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Manure Use in Cropping

Cooperative Extension South Dakota State University

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South Dakota Cooperative Extension Energy Information

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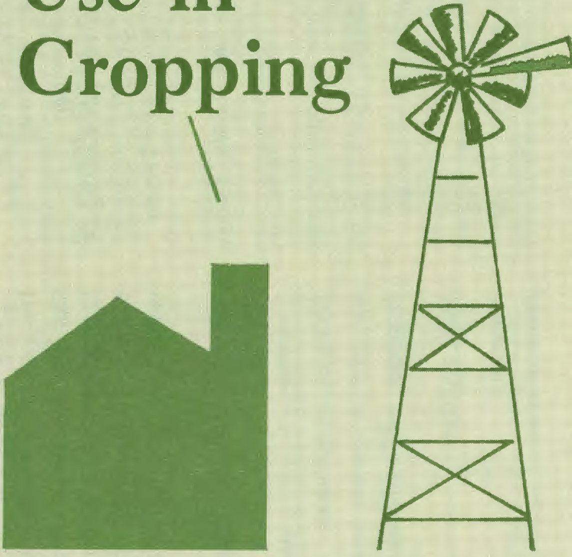

Cooperative Extension Service
South Dakota State University
U.S. Department of Agriculture

Manure Use in Cropping

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Confined feeding of dairy, beef, and swine is estimated to produce over 5 million tons of livestock waste annually in South Dakota. Additional amounts are randomly distributed over grazed land.

The total plant food content of that waste is equal to approximately 38,000 tons of anhydrous ammonia (82-0-0), 39,000 tons of phosphate (0-45-0) and 46,000 tons of potash (0-0-60). The waste also contains smaller but nevertheless important amounts of secondary and trace elements essential for crop production.

Proper management and utilization of this plant food resource can mean not only less investment in commercial fertilizer but also increased crop yields because of improved soil structure and water infiltration.

Poor handling and storage practices of manure can cause nutrient losses. Nitrogen losses can approach 50 per cent.

Such losses cut farm profits and lower the quality of nearby surface water and shallow aquifers. Replacing each equivalent ton of anhydrous ammonia lost to the atmosphere requires 38,000 cubic feet of natural gas for its manufacture. Better utilization of agricultural wastes can contribute significantly to today's effort to conserve energy.

Fertilizer nutrient levels in livestock wastes

The content of essential plant food elements in manure can vary widely. These variations depend on the type of livestock involved, the quantity of nutrients fed in the ration, and the handling of the manure to incorporation into the soil.

Table 1 shows the amount and the nutrient content of wet manure as excreted by various kinds of livestock. These should be considered only average values; numerous factors can cause the levels to range both above and below those shown.

Dilution such as flushing or bedding water will lower the nutrient content of the manure; for example, one foot of additional flushing water in a 10-foot deep pit or tank reduces the nutrient level 10 per cent. The nutrient levels of bedding materials such as straw and wood products are lower than those of manure. The addition of straw and wood products dilutes the final nutrient level of manure as does water.

It is advisable, therefore, to have a representative manure sample tested by a laboratory just prior to its use to more accurately determine its plant food content.

The distribution of plant food nutrients in the solid and liquid portions of manure will vary (Fig. 1). The liquid manure fraction should be retained because of its high nitrogen and potash content. It also carries other nutrients, such as sulfur and boron.

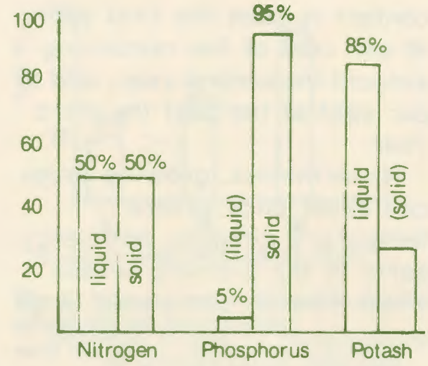

Fig. 1. Nutrient distribution in liquid-solid forms of manure.
Drs Walsh and Hensler, University of Wisconsin

Availability of nutrients in manure

Most of the nutrients in manure exist in organic forms which are unavailable to the plants. Rotting or decomposition is necessary for the organic forms to be converted to inorganic or available types of nutrients that can eventually be utilized by plants.

