A Sustainable Approach to Recycling Urban and Agricultural Organic Wastes

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New Mexico residents generate approximately 1.4 million tons of solid waste per year. Much of this waste is sent to 113 active disposal facilities (1992) in New Mexico, less than half the number of landfills and "dumps" recorded in the 1970s and 1980s (NMED, 1993).

By volume, the largest component of New Mexico's waste stream is residential waste (approximately 52.2%). Yard and landscape wastes are estimated to be 6.1% (NMED, 1993), but this is probably a low estimate because yard and landscape wastes were not identified separately in the residential component of the 1993 NMED survey. In Albuquerque, yard waste made up 33.8% of the residential solid waste stream during a landfill survey conducted in 1991–1992 (Romo, Cave, and Watkins, 1992).

BACKYARD RECYCLING

Disposing of yard wastes in landfills is not only expensive, it can cause environmental problems, including air quality problems associated with methane production (rotting organics) and acid-liquid drainage that can contaminate groundwater. One of the more practical ways to decrease the amount of yard waste in landfills is by recycling it in the backyard.

MULCHING

The easiest way to recycle yard wastes in the backyard is as mulch, which can be applied to gardens, flowerbeds, and even lawns. Mulches help conserve soil moisture, reduce annual weed growth, and reduce extreme fluctuations in soil temperatures.

Dried bluegrass and fescue clippings make excellent mulches for both gardens and flowerbeds. Clippings should be dry to prevent matting. Avoid using Bermudagrass as a mulch because sprigs and seed from common bermuda may sprout, causing a weed problem.

Clippings can also be returned directly to the lawn using a mulching mower. Mow lawns frequently, removing no more than 1/3 of the leaf blade at any one cutting. Mulching mowers will not only cut the grass, but will also shred the grass into smaller pieces. These clippings used as mulch will filter down through the grass canopy, conserving moisture as well as returning nutrients to the lawn. Mulching will not increase thatch accumulation.

Leaves make excellent mulches for both gardens and flowerbeds. Run leaves through a mulching or rotary mower to increase their surface areas and keep them from matting. Shredding leaves in this way will increase breakdown and return nutrients to the soil faster.

Brush debris from pruning shrubs and trees in winter and spring is somewhat more difficult to handle than grass clippings or leaves. A power chipper or shredder is needed to chip or shred branches into a mulch, which makes an excellent mulch around trees and shrubs.

Shredded pine, piñon, or juniper (sawdust) can be also used as a mulch around acid-loving plants like strawberries because of the relatively low pH of these materials. Avoid sawdust that has turned sour from fermentation in deep piles. Sawdusts should not be incorporated into the soil directly because of their relatively low nitrogen level. Sawdusts will typically have high carbon-to-nitrogen ratios (300–500:1) and tend to rob soils of plant-available nitrogen. Microorganisms that decompose organic materials require nitrogen for protein production when reproducing and will absorb plant-available nitrogen (ammonium and nitrate); thus plants propagated in soils with high sawdust contents will tend to turn yellow from nitrogen deficiency. Supplemental nitrogen (fertilizer or manures) will be required for good crop production.

Tree limbs can also be cut up and used for firewood the following winter. Smaller twigs can be trimmed and tied together into bundles for kindling. Juniper and piñon are two of the most popular trees used as firewood. Although their ashes are rich in nutrients, they should not be applied directly to garden soils. Most soils in New Mexico tend to be alkaline. Piñon and juniper ashes are extremely high in pH and will only aggravate a soil alkalinity problem. Both ashes also tend to contain a lot of calcium, an element which tends to be adequate or high in most New Mexico soils.

Both piñon and juniper ashes are highly saline. Adding piñon or juniper ashes to soils with high salt contents could aggravate the problem. For the same reason, fireplace ashes should not be added to garden composts.

COMPOSTS

Recycling grass clippings, leaves, and shredded branches as compost has a number of significant advantages over mulching alone. Not only can compost be used as a mulch—it is also a source of macro and minor elements used for plant growth, even if they occur in relatively small amounts. Elements also occur in organic forms, that tend to make them more available in alkaline soils and less likely to leach. Humic acid produced in the composting process also makes other elements in the soil more available for plant uptake. Compost will also help improve soil structure, improving the drainage of clay soils and the water-holding capacity of sandy soils. The ability of sandy soils to retain nutrients will also increase significantly with the addition of compost.

