Marketing Swine Manure as a Fertilizer

Introduction

Swine manure contains components that improve soils and facilitate crop productivity. Oftentimes manure is applied in a manner to minimize the cost of application. A rational decision maker focuses on maximizing the net value of manure rather than minimizing the cost. The net value is the value of manure as a fertilizer minus the cost of application. By managing swine manure to maximize its value while holding down its cost, producer income can be increased. Understanding what increases value is critical for marketing manure and maximizing net income.

Objectives

This fact sheet discusses the factors that affect value of manure as a soil amendment/fertilizer source. The objectives are to:

- Provide insights into how to maximize the value of manure as a fertilizer;
- Provide information on the fertilizer value of N, P and K in manure;
- Provide ideas for increasing the value of manure.

Net Income Concepts

Producers often focus on minimizing cost of manure management rather than maximizing the net value of manure management. While the net value of manure management is negative in many cases, there are ways of increasing the net value – making it less negative or even positive. Net value is defined as the gross value minus the cost. Net value can be increased by:

1. Increasing gross value while holding cost constant;
2. Increasing gross value more than an increase in cost necessary to obtain the increased value;
3. Decreasing cost while holding gross value constant; and
4. Decreasing cost more than any decrease in gross value that may result from the action.

This fact sheet focuses on increasing the gross value (or item 1 and 2 listed above). Item 1 is easy to understand. Sometimes people overlook item 2 because they become preoccupied with costs. Net value can increase when costs increase – as long as gross value increases more than the cost.
Valuation Concepts

The potential value of manure is affected by:

- The fertilizer value of its components
  1. Nitrogen
  2. Phosphorus
  3. Potassium
  4. Minor nutrients
  5. Organic matter
- The crop or cropping system
- Soil fertility needs
- The yield of the crop receiving the manure
- Manure Source
  1. swine, dairy, beef, poultry, etc.
  2. lagoon, slurry, dry, etc.
- Manure Application Method
- Legal Application Limits
- Total Quantity of Manure Nutrients Applied

Components that decrease the value of manure include

- Undesirable components
- Timing of application
- Legal Constraints

Price is established by supply and demand in a market economy. In some areas of the country a market for manure has developed and the price is being determined by the local supply and demand conditions. But where a market has not yet formed, value can be approximated by using the price of close substitutes.

In the case of manure supplied N, P2O5 and K2O, the most obvious close substitute would be commercial fertilizer. The price of close substitutes does not establish the value of manure supplied N, P2O5 and K2O because form is important in determining price. The impact of form on price is most easily seen with the price for N.

Table 1 shows the price per pound of nitrogen for three common fertilizer sources. The cost ranges from $0.32 to $0.55 per pound – almost a 2 fold difference.

<table>
<thead>
<tr>
<th>Fertilizer</th>
<th>Price/lb N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium Nitrate</td>
<td>$0.55</td>
</tr>
<tr>
<td>Anhydrous Ammonia</td>
<td>$0.32</td>
</tr>
<tr>
<td>Urea</td>
<td>$0.40</td>
</tr>
</tbody>
</table>

Source: USDA Agriculture Prices, April 2006

Recognizing the nitrogen in the form of anhydrous ammonia is valued at ½ that of nitrogen in the form of ammonium nitrate, it is a logical step to assume that nitrogen in the form of manure will be valued differently than either one. Some would contend that manure supplied nitrogen is less valuable than commercial fertilizer because manure is bulky and the nutrient content is not guaranteed, as in commercial fertilizers. On the other hand, organic producers would ascribe more value to manure supplied nitrogen than to inorganic sources of fertilizer. The form influences value.

While the price of close substitutes does not establish the value of manure supplied N, P2O5 and K2O, they can be used to begin the negotiation process that does establish a price. For ease, the price of the fertilizer that would be used, if manure is not, is probably the best price to use. Fertilizer price gives a reasonable estimate of the value of the manure supplied N, P2O5 and K2O and serves as a starting point for negotiations in a developing market. A person with an estimate of potential manure value can use it to interest another in buying the manure, thus creating a market that establishes a price for manure.
**Nitrogen Valuation**

Several aspects of manure supplied nitrogen affect its nutrient and market value. The expected availability of manure supplied nitrogen is dependent on the form of the nitrogen in the manure and the land application method. Manure contains both an organic fraction and an inorganic fraction of N. Organic N is not immediately available to plants. Nitrogen in the ammonia form is more readily available but also more volatile. Whether or not the user believes the N will be present and available at the time the crops need it will influence its perceived value.

