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OKLAHOMA COOPERATIVE EXTENSION SERVICE

Using Stockpiled Feedlot Manure as Fertilizer

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The application of animal manure to farmland is an economically and environmentally sound management practice for most feedlot operators and farmers. Land application returns nutrients from manure to the soil and helps build soil fertility. Manure provides nitrogen (N), phosphorus (P), potassium (K), calcium, magnesium, micronutrients and organic matter. Applying manure to soil has been shown to improve soil tilth, increase water holding capacity, reduce wind and water erosion and improve soil aeration. Land application of manure should be managed to recycle plant nutrients rather than used as a disposal method. The steps to properly using stockpiled manure are:

1. Determine crop nutrient requirements, based on a realistic yield goal;
2. Determine the nutrient content of the manure;
3. Determine the fraction of manure nutrients available to the crop in the first year of application;
4. Calculate the application rate to supply crop nutrient needs;
5. Determine supplemental nutrients needed for optimum crop growth.

These steps will assure the proper amount (agronomic rate) of feedlot manure is applied, so the risk to soil and water quality is minimized.

Crop Nutrient Requirement

Feedlot manure should not be applied to fields beyond the limits of the growing crop's nutrient needs. This ensures efficient use of manure nutrients and minimizes nutrient leaching or runoff into the water system. Applications of manure at agronomic rates generally will not create salinity problems. Any cropland scheduled to receive manure should first be soil tested to determine its present fertility level. Periodic soil testing is recommended to monitor the nutrient-supplying capacity of the soil. Fertilizer recommendations, based on soil test results, are the only reliable way to obtain crop nutrient requirement.

Soil analysis is available through the *OSU Soil, Water and Forage Analytical Laboratory* in Stillwater as well as a number of commercial laboratories. Crop nutrient needs are given in the interpretations and requirements section of the soil test report. You also can determine crop nutrient needs using OSU Extension Fact Sheet F-2225, OSU Soil Test Interpretations. Contact your local Extension office for instructions and supplies for taking and submitting soil samples.

Manure Nutrient Content

The nutrient content of feedlot manure is highly variable (Table 1). Fertilizer value depends on animal age, type of ration, manure handling methods and moisture content. Because of this variability in nutrient content, manure must be analyzed, and individual land application decisions should be based on the nutrient content of the manure to be applied.

Samples collected for analysis should be representative of the lot or stockpile. See OSU Extension Fact Sheet F-2248, Procedures for Sampling Animal Manure, for details of manure sampling techniques. Feedlot manure should be analyzed for electrical conductivity (EC) and sodium content as well as major plant nutrients because EC is related to the amount of soluble salts you are going to add to the fields. Improper balance of sodium in relation to calcium and magnesium salts may cause the soil aggregates to disperse into individual particles make the field difficult to manage.

Availability of Manure Nutrients to Crops

Nutrients in manure cannot be substituted for those in commercial fertilizer on a pound-for-pound basis, since not all the nutrients listed on a manure analysis report are readily available to a crop in the year of application. Some elements

Table 1. Approximate Dry Matter and Nutrient Content on Dry Weight and "as is" Basis of Typical Feedlot Manure in Oklahoma.

Analyses	*Range %*	*Average %*	*lb./ton (dry wt. Base)*	*lb./ton (as is)*
Dry Matter	48.2-78.3	61.9	1239	2000
Total N	1.67-2.36	1.97	39.4	24.4
Organic N	1.29-1.93	1.63	32.6	20.2
Phosphorus (P_2O_5)	1.45-2.06	1.71	34.1	21.1
Potassium (K_2O)	1.75-2.34	1.98	39.6	24.5

are released when organic matter is decomposed by microorganisms. Some elements can combine with soil constituents and become unavailable. Other nutrients, such as nitrogen, may also be lost to the atmosphere through ammonia volatilization or denitrification, or lost below the root zone through leaching.

Nitrogen available from feedlot manure during the year of application varies greatly and ranges from about 40 to 80 percent. Most of the nitrogen is present in the organic form. Organic N must be converted (mineralized) into inorganic forms, such as NH_4^+–N and NO_3– N before it can be taken up by plant roots. The amount of organic N converted to plant-available forms during the first cropping year after application varies depending on manure handling systems. In general, about 40 percent of the organic N may become available the year of application. Combining the inorganic N and the available N from organic matter, there is about 50 percent of total N available to crop uptake during the first year after application, 15 percent and six percent for the second and third year after application, respectively. Soil test data should be used to follow the potential accumulation of N and P after repeated manure application. Table 2 compares effects of nitrogen from stockpiled feedlot manure and commercial fertilizer on irrigated corn yields in New Mexico. About two pounds of manure nitrogen are found to be equivalent to one pound of urea nitrogen. In other words, 50 percent of the N from manure contributed to corn yields.

Phosphorus and potassium in feedlot manure are considered to be about 80 to100 percent available when compared with commercial fertilizers for the first year after application. In general, 90 percent availability is assumed when determining an application rate based on P or K.

Application Rate

Land application rates should be based on the nutrient requirements of the crop. Too little manure application will not provide sufficient nutrients for the desired crop production. Excess nutrients are a waste of resources, resulting in nutrient buildup in soils, which may cause water contamination.

