Composting for Feedlot Manure Management and Soil Quality

doi:10.2134/jpa1997.0235

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Abstract

Contemporary industrialized grain and livestock production is characterized by efficient, large-scale confined animal feedlot operations (CAFOs) and equally efficient and large-scale, but separate, grain operations. Though both are highly productive, feedlot operators have come to view manure as a waste management problem, while grain operations face declining soil quality and a reliance on commercial fertilizers to maximize yields. Neither type of operation can be considered sustainable. Cooperative on-farm composting may provide solutions to some of the problems facing our industrialized agricultural systems and render the systems more sustainable. In this paper we view cooperative on-farm composting as the combination and processing of feedlot manure with crop stover to produce a beneficial natural soil amendment and fertilizer for those fields from which the stover was taken. Cooperative on-farm composting would help protect surface and ground-water from nutrient loading, save resources, and help renew social ties within the agricultural community. Composting stabilizes nutrients, kills pathogens and weed seeds, reduces moisture content, reduces odor, and improves physical properties of manure, thereby improving its value as a soil amendment and fertilizer. Although some N in raw manure is lost during composting, the end product differs from raw manure in that it exhibits minimal N loss in storage or after field application. Composted manure can become the primary fertilizer for grain production once the cumulative N mineralization from previous applications reach steady-state. The use of composted manure improves soil quality and greatly reduces total energy consumption compared with the use of commercial fertilizer. A hypothetical example illustrates how compost applications to irrigated corn (Zea mays L.) could result in a net energy savings of about 3.3 million Btu/acre, which is equivalent to the energy contained in 19.4 gallons of diesel fuel/acre.

Research Question

How can composting of feedlot manure help increase the sustainability of contemporary agricultural systems?

Proponents of sustainable agriculture have suggested that, to be sustainable, farming systems must consist of integrated crop and livestock production that return organic matter and nutrients to soil in the form of green and animal manure. Contemporary large-scale grain and livestock production facilities in the USA are typically not integrated. The concept of sustainability is broad, but certainly includes minimizing external inputs, minimizing waste production, maximizing net return, and maintaining native natural resources. Increasing sustainability of feedlots might involve manure management that minimizes nutrient losses and enhances the value of manure as a soil amendment. Grain operations might increase sustainability by reducing reliance on commercial fertilizers and building and maintaining soil quality. In this paper, we suggest cooperative on-farm composting will enhance these elements of sustainability in both feedlots and grain operations.

Literature Summary

To date there has been little serious consideration of composting as a means of manure management on large confined animal feedlot operations (CAFOs) in the USA. This is evidenced by both the absence of composting on CAFOs and the lack of discussions of composting in manure management review articles and livestock management text books. In
In the USA, cattle found in CAFOs produce over 85 million tons of manure each year. This management involves direct application of manure to nearby fields after some form of stockpiling. Although land application of raw manure can provide plant nutrients and soil organic matter, application of raw manure to grain fields is often discouraged because of the potential for introducing weed seeds, plant and human pathogens, and insect larvae. Excessive applications of raw manure to agricultural fields can also result in nutrient loading of surface and groundwaters.

Land application of composted manure also improves soil properties while providing plant nutrients, but compost is not subject to many of the problems associated with raw manure. The N and P in compost are stabilized into organic or humified forms, and pollutant potential is reduced. Composting destroys most weed seeds, plant and human pathogens, and insect larvae. Compost can become the primary fertilizer for small grain production once consecutively annual compost applications have allowed cumulative N mineralization rates to reach steady state.

Applied Questions

What is cooperative on-farm composting?

For the purposes of this paper, we define cooperative on-farm composting as the combination and processing of crop stover from small grain operations with manure from feedlots to produce composted manure that could then be used as a beneficial soil amendment and fertilizer on grain fields that provided the stover. Cooperative on-farm composting brings together large-scale feedlot operators and grain producers in an alliance that would serve to increase the sustainability of both operations. Feedlot operators gain an environmentally sound method of managing manure that increases the value of manure as a soil amendment. Grain operators gain a means of converting crop stover into a soil amendment that increases the fertility and quality of soils and decrease their reliance on commercial fertilizers.

