COSTS OF BULK MILK ASSEMBLY FOR THE PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA

By

JOHN WILLIAM GOODWIN

Bachelor of Arts

Panhandle Agricultural and Mechanical College

Goodwell, Oklahoma

1956

Submitted to the faculty of the Graduate School of the
Oklahoma State University of Agriculture and
Applied Science in partial fulfillment
of the requirements for the degree of
MASTER OF SCIENCE
May, 1959

COSTS OF BULK MILK ASSEMBLY FOR THE PURE MILK

PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA

Thesis Approved:

Leo C. Bartley
Thesis Adviser

Kenneth E. Boggs

Dean of the Graduate School

ACKNOWLEDGEMENT

The author wishes to express his sincere appreciation to the Department of Agricultural Economics of Oklahoma State University, Stillwater, Oklahoma, for making this study possible. In addition, he is indebted to the Departments of Agricultural Economics at both Oklahoma State University and the University of Connecticut for the financial aid he received in pursuing post-graduate study. Thanks are extended, also, to the Pure Milk Producers Association of Eastern Oklahoma, Tulsa, Oklahoma--especially to the route drivers--for their co-operation with the enumerators and with the author throughout the course of the research preliminary to the writing of this thesis.

Professor Leo V. Blakley, major advisor, has been invaluable to the author in his supervision as well as his advice on research, writing, and organizational techniques. Professor Blakley has also been of great worth throughout the author's graduate study at Oklahoma State University in his advice concerning the graduate program and his encouragement from time to time.

Appreciation is extended to Professor George G. Judge, and Assistant Professor Kenneth Boggs for their suggestions, guidance, and criticisms in developing the graduate program.

Acknowledgement is made of the assistance received from the secretarial and statistical staff of the Department of Agricultural Economics, and to Mrs. Gwendol Martin for her co-operation in the typing of the final manuscript.

Special recognition is due the author's mother, Mrs. Obera Goodwin of Durham, Oklahoma, for her assistance and occasional prodding.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

APPENDICES

CHAPTER I

INTRODUCTION

PURPOSE OF THE STUDY

The primary purpose of this study was to analyze the operations of the Pure Milk Producers Association of Eastern Oklahoma--a marketing cooperative--from the standpoint of cost of operating the bulk milk pickup service throughout the Tulsa milkshed. An effort has been made to determine the costs of performing the specific functions of bulk milk assembly and then to discover methods of reducing these costs.

Bulk milk pickup is one of the more recent technological developments in Oklahoma dairy marketing. Little is known about the costs involved in the transporting of milk, the efficiencies of operation of managerial decisions facing the haulers and handlers of milk. Hence, the problem lies in finding just what the costs are and then how to reduce these costs.

The bulk pickup system potentially offers saving to both farmers and processors or distributors; hence, in the long-run, the system offers potential savings to all consumers of milk. Farmers may benefit primarily from lower transportation costs while processors and distributors get their milk at reduced receiving costs. Part of the savings will eventually be passed on to the consumer, thus giving him a share of the beneficial effects of an improved milk marketing system.

In 1954, the Oklahoma Agricultural Experiment Station Dairy Department, Stillwater, Oklahoma, conducted a study of the bulk milk pickup

system for one dairy farm. This study was primarily concerned with the influence of the system on production--that is, the influence on flavor, weight accuracy, milk losses, and savings on labor.[1]

In the summer of 1956, Blakley, Boggs, and Rogers, two staff members and a graduate assistant in the Department of Agricultural Economics at Oklahoma State University, Stillwater, Oklahoma, conducted a study of the system in the Oklahoma City Milkshed in cooperation with the Central Oklahoma Milk Producers Association of Oklahoma City. This study was concerned with the marketing phases of the bulk milk pickup system. It was based on observations obtained on 44 route days taken from COMPA's routes and from audit reports of the Association.[2]

Other than the Blakley, Boggs, and Rogers study, the marketing phases of this system of milk marketing have been ignored in Oklahoma. However, there have been numerous studies in other states which indicate decreased costs resulting from the initiation of such a system. Baum and Pauls[3] noted this indication in their Washington State study as did Clark[4] in California. Though some of Clark's, Baum and Paul's, and Blakley, Boggs, and Rogers' techniques will be of value, their actual findings will not

---

[1]Paul E. Johnson, Harold C. Olson, and Robert L. Von Gunten, A Comparison of the Bulk and Can Systems for Handling Milk on Farms, Oklahoma Agricultural Experiment Station, Bulletin No. B-436, August, 1954.

[2]Leo V. Blakley, Kenneth B. Boggs, and Walter Rogers, A Preliminary Report on an Analysis of Bulk Milk Transportation Costs of the Central Oklahoma Milk Producers Association, Departmental Report, Department of Agricultural Economics, Oklahoma State University, Stillwater, Oklahoma, January, 1958.

[3]E. L. Baum and D. E. Pauls, A Comparative Analysis of Costs of Farm Collection of Milk by Can and Tank in Western Washington, 1952, Washington Agricultural Experiment Station, Technical Bulletin No. 10.

[4]D. A. Clark, Jr., A Comparative Analysis of Costs of Operating Milk Collection Routes by Can and Tank in California, Giannini Foundation of Agricultural Economics, Berkeley, California, Mimeo. Report 91, October, 1947.

apply directly to the Tulsa situation because of the differences in roads, routing conditions, and farm sizes.

This study is limited to the northeastern Oklahoma-southwestern Missouri milk producing area and the Pure Milk Producers Association of Eastern Oklahoma. For this reason, the findings of this study will be applicable only to the plant included in the study, or to plants with similar circumstances in roads, routing, and production capacity of farms with which these plants deal. Since the most logical method of conducting such a study as this one is by use of questionnaires and schedules, the accuracy of the findings of this study will be limited to the accuracy of the enumerators who completed the schedules.

In making a study such as this, a number of assumptions must be made. The first assumption is the profit motive--all milk marketers and processors included in the study desire to maximize profits. In line with this it must be assumed that all milk marketers and processors--namely the Pure Milk Producers Association of Eastern Oklahoma, Tulsa, Oklahoma-- are willing (1) to make necessary changes in scales of plant to reach and maintain an optimum scale of plant, (2) to make necessary routing changes, and (3) to make necessary changes in personnel. Further, it was assumed that prices for milk, labor, and transportation equipment and supplies remained constant.

Three concepts have been set forth at this point--the profit motive which has already been defined, optimum scale of plant, and constant costs of labor, transportation, and milk. "Constant costs" means simply that the per unit price of these factors remains the same. Leftwich[5] defines optimum

---

[5]Richard H. Leftwich, The Price System and Resource Allocation, Rinehart and Company, New York, 1955, p. 155.

scale of plant as the most efficient of all scales of plant which the firm can build. The optimum scale of plant is the one in which the short-run average cost curve forms the minimum point of the long-run average cost curve. It can also be thought of as that scale of plant where a short-run average cost curve is equal to the long-run average cost curve at the minimum point of both curves.

The data used in this study have been collected from the routing and pickup practices, and time and motion studies of the individual drivers operating the trucks which pick up the milk from producers in the Tulsa milkshed. Since the Pure Milk Producers Association of Eastern Oklahoma is a cooperative association, it operates somewhat differently from a private enterprise. The cooperative markets the milk and charges a per-hundredweight transportation fee based on the distance a producer is located from Tulsa. This fee is set up on five mile intervals to eliminate discriminatory charges to producers as nearly as possible. These fees theoretically cover the costs of operating the cooperative. Since the objective of the cooperative is to provide as inexpensive a marketing service as possible, any surplus is redistributed to the participants according to the volume of their production.

