# Economics of Nutrient Systems and Sources

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The long-term economic viability of a crop production system depends on sound management decisions such as the selection of nutrient sources. Commercial fertilizers are the most common, but they can be supplemented, or sometimes replaced, by nutrients generated by the crop rotation [primarily nitrogen (N) from legumes], livestock manure, or other organic sources. Economic analysis of the nutrient management plan becomes more complex when organic nutrient sources are used.

Economic comparisons of different cropping systems for central Illinois provide examples of how crop rotation influences profitability. Nutrient management is an important part of that analysis. Evaluation of various manure sources and storage systems is included to show the economic value of the nutrients supplied.

Nutrient use should be evaluated on the basis of all crops in a rotation as well as the entire farm enterprise. When manure is used, it should be sold or charged as an expense to the crop on which it is applied and treated as an income for the farm livestock enterprise where it was produced. If the farm has no livestock, there still may be opportunity to obtain manure from local concentrated livestock operations. It is important to analyze the value of manure compared to commercial fertilizer as a nutrient source.

### Rotation Impacts on Fertilizer Sources: Corn/Soybean Example

Crop rotation is an important factor in decisions about nutrient sources. Nitrogen is usually the nutrient of economic concern in rotation systems. In a corn/soybean rotation, for example, the value of the N in manure applied for the soybean year is relatively low, because it will likely replace only N that would normally be fixed by nodulating bacteria living on the soybean roots. Planning manure application to best match the crop's need for N will help capture more of the value of the manure. If the N is lost or not needed by the growing crop, that value is forfeited, and the potential for groundwater pollution increases.

A comparison of several cropping system scenarios will help illustrate an approach to evaluating the value of various nutrient sources in different crop management systems. The effect of crop residues and nutrient removals from the crops in the rotation form the basis for agronomic and economic comparison.

**Table 1** lists budgets giving annual revenues and costs for corn and soybeans when the preceding crop is either corn or soybeans. For example, the corn following soybeans column gives a budget for corn, given that the previous year's crop was soybeans. While multi-crop rotations are sometimes suggested as an alternative that could provide organic nutrient sources, these budget comparisons help illustrate why Illinois farmers have shifted toward the corn-soybean system. Where there is a special market or need for wheat or alfalfa, such a system still has its place among viable options. The budgets in **Table 1** do not include government payments. This is appropriate for looking at rotations because payments are

**TABLE 1.** Crop budgets for central Illinois, 2001.

| | Corn following soybeans, | Corn following corn, | Soybeans following corn, | Soybeans following soybeans, | Wheat, | Alfalfa estab., | Alfalfa, |
|---|---|---|---|---|---|---|---|
| | ........................ | ........... bu | ........................ | ........... | ........... | ........... tons | ........... |
| Average yield per acre | 158 | 148 | 49 | 44 | 75 | 2.5 | 4 |
| Price received, $/bu or $/ton | 2.00 | 2.00 | 5.45 | 5.45 | 2.30 | 100 | 100 |
| Revenue, $/A | 316 | 296 | 267 | 240 | 173 | 250 | 400 |
| Variable costs, $/A | | | | | | | |
| Fertilizer and lime | 58 | 63 | 20 | 20 | 42 | 41 | 46 |
| Pesticides | 32 | 39 | 33 | 33 | 0 | 48 | 32 |
| Seed | 33 | 33 | 19 | 19 | 15 | 48 | 0 |
| Drying and storage | 17 | 16 | 6 | 6 | 8 | 0 | 0 |
| Machinery repair, fuel, and hire | 34 | 34 | 28 | 28 | 19 | 35 | 42 |
| Total variable costs, $/A | 174 | 185 | 106 | 106 | 84 | 172 | 120 |
| Fixed costs, $/A | | | | | | | |
| Labor | 25 | 25 | 20 | 20 | 20 | 30 | 30 |
| Building repair and depreciation | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Machinery depreciation | 19 | 19 | 17 | 17 | 15 | 15 | 15 |
| Interest on investment | 23 | 23 | 23 | 23 | 16 | 16 | 15 |
| Overhead | 15 | 15 | 15 | 15 | 15 | 20 | 15 |
| Land (cash rent equivalent) | 145 | 145 | 145 | 145 | 145 | 145 | 145 |
| Total fixed costs, $/A | 235 | 235 | 228 | 228 | 219 | 234 | 228 |
| Total costs, $/A | 409 | 420 | 334 | 334 | 303 | 406 | 348 |
| Revenue less variable costs, $/A | 142 | 111 | 161 | 134 | 89 | 78 | 280 |
| Revenue less total costs, $/A | -93 | -124 | -67 | -94 | -131 | -156 | 52 |

Source: Based on calculations and other publications by authors.

not tied to production practices. Prices received reflect the higher of market prices or loan rates.

In the above comparison, corn following soybeans yielded 10 bu/A higher than corn following corn. Research shows that yields decline by up to 10 percent when a rotation is not used. Fertilizer and lime costs are higher for corn following corn because of higher amounts of N recommended than for corn following soybeans. Pesticide costs are also higher because of higher insecticide applications on corn following corn. As a result, the corn following soybeans rotation is more profitable than the corn following corn. Phosphorus (P) and potassium (K) are applied at replacement levels.

