Appendix M

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Compost Sampling Guideline

Dairy Compost Utilization

C.A. Gerngross, M.L. McFarland and W.H. Thompson

The sampling of compost is an essential aspect of process monitoring, quality control, marketing, labeling of product and regulatory compliance. This sampling guide should be used to assess the quality of a finished product. By following these guidelines, the compost facility initiates the first step in participating in the US Composting Council's *Seal of Testing Assurance Program ("STA")*.

Please consult *Test Methods for the Examination of Composting and Compost*, Method 02.01-B online at http://tmecc.org/tmecc/ for original information related to this sampling guideline.

MATERIALS

- Front-end loader
- 15 cup-size compost samples per cut
- Sterilized sampling tool or glove
- Sterilized collection bucket(s) for cut areas
- 2, 5-gal sterilized mixing pails
- 2, 1-gal sample storage containers, (e.g., resealable plastic containers)
- 5% bleach solution
- Aluminum foil
- Newspaper, Butcher or Kraft paper
- Rigid shipping container, (e.g., cardboard box, etc.)
- Frozen ice packs
- Packing tape

WHAT TO SAMPLE

TMECC Method 02.01-B describes composite sampling to assess in-process compost and finished compost product. However, this sample guideline addresses the procedure for sampling a finished product.

A composite sample is a single sample composed of multiple, well-blended subsamples that, after thorough mixing, represents the traits of interest for an entire pile or windrow.

Select a screened pile or a finished windrow waiting to be screened. Avoid sampling from areas that are excessively wet, i.e., greater than about 60% moisture.

WHERE TO SAMPLE

Using a front-end loader, cut into the pile or windrow in at least 5 locations (figure 1). The 5 cuts must be randomly assigned and may be selected from either side of the windrow or pile. Cut into the entire depth of the pile and at least into half of the width of the pile. The cut should expose the middle of the pile from its natural base to its natural peak.

Take all necessary precautions that the walls of each cut are stable to prevent the potential for collapse. Also, make certain the sampling area is well ventilated to avoid exposure to potentially harmful gases.

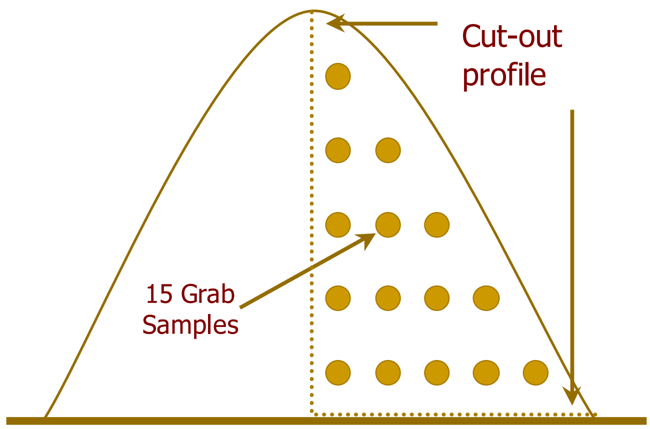

Figure 1. Cross-sectional illustration of one cut-out from an inverted "V" compost window. Circles represent 15 uniformly dispersed grab samples. Avoid collection of samples from pile or windrow surfaces.

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HOW TO SAMPLE

Collect 15 uniformly dispersed 1-cup samples from within one side of each of the 5 cut areas as illustrated in figure 1. Combine and thoroughly mix the 15 grab samples in the sterilized collection bucket. Repeat this process for each cut area.

In the 2 sterilized 5-gal mixing pails, combine all samples from the 5 cuts and thoroughly mix to make one composite sample. If balls form when mixing, the compost is too wet and should be partially air-dried prior to further mixing. Sample integrity is diminished and nitrogen loss should be anticipated when a sample is air-dried prior to shipping.

Quarter the composite sample by repeatedly dividing it in half until you have a 2-gal sample. Gently transfer the 2-gal sample into the 2 1-gal plastic resealable storage containers. Do not compact the compost samples.

7 Steps to Compost Sampling

1. **Select 5 areas of sample pile and cut into pile**
2. **Take 15 uniformly dispersed 1-cup samples from each of 5 cut areas**
3. **Thoroughly mix 15 grab samples from each cut together**
4. **Blend all samples to form 1 composite sample**
5. **Quarter the composite sample to 2-gal for testing**
6. **Cool 2-gal sample to 39°F**
7. **Package samples and ship by 1-day delivery to selected STA-approved laboratory for analysis.**

SANITATION PROCEDURES

Use a sterilized sampling tool and collection bucket made of stainless steel, plastic, glass or Teflon® to avoid sample contamination. Sterilize all sampling equipment before sampling and between different windrows or piles. To sterilize, wash sampling tools with soap and water, rinse with 5% bleach solution and then triple rinse with fresh water.

Wear appropriate protective clothing and use care when handling bleach or any other chemicals.

SAMPLE PRESERVATION

After packaging samples in 1-gal containers, chill them to about 4°C (39°F). Separately wrap each chilled sample container together with an ice pack, using multiple layers of newspaper, butcher or kraft paper. Line the inside of a rigid shipping container and its lid with aluminum foil. The paper and foil will help to insulate the shipping container. Place wrapped samples in the shipping container, filling voids between the sample containers and shipping container walls and lid with crumpled newspaper, butcher or kraft paper. Seal the lid on the shipping container with packing tape. Send the shipping container by 1-day delivery to your selected laboratory for analysis.

Laboratories that follow TMECC protocols must be approved through the STA program. A list of participating laboratories is available online at http://tmecc.org/sta/

WHEN TO SAMPLE

This is an end-process sampling so only material that is ready for market should be tested. According to STA program requirements, sampling frequency should be based on a facility's production capacity.

- 1 to 6,250 tons – sample once per quarter
- 6,250 tons to 17,500 tons – sample once per 2 months
- 17,500 tons and above – sample once per month

For more information concerning the Marketing Dairy Compost project or the STA program, please contact Cecilia Gerngross by email (cecilia@tamu.edu) or phone (979.458.1138).

Economics of Using Composted Dairy Manure

Dairy Compost Utilization

A variety of soil amendment products and potential nutrient sources provide flexibility for agricultural and horticultural systems. However, comparing the cost and value of these different soil amendments is not as simple as it might seem. Dairy manure compost, for example, supplies not only the major nutrients (nitrogen, phosphorus and potassium) but also a broad range of secondary nutrients, micronutrients and organic matter. These plant nutrients have an economic value, which can be utilized to estimate compost value for comparisons with traditional fertilizer materials. Organic matter applications, such as dairy manure, can also improve soil's water and nutrient holding capacity, reduce erosion and reduce fluctuations in soil pH.

Nutrients in compost products are more stable and typically released gradually over three or more years; whereas inorganic fertilizers are generally formulated to release nutrients within a year of application. Thus, a realistic assessment of compost value requires at least a three-year time frame. Also, since compost nutrient ratios and release rate may not be optimal for crop needs, some supplemental inorganic fertilizer (particularly nitrogen) may be necessary.

The following information provides steps to determine the economic feasibility of utilizing dairy compost as an alternative or a supplement to inorganic fertilizers.

STEP 1: UNDERSTAND NUTRIENT REQUIREMENTS AND AVAILABILITY

Soil nutrition specialists price nutrients on a per pound of nutrient basis; thus, dairy compost can be valued based on nutrient content. Before using dairy compost or any soil amendment, obtain a nutrient analysis of the material from the supplier or a local testing laboratory. Knowing the nutrient content will be valuable in determining application rates. A local County Extension Agent will be able to provide information on obtaining such analysis. Compost releases its nutrients slowly (over several years) as the material decomposes, while inorganic fertilizers typically release everything in one year. Table 1 presents nutrient availability from dairy manure compost over a three year period.

Table 2 presents basic costs associated with purchasing, transporting and applying dairy manure compost. Combine this information with table 1 to determine the initial value and cost of utilizing dairy manure compost.

Table 1. Estimated nutrient availability from 1 ton of dairy manure compost

Nutrient	Year 1	Year 2	Year 3
		lb	
N	9.38	4.69	2.34
P_2O_5	12.20	6.10	3.05
K_2O	15.90	7.95	3.98

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Table 2. Estimated costs related to the purchase, transportation and application of compost

Service	Price
Compost FOB	$10 per ton
Application	$2 per ton
Transportation	$2.50 per loaded mile

STEP 2: DETERMINE SPECIFIC NUTRIENT REQUIREMENTS

In addition to determining the nutrient content of the dairy manure compost, it is equally important to obtain a soil sample analysis of the intended application site. With the soil sample results, a local County Extension Agent can provide nutrient recommendations for a given crop or advise which nutrients are critical for a specific growing season.

With this information, you can estimate the costs associated with meeting specific nutrient requirements. Table 3 presents a cost analysis of utilizing inorganic fertilizer to meet specific requirements and since compost mineralizes over several (three) years, the cost analysis in Table 3 is evaluated over a three-year period.

STEP 3: DETERMINE APPLICATION RATE

Information about your soil and the compost discussed in Steps 1 and 2 provide a means to determine the application rate for composted dairy manure that would best meet nutrient needs of your desired crops. The selected rate typically satisfies the smallest of the NPK requirements (usually P) for an entire three-year cropping period. The analysis will also reveal whether there is anything about the compost that would require a lower rate of application, such as pH or salt content.

Once the compost application rate is determined, an inorganic fertilizer application may be recommended (primarily N) to maintain the best nutrient balance for your crops over the three year period.

