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Survey of Manure Spreading Costs Around York, New York

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Summary: Manure handling continues to be a concern for dairy farmers. Potential alternatives to manure handling need to be evaluated based on the present cost of spreading manure. Survey results were used to find the variation in the cost of spreading and the fertilizer saved around a potential centralized anaerobic digester. The average farm in the York, New York area had a net cost of spreading manure of $77 with a range of a net return of $37 to a net cost of $225 per acre spread. Costs were higher for farms less than 400 cows and for farms that did not store manure. There is potential cost reduction in both better fertilizer management, use of more efficient equipment, and the use of alternative handling methods on smaller farms.

Keywords:

Dairy Manure, Manure Spreading, Agricultural Machinery Management, Nutrient Planning

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Introduction

Handling manure on a dairy farm can be a costly and difficult task. A dairy farmer deals with waste materials very similar in nature to sewage sludge, except that it is cleaner, since it does not contain the range of pollutants found in municipal wastes. The quantity can exceed the sludge generated by communities of 10,000 people or more. Larger dairies may handle manure volumes equal to sludge generated by a city of 250,000 people. Whereas city taxes pay for sludge or biosolids treatment and disposal, the dairy farmer must minimize his costs to stay competitive.

Today as more economic and population pressures grow and as agricultural enterprises increase in size agricultural management is challenged to provide both an economical and environmentally correct way to handle manure. Increasing non agricultural rural residents are less tolerant of both water and air pollution. Environmental agencies are looking closer at the potential discharges from farms. These factors cause many farmers to feel pressured to improve their manure handling systems.

Part of good dairy farm management has been the assumption that dairy wastes are recycled to the cropland in proportion to fertilizer needs. This cycle has been practiced to minimize water pollution, while also minimizing the purchases of inorganic fertilizers. Farms vary in their ability to do this successfully. Often farmers store their manure for both water quality and efficiency reasons. The odors created when spreading the stored manure on a large portion of the farm can cause conflicts with irate neighbors.

In order to explore opportunities for alternative manure handling methods the cost of present manure spreading practices needs to be determined. If the present practices are a benefit to the farm then replacing them with handling methods that may cost the farm will not be readily accepted by the farms. If however, the present manure practices are a net cost to the farm, farmers should be more willing to explore alternative manure handling methods even if it is determined that they have a cost equivalent to present practices.

Because of odor concerns a feasibility study was initiated in the York, New York area to determine if methane digestion at a centralized location would be an appropriate method to handle the manure on the dairies surrounding the hamlet. Of course, each farm situation is different depending on its location, management, equipment, et cetera. In order to identify manure management costs and benefits through the eyes of York, New York dairy farmers, a detailed survey was taken during the Spring and Summer of 1996. The objective was to determine the manure spreading costs of the farms in this area.

Data Collection

The Natural Resources Conservation Service, and Soil and Water Conservation Districts, in Livingston, Wyoming, and Genesee Counties, identified 97 dairy farms as being within 20 miles of the proposed site and having at least 100 dairy cows. The farms have an estimated 30,450 mature dairy cattle in this area. Cow numbers and road miles from a proposed centralized digester site are shown in Table 1.

Table 1. Farms Around The Proposed Centralized Anaerobic Digester near York, NY.

Road Miles From Site	Mature Cows	Number of Farms	Average Cows per Farm
1.8 or less	3820	5	764
5.2 or less	5600	16	350
10 or less	10,010	36	278
14.3 or less	16,980	65	261
15.5 or less	21,215	75	283
16.9 or less	26,010	85	306
21.4 or less	30,450	97	313

Responses

A survey was sent to the 97 dairy farms identified. The farms were asked the amount of waste they produced, the equipment used to spread the waste, and the time it took to do so. They were asked to give the value of commercial fertilizer spread on manured and non-manured fields and the value they placed on the manure. Other questions relating to methane digestion were also asked in the survey. Thirty three responses were returned. Some surveys were returned with out providing answers to all the questions. Two of the farms responding were no longer in operation. Many farms had different cow numbers, both higher and lower, than were estimated by the agencies.

Survey Analysis

Many assumptions were used to estimate costs associated with manure, using the survey data. One of the problems related to the assignment of costs of tractors used to spread manure, is that they are also needed for other essential operations. Ideally, partial budgets on each farm would compare what each farmer would do if the manure spreading operation was eliminated. Presumably they might be able to lease a tractor cheaper than owning one if a large portion of the hours put on the tractor used to spread manure was eliminated. Another possibility would be that the they would keep their tractor longer thus spreading out the depreciation costs. One other possibility is that they would keep the tractor the same number of years but trade it in with a higher resale value since there would be less hours on it. All of these possibilities could not be explored with the farmers in this study.

Ownership costs of the tractor were applied on a per hour basis, based on the proportion of time that the tractor was used in manure spreading operations. Each tractor was assumed to be used the greater of: 600 hours per year or 100 hours more than the manure spreading hours. Six hundred hours was an average yearly amount that several farmers reported for yearly tractor hours. To determine the ownership costs, a 25 year or 15,000 hour life for the tractors was used. For those tractors older than 25 years, the tractor was assumed to have 5 additional years of life. All the tractors were assigned the retail price as given in official equipment dealer guides. A spreadsheet analysis was used to determine total per hour costs using the methods described in the ASAE Standards. (Agricultural Machinery Management Data ASAE D497.2 MAR94)

Operating cost of each tractor was also calculated using the spreadsheet analysis. Repair factors given in the ASAE Standard for 4-wheel drive tractors of R1 = 0.003 and R2 = 2 was used. Some of the tractors listed in the surveys were not 4-wheel drive. Four wheel drive rates were used since it was assumed that the repair factors for the two wheel drive

tractors were too high as maintenance on the small northeast dairy farms might be better than that represented by the MidWest data that was used to obtain the repair factors. Total labor costs were estimated at twelve dollars per hour. Fuel cost was determined by ASAE calculations based on horsepower. Diesel fuel was assumed for all tractors at a cost of $1 per gallon.

