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# Composting Converts Waste Into Valuable Resources

**By Leon Chesnin**

Rural and urban communities and farms have at least one problem in common: the accumulation of various organic wastes. Farms produce wastes such as animal manures, and crop residues such as straw, corn cobs, hay stack bottoms and spoiled silage.

In Nebraska's towns and cities, the organic wastes include sewage sludge, paunch manure from slaughter houses, and garbage originating from household foods and paper.

Some of these organic wastes are associated with the nuisances of flies, odors and dust. Fresh animal manures, paunch manure, sewage sludge and garbage are favorite breeding places for flies. Flies are attracted to odors and moisture. As these wastes dry and become free of odors, they do not attract flies and are no longer breeding places.

Many large communities bury their garbage and sewage sludge wastes in landfills. This is a costly burden to taxpayers that can result in ground water contamination. Accumulations of dry manure in feedlots or animal confinement facilities results in serious dust problems.

But there is a way all of these wastes can be converted into valuable resources—through composting. Composting is the process of biological decomposition of organic wastes or mixtures of organic wastes that have been piled together. The resulting products are similar to soil organic matter in that a great deal of the cellulose and fiber in the waste have been consumed by microorganisms.

The composted waste is much lower in moisture content because of the heat generated during composting. These changes greatly reduce the bulk of the material and usually concentrate the plant nutrients in the waste.

A compost pile requires lots of air for the microorganisms to break down the waste. The heat generated by composting pasteurizes or kills the disease organisms in the wastes. The compost is generally aerated by mixing when the temperature is around 140° to 150° F (60° - 66° C). Composting is an ancient art. It is practiced on a small scale by many organic and backyard farmers, but specialized equipment has been developed to handle large volumes of wastes.

Figures 1-3 show the modified Brown Bear integral auger tractor which has been loaned to the UN–L Agronomy Department by the Roscoe Brown Corp. of Lenox, Iowa, for use by the author in composting feedlot manure, paunch manure, sewage sludge and crop residues. The paunch manure was obtained from the American Stores Packing Co., Lincoln; the secondary treatment sewage sludge (90 per cent moisture content) was obtained from the City of Fremont. Composted beef cattle manure samples were obtained from a commercial custom composting company, Mid America Compost of Gothenburg.

**Beef Cattle Manure**— Fresh beef cattle manure contains about 85 per cent moisture. The moisture content of feedlot manure depends on climate and length of exposure. In Nebraska's climate feedlot manure averages about 50 per cent moisture. When composted, beef cattle manure changes from large sized masses which are difficult to spread uniformly, to small particles which can be applied as easily as commercial fertilizer.

Marked changes also occur in the chemical composition of composted beef cattle manure obtained at the Mead Field Laboratory and from Mid American Compost (Table 1). During composting, manure, cellulose and fiber are decomposed and water is lost. The total mass or volume of the waste is reduced. On the average, 4 to 6 tons of beef cattle manure will be converted to one ton of finished compost. Depending on the climatic conditions, composting feedlot manure can take 6 to 10 weeks of periodic turning and aerating to produce a finished product. This process can go on during the winter months because heat is being generated.

**Nutrients in Manure and Compost**—Fresh beef cattle manure has about 3.5 per cent nitrogen. A considerable amount of this nutrient can be lost if the waste is not managed properly. Composting under controlled conditions will conserve and concentrate the nitrogen in the manure. If the compost pile is allowed to overheat, nitrogen can be lost as ammonia. Under these conditions, a strong odor of ammonia can be smelled when the waste is turned.

It has been found that about 50 per cent of the nitrogen in beef cattle manure is available to plants the first year. Since composted manure is partially decomposed, it is not known what percentage of the nitrogen is available to plants during the growing season. Research is currently underway to establish the rate of availability of nitrogen in composted manure.

The phosphorus, potassium, sulfur and zinc contents of beef cattle manure are increased or concentrated when this waste is composted.