Traditional composting occurs best when the compost warms up and the pile is decomposed rapidly by mesophilic bacteria (70–100°F), creating heat. Thermophilic bacteria subsequently become active between 113°F and 155°F. Heat generated in the composting process will pasturize the mixture, killing most disease organisms and weed seed. In this heat-generating process, carbon dioxide is produced, with a resultant net loss of 1/3 or more of the organic waste.

Vermicomposting, or composting with earthworms (red wigglers), is an alternative to traditional composting. Earthworms are particularly fond of food wastes, which can make up as much as 8–9% of the national waste streat. Vermicomposts tend to be richer in nutrients than traditional garden composts.

BIOSOLIDS AND MUNICIPAL COMPOSTING

Shredding branches is often a major problem for homeowners wishing to recycle organic matter in their backyards because power shredders are expensive. Woody yard waste generally ends up in the landfill. Many municipalities throughout the United States (including Albuquerque) have diverted woody yard waste from the landfill (curbside pickup or convenience centers) to municipal composting facilities. These composts can be screened and marketed to the public or recycled on public parks or golf courses. Municipal composts can also be used to cover old landfills, reclaim mine spoils, or can be applied directly to farmland.

As much of the yard waste in municipal composting projects is brush with high “carbon-to-nitrogen” ratios, a source of nitrogen is needed to reduce the “carbon-to-nitrogen” ratio to an appropriate level (30:1) for efficient composting. Many municipalities have turned to biosolids (formally called sludge) for this purpose.

Biosolids are a product of wastewater treatment (sewage treatment) facilities associated with most large towns or cities. In many cases, cities dispose of the biosolids in landfills. Disposition of these biosolids can be significant both in terms of environmental problems and the amounts involved. For example, the City of Albuquerque treats over 50 million gallons of mixed residential and industrial wastewater daily, producing about 22 dry tons of stabilized biosolids per day.

Typically, in larger wastewater treatment facilities, sewage undergoes activated air treatments (aerobic microbial breakdown). Through this process, wastewater organic matter is converted to microbial biomass, which is stabilized by anaerobic degradation (digestion) to form biosolids. Dewatered biosolids (80% moisture) are excellent sources of organic matter, nitrogen, phosphorous, and micronutrients for soils. Assuming industrial pollutants have been controlled and meet EPA standards (Clean Water Act of 1987, 40 CFR Part 503), anaerobically digested biosolids (EPA-Process to Significantly Reduce Pathogens) may be applied to non-food crops with applicable restrictions on planting time and public access.

Digested (stabilized) biosolids do not smell like raw sewage, but have more of an earthy odor. Most of the viruses, bacteria, and other pathogenic organisms associated with sewage are destroyed in the digestion and stabilization process. The few that remain tend to die quickly when the material is applied to land. Recommended precautions in applying biosolids should, however, be taken to limit health risks.

Using anaerobically digested biosolids as a soil amendment has two major problems: application is restricted to non-food crops, and hauling and spreading is difficult because of water content. Biosolids that meet EPA heavy metal restrictions can, however, be heat treated to kill pathogens and sold for unrestricted use. Combining shredded yard waste (branches) with biosolids makes a pasteurized compost that’s easier to store and spread and that can be applied to crops for direct human consumption without restrictions (EPA-composting qualifies as a Process to Further Reduce Pathogens). Application rates of biosolid composts to farmland should be limited to no more than the amount needed to supply nitrogen for crop growth and to minimize the amount of nitrogen leached below the root rone.

To control pathogenic microorganisms in composted biosolids, Federal regulations are strict regarding exposure to high composting temperatures. Windrows of composted biosolids must maintain a temperature of 55°C for 15 days and be turned 5 times while in maximum heating phase. Finished compost should have less than 1000 organisms (most probable number)/gram total dry solids for the benign indicator bacteria, fecal coliform (USEPA, 1993).