Manure spreaders were all assumed to be purchased new. Current purchase prices were obtained from two dealers (see Table 2). Vee spreaders were assumed to last 8 years and tanker spreaders were assumed to last 10 years. Repair factors for the spreaders were assigned at R1 = 0.096 and R2 = 1.4

Table 2 Sizes and Prices of New Manure Spreaders in York, NY Area, 1996.

I. Vee Spreaders					
capacity in gallons	912	1255	1621	2239	3000
capital cost	$7,500	$10,000	$12,500	$16,700	$20,000
II. Tanker Spreaders					
capacity in gallons	2250	3250	4500	5000	6000
capital cost	$9,000	$9,500	$14,000	$15,500	$18,500

The cost of using a truck to spread manure can vary a great deal. A new truck with a tank spreader from a manufacturer can cost more than $100,000. Most farmers buy used trucks and then have a local shop add a tank to the truck bed. Cost assumptions of $32 per hour used in this study come from an analysis of the operating and ownership costs of this manner of vehicle used on a farm in central New York. (Rasmussen, 1996) Larger tractor trailer trucks used to transfer manure on one farm are rented with a driver for $45 per hour.

Irrigation costs were calculated from a 100 Hp chopper pump, 1.23 operators, 1 mile of pipe, and a tractor run 23 % of the time to set up the traveling gun reel. Irrigation costs on each farm will be different with differing lengths of pipe needed, the amount of time needed between setups, and total hours or gallons that the ownership costs can be spread over. Thirty four dollars per hour used in this study may be low for other farms.

Two farms that irrigated their manure also had conventional manure spreading equipment. The ownership cost of this equipment resulted in a higher cost per hour since it was used less hours than if it were on a comparable farm without some of the manure spread by irrigation.

Most of the manure is available for collection in NY farms because the mature animals are kept inside 88% of the time (see figure 1). The total number of cows including replacement heifers, was about 60% higher than the number of milk cows (see figure 2). Thus a dairy that milked 100 cows actually maintains a herd size of about 160 animals. This is exactly the number of animals estimated to be on a small dairy in earlier studies (Jewell et al, 1976). The younger heifers were reported to spend an average of about 40% of the time outside the barn. It was assumed that the manure produced by the animals outside the barns was not spread mechanically.

Figure 1. Average time that mature cows spent outside the barn in the York area was 12% according to responses from the survey.

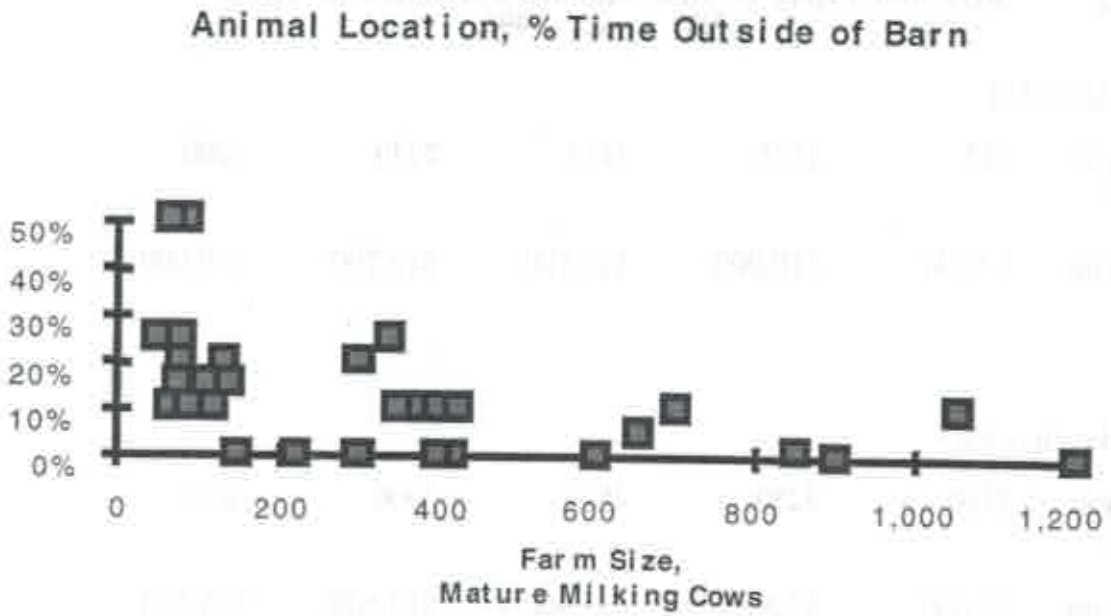
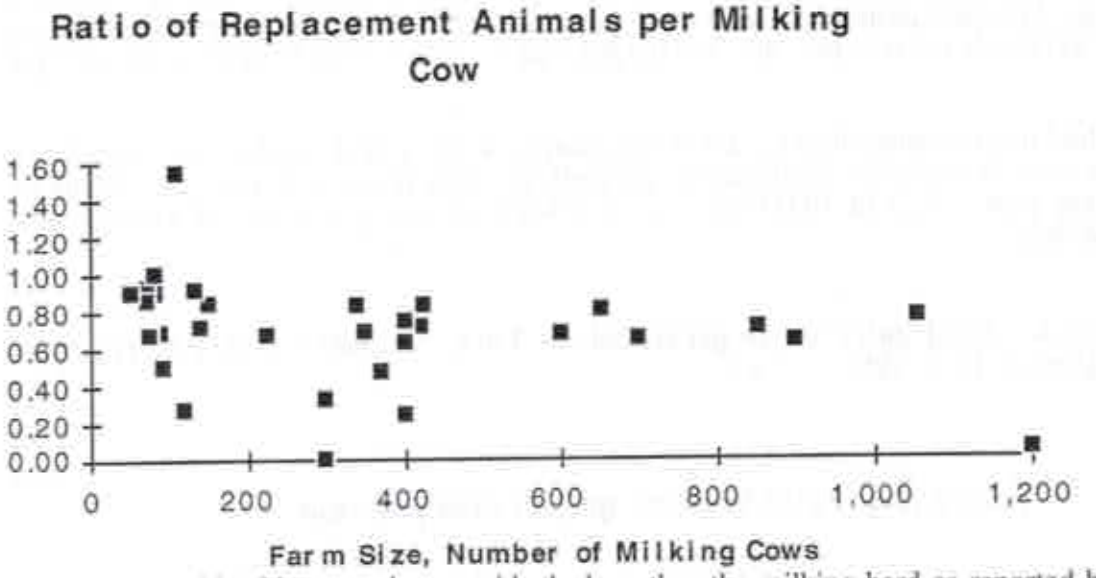
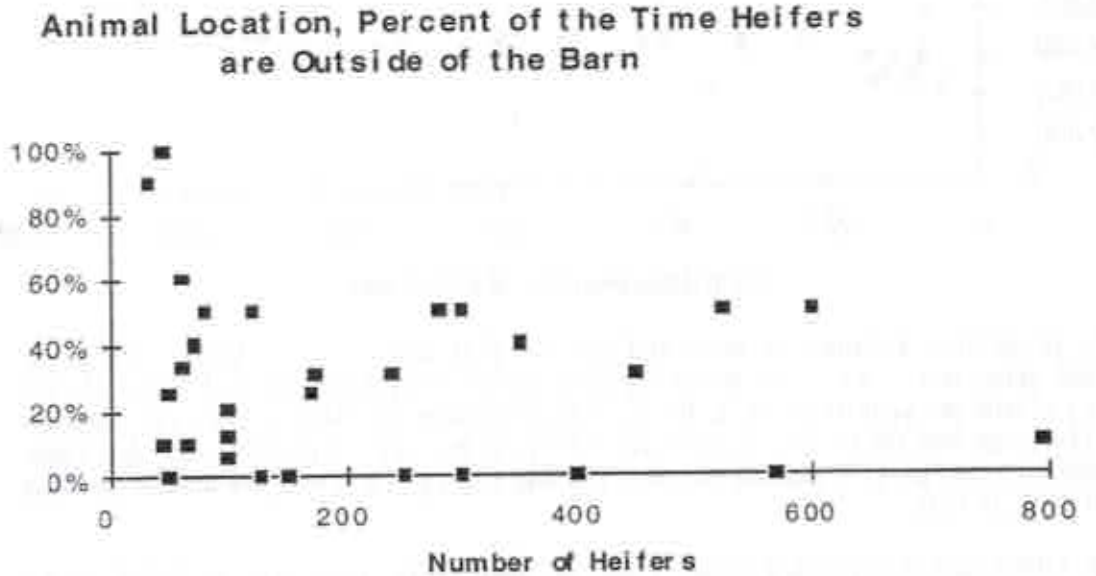