Decomposition rates of manure will vary widely because of differences in nitrogen content, moisture level, oxygen level, kind of starch and cellulose present, etc. Nutrient availability will vary accordingly.

One common rule of thumb says 50 per cent of the total nutrient content of manure is released in plant available forms each year. Assume 50 per cent of the total nutrient

Table 1. Manure nutrients and value*

Item	Dairy cattle	Beef cattle	Poultry	Swine	Sheep
Animal size, lb	1000	1000	5	100	100
Wet manure, tons/yr	11.86	10.95	0.046	1.46	0.73
Moisture, %	85	85	72	82	77
			Pounds per ton		
Nutrients					
Nitrogen (N)	10.0	14.0	25.0	10.0	28.0
Phosphorus (P)	2.0	4.0	11.0	2.8	4.2
Potassium (K)	8.0	9.0	10.0	7.6	20.0
Sulfur (S)	1.5	1.7	3.2	2.7	1.8
Calcium (Ca)	5.0	2.4	36.0	11.4	11.7
Iron (Fe)	0.1	0.1	2.3	0.6	0.3
Magnesium (Mg)	2.0	2.0	6.0	1.6	3.7
Boron (B)	0.01	0.03	0.01	0.09	--
Copper (Cu)	0.01	0.01	0.01	0.04	--
Manganese (Mn)	0.03	--	--	--	--
Zinc (Zn)	0.04	0.03	0.01	0.12	--

Dr. Leo Walsh, University of Wisconsin

content is used the first year, 50 per cent of the remaining amount the second year, and 50 per cent of the rest the third year.

Nevertheless, growing crops can experience severe temporary nitrogen deficiency early in the growing season when manure containing large amounts of straw is applied.

Oxygen availability is perhaps the most important factor in the decomposition process; optimum levels assure the most rapid and complete decomposition. While rapid initial decomposition is desirable for releasing nutrients in manure, failure to trap or retain these nutrients results in significant loss. These losses can be reduced by incorporation into the soil or by storing manure in mounded large piles.

Fertility value of manure in crop production

Manure seldom contains plant food nutrients in the same ratio as required by crops commonly grown in South Dakota. The plant food elements from manure, however, can reduce the commercial fertilizer required.

The best use of manure is probably obtained by following the old rule of thumb, "cover as many acres as frequently as possible." Cost of handling the manure, time, crop rotations, and possibly other reasons may make it desirable to make heavier application on fewer acres.

Under these conditions the rate of application should not exceed the rate that will supply the nitrogen needs of the crop. One other precaution concerns excess salts in feedlot manure, considered in a later section.

Table 2. Suggested average N, P_2O_5, and K_2O credits for manure [wet].

Kind of manure	Credit, pounds per ton		
	N	P_2O_5	K_2O
Cattle or hog	10	5	10
Sheep	20	9	20
Poultry and turkey	20	25	10

You need to take previous manure applications into account when evaluating the nutrient needs of a particular crop. For example, 10 tons of manure with 20 lbs of N, 10 lbs of P_2O_5, and 20 lbs of K_2O per ton would release 50 per cent of the nutrient content the first year. That is, the 10 tons would supply 100 lbs of nitrogen the first year, 50 lbs the second year and 25 lbs the third year.

Where to apply

It is important to use manure where it will be of greatest value. The choices, in descending order, are:

1. Row crops--corn, sorghum, sunflowers, and soybeans.
2. Small grains--wheat, oats, barley, rye, etc.
3. Legumes
4. Pastures

Row crops and small grains are not only the better choice for manure application but provide a means of incorporation during the tillage operations.

The use of manure on pastures and legumes is very wasteful of the nitrogen present in the manure because it cannot be incorporated into the soil. A light application (1 to 2 tons per acre) of manure is sometimes top dressed on a new seeding of grass or legume. It provides some protection for the new seedlings.

Another excellent use of manure is to help alter the physical characteristics of certain soils, such as sands, where added manure increases the water-holding capacity, and clay, where the addition of manure increases the water infiltration rate.