Most manure management plans use nutrient retention values that consider the impact of application method on plant availability. More nitrogen is volatilized when applied on the surface than when injected. Therefore, effluent that is land applied via an irrigation system may have only 10 or 20% of the nitrogen in the effluent available to the plant when the plant needs it. The nitrogen value of the manure therefore is not the nitrogen content in the manure but the amount of nitrogen that is actually available to the plant. Efforts to minimize N loss may cost the livestock producer but can increase net income if additional nutrient value can be captured.

For ease, the value of the fertilizer that would have been used if manure had not supplied the nutrient is probably the best value from which to begin negotiations. However, it probably does not represent the price that neighbors are willing to pay for the manure supplied nitrogen.

**Phosphorus and Potassium Valuation**

The value of commercial P and K fertilizer will likely approximate the value of manure supplied P and K because manure supplied P and K are stable (no volatile losses). The value of P and K fertilizer is an acceptable value to use in estimating the value of manure. As will be discussed later, P and K have value only if they are needed by the soil and cropping system.

**Minor nutrients**

Any minor nutrients, such as sulfur or zinc, that are supplied by manure have potential value. To actually have value, their presence would need to be established by manure testing and a soil test would need to establish their need in the soil or cropping system. While not the same as commercial fertilizer’s guaranteed analysis, a manure test showing the concentrations of nutrients helps establish manure’s potential value as a source of nutrients.

**Organic Matter**

In the absence of a market for organic matter, the value of organic matter in manure is determined by its impact on production. Organic matter can contribute to production by increasing the quantity or quality of the crop being harvested or by providing an environmental benefit such as increasing water holding capacity or reducing erosion. In soils that are worn or low in organic matter, the organic matter may have value. Certain manures (dry manure with bedding) are going to supply more organic matter than others (swine lagoon effluent). Those which supply little organic matter may contribute nothing while those that contribute significant amounts of organic matter may contribute enough to be valued.

Once it is determined that the organic matter is contributing to production, it needs to be valued. This is difficult because organic matter does not typically have a market. Estimating the impact of the additional organic matter on yield or quality is the best way to estimate the value of organic matter. Organic matter that provides an environmental benefit is more difficult to value because a person cannot quantify its contribution to the profit of the farm.

**Units of Value**

In order for price to be meaningful, an explicit or implied unit is necessary. Three units are useful for discussing the value of manure: 1) dollars/1000 gallons (or ton), 2) dollars/acre and 3) total dollars of annual manure production. All three have different uses.

Value per 1000 gallons or tons is useful when comparing the value of different manure types. By determining the value/1000 gallons, comparisons can be made between dairy and swine manure or between slurry and lagoon effluent. This type of information is useful when deciding what type of manure storage
to use and how it will impact your manure value. Value per 1000 gallons is not a particularly useful unit when marketing manure for two reasons. First, as will be seen later, it frequently overvalues manure. Second, it does not report the value in a manner that relates to crop producers use of fertilizer.

When manure is considered as a fertilizer substitute, the dollars/acre unit puts it in a unit that can be compared to other fertilizers. The person interested in possibly buying the manure is the crop producer who is going to compare manure to his current per acre fertilizer expense. Any attempt to sell manure for more per acre than commercial fertilizer costs is likely to draw attention to the manure as an increased expense and potentially lose a customer.

Total value of annual production is useful in understanding the system impact of any manure management decisions. Applying manure according to a phosphorus limit may reduce the value/1000 gallons or value/acre but actually increase the total value of annual production because more acres will receive the manure. The positive impact of more acres can be greater than the negative impact of less value per acre. Total value of annual production is an important unit for determining the net income from manure management.

**Cropping System**

Often livestock producers assume that all of the plant nutrients supplied by manure have value. Actually, a manure supplied nutrient has fertilizer value only if it enhances the yield or quality of the crop harvested. The assumption of value to all nutrients is limited by the following considerations:

- Nitrogen applied to legumes such as soybeans and alfalfa is not valued because those crops could have been grown without nitrogen fertilizer.
- Nutrients in excess of crop need are not valued unless there is some peculiarity of the cropping system that merits valuing the over-supplied nutrient.

When manure is applied at a rate that approximates the crop removal of nitrogen by corn, frequently excess P and K are applied. If the manure is applied to the same ground each year and corn is grown on that ground each year, the excess P and K will never have value.