Table 3: Example nutrient recommendations following soil analysis and cost of using an inorganic fertilizer to meet nutrient requirements

	Soil Test Recommendations	Nutrient Cost	Year 1 Cost	Year 2 Cost	Year 3 Cost	Total Cost[1]
	lb/A	$/lb	$/A			
N	300	$.29	$87	$87	$87	$261
P_2O_5	100	$.23	$23	$23	$23	$69
K_2O	300	$.15	$45	$45	$45	$135
Spreading			$3	$3	$3	$3
Hauling			0	0	0	0
Total			$158	$158	$158	$474

[1] Excludes the per Acre Cost of an optional Nutrient Management Plan

STEP 4: CALCULATE COST BENEFIT OF COMPOST AS A NUTRIENT SOURCE

Once nutrient recommendations and application rates are determined, a cost comparison can be developed. In this example, the per-acre cost of fertilizing coastal Bermudagrass at an agronomic rate with inorganic fertilizer alone to the cost of doing so with composted dairy manure supplemented by inorganic fertilizer is presented.

Table 4 provides a preliminary TAMU cost analysis for application of typical composted manure with the nutrient release rates shown in Table 1, along with the added cost of supplemental inorganic nitrogen applications in each of the three years. Because the transportation cost of compost is a significant part of its total cost, Table 4 provides three separate cost estimates representing the hauling cost at a distance of 10, 20, and 30 miles.

Table 4. Estimated costs at 3 distances (10, 20 and 30 miles) of using dairy compost with supplemental inorganic fertilizer as a nutrient source for coastal Bermudagrass production

Year	Application Rate	Hauling Distance	Hauling Cost	Compost[1]	Supplemental Inorganic Fertilizer	Total[2]
	ton/A	miles	$/A			
1	16	10	$15.50	$192	$43.50	$251.00
1	16	20	$31.00	$192	$43.50	$266.50
1	16	30	$46.50	$192	$43.50	$282.00
2	0				$65.00	$65.00
3	0				$87.00	$87.00

[1] Includes both cost of material and cost of application
[2] Excludes the per Acre Cost of an optional Nutrient Management Plan

Table 5 provides the net benefit or net saving of using compost as a primary nutrient source (at three different hauling distances) over a three year period. The net savings was calculated by subtracting the cost of utilizing compost supplement with inorganic fertilizer (Table 4) from the higher cost of utilizing inorganic fertilizer alone (Table 3). In this example, a combined program of compost and supplemental inorganic nitrogen fertilizer saves the producer approximately $40 to $71 per acre.

Note the cost of transportation is an important consideration. In this example, the cost of using the compost with supplements is equal to the cost of using inorganic fertilizer alone when the compost is transported 56 miles.

Table 5. Estimated cost comparison of a compost & supplemental inorganic fertilizer program to an inorganic fertilizer alone program. Savings are presented on a per acre basis and are calculated over a three year period

Distance	Compost Cost[1]	Supplemental Fertilizer Cost	TOTAL[2] Compost & Supplemental Fertilizer	TOTAL[2] Inorganic Fertilizer Only	Savings from Compost
miles			$/A		
10	$208	$196	$403	$474	**$71**
20	$223	$196	$419	$474	**$56**
30	$239	$196	$434	$474	**$40**

[1] Includes cost of transportation and application of compost
[2] Excludes the per Acre Cost of a Nutrient Management Plan

STEP 5: ESTIMATE THE ADDITIONAL VALUE OF COMPOST

The cost benefit estimated in Table 5 considers only the nutrient value of composted dairy manure. Dairy compost can provide economic benefits in addition to nitrogen, phosphorus and potassium. For example, compost applications can supply the soil and plants with secondary macronutrients and micronutrients. Also, water holding capacity of soil may be improved following the addition of organic materials, such as dairy compost, resulting in a decrease in irrigation costs. When mixed with a coarse mulch material, such as woodchips, dairy compost may also provide erosion control and support vegetation establishment, which may further reduce erosion. Finally, when utilized to establish landscapes, dairy compost may improve long-term performance of ornamental and turf plants.

If any of these additional benefits potentially provide a significant savings for your intended use, you may wish to experiment with composted dairy manure and determine the cost benefit for your particular application. A County Extension Agent can help with selecting a compost application rate to serve some of these purposes in addition to supplying nutrients.

For additional information on the use of compost, visit http://compost.tamu.edu.

Using Compost for Erosion Control and Revegetation

S. Mukhtar

WHAT IS COMPOST?

Composting refers to the biological decomposition and stabilization of organic materials by microorganisms under aerobic (in the presence of oxygen) conditions. During the composting process, biologically produced heat under proper moisture and aeration conditions, accelerates decomposition of raw material followed by stabilization and well managed curing of the product. As a result, good quality compost is produced that is biologically stable, relatively uniform in appearance, free of most pathogens and weed seeds, and has benefits as a soil amendment material with essential nutrients for plant growth. Thus, compost from various feed stocks including yard, manure, food processing residuals and other organic materials has been used to improve soil quality and productivity as well as prevent and control soil erosion.

COMPOST FOR EROSION CONTROL

Soil erosion from construction sites can be as much as 10 to 20 times greater than that from agricultural lands. Research reports from academia, the EPA, state departments of transportation (DOTs) and other sources suggest that compost can be effective in controlling erosion from construction sites including road rights-of-way, general construction and land development.

Figure 1 illustrates the use of compost as immediate, temporary erosion and sediment control in filter berms and compost blankets on top of existing soil on a steep slope. The berms or filter socks manage storm water run-on and retain sediment from above the slope, as well as retain runoff and sediment from the slope itself. The compost blanket controls slope erosion by reducing water flow velocity and the volume of sediment coming off of the slope.

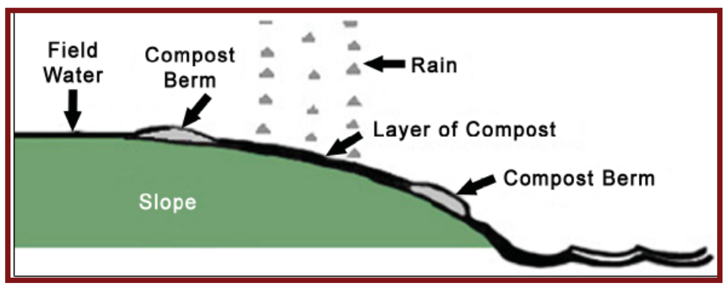

Figure 1. Compost filter berms and blankets (layer of compost covering the soil) for sediment and erosion control on steep slopes.

Compost can also be incorporated as a soil amendment or topsoil blend to improve soil structure. Both practices help establish a protective vegetation cover, which provides long-term erosion and sediment control. Due to compost's nutrient value and abundant organic matter, vegetation established in compost amended soils grows healthier, faster. It is better able to endure extreme climatic conditions compared to vegetation planted in soil that receives commercial fertilizer as a sole nutrient source.

The same characteristics that benefit vegetation may also create water quality problems. Therefore, it is important to

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analyze the nutrient (N, P, K and other micronutrients), pH and soluble salt content of the compost before selecting and establishing its application rate for sediment or erosion control. Biosolid composts also require analysis for heavy metals. Lower nutrient composts should be considered for use on nutrient impacted areas. For example, a two-inch layer of compost weighing 1,500 pounds per cubic yard, applied over one acre will equal an application rate of nearly 200 tons per acre. If the compost contains average to high nutrient concentrations, this rate of application may be higher than the nutrient requirements of vegetation used for soil stabilization. This could lead to negative water quality impacts. The blending of compost with wood chips as an erosion-control blanket material may reduce the amount of nutrients applied per acre and their rate of release.

STORM WATER MANAGEMENT APPLICATIONS

New federal storm water permit requirements for general construction activities and for municipalities have placed much greater responsibility on local governments and construction contractors to put effective erosion and sediment controls in place. At the same time, research has been demonstrating the effectiveness of several practices using compost to stabilize soil, reduce suspended solids and sediment in runoff, reduce chemical loads and delay the onset and volume of runoff. Guidelines and specifications for the use of compost in erosion and sediment control applications can be found in the TCEQ reference document BMP Finder, http://www.tnrcc.state.tx.us/water/quality/nps/nps_stakeholders.html#bmp%20finderD.

DEPARTMENT OF TRANSPORTATION APPLICATIONS

The use of compost in erosion and sediment control has been extensively applied and studied in the stabilization of highway rights-of-way after construction or maintenance. In 1997, a survey of trends in using compost for road side applications revealed that nearly 70 percent of the nation's DOTs were either experimenting with or routinely using compost. Some of the uses listed by these DOTs were:

- Mulch or top dressing
- Erosion control blankets for steep slopes
- Filter berms to control sediment movement (similar to silt fences)
- Hydroseeding (seed, water and compost mixed and sprayed on ground to establish vegetation)
- Wetlands mitigation
- Bioremediation (composted organic matter can break down pollutants into simpler, safer forms)
- Filter socks (mesh sock containing compost or mulch material)

Figure 2: Grass seed and compost being applied as a compost blanket for erosion control and revegetation of a road right-of-way.

In Texas, the DOT has used composted dairy manure, feedlot manure, chicken litter, cotton gin burs, yard trimmings, and municipal biosolids as compost blankets for hydroseeding road rights-of-way to control soil erosion from steep slopes (Figure 2), and as filter berms to control erosion and sedimentation from low volume runoff (Figure 3). Recent projects utilize filter socks rather than berms as socks have a greater ability to withstand concentrated flows and retain sediment (Figure 4). In other applications, a West Texas municipal landfill uses compost produced from a mixture of poultry manure, sawdust and other wood residuals to control erosion, as a soil amendment and to create a vegetated cover over closed landfill cells.

Figure 3: Grass seed and compost being applied as a filter berm in a city park waterway to control runoff and sedimentation.