Estimating quantities of animal manure

Determining the amount of manure applied per acre is not easily nor accurately done. The type of livestock involved, moisture content, amount and type of bedding, and size of spreading or hauling equipment need to be evaluated. Some guidelines for estimating the ton capacities of moist solid type manure are shown in Table 3.

Liquid manure is more easily measured. Most operators know the gallon capacity of liquid tank spreaders, and it is easy to directly weigh a gallon of the waste to use in determining tons per acre.

You can estimate the amount of plant food elements supplied in manure by following the values given in Table 1, if the fresh manure is applied each day. If stored manure is being applied, a laboratory analysis will provide an accurate determination of the amount of plant food elements present.

If sampling and analyses are not possible or practical, an estimate of the amounts present can be made from Table 2. Using these values and the estimate of the tonnage applied from Table 3, you can achieve a reasonably good estimate of the total amount of plant food elements applied.

Sampling manure for lab testing

The value of laboratory tests for plant food content in manure depends on how accurately the manure was sampled. While only 1 to 2 pints of liquid or solid wastes are needed for a laboratory sample, you should take several (perhaps 6-8) probes or sub-samples and mix them together before preparing the final pint samples for the lab test.

Pit storage areas should be thoroughly agitated before

Table 3. Estimating spreader capacity.

Spreader size, bu (heaping)	Tons
75	1.75
100	2.50
125	3.00
150	3.75
200	4.80
250	6.00
300	7.20
350	8.40

samples are taken. Be sure ample fresh air is present when taking samples, because of the potential hazards of toxic gas buildup. Solid manure should also be probed well to get a representative sample. Include raw manure and bedding materials in the same proportion as they occur in the stored mass.

Samples should be submitted to the laboratory in the same physical state as they will be when applied to soil. In most cases this will be in a moist condition. Closed glass or plastic containers of various types are well suited for sending samples. Send samples to the Station Biochemistry Department of South Dakota State University, Brookings, South Dakota 57007.

Hazards of excessive manure rates

While farmers can realize impressive yield increases when reasonable rates of manure are applied, some disastrous drops in yield have been observed when excessive rates were used.

The maximum rate to be applied annually should remain below 25-30 tons (wet basis equivalent) per acre of non-diluted feedlot manure. As rates exceed these levels, increased salt levels and destruction of soil structure begin to cause yield loss.

Corn yields have declined as much as 25 per cent where soil electrical conductivity, a measure of soil salt levels, reached 5.0 mmhos-cm.

Breakdown of soil structure, along with reduced aeration and water infiltration, commonly occurs in medium to fine textured soils where excessive amounts of manure are applied. Excessive rates of manure application on very shallow, porous, sandy soils can contribute to ground water pollution. An even greater potential problem can develop where a single field is used strictly as a manure disposal site, meaning it may receive 50, 100, or even greater tonnages of manure annually. Large applications of manure can cause lodging of small grain crops. In general, applications of greater than 10 tons per acre are not encouraged.

Significant nutrient losses can occur from manure. This includes gaseous loss of nitrogen as well as leaching losses of virtually any of the plant food elements. Completely avoiding loss may be impossible. However, certain practices may help reduce it.

Losses can occur during storage as well as during application (Table 4). Nitrogen loss, as a gas or in water draining through storage piles, is potentially greater than phosphorus and potassium losses. Odors from manure will contain nitrogen and non-nitrogen forms of gas, depending on the type of rotting process underway. The absence of oxygen during rotting, such as heating in a pile, results in the formation of ammonia nitrogen compounds (gases). Nitrogen loss also occurs from pit storage, so frequent removal and incorporation into soil is the surest way of reducing loss.

Significant nitrogen losses can take place where either solid or liquid forms of manure are field applied but not mixed or incorporated into the soil. Figure 2 shows such losses can reach 45 per cent in just 4 days. Some type of tillage such as disking, chiseling, or plowing immediately after spreading or injection will greatly reduce such losses (Table 5). Those operators who inject liquid manure directly into the soil avoid most gaseous loss.

Table 4. Nitrogen loss during manure storage .

