.

Plan 2: 2,000 ÷ 100 acres limits the rate per acre to 20 pounds/acre.

Step 2. Look at table 1 (or some other experimental results applicable to your area and soil) and find the yield increase corresponding to the 20 and 40 pound applications of nitrogen. Multiply the acreage found in step one by the yield increase due to those fertilizer levels:

Plan 1: 50 acres x 14 bushels per acre=700 additional bushels of corn

Plan 2: 100 acres x 9 bushels per acre=900 additional bushels of corn

Step 3: Multiply the expected gain in bushels of corn by the price per bushel to obtain the gross return in each plan due to $300 of fertilizer:

Plan 1: 700 bushels x $1 per bushel=$700

Plan 2: 900 bushels x $1 per bushel=$900

Obviously Plan 2, applying only 20 pounds to each of the entire 100 acres yields a return $200 in excess of Plan 1. This is generally true whenever we do not have the capital to apply all of the fertilizer which yields the highest net returns per acre.

Under Plan 2 we may expect a threefold return of our investment in fertilizer. There are not many other uses of operating capital that yield a similar return. Thus, while it is not always possible to fertilize enough to obtain the highest net return per acre, money in-
vested in fertilizer and applied at moderate rates of application should be seriously considered as a farm practice even if it means to withdraw this money from other alternative uses.

A Note of Caution: Agronomists warn us that very low rates of fertilization (say, less than 10 pounds per acre) may not bring much of a yield increase in some locations, since they are absorbed by the soil, used up by soil microorganisms, before the plants’ roots have a chance to get hold of them. Thus very low rates for Plan 2 as determined in Step 1 may not be the best solution. A third plan, which considers the minimum safe rate of application may be the next best. Consult your county agent about minimum rates of application.

FERTILIZER FINANCING

Credit is an increasingly important tool of management. Commercial banks, production credit associations and others are extending credit for the use of commercial fertilizer. Bankers and other credit men believe that a carefully prepared plan for the use of borrowed funds should precede a request for credit. The plan should show:

1. The kind and amount of fertilizer for each field.
3. The expected dollar return from applying fertilizer over cost.

Farmers who approach a lender with a carefully prepared plan showing how he is going to use the money and an estimate of the probable outcome usually have little difficulty in obtaining credit.