Figure 2. Ratio of replacement animals or heifers per mature cow as reported by dairy farms in the York survey.



Heifers spent considerably more time outside the barn than the milking herd as reported by the survey respondents. Figure 3 shows the time they were in a pasture situation. Their manure was also assumed to not be spread mechanically when it was produced outside the barn.

Figure 3 Nearly half the time the replacement heifers were outside the barn according to the York farm survey.



Quantity and Characteristics of Manure

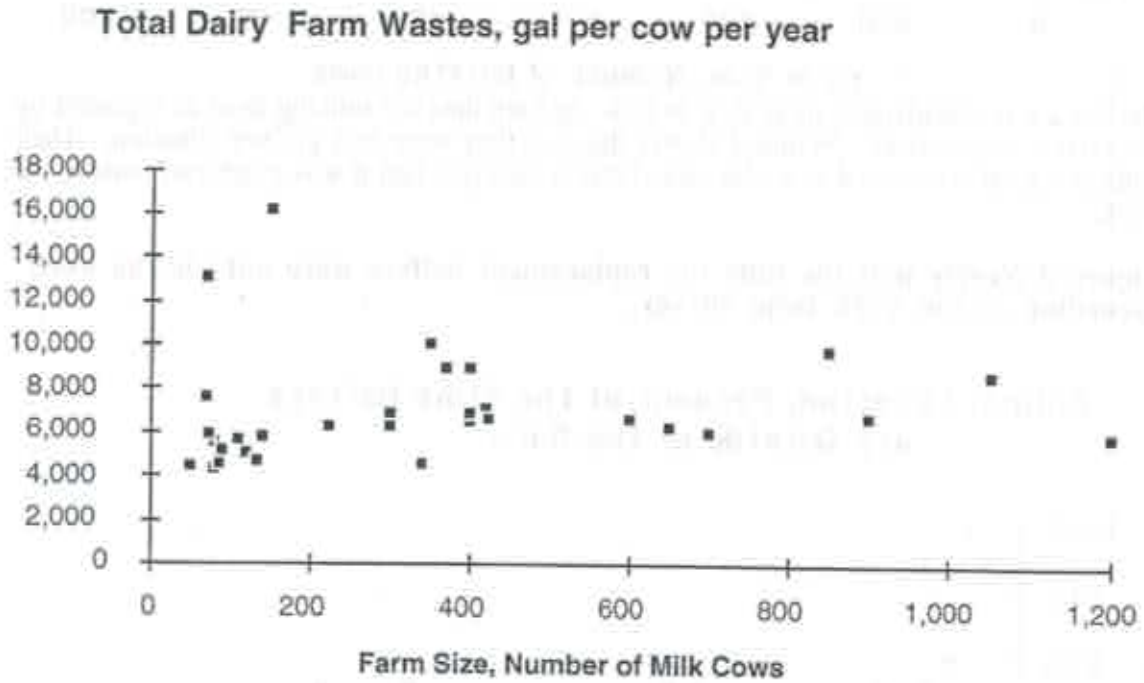
The amount of manure produced could be estimated in three ways. Method 1 used the number of loads per day times the volume of the spreader. Fourteen farmers responded

with information applicable to this method. The average number of loads was 3 per day with a range of from 1 to 6 loads. The average size of the spreader was 2900 gallons with a range of from 900 to 6000 gallons.

