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Options for Land Application of Solid Manure

Shafiqur Rahman, Assistant Professor
Extension Waste Management Engineer
North Dakota State University

Ron Wiederholt, Nutrient Management Specialist
Carrington Research Extension Center
North Dakota State University

Based on the type of livestock facility, manure can be handled and stored as a liquid (less than 5 percent dry matter), slurry (5 to 10 percent dry matter) and/or solid (greater than 15 percent dry matter). Figure 1 shows the relative consistency of the various types of manure that common animal species excrete. Depending on manure consistency, manure application equipment and application methods differ significantly.

Typically, beef cattle and poultry manure are handled as solid manure, whereas dairy and swine manure are stored and handled as liquid manure. Manure contains essential nutrients (nitrogen, phosphorus, potassium, etc.) and can be applied to land as fertilizer to meet crop nutrient requirements.

During storage, nutrient losses are a normal phenomenon. A significant portion of nutrient losses

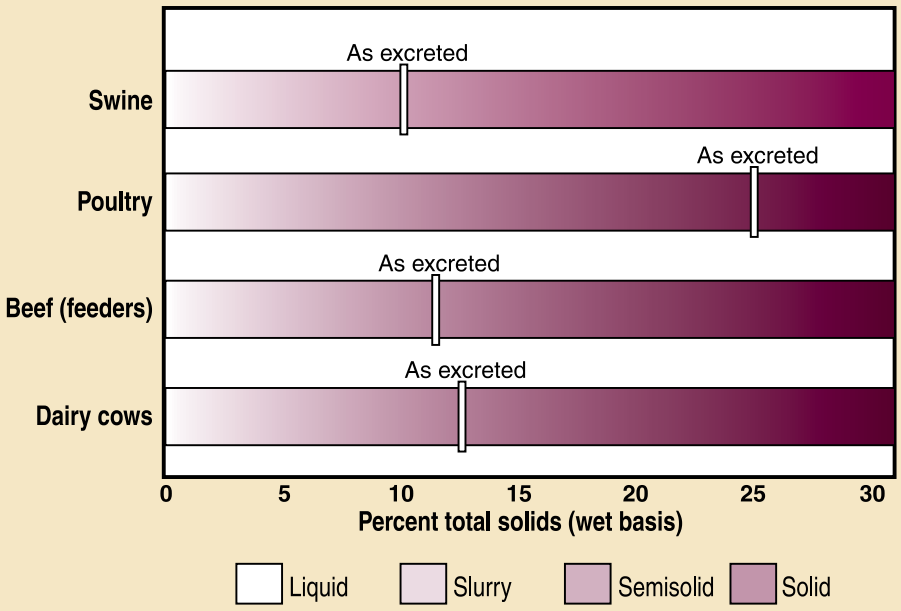

Figure 1. Relative consistency of various types of manure (Fulhage et al., 2001)

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Figure 2. Manure spreader configurations: a) spinner spreader, (b) double horizontal beater and c) double vertical beater
(Shafiqur Rahman, NDSU)

occurs during land application, depending on the application method, such as surface vs. subsurface injection. Typically, most solid manure is applied on the surface, often followed by incorporation.

Truck-mounted and trailer-towed box spreaders are very common for solid-manure application. However, solid manure typically is applied using truck-mounted spreaders (Figure 2) ranging in capacity from 3 to 20 ton and in lengths from 16 to 22 feet.

Solid-manure spreaders provide side or rear delivery of manure. However, technology for side delivery of manure is pretty much obsolete, while rear delivery of solid manure is widely practiced as the technologies become more advanced.

The spreader mechanism (paddles, flails or augers) at the side or rear of the spreader disperses manure on the ground. Rear-delivery technologies may include a spinner spreader, single or double horizontal beater and vertical beaters. Norman-Ham et al. (2008) concluded that distribution of manure across the application swath of a spreader needs to be relatively uniform to take full advantage of the fertilizer value of solid manure.

Single-beater spreaders have difficulty spreading manure uniformly to take full advantages of nutrients in manure. They also have trouble breaking litter cakes and large clumps.

With horizontal beaters, manure is spread only as wide as the wheel tracks (Figure 2b). To overcome this issue, double vertical beaters might be a better option (Figure 2c). Double vertical beaters may spread manure wider and thinner, compared with horizontal beaters.

The main problem with the box spreader is uniformity. A more uniform pattern can be achieved by reducing the swath width and increasing overlap. Similarly, regardless of type, manure spreaders are heavy and they likely will compact soil, especially during fall and spring application when soil moisture is high.

Truck-mounted double beater spreaders have various arrangements and control systems (hydraulic push, variable speed apron drive)

Figure 3. Rear-delivery double-beater spreader configurations: (a) Double vertical beaters with lower spinner disks, (b) Double vertical beaters with lower spinner disks and hydraulic push manure spreader, (c) Chisel teeth horizontal beaters, (d) Chisel teeth vertical beaters (Shafiqur Rahman, NDSU)

(Figure 3). All of them have unique beater design and manure-spreading patterns. Figure 3 shows various vertical and horizontal spreader beater configurations available on the market. Double vertical spreaders have greater discharge capacity and swath width.

The beater assembly in many of the new spreader systems can be removed easily, and the spreader box can be used for other purposes, such as stockpiling manure or as a silage wagon.

The traditional surface application of manure may lead to nutrient loss, nuisance odor, nutrient runoff and soil compaction. Although incorporation will minimize some of these concerns, delayed incorporation (more than 24 hours) can result in increased nuisance odor, nitrogen nutrient losses through volatilization, and surface runoff.

Manure can be subsurface banded to overcome problems associated with surface application of solid manure. Until recently, subsurface application has been available only for liquid manure or slurry. Research has been conducted in Canada and the U.S. to develop implements for subsurface band application of solid manure from poultry and feedlots.

Applying the manure using a subsurface method decreases odor and greenhouse gas emissions while improving air quality and the social acceptance of the practice. The U.S. Department of Agriculture-Agricultural Research Service's (USDA-ARS) National Soil Dynamics Laboratory (Auburn, Ala.) has developed a four-row prototype implement for subsurface band application of poultry litter (Figure 4) and has used the implement to apply poultry litter in row crops and pastures.

Figure 4. Side view of a prototype of the subsurface band applicator implement for poultry litter developed by USDA-ARS at Auburn, Ala. (Source: Thomas Way, USDA-ARS).

CONCLUSIONS

Feedlot manure typically is handled as a solid and can be applied as fertilizer to meet crop nutrient requirements. Most of the solid manure-handling equipment is truck- mounted or tractor-towed to disperse manure using single or double beaters in a horizontal or vertical configuration on the side or rear of the implement. Compared with horizontal beaters, vertical beaters have greater discharge capacity and swath width, and better uniformity of application.

To minimize nutrient losses and maximize nutrient utilization, manure may be incorporated within 24 to 48 hours of application. Although solid manure injection systems are not commercially available, research is ongoing and technology will be available commercially.

Suggested References

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