However, if the manure is applied every 2nd, 3rd or 4th year to land the excess P and K applied in year one is useful to the crops grown in subsequent years – thus giving the P and K value. By altering the cropping system and the manure application schedule the potential value of the manure can be increased.

The potential value of the manure can be increased by growing crops that remove a substantial amount of nutrients. Cropping systems such as corn silage can increase the value of manure over a corn for grain cropping system. The P and K in the stover removed increase the demand for those nutrients, fewer pounds of P and K are in excess and thus a larger percent of the P and K supplied by the manure have value.

Potential value is also increased by applying manure to crops that have market value. In some areas of the country, manure is applied to crops that may remove a lot of nutrients but then have very little value themselves. In these situations, crop production is not a profit center but rather a part of the manure-environmental management system of the animal feeding operation. Manure applied to low value crops will have little, if any, value.

**Soil Fertility**

Soils testing low in P and K are frequently improved by adding P and K in excess of crop removal until the soil test levels meet an agronomic optimum. The period of time when excess P and K are added is referred to as a soil buildup period. During a soil buildup period, all manure supplied nutrients have value. The principle is that manure supplied nutrients have value when they increase crop yield or quality. During buildup, the supplied nutrients are expected to increase crop value in the year of application and in subsequent years because the quality of the soil has been enhanced.

Once the soil nutrient levels have been built to agronomic optimums, the value of the manure reverts back to just the crop removal value of the nutrients.
In fields that have very high soil test levels of P and K, additional P and K will not enhance crop value. Manure supplied P and K have no value on soils testing very high in P and K. Indeed they can have negative value because they are perceived as an environmental hazard.

Manure value can be increased by seeking land with low fertility status to receive the manure.

**Crop Yield**

Because manure supplied nutrients are generally valued on their crop removal basis, the higher the crop yield, the greater the value of the manure. Manure will have more value on productive soils than on poor soils because more crop is removed and sold.

Manure value can be enhanced by applying it to land that is high yielding.

**Manure Source**

The manure from different species of animals has different total and relative concentrations of nutrients. Manures that have been stored in different structures have different total and relative concentrations of nutrients.

Manures with more total nutrients have potentially higher value because more nutrients exist to provide value. However, the nutrients have value only if the animal feeding operation can receive their value. While lagoons tend to dissipate N so that it is not available to crops, this can be a reasonable form of manure storage if the business does not need the nitrogen. When an animal feeding operation is integrated with a crop farm of sufficient size to use all the excreted nutrients or can sell the manure, storage that preserves the nutrients would increase the value of the manure.

Manures whose relative concentration of nutrients is closely aligned with the crop removal rate of those nutrients will have greater value. When manure’s relative nutrient concentrations are not well aligned with crop removal, the potential exists for many of the applied nutrients to be in excess of crop need and therefore have no value.

**Manure Application Method and Timing**

Manure that is surface applied will have more N volatilized than manure that is injected or incorporated into the soil. Farmers wanting to conserve the nitrogen value of manure can increase the manure value by injection or incorporation.

Applying manure nutrients near the time that the plants can use nutrients is most beneficial. If applied in the summer or early Fall for future Spring-planted crops, the time until crop utilization may result in potential nutrient losses of manure nutrients, especially nitrogen with less available nitrogen to support crop production. However, cost and amount of manure storage may dictate when manure must be applied to the cropland.

**Application Rates**

Manure value is affected by whether manure is applied to meet the crop nitrogen removal rate or crop phosphorus removal rate. Manure applied to meet the nitrogen needs of the crop will probably meet all of the N, P and K needs of the crop. Since all of the nutrient needs of the crop are met, the per acre value of the manure could equal the commercial fertilizer expense of growing the crop. However, it is likely that P and K will be over-applied and have no value. Over-applied, unvalued nutrients decrease the manure’s value/1000 gallons.

Manure applied to meet the P needs of the crop will probably undersupply the nitrogen needs of the crop (assuming that it is not a legume). In this situation, the manure value per acre is decreased by the amount of N fertility that needs to be supplemented by commercial fertilizer. Since all of the N and P and more of the K are valued when the application is limited to P removal, the value/1000 gallons increases.
Some crop producers do not like to depend on manure to supply all of their nitrogen needs because the quantity and availability of the N is less certain with manure than with commercial fertilizers. These producers may request that manure be applied at less than the N removal rate, planning to supplement the crop needs with commercial fertilizers. The maximum value such producers will ascribe to manure is the normal fertilizer expense per acre less the cost of necessary supplemental N and commercial fertilizer application. Willingness to sell manure at this lower value/acre, may translate into an increased crop farmer willingness to use manure as a fertilizer.