In this study, the problem was to provide a framework of data and analytical techniques whereby firms engaged in bulk milk assembly operations can (1) evaluate the efficiency of present operations, and (2) devise a pricing procedure which is equitable among producers. To accomplish this, several alternative methods of doing jobs will be devised and time and expense of each will be calculated. With these as guides, we can determine by comparison whether a phase of the bulk milk assembly operation is efficient or not, and also which alternative might

be most efficient. The time spent at various phases of the jobs was listed on the forms included in Appendix A of this thesis.

From a series of the schedules plus plant audits, the cost per mile or route by road class and condition, and the cost per producer can be obtained. The method of doing this will be shown in the sections analyzing time and costs. From this information it will be possible to determine the criteria the Association may use in making decisions concerning the installation of bulk tanks for various producers. If it costs more to allow a new producer to participate in the bulk pickup system than this producer's volume returns to the cooperative, then obviously, the cooperative could not afford to install a bulk tank for this producer from the standpoint of economic efficiency.

CHAPTER II

PROCEDURE

In making this study, data were collected from two sources. First, cost information was secured from monthly audits of the Pure Milk Producers Association of Eastern Oklahoma, Tulsa, Oklahoma. Second, data providing for the allocation of these costs to specific functions performed in bulk milk assembly were obtained from schedules from 14 route days on a sample of routes of the Association. Two additional schedules were taken on the Association routes in southwest Missouri in an effort to learn if the waiting time of the tank transport which conveyed this milk back to Tulsa might be reduced.

The Schedule Used

In gathering information for cost allocation, time and motion data were obtained from a schedule patterned after the one used by Blakley, Boggs, and Rogers in a similar study of the Oklahoma City Milkshed. The first page of the schedule dealt with time spent on operations performed by the drivers before leaving to make milk pickups along the route. However, drivers in the Oklahoma City milkshed were required to perform tasks not required of drivers in the Tulsa study. Of the operations listed--check instructions, check truck (oil, fuel, etc.), warm up truck, truck to building, sterilize tank, hook up pump, sterilize pump, get ice, get supplies, and get sample bottles--Pure Milk Producers Association drivers were required to perform four. These were check instructions

check truck, warm up truck, and get sample bottles. In one and only one observation, the driver delivered supplies.

The second and third pages of the schedule dealt with overhead driving, that is the driving from the plant to the first producer and from the last producer back to the plant. Roads were classified first according to type (paved, gravel, and dirt) then according to condition within each type (good, fair, and poor). Determining if a road were paved, gravel, or dirt was a relatively simple process, but drawing the bounds of "good", "fair", or "poor" condition proved to be somewhat more of a problem. This depended entirely upon the enumerator. It is doubtful that there would be difficulty in distinguishing between "good" and "poor" condition, but the line between a high "fair" and a low "good" or between a low "fair" and a high "poor" road condition was difficult to determine. These pages listed mileage and time spent in driving this mileage on each of the nine road classifications.

For each of the producer stops, a sheet such as page 4 was filled out. This sheet included time of travel, road type, and mileage between the preceding producer and the producer whose name appeared at the top of the sheet. The second portion of this sheet dealt with time spent in the various operations at the barn. These were as follows:

1. Hooking up hose and cord
2. Writing ticket
3. Weighing milk
4. Agitating milk
5. Taking sample
6. Pumping

7. Putting up hose and cord

8. Washing tank

Hooking Up Hose and Cord

The hose and cord were enclosed in a compartment at the rear of the truck. It was necessary for the driver to open this compartment, take the hose out and connect it with a valve located at the end of the bulk tank. The cord was on a spring-operated reel and had to be unreeled, the reel locked, and the cord plugged into an electric outlet in the barn.

Writing Ticket and Weighing Milk

Each producer was assigned a permit number. The driver was required to write out a ticket in quadruplicate on which this number, the weight of milk, and the temperature of the milk appeared. The milk was weighed by a calibrating device on which each sixteenth or thirty-second of an inch was the equivalent of some poundage of milk. The calibrating stick was washed with hot water to give an accurate milk reading (butterfat might "crawl" up on a cold stick) and then the hot stick was set into position in the tank, removed from the tank, and the calibration noted on the ticket. Milk poundage was taken from a chart provided with the tank.

Agitating Milk

It was necessary for the drivers to agitate the milk about a minute and a half before taking a sample. Since cream will rise and milk is sold on basis of butterfat content, unagitated milk may give a deceiving test. Upon occasion the agitator would be operating when the truck arrived and the driver had to wait for the milk to settle before calibration.

Sampling

A sample of milk for testing was taken from each tank since butterfat content is one basis for pricing milk. Bacteria counts were also taken from this sample. The driver had a very small dipper with an approximate capacity of one tablespoon. Three dippers of milk were taken from different areas of the tank, poured into a 1/2 cup bottle, and the bottle placed in a rack next to the cord in the compartment of the truck.

Pumping

Pumping was the only variable operation consistently performed at the farm. Logically, the length of time spent in pumping depends on the volume of milk. Pumping was started by throwing a switch in the barn, or upon occasion, plugging the cord into an electric outlet was delayed until the driver was prepared to begin pumping.

Putting Up Hose and Cord

When pumping was completed the driver unhooked the hose from the tank and returned it to the truck. Then he unhooked the cord and released the lock on the reel. The cord was automatically reeled back into the rear compartment. The driver then closed and latched the doors enclosing the compartment and returned to the barn to wash the tank.

Washing Tank

Drivers ordinarily washed the tank when the milk had been completely pumped out, though occasionally the producer performed this operation. This was to prevent milk from drying on the sides of the tank and forming "milkstone" deposits.

The various operations at the barn might be performed in any of several orders, and some operations might be performed simultaneously.

Most drivers took the sample and wrote the ticket while the milk was being pumped into the truck. Some hooked up the hose and cord before weighing the milk, others after weighing. Some washed the tank before putting up the hose and cord, and others afterward. Outside influences might change any driver's order of performing the various operations at the farm.* Also, farm stop time might be increased by these outside influences. For example, a producer who was tardy in milking could add considerable time to the farm stop since the driver would be forced to wait until milking was completed. Or a producer who was present at the barn would increase farm stop time by visiting with the driver.

In the use of Association audit reports for figuring cost data, the entire year of 1957 was first used. But due to the rapid growth and expansion of the Association, the month of March, 1958, was more nearly descriptive of the present situation. For this reason March data were used as a basis of determining costs of bulk milk assembly. Also, it was possible to get a more complete break down of costs in March than for the preceding periods. In parts of the analysis, certain costs which are generally considered variable were defined as fixed costs since they did not vary with road classes and conditions. In other sections these costs were treated in the usual context of variable cost classifications.

Throughout this study, an attempt has been made to allocate costs to the time spent in various functions. Since all labor costs were on a fixed salary basis, this has been done on an arbitrary basis of the number of routes per month multiplied by the average time per route observed in the

---

*If the agitator were running when the truck arrived the order probably would be (a) take sample (b) hook up hose and cord (c) wait for milk to settle (d) weigh milk (e) begin pumping and write ticket (f) put up hose and cord (g) wash tank.

sample. When this figure was divided into the wages paid to drivers in this period an hourly rate of $1.78 or 2.98 cents per minute was obtained. Other labor expense was figured on the basis of driver time, except for mechanic labor which has been treated as a fixed truck cost.