Method	N loss, pct.
Solid	
Daily scrape-haul	25
Manure pack (feed lot)	35
Open lot	55
Deep pit-poultry	20
Liquid	
Anaerobic pit	25
Oxidation ditch	60
Lagoon	80

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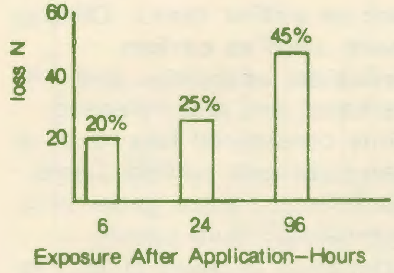

Fig. 2. Nitrogen loss – fermented manure spread but not incorporated.
Walsh and Hensler, University of Wisconsin

Avoiding nutrient loss when handling manure during the winter months is difficult, if not impossible. Surface application of manure on frozen sloping fields is not recommended. Not only do considerable nutrient losses take place, but contamination of nearby surface water often occurs. Data from Vermont show 3 to 11 lb nitrogen loss and 1 to 2 lb phosphorus loss from 10 ton per acre manure applications on frozen 10 to 20 per cent sloping fields. Expanded winter storage that limits exposure to air or rain keeps nutrient losses to a minimum.

Dangers with manure storage and handling

Death has been reported in connection with the handling of manure, so be cautious. The main threat exists whenever manure is being stored or removed from a pit or enclosed building.

Toxic gases such as hydrogen sulfide, released during decomposition, are lethal at only 1 ppm. Hydrogen sulfide is heavier than air so would accumulate in low areas

Table 5. Nitrogen losses affected by application needed .

Method	Manure type	N loss, pct.
Broadcast, no cultivation	Solid	21
	Liquid	27
Broadcast, with cultivation	Solid	5
	Liquid	5
Knife injection	Liquid	5
Irrigation	Liquid	30

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such as pits or tanks. Other gases, such as carbon monoxide, ammonia, and methane, are also released. While considered less toxic than hydrogen sulfide, large quantities of these gases in themselves could cause suffocation because of inadequate oxygen.

Air ventilation for moisture removal in confinement buildings or dry manure storage areas is usually considered adequate for toxic gas removal. SDSU agricultural engineers recommend at least minimum circulation fan use in pit storage areas for adequate gas removal.

Some of the objectionable odors from manure and its decomposition can be reduced, if not eliminated. For example, data from Illinois show chlorine has been effectively used to control odor. A rate of approximately .04 lb of available chlorine per day is needed to deodorize the waste of a 100-lb hog.

Disease-insect hazards in handling manure

In general, manure storage areas do not create a serious overall disease threat to livestock or humans. The internal heating or fermentation-decomposition process causes an unfavorable environment for disease organisms. Nevertheless, **Salmonella pullorum** in poultry feces can be transferred by flies to nearby poultry feed. The nuisance of large insect buildups, such as flies, along with the remote possibility of disease transfer, are important reasons to not let manure reserves accumulate in warm weather.

Manure as an energy source

Perhaps the best way to properly use manure to help ease an energy crisis is in substituting the waste for commercial fertilizer whenever possible.

The current manufacturing process for anhydrous ammonia requires 21,000 BTUs per lb of actual nitrogen; this converts to 46,000 cubic feet per ton of actual fertilizer nitrogen. A ton of beef manure supplying 14 lbs of nitrogen (Table 1), substituted for commercial anhydrous in crop production, would save 294,000 BTUs. These figures do not consider energy use for the application of the nitrogen.

Methane gas, released during manure decomposition, has been successfully trapped and utilized to operate internal combustion engines of tractors, pickups and other farm equipment. The practice is still in its early infancy and is of limited practical value to farmers at this time.

The use of manure to improve yields of crops for use in gasohol production may represent still another example of energy conservation. The relative low current prices of petroleum fuels make the use of gasohol an uneconomical concept at this time. However, changing economic values of these different energy sources could quickly make their use more desirable.

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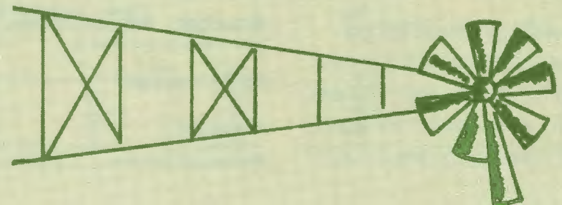

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