Method 2 used the dry matter intake of the cows per day to estimate the manure produced. (Stone) Fourteen farms responded to this question. The average dry matter intake given was 50 pounds per cow per day. The range given was from 45 to 58 pounds per cow per day.

The third method determined the amount of manure based on milk production (Van Horn). There were 24 responses applicable to this method. Milk production averaged 24,200 lb. per year with range of 19,000 to 32,000 pounds per cow per year, for farmers who responded.

Figure 4. Total dairy waste generated on York, NY dairy farms as reported by farmers in a 1996 survey.

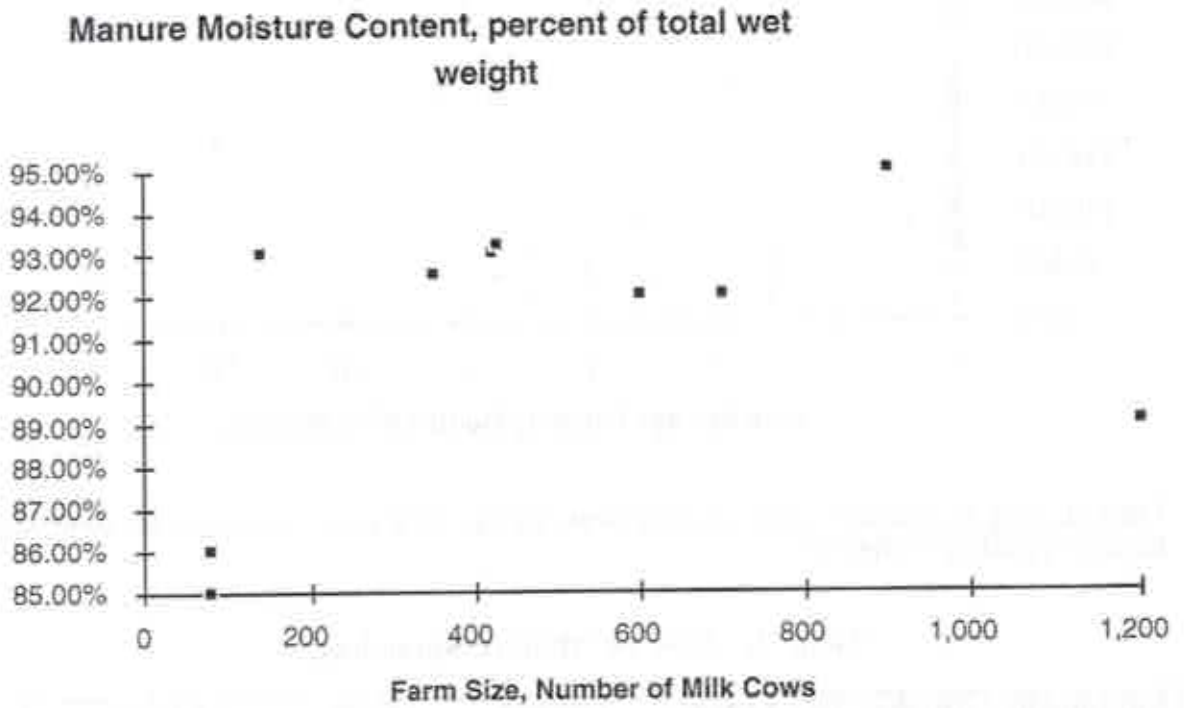


Manure production volumes as estimated by the York area dairies agrees with other estimated generation rates. The range reported varied from a low of just under 5,000 gallons per cow per year to 16,000 gallons, with an average of 7,000 gallons per cow per year. This is an average of 19.2 gallons per milk cow per day, or close to the total waste management value of 21.6 gallons per cow per day (82 kg wet waste per animal per day (Jewell et al, 1976)).

Sixteen farms said that milking center waste or other extra water was included in the manure. The average estimated amount of extra water was 2,000 gallons per day with a range of from 10 to 10,000 gallons / day.

Ten farms responded that they had a copy of their manure analysis available. The average moisture content of the manure from the analysis was 91%, with a range of 85% to 95%. This is in agreement with numerous samples taken during this study which had a dry matter range of 7.5 to 17 percent of the wet weight. The average dry matter of samples was 12.5 percent. An effort to obtain samples unaffected by dry bedding was made during the manure sample collection.

Figure 5. Reported water content of manure in York area 1996 survey.