Composted biosolids tend to have less total kjeldahl nitrogen, more nitrate nitrogen, less phosphorous, and lesser quantities of minor elements than biosolids. Composting reduces the total amount of both biosolids and landscape wastes and creates a more desirable product that can be recycled on areas such as cropland, turf, or mine spoils.

LIVESTOCK MANURE

Landscape wastes (branches) and brush associated with pruning orchards can also be combined with livestock manures to create composts that can be returned to cropland, particularly in rural areas where composting with biosolids may not be an option.

Dairy manure has become a major waste component in several agricultural counties in New Mexico. There are over 50,000 dairy cows in Chaves County and 30,000 in Doña Ana County (Smith, 1993). Cows in these and other counties produce a tremendous amount of manure, which can be a valuable source of nutrients.

Other manure sources include feedlots (steer), egg production (hen), and race horses. Manure nutrient content will vary depending on type of animal, moisture content, percentages and type of litter or bedding, age of manure, storage conditions, and how it is spread and incorporated into the soil. All manures can become problems for the environment if allowed to accumulate. Though manure can be applied to cropland in the fall as a source of nutrients for crop production the following growing season, high soluble salts (electrical conductivity readings) for all except horses can cause salt burn on sensitive crops if applied at heavy rates.

Other problems associated with livestock manures include odor and fly problems, weed seeds, high moisture content, and poor particle size and weight uniformity.

Composting livestock manures has a number of advantages over applying them directly to land. Besides reducing the amount of landscape or orchard wastes (high carbon) entering landfills or being burned, livestock manures composted with pruning wastes produce a stabilized product that can be stored or applied to cropland with very little odor or fly problems. The relatively low moisture content of the finished compost, more uniform particle size (screened), and lighter weight make it easier to handle. Thermophilic composting techniques will also kill most annual weed seed and pathogens.

The process of composting biosolids as well as steer manures tends to increase both pH and the soluble salts (electrical conductivity). Composting straight steer manure tends to increase pH and soluble salts more than when it is combined with a feedstock like cotton gin trash. These higher soluble salts could limit the amount of these composts that should be applied per acre.

SUMMARY

Organic urban and agricultural wastes need no longer be an environmental hazard. Combining high- and low-carbon wastes to form compost will not only reduce the amount of organic wastes that need to be landfilled or burned, but will also reduce surface- and groundwater pollution associated with nitrates leached from manures. Composts can be returned to cropland, turf, landscapes, and mine spoils to improve soil structure, conserve moisture, and increase productivity through nutrient recycling. Managing organic waste as a sustainable asset not only improves the environment—it means greater profitability.

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CHEMICAL CHARACTERISTICS

Pine sawdust, piñon ash, and juniper ash, 1994.

Parameter	Pine sawdust	Piñon ash	Juniper ash
pH	5.4	13.0	12.6
EC (mmhos/cm)	0.2	31.6	20.1
Total kjeldahl nitrogen (%)	0.17	0.04	0.08
Nitrate nitrogen (ppm)	6.5	29.2	8.5
Phosphorous (%)	.02	.34	.31
Potassium (%)	.04	2.42	2.42
Calcium (%)	.39	23.07	19.90
Sodium (%)	.01	< .01	< .01
Magnesium (%)	.04	1.42	.60
Iron (ppm)	510	6765	7178
Zinc (ppm)	25	358	136
Manganese (ppm)	63	1180	473
Copper (ppm)	4	54	63
Boron (ppm)	7	176	253
Aluminum (ppm)	404	9616	10600

Garden compost and vermicompost, 1994.

Parameter	[1]Garden compost	[2]Vermicompost
pH	7.8	6.8
EC (mmhos/cm)	3.6	11.7
Total kjeldahl nitrogen (%)	0.80	1.94
Nitrate nitrogen (ppm)	156.5	902.2
Phosphorous (%)	.35	.47
Potassium (%)	.48	.70
Calcium (%)	2.27	4.40
Sodium (%)	< .01	.02
Magnesium (%)	.57	.46
Iron (ppm)	11690	7563
Zinc (ppm)	128	278
Manganese (ppm)	414	475
Copper (ppm)	17	27
Boron (ppm)	25	34
Aluminum (ppm)	7380	7012

[1]Albuquerque sample
[2]Tijeras sample

Municipal biosolid and municipal biosolid compost, 1993.

