IMPACT ON MILK ASSEMBLY COSTS OF DAILY MILK PICK-UPS

Daniel R. Strang
Assistant Professor of Economic and Management Science
State University of New York at Geneseo

and

Doyle A. Eiler
Assistant Professor of Marketing
Department of Agricultural Economics
Cornell University

The majority of U.S. dairy farmers have invested in on-farm storage equipment with capacity for at least two days' milk production[1/]. However, the remaining farms, with limited investment in storage capacity may have a major impact on milk assembly costs. The purpose of this study is to explore the impact daily milk pick-ups have on milk assembly costs and to compare these costs to the cost of increasing on-farm milk storage capacity.

The cost of milk assembly is determined by the quantity of inputs required and the price of these inputs. Since increasing on-farm storage is unlikely to have any significant effect on the price of assembly inputs, this analysis focuses on the change in the quantity of assembly inputs required, valued at constant prices. The quantity of inputs can be described in terms of the number and size of collection trucks and the number of minutes and miles required to collect the milk.

The input requirements for any specific assembly area depend upon: the location of farms relative to each other and relative to the receiving point, milk production and storage capacity at each farm and the capacity and routing of the collection vehicles. In this study, milk assembly costs in two case study areas in western New York are empirically examined.

Study Areas

Detailed data on the geographic location of each farm, the location of the receiving plants, the road network and the milk shipments

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1/ In the New York-New Jersey marketing approximately 10% of the dairy farms have storage for only one day's milk.

on March 29 and 30, 1970[2] were collected for each of two study areas. Study area I (Figure 1 and Table 1) consisted of 42 farms, seven of which required milk collections on both March 29 and 30. Study area II (Figure 2 and Table 2) contained 65 farms including eight farms which were served daily.

Method of Analysis

In 1960 Johnson and Brinegar [4] in their study of milk assembly cost in Connecticut identified two reasons why assembly costs will be reduced if farms which currently must be served daily can be converted to every other day service:

1) The elimination of daily pick-ups reduced the total time required to collect milk through a 50% savings of the on-farm time of hook-up, agitation, sampling, and record keeping. (Fixed time requirements)

2) The elimination of daily pick-ups increases the flexibility of truck routing. This increased flexibility can lead to a reduction in truck miles and travel time.

While they were able to estimate the cost savings from the reduction in the fixed time requirements, they were unable to quantify the savings which accrue to increased routing flexibility.

Schruben and Clifton [6] reported, in 1968, the development of a heuristic procedure for "efficient" vehicle routing based upon the conceptual framework of Clark and Wright [1]. Their work with the collection and delivery of agricultural products demonstrated the importance of routing to assembly costs.

While assembly costs do depend heavily upon the routing of assembly vehicles, algorithms which insure optimal routes are not available. Gaskell [2] compared the performance of the various types of vehicle routing algorithms and found that it was entirely possible for a technique to work well for one problem with its specific associated parameters and restrictions but not to work well for another problem. He also found that a visual inspection technique of route development produced more efficient routing than did any of the heuristic algorithms.

Since the performance of routing algorithms depends upon the characteristics of the particular problem, two alternative routing

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[2] Late March was selected for analysis because it is representative of a period of "normal" seasonal production. Throughout the year as production varies the service requirements of some farms may change. The seasonal variability in production can cause changes in the aggregate input requirements for milk assembly.