The Texas DOT (TxDOT) accepts high-quality compost such as dairy manure compost for use in compost manufactured topsoil (CMT), in erosion control compost (ECC) and as general use compost (GUC) (TxDOT Special Specification 1058, Compost). Compost is also used by TxDOT in the form of filter berms for erosion and sedimentation control (TxDOT Special Specification 1059, Compost/Mulch Filter Berm). A one-time use Special Specification is available from TxDOT regarding the use of filter socks. TxDOT requires all compost to be sampled and tested according to the Test Methods for Examination of Composting and Compost (TMECC) and must be Seal of Testing Assurance (STA) Program certified.

For TxDOT contracts, the CMT should consist of 75 percent topsoil blended with 25 percent compost on a volume basis. For ECC, 50 percent untreated woodchips are blended with 50 percent compost by volume. When used as GUC, 100 percent of the material should be compost. The compost filter berm will be a combination of 50/50 compost and wood chips. Table 1 provides general physical requirements for compost to be used for TxDOT contract work. For a detailed description of all the requirements, see TxDot Specifications 1058 and 1059 at http://www.dot.state.tx.us/des/landscape/compost/specifications.htm.

Figure 4. Compost and wood chip mixture applied in a mesh casing as a filter sock to control runoff and sedimentation.

Table 1. Physical and chemical requirements of compost utilized in TxDOT Special Specification 161.

Property	Requirements
Particle Size	95% passing $^5/_8$" sieve, 70% passing $^3/_8$" sieve with TMECC Method 02.02-B
Heavy Metals	Following Pass in accordance with TMECC Method 04.06 Arsenic (As), Cadmium (Cd), Copper (Cu), Lead (Pb), Mercury (Hg), Molybdenum (Mo), Nickel (Ni), Selenium (Se) and Zinc (Zn)
Soluble Salts	$\leq$ 5.0 dS/m ($\leq$ 10.0 dS/m accepted for CMT) with TMECC Method 04.10-A
pH	5.5-8.5 with TMECC Method 04.11-A
Maturity	80% with TMECC Method 05.05-A
Organic Matter Content	25-65% (dry mass basis) with TMECC Method 05.07-A
Stability	$\leq$ 8 with TMECC Method 05.08-B
Fecal Coliform	Pass in accordance with TMECC method 07.01-B

TxDOT Specification 1059 defines placement and use of compost as a filter berm. Such compost must still meet guidelines outlined in TxDOT Specification 161. See TxDOT Specification 1059 for additional requirements.

Using Organic Matter to Improve Sports Fields

J. A. McAfee and C. A. Wagner

CREATING A SUCCESSFUL SPORTS FIELD

One of the keys to establishing a successful sports field is the selection of a good quality soil for the root zone. Unfortunately, the majority of high school and city park sports fields are currently constructed on native type soils, which may contain clay or sand to a degree that affects the ability to grow and sustain quality turfgrass.

Clay soils can compact, which impedes drainage and infiltration of water and causes a reduction in nutrient uptake and root growth. Additionally, compacted soils increase potential for player injury and increase the amount of nutrients, pesticides and water required to properly maintain a quality turfgrass stand. While a good aeration program will help alleviate soil compaction problems, the addition of organic matter in conjunction with aeration is the best method to correct such problems associated with heavy clay soils.

While soils high in clay content are a major problem for growing good turfgrass, soils high in sand content also can be a problem. Although sandy soils are less likely to compact and have better water infiltration and percolation rates, these soils still require an organic matter source to maintain an optimum playing field. Organic matter deficient sandy soils have little nutrient and water holding capacity. Increasing this capacity through the addition of organic matter will reduce the amount of fertilizer and water required to maintain healthy turfgrass on the field.

Breckenridge High School employees apply inorganic nitrogen fertilizer to the football practice field after composted dairy manure was applied. Supplemental nitrogen is often required because the nutrient ratio in compost is rarely an exact fit for turfgrass needs.

SOURCES OF ORGANIC MATTER

There are many organic matter sources for use on sports fields such as peat, rice hulls, sawdust, composted manures and yard trimmings. Table 1 provides an outline of recommended characteristics to consider when selecting an organic matter source.

COMPOST AS AN ORGANIC MATTER SOURCE

Composting is the biological decomposition of organic materials such as manure to a relatively stable endpoint. Fresh livestock manure is a mixture of urine and feces, varying in chemical and biological composition which is determined by the species of animal and their diet. Because bedding material is consequently harvested with raw manure during traditional collection practices, resulting compost contains additional components such as straw or sand. Biological activity, ventilation and heat generated during the composting process remove much of the moisture in raw manure, reduce odors, and kill most weed seeds and most disease microbes and parasites. In addition, composting reduces the total volume of manure by as much as 50 percent.

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Table 1. Recommended characteristics of an organic matter source, specifically compost

Parameter	Optimum Range	Considerations
Moisture Content	30-50%	Material clumps when excessively wet and is dusty when excessively dry making application difficult.
Color	Dark brown to black	Feedstock sources such as rice hulls, sawdust, yard waste or manures should be fully composted.
Odor	No foul odor	Material should have an earthy smell.
Organic Matter	≥ 25%	Source should have no more than 75% ash content.
C:N Ratio	≤ 25:1	If C:N is too high, plants show nitrogen deficiency.
pH	6-8	A neutral to acidic pH is preferred as some common turfgrass diseases are associated with an alkaline pH
Heavy Metals	low	
Salinity Level	low	Lab should test for both salt level and salt type.
Particle Size	⅜ - ½ to incorporate ⅛ - ¼ to top dress	Contaminants such as rock or other debris can damage mowing equipment in topdress material.
Nutrient Content	low to medium	Nutrient content varies. Establish application rate from soil nutrient requirements, specifically nitrogen and phosphorus, and the corresponding nutrient content of the organic matter source.

Composted manure can be a significant source of essential plant nutrients including nitrogen, phosphorus, potassium, calcium, magnesium and sulfur, as well as, micronutrients such as zinc, iron, copper and manganese. However, the nutrient concentrations can vary widely from one manure compost to another. To determine appropriate compost application rates, it is important to obtain laboratory nutrient analysis of the sports field and selected compost product. Visit: http://soiltesting.tamu.edu for more information about laboratory analysis. Table 2 shows the average and range in nutrient concentrations in composts made from different materials. The ratio of nutrient concentrations in a compost product is rarely an exact fit for crop needs. In particular, an application of compost that meets nitrogen requirements will often provide excess phosphorus. As a result, compost application rate should typically be determined based on crop phosphorus requirements and a phosphorus free inorganic fertilizer should be utilized to complete crop nitrogen and/or potassium requirements.

Nutrient levels in compost are generally organic. Therefore, it is important to account for their slow release rate. Preliminary research using dairy manure compost in the production of warm-season grasses has indicated that nitrogen release rates are in the range of 30-35% of total N in the first year with decreasing rates the following years. As a result, fast growing, high nutrient demand crops typically require some amount of supplemental inorganic fertilizer to achieve desired growth.

Table 2. Average and range ( ) in nutrient values for various composts (McFarland, 2003; Risse, 2003; Brodie et al, 1996)

Compost Type	Dry Matter	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)
	%	lbs/ton		
Dairy Manure	**70 (58-80)**	**16 (11-23)**	**18 (6-31)**	**21 (8-48)**
Beef Manure	65 (54-72)	10	22	28
Poultry Litter	30 (22-36)	18 (11-25)	31 (11-52)	17 (10-21)
Municipal Solid Waste	40	24	15	6
Yard Waste	38	26 (6-84)	9 (2-23)	9 (1-65)

In addition to serving as a nutrient source, compost supplies stabilized organic matter, which is an important component of soils. Organic matter serves a special role in soils acting in the formation of very small soil clods, called aggregates, which improve soil structure and tilth, and increase water infiltration and water holding capacity. Organic matter also functions similar to clay in soils by increasing the cation exchange capacity, or the nutrient holding potential of a soil.

APPLICATION OF ORGANIC MATTER

Two primary methods of adding organic matter to sports fields are soil incorporation and topdressing. Incorporation is the most effective method to improve poor quality soils as it provides direct improvement in soil structure, porosity and infiltration rates. Ideally, blend organic matter with soil off site to insure uniform mixing. On-site mixing can create "hot spots", which are detrimental to plant growth. For best results, thoroughly incorporate 1 to 3 inches organic matter into 6 to 8 inches of soil prior to turfgrass establishment. Always consult a soil test and product analysis to determine exact rates as nutrient content will vary depending on product selection. Add enough product to increase organic matter content to a 2 to 5% range for heavy clay soils and a 10 to 20% range for sandy soils, depending on the type of sand used in construction.

A scarab mixes the dairy manure during the composting process to aerate the windrow which ensures proper composting.

Once turfgrass is established, adding significant amounts of organic matter to the soil becomes difficult and will require multiple years of application. Topdressing with organic matter or a mixture of sand plus organic matter followed by aeration and dragging will help move organic matter into the soil over time. Ideally, apply a ⅛- to ¼-inch layer of an organic matter source during each topdress application. Because cool season grasses are maintained at a higher cut, an application of up to ½-inch may be appropriate.

Applications of organic matter can be made 1 to 3 times per year depending on the composition and quality of the product. Due to nutrient composition of dairy manure compost, it typically provides more phosphorus than the turfgrass requires. Thus, soil tests must be conducted prior to multiple compost applications in subsequent years.

A Texas Cooperative Extension employee spreads compost on the Santo High School football field to help improve the field's playing surface.

Santo High School Football Field Improved with Dairy Compost

The Fighting Wildcats of Santo High School, Santo, TX, implemented a sports field management plan in 2004 with the help of Texas Cooperative Extension to improve its football field. The plan included mechanical aeration of the football field, a top-dress application of dairy manure compost and inorganic nitrogen fertilizer, timely applications of irrigation and efficient weed control practices.

District employees uniformly applied dairy manure compost to the field's surface at a rate of 80 tons per acre. As the season progressed, the field received two additional applications of 20 pounds per acre of inorganic nitrogen fertilizer.