Some of the cost analysis procedure may seem somewhat unorthodox to the economically sophisticated reader, but since costs have been allocated on basis of road types and conditions in certain sections, some costs which are normally considered variable with respect to a given time period (e.g. utilities) were treated as fixed costs since they were unaffected by road conditions.

CHAPTER III

TYPES OF ROUTES

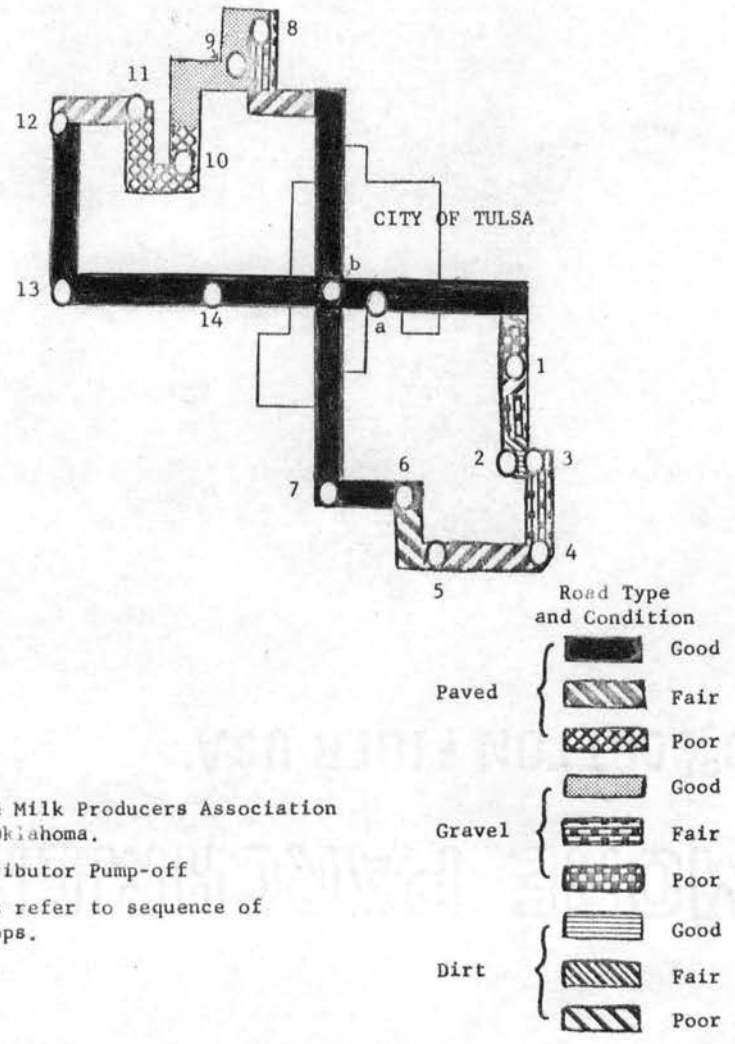
The milk routes involved in this study were divided into two categories, (1) those with mid-route pump-off stops and (2) those without such stops. The group with pump-off stops were further divided into two sub-categories: (1) those routes which were split into two portions by a pump-off stop at a distributor and (2) those which were split into two portions by a pump-off stop at some point along the route. In both cases, the route was continued and another load was obtained. The last load was returned to the Pure Milk Producers Association plant or to distributors in the Tulsa area.

Routes split into two portions by a pump-off stop at a distributor consisted primarily of stops at fairly large local producers. These routes originated in Tulsa, made a loop in the area on one side of Tulsa, and then returned to the city to unload at a distributor's plant (Figure 1). In every route observation, this distributor was Hawks Dairy; however, plant records show that deliveries were made to Epler, Glenclift, and other distributors in the Tulsa area. From the distributor, a loop was made in another direction from Tulsa and the milk was returned to the Association headquarters or possibly to a distributor. Actually, this "split pump-off" type route might be considered as two short routes completed during the same day.

The "enroute pump-off" routes were organized in such a manner that the times spent by the drivers were approximately equalized. Figure 2 illustrates the route driver left the plant at approximately 5:30 a.m.

Figure 1

"Split-Pump-Off" Type Route Observed in the Bulk Milk Assembly Operations of the Pure Milk Producers Association of Eastern Oklahoma; 1958



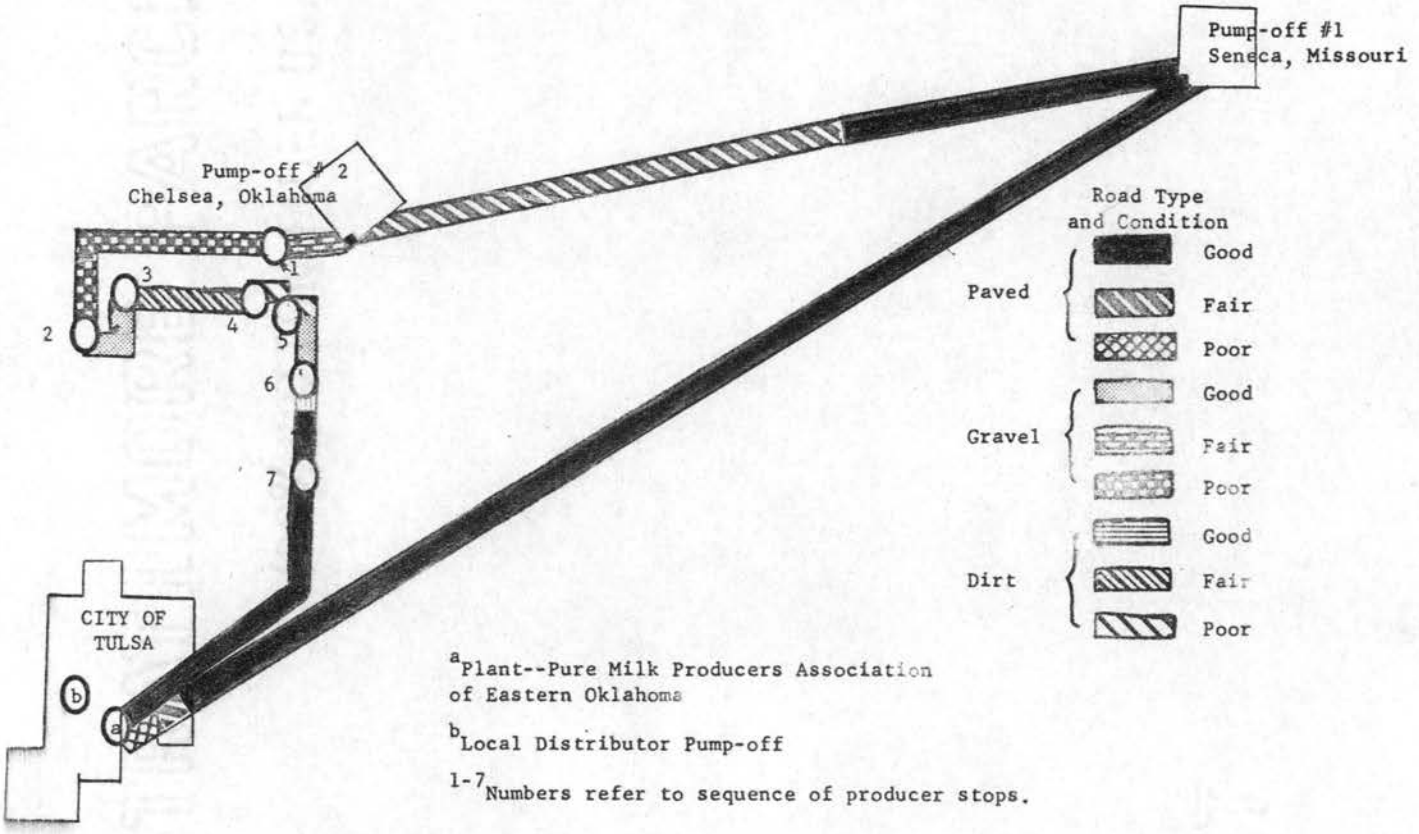
[a]Plant--Pure Milk Producers Association of Eastern Oklahoma.