FIGURE I. MAP OF 42 FARM STUDY AREA

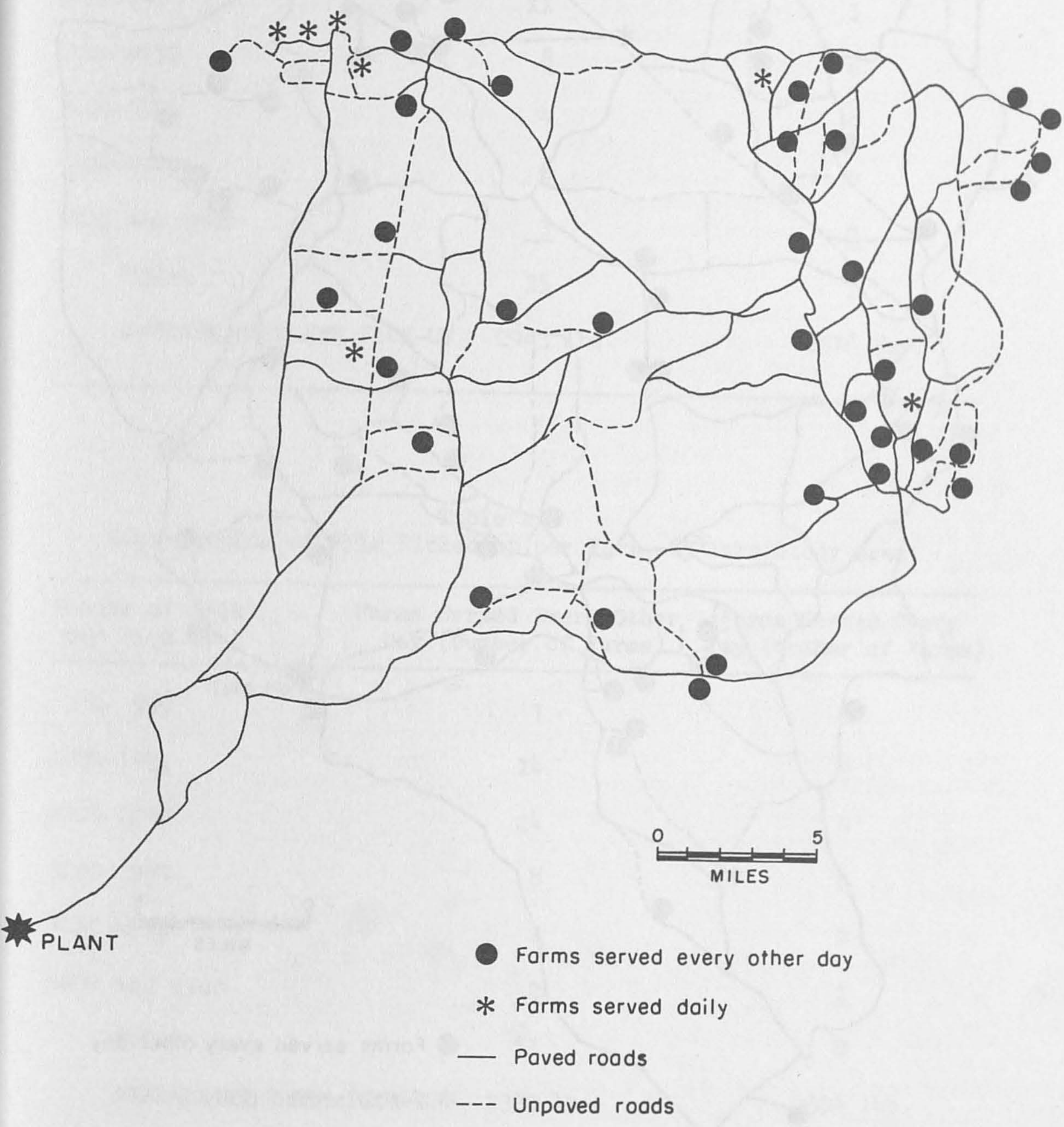

FIGURE 2. MAP OF 65 FARM STUDY AREA

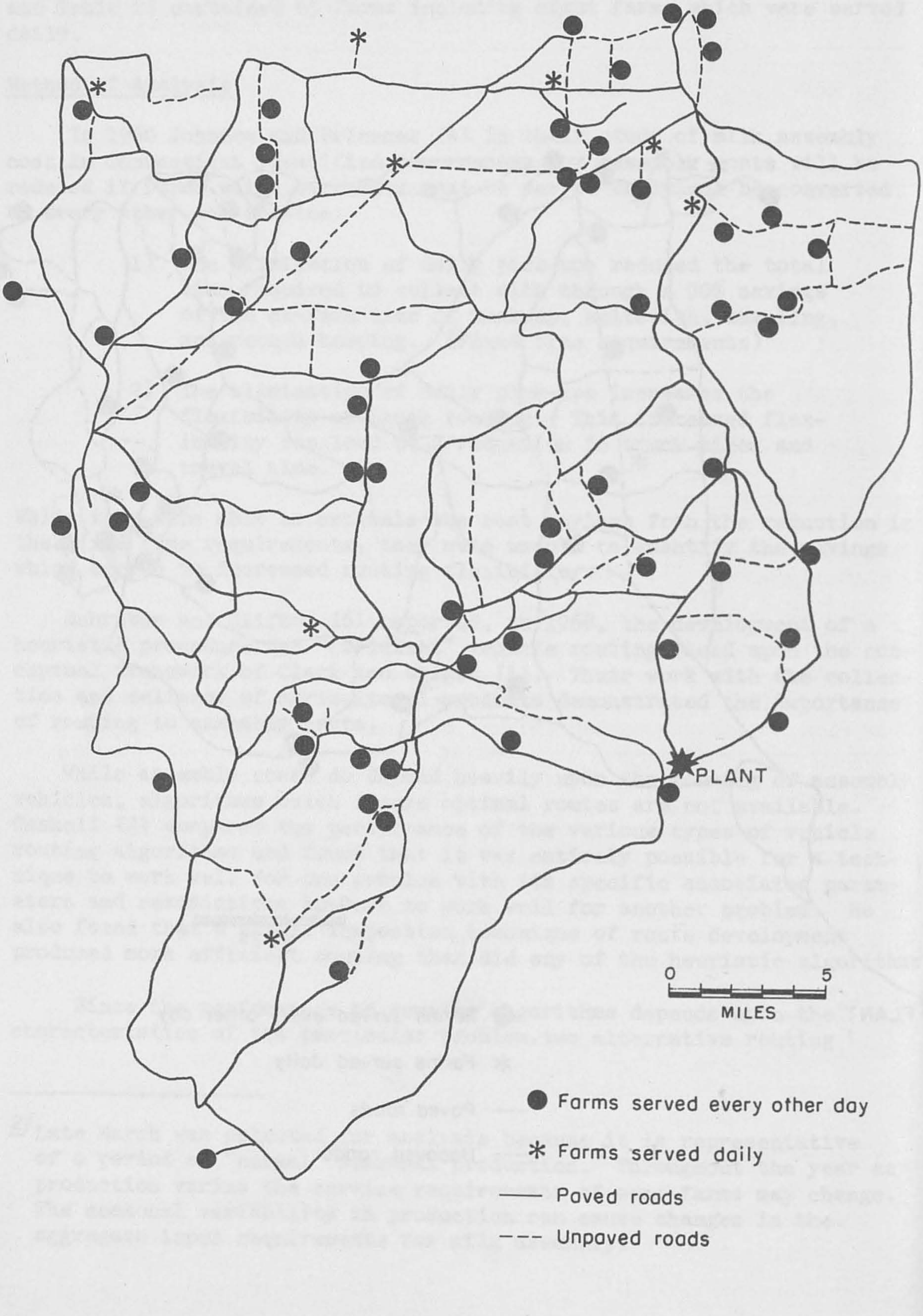

Table 1
Distribution of Milk Picked-up per Farm--42 Farm Study Area

Pounds of Milk per Pick up	Farms Served Every Other Day (Number of Farms)	Farms Served Every Day (Number of Farms)
0- 999	3	0
1000-1999	11	1
2000-2999	8	6
3000-3999	4	0
4000-4999	6	0
5000 and over	3	0
TOTAL	35	7
AVERAGE MILK PER PICK-UP	2943 lbs.	2376 lbs.

Table 2
Distribution of Milk Picked-up per Farm--65 Farm Study Area

Pounds of Milk per Pick up	Farms Served Every Other Day (Number of Farms)	Farms Served Every Day (Number of Farms)
0- 999	7	0
1000-1999	14	3
2000-2999	24	4
3000-3999	8	0
4000-4999	2	0
5000 and over	2	1
TOTAL	57	8
AVERAGE MILK PER PICK-UP	2320 lbs.	2594 lbs.

techniques were compared. Halberg and Kriebel's [3] computer algorithm[3/] was used to develop assembly routes for both case problems. The results of the computer analysis were compared to the assembly routes generated by a visual technique [7 p. 146]. The differences in total route miles between these two procedures were less than five per cent. Because of the comparability of the results the least expensive routing procedure (visual inspection techniques) was selected for use in this study[4/].