The treatments and timely maintenance combined to give the field better grass density, health, color, and overall appearance. Ray Hollis, Santos ISD maintenance supervisor noted that the football players liked the added cushion of the healthy turf stand, which helped when falling during play.

For more information on the Santo ISD Football field dairy manure compost demonstration, visit http://compost.tamu.edu/demos_palopinto.php.

Using Dairy Manure Compost in the Urban Environment

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Dairy Compost Utilization

WHAT IS COMPOST?

Compost is an organically rich soil amendment produced by the decomposition of waste materials from landscapes, animal feeding operations, municipal wastewater treatment facilities, and food industries. A properly composted product is dark colored and does not resemble the original parent materials. It is generally composed of 50 to 80 percent hemi-cellulose and lignin, which are stable and slow to decompose plant components. The remaining 20 to 50 percent are water-soluble compounds that soil microorganisms quickly break down. Fully decomposed materials do not tie-up plant nutrients when mixed with soil or produce any undesirable odors. Compost provides a slow release source of nutrients and hence, in the past was called "black gold" by farmers.

BENEFITS

- **Environmentally sound method of recycling plant and animal wastes.**
  Composting urban yard waste diverts plant materials from municipal landfills, which may reduce homeowners' utility fees. Composting animal wastes for urban uses removes manure from agricultural watersheds, which may improve water quality in impacted rivers and lakes.
- **Compost improves soil physical properties.**
  Organic matter is an essential component of soil. As compost decomposes in the soil, it releases organic molecules that bind soil particles together increasing soil aggregation. As a result, water and air infiltrate clay-textured soils more easily and sand-textured soils retain more plant available water. Accordingly, these effects improve the root zone environment.
- **Compost can serve as a slow release source of plant nutrients.**
  Plant or animal tissues used to produce compost inherently contain plant essential macro- and micro-nutrients. The composting process retains these nutrients, which are slowly released to plants during their life cycle as the compost decomposes in the soil.
- **Compost increases the nutrient retention capacity of the soil.**
  Compost increases soil organic matter. Soil organic matter provides many cation exchange sites where plant nutrients are protected from being washed from the soil by rainfall or irrigation. The nutrients are held in the soil until they are utilized by the plant. Hence, compost increases the amount of plant nutrients retained in the soil root zone.

Soil physical properties like water infiltration and water retention capacity are improved as compost decomposes in the soil and releases organic matter. In turn, the root zone environment improves.

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- **Compost suppresses plant diseases.**
  Compost can control or suppress certain soil-borne plant pathogens such as Fusarium, Pythopthora, Pythium, and Rhizoctonia. The use of compost for disease control is theoretically sound, but its mode of action is poorly understood. Control of plant diseases by compost can be explained by five potential modes of action: (1) competition by beneficial microorganisms for space and nutrients; (2) antibiosis where beneficial microorganisms produce antibiotics that kill possible pathogens; (3) predation where beneficial organisms prey and feed on possible pathogens; (4) plant defense activation by elicitors in the composts; and (5) production of byproducts in the compost that are detrimental to possible pathogens.

TIPS ON URBAN COMPOST USAGE

Compost quality depends on the feedstock used to produce it. Table 1 provides an outline of recommended characteristics to consider when selecting an organic matter source.

Product stability, defined by the ratio of carbon to nitrogen (C:N), is particularly important because compost products can vary widely in their degree of decomposition. A properly stabilized (C:N < 25:1) material prevents nutrient immobilization in the soil. If unstable compost (C:N ratio greater than 25:1) is added to the soil, soil microorganisms will temporarily tie up plant available nutrients in the soil, especially nitrogen, as they break down the unstable organic matter. In the short term, this nitrogen deficiency can cause severe yellowing of plants.

A rotating basket type spreader is an effective unit for topdress applications of compost or any sand based mix. Its small size and ease of handling makes it effective for applications in small areas.

While several organic matter sources exist, not all provide plant essential nutrients. Typically, composted animal manures have higher nutrient levels than other composted materials. However, understanding the nutrient and salinity content of your product is critical in achieving the maximum benefit from the material. Excessive nutrients, especially phosphorus, can tie up micronutrients in the soil, causing plant deficiencies. Such deficiencies can occur with repeated heavy applications of high phosphorus composts. Certain poultry litter composts may contain excessive salinity, which can be detrimental to seed germination, stunt plant growth and cause premature death.

Most soils can benefit from the addition of compost, but clay and sandy soils benefit more than loamy soils. Regardless of the soil type, it is important to begin with a laboratory analysis of the soil in order to determine pH, salinity, fertility levels, organic matter content and soil texture. The Texas Cooperative Extension's Soil, Water & Forage Testing Laboratory accessible at http://soiltesting.tamu.edu can provide a soil analysis that identifies existing nutrient levels in the soil, recommends additional fertility requirements and identifies potential salinity problems.

APPLICATION OF COMPOST

Compost is most easily used as a topdress for lawns and professional turf or as a mulch for bedded areas. Applying compost to the surface of the soil will reduce the risk of nitrogen immobilization by soil microbes due to unstable organic matter (C:N > 25:1). The compost will continue to decompose slowly on the soil surface. Rain and irrigation water will wash nutrients and organic compounds into the root zone. During the next growing season, this organic matter can be safely mixed into the soil prior to planting.

If the compost is stable and of good quality (as indicated in Table 1), then incorporating the material is the most effective method of adding organic matter to the soil profile. Prior to application, kill any existing perennial weeds or undesirable plants, with an appropriate herbicide. After two weeks or effective weed kill has been established, cultivate soil with a roto-tiller to remove annual weeds and rocks and breakup compacted areas. Apply a 1 to 4 inch layer of compost to the cultivated soil and incorporate to a depth of 8 to 12 inches. Determine nutrient content of soil and compost and apply synthetic fertilizers if required to meet additional nutrient requirements of selected vegetation. Also, apply lime or other soil amendments at this time if necessary. Rake and level soil surface to establish a smooth, firm planting bed and finally, plant seeds or transplants directly into prepared soil.

Table 1. Recommended characteristics of an organic matter source, specifically compost

Parameter	Optimum Range	Considerations
Moisture Content	40-50%	Material clumps when excessively wet and is dusty when excessively dry making application difficult.
Color	Dark brown to black	Feedstock sources such as rice hulls, sawdust, yard waste or manures should be fully composted.
Odor	No foul odor	Material should have an earthy smell.
Organic Matter	≥ 25%	Source should have no more than 75% ash content.
C:N Ratio	≤ 25:1	If C:N is too high, plants show nitrogen deficiency.
pH	6 - 8.5	
Heavy Metals	low	
Salinity Level	low	Lab should test for both salt level and salt type.
Particle Size	⅜ - ½ to incorporate ⅛ - ¼ to top dress	Contaminants such as rock or other debris can damage mowing equipment in topdress material.
Nutrient Content	low to medium	Nutrient content varies. Establish application rate from soil nutrient requirements, specifically nitrogen and phosphorus, and the corresponding nutrient content of the organic matter source.

Using Compost to Establish New Landscapes

J.J. Sloan, K. Ong, C. McKenney, W.A. Mackay

Establishment of a healthy landscape involves more than selecting plants that will thrive in the intended location and climate. Dedicating substantial effort towards soil and landscape preparation will ensure that turf and other ornamental plants are better prepared for long-term healthy growth.

Typically in a newly constructed home or business landscape, the surrounding soil is severely disturbed and often, the subsoil and construction debris are mixed with or completely replace the original top soil. Ornamental plants and turf grasses planted in these disturbed soils may perform well in the short term due to abundant watering and fertilization, but they frequently decline with time when heat and drought stress become prevalent. Turf grass, perhaps is the single most important plant established in a new urban landscape due to the large area it occupies and its ability to protect the soil surface from erosion. Installation of sod following construction of a new home or business is an effective way to quickly protect soil that was severely disturbed and degraded by the construction process.

The aesthetic value and environmental protection of vegetation, however, is only as good as the landscape in which it is planted. Thus, the best time to amend and/or improve your landscape is before establishing any ornamental plants or turf grass. By incorporating organic amendments prior to vegetation establishment, soil properties such as organic matter, water holding capacity, fertility and buffering capacity can be enhanced. Dairy manure compost is one type of organic amendment that can be utilized to improve the soil.

Following construction of a new home or business, many times little effort is put towards landscape preparation, particularly the soil. Mixing dairy manure compost in the landscape prior to establishing vegetation, will enhance soil properties and prepare turf and ornamental plants for healthy growth.

WHAT IS COMPOST?

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Nutrient Content	low to medium	Nutrient content varies. Establish application rate from soil nutrient requirements, specifically nitrogen and phosphorus, and the corresponding nutrient content of the organic matter source.

APPLICATION OF COMPOST

Application rates of compost will vary depending on nutrient content of the compost and the soil. The nutrient concentrations can vary widely from one manure compost to another as noted in Table 2. Thus, it is important to begin with a laboratory analysis of the soil in order to determine pH, salinity, fertility levels, organic matter content and soil texture.

Once an application rate is determined, it is best to incorporate the compost 4 to 6 inches into the soil for best results. Because most vegetation established in landscapes will be permanent, (ie. turf grass), this will be the only opportunity to amend your landscapes surface and subsoil.

BENEFITS OF ESTABLISHING LANDSCAPES WITH DAIRY MANURE COMPOST

Scientists at the Texas A&M Agricultural Research and Extension Center in Dallas evaluated soil characteristics and plant performance following three dairy manure compost application rates (2, 4 and 6 lbs per ft^2) to construct new landscapes. Assuming an average density of 1,100 lbs per cubic yard, these rates are equivalent to applying compost at ½, 1 and 1-½ inches, respectively, to the surface of the soil. The compost was then incorporated or mixed into the soil at a 3 inch depth. Given the nutrient content of the dairy manure compost, all three applications supplied large amounts of N, P, and K to the soil.

