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LABOR REQUIREMENTS FOR HANDLING MANURE SOLIDS ON SMALL DAIRIES

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Summary:

Data from six dairies were obtained to determine labor requirements for handling manure from concrete basins. Most of the basins provided a minimum of 90 days of available storage. Time requirements for loading a manure spreader and traveling to and from the field varied from 13 to 32 minutes per load. However, the data showed only 1 to 2 minutes were required per cubic meter (5 to 8 minutes per 1,000 gallons) for five dairies. The sixth dairy required twice as long due to longer travel times. Results of the time and motion data indicated about 30 minutes per cow per year are required for handling manure from a concrete storage basin. The results were consistent amongst the dairies evaluated even though there were differences in loading and hauling equipment and travel distances.

Keywords:

Manure, Time, Labor, Storage

LABOR REQUIREMENTS FOR HANDLING MANURE SOLIDS ON SMALL DAIRIES

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Abstract

Data from six dairies were obtained to determine labor requirements for handling manure from concrete basins. Most of the basins provided a minimum of 90 days of storage. Time requirements for loading a manure spreader and traveling to and from the field varied from 13 to 32 minutes per load. However, the data showed only 1 to 2 minutes were required per cubic meter (5 to 8 minutes per 1,000 gallons) for five dairies. The sixth dairy required twice as long due to longer travel times. Results of the time and motion data indicated about 30 minutes per cow per year are required for handling manure from a concrete storage basin. The results were consistent amongst the dairies evaluated even though there were differences in loading, hauling equipment, and travel distances.

(Keywords: manure, time, labor, storage)

Introduction

Time and motion (TM) studies are useful in determining the labor requirement to perform a specific task in manufacturing processes. These studies have been used in the dairy industry to evaluate the labor requirements for various tasks associated with milking routine and milk parlor performance (Smith et al. 1998, Armstrong and Quick, 1986, Armstrong, et 11. 1994). Herrman and Harner (1997) used TM data to evaluate various operations associated with portable grinder mixers in preparing swine feed. Data may be used to evaluate the impact of changes or help in understanding labor requirements. The objective of this paper was to determine the labor requirements for removing manure from concrete basins prior to land applications.

Procedures

The study was conducted at six dairies located in northeast Kansas. The dairies utilized concrete basins for storing manure prior to land application. Manure was removed from the freestall alleys using either scrape or flush systems. The storage period in the basins ranged from 21 to 150 days. The moisture content of the manure was less than 80 percent if alleys were scraped. Flushing resulted in moisture contents above 80 percent when the manure was handled. The concrete basins were 0.9 to 1.8 m (3 to 6 feet) deep with the volume in proportion to the storage period and herd size. All of the dairies utilized sand for bedding freestalls. The hauling distances from a concrete basin to a field varied between

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the farms. The study was conducted during the summer, 1999 when schedules could be coordinated.

Data were collected utilizing stop watches to time a specific task required during the handling of the manure. The specific tasks recorded were:

Loading Time: time from when the spreader stopped at the loading area when one operator was used or when the first bucket began to dump into the spreader if two or more operators were present until the spreader moved away from the loading area.

Travel Time to Field: time from when the spreader moved away from the loading area until the spreading operations begin.

Spreading Time: time from when the spreading operation began until the spreading operation was completed.

Travel Time from Field: time from when the spreading operation was completed until when the loading time begins.

Wait Time: time spent waiting to back into loading position if more than one spreader was used.

The total time was equal to the summation of the five events. Radios were used to communicate when certain events occurred. Each dairy had different operating procedures as described below.

Dairy A. Utilized an industrial bucket loader and 12.5 m^3 (3,300 gal.) spreader with one person operating all of the equipment.

Dairy B. Utilized a tractor mounted front-end loader and 6.9 m^3 (1,820 gal.) spreader with two people or one person operating each piece of equipment.

Dairy C. Utilized a skid loader and three manure spreaders with four people or one person operating each piece of equipment. Data were also collected using a manure tank wagon with a single operator at this dairy. The spreader capacities were 11.1 m^3 (2,920 gal.), 8.5 m^3 (2,240 gal.) and 6.9 m^3 (1,820 gal.). The manure tank capacity was 12.7 m^3 (3,350 gal.).