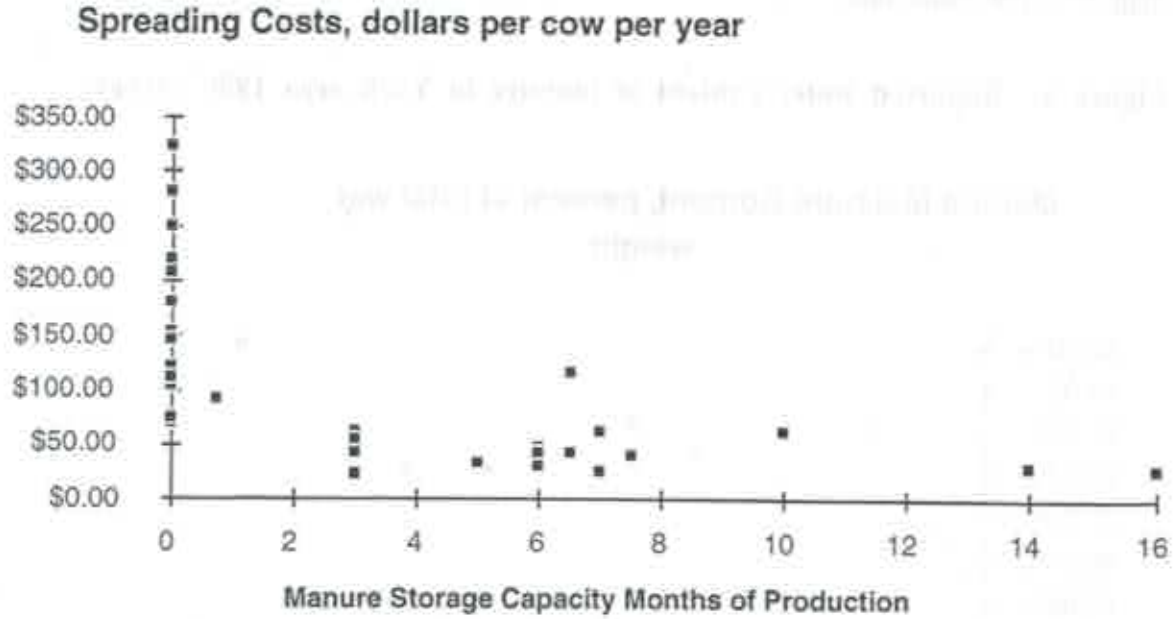


Estimated Cost of Manure Spreading

Nineteen farms responded that they spread manure daily, while seven responded that they did not. Sixteen farms had long term storage with an average length of storage of 7 months. Some farms had long term storage but also daily spread. The range in storage times was from 1 month to 16 months. Storage enables farms to make more efficient use of equipment, and this appeared to reduce the cost per cow (see figure 6).

Although these calculated costs did not include the cost of storage, analyses from Ontario indicates that storage may reduce the manure handling costs on most farms. (Hilborn, 1996) The cost of an earthen manure storage facility is not a major part of the manure handling cost.

Figure 6. Correlation of manure storage to annual cost of manure spreading as estimated on York area dairy farms.



The following summarizes types of equipment, average time used, and estimated costs of manure spreading equipment:

Table 3. Cost Of Manure Spreading

Equipment	Number Of Farms	Average Time Used: Hours per Year	Range hours	Cost $ / Hr	Range $ / Hr
Tractors:	29	491	100-1,100	31.42	23.21-43.23
Spreaders:	29	491	100-1,100	8.21	2.21-16.40
Trucks	6	495	100-1460	32	32 or 45
Irrigation equipment	2	135	100 - 170	34	34

The average time used to spread manure was 2.94 hours per cow year. There was a wide range in the time per cow from 0.57 to 12.5 hours per cow per year. The longest time was from a farm that spread manure from a small herd over extensive acreage as phosphorus fertilizer. Lower spreading times could be because of more efficient operations, the use of higher speed trucks, or from spreading most of the manure close to the barn.

The cost per hour of spreading with a truck is less than the hourly cost of spreading with a tractor and spreader. It is also faster, so more manure can be moved per hour. One disadvantage of using a truck is their limited use on snow or saturated ground. Daily spreading on most farms requires the use of a tractor and spreader.

The average number of acres spread with manure was 1.17 acres per cow. At 1,300 pounds per cow This is a loading rate of 1.11 animal units per acre. The Agricultural Environmental Planning Worksheets for NY (Cornell Cooperative Extension, 1995) list an average loading rate of 1 animal unit per acre for a corn - legume rotation as being a low potential for pollution. A ratio of 1.5 animal units per acre is listed as higher potential concern.

Spreading costs on various farm sizes can be related to annual costs per cow and cost per acre (see figures 7 and 8). Substantial unit costs are involved with frequent manure spreading on farms with less than 400 cows. This cost decreases to around $50 per cow per year or $45 per acre per year for larger dairies.

Figure 7. Calculated manure spreading costs for York area dairy farms.

