TECHNICAL NOTES

NATURAL RESOURCES CONSERVATION SERVICE – WYOMING

AGRONOMY NO. 14 **July 18, 2002**

SUBJECT: Waste Utilization Application Guidelines

The following guidelines provide information that NRCS personnel can use in the **preliminary steps of planning** Agricultural Waste Systems. These are only intended as general guidelines, as development of site-specific Waste Utilization/Nutrient Management plans still requires quantification of application rates based upon soil and manure test values, as well as site-specific crop yield goals.

MANURE PRODUCTION

A single 750 pound beef animal will produce about 42 pounds of manure per day. Over the course of a year, this animal will then produce about 7.5 tons of manure. This manure is approximately 88% moisture. Most manure, once exposed to the elements will be between 35 and 30% moisture. Therefore, once the moisture adjustment is made, this animal will produce about 1.2 ton of manure.

Table 1 provides a summary of manure production by livestock (beef) class by days of production for as-excreted values, and at 30% moisture which is a typical Wyoming value. To approximate herd manure production, multiply the number of animals times the values in column 4.

TABLE 1 – AVERAGE MANURE PRODUCTION

Class of Beef Animal	Days of Production	Manure @88% Moisture (tons)	Manure @30% Moisture (tons)
(1)	**(2)**	**(3)**	**(4)**
450 – 750 lbs	30	0.5	0.1
(600 lb avg. weight)	45	0.8	0.1
	60	1.0	0.2
	75	1.3	0.2
	90	1.6	0.3
	120	2.1	0.4
	150	2.7	0.5
	180	3.1	0.5
	210	3.7	0.6
	270	4.7	0.8
	365	6.4	1.1

TABLE 1 – AVERAGE MANURE PRODUCTION (cont'd)

Class of Beef Animal	Days of Production	Manure @88% Moisture (tons)	Manure @30% Moisture (tons)
(1)	(2)	(3)	(4)
750 – 1,100 lbs	30	0.8	0.1
(900 lb avg. weight)	45	1.2	0.2
	60	1.6	0.3
	75	2.0	0.3
	90	2.4	0.4
	120	3.2	0.5
	150	4.0	0.7
	180	4.5	0.8
	210	5.2	0.9
	270	6.7	1.1
	365	9.0	1.5
Cow	30	1.0	0.2
	45	1.7	0.3
	60	2.3	0.4
	75	2.8	0.5
	90	3.4	0.6
	120	4.5	0.8
	150	5.7	0.9
	180	6.8	1.2
	210	7.9	1.4
	270	10.2	1.7
	365	13.8	2.4

MANURE NUTRIENT VALUES

The nutrient value of manure varies depending upon the type of feed, the way the manure is handled prior to application, and the conditions and time to incorporation after application. **Typical** feedlot manure contains the following:

TABLE 2 – MANURE NUTRIENT CONTENT

NO_3 – N (lbs/ton)	Ammonia – N (lbs/ton)	Organic N (lbs/ton)	P_2O_5 (lbs/ton)	K_2O (lbs/ton)
1.5	1.5	18	16	40

Again, these are only general values and NRCS strongly recommends having manure tested to quantify nutrient content.

AVAILABLE NUTRIENT VALUES

Only a portion of the nutrients contained in the manure becomes plant available during the first year. About 50% of the organic nitrogen is mineralized and becomes plant available the first year, while 100% of both the nitrate and ammonia is plant available. During the first year, about 90% of the phosphorus and 95% of the potassium becomes plant available. In addition, some of the nitrogen is lost to volatilization when land-applied. In general, the following nutrient values apply.

TABLE 3 - AVAILABLE NUTRIENT CONTENT OF MANURE

Nitrogen (lbs/ton)	Phosphorus (lbs/ton)	Potassium (lbs/ton)
12	14	38

Once the supply side of the equation is completed, determine the demand for the nutrients by various crops.

CROP NUTRIENT REQUIREMENTS

Crop nutrient requirements vary widely depending upon realistic yield goals and inherent and/or residual soil nutrient content. Approximate crop nutrient values are reflected in Table 4 and are based on average soil organic matter values, low soil test values for N, P, and K and a medium textured soil. More accurate crop nutrient requirements would be realized by the use of proper soil test information and by using the Wyoming Guide to Fertilizer Recommendations (Agronomy Tech Note 10).

TABLE 4 – AVERAGE CROP NUTRIENT REQUIREMENTS

Crop	Yield	Nitrogen (lbs/acre)	Phosphorus (lbs/acre)	Potassium (lbs/acre)
Corn	20 ton silage	145	70	142
	25 ton silage	190	85	182
	30 ton silage	235	100	222
Corn	100 bu grain	155	70	162
	125 bu grain	195	85	192
	150 bu grain	235	100	222
Barley	50 bu grain	43	5	82
	75 bu grain	81	23	122
	100 bu grain	120	40	162
Wheat	50 bu grain	51	0	82
	75 bu grain	94	15	132
	100 bu grain	137	50	182

TABLE 4 – AVERAGE CROP NUTRIENT REQUIREMENTS (cont'd)

Crop	Yield	Nitrogen (lbs/acre)	Phosphorus (lbs/acre)	Potassium (lbs/acre)
Alfalfa[1]	1 ton	0	25	40
	2 ton	0	40	80
	3 ton	0	55	120
	4 ton	0	70	160
	5 ton	0	85	200
Alfalfa[2]	1 ton	65	25	40
	2 ton	125	40	80
	3 ton	190	55	120
	4 ton	250	70	160
	5 ton	315	85	200
Grass Hay	1 ton	50	0	35
	2 ton	90	15	70
	3 ton	130	30	105
	4 ton	170	45	140
	5 ton	210	60	175

MANURE APPLICATION RATES

Once the nutrients supplied by the manure, and the nutrients required by the crop are determined, an approximate manure application rate can be calculated. To determine the application rate, divide the pounds per acre of nutrient required by the crop, by the pounds of nutrient per ton of manure.