**Total Quantity of Manure Nutrients Applied**

During the planning stages of designing an animal feeding operation, the type of storage is a major decision. The choice of manure storage structures will influence the total value of manure by influencing the amount of nutrients retained and available for use as a fertilizer.

Lagoons volatilize N and precipitate P and K so that the effluent pumped onto cropland has few nutrients. Lagoons may fit well with particular systems, such as when the animal feeding operation has little cropland to use the manure or must apply the effluent to growing crops. But it decreases its total potential value of the manure.

Storing manures in slurry pits conserves more nutrients and therefore increases the total value of the manure applied. Animal feeding operations with adequate need or market potential for manure supplied nutrients could increase the total potential value of manure by using slurry storage systems.

**Negative Components**

The impact of any negative components on the value of manure will be difficult to quantify. Frequently their presence is used as justification for not accepting manure, regardless of the price of manure. In such cases, they totally negate the beneficial qualities of manure.

**Foreign Material**

Farmers tend to value manure as an inferior fertilizer when it contains material that interferes with their cropping activities. If manures contain viable weed seed or foreign materials, such as wire or plastic or artificial insemination pipettes, it may interfere with profitable crop production. The more likely a manure source is to have weed seed or foreign materials, the lower its value will become. Animal feeding operations can increase the value of their manure by managing their operation in such a way that these negative components do not make it to the field.

Chemicals within manure that are not necessary for crop production can also reduce the value of manure. Salt buildup, heavy metals (more common with municipal waste), or antibiotics are considered potential negative impacts of manure use. While these will probably never decrease the quantity or quality of crop removed, farmers will tend to discount manure because of their potential presence.

**Application Duration**

Due to its bulky form, supplying crop nutrients in the form of manure takes more time than the use of commercial fertilizers. If the application window available for fertilizing activities is limited, farmers will tend to value commercial fertilizers over manure.

**Compaction**

Driving heavy equipment over fields, particularly in the spring, causes soil compaction that reduces productivity. Manure application can cause more compaction than commercial fertilizer application because manure application equipment tends to be heavy and occurs under less than ideal conditions if the animal feeding operation needs to empty its manure storage structures during wet seasons. Farmers are wise to discount manure use if compaction occurs.
Legal Constraints

Various states require that manure application be accompanied by increased nutrient management planning and record keeping. Farmers who can apply commercial fertilizer without regulatory hassle will discount manure that requires that they maintain and provide records for environmental agencies.

Example Manure Valuations

Assigning fertilizer value to the N, P and K of a grow finish slurry containing 40 pounds of available nitrogen (32 lb. ammonium N and 8 lb. organic N), 42 pounds of P2O5 and 30 pounds of K2O per 1000 gallons results in a total value of $36.44 per 1000 gallons. Farmers tend to think of fertilizer expense per acre rather than per 1000 gallons of manure. The value of $36.44 per 1000 gallons is incomplete information without specifying how much will be applied and the final cost per acre to meet his soil fertility needs.

Table 2. Manure analysis

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Pounds per 1000 gallons</th>
<th>Dollars per pound</th>
<th>Value per 1000 gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>40</td>
<td>$.35</td>
<td>$14.00</td>
</tr>
<tr>
<td>P2O5</td>
<td>42</td>
<td>$.37</td>
<td>$15.54</td>
</tr>
<tr>
<td>K2O</td>
<td>30</td>
<td>$.23</td>
<td>$6.90</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>$36.44</td>
</tr>
</tbody>
</table>

If applied at 4000 gallons/acre, the slurry would supply the nitrogen needs of a corn crop. Multiplying the $36.44 per 1000 gallons times 4 results in a value of $145.76 per acre. Such a valuation is an overestimate of the value of manure nutrients and is likely to discourage crop producers from using manure. The following examples are used to illustrate how manure is properly valued.