Budgeting input requirements with the visual inspection routing technique allows the consideration of both the fixed time requirement and the flexibility of truck routing in estimating the impact of daily farm pick-ups on milk assembly costs. For each study area the input requirements were budgeted for the period March 29 and 30[5/]. These input requirements were then compared to the input requirements assuming all of the farms served daily had larger on-farm storage and thus could be serviced every other day.

Assembly Input Savings from Increasing On-Farm Storage

Table 3 provides a comparison for the 42-farm study area of the input requirements when seven of the farms must be served on a daily basis and when all farms can be served every other day. Increasing the on-farm storage for the seven current every day farms would decrease the total mileage driven for a two-day collection cycle by 100 miles and it would reduce the total labor requirements by 320 minutes. This is a twenty percent reduction in mileage and a fifteen percent reduction in time.

Table 3
Input Savings for 42-Farm Study Area

	Routes	Miles	Stops	Pounds Picked Up	Minutes
Requirements for Existing Situation	6	493	49	136,257	2,079
Requirements with All Every-Other-Day Farms	6	393	42	136,257	1,759
Savings	-	100	7	---	320

3/ This program like Schruber and Clifton's is based upon the conceptual framework of Clarke and Wright [6].

4/ On larger routing problems, computer-developed routes may be more efficient.

5/ The detailed assumptions used in budgeting the input requirements are presented later in this report.

Similar results are presented for the 65-farm study area in Table 4. The conversion of the eight every day farms to every other day services would reduce the total route distance by 101 miles and the total labor requirements by 349 minutes for each two-day collection cycle. The mileage savings are 22 percent and the time savings 14 percent.

Table 4
Input Savings for 65-Farm Study Area

	Routes	Miles	Stops	Pounds Picked Up	Minutes
Requirements for Existing Situation	7	469	73	173,730	2,480
Requirements with All Every-Other-Day Farms	7	368	65	173,730	2,131
Savings	-	101	8	---	349

The institutional arrangements within an assembly area will determine who is beneficiary of the input savings accruing to the elimination of daily farm pick-ups. The translation of these input savings into dollar savings depends upon the methods used in compensating milk haulers. If the trucks are owned by a milk cooperative and the drivers are paid on an hourly basis, the savings accruing to the cooperative will be determined by the variable operating cost of its fleet and the hourly wage rate for the drivers[6].

Using current industry estimates of 47¢ per mile truck costs[7] and a driver wage rate of $4.50 per hour, the savings in milk assembly cost for each two-day collection is $71.00 in the 42-farm study area and $73.65 in the 65-farm study area. On an annual basis this amounts to $12,958 in the 42-farm area and $13,441 in the 65-farm area.

On a per farm basis each every day farm in the 42-farm study area imposed an average additional cost of $5.07 per day on the assembly organization. In the 65-farm area the average additional cost was $4.60 per every day farm per day.

It is clear that farms requiring daily pick-ups can impose substantial costs on an assembly organization. If the cost of daily pick-ups is shared collectively through an assembly organization, individual

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6/ If driver compensation is not on a strict hourly basis, the reduction in route times may not be immediately translatable into cost savings.

7/ Unpublished study of Operating Costs of Farm Collection Trucks prepared by Prof. Dennis R. Lifferth, Cornell University, 1975.

farmers may have little economic incentive for increasing their on-farm storage. If dairy farmers are to be economically encouraged to increase their on-farm storage the differential charge to farmers requiring daily service must be greater than the cost of expanding their bulk tank.

While the actual cost of replacing a bulk tank can vary substantially depending upon the individual installation requirements, equipment dealers can provide estimates of conversion cost which will cover the vast majority of installations. Using the cost estimates of an experienced equipment dealer in the study areas and a ten percent discount rate, a daily equivalent cost of increasing on-farm storage was calculated to be $2.29 per day[8/].

Thus, if an assembly organization in the study areas was interested in encouraging an expansion of on-farm storage it would need to impose a differential cost of over $2.29 per day for farms requiring daily service. In fact, if the assembly organization currently bears all the costs of daily milk pick-ups, it would be to its own economic advantage to subsidize the expansion of on-farm storage since the cost of expansion is less than one-half the cost of continuing to serve farms daily.

<u>Summary and Conclusions</u>

The capacity of on-farm milk storage relative to herd production determines whether milk must be picked-up daily. Daily pick-ups increase not only the fixed stop time requirements of hook-up, agitation, sampling, etc., but decrease the flexibility in truck routing causing an increase in mileage and travel time.