Parameter	[1]Biosolid	[2]Biosolid compost
pH	7.0	7.3
EC (mmhos/cm)	10.7	14.5
Total kjeldahl nitrogen (%)	3.81	2.47
Nitrate nitrogen (ppm)	2.9	194.7
Phosphorous (%)	1.7	1.84
Potassium (%)	.09	.79
Calcium (%)	3.99	3.56
Sodium (%)	.02	.04
Magnesium (%)	.29	.33
Iron (ppm)	13040	7533
Zinc (ppm)	694	309
Manganese (ppm)	183	193
Copper (ppm)	775	215
Boron (ppm)	38	34
Aluminum (ppm)	12848	5702

[1]Albuquerque Wastewater Treatment Plant (1993)
[2]Albuquerque Municipal Composting Facility (1993)

Four livestock manures, 1994.

Parameter	[1]Dairy cow	[2]Feedlot steer	[3]Chicken	[4]Horse
pH	8.7	7.2	7.3	7.3
EC (mmhos/cm)	15.9	34.1	43.2	9.2
Total kjeldahl nitrogen (%)	1.74	2.44	3.67	3.14
Nitrate nitrogen (ppm)	87.4	6.6	22.8	26.6
Phosphorous (%)	.45	.47	2.71	.85
Potassium (%)	1.51	1.52	3.10	1.15
Calcium (%)	1.81	4.89	15.10	1.55
Sodium (%)	.24	.18	.42	.49
Magnesium (%)	.43	.57	.73	.27
Iron (ppm)	2197	8540	225	1107
Zinc (ppm)	149	101	443	131
Manganese (ppm)	196	324	513	179
Copper (ppm)	28	19.7	47	25
Boron (ppm)	28	27	57	30
Aluminum (ppm)	1216	7944	370	6866

[1]Albuquerque dairy
[2]Clayton feedlot
[3]Albuquerque laying hen operation
[4]Albuquerque racehorse

Feedlot steer manure and composted steer manure, 1994.

Parameter	[1]Manure	[1]Composted manure
pH	6.75	7.23
EC (mmhos/cm)	28.33	47.34
Total kjeldahl nitrogen (%)	3.54	3.00
Nitrate nitrogen (ppm)	34	905
Phosphorous (%)	.55	1.00
Potassium (%)	1.78	2.31
Calcium (%)	5.7	4.75
Sodium (%)	.50	.46
Magnesium (%)	.77	1.05
Sulfur (%)	1.25	1.71
Iron (ppm)	2798	4517
Zinc (ppm)	343	185
Manganese (ppm)	348	263
Copper (ppm)	92	61
Boron (ppm)	51	57
Aluminum (ppm)	3775	4750

[1]West Hereford, Texas feedlot

Feedlot steer manure, cotton gin trash, and composted cotton gin trash/steer manure, 1994.

	Results (dry matter)		
Parameter	[1]Manure	[1]Cotton gin trash	[1]Composted manure/ cotton gin trash
pH	6.80	6.24	7.86
EC (mmhos/cm)	29.75	9.70	36.35
Total kjeldahl nitrogen (%)	2.41	1.76	2.70
Nitrate nitrogen (%)	19	106	61
Phosphorus (%)	.71	.13	.89
Potassium (%)	1.91	1.51	2.53
Calcium (%)	4.34	1.17	4.07
Sodium (%)	.49	.07	.87
Magnesium (%)	.95	.27	.79
Sulfur (%)	1.58	.51	1.96
Iron (ppm)	3550	2229	5392
Zinc (ppm)	138	32	176
Manganese (ppm)	162	68	227
Copper (ppm)	17	17	44
Boron (ppm)	53	48	72
Aluminum (ppm)	4511	2441	6866

[1]East Hereford, Texas feedlot

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