Manure applied to corn to meet the nitrogen needs of the crop would supply all of the nitrogen, and more than enough P2O5 and K2O (see Table 3). All of the nitrogen is valued because all is needed to grow the crop. Its value is 160 lbs. N supplied times $.35/lb N from commercial fertilizer. Only 55 lbs of the P2O5 is valued even though 168 lbs is provided because the corn is only going to use 55 lbs. This 55 lbs is valued at commercial fertilizer price of $.37/lb P2O5. Only 40 lbs of the 120 lbs of K2O is valued because only 40 lbs is used by the corn. This 40 lbs is valued at commercial fertilizer price of $.23/lb K2O. The total value of the manure is $85.55/acre. Therefore, the crop producer considers the commercial fertilizer cost of growing corn at $85.55/acre and is not willing to consider the value of the livestock producer wanting to supply nutrients for $145.76/acre.

Table 3. Value of manure applied to corn.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Applied</th>
<th>Needed</th>
<th>Lbs valued.</th>
<th>$/lb</th>
<th>Value/Ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>$0.35</td>
<td>$56.00</td>
</tr>
<tr>
<td>P2O5</td>
<td>168</td>
<td>55</td>
<td>55</td>
<td>$0.37</td>
<td>$20.35</td>
</tr>
<tr>
<td>K2O</td>
<td>120</td>
<td>40</td>
<td>40</td>
<td>$0.23</td>
<td>$9.20</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$85.55</td>
</tr>
</tbody>
</table>

The value of the manure in Table 3 assumes that the excess application of P and K would not be used in subsequent years. Changes in the cropping system and soil test assumptions could increase the value of the manure.

If the soil was low in P2O5 and the farmer was in a buildup phase, all of the P2O5 fertilizer value of the applied manure would be obtained. Table 4 shows that the value of the manure increased from $85.55 to $127.36 per acre. This increased value would continue only until the P2O5 level was raised to a level where no additional P2O5 is needed. At that point the value would return to that shown in Table 3.

In the same way, if the manure were applied to corn in the first year and no manure was applied to the land planted in soybeans the subsequent year, the excess P and K applied during the corn year would be valuable to the soybean in the next year.
Table 4. Value of manure on corn acres needing P2O5 buildup.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Applied</th>
<th>Needed</th>
<th>Lbs valued.</th>
<th>$/lb</th>
<th>Value/Ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>$0.35</td>
<td>$56.00</td>
</tr>
<tr>
<td>P2O5</td>
<td>168</td>
<td>168</td>
<td>168</td>
<td>$0.37</td>
<td>$62.16</td>
</tr>
<tr>
<td>K2O</td>
<td>120</td>
<td>40</td>
<td>40</td>
<td>$0.23</td>
<td>$9.20</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$127.36</td>
</tr>
</tbody>
</table>

If manure is applied to soybeans rather than corn, the nitrogen supplied by the manure would have no value because soybeans need no nitrogen fertilizer. Table 5 shows the value of the manure where the nitrogen has no value.

Table 5. Value of manure on soybean acres.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Applied</th>
<th>Needed</th>
<th>Lbs valued.</th>
<th>$/lb</th>
<th>Value/Ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>160</td>
<td>0</td>
<td>0</td>
<td>$0.35</td>
<td>$0.00</td>
</tr>
<tr>
<td>P2O5</td>
<td>168</td>
<td>31</td>
<td>31</td>
<td>$0.37</td>
<td>$11.47</td>
</tr>
<tr>
<td>K2O</td>
<td>120</td>
<td>48</td>
<td>48</td>
<td>$0.23</td>
<td>$11.04</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$22.51</td>
</tr>
</tbody>
</table>

Injecting manure, rather than surface applying the manure, will conserve nitrogen so that fewer gallons of manure are required to obtain the same amount of nitrogen. This changes the ratio of N, P2O5 and K2O so that less P2O5 and K2O is over applied, causing it to become valuable. It also allows for the manure to be spread over more acres so that the total value increases as more acres receive the value per acre illustrated in the tables above.

Summary

The net income resulting from manure marketing can be increased by increasing the value of the manure to crop producers – even if that increased value is accompanied by increased costs. Focus on increasing value faster than costs increase. The maximum potential value of the manure will depend on nutrient composition and the customary cropping activities of the locale. Increase manure value by delivering the nutrients that crop producers want in the quantities that they want for the crops that they grow. Target crop producers growing crops with high N, P and K needs. Foster the demand for manure supplied nutrients by understanding what crop producers want from manure. Flexibility in application rates, timing of application and choice of application method has the potential to increase demand for, and hence value of, manure. Receiving value for all or most of the N, P and K in your manure can offset the additional cost of transporting the manure to fields that need the nutrients.