[b]Local Distributor Pump-off

[1-14]Numerals refer to sequence of producer stops.

Figure 2

"Enroute Pump-off" Type Route Observed in the Bulk Milk Assembly Operations of the Pure Milk Producers Association of Eastern Oklahoma; 1958



[a]Plant--Pure Milk Producers Association of Eastern Oklahoma

[b]Local Distributor Pump-off

[1-7]Numbers refer to sequence of producer stops.

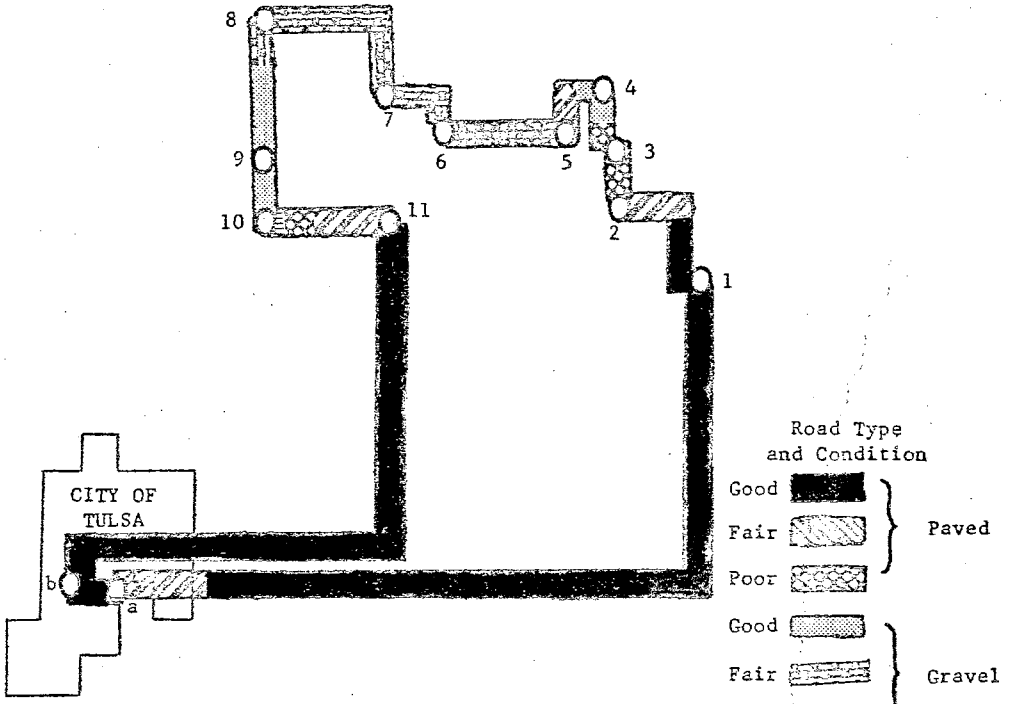
to begin picking up milk along his route. The driver of the transport made his departure some three hours later, drove to Seneca, Missouri, where he met the driver of a bulk milk route covering southwest Missouri to load 17,000 to 20,000 pounds of milk which had been collected along the Missouri route. The transport then returned to some predesignated point along the route--in most cases, Chelsea, Oklahoma --to meet the driver of the route which originated in Tulsa. Milk collected on the first half of that route was pumped into the transport. After loading, the driver of the transport and the route driver exchanged trucks. The route driver returned the transport to the Tulsa plant and the transport driver made the last half of the stops along the route and returned to the plant. In this manner, the time spent on the route was approximately equalized among drivers. Figure 2 illustrates the route driven by the driver who started his day on the transport.

The non-pump-off routes were similar to one-half of those routes split by the Tulsa pump-off discussed above. Originating and terminating at the Association headquarters, travel was completed on one large loop in one direction from Tulsa (Figure 3). The distributors to which they delivered may have been any of several commercial distributors in Tulsa, or the milk may have been returned to the Association headquarters to be diverted to dairy processing plants outside the Tulsa area.

Two additional schedules were taken on the Association routes in southwest Missouri in an effort to learn if the waiting time of the tank transport which conveyed this milk back to Tulsa might be reduced. Such a reduction would reduce substantially the waiting time required for a second "enroute pump-off" at some point between Tulsa and Seneca, Missouri, on the

Figure 3

"Non-Pump-off" Type Route Observed in the Bulk Milk Assembly Operations of the Pure Milk Producers Association of Eastern Oklahoma; 1958



[a]Plant--Pure Milk Producers Association of Eastern Oklahoma

[b]Local Distributor Pump-off

[1-11]Numerals refer to sequence of producer stops.

tanker return trip to Tulsa. While the study was in process, however, the Association made routing changes which eliminated most of the waiting time for the second "enroute pump-off" route. The greatest reduction of waiting time for the tanker would have occurred had the Association sent a larger tank to run the southwest Missouri routes. The tank operating in the area was not large enough to hold all the milk and it was necessary for the driver of this route to bring in a full tank then return to his route and pick up another producer's milk--a procedure requiring approximately 40 minutes--then return to the pump-off location to pump his load into the tanker. All in all, this procedure added about 48 minutes to the waiting time of the tanker.

The tank transport run to Missouri was discontinued in April, 1958. After this time, the driver of the southwest Missouri routes completed his route--using a larger tank leased from the Association--and then transported this milk to Tulsa in his own truck. Wholesale changes in the routing and route operation have rendered the entire routing procedure virtually unrecognizable from the information gathered during the sample period. However, the study still has considerable value from the point of cost allocation and time required in this operation.