Two study areas in western New York with some farms requiring daily service were examined to determine the assembly cost savings which could result if those farms requiring daily service could be served every other day. The additional cost of these daily service farms was $5.07 and $4.60 per day per daily farm.

The cost of increasing on-farm storage capacity adequate to allow every other day pick-up was estimated to be $2.29 per day. Thus, the cost of increasing storage capacity was approximately one-half the cost imposed upon the assembly system by farms requiring daily pick-ups.

The institutional arrangement in the assembly area determines who bears the cost of daily pick-ups. If the assembly organization is to provide an economic incentive to increase on-farm storage a differential charge in excess of the cost of increasing on-farm storage must be imposed on farms requiring daily service. One approach for providing an economic incentive frequently mentioned in the dairy industry is the imposition of a stop-charge. If a stop-charge is used, the daily stop-charge would need to be greater than the cost of increasing on-farm storage. Thus, in this case a stop-charge in excess of $2.29 would be required.

8/ The detailed cost estimates and budgeting procedures are presented in the appendix.

References

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7. D. R. Strang, An Economic Analysis of the Sources and Magnitudes of Inefficiency in Bulk Milk Assembly in New York State, Unpublished Ph. D. thesis, Cornell University, June 1975.

APPENDIX

Budgeting Assumptions Used in Determining Assembly Input Requirements

1. Each farm pick-up truck has an effective capacity of 27,500 pounds. This is 80% of maximum capacity; thus allowing for route stability with production variability.

2. Average driving speed between farms was 20 mph. Average driving speed from plant to first farm and last farm to plant was 30 mph.

3. Each truck and driver are available for a maximum of 520 minutes per day. This time is recorded from the arrival of the driver at the plant, through all route operations, unloading, including twenty minutes for tank washing at the end of the day.

4. Of the 520 minutes available per day an average of sixty minutes per day was assumed to be non-productive. The non-productive time included provisions for driver breaks, fatigue breakdown, etc.

5. The fixed time requirement of a farm stop was budgeted at 8.7 minutes per stop. This included a provision for hook-up, agitating, sampling, unhooking and record keeping.

6. The variable time component of each farm stop was based upon an average pumping rate of 430 pounds per minute.

7. Unloading time at the receiving plant was divided into a fixed and variable component. The fixed time of ten minutes included a provision for agitation, hook-up and sampling. The variable time requirements were determined by the load size assuming an unloading rate of 1000 lbs per minute.

Budgeting Assumptions for Increasing On-Farm Milk Storage Capacity[8/]

These cost estimates were designed to be adequate for all but the largest farms requiring increased milk storage.

1. A new 800 gallon bulk tank (adequate for approximately 65 milk cows) with an automatic washer, compressor and installation costs $5,800.

[8/] The equipment and construction estimates were provided by Mr. Stan Mummery, Surge Equipment Service, Warsaw, N.Y. Mr. Mummery is an experienced dealer in farm dairy equipment.

2. A new compressor will be needed at the end of the seventh and fourteenth year. This will be $400 more than the cost of replacing the smaller compressor.

3. Bulk tanks come in many sizes and shapes. In most instances installing a larger tank does not necessitate adapting the milk house[9/]. However, if the milk house is not large enough, a bulk-headed tank can be installed. The additional cost of this installation is the cost of footers and masonry--$1,000.

4. The trade-in value of current tank is assumed to be zero.

5. The larger tank was assumed to have no salvage value at the end of twenty years.

A discounted cash flow procedure was used to estimate the annual equivalent cost of increasing on-farm milk storage. A planning horizon of twenty years and a discount rate of ten percent were assumed.

Cost of conversion	
Initial cost of new tank	$5,800
Adapting milk house for bulk head unit	1,000
Trade-in value of old tank	---
Additional cost of replacing larger compressors	800
Salvage value at the end of twenty years	---
Present value of cost at 10% discount rate	7,110
Annual equivalent cost at 10% discount rate	835
Cost per day of increasing on-farm milk storage (835 ÷ 365)	2.29

9/ Mr. Mummery indicates from his experience that as few as one in five milk houses must be adapted to accommodate a larger bulk tank.