Dairy D. Utilized a skid loader and 8.5 m^3 (2,240 gal.) spreader with one person operating both pieces of equipment.

Dairy E. Utilized an industrial bucket loader and two truck mounted spreaders with two people. Each person operated the loader to load his own truck. The spreader capacities were 11.1 m^3 (2,920 gal.) and 8.1 m^3 (2,145 gal.).

Dairy F. Utilized a skid loader and 8.5 m^3 (2,240 gal.) spreader with one person operating both pieces of equipment.

Data were collected during 10 to 15 round trips per spreader. A round trip was considered

the time required to complete the five sequenced time events. Data from each farm were then averaged. Statistical analysis was not performed on the data due to the variability in dairies, equipment and procedures. Manufacturer information related to spreader capacity was obtained and converted to cubic meters (1,000 gallons) for comparison among the six dairies. The manure spreaders ranged in size from 6.9 to 12.7 cubic meters (1,820 to 3,350 gallons) capacity.

Results and Discussion

Figures 1 through 3 show the results obtained from the dairies A through F respectively. The average time for loading a spreader ranged from 3 to 7 minutes. Data from Dairy C indicated a manure tank could be filled in less than four minutes which was similar loading time as compared to a spreader. Dairy C, with four persons operating a skid loader and three spreaders, had the quickest loading times. Using an industrial bucket loader with a larger bucket did not decrease loading time. This was probably due to the fact that the industrial loaders could not maneuver in the basins as easily as the skid loaders.

The time required to go from the loading area to a field or back was around four minutes. Dairy E (Figure 3) had the highest travel time, which was over 8 minutes. This occurred in part to the difficulties in moving the trucks through a congested farmstead and a two to three mile travel distance. Dairy B accomplished this task in less than two minutes but the travel distance to the edge of the field was less than 90 m (300 ft). However, Dairy A (Fig 1) had a hauling distance similar to Dairy E (Fig 3), but easier access to the storage basin reduced travel time about three minutes per one way trip. Spreading time was generally accomplished in less than two minutes. Overall, the total time required per load of manure ranged from 13 to 23 minutes except for Dairy E which had a total time per load of over 30 minutes.

The data were converted to time required per cubic meter (1,000 gallons) since there was variation in the size of manure spreaders. A bushel of spreader capacity was assumed to be equal to 0.023 m^3 (0.8 ft^3 or 7 gal.). The data shown in Figure 4 is the time requirements per cubic meter for all of the dairies. Between one and two minutes were required per cubic meter removed from the concrete basin for all of the dairies except Dairy E. This was in spite of the number of operators, differences in spreader capacity and loading equipment and distance to the fields. The increased travel time at Dairy E was mainly due to the difficulties moving from their concrete basin through the farmstead to the road.

A 635 kg (1,400 lb) cow produces around 54 kg (120 lb) of manure per day. Fresh manure averages 87 percent moisture content. Previous work found that manure in most concrete basins averaged less than 80 percent moisture. Therefore, at 80 percent moisture about 12.7 Mg (28,000 lb) or 11.4 m^3 (3,000 gal) enters a basin each year per cow. Using the TM data, about 15 to 20 minutes of labor are required per cow each year when the manure is stored in a concrete basin. For a 100-cow dairy, this represents about 30 hours of time per year. Time requirements for a small dairy which typically scrapes and hauls is equal to around 90 hours. This was based on hauling every other day and 30 minutes per trip. Dairy E would require about 30 minutes per 11.4 m^3. There does not appear to be any additional labor or time required for hauling manure stored in a concrete basin when compared to hauling three or more times per week. Using labor and equipment cost of $60 per hour, the

concrete basin would save $3,600 per year per 100 cows in handling manure.

Summary

Time requirements for loading a manure spreader and traveling to and from the field varied from 13 to 32 minutes per load. However, the data showed 1 to 2 minutes were required per cubic meter (5 to 8 minutes per 1,000 gallons) irrespective of the loading and handling procedures used. The preliminary results of the TM data indicate less than 30 minutes per cow per year are required for handling manure from a concrete storage basin. Each dairy is being revisited during the summer, 2000 to determine if the TM data are similar. The 1999 results were consistent amongst the six dairies evaluated even though there were differences in operating procedures. The data enables dairy producers to assess labor and equipment needs for performing the various operations associated with hauling manure from a concrete storage basin.

