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FACTORS THAT AFFECT THE PRICE OF MANURE AS A FERTILIZER

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This paper discusses the value of manure as a soil amendment/fertilizer source. It does not attempt to provide information regarding the use of manure for other things such as feed to livestock, energy generation, etc.

An often asked question is "what is the price of manure?" This question is difficult to answer because price is determined by markets. In the absence of markets for manure, its price is unknown. The best that can be done is to estimate the *potential* price of manure for a specific purpose.

The estimation process is called hedonic pricing. In the absence of a market, the sum of the value of various manure components approximates a price for the manure itself. Hedonic pricing is heavily dependent on the many assumptions imposed on the use of manure. Any change in assumptions will result in a change in the approximate price of the manure.

Because this type of estimation of the price of manure is dependent on its many assumptions rather than on market supply and demand, it is only as a starting point for negotiations in a developing market. A person with an estimate of potential manure price can use it to interest another in buying the manure, thus creating a market that establishes a *price* for manure.

The potential value of manure is affected by:

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

Components that decrease the value of manure include

- Negative components

    - Weed seed
    - Foreign matter – wire, concrete, etc.
    - Undesirable chemicals – antibiotics, hormones, heavy metals, etc.
- Timing of application
- Legal Constraints

The remainder of this paper will present information on how each of the components affects the potential value of manure. The concepts are illustrated at the end by use of several examples. An EXCEL® spreadsheet entitled "Value of Manure" is available that permits users to enter pertinent information to receive an estimate of the maximum potential value of manure to a crop producer.

Units of Value

In order for price to be meaningful, an explicit or implied unit is necessary. When farmers sell corn, they sell it by the bushel. When livestock feeders feed corn they consider it by the pound or hundredweight. To say that corn is worth $2.50 without mentioning the unit bushels, is potentially confusing to the feeder wondering what the cost per hundredweight of his feed will be. The same phenomenon exists for manure. Different actors in the market will be considering different units. While growing, marketing and feeding corn is so common place that the unit is understood from the context of the discussion, the units of manure implied in a particular conversation will not be so easily discerned.

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. (Note: For the remainder of this lesson, I will use 1000 gallons. This is for brevity and clarity. Persons using dry manure will need to translate "1000 gallons" into "tons.")

Because manure is seen as a fertilizer substitute, the dollars/acre puts it in a unit that can be compared to other fertilizers. Valuing manure in dollars/acre differs from the method of application which is usually 1000-gallon units. The person interested in possibly buying the manure is the crop producer who is going to compare manure to his current per-acre fertility expense. Assuming that all the fertilizer needs of the crop are going to be met, the cost/acre of various fertilizer alternatives can be compared.

Value per 1000 gallons 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.

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.

Fertilizer Form and Manure Nutrient Value

The easiest way to value a pound of N, P_2O_5 and K_2O in manure is to use the value of common commercial fertilizers. The correlation is not complete because form is important in determining value. Even with commercial fertilizers, the form of the fertilizer impacts the cost per pound of nutrient.

Nitrogen

Table 1 shows the price per pound of nitrogen for three common fertilizer sources. The cost ranges from $.32 to $.57 per pound – almost a 2 fold difference.

Table 1. US nitrogen fertilizer prices (2007).

Fertilizer	Price Per Ton	% Nitrogen	Price per pound
Ammonium Nitrate	$382	33.5	$0.57
Anhydrous Ammonia	$523	82	$0.32
Urea	$453	45	$0.53

Source: USDA Agriculture Prices Summary

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. Manure supplied nitrogen would logically be less valuable than commercial fertilizer to some crop producers 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 expected availability of manure supplied nitrogen is dependent on the form of the nitrogen and the application method. Organic N becomes available over time to the plants so not all is available during the season it is applied. Nitrogen in the ammonia form if applied too early (i.e. in the fall for use by spring planted crops) may not be available for crop use because of its volatile nature.

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 useful to the plant.

For ease, the value of the fertilizer that would have been used if manure had not supplied the nutrient is probably the best value to use. This value gives a

reasonable estimate of the value of the fertilizer used by growing crops. Fertilizer value of nitrogen probably does not represent the price that neighbors are willing to pay for the manure supplied nutrients.

Phosphorus and Potassium

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. The value of P and K fertilizer is an acceptable value to use in estimating the value of manure.

Minor nutrients

Any minor nutrients that are supplied by manure have potential value. In order to consider that value, the presence of them would need to be established by manure testing and the need would require establishing by a soil test. 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 minor nutrients.

Organic Matter

Many people believe that the organic matter in manure should be given a value. In order to justify this estimation of value for organic matter 2 things need to exist: 1) the organic matter must contribute to production and 2) a market price for the organic matter needs to be obtained.

Organic matter can contribute to production by increasing the quantity or quality of the crop being harvested or by providing an environmental benefit. In soils that are worn or low in organic matter, the organic matter may have value. Certain manures (poultry litter) 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 one way to estimate the value of organic matter. Organic matter that provides an environmental benefit is more difficult to value because a person cannot isolate its contribution to the profit of the farm.

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. In fact, the excess P and K has the potential to reduce the value of that particular parcel of ground by making it unsuitable to receive manure in the future and increasing the cost of manure application as the animal feeding operation seeks suitable land farther away.