The budgets shown in **Table 1** are used in **Table 2** to evaluate rotations. These examples show the annual average expenses and revenues for each of the rotations, providing an average cash flow picture for comparison. Revenues and costs for a rotation represent a blend of revenue and costs for a blend of the crops in the rotation. For example, the corn/soybean rotation has a $39 fertilizer and lime cost. This equals half of the $58 fertilizer and lime cost from corn

**Both economic** and agronomic benefits have been identified with crop rotation.

**TABLE 2.** Returns and costs of alternative rotations in central Illinois, 2001.

| | Corn/ soybeans | Conti- nuous corn | Corn/ soybeans/ wheat | Corn/ soybeans/ alfalfa (estab.) | Corn/ soybeans/ alfalfa (4 yrs.) |
|---|---|---|---|---|---|
| Revenue, $/A | 292 | 296 | 252 | 278 | 339 |
| Variable costs, $/A | | | | | |
| Fertilizer and lime | 39 | 63 | 40 | 40 | 43 |
| Pesticides | 33 | 39 | 22 | 38 | 35 |
| Seed | 26 | 33 | 22 | 33 | 17 |
| Drying and storage | 12 | 16 | 10 | 8 | 4 |
| Machinery repair, fuel, and hire | 31 | 34 | 27 | 32 | 37 |
| Total variable costs, $/A | 141 | 185 | 121 | 151 | 135 |
| Fixed costs, $/A | | | | | |
| Labor | 23 | 25 | 22 | 25 | 28 |
| Building repair and depreciation | 8 | 8 | 8 | 8 | 8 |
| Machinery depreciation | 18 | 19 | 17 | 17 | 16 |
| Interest on investment | 23 | 23 | 21 | 21 | 18 |
| Overhead | 15 | 15 | 15 | 17 | 16 |
| Land (cash rent equivalent) | 145 | 145 | 145 | 145 | 145 |
| Total fixed costs, $/A | 232 | 235 | 228 | 233 | 230 |
| Total costs, $/A | 373 | 420 | 349 | 384 | 365 |
| Revenue less variable costs, $/A | 151 | 111 | 131 | 127 | 204 |
| Revenue less total costs, $/A | -81 | -124 | -97 | -106 | -26 |

Sources: Calculations based on costs from Table 1.

following soybeans and half of the $20 per acre costs from soybeans following corn. The most profitable rotation is corn/soybeans/ alfalfa (4 years). Most farmers do not include alfalfa in their rotations because marketing alfalfa can be difficult, particularly if an outlet cannot be identified. Compared to corn and soybeans, alfalfa requires more intensive management and a completely different set of equipment. The second most profitable rotation is corn/soybeans. The revenue less variable cost for corn/soybeans is $151. The revenue less total cost is -$81 per acre. A 50 percent corn and 50 percent soybeans rotation is the most popular rotation in central Illinois. Much of the reason for this is that it is the most profitable grain crop combination. Moving to alfalfa or other higher end crops would add costs. Wheat in the rotation decreases profitability. Similarly, adding alfalfa for only the establishment year to a corn/soybeans rotation decreases profitability.

## Considering Livestock Manure as a Nutrient Resource

Livestock manure is an important resource for some farms. Where it is available, it is a good nutrient source. However, there is not enough manure produced to meet a large percentage of the nutrient needs of intensive crop production. Perhaps even more important, the manure production tends to be in areas not geographically located near the cropland that can utilize it.

**Table 3** shows daily nutrient production from livestock. Nutrient production can vary tremendously depending on many factors, including the animal's diet. Large operations can produce significant amounts of manure. Even with a relatively low value per animal per day, the cumulative value of manure from a large livestock enterprise is a significant economic value to the overall farm operation. However, livestock manure does have some limitations. One of the most serious is the variability in nutrient content

**TABLE 3.** Daily nutrient production from different species of livestock.

| | Animal weight, lb | Manure produced | N | $P_2O_5$ | $K_2O$ | Value[1], $/day |
|---|---|---|---|---|---|---|
| | | lb/day | | | | |
| Dairy | 1,000 | 82.00 | 0.410 | 0.168 | 0.324 | 0.164 |
| Beef | 1,000 | 60.00 | 0.339 | 0.252 | 0.285 | 0.163 |
| Veal | 200 | 12.40 | 0.054 | 0.013 | 0.056 | 0.022 |
| Swine-nursery | 35 | 2.30 | 0.016 | 0.012 | 0.012 | 0.008 |
| Swine-grower | 65 | 4.20 | 0.029 | 0.023 | 0.023 | 0.014 |
| Gestating sow | 275 | 8.90 | 0.062 | 0.048 | 0.088 | 0.035 |
| Poultry-layer | 4 | 0.21 | 0.003 | 0.003 | 0.001 | 0.001 |
| Poultry-broiler | 2 | 0.14 | 0.002 | 0.001 | 0.001 | 0.001 |

[1]Valued based on $0.22, $0.22, and $0.14 price per pound for N, $P_2O_5$, and $K_2O$, respectively.
Sources: Midwest Plan Service 18, 1991.

because of different feed rations. Storage system and duration, application method, and timing relative to crop growth will impact the amount of nutrient actually available for crop production. For example, N loss from denitrification during storage in a lagoon or volatilization during surface application will reduce the value associated with manure N.

Testing the manure is an important, but mostly overlooked, part of the planning process. Transportation costs must be considered in determining manure value. The high volume, low nutrient analysis of manure makes transportation costly, so it rarely can be economically transported more than a short distance from the livestock operation. Manure is an important nutrient source if properly handled and if care is taken to balance nutrients in the manure with other fertilizer materials in a complete nutrient management plan.

USDA photo by Ken Hammond.

**Livestock manure** can be an important nutrient source if managed properly.

## Economics of Organic Production Systems

Crop production systems that use no commercial fertilizers, but depend entirely on manure and other organic sources, face certain limitations...including economic considerations. They tend to be centered around specific markets. Favorable economics depend, to a large extent on the availability of organic nutrient sources, the ability to produce profitable yields, and the dependability of the markets. To use the "USDA Organic" label in marketing, restrictive practices are required. Organic production systems can be an economically sound alternative for those who are willing and able to participate in the limited opportunities to market products. BC

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