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References

Armstrong, D.V., and A.J..Quick. 1986. Time and motion to measure milking parlor performance. *J. Dairy Science.* 69(4):1169-1177.

Armstrong, D.V., J.F. Smith and M.J. Gamroth. 1994. Milking parlor performance in the United States. In *Dairy Systems for the 21st Century. Proc. of 3rd Int'l Dairy Housing Conf.*, 59-69. ASAE: St. Joseph, Mich.

Herrman, T.J., J.P. Harner, S. Baker, M.R. Langemeier. 1997. Time and cost analysis of on-farm portable feed manufacturing. *Applied Engineering in Agriculture*. Vol 13(3):421-425.

Smith, J.F., D.V. Armstrong, M.J. Gamroth and J.P. Harner, III. 1998. Factors affecting milking parlor efficiency and operator walking distance. *Applied Engineering in Agriculture*. Vol 14(6):643-647.

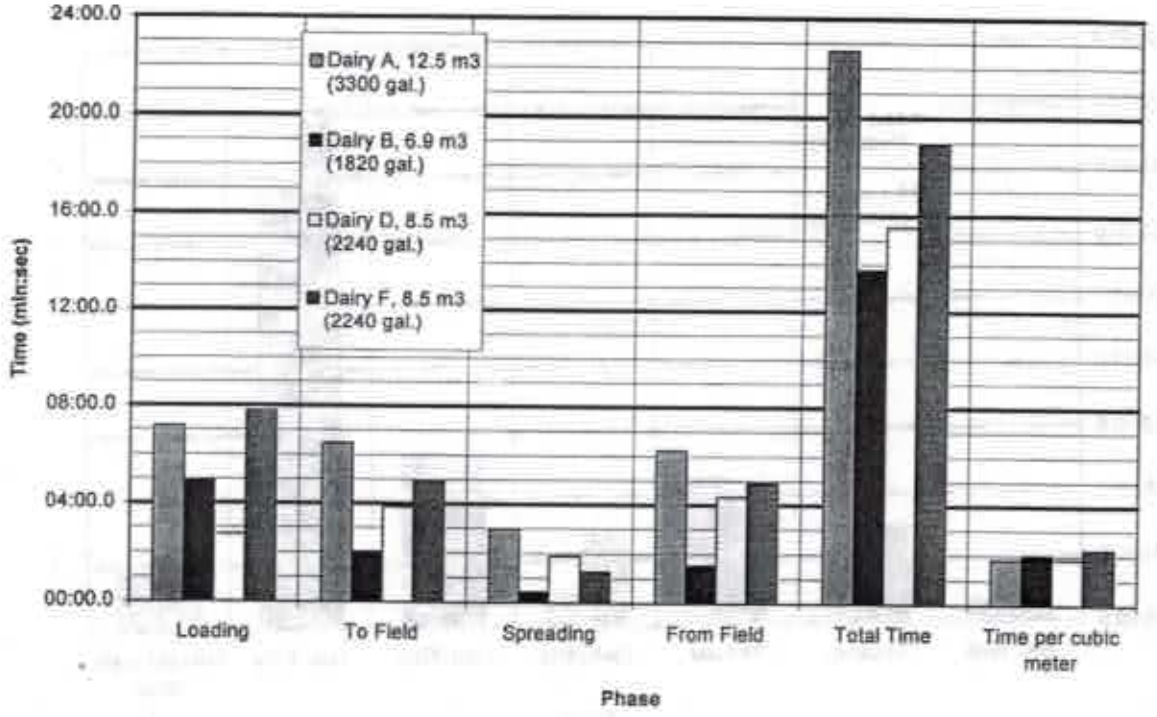

Figure 1. Time and motion data from Dairies A, B, D, and F. Each using one spreader, but with different loaders and travel distances.