Table 2. Average and range ( ) in nutrient values for various composts (McFarland, 2003; Risse, 2003; Brodie et al., 1996)

Compost Type	Dry Matter	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)
	%	lbs/ton		
Dairy Manure	**70 (58-80)**	**16 (11-23)**	**18 (6-31)**	**21 (8-48)**
Beef Manure	65 (54-72)	10	22	28
Poultry Litter	30 (22-36)	18 (11-25)	31 (11-52)	17 (10-21)
Municipal Solid Waste	40	24	15	6
Yard Trimmings	38	26 (6-84)	9 (2-23)	9 (1-65)

Water infiltration and moisture content. Water infiltration in the silty clay soil at Dallas was significantly increased by application of dairy manure compost 18 months after application. Consequently, rainfall and irrigation water infiltrated the compost-amended plots more quickly reducing the possibility of loss due to runoff or evaporation. This suggests that soil moisture levels following rainfall or irrigation would be elevated in the compost-amended plots, especially in the subsoil where water was able to infiltrate more easily.

Soil Compaction. Soil resistance measurements in the upper 8 inches were significantly reduced with the addition of dairy manure compost—especially with the highest rate of 6 lb per ft^2. Reduced penetration resistance in soil can increase root length by making it easier for roots to expand into the soil. Soil resistance is influenced by soil moisture, especially in clay soils like those in these study plots. It is likely that increased subsoil water content in the compost-amended plots reduced soil resistance measurements.

Soil Fertility. One of the greatest advantages of dairy manure compost is that it is a safe source of nearly all the essential plant nutrients, including some (Fe, Zn, Cu) that are frequently limiting in calcareous soils typical of the Blacklands Resource area. Continued availability of essential plant nutrients in compost-amended soils is one of the reasons it makes sense to use a large application of compost when initially establishing urban landscapes. As the compost organic matter continues to mineralize over subsequent growing seasons, there will continue to be an elevated concentration of plant available nutrients in the compost-amended soils, which reduces the need for subsequent fertilization.

Plots at the Texas A&M Agricultural Research and Extension Center in Dallas compared various rates of dairy manure compost to establish landscapes of turfgrass and perennial and annual ornamental plants.

Soil Phosphorus. Consequently, the continued source of plant nutrients provided by compost can also potentially pollute water quality. Phosphorus is the primary nutrient of concern because excessive soil P can reduce surface water quality when soluble and particulate forms of P reach surface water bodies. Dairy manure compost applications significantly increased soluble P in the soil in the Dallas Study. The plant available P in the upper 3 inches of compost-amended plots exceeded the critical P level (45 mg per kg) for soils, demonstrating that even modest applications of dairy manure compost can supply adequate P. Large dairy manure compost applications (more than 6 lb per ft^2) may actually add excessive P to the soil. Consequently, large repeated applications of dairy manure compost should be avoided because they can elevate soil P to levels that increase the risk of surface water quality degradation.

Dr. Cynthia Mckenney of the Texas A&M Agricultural Research and Experiment Station at Dallas discusses the use of dairy manure compost to establish newly constructed landscapes at the center's annual turf and ornamental field day.

Ornamental Plant Response. In general, the annual and perennial plants demonstrated positive responses to dairy compost applications. Out of all ornamental plants evaluated, Lantana had the greatest response to compost, followed by Pentas (Egyptian Star flower) and Dwarf Burford Holly. Their was sufficient evidence in the plant growth indicators to conclude that incorporation of dairy manure compost into the soil when establishing an urban landscape improved subsequent establishment and growth of ornamental plants.

Turf grass Response. Dairy manure compost significantly increased Bermuda grass color and quality ratings during the first year after application and also increased turf density during the later part of the growing season. The greatest effect on turf color, density, and quality ratings occurred during the second year after application, but the effects were still visible after 3 years, especially for color and quality ratings. In the absence of additional supplemental fertilization, Bermuda grass growth was significantly increased by dairy manure compost. The large effect of dairy manure compost on Bermuda grass ratings was mostly due to the large amount of N, P, K and micronutrients supplied by the compost.

CONCLUSION

Based on the data, there was ample evidence to conclude that amending an urban soil with an abundant amount of dairy manure compost prior to installing ornamental and turf plants will improve the long-term performance of those plants. Turf grass benefits, for example, persisted 3 years after application with no additional fertilization. The increased performance is probably due to greater levels of soil fertility, including major and minor essential plant nutrients, and improved soil physical properties, such as increased water infiltration and reduced soil compaction. Large repeated applications of dairy manure compost should be avoided to prevent excessive accumulation of soil phosphorus. However, given proper soil test results, an application of 2 to 4 lbs per ft^2 dairy manure compost (equivalent to ½ to 1 inches) is a very effective way to create and sustain a high-quality urban landscape.

Using Dairy Manure Compost for Corn Production

T.J. Butler, M.L. McFarland, and J. P. Muir

Dairy Compost Utilization

Corn is an important grain crop in Central Texas and the preferred silage crop due to its high yield and high-energy content. Corn silage can yield 20-25 tons of forage per acre based on 35% dry matter content. The kind and amount of fertilizer required for corn grain or silage will depend on the fertility status of the specific field, the cropping program, and whether compost or other organic nutrient sources will be used along with inorganic fertilizer. However, accurate fertilizer recommendations can be made only if soil test results are available for each production field.

Livestock manures have been used for centuries in crop production systems as a source of nutrients and organic matter. However, raw manure typically has a high moisture content, which increases transportation costs and can be a significant source of soluble nutrients, viable weed seeds and fecal bacteria that may be conveyed to surface water in runoff. Increasingly, composting is being utilized to improve the characteristics of manure for beneficial reuse in crop production systems.

BENEFITS OF COMPOSTED MANURE

Composting is the biological decomposition of organic materials such as manure to a relatively stable endpoint. Fresh livestock manure is a mixture of urine and feces, varying in chemical and biological composition, which is determined by the species of animal and their diet. Because bedding material is consequently harvested with raw manure during traditional collection practices, resulting compost contains additional components such as straw or sand. Biological activity, ventilation and heat generated during the composting process remove much of the moisture in raw manure, reduce odors, and kill most weed seeds and most disease microbes and parasites. In addition, composting reduces the total volume of manure by as much as 50%.

Composted manure can be a significant source of essential plant nutrients, including nitrogen, phosphorus, potassium, calcium, magnesium and sulfur, as well as micronutrients as zinc, iron, copper and manganese. However, nutrient concentrations can vary widely from one manure compost to another. To determine appropriate compost application rates, obtain a laboratory nutrient analysis of the production field and selected compost product. Table 1 shows the average and range in nutrient concentrations in composts made from different materials. The ratio of nutrient concentrations in a compost product is rarely an exact fit for crop needs. In particular, an application of compost that meets nitrogen requirements will often provide excess phosphorus. As a result, compost application rates should be determined based on crop phosphorus requirements and a phosphorus free inorganic fertilizer should be utilized to complete crop nitrogen and/or potassium requirements. Two of the most important nutrients in compost, nitrogen and phosphorus, may be predominantly in organic forms in compost. Therefore, it is important to account for a slower release rate than is

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expected from inorganic fertilizer. Research using dairy manure compost in the production of warm-season grasses has indicated that nitrogen release rates are in the range of 30-35% of total N in the first year with decreasing rates the following years. As a result, fast growing, high nutrient demand crops such as corn typically require some amount of supplemental inorganic fertilizer to achieve optimum yields.

In addition to serving as a nutrient source, compost supplies stabilized organic matter, which is an important component of soils. Organic matter serves a special role in soils acting in the formation of very small soil clods, called aggregates, which improve soil structure and tilth, and increase water infiltration and water holding capacity. Organic matter also functions similar to clay in soils by increasing the cation exchange capacity, or the nutrient holding potential of a soil. Increasing soil organic matter with compost or other supplements is particularly important for maintaining soil quality in cropping systems where most of the above-ground biomass is removed, such as corn silage or hay.

Table 1. Average and range ( ) in nutrient values for various composts (McFarland, 2003; Risse, 2003; Brodie et al., 1996)

Compost Type	Dry Matter	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)
	%	lbs/ton		
Dairy Manure	**70 (58-80)**	**16 (11-23)**	**18 (6-31)**	**21 (8-48)**
Beef Manure	65 (54-72)	10	22	28
Poultry Litter	30 (22-36)	18 (11-25)	31 (11-52)	17 (10-21)
Municipal Solid Waste	40	24	15	6
Yard Trimmings	38	26 (6-84)	9 (2-23)	9 (1-65)

CORN NUTRIENT REQUIREMENTS

Corn has a high demand for nitrogen (N), phosphorous (P_2O_5), and potassium (K_2O), because of its high yield potential and the amount of dry matter produced. Obtain regular soil tests to predict the amount and type of fertilizer needed. Corn yields are often limited by inadequate supplies of nitrogen because it is commonly the single most deficient nutrient in soils and is required in the greatest amounts. Corn extracts less than 15 percent of its seasonal nitrogen uptake before rapid vegetative growth begins, with maximum nitrogen use occurring just before pollination. Thus, split application of nitrogen fertilizer is often recommended to improve nitrogen use efficiency.

Typically, one third of the total N and all of the P & K are applied at planting and the remaining two thirds of the N is applied at the V5 to V8 growth stage (5 to 8 emerged leaves with collars present), which occurs about 25 to 35 days after emergence. Corn requires 1.2 lbs N per bushel when yields exceed 150 bushels; 1.1 lbs N per bushel for yields of 100 to 150 bushels; and 1 lb N per bushel for yields less than 100 bushels per acre.

