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Economics of Liquid Manure Transport and Land Application

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Many of the questions that manure managers have relate to capacity, cost, and labor requirements of manure hauling systems. As farms have consolidated and increased in size manure handling equipment has evolved to transport and apply manure quickly and efficiently. Large spreader tanks, in excess of 10,000 gal, have been developed, the use of in-field manure transfer systems have improved the productivity of over-the-road nurse trucks, boom extensions have reduced the need for in-field truck maneuvering, and high-capacity pit and spreader pumps have reduced the time needed for loading, unloading and land application. We recently completed an economic evaluation of liquid manure hauling costs and labor needs with top-loading tank spreader systems on dairy farms based on the hauling rates (gal/hr) and efficiencies we observed on several well-managed livestock farms.

The cropping systems included acreage in alfalfa, corn silage and corn grain. The average manure hauling distance was 1, 1.5, 2, and 2.5 miles for 175-, 350-, 700- and 1400-cow farms, respectively. Some fields were as far as 2 miles from the manure storage on the 175-cow herd, 3 miles for the 350- and 700-cow herds, and 4 miles for the 1,400-cow herd. Tank spreaders ranged from 3,000 to 9,000 gal and the equipment used was sized to complete annual manure hauling operations in about twenty, 10-hr days (200 hr).

The economic evaluation included costs for agitation and pumping, over-the-road transport and land application by either injection with a 6-point injector or surface broadcast with tillage incorporation. The hauling rate declined rapidly as the distance increased. Compared with fields near the storage facility, the hauling rate fell by 20% with a 1-mile haul, 40% with a 2-mile haul and 50% with a 3-mile haul.

175-cow Dairy Example

The 175-cow dairy applied about 1.53 million gal/yr with an average hauling distance of 1 mile, but some fields were as much as 2 miles from the manure storage. Transport and application was with a 3,000 gal tank spreader and 120 hp tractor. Tillage incorporation was with an 18-ft disk and 140 hp tractor. The farm-average hauling rate was about 10,000 gal/hr, but the field-average rate ranged from 12,000 gal/hr for fields near the pit to 7,600 gal/hr for outlying fields. Eighteen days were needed for transport and land application.

The total cost for pumping, agitation, hauling, land application and tillage incorporation was 1.18 cents/gal (Figure 1 on page 14). Transport and land application accounted for two-thirds of the total cost. Manure agitation and pumping included 16 labor hours for set-up and agitation, plus agitation while the pump was filling the spreader. Pumping and agitation was about 14% of the total cost. Thirty-one hours were needed for tillage incorporation at a cost of \$14.30/acre. Tillage incorporation accounted for 20% of the total hauling cost. The total cost for these operations was \$103/cow per year or \$74/acre.

Slurry injection eliminated the need for tillage incorporation and helped reduce odor and nitrogen loss, but increased the cost of transport and land application by a small amount. When slurry injection was used the farm-average hauling rate fell about 13% to 8,900 gal/hr. The field-average rate ranged from 10,300 gal/hr near the pit to 6,800 gal/hr for the outlying fields. Two additional days were needed for injection compared with a surface broadcast application because the unloading rate was less and more time was needed for maintenance of injectors. However, when the time for tillage incorporation was added to the time for surface broadcast, about 10 more hr (one additional day) was needed for broadcast and incorporation than for injection on the 175-cow farm.

The total cost for injection (1.22 cents/gal) was about 3% greater for broadcast with tillage incorporation. The annual cost for pumping, agitation, transport and injection was \$73/acre or \$107/cow per year, about \$4/cow per year, more than with broadcast and incorporation.

1,400-cow Dairy Example

The 1,400-cow dairy applied 12.2 million gal/year with an average hauling distance of 2.5 miles but some fields were as far as 4 miles from the manure storage. Four 9,000 gal tank spreaders with 240 hp tractors were used for transport and broadcast application. The farm-average hauling rate was 72,400 gal/hr, but the field-average rate ranged from 90,300 gal/hr within 1 mile of the farm to 48,600 gal/hr with a 4-mile haul. Manure was incorporated with a 32-ft disk and 180 hp tractor. Two large lagoon pumps were used for pit pumping and agitation.

The total cost for pumping, agitation, hauling, land application and tillage incorporation was 1.34 cents/gal (Figure 2). Transport and land application accounted for 79%, pumping and agitation was 13% and tillage incorporation was 8% of the total cost. Surface broadcast application required 217 hr (21.7 days), tillage incorporation required 136 hr (13.6 days).

When slurry injection was used the farm-average hauling rate was 58,600 gal/hr, but the field-average rate ranged from 71,000 gal/hr near the storage to 42,700 gal/hr for outlying fields. Twenty-six days (260 hr) were needed for injection compared with 21.7 days (217 hr) for a broadcast application, but when the time needed for incorporation was included, the broadcast application required 90 more machine hours than injection. The total cost of injection (1.48 cents/gal) was 10% greater than broadcast with tillage incorporation. The annual cost for pumping, agitation, transport and injection was about \$84/acre or \$129/cow per year, about \$13/cow per year greater than broadcast and incorporation.

Summary

Manure transport and land application is an expensive and time consuming process. The cost for pit agitation, pumping, and transport and land application ranged from 1.18 cents/gal (\$103/cow/yr) for broadcast and incorporation for a 175-cow herd with a 1-mile haul to 1.48 cents/gal (\$129/cow per year) for a 1,400-cow herd with tank spreaders, nurse trucks and subsurface injection. There was no cost advantage for large farms when manure handling equipment was selected to complete field operations within about 20, 10-hr days (200 hr) per year. The hauling efficiencies of larger tank spreaders were offset by the greater hauling distance for the larger herds.

Custom manure haulers have the skill, labor and specialized equipment to handle manure efficiently and effectively. Custom hire of manure application services may be a good management choice for many dairies. Based on a current value of \$0.50/lb for commercial nitrogen, phosphorus and potassium, the nutrient value of liquid dairy manure with an analysis of 24 lb N:18lb P₂O₅:29 lb K₂O is about \$36/1,000 gal. Manure managers can recover handling costs by testing soil and manure and reducing commercial fertilizer purchases when crop nutrient needs can be met by manure nutrients.

For additional information about the economic analysis and results reported in this article see, Hadrich, J.C., T.M. Harrigan and C.A. Wolf. 2010. Economic Comparison of Liquid Manure Transport and Land Application. *Applied Engineering in Agriculture* 26(5): 743-758. To contact by email, write to Tim Harrigan <harriga1@anr.msu.edu>.