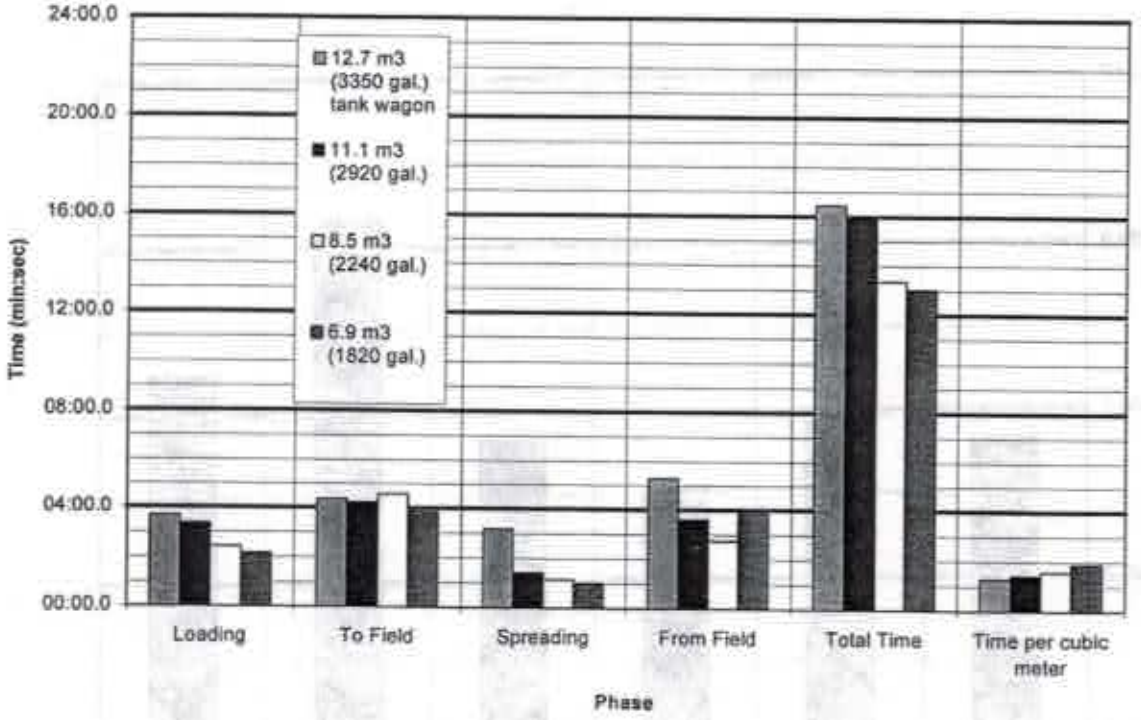

Figure 2. Time and motion data from Dairy C using a skid loader and three manure spreaders with one person operating each piece of equipment. Data for the manure tank wagon were based on a single operator.