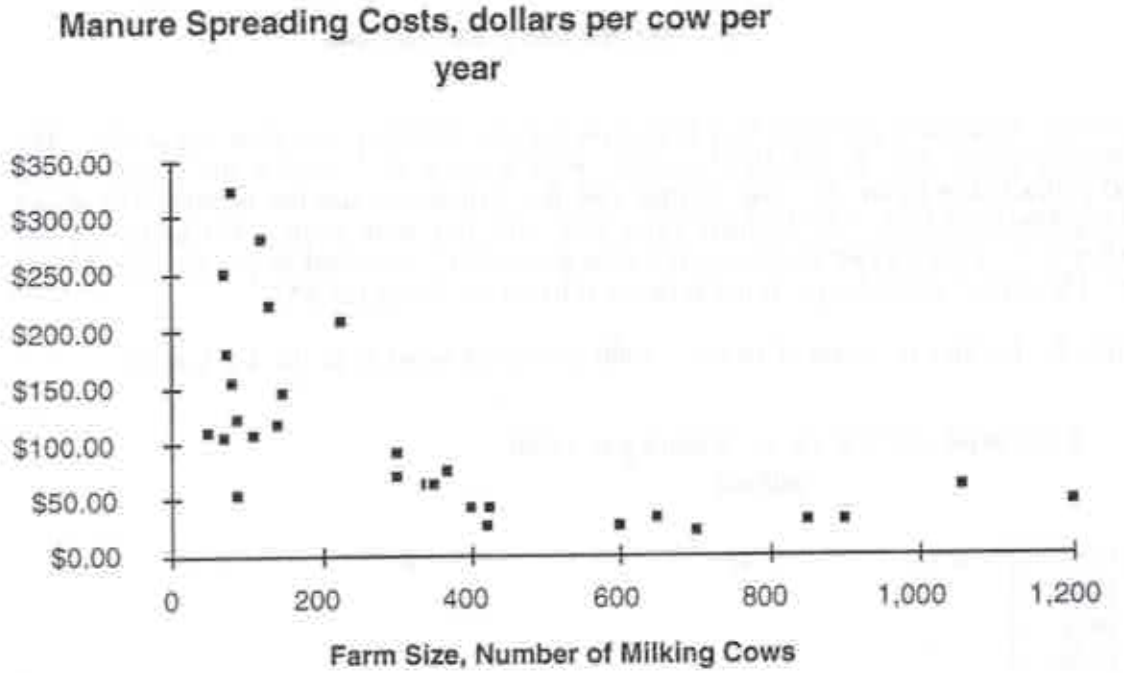
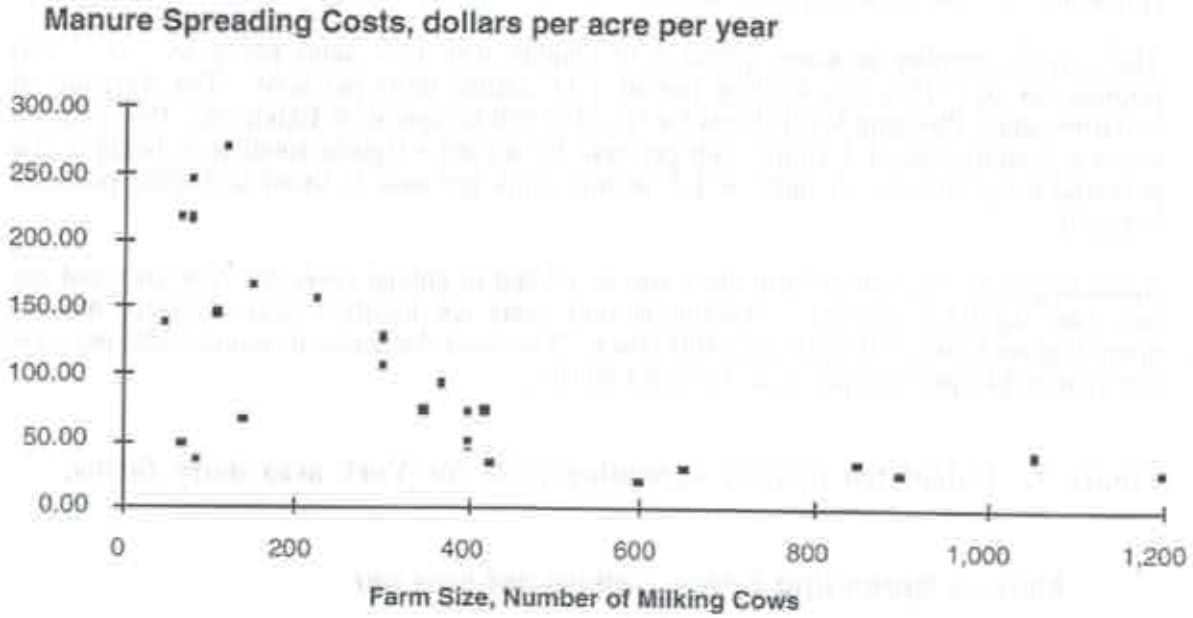
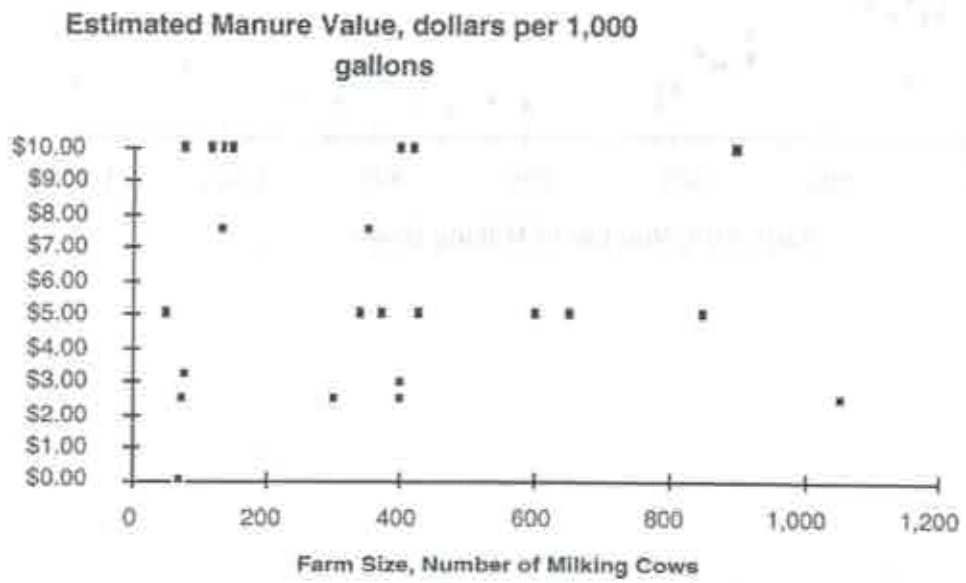


Figure 8. Calculated areal manure spreading costs for the York area dairy farms.



The farms were asked the value they placed on manure after it is loaded on a spreader. The average response was $6 per 1000 gallons, with a range of from 2.5 to 10 dollars per 1000 gallons (see figure 9) The average rate the farmers spread the manure was about 6,000 gallons per acre. The fertilizer value they said they were getting was an average of $36 per acre. This is close to the average savings that they observed in practice of $33 per acre. The cost of spreading was not accounted for in obtaining the $33.

Figure 9. Farmer estimate of value of 1000 gallons of manure in the York area.



Actual fertilizer savings were calculated by taking the cost of fertilizer on non manured fields, subtracting the cost of fertilizer on manured fields to show the fertilizer savings by using manure, and then subtracting the cost of spreading on fields. Fifteen farms responded with both manured and non manured fields; results are shown in figures 10 and 11.

Figure 10. Calculated cost of fertilizer applied to manured land in the York area.