Table 2 provides average nutrient requirements for corn grain and silage based on yield goal. For example, if corn is producing 150 bushels per acre, 165 lbs of N, 95 lbs of P_2O_5, and 140 lbs of K_2O are needed per acre. Likewise, a 25-ton yield of corn silage requires approximately 250 lbs of N, 100 lbs of P_2O_5, and 140 lbs of K_2O per acre. Continuous corn silage production may require an increase in N, P, and K fertilizer rates compared to conventional grain production due to removal of the whole plant and all the nutrients contained therein.

Average nutrient values for dairy compost from Table 1 (16, 18, and 21 lbs/ton for N, P_2O_5, and K_2O, respectively) can be used along with the estimated nutrient requirements for corn in Table 2 to develop the proposed compost use rates presented in Table 3. An estimated 35% N release rate for compost was used for the calculations. It is important to note that because compost nutrient concentrations vary, estimated rates listed in Table 3 should be adjusted based on nutrient analysis of compost and application site. If the C:N ratio of the compost is greater than 25:1 (or unknown) then supplemental N should be applied along with the compost. When the C:N ratio is greater than 25:1, soil microbes will tie up the N to break down organic matter, which can result in a N deficiency.

Table 2. Estimated nutrient requirements for corn grain and silage (Texas A&M University Soil, Water and Forage Testing Laboratory)

Grain Yield	N	P_2O_5	K_2O	Silage Yield*	N	P_2O_5	K_2O
bu/A		lbs/A		ton/A		lbs/A	
70	70	65	80	**5**	50	45	55
90	95	75	90	**10**	100	65	75
110	120	85	110	**15**	150	85	100
125	145	90	130	**20**	200	95	120
150	165	95	140	**25**	250	100	140
190	210	100	150	**30**	300	105	160

*Based on 35% dry matter content.

Based on the rates used in Table 3, a single application of compost typically will provide enough P & K for three or more growing seasons. However, the nitrogen based loading rate should only be used on soils testing very low or low in plant available phosphorus and with composts having a low salt index. Accumulation of soluble salts near seed can reduce germination and/or kill young seedlings.

Table 3. Estimated rates of compost application for production of corn grain or silage based on crop N requirements and assuming a 35% N release rate from compost

Grain Yield	Compost Rate		Silage Yield	Compost Rate	
	Dry	Wet*		Dry	Wet*
bu/A	tons/A		ton/A	tons/A	
70	12.5	17.9	**10**	17.9	25.5
110	21.4	30.6	**20**	35.7	51.0
150	29.5	42.1	**25**	44.6	63.8
190	37.5	53.6	**30**	53.6	76.5

*Based on 30% moisture content in compost. Moisture content of compost may vary and should be determined to develop accurate rate recommendations.

Most often, compost rates are calculated based on the phosphorus requirements of the crop and supplemental N is applied to balance the ratio of nutrients that the crop needs. Calculations developed in Table 4 are based on an estimated 75% phosphorus availability rate from compost.

It is recommended to use this strategy when nitrogen release rates of compost are not known, or when the soil test indicates that phosphorus levels are moderate or higher. Listed rates may be multiplied by 2 or 3 to provide P for multiple years from one single application on sites where compost will be applied and thoroughly incorporated into the soil. However, compost application rates should always be based on annual crop phosphorus requirements in watersheds of streams or lakes that are nutrient impaired or on land that is subject to significant surface runoff. Also, select a fertilizer with a low phosphorus value to provide the indicated supplemental N.

Table 4. Estimated rates of compost application for production of corn grain or silage based on P & K requirements and with recommended supplemental N fertilizer rates

Grain Yield	Compost Rate		Fertilizer	Silage Yield	Compost Rate		Fertilizer
	Dry	Wet*			Dry	Wet*	
bu/A	tons/A		lbs N/A	ton/A	tons/A		lbs N/A
70	4.8	6.9	43	**10**	4.8	6.9	73
110	6.3	9.0	85	**20**	7.0	10.0	161
150	7.0	10.0	126	**25**	7.4	10.6	209
190	7.4	10.5	169	**30**	7.8	11.1	256

*Based on 30% moisture content in compost. Moisture content of compost may vary and should be determined to develop accurate rate recommendations.

SUMMARY

Manure compost can be a valuable addition to a crop production system by modifying and improving soil physical properties and serving as a source of plant nutrients. Because crops such as corn and corn silage have a high nutrient demand, supplemental nitrogen in the form of inorganic fertilizer often will be required to produce optimum crop yields. Use soil testing to determine nutrient needs in each field and for each crop based on a realistic yield goal. In addition, test compost prior to use to determine the nutrient composition and salt index. Compost application rates are most often based on the phosphorus requirements of the crop, with supplemental inorganic nitrogen applied to meet expected crop demands. Finally, avoid over application of nutrients such as hosphorus, whether from organic or inorganic sources, particularly in sensitive or impaired watersheds.

Using Dairy Manure Compost for Forage Production

T.J. Butler, J.P. Muir, T.J. Helton,
C.A. Wagner, and M.L. McFarland

Dairy Compost Utilization

Forage crops make up a significant part of the total agricultural land in Texas and provide a critical food supply for the livestock industry. Most improved forages, such as the improved bermudagrasses, have been selected for their response to fertilizer inputs. Providing an adequate and balanced nutrient supply to these crops is important to produce high yields of quality forage while optimizing economics. The kind and amount of fertilizer required for forage crops depends on the fertility status of the specific field, the management system, and whether compost or other organic nutrient sources are to be used along with inorganic fertilizer. However, accurate fertilizer recommendations can be made only if soil analysis results are available for each production field.

Livestock manures have been used for centuries in crop production systems as a source of nutrients and organic matter. However, raw manure typically has a high moisture content, which increases transportation costs and can be a significant source of soluble nutrients, viable weed seeds and fecal bacteria that may be conveyed to surface water in runoff. Increasingly, composting is being utilized to improve the characteristics of manure for beneficial reuse in crop production systems.

BENEFITS OF COMPOSTED MANURE

Composting is the biological decomposition of organic materials such as manure to a relatively stable endpoint. Fresh livestock manure is a mixture of urine and feces, varying in chemical and biological composition which is determined by the species of animal and their diet. Because bedding material is consequently harvested with raw manure during traditional collection practices, resulting compost contains additional components such as straw or sand. Biological activity, ventilation and heat generated during the composting process remove much of the moisture in raw manure, reduce odors, and kill most weed seeds and most disease microbes and parasites. In addition, composting reduces the total volume of manure by as much as 50%.

Nutrient concentrations can vary widely from one manure compost to another but their outcomes are beneficial when applied at appropriate rates.

Composted manure can be a significant source of essential plant nutrients including nitrogen, phosphorus, potassium, calcium, magnesium and sulfur, as well as, micronutrients such as zinc, iron, copper and manganese. To determine appropriate compost application rates, it is important to obtain laboratory nutrient analysis of the production field and selected compost product. Table 1 shows the average and range in nutrient concentrations in composts made from different materials. The ratio of nutrient concentrations in a compost product is rarely an exact fit for crop needs. In particular, an application of compost that meets nitrogen requirements will often provide excess phosphorus. As a result, compost application rate should be determined based

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on crop phosphorus requirements and a phosphorus free inorganic fertilizer should be utilized to complete crop nitrogen and/or potassium requirements.

Two of the most important nutrients in compost, nitrogen and phosphorus, typically are in organic forms in compost. Therefore, it is important to account for a slower release rate than is expected for inorganic fertilizer. Research using dairy manure compost in the production of warm-season grasses has indicated that nitrogen release rates are in the range of 30-35% of total N in the first year with decreasing rates the following years. As a result, fast growing, high nutrient demand crops typically require some amount of supplemental inorganic fertilizer to achieve optimum yields.

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Yard Trimmings	38	26 (6-84)	9 (2-23)	9 (1-65)

FORAGE NUTRIENT REQUIREMENTS

There are numerous species of forages with varying nutrient requirements, but they can be classified into two main groups: warm-season or cool-season. The most common warm-season grasses are bermudagrass, kleingrass, Old World Bluestems, and bahiagrass while the most common cool-season grasses are oats, rye, ryegrass, wheat, tall fescue, and tall wheatgrass.

The ratio of nutrients required is similar within each group, so yield potential is the primary factor determining differences in total nutrient requirements among the various species within a group. Typically, warm-season forages require 50 lb N, 14 lb P_2O_5, and 42 lb K_2O per ton of forage produced while cool-season forages require 60 lb N, 20 lb P_2O_5, and 32 lb K_2O per ton of forage produced (Table 2). The yield potential will vary slightly for species within a group. The major difference among warm-season grasses is that bermudagrass responds more to higher N rates compared to other grasses. The major factor determining bermudagrass yield potential is the amount of rainfall within a given year. In general, other introduced grasses have a maximum yield potential of approximately 4 ton/A.

Table 2. Estimated nutrient requirements for introduced warm-season and cool-season grasses (Texas A&M University Soil, Water and Forage Testing Laboratory)

Yield	Warm-Season			Yield	Cool-Season		
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
tons DM/A		lbs/A		tons DM/A		lbs/A	
1	50	14	42	1	60	20	32
2	100	28	84	2	120	40	64
4	200	56	168	3	180	60	96
6	300	84	252	4	240	80	128
8	400	112	336				

The average nutrient values of dairy compost (Table 1: 16, 18, and 21 lbs/ton for N, P_2O_5, and K_2O, respectively) have been used along with the estimated nutrient requirements (Table 2) to develop the recommended compost use rates presented in Table 3. Most often, compost rates are calculated based on the phosphorus requirements of the crop and supplemental N is applied to balance the ratio of nutrients that the crop needs. Calculations developed in Table 3 used an estimated 75% phosphorus availability from compost.