Are contemporary agricultural systems unsustainable?

Operators of large feedlots are faced with handling large quantities of manure generated within a relatively small area. When manure is improperly managed it loses its value as a beneficial soil amendment and causes nutrient loading of surface and groundwater. Common forms of improper manure management include indefinite stockpiling of manure and excessive application of raw manure to immediately adjacent cropland. Managing large quantities of manure as a waste product rather than a valuable natural resource should be considered unsustainable.

Because of economic forces and government policies, large-scale grain operators have adopted farming practices that maximize short-term yield, rather than maximize net profits. These practices have depleted the soil of native organic matter and nutrient reserves, and have forced a reliance on purchased commercial fertilizers and must also be considered unsustainable.

How is energy saved by applying composted manure rather than commercial fertilizer, and are the energy savings realized by the grain producer?

Composting of cattle manure and its application to grain fields certainly consumes a significant amount of energy and labor. The total energy consumed in the composting and application of cattle manure that has been composted with corn stover at a C:N of 30:1 is roughly 33 000 Btu/lb of finished compost. This reflects a total energy consumption of just under 2 billion Btu/acre. In contrast, the energy required for the production and application of commercial N and P fertilizers totals over 5 billion Btu/acre. By replacing commercial fertilizers with composted manure, a net energy savings of over 3 billion Btu/acre would be realized, a value equivalent to over 19 gal of diesel fuel/acre.

Whether grain producers would realize this significant energy savings is partially dictated by the relationship of economics to energy production. Currently, the costs of energy production in the USA are kept artificially low: the consumer pays only of fraction of the full cost of modern energy extraction, production, and delivery. Subsequently, costs of producing commercial fertilizers have been kept artificially low. The relatively low cost of commercial fertilizers along with the relatively high cost of land make fertilizer purchases a minor component of total operating costs. Fertilizer costs would become more daunting if the cost of energy required to produce the fertilizers were to rise.

Can composted manure effectively supply the N fertility needs of grain crops?

Commercial fertilizers supply a readily available source of nutrients for crop uptake, whereas nutrients in composted manure must be transformed by microorganisms to a mineral form prior to plant uptake. This means that all the N applied in the form of compost will not be available for plant use during the first growing season. During the first few years of compost applications, insufficient N will be released from the compost for plant uptake and supplemental N fertilization would be required. However, each year the cumulative N mineralization rates will increase until a steady-state condition is reached. Using published N mineralization values, it would take about 12 yr of consistent compost applications to reach degraded soils and yield of crops grown in Western Serbia.

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soil. Composting converts nutrients into forms that don’t leach, kills weed seeds and pathogens (like fecal coliform), makes nutrients more available to plants, and may increases plant health. It also reduces the volume of material by as much two-thirds, and it can be spread year-round. batch of poor quality compost can undo years of marketing work and drive customers away indefinitely. The importance of perception cannot be overstressed. Composting reduces the carbon to nitrogen ratio in manure. A high carbon content promotes the growth of soil microorganisms, but these same organisms also require nitrogen for growth and cell maintenance. When there is not enough nitrogen available, these organisms will “steal” nitrogen from plants and desired crops. Compost as a soil amendment: Amending soils with composted materials has been reported to increase tomato and pepper yields. However, combining compost and inorganic fertilizer has generally been more effective in producing a positive plant response than separate. Prepared by: Dr. Monica Ozores-Hampton. 38. SOIL AND NUTRIENT MANAGEMENT: Compost and Manure. How to calculate compost application rates for tomatoes based on crop N requirements: 10 tons of compost x 60% dry weight = 6 tons compost dry weight. Feedlot manure composting: Some individual operations compost with their own equipment. • Others contract out their manure composting. • Either way: • Manure is formed into long narrow windrows • Involves incorporation of air into manure by. Feedlot manure composting/GHG trials at Lethbridge Research Centre. Year 1997 1999 2002. Comparison Passive vs. Active Aeration Straw vs. Wood Bedding Check vs. Phosphogypsum Addition.