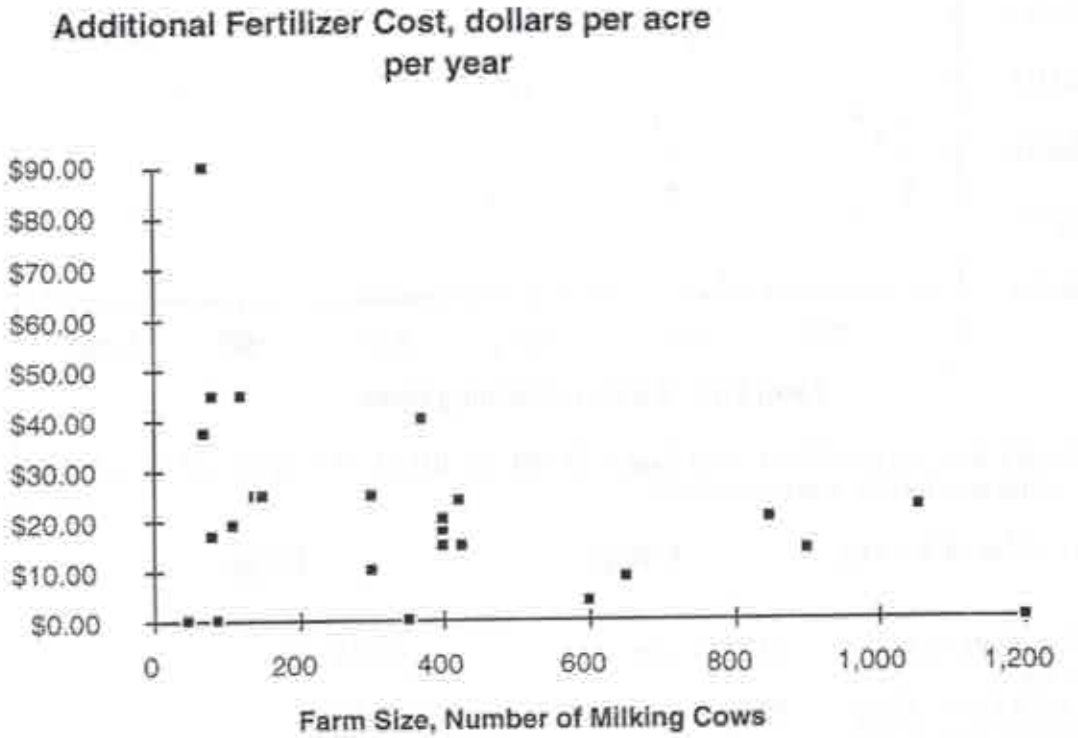
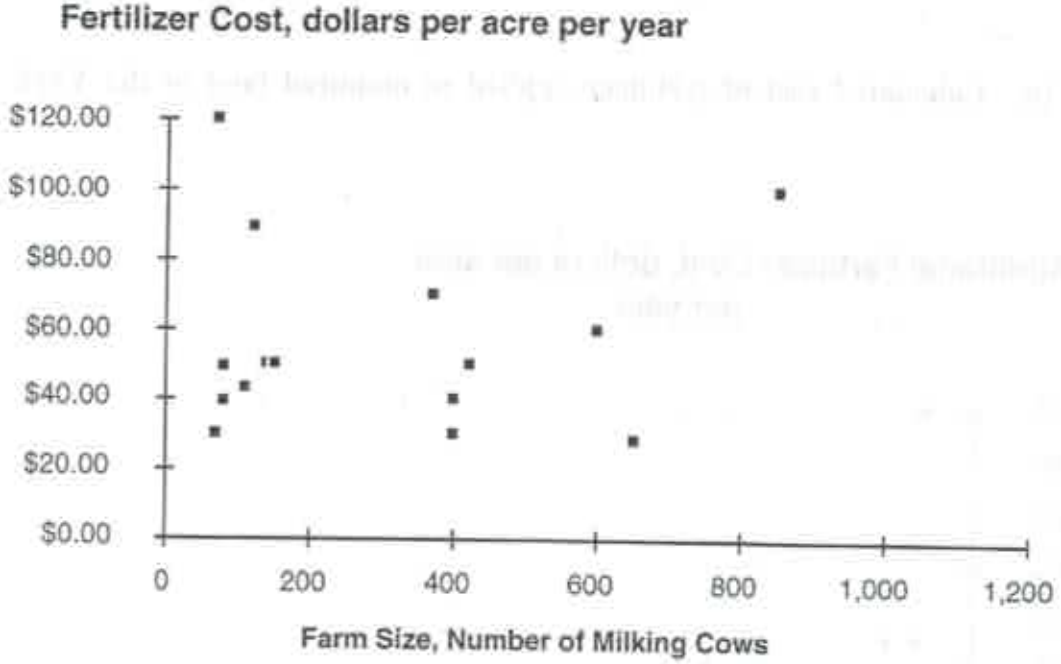


Figure 11. Cost of fertilizer on dairy farm land where no manure was applied in the York area.



The averages and ranges from calculations based on the survey response to establish manure value as a fertilizer are as follows.