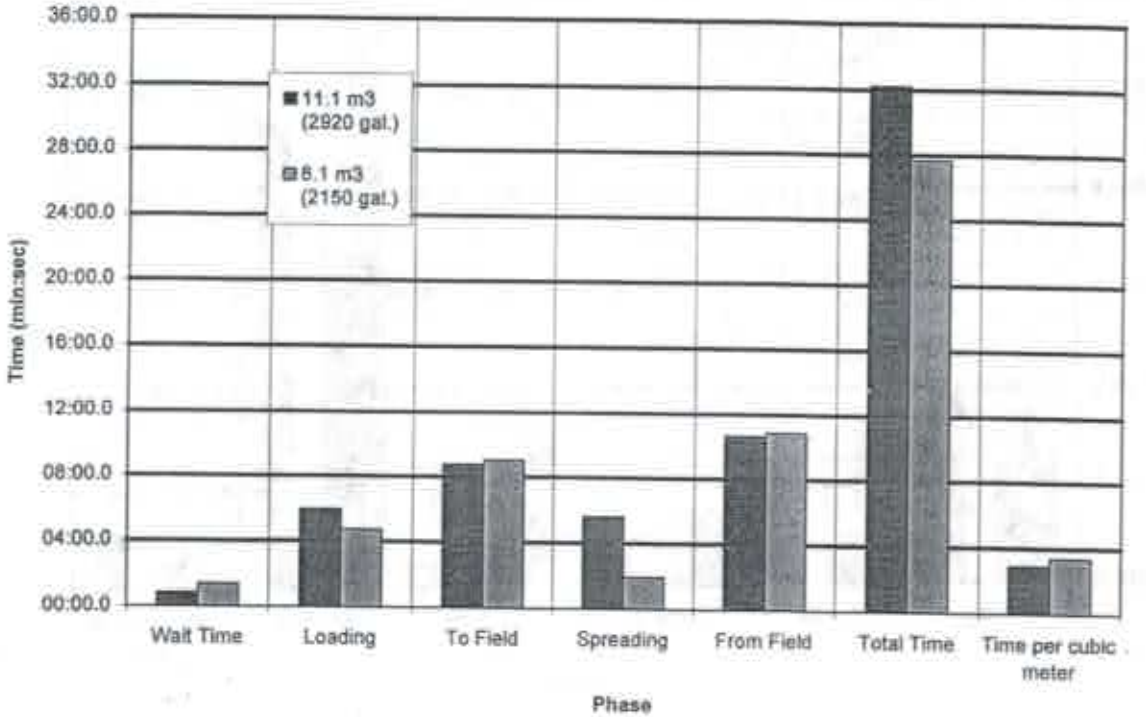

Figure 3. Time and motion data from Dairy E, using an industrial bucket loader and two truck mounted spreaders with two operators, where each one loaded their own truck.

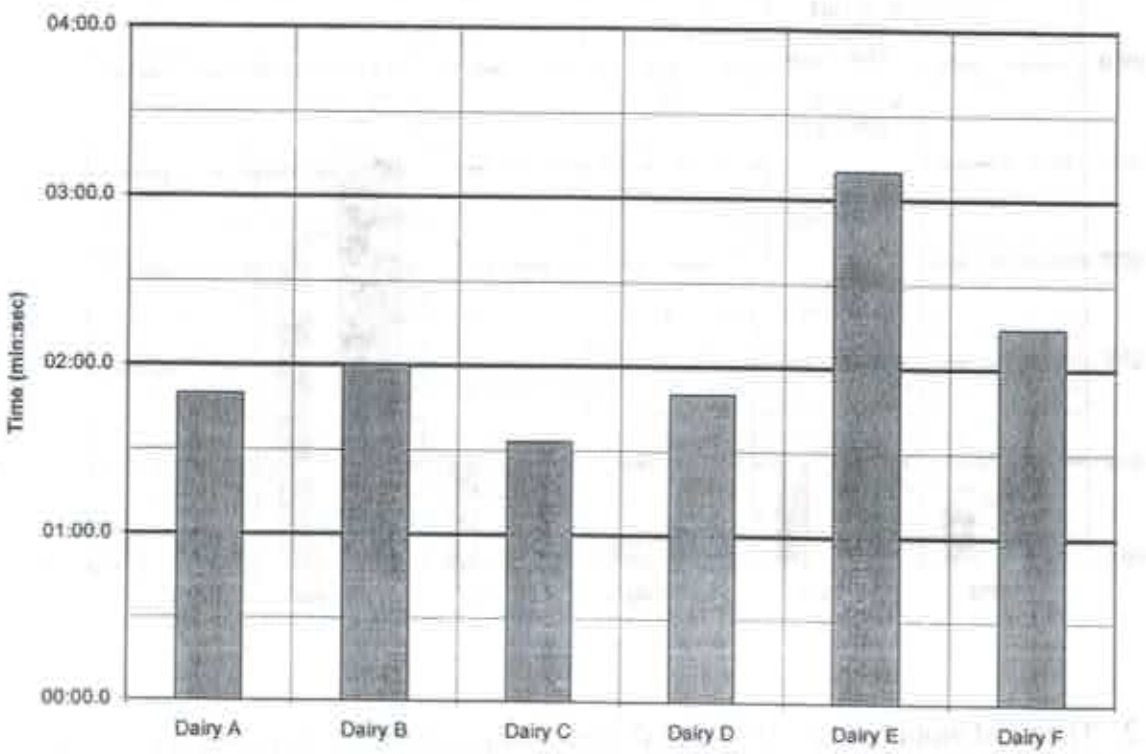

Figure 4. Total time required for loading, hauling and spreading of one cubic meter of manure from six dairies with different operating procedures.