This strategy is typically recommended to ensure that phosphorus levels added to the soil are not excessive. Listed rates may be multiplied by 2 or 3 to provide P for multiple years on sites where compost applications are thoroughly incorporated into the soil, or where surface applications have little potential for runoff. However, base application rates on annual crop phosphorus needs in watersheds that are nutrient impaired or on land that is subject to significant surface runoff. In addition, the use of buffer zones or filter strips is recommended where surface applications are made.

An estimated 30% N release was used to calculate the supplemental N rates presented in Table 3. If the carbon to nitrogen (C:N) ratio in compost is greater than 25:1 (or unknown) then supplemental inorganic N rates applied along with the compost may need to be increased accordingly. This is because when C:N ratios are greater than 25:1, soil microbes can tie up N to break down the organic C, which can lead to a N deficiency in the crop. Application of supplemental inorganic N will ensure that adequate N is available to supply the crop and to promote nutrient release from the compost.

Table 3. Estimated rates of compost application for production of warm-season or cool-season grasses based on P requirements and with recommended supplemental N rates

Warm-season Yield	Compost		Fertilizer	Cool-season Yield	Compost		Fertilizer
	Dry	Wet*			Dry	Wet*	
ton/A	ton/A		lbs N/A	ton/A	ton/A		lbs N/A
2	2.1	3.0	90	**1**	1.5	2.1	53
4	4.2	6.0	180	**2**	3.0	4.3	106
6	6.2	8.9	270	**3**	4.5	6.4	158
8	8.3	11.9	360	**4**	6.0	8.6	211

*Based on 30% moisture content in compost. Moisture content of compost may vary and should be determined to develop accurate rate recommendations.

Compost rates ranging from 16 to 32 wet tons/acre with supplemental N applied at rates of 50, 75 and 100 lbs/acre produced forage yields equal to a balanced (N:P:K) application of inorganic fertilizer at recommended rates. These studies indicated that compost supplied sufficient P to provide for the needs of the crop over two growing seasons. On some soils, supplemental K may be needed in the second season to obtain optimum yields. Annual soil testing should be used to determine supplemental inorganic K application rates.

SUMMARY

Manure compost can be a valuable addition to a crop production system by modifying and improving soil physical properties and serving as a source of plant nutrients. Because the ratio of N:P:K in compost is typically not an exact fit for crop needs and because the compost nutrient release rate is slow, supplemental inorganic fertilizer often will be required to produce optimum crop yields. Use soil testing to determine nutrient needs in each field and for each crop based on a realistic yield goal. In addition, test compost prior to use to determine the nutrient composition and predict nutrient supplying potential. Most often, base compost application rates on the phosphorus requirements of the crop, with supplemental inorganic nitrogen applied to meet expected crop demands.

Field studies conducted at the Stephenville Research Center have shown that dairy manure compost applied in combination with supplemental inorganic N can be effective for producing Coastal bermudagrass.

Using Dairy Manure Compost for Specialty Forages

J. Muir, T. Butler, and M. McFarland

Specialty forages are those that do not have a wide application in animal production systems of Texas. Other than beef cattle, systems that use cultivated forage can be considered atypical in our state. These include white-tailed deer, game birds (quail or turkey), exotic game, goats, sheep, domesticated rabbits or any other species that is primarily an herbivore. These animals generally require greater quality in their diets than do bulk (undiscriminating) grazers such as cattle, horses, donkeys, bison or Asiatic water buffalo. Selective grazers/browsers (the latter pluck individual leaves off forbs, bushes, trees and grass) usually harvest individual plant parts such as seeds, fruits or new leaves, which provide a greater concentration of available nutrients but are more difficult to collect. Grasses and legumes more palatable to selective grazers tend to be more difficult to maintain in pastures or range since they are generally less adapted to local conditions and are grazed (browsed) out more easily.

The fertilizer requirements of specialty forages will depend on the fertility status of the specific field, the plant species, the type and degree of grazing, and whether compost or other organic nutrient sources are to be used along with inorganic fertilizer. Livestock manures have been used for centuries in crop production systems as a source of nutrients and organic matter. However, raw manure typically has a high moisture content, which increases transportation costs and can be a significant source of soluble nutrients, viable weed seeds and fecal bacteria that may be conveyed to surface water in runoff. Increasingly, composting is used to improve the characteristics of manure for beneficial reuse in crop production systems. However, the first step in developing an effective nutrient management plan is to obtain a soil analysis for each production field.

BENEFITS OF COMPOSTED MANURE

Composting is the biological decomposition of organic materials such as manure to a relatively stable endpoint. Fresh livestock manure is a mixture of urine and feces, varying in chemical and biological composition which is determined by the species of animal and their diet. Because bedding material is consequently harvested with raw manure during traditional collection practices, resulting compost contains additional components such as straw or sand. Biological activity, ventilation and heat generated during the composting process remove much of the moisture in raw manure, reduce odors, and kill most weed seeds and most disease microbes and parasites. In addition, composting reduces the total volume of manure by as much as 50%.

Composted manure can be a significant source of essential plant nutrients including nitrogen, phosphorus, potassium, calcium, magnesium and sulfur, as well as, micronutrients such as zinc, iron, copper and manganese. However, the nutrient concentrations can vary widely from one manure compost to another. To determine appropriate compost application rates, it is important to obtain laboratory nutrient analysis of the production field and selected compost product. Table 1 shows the average and range in nutrient concentrations in composts made from different materials. The ratio of nutrient concentrations in a compost product is rarely an exact fit for crop needs. In particular, an application of compost that meets nitrogen requirements will often provide excess phosphorus. As a result, compost application

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rate should be determined based on crop phosphorus requirements and a phosphorus free inorganic fertilizer should be used to complete crop nitrogen and/or potassium requirements.

Nutrient levels in compost are generally organic. Therefore, it is important to account for their slow release rate. Preliminary research using dairy manure compost in the production of warm-season grasses has indicated that nitrogen release rates are in the range of 30-35% of total N in the first year with decreasing rates the following years. As a result, fast growing, high nutrient demand crops typically require some amount of supplemental inorganic fertilizer to achieve optimum yields.

In addition to serving as a nutrient source, compost supplies stabilized organic matter, which is an important component of soils. Organic matter serves a special role in soils acting in the formation of very small soil clods, called aggregates, which improve soil structure and tilth and increase water infiltration and water holding capacity. Organic matter also functions similar to clay in soils by increasing the cation exchange capacity, or the nutrient holding potential of a soil. Increasing soil organic matter with compost or other supplements is particularly important for maintaining soil quality in cropping systems where most of the above-ground biomass such as through grazing.

Table 1. Average and range ( ) in nutrient values for various composts (McFarland, 2003; Risse, 2003; Brodie et al., 1996)

Compost Type	Dry Matter	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)
	%		lbs/ton	
Dairy Manure	**70 (58-80)**	**16 (11-23)**	**18 (6-31)**	**21 (8-48)**
Beef Manure	81	10	14	12
Poultry Litter	30 (22-36)	18 (11-25)	31 (11-52)	17 (10-21)
Municipal Solid Waste	40	24	15	6
Yard Trimming	38	26 (6-84)	9 (2-23)	9 (1-65)

SPECIALTY FORAGE DATA FROM STEPHENVILLE

The forage program at Stephenville has focused on specialty systems for the past five years. Most of these systems were legumes originally intended for wildlife plots, but they also have wider application such as for small ruminant systems. Due to the seasonal nature of their production, species adapted to cool-season and warm-season were studied separately. As indicated in Table 2, cultivated cool season legumes generally had very high quality indicators such as low levels of acid detergent fiber (quicker passage rates through digestive tracts) and high crude protein concentrations. Some of the medics and all the annual clovers had lower levels of lignin (indigestible fiber) than the vetches. The warm season legumes studied in Stephenville were also of general high quality (Table 2) while non-leguminous forbs were slightly lower. Legumes did not receive N fertilizer while the non-leguminous forbs did receive commercial rates of N.

BENEFITS OF INCORPORATING COMPOST INTO SPECIALTY FORAGE SYSTEMS

Application of dairy manure compost at rates of 18 tons/acre/year for two years to dryland cool season legumes increased yields by 48%, making this investment worthwhile (Table 3). In contrast, compost at 10 tons/acre/year over two years had no noticeable effect on warm-season dryland forage legumes. Lack of moisture (yields were generally low in drought years) appears to inhibit positive legume response to compost application since the same forages, when grown under more ideal irrigated conditions, did respond positively to compost application at 11 tons/acre/year, increasing yields by an average of 13%.

A review of the research to date at Stephenville indicates that, at least in the short term (all experiments were conducted for only two years) and at the levels applied (10 to 18 tons/ac.), compost did not improve forage quality. Even P levels in the forage did not improve, despite large increases in plant-available P in the soils. Other experiments have indicated that increasing soil P will often improve legume growth in infertile soils because this element is important for proper rhizobium development. However, the amounts of compost applied and the duration of the trials may not have given these crops sufficient time to show an effect of compost on nutritive quality.

SUMMARY

Application of dairy manure compost can significantly increase herbage yields of some specialty forage crops. This is especially apparent in the case of cool-season legumes, where compost nearly doubled yields under dryland conditions. Irrigated warm-season forbs appear to respond to dairy manure compost application more readily than do dryland systems, especially in drought years when moisture stress masks the benefits of compost. Although the growth response to compost addition was substantial for most crops, compost did not affect the nutritive value of these crops.