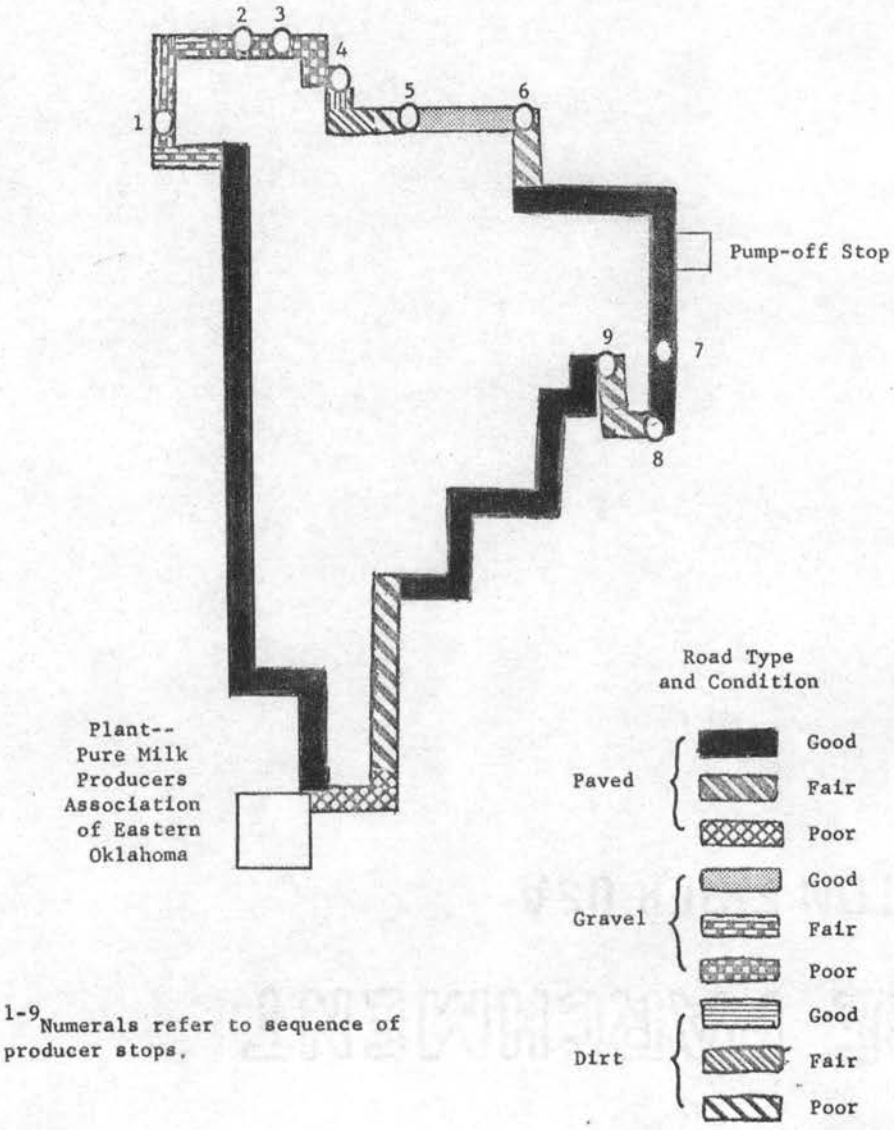
While the bulk pickup operation itself has changed, the marketing costs for producers remained approximately the same and the overall picture was not greatly changed.

Route Lengths

From the route observations, an overall average route concept was derived. This route would have either nine or ten stops and would be 175.2 miles in length. Figure 4 shows this overall average route with nine producer stops, and with a pump-off stop.

Figure 4

Over-all Average Route Derived from Observations of Routes in the Bulk Milk Assembly Operations of the Pure Milk Producers Association of Eastern Oklahoma; 1958



1-9 Numerals refer to sequence of producer stops.

An overall average route concept is misleading in the case of the Pure Milk Producers Association because of the great diversity between routes in the number of producers, length of route, and volume of milk. This diversity is illustrated by the variation in average length as follows:

Route Type	Length (Miles)
Overall Average	175.20
"Split Pump-off"	142.17
"Enroute Pump-off"	197.28
Non-Pump-off	178.60

These data imply that the non-pump-off route is the average. This is not the case since there were three pump-off routes to each non-pump-off route.

CHAPTER IV

ANALYSIS OF TIMES

The total time drivers spent on bulk pickup routes was divided into six parts. These were as follows:

$$(4.1) \qquad T = T_1 + T_2 + T_3 + T_4 + T_5 + T_6$$

Where T is total time

T_1 is the time spent at Association headquarters before departure to run route.

T_2 is the driving time.

T_3 is the time spent at farm stops.

T_4 is the time spent at lunch and coffee, waiting, etc.

T_5 is the time spent at pump-off stops.

T_6 is the time spent during mechanical difficulties and trouble.

Time Spent at Plant

The average time spent by drivers preparatory to running the bulk milk routes (T_1) was estimated to be 13.2 minutes per route. This included checking the oil and tires, picking up sample bottles and the tackograph card (a tackograph is a device which records rate of speed, mileage, and stop time along the route) and checking instructions. The sample bottles and tackograph cards were located in the truck office of the Association building. Driver instructions were posted on a blackboard in this same office. These instructions stated which driver would drive which route, and which truck and tank would be used in the process.

Driving Time

Driving time per mile varied, as would be expected, with types and conditions of roads traveled. Roads were classed as paved, gravel, or dirt. Any of these classes might be in any of three conditions--good, fair, or poor. The class of road was, of course, easy to determine, but the line between good and fair or fair and poor condition is broad. Hence, the condition listed was in some cases quite subjective and dependent upon the enumerator.

In the Tulsa milkshed, about 79 percent of all roads traveled was classified as paved highway with about 60 percent on good highway, 16 percent on fair highway and 3 percent on poor highway (Table I). Some 18 percent of roads was classed as gravel with 4 percent grouped as good, 8 percent as fair and 6 percent as poor gravel. Only 3 percent of all roads was classed as dirt. One-half of one percent was classified as good dirt, about one and one-half percent as fair and one percent as poor dirt road. Based on the average speed for each road type and condition the following formula summarizes the time required to travel a given number of miles (T_2) with various percentages of roads of each specified type (R), and condition (C):

$$(4.2) \quad T_2 = D\left[1.48\ R_1C_1 + 1.39\ R_1C_2 + 2.15\ R_1C_3 + 2.10\ R_2C_1 + 2.16\ R_2C_2 + 4.08\ R_2C_3 + 2.76\ R_3C_1 + 2.47\ R_3C_2 + 4.27\ R_3C_3\right]$$

In this formula,

D = distance in miles

R_1C_1 = percentage of roads classified as good highway

R_1C_2 = percentage of roads classified as fair highway

R_1C_3 = percentage of roads classified as poor highway

TABLE I

TOTAL MILES AND MINUTES PER MILE FROM A SAMPLE OF ROADS TRAVELED ON BULK MILK ROUTES, CLASSIFIED BY TYPE OF ROAD AND CONDITION OF ROAD, PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA, 1958

Road Class and Condition	Miles	Percent of Total	Minutes per Mile
Paved	2,394.9	78.69	1.485
Good	1,817.6	59.72	1.476
Fair	479.9	15.77	1.385
Poor	97.4	3.20	2.147
Gravel	558.1	18.34	2.818
Good	120.8	3.97	2.098
Fair	242.1	7.95	2.161
Poor	195.2	6.41	4.079
Dirt	90.5	2.97	3.060
Good	14.0	.46	2.757*
Fair	49.0	1.61	2.465
Poor	27.5	.90	4.273

*Observations based on less than 25 miles for each road classification were considered unreliable for reporting.

Source: Computed from survey data obtained from Pure Milk Producers Association of Eastern Oklahoma, December 31, 1957 through February 1, 1958.

R_2C_1 = percentage of roads classified as good gravel

R_2C_2 = percentage of roads classified as fair gravel

R_2C_3 = percentage of roads classified as poor gravel

R_3C_1 = percentage of roads classified as good dirt

R_3C_2 = percentage of roads classified as fair dirt

R_3C_3 = percentage of roads classified as poor dirt

An example might be of aid in the interpretation of this formula. If there were a route--say 100 miles in length--driven only on good highway, the driving time would be 148 minutes or two hours and 28 minutes. The driving time for combinations of road types or conditions would be calculated from data included in the formula. For example, consider a route which consisted of one-half good highway and one-half good gravel roads. With half of all roads traveled classed as good highway, a net of approximately .74 minutes would be required to travel the good highway part of an average mile [1.48 (.50) = .74]. A like calculation for the gravel portion of this mile would give 1.05 minutes [2.10 (.50) = 1.05]. The driving time for an average mile is obtained by summing the parts to get a total of 1.79 minutes required to drive an average mile. This is a weighted average number of minutes per mile. For the hypothetical 100 mile route, the driving time would be 179 minutes or one minute less than three hours. This same procedure is applicable to all roads and conditions in determining driving times on typical routes. For the routes in the sample period in early 1958, the time totaled approximately 311.7 minutes or about 5 1/4 hours to drive an average route distance of 175.2 miles.