If 10 tons of feedlot manure with 50 per cent moisture are compared with two tons of composted feedlot manure with 19 per cent moisture, using the data in Table 1 the nutrient values would be as follows:

| | *10 Tons Beef Cattle Feedlot Manure* | *2 Tons Composted Feedlot Manure* |
|---|---|---|
| Nitrogen | 45 – 75 lbs. | 65 – 97 lbs. |
| Phosphorus | 15 – 25 lbs. | 29 – 39 lbs. |
| Potassium | 30 – 90 lbs. | 91 – 113 lbs. |
| Sulfur | 10 – 15 lbs. | 13 – 19 lbs. |
| Zinc | 0.4 – 0.6 lb. | 0.5 – 0.7 lb. |

The value of applied manure or composted manure is increased far

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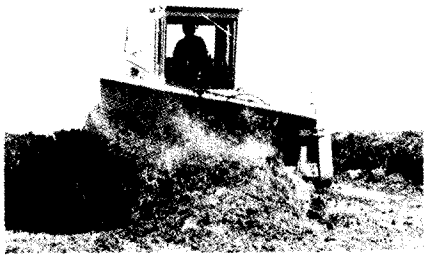

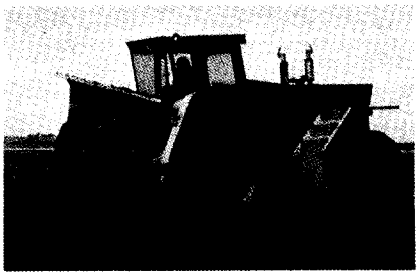

Figure 1. (Above) The Brown Bear compost tractor composts feedlot manure. Figure 2. (Far left) Steam rises from composted sewage sludge during aeration. Figure 3. (Left) Full view of the Brown Bear tractor.

**Composting . . .**

beyond the commmercial value of the above nutrients if one considers the effects on the soil. Applying organic wastes to soils markedly improves soil structure, increasing its water intake rate and soil aeration. With moderate continued applications of organic wastes, there is a bonus of greatly reduced runoff of rainwater. Conservation of rainfall, associated with the benefits of recycling organic wastes on soil-water relations, can become important in reducing the cost of efficient crop production. This benefit would apply to both dryland and irrigated fields.

**Municipal Wastes**—Approximately 90,800 tons of solid sewage wastes are produced every year in Nebraska. These wastes vary in physical nature from a slurry of solids to filtered solids with from 70 to 90 per cent moisture. On a dry weight basis, the nitrogen content of these sewage sludges have varied from 2.0 to 3.0 per cent. These wastes are just as important a resource to the agriculture of Nebraska as are animal wastes. While sewage sludge suspensions can be injected into the soil, it requires the costly transportation of a large amount of water.

Filtered sewage sludge with 70 per cent moisture does not present a problem for composting. However the 90 per cent moisture sludge has the physical nature of gelatin. The high moisture sludge does not aerate easily. It is necessary to mix this sewage sludge with some drier bulky mass such as hay, straw, corn cobs or feedlot manure. These will absorb some of the moisture from the sludge and permit air to penetrate the waste. The natural heating that develops during composting will reduce the moisture content of the sludge. Sewage sludges from Nebraska communities are valuable sources of other essential plant nutrients in addition to nitrogen. On a dry weight basis, sludges have varied from 0.38 – 0.77 per cent phosphorus and 2.98 – 5.71 potassium.

Recent visitors to mainland China have noted that all organic wastes there are utilized or recycled through the soil. Garbage is fed to animals and all manures and sewage materials are returned to agricultural soils as a source of nutrients. This practice has been followed for thousands of years. As a result the agricultural soils of China are still

productive and show little evidence of nutrient deficiencies. About 70 per cent of all nutrients are being supplied by waste recycling. The savings in energy needed to produce commercial fertilizers is very great.

Nebraska communities have an unusual opportunity to recycle their sewage wastes. Primary and secondary treatment sludges can be composted and converted into an economic resource.

Filtered primary treatment sewage sludge (70 per cent moisture) can be composted easily without mixing with crop residues. The heat generated during composting would pasteurize and kill all pathogenic organisms present. This would eliminate the need for secondary treatment of the solids.

Composting primary treatment filtered sludge could result in huge savings to taxpayers. Taxes needed to build and operate secondary treatment plants and landfill wastes could be eliminated. The cost of composting primary treatment would be more than covered by selling the product to the farm, lawn and turf trade.

Farmers are paying $25 a ton for composted manure in bulk. Milorganite, the dried sewage sludge of Milwaukee, is sold in bags in Lincoln for $125 per ton wholesale and $230 per ton retail. It should be mentioned that Nebraska sewage wastes have much less toxic metals than the wastes of Milwaukee or Chicago.