Table 2. Forage crude protein (CP), acid detergent fiber (ADF) and lignin concentration of cool season annual legumes, compiled from various experiments at Stephenville, TX

Forage Variety	CP	ADF	Lignin
		% of forage	
Cool-Season Legumes			
Medics			
Jemalong Barrel Medic	23.4	26.7	5.1
Little Medic, Devine	18.9	28.6	6.4
Black Medic, Beeville	23.5	25.0	5.6
Estes Button Medic	24.1	20.1	4.1
Button Medic, Stephenville	24.8	21.7	4.5
George Black Medic	20.9	20.7	4.9
Armadillo Burr Medic	24.6	29.9	6.6
Burr Medic, Stephenville	23.3	29.9	6.1
Burr Medic, Beeville	23.1	32.8	7.5
Spotted Medic, Stephenville	22.0	25.8	6.6
Cogwheel Medic, Stephenville	14.0	30.7	6.2
Clovers			
Dixie Crimson Clover	20.4	29.8	4.9
Overton R18 Rose Clover	17.1	35.5	4.2
AU Sunrise Crimson Clover	21.3	28.6	5.3
Common Ball clover	22.3	26.9	5.3
Vetches			
Common (narrowleaf) vetch	17.8	31.5	7.7
Hairy vetch	22.1	38.3	8.3
Llama vetch	17.4	36.8	8.6
Deerpea vetch (native)	18.4	32.6	7.9
Warm-Season Legumes			
Partridge Pea	18.1	19.4	5.9
Peanut	20.0	24.3	3.6
Phasey Bean	19.3	21.4	6.4
Tecomate lablab	19.7	23.7	4.5
Soybean (forage)	11.0	19.6	4.2
Iron-clay cowpea	18.7	21.3	3.9
Kudzu	15.3	25.1	6.1
Rayado bundleflower	16.9	17.1	4.4
Illinois bundleflower	13.5	19.3	5.0
Other Forbs			
Sunflower (oil type)	9.2	32.4	6.1
India Kenaf	14.9	26.9	3.6

Table 3. Forage dry matter yield of specialty forages grown with and without dairy manure compost in various experiments at Stephenville, TX

Forage Variety	Control Yield	Compost Yield
	lb/A	
Warm-Season Legumes (dryland) @ 10 tons compost per acre		
Partridge Pea	1050	NS[1]
Peanut	1350	NS
Phasey Bean	620	NS
Tecomate lablab	1400	NS
Soybean (forage)	600	NS
Iron-clay cowpea	1850	NS
Warm-Season Forbs (irrigated) @ 11 tons compost per acre		
Sunflower (oil type)	4650	5350
Kenaf (India)	12800	14750
Lablab (Tecomate)	7350	8500
Cowpea (Iron-clay)	4000	4600
Cool-Season Legumes (dryland) @ 18 tons compost per acre		
Yuchi arrowleaf clover	1850	3300
Common vetch	440	600
Armadillo burr medic	200	450
Estes button medic	500	1250
Black medic (North Texas)	100	250
Little burr medic (Devine)	100	250

[1]Compost plots produced greater (P>0.05) yields unless noted as not significant (NS).

Improving Compost Use through Application Methods

R. Alexander, C. Wagner

Dairy Compost Utilization

In the past, inefficient application methods have been a major barrier to the increasing use of compost in agriculture and horticulture, but that barrier is rapidly fading. Not only is special equipment becoming available, but compost producers and marketers often provide spreading services in combination with compost purchases.

Spreading equipment currently available varies in size, cost, technique and purpose and the efficacy of the compost application often depends on proper equipment selection. Being more knowledgeable of application equipment increases the value of the compost purchase and allows a user to take full advantage of the benefits of a compost material. The specific application method and selection of equipment compost depends upon several factors.

In large applications, the composted material is typically delivered to the application site in large trucks. Additional equipment is then often needed to load the compost into the unit for application.

- Know the **characteristics of the product**. Application equipment is specially designed to handle excessively dry or moist products. Particle size is also important. Most equipment is designed for products with consistent characteristics; thus, contaminants such as stones and sticks can efficacy.
- Know the **conditions of the application area**. Compost application equipment varies in size and spreading capability. Therefore, accessibility and size of the application area is an important factor. Finally, the equipment may be self propelled, tractor pulled or manually driven, which also affects equipment selection.
- Know the **desired amount and rate of compost**. For small projects, compost may be obtained in bags, but for larger projects, compost may be obtained in bulk and transported to the site by truck. The desired rate is also important as application equipment varies in ability to accurately apply very small or very large rates.
- Know about **past experience or use of equipment**. Some equipment used to apply compost today has not been specifically designed with compost in mind. The majority of units was engineered to apply agricultural by-products, such as manure, lime, fertilizer, mulch, or sand-based mixes and was modified to apply compost.

AGRICULTURAL APPLICATIONS

Two main types of compost applications in agriculture involve broadcast and row applications. For example, crops such as coastal Bermuda grass typically require a broadcast application in which compost is applied topically over a large area, yet specialty crops such as watermelons utilize row applications to concentrate compost in smaller, defined areas.

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Broadcast applications such as flail, slinger and spinner-type units project the compost from the rear of the spreader into the air. Flail units, which use paddles to broadcast the product from the rear of the unit, were developed to apply products with a higher solids content and are able to apply wider strips in the application area. Slinger units have a spinning drum with teeth that slings product up to 200 feet. These units can handle materials with higher moisture content such as ash, wet lime and biosolids. Spinner units rely on centrifugal force to project product from the rear of the unit. They work best on drier, denser materials that are fine in texture. Spinner units are typically used to apply compost in agricultural applications and at application rates of five to ten tons per acre or less.

This broadcast application, utilizes a spinner unit, which projects compost from the rear of the spreader at a calibrated rate of 10 tons per acre.

Topdressing units for broadcast applications include brush and cylinder-type units, in which a rotating, cylindrical brush projects the compost down towards the soil surface. Both broadcasting and topdressing units have the ability to apply low (1/4 to ½ inch layer) or high (1 inch layer) rates of compost. When rates of one inch or more are desired, piles of compost are strategically placed throughout the site and a grading blade, York rake or front-end loader/bull-dozer blade is used to spread the compost. While this method may not provide an accurate application rate, it is typically more efficient as most large-scale compost spreading units are not able to apply rates greater than 1 inch and thus would require multiple application trips through the field.

Moisture content and particle size of the compost is very important when broadcasting compost. For example, "box spreaders" or modified agricultural spreaders (used for commercial fertilizer or lime applications) often have difficulty spreading coarse or wet compost.

Row applications use both flail and slinger-type units, which can discharge compost from the side of the unit. Flail units with a side discharge were developed to apply products possessing higher solids content in narrow strips, or rows. Tractor trailers have even been fitted with flails to allow large volumes of compost to be spread. The most common slinger unit also side discharges manure. It applies a thin layer of material between planting rows and can apply compost to a depth of ½ to one inch over a raised nursery bed.

TURFGRASS APPLICATIONS

The best time to add organic matter in the form of compost to turfgrass is before planting or during establishment. In such cases, compost can be added at higher rates and incorporated thoroughly into the soil. Once the turfgrass is established, however, topdress applications of compost can be effective.

These topdress applications often use brush or beater drum/rotating cylinder-type units, which were designed to apply sand-based mixes for golf courses and athletic fields. Brush units use a spinning bristled brush to project materials at the soil surface. These units can handle product with a moisture content of over 50 percent, as well as somewhat coarse materials. The units are typically used to apply a one-eighth to one-half inch layer of compost, wood chips or sand/compost blends. Beater drum/rotating cylinder type units were designed to apply thicker application rates of high bulk density (sand-based) mixes over large open turf areas. The unit is extremely versatile, having the ability to apply a $^{1}/_{64}$ to three-inch layer of various materials. The unit is primarily used for golf course and athletic field applications and may be fitted with a finishing brush to break up product clumps and project the material more uniformly onto the soil surface. Blower type units can also apply compost for topdressing, however, obtaining accurate application rate with a blower type unit can sometimes be difficult.

Turfgrass application units, like this one shown above, are extremely versatile and can accurately apply compost at varying rates.

SPECIALIZED APPLICATIONS

Compost is often used as a mulch material to manage erodible soils, for decorative purposes or to provide organic matter to vegetated beds. Such applications often require special placement of compost around existing plants or release of compost in inaccessible areas.

Smaller units like this pneumatic/blower, propel compost through a wide hose which can be directed around plants and other objects. It also works well when applying compost to slopes and roadsides.

For erosion control berm applications, a pneumatic/blower type unit works well in that it can apply materials precisely and in inaccessible areas, using a hose of up to 300 feet in length. Larger blower-type units have been used to propel the compost up to 200 feet. This newly marketed technology was designed for products with a particle size of two inches or under in length and those possessing a moisture content of no more than 40 to 45 percent. Since typical composts do not meet these requirements, it is a common practice to combine compost with wood chips, sawdust or other wood material to create a mulch-type material. Larger capacity units (truck and trailer mounted units have a 20 to 60 cubic yard capacity) can also reduce the need to reload during application, which significantly improves efficiency. In the instance when such large applications are not required, applying the material by hand or with a basket type spreader is appropriate. In addition to blower units, newer slinger-type units have recently been fitted with devices that allow them to create berms as well.

Roadside slope applications use slinger units to apply the material. These are usually larger, pull-behind and truck-mounted units for use on highway and reclamation applications. These units can handle materials at higher moisture content such as ash, wet lime and biosolids. They can treat steep slopes and sites where accessibility is limited.

SELECTING AN APPLICATION METHOD

The key to efficient application of compost, as well as other products, is making sure the product being applied is compatible with the equipment being utilized. If it is not, an alternate piece of equipment should be used or the product's qualities should be modified. This typically can be accomplished by screening the product or by drying it to reduce its moisture content.

Finally, rely on the compost manufacturer and/or marketer as a resource for compost application services. Combining the compost purchase with the application service may prove to be more economical. However, if application services are not provided with your purchase, the compost producer will likely be able to direct you towards a business or individual who can meet your application needs.

Similar to the unit equipped with a hose, this roadside application is also spread with the pneumatic/blower technology. However, in this application, the unit is equipped with a side blower allowing for more coverage and mechanized application.