There were a number of outside factors which might affect time spent in driving. Poor farm driveways were responsible for delays in bad weather.

On one route which was observed three times, the truck was stuck in one particular drive three times. Other factors included bad bridges and narrow gates.

Farm Stops

A detailed analysis was made of times devoted to various functions performed by drivers at the farm stops. The procedures followed by the drivers in performing the various functions were standardized but actual times varied from driver to driver.

Regardless of order for the overall fixed operations, no significant statistical differences between drivers were found. One driver might be more efficient in some phase such as weighing while another saved time in sampling. When the data were pooled for all drivers, a regression was computed between time at the barn and the volume of milk pumped. In this analysis, an approximate 5.969 minutes were used in performing the fixed operations and .205 minutes were required for pumping each hundredweight of milk. The fixed functions included hooking and unhooking, calibration, sampling, writing the ticket, washing the tank and other functions.

On the basis of these data, the formula for time at the farm (T_3) is:

(4.3) $$T_3 = n\,(5.969) + 0.205X$$

where X is hundredweight of milk picked up

n is number of stops per route

For a thousand pound pickup, the total time would be about eight minutes $\left[5.969 + 0.205\,(10) = 7.969\right]$. If there were ten producers on this route, the total times at farms for this route would be 80 minutes or 1 1/3 hours.

Studies of these operations in other milksheds indicate a slightly different time scale. Cowden of the Farmer Cooperative Service estimated 6.8 minutes for the fixed operations and 0.35 minutes per 100 pounds of milk pumped, based on observations from two routes.[6] For a 1,000 pound pickup, these estimates would indicate a total time at the farm of about 10.3 minutes--almost 25 percent higher than in the Tulsa milkshed for the same volume.

Blakley, Rogers and Boggs of the Department of Agricultural Economics at Oklahoma State University, Stillwater, Oklahoma, in their study of similar operations in the Oklahoma City, Oklahoma, milkshed obtained estimates of 7.5 minutes for the fixed operations and 0.214 minutes per hundredweight of milk pumped, based on 570 observations from 14 routes.[7] For a 1,000 pound pickup, these estimates indicate a total time at the farm of about 9.6 minutes--still somewhat higher than the estimates obtained in the Tulsa milkshed.

During the sample period of late 1957 and early 1958, there were ten producers on the average route of 175.2 miles in the Tulsa milkshed. The average volume for each producer (1,976 pounds per pickup) was used with the formula above to compute the time per stop of 10.02 minutes. The times per stop were added to obtain 100.2 minutes spent at farm stops on the average route.

---

[6] Joseph H. Cowden, Farm-to-Plant Bulk and Can Milk Hauling Costs, Farmer Cooperative Service Report 18, U. S. Department of Agriculture, Washington 25, D. C., March, 1956.

[7] Leo V. Blakley, Kenneth B. Boggs, and Walter Rogers, A Preliminary Report on an Analysis of Bulk Milk Transportation Costs of the Central Oklahoma Milk Producers Association, Departmental Report, Department of Agricultural Economics, Oklahoma State University, Stillwater, Oklahoma, January, 1958.

Time Spent at Lunch, Coffee, Waiting, etc.

Some drivers stopped for meals, and almost without exception for an early morning coffee break. With some particular trucks, it was necessary to re-fuel at some point along the route; however, this occurred in few enough instances that the time spent in this operation has been incorporated with time spent at lunch, coffee breaks, and in visiting with producers--as was occasionally the case. In the sample of routes, an average of 24.2 minutes was spent in these ways.

Along most routes, a mid-route pump-off was observed. Also, on most routes the last load each day was delivered to a receiving plant. Many times, it was necessary to wait either for the transport tanker into which the load was pumped, or for the receiving plant to make arrangements to accommodate the milk. The average waiting time on all routes was 27.0 minutes. This varied greatly between routes, primarily because of inadequate facilities at some receiving plants.

The combined lunch-coffee time, and the waiting time (T_4) averaged 51.2 minutes.

Pump-off Time

Ordinarily, along any route, there were from one to three pump-off stops. On those routes designated as "non-pump-off", there was only one stop at the end of each route to deliver the milk to a receiving plant somewhere in the city of Tulsa. On the "enroute pump-off" routes, there were either two or three pump-offs, depending on the final destination of the milk and on which part of the route the enumerator was riding. For example, if he were riding the transport in the beginning, he would

observe a pump-off in Seneca, Missouri, another in Chelsea, Oklahoma--where he would change trucks--and possibly a third when the route truck returned to Tulsa to unload at a commercial dairy or receiving station. On the other hand, if the enumerator were to begin the day on a route truck, he would observe a pump-off at Chelsea, where he would change trucks, return to Tulsa with the transport and possibly enumerate a second pump-off. Generally, however, the transport did not unload in Tulsa since this milk usually was diverted to other markets. In the "mid-route pump-off" routes--those which were split by a pump-off stop at a dairy processing plant in Tulsa--the enumerator would observe two pump-offs, one in the middle and one at the end of the route.

The average time spent on all routes in unloading and loading milk (T_5) was 52.9 minutes per route. Actually, there was considerable variation between routes since some routes unloaded three times and some only once. Also responsible for some of the variation were the different tank sizes which allowed different sizes of loads and the different pump sizes which moved milk at different speeds.

Mechanical Difficulties and Trouble

Along any bulk milk route which requires travel on country roads, there will be stoppages resulting from tire trouble, motor trouble, or bad roads. From observations in the Tulsa milkshed, estimates of these stoppages were obtained. Some things listed under this heading were tire changes, difficulty in starting truck, brake trouble, and trucks being stuck on wet, muddy roads. The average time spent in stoppages of various sorts (T_6) was 33.1 minutes per route.

An average route of the Pure Milk Producers Association consisted of the times in the sample period of late 1957 and early 1958 shown in Table II.

TABLE II

DISTRIBUTION OF TIME SPENT ON AN AVERAGE ROUTE, PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA; 1958

Time	Minutes	Percent of Total Time
T_1 (time at plant)	13.2	2.34
T_2 (driving)	311.7	55.43
T_3 (farm stops)	100.2	17.82
T_4 (lunch, coffee, etc.)	51.2	9.11
T_5 (pump-off)	52.9	9.41
T_6 (trouble)	33.1	5.89
Total	562.3 minutes or 9.37 hours* (9 hours, 22 minutes)	100.00

*Overall observed average time was 555 minutes (9.25 hours). The seven minute discrepancy is due to rounding errors in the various parts.

Source: Computed from survey data obtained from Pure Milk Producers Association of Eastern Oklahoma, December 31, 1957 through February 1, 1958.

CHAPTER V

COST ANALYSIS

Labor costs, truck and tank costs, and other costs, such as equipment and overhead costs, constituted the major cost items in bulk milk pickup operations. Some of these costs varied directly with use and were defined as variable costs. Others did not vary with use and were defined as fixed costs.

Labor Costs

Labor costs were broken down into three major categories; (1) driver labor, (2) mechanic labor, and (3) overhead. All of these categories may be defined as fixed on a monthly basis with the exception of a mechanic's helper--if one is used--who is paid by the hour. According to the company records, funds paid out to mechanic's helpers amounted to less than $100 for the preceding year.

Driver labor cost must be treated as a fixed cost with respect to operations performed within a period of one month. Drivers started at $300 per month with a $25 raise the first month. The following two months, drivers received $12.50 raises whereupon their salaries were fixed at $350 per month. In the sample month, drivers were paid $3,620.50 for driving 36,510 miles and payroll taxes amounted to $81.50. Total payroll tax and driver salaries amounted to $3,702.00, which was equivalent to a per-mile rate of 10.1397 cents.