Example #1:
The 25-ton corn silage crop requires approximately 190 lbs/acre of nitrogen.
The manure supplies approximately 12 lbs of nitrogen per ton of manure.
190 lbs/ac ÷ 12 lbs of N/ton of manure = 16 tons per acre

If there are 1,000 tons of manure to utilize, calculate the approximate number of acres of a particular crop needed for utilization.

1,000 tons ÷ 16 tons per acre = 63 acres of 25 ton corn silage.

Table 5 displays average manure application rates by crop and crop yield.

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[1] Assumes producer has inoculated with proper Rhizobium species, and wishes to maintain proper symbiotic fixation. Therefore, manure will be applied at a phosphorus-based rate, and symbiotic fixation by Rhizobium bacteria will satisfy the alfalfa nitrogen requirement.

[2] Assumes producer is not concerned with maintaining a functioning legume/Rhizobium symbiosis and will apply at a nitrogen-based rate. Therefore, symbiotic fixation by Rhizobium bacteria will not account for any of the alfalfa nitrogen requirement. These rates assume an average alfalfa nitrogen requirement of 50 lbs per ton adjusted upwards 25% to account for volatilization losses due to surface application with no incorporation of applied manure. In these scenarios, planners should pay close attention to subsequent soil nitrate levels after application at nitrogen-based rates.

Example #2:
A producer needs to apply manure to an established alfalfa crop that has an average yield of 4 tons per acre. The 4-ton alfalfa crop requires approximately 250 lbs/ac of nitrogen. The manure supplies approximately 12 lbs of nitrogen per ton of manure.
250 lbs/ac ÷ 12 lbs of N/ton of manure = 21 tons per acre

If there are 1,000 tons of manure to utilize, calculate the approximate number of acres of a particular crop needed for utilization.

1,000 tons ÷ 21 tons per acre = 48 acres of 4 ton alfalfa.

Table 5 displays average manure application rates by crop and crop yield.

TABLE 5 – AVERAGE MANURE APPLICATION RATES BY CROP

Crop	Yield	Nitrogen Based Rate (tons/acre)	Phosphorus Based Rate (tons/acre)	Potassium Based Rate (tons/acre)
(1)	(2)	(3)	(4)	(5)
Corn	20 ton silage	12	5	4
	25 ton silage	16	6	5
	30 ton silage	20	7	6
Corn	100 bu grain	13	5	4
	125 bu grain	16	6	5
	150 bu grain	20	7	6
Barley	50 bu grain	4	.4	2
	75 bu grain	7	2	3
	100 bu grain	10	3	4
Wheat	50 bu grain	4	0	2
	75 bu grain	8	1	3
	100 bu grain	11	4	5
Alfalfa	1 ton	0	2	1
	2 ton	0	3	2
	3 ton	0	4	3
	4 ton	0	5	4
	5 ton	0	6	5
Alfalfa	1 ton	5	2	1
	2 ton	10	3	2
	3 ton	16	4	3
	4 ton	21	5	4
	5 ton	26	6	5
Grass Hay	1 ton	4	0	1
	2 ton	8	1	2
	3 ton	11	2	3
	4 ton	14	3	4
	5 ton	18	4	5

Application at nitrogen-based rates will over-apply both phosphorus and potassium. Therefore, it becomes important to evaluate potential phosphorus losses using a risk assessment tool such as the Phosphorus Index. See Agronomy Technical Note #15.

To determine if a producer has an adequate land base to utilize the total manure produced, divide the total manure produced by the application rate (column 3 or 4, Table 5).

Example:

STEP 1 – Annual Manure Production

The ABC Feedlot feeds 3 groups of 2,000 steers (each group in the feedlot for 4 months prior to shipment) throughout the year (365 days of manure production). They start at 500 pounds and are shipped at 900 pounds. The average weight is 700 pounds. From Table 1, column #4, we know that each animal will produce approximately 1.1 tons of manure at 30% moisture. Multiplying 1.1 tons per animal times 2,000 animals gives us a total manure production of 2,200 tons.

STEP 2 – Average Manure Application Rates

The ABC Feedlot grows 25-ton corn silage on two 180-acre pivots (360 total acres). Because of repeated manure application on these same two fields, the Phosphorus Index indicates a phosphorus-based application rate of 6 tons per acre (Table 5, column 4).

To determine crop acres needed to utilize the 2,200 tons of manure, divide the tons of manure by the application rate.

2,200 tons ÷ 6 tons/acre = 366 acres.

Therefore, in this example, the producer has an adequate land base for proper utilization. However, since application will be phosphorus - based, he/she would need to augment the nitrogen supply with a commercial source.

This Technical Note is ONLY for preliminary planning purposes. It is the policy of the NRCS to base all Nutrient Management Plans on soil test values that are no more than 5 years old. In addition, it is important to quantify actual manure nutrient content via a manure test. Refer to Agronomy Tech Notes 10 and 12 for completing site-specific Nutrient Management Plans.

WORKSHEET FOR CALCULATING ACREAGE BASE

PRODUCER _____ **DATE**_____

FIELD_____ **ASSISTED BY**_____

CROP #1_____ **ACRES AVAILABLE**_____

CROP #2_____ **ACRES AVAILABLE**_____

STEP 1

Number of Animals		Table 1, Column 4 Value		Total Tons Manure to Utilize
	X		=	

STEP 2

	Step 1 Product		Table 5, Column 3 Value		Acres Needed
Nitrogen Based		÷		=	

	Step 1 Product		Table 5, Column 4 Value		Acres Needed
Phosphorous Based		÷		=	