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DAILY MILK PICK-UPS:
THEIR IMPACT ON MILK ASSEMBLY COSTS

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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

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

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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 on March 29 and 30, 1970[2/] were collected for each of two study areas. Study area I (figure 1) consisted of 42 farms, 7 of which required milk collections on both March 29 and 30. Study area II (figure 2) contained 65 farms including 8 farms which were served daily.

## Determining Input Requirements

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.

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

FIGURE 1. MAP OF 42 FARM STUDY AREA

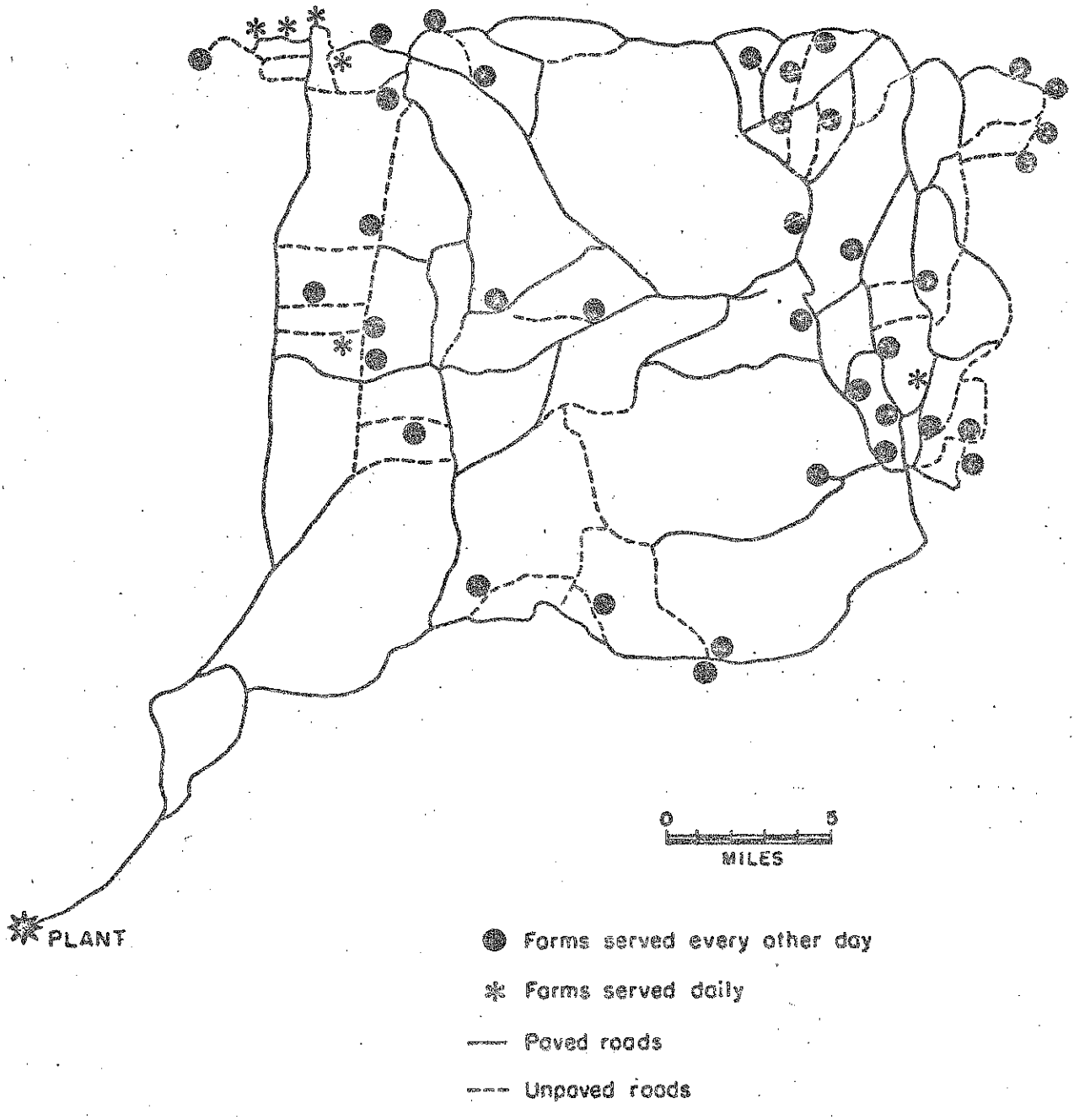
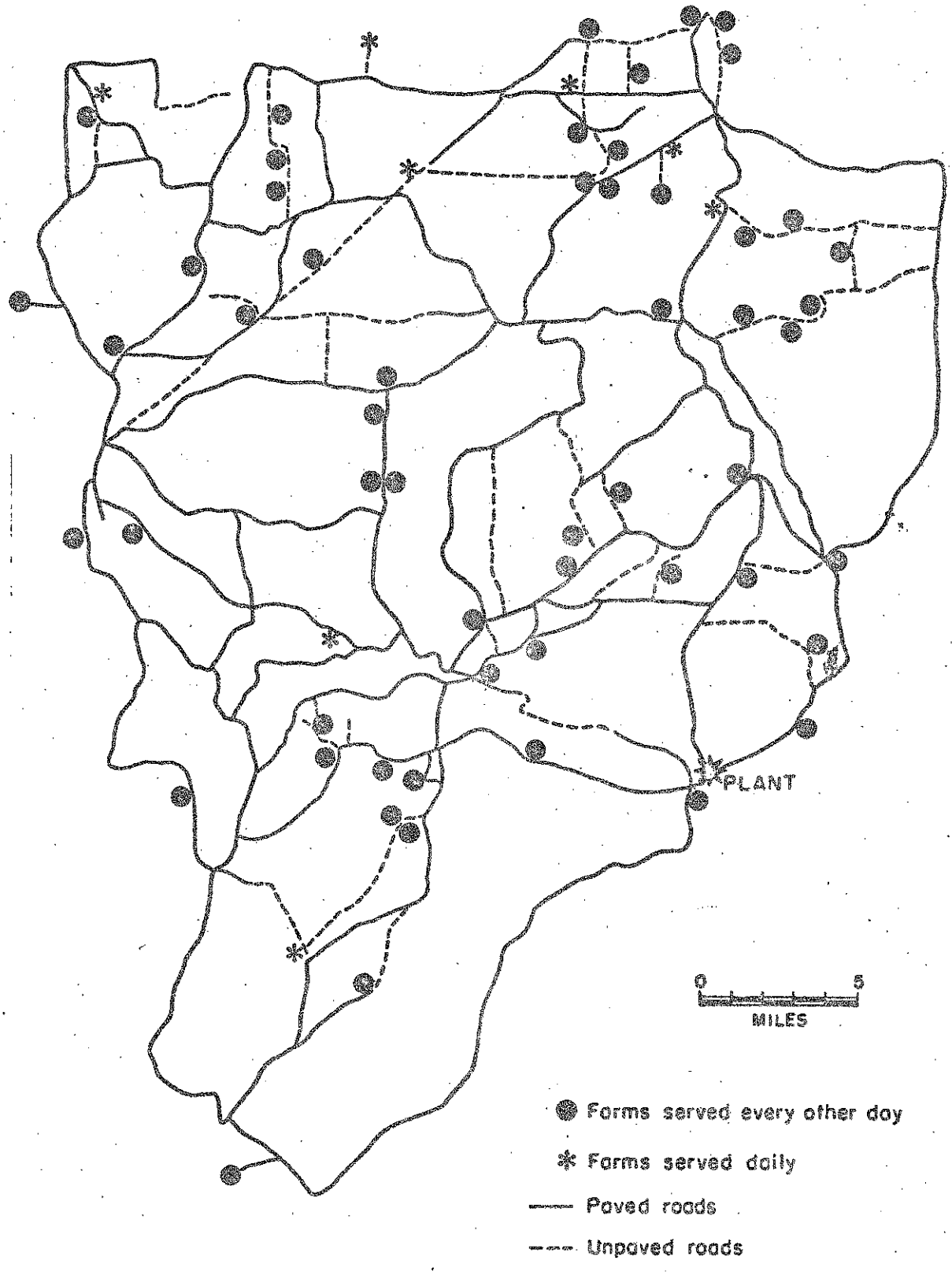


FIGURE 2. MAP OF 65 FARM STUDY AREA



Using a visual inspection routing technique[3/] which allows the consideration of both the fixed time requirements and the flexibility of truck routing it was possible to estimate 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.[4/] 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 1 provides a comparison for the 42-farm study area of the input requirements when 7 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 7 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 20 percent reduction in mileage and a 15 percent reduction in time.