However, if the manure is applied every other year to land in a corn-soybean rotation, the excess P and K in the corn year is useful to the soybeans in the subsequent year and thus has value. By altering the cropping system and the manure application schedule the value of the manure can possibly be increased.

By growing crops that have value and that remove a substantial amount of nutrients, the value of the manure can be increased. 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.

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 not have much, 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 a predefined 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 fertility 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; any manure supplied P and K is not valued. Manure

supplied nutrients 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 enhanced by seeking land with low fertility 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

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.

Legal Application Limits

Manure value is affected by whether manure is limited to 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 will be equal to the commercial fertilizer expense of growing the crop.

Not all of the nutrients applied will be valued because excess P and K 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. When manure is applied to crops to meet all of the nitrogen needs, environmental regulations frequently forbid the addition of other nitrogen fertilizers. However, when manure is applied at a rate less than the N removal rate of the crop, commercial fertilization is permitted. Some farmers may request that manure be applied at the P removal rate rather than an N removal rate because it gives them the flexibility to supplement with commercial fertilizer. Though the farmer desires the lower application rate, they will still recognize that their total fertilizer expense has not been met with the manure. The maximum value they will ascribe to manure is the normal fertilizer expense per acres less the cost of necessary supplemental N and commercial fertilizer application. Willingness to sell manure at this lower value/acre, may translate into increased 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 it 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.

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 concrete, it will 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), hormones or antibiotics are considered potential negative impacts of manure use. While these may not decrease the quantity or quality of crop removed, farmers will tend to discount manure because of their potential presence.

Timing of Application

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

Animal feeders tend to think of manure value as the sum of its nutrients. Suppose Table 2 summarizes a manure analysis for 1000 gallons of swine pit slurry. A common estimate of the value of manure is obtained by multiplying the quantity of each nutrient by its commercial fertilizer value. In this case 39 lb. N

would be multiplied by $.32/lb N, 23 lb. P_2O_5 would be multiplied by $.46/lb P_2O_5 and 40 lb K_2O would be multiplied by $.23/lb K20 and summed to get a total fertilizer value of $36.40/1000 gallons of manure. The result is an overestimate of the value of manure nutrients.

Table 2. Manure Analysis (1000 gallon swine pit slurry)

Nutrient	Pounds per 1000 gallons	$ per pound	$ per 1000 gallons
Available Nitrogen	39	$0.32	$12.48
P_2O_5	32	$0.46	$14.72
K_2O	40	$0.23	$9.20
Total Value			**$36.40**

Farmers tend to think of fertilizer expense per acre rather than per 1000 gallons of 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 P_2O_5 and K_2O (see Table 3 where 4000 gallons/acre is applied to meet the N needs of the crop). All of the nitrogen is valued because all is needed to grow the crop. Its value is 155 lbs. N supplied times $.32/lb N from commercial fertilizer. Only 55 lbs of the P_2O_5 is valued even though 128 lbs is provided because the corn is only going to use 55 lbs. This 55 lbs is valued at commercial fertilizer price of $.46/lb P_2O_5. Only 40 lbs of the 160 lbs of K_2O is valued because only 40 lbs is used by the corn. This 40 lbs is valued at commercial fertilizer price of $.23/lb K_2O. The total value of the manure is $84.10/acre.

Table 3. Value of Manure applied to corn.

Nutrient	Applied	Needed	Cost	Value/acre
	-------- Pounds --------		$/lb.	
Available Nitrogen	155	155	$0.32	$49.60
P_2O_5	130	55	$0.46	$25.30
K_2O	160	40	$0.23	$9.20
Total Value				**$84.10**

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 P_2O_5 and the farmer was in a buildup phase, all of the P_2O_5 fertilizer value of the applied manure would be obtained. Table 4 shows that the

value of the manure increased from $84.10 to $118.60 per acre. This increased value would continue only until the P_2O_5 level was raised to a level where no additional P_2O_5 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 P_2O_5 Buildup.

Nutrient	Applied	Needed	Cost	Value/acre
	-------- Pounds --------		$/lb.	
Available Nitrogen	155	155	$0.32	$49.60
P_2O_5	130	130	$0.46	$59.80
K_2O	160	40	$0.23	$9.20
Total Value				**$118.60**

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.

Nutrient	Applied	Needed	Cost	Value/acre
	-------- Pounds --------		$/lb.	
Available Nitrogen	155	0	$0.32	$0.00
P_2O_5	130	55	$0.46	$25.30
K_2O	160	40	$0.23	$9.20
Total Value				**$34.50**

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, P_2O_5 and K_2O so that less P_2O_5 and K_2O is over applied and therefore not valued. 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

Until a local market develops for manure, its value will remain unknown. The sum of the value of the nutrients in manure is not going to be the price that animal feeders will be able to sell manure. The maximum potential value of the

manure will depend on nutrient composition and the customary cropping activities of the locale.

Animal feeders can foster the development of a manure market by understanding what crop producers value and discount in receiving crop nutrients in the form of manure. Efforts to increase the value of manure to crop producers will increase their acceptance of it and increase its eventual market price.

Flexibility in application rates, timing of application and choice of application method will all improve the opportunity for developing a market for manure. As the market develops the price of manure will fluctuate as the supply of manure and the demand for it changes from year to year. Manure price, like that of livestock and crops, will fluctuate from year to year.

Other potential markets, such as feeds or energy production, exist for manure. Many of the same principles apply but the list of positive and negative characteristics of manure would be different.