When it is not feasible for a community to do its own composting because of equipment and labor costs, custom composting operators are available. These custom operators charge about half the retail value of the composted waste. Smaller communities can cooperate by bringing their sewage wastes to a common site for composting. This would provide enough sludge to be handled economically. Sewage sludge is currently buried in landfills at a considerable cost to taxpayers and recycling this waste in agriculture would be a great savings to taxpayers.

**Table 1. Composition range of beef cattle feedlot manure and composted feedlot manure from the Mead Agricultural Field Laboratory and Mid America Compost, Gothenburg.**

| | Feedlot Manure | Composted Feedlot Manure |
|---|---|---|
| Moisture % | 50 – 80 | 19 – 25 |
| Nitrogen % | 0.9 – 1.5 | 2.0 – 3.0 |
| Phosphorus % | 0.3 – 0.5 | 0.9 – 1.2 |
| Potassium % | 0.6 – 1.8 | 2.8 – 3.5 |
| Sulfur % | 0.2– 0.3 | 0.4 *8* 0.6 |
| Zinc ppm | 82 – 125 | 156 – 226 |

**Paunch Manure**—About 94,000 tons of this waste (stomach contents of slaughtered cattle) are produced in Nebraska. This material is now incinerated or buried in landfill areas. Paunch manure supplied by the American Stores Packing Co. for recycling studies averaged about 1.4 per cent nitrogen on a dry weight basis. Composting is an excellent pretreatment for paunch manure before applying it to the soil. The very high moisture content and associated bad odor of paunch manure can both be eliminated through composting. This eliminates the problem of flies being attracted to the waste as a breeding site. At Mead, composting of paunch manure has been enhanced by mixing a windrow of the waste with composted feedlot manure. After short periods of turning and aerating the pile, there were no flies or noxious odors.

By mixing a high carbon content ash (such as that from the Quaker Oats Co. furfural plant in Omaha) with fresh paunch manure, the bad odors of the waste are eliminated by absorption, even though the moisture content is high. Composting reduces the moisture content. However, diluting the waste with carbon ash results in a reduction of the final nitrogen content of the finished compost. Using carbon ash in the first stages of composting manures, sewage sludge and paunch manure would be of special benefit near Nebraska's towns and cities. Eliminating odors would greatly curtail the attraction of flies to the wastes.

**Nebraska's Organic Resources**—A calculation of the amount of waste production in Nebraska based on animal and human populations is shown in Table 2.

**Organic Nitrogen Energy Conservation**—It is very clear that if all the animal and human wastes could be used, and applied to Nebraska's corn crop, there would be enough to apply about 10 tons per acre. Unfortunately part of the livestock wastes are spread on pastures and part of the human wastes are disposed of in septic tank systems. However, the remainder, which can be recycled in agricultural soils, is a valuable resource.

The total organic wastes contain about 1.3 million tons of nitrogen. It takes 40,277 cubic feet of natural gas to produce a ton of nitrogen in the form of anhydrous ammonia fertilizer. To recycle the organic wastes in agricultural soils for crop production would result in saving as much as 52.3 billion cubic feet of natural gas. Considering the need to conserve energy, animal and human manures must be regarded as valuable resources. While there is energy required to apply the organic nitrogen resources to agricultural soils, reducing the waste volume and moisture content by composting will accomplish further savings in energy needed to recycle the nutrients for crop production.

There are just not enough organic wastes available for recycling in agricultural soils to supply all the nutrient needs for crop production. Commercial fertilizer will continue to play a major role in agriculture. However the combined use of these organic resources and the additional needed commercial fertilizers will result in increasing the productivity of Nebraska soils. The benefits will apply to irrigated and dryland fields. Available moisture is the key to the benefits from organic resources. Under drought conditions, the organic wastes applied to soils are not lost but become available when rainfall resumes.□

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**Table 2. Animal and human manure production in Nebraska.**

| Source of manure | Tons/year, wet |
|---|---|
| Cattle | 61,251,380 |
| Swine | 2,189,290 |
| Poultry | 603,861 |
| Sheep | 27,010 |
| Total animal manure | 64,071,541 |
| Human | 90,800 |
| Paunch manure (slaughter houses) | 94,000 |
| Total organic resource | 64,256,341 Tons/year, wet |