Soil testing, manure analysis, and proper estimation of yield goal are necessary to calculate proper agronomic application rates of feedlot manure and additional fertilizers. If manure is applied to the same field in the following years, nitrogen credits should be given to previous years' application because a certain percentage of nitrogen is carried over to each year after first application for several years as discussed in the nutrient availability section. Follow the five steps in the attached worksheet to calculate application rate of manure and any additional nutrients from commercial fertilizers to balance crop needs.

Table 2. Average Corn Grain Yields at Five Nitrogen Treatments.

N Rates and Sources	*Yield (lb./acre)*
0 lb/acre N	8,531
50 lb/acre urea N	10,233
100 lb/acre manure N	10,328
100 lb/acre urea N	10,660
200 lb/acre manure N	10,684

Application Timing

Proper timing of feedlot manure application is essential to efficient use of nutrients and pollution prevention. It should be applied as near to the planting dates as possible. Applying manure outside of crop growth periods decreases nutrient availability, and may increase the risk to environmental quality.

Manure applied during the spring provides the needed starter nutrients for summer crops and will release nutrients through mineralization during the growing season. Summer application is most suited to pasture. Grasses or pasture also offer the flexibility when crop fields are not available to receive manure or too wet to conduct spreading operations. Generally, applying manure in the fall results in greater nutrient loss than spring application, especially if the manure is not incorporated. If the manure is incorporated and the soil temperatures are below 50°F, most of the available nutrients will be retained by soil until the following spring. Sometimes fall application is needed to free up manure storage space. In this case, it is best to apply manure to fields where winter grains or cover crops will be planted. Winter application is the least desirable because manure must remain on the soil surface for three to four months ahead of the crop's active growing period.

Proper Manure Application

Feedlot manure normally is applied to land by surface broadcasting, using a manure spreader followed by plowing or disking, or broadcasting without incorporation. Research has shown that maximum nutrient benefit is realized when manure is incorporated into the soil immediately after application. Immediate incorporation of solid manure minimizes nutrient loss in runoff and nitrogen loss to the air, and allows soil microorganisms to start decomposing the organic fraction of the manure quickly. This increases the amount of available nitrogen to the crop. Manure should be applied uniformly to prevent localized high concentrations of ammonium and other inorganic salts, which can reduce germination and affect yields. The application equipment needs to be calibrated to achieve accurate application rates.

Prevention of Salt Buildup in Soils from Manure Application

Salt buildup also is possible if application rate is excessive and rainfall is low. The amount of salt a soil can handle depends on soil texture, amount of irrigation and natural rainfall. It also important to know what kinds of salts and how much of each kind is being added to the soil. Improper amount of sodium in relation to calcium and magnesium salts in soil may cause the aggregates to disperse into individual particles. This will result in poor soil physical properties. Tests including soil salinity and manure salt content may also be needed to monitor soil salt levels in dry climate regions. It is recommended to include EC (electrical conductivity) and ESP (exchangeable sodium percentage) in your annual soil testing program to monitor the effects of manure salts.

Stockpiled Manure Application Rate Calculation Work Sheet

		Example:			Your numbers:		
1a	**Nutrient needs of crop (lbs/acre)**	N	=	200	N	=	_____
	Recommendations based on soil test results and a	P_2O_5	=	40	P_2O_5	=	_____
	realistic yield goal	K_2O	=	0	K_2O	=	_____
1b	**Nutrient carried over in last 2 years'**	N	=	20	N	=	_____
	applications (lbs/acre)	P_2O_5	=	0	P_2O_5	=	_____
	15% N from last year's application	K_2O	=	0	K_2O	=	_____
	6% N from year before last year's application						
1c	**Nutrient needs to meet with manure**	N	=	180	N	=	_____
	Subtract line 1b from line 1a	P_2O_5	=	40	P_2O_5	=	_____
		K_2O	=	0	K_2O	=	_____
2	**Total nutrients available in manure (lb/ton)**	N	=	24	N	=	_____
	Based on manure analysis of representative	P_2O_5	=	21	P_2O_5	=	_____
	sample collected close to time of application.	K_2O	=	25	K_2O	=	_____
3	**Determine available nutrients (lb/ton)**	N	=	12	N	=	_____
	Multiply the value in step 2a by availability, 50%	P_2O_5	=	19	P_2O_5	=	_____
	for N and 90% for P and K.	K_2O	=	23	K_2O	=	_____
4a	**Calculate application rates to supply N, and**	N	=	15	N	=	_____
	P_2O_5 needs (tons/acre)	P_2O_5	=	2.1	P_2O_5	=	_____
	Divide values form Step 1C by values from Step 3.						
4b	**Choose between N or P_2O_5 application rate (tons/acre)**	Rate	=	2.1	Rate	=	_____
	Select highest rate in Step 4a to use manure as						
	complete fertilizer. Select lowest rate to maximize	(based on P)					
	nutrient use from manure.						
5a	**Determine amount nutrients applied at chose rate (lbs/acre)**	N	=	25	N	=	_____
	Multiply the rate chosen in step 4b by available	P_2O_5	=	40	P_2O_5	=	_____
	nutrients in Step 3.	K_2O	=	48	K_2O	=	_____
5b	**Determine supplemental nutrients (lbs/acre)**	N	=	155	N	=	_____
	Subtract the nutrients applied, Step 5a from nutrients	P_2O_5	=	0	P_2O_5	=	_____
	needed, Step 1c. If the difference is negative, enter 0.	K_2O	=	0	K_2O	=	_____

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Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

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- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and research-based information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
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- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
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