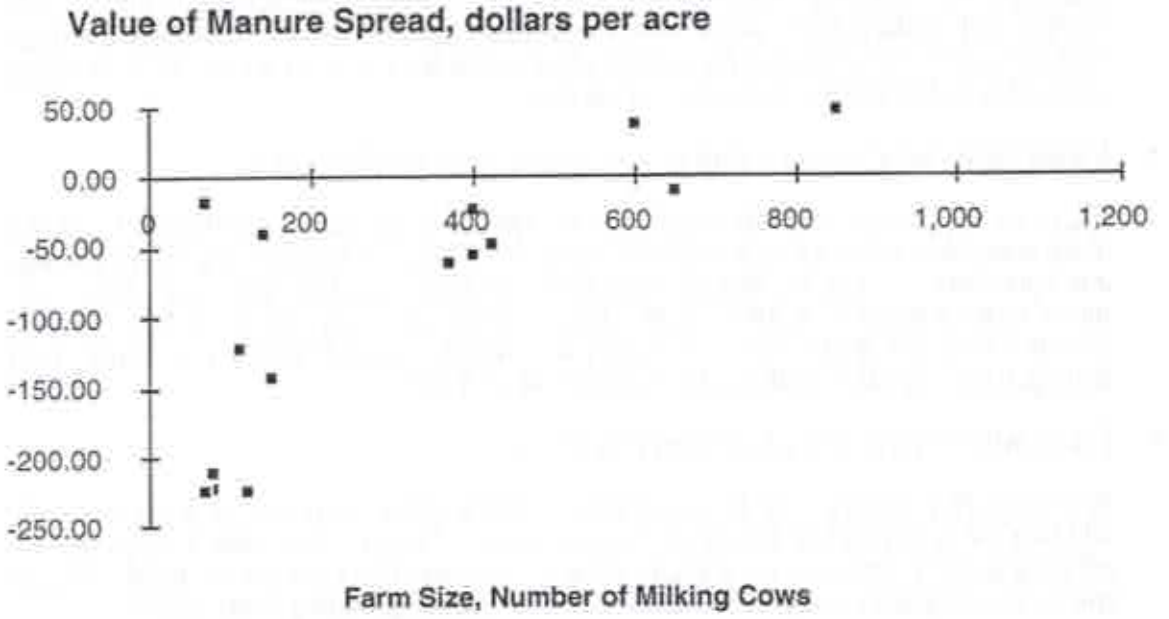
Fertilizer Value of Manure:	Average	Range
Cost of fertilizer on non-manured fields	$57 per acre	$30-$120
Cost of fertilizer on fields where manure was spread.	$24 per acre	$0-$90
Fertilizer savings	$33 per acre	$5- $80
Average cost of spreading	$100 per acre	$18.72-$269.35
Net return from spreading manure	-$77 per acre	+$37.51- -$225.02

Finally, the actual value of the manure as calculated here is shown in figure 12. Because of high costs of equipment and labor, the net value of manure is negative for smaller farms, those less than 600 cows. That is, spreading the manure costs much more than its fertilizer value on their operations. These estimates suggest that removing manure from dairies sized less than 600 cows would result in a net benefit equal to $10 to $240 per cow per year.

Alternative treatment processes that completely removed the manure and nutrients from the farm could include composting, wetland treatment, sequencing batch reactors, or protein production. These processes could reduce the ammonia from the manure leaving a solid byproduct which could be moved off the farm, or in the case of protein production, converted to animal feed. These technologies should be looked at favorably as they would also reduce the cost to the farm of spreading manure.

Anaerobically digesting the manure may not be feasible on smaller individual farms. However a centralized facility may be an alternative. Smaller farms could truck their manure to be treated and return with stabilized, odorless effluent for storage on the farm. They could then hire an efficient custom applicator to irrigate this effluent during the summer. Since the nutrients would be applied during the maximum uptake of the crop, when the soil is less likely to be saturated, and by specialized equipment it would be more likely to replace fertilizer and be lower cost than daily spreading.

Figure 12. Net value of manure spreading calculated by subtracting fertilizer cost applied to manured land and the spreading cost from fertilizer costs for non-manured land as reported by York area dairies.



A typical nutrient content of dairy manure from storage is 18 pounds of N, 6 pounds of P, and 19 pounds of K per 1000 gallons. If we assume that all the N is retained and that the P and K is needed, and that the average value of these nutrients is $0.25 per pound. Then 6,000 gallons of manure would contain $64.5 of nutrients or $10.75 per 1,000 gallons.

If the nitrogen is not incorporated and the P and K levels are already too high on the farm then the value of the manure would only be the organic portion of the nitrogen which typically is 11 pounds per 1,000 gallons. At $0.25 per pound this would only be $2.75 per 1,000 gallons or $16.5 per acre at a rate of 6,000 gallons of manure per acre. This compares well with farmers estimates of fertilizer value of from $10 to $2 per 1,000 gallons. These values do not reflect the cost of spreading the manure.

Conclusions

Although there is a wide variety of spreading equipment in use, and similarly varied farm situations, there are some trends in the data collected.

- Most farms do not have an accurate perception of the value of their manure.

  They are spending more to spread the manure than the fertilizer value that they are crediting the manure with. Since in the present system manure must be spread on the land and environmental concerns prevent extremely excessive spreading rates, manure is used as a fertilizer to try to cover the costs of disposal.

  If the ownership costs of the spreading equipment is not charged against the spreading operation, once the manure is loaded on a spreader the additional labor and operating costs can justify spreading it quite a distance from the source. Farms would be better off if the manure could be disposed of without incurring any spreading cost.

- Spreading costs can be reduced by better management.

  Spreading costs can be reduced by accurately analyzing the nutrient value of the manure and then by reducing fertilizer purchases appropriately. Several farms could significantly reduce their costs now with their present manure handling method. Reducing costs by spreading the manure close to the barn without regard to its fertilizer value may not be environmentally responsible.

- Larger farms have lower manure spreading costs than smaller farms.

  There are efficiencies of scale in the manure spreading operations on the dairies in the York area. A number of factors may contribute to this. Apparently the larger tractors and spreaders, the trucks, and the irrigation equipment used on the larger farms can move more manure at a lower cost. Larger farms are more likely to have storage systems with the lower costs associated with them. Larger farms may have more management expertise to utilize their manure as a fertilizer.

- Farms with storage have lower spreading costs.

  Spreading from storage results in a greater volume of waste to spread because of the addition of precipitation falling in the storages. Despite this added volume, the efficiencies of a continuos large scale spreading operation and the use of more efficient trucks and irrigation equipment, reduce the total cost of spreading from storage.

- Alternative manure handling methods should be explored.

  Technologies that would allow more storage, with once per year unloading, would benefit most farms. The average farm in the study should be able to afford paying up to $77 per acre per year minus fertilizer costs, to eliminate spreading altogether by treating the manure for disposal.

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