However, the Association truck and tank expenses as well as miles driven were not all derived from route traffic. About 11,900 of the 36,510 miles driven in March were driven in milk diversion operations which left 24,610 miles driven on bulk milk routes. Based on the proportion of miles classified as route miles, route drivers were paid $2,492.37 (including payroll tax). Using this more realistic concept of route costs, the per-mile rate would be equivalent to 10.127 cents.

Considering driver salaries variable, total variable costs associated with labor was estimated at $3702.00 (Table III). The route share of these costs shown in the right column was $2,492.37.

The sample revealed that the average route length was 175.2 miles and the average time required to drive this mileage was 9 hours and 15 minutes or 9.25 hours. The total route mileage driven in March was 24,610 miles or 150.74 routes. Based on average time for the average route, March route driving required 1,394.35 hours. Since route drivers were paid $2,492.37 during March for 1,394.35 hours, this would give an hourly rate of $1.78747 or 2.98 cents per minute.

There were certain expenses connected with driving which were variable in a general economic sense. These were driver expense and driver uniform rental. Driver expense--expenses incurred while on the road, including telephone, tire repair, and in cases of long-range milk diversion, meals and lodging--amounted to $98.08. The Association rented uniforms for the drivers from a firm specializing in this service. This cost amounted to $142.10. These items, while variable in an economic sense, were fixed with road classification. Hence, they have been treated as fixed costs in this analysis.

TABLE III

DRIVER LABOR COSTS, PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA; MARCH, 1958

	Total Costs (36,510 miles)	Route Costs (24,610 miles)
Costs Variable with road classification		
Drivers' Salaries	$3,620.50	$2,437.50
Payroll Taxes	81.50	54.87
Total	$3,702.00	$2,492.37
Costs Fixed with road classification		
Coveralls and Laundry[1]	$ 142.10	$ 95.78
Driver Expense[1]	98.08	66.11
Total	$ 240.18	$ 161.89
Total Labor Costs	$3,942.18	$2,654.26

[1]These items may be classified as variable costs for some analyses. These items totaled $240.18 in March, 1958.

Source: Audit Report for month of March, 1958, Pure Milk Producers Association of Eastern Oklahoma.

Total variable costs associated with labor and fixed with road classification were estimated at $240.18. This was the total of driver expense and uniforms. Thus, total fixed labor costs associated with routes was $161.89 (right column, Table III).

Route labor operations were considered to fall into three separate categories. These were (1) the fixed operations of running the route, (2) driving operations, and (3) operations performed at farm stops.

Fixed Operations

Fixed operations of running the route included such things as (a) time spent at the plant before departure (T_1); (b) time spent at lunch, coffee, waiting, etc., (T_4); (c) pump-off time (T_5); and (d) time spent in mechanical difficulties and trouble (T_6). The values for time spent in the fixed operations on the average route, summarized from Table II, are as follows:

Operation	Minutes
T_1 (time at plant)	13.2
T_4 (lunch, coffee, waiting, etc)	51.2
T_5 (pump-off)	52.9
T_6 (trouble)	33.1
Total	150.4

With a per-minute labor charge of 2.98 cents, these fixed operations on the average route would cost $4.48, and would represent about 27 percent of the total time. Total route labor cost amounted to $2,492.37 during March. Assuming that the average route was representative of all routes, the cost of fixed labor operations was responsible for about 27 percent of the total route labor cost or for $672.94 during March.

Driving Operations

Driving operations included all driving (T_2) from the time the truck left the plant until its return. Table II listed 311.7 minutes in driving the average route of 175.2 miles. With a per-minute labor charge of 2.98 cents, labor cost of driving the average route amounted to $9.29, and represented about 55 percent of total time spent on the average route. Labor cost of the route driving operation during March was assumed to be approximately 55 percent of the total route labor cost of $2,492.37 or $1,370.80.

Farm Stop Operations

Farm stop operations included all operations performed at the farm stops. Table II listed 100.2 minutes spent at farm stops (T_3) on the average route of 175.2 miles with ten stops. This accounted for about 18 percent of total time on the average route. The per-minute labor charge of 2.98 cents gives us a cost of $2.99 for labor at farm stops. The March labor cost for these operations was assumed to be $448.63 or approximately 18 percent of the March total for route labor.

Truck and Tank Costs

Truck and tank costs formed the bulk of variable costs and certainly the major equipment costs. For purposes of this analysis, the depreciation on trucks and tanks was considered variable. The Association depreciated road equipment at the rate of three cents per mile, and this assumption has been adopted for this study. Certainly, the depreciation costs of trucks will vary with mileage, road type and condition. Tanks were depreciated on the basis of a ten year life span with ten percent

salvage value. In the sample month of March, 1958, total truck and tank depreciation amounted to $1,621.98--$1,095.30 for trucks and $526.68 for tanks. Total depreciation chargeable to bulk milk routes was $1,093.31 (Table IV).

In the sample month, truck and tank operation and maintenance amounted to $1,905.96, of which $738.25 was attributed to mechanic's labor and payroll tax, leaving $1,167.71 which may be considered as variable costs.

Fuel costs were $2,161.30, and the amount paid out for tires and tubes was $165.30. However, variable costs for tires and tubes was unusually low during March, so the 1957 monthly average of $402.63 was used in the analysis. Oil and lubrication costs amounted to $100.14.

On the routes that cover the area around Seneca, Missouri, drivers were instructed to use the Will Rogers Turnpike between Tulsa and Missouri. Cost of driving on the turnpike during March amounted to $101.45.

The total variable cost attributed to the truck and tank portion of the Pure Milk Producers Association bulk milk pickup operation during March amounted to $5,555.21. This amount was not all attributable to route costs, however. In the right column of Table IV, route costs have been computed on the basis of the percent of total mileage reflected by route driving.

Fixed costs associated with trucks and tanks were a little over one-third as much as variable costs and are shown in Table V. As mentioned above, there was a fixed mechanic's salary of $738.25 monthly. Monthly cost of insurance was $601.72 and monthly cost of licenses was $392.07. Monthly Federal and State highway use tax were $37.50 and $16.67, respectively. Depreciation on LP gas equipment was $48.72.

TABLE IV

TRUCK AND TANK COSTS VARIABLE WITH ROAD CLASSIFICATION, PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA; MARCH, 1958

Item	Cost	
	Total Truck Cost (36,510 miles)	Route Cost (24,610 miles)
March, 1958, Actual Costs		
Truck and Tank Operation and Maintenance	$1,167.71	$ 787.11
LP Gas	1,147.81	773.69
Gasoline	1,013.49	683.15
Oil and Lubrication	100.14	67.50
Tires and Tubes	402.63*	271.40
Turnpike	101.45	101.45**
Total	$3,933.23	$2,684.31
March, 1958, Depreciation Costs Assumed to Vary with Road Conditions		
Trucks	$1,095.30	$ 738.30
Tanks	526.68	355.01
Total	$1,621.98	$1,093.31
Total of Actual Plus Depreciation	$5,555.21	$3,777.62

*Expenditures for tires and tubes were deceivingly low ($165.30) during March. For this reason, the 1957 monthly average of $402.63 was used in the analysis.

**This item is solely a route cost. For this reason there is no reduction.

Source: Audit report of Pure Milk Producers Association of Eastern Oklahoma, March, 1958.