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3/ The importance of truck routing has been reported by Schruber and Clarke /_6_/. Computer routing algorithms based upon the conceptual framework of Clarke and Wright /_1_/ have been developed by Schruber and Clarke /_6_/ and Halberg and Kriebel /_3_/. Gaskell /_2_/ compared the performance of alternative routing procedures and found that a visual inspection technique produced more efficient routes than did any of the computer heuristics. Strang /_7 p 101-161_/ reports that for the dairy assembly problem a visual inspection procedure provided results similar to the computer algorithm but at a substantially lower cost.

4/ The detailed assumptions used in budgeting the input requirements are presented on page 11.

Table 1. 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 |

Similar results are presented for the 65-farm study areas in Table 2. The conversion of the 8 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 2. 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 benificiary 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.

Using current industry estimates of 47¢ per mile truck costs[5/] 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 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

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

equipment dealer in the study areas and a 10 percent discount rate, a daily equivalent cost of increasing on-farm storage was calculated to be $2.29 per day.[6/]

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 cost 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.

## Summary and Conclusions

The capacity of on-farm milk storage relative to herd production determines whether milk must be picked-up daily. Daily pick-ups increases not only the fixed stop time requirements of hook-up, agitation, sampling, etc., but decreases 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.

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6/ The detailed cost estimates and budgeting procedures are presented on page 12 of the appendix.

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 industry is the imposition of a stop-charge. If the stop-charge approach 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.

## References


1. G. Clarke and J. Wright, "Scheduling of Vehicles from a Central Depot to a Number of Delivery Points", The Journal of the Operations Research Society of America, Volume 12 No. 4 July-August 1964, pp 568-581.

2. T. J. Gaskell, "Bases for Vehicle Fleet Scheduling", Operational Research Quarterly, Volume 18 No. 3 September 1967, pp 281-295.

3. M. C. Hallberg and W.R. Kriebel "Designing Efficient Pickup and Delivery Route Systems by Computer", The Pennsylvania State University, College of Agriculture, Agriculture Experiment Station, University Park, Pennsylvania, Bulletin 782, June 1972.

4. S. Johnson and G. Brinegar, "Economic Analysis of the Milk-Hauling-Rate Structure for Members of a Producers' Cooperative", University of Connecticut College of Agriculture, Storrs, Connecticut, Bulletin 353, June 1960, pp. 1-20.

5. J. Roof and G. Tucker, "An Equitable Charge and Payment System for Least-Cost Milk Assembly in Indiana", Farmer Cooperative Service, U.S. Department of Agriculture, Service Report No. 127, July 1972, pp. 1-35.

6. L. W. Schruben and R. E. Clifton, "The Lockset Method of Sequential Programming Applied to Routing Delivery and Pickup Trucks", American Journal of Agricultural Economics, Vol. 50, November 1968.

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 20 minutes for tank washing at the end of the day.

4. Of the 520 minutes available per day an average of 60 minutes per day were 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 10 minutes included a provision for agitation, hook-up and sampling. The variable time requirements was determined by the load size assuming an unloading rate of 1000 lbs per minute.

Budgeting Assumptions for Increasing On-Farm Milk Storage Capacity[7/] 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.

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.[8/] 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 20 years.

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7/ The equipment and construction estimates were provided by Mr. Stan Mummery, Surge Equipment Service, Warsaw, NY. Mr. Mummery is an experienced dealer in farm dairy equipment.

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

A discounted cash flow procedure was used to estimate the annual equivalent cost of increasing on-farm milk storage. A planning horizon of 20 years and a discount rate of 10 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 20 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 |