TABLE V

TRUCK AND TANK COSTS FIXED WITH ROAD CLASSIFICATION, PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA; MARCH, 1958

Item	Total Truck Costs (36,510 miles)	Route Costs (24,610 miles)
Mechanic Salary	$ 738.25	$ 497.62
Truck and Tank Insurance	601.72	405.60
Truck and Tank Licenses	392.07	264.28
Federal Highway Use Tax	37.50	25.27
State Highway Use Tax	16.67	11.24
Interest	250.37*	168.76
LP Gas Equipment Depreciation	48.72	32.84
Total	$2,085.30	$1,405.62

*Interest is imputed from percent of total major investment that cost of trucks and tanks and LP gas equipment represent. This percent of total monthly interest paid is assumed to be the interest paid on these items.

Source: Audit report of Pure Milk Producers Association of Eastern Oklahoma, March, 1958.

Interest on items included in fixed costs was imputed on the basis that total major investment was $327,610.89. Truck and tank cost and the cost of the LP gas equipment was 40.32 percent of this amount or $132,092.71. Total interest paid annually amounted to $7,451.40 (a total principle of $173,499.19 and an average rate of 4.3 percent). About 40 percent of $7,451.40 amounted to $3,004.40 which was assumed to be the annual interest paid on the truck and tank portion of the operation. The monthly interest would be 1/12 of this or $250.37.

Total monthly fixed cost attributed to the truck and tank portion of Pure Milk Producers Association's bulk milk pickup operation was estimated at $2,085.30. Like variable truck costs, fixed truck costs have been reduced with respect to the percentage of total mileage represented by route driving in Table V. Total fixed cost for routes amounted to $1,405.62.

Other Costs

All other costs were fixed with road classification and condition (Table VI). However, there were a few costs in this classification which were variable in an economic sense. These included office supplies and utilities. In March, 1958, office supplies amounted to $160.77 and the total utility bill was $353.97. It has been assumed that 1/3 of utility costs were chargeable to other departments, leaving 2/3 ($235.98) of the total to vary with bulk milk assembly operations, but fixed with respect to roads. One-half of total office supplies were assumed to be costs of bulk milk assembly or $80.39. The total of these "pseudo-fixed" costs attributed to the other cost classification amounted to $316.37.

TABLE VI

OTHER COSTS FIXED WITH ROAD CLASSIFICATION, PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA; MARCH, 1958

Item	Total Truck Cost (36,510 miles)	Route Cost (24,610 miles)
Building Depreciation	$ 68.39	$ 46.10
Boiler Depreciation	4.58	3.08
Furniture and Fixtures Depreciation	9.23	6.22
Machinery and Equipment Depreciation	3.27	2.20
Land Improvements Depreciation	17.16	11.57
Interest	45.08*	30.39
Office Overhead	797.12	797.12**
Office Supplies[1]	119.26	80.39
Utilities (2/3)[1]	235.98	159.06
Total	$1,300.07	$1,136.14

*Interest was imputed from percent of total investment represented by cost of buildings, machinery and equipment, boiler, furniture and fixtures, and land improvement. This percent of total monthly interest was assumed to be the interest paid on these items.

**Office overhead here has been computed with respect to routes. Hence, there was no reduction.

[1]These items may be considered variable in the general economic sense and may be so treated in some analyses. They totaled $316.37 for March.

Source: Audit report of Pure Milk Producers Association of Eastern Oklahoma, March, 1958.

Fixed costs classed under other costs included depreciations on the building, ($68.39), the boiler ($9.16), furniture and fixtures ($9.23), machinery and equipment ($3.27) and land improvement ($17.16). Interest cost was imputed on the same basis as for the truck and tank fixed costs. The percentage of total investment represented by cost of buildings, machinery and equipment, boiler, land improvement, and furniture and fixtures was computed. Then this percentage of total monthly interest paid was used to estimate interest paid on these items. The resulting figure was $45.08.

Office overhead included the salary of the truck manager whose duty it was to see that routes were coordinated and that the drivers' route time was as nearly equalized as possible. This employee was also in charge of maintaining truck records. Also included in office overhead was the salary of the wash boy, one-half of one clerk's salary and one-half the depreciation on an office computer. While the wash boy was not actually office help, his services were performed at the plant and his pay was fixed. For this reason his salary was included in the fixed cost of office overhead. The clerk and machine cost was split because, according to Association records and estimates, the bulk milk pickup portion of their operations did not require the full time services of a clerk and calculator. Total office overhead amounted to $797.12 in March, 1958.

Total fixed costs attributed to "other costs" were estimated at $1,304.65. In the right column of Table VI, these have been adjusted to give more realistic estimates for route costs totaling $1,139.22.

Costs Per Mile

Labor Costs Per Mile

In March, 1958, a total of 1,394.35 hours of route driver labor were used at a cost of $2,492.37. This was equivalent to a per-minute cost of 2.98 cents for route driver labor. Variable labor cost per route mile was computed by multiplying the variable labor cost per minute by the number of minutes required per mile.

The formula for variable labor cost for roads with various percentages of each road type and condition is:

$$(5.1)\quad VLC = D\left[4.41\,R_1C_1 + 4.14\,R_1C_2 + 6.41\,R_1C_3 + 6.26\,R_2C_1 + 6.44\,R_2C_2 + 12.16\,R_2C_3 + 8.22\,R_3C_1 + 7.36\,R_3C_2 + 12.72\,R_3C_3\right]$$

If all roads were in only one classification, the variable cost would be given directly in this formula. For example, if all roads were good highway, the variable labor cost would be 4.41 cents per mile.

Total fixed route labor costs amounted to $161.89, or an equivalent of .657 cents per mile. Labor cost per route mile was computed by adding the per-mile fixed labor cost to the variable labor cost computed in formula 5.1. The formula for labor cost for roads with various percentages of each road type and condition is:

$$(5.2)\quad LC = D\,(.657) + D\left[4.41\,R_1C_1 + 4.14\,R_1C_2 + 6.41\,R_1C_3 + 6.26\,R_2C_1 + 6.44\,R_2C_2 + 12.16\,R_2C_3 + 8.22\,R_3C_1 + 7.36\,R_3C_2 + 12.72\,R_3C_3\right]$$

For 24,610 miles driven in March, 725.06 hours of driving time was required at a cost of $1,458.29 for labor costs.

Truck Costs Per Mile

Variable truck and tank costs totaled $3,777.61 in March. Actual driving time for trucks was the same as the driving time for drivers--

725.06 hours. If these costs were related directly to the time on the road then the variable truck cost would be 8.68 cents per minute. Multiplying this rate by actual time involved in travel would give one estimate of cost by road type and condition. Costs based on this estimating procedure were as follows:

$$(5.3)\quad VTC_1 = D\left[12.84\ R_1C_1 + 12.07\ R_1C_2 + 18.66\ R_1C_3 + 18.23\ R_2C_1 + 18.75\ R_2C_2 + 35.41\ R_2C_3 + 23.96\ R_3C_1 + 21.44\ R_3C_2 + 37.06\ R_3C_3\right]$$

However, costs based on actual time overstated the costs of travel on highways and understated the costs of travel on gravel and dirt roads. On the latter roads equipment will not stand up as long and occasionally additional time is required because of wet roads. In an attempt to approximate actual cost on the various roads the following assumptions were made:

1. Each minute of actual time of travel on highway roads would constitute 1.0 unit of cost.
2. Each minute of actual time traveled on gravel roads would constitute 1.5 units of cost.
3. Each minute of actual time traveled on dirt roads would constitute 2.0 units of cost.

On the basis of these assumptions, a total of 52,297.73 units of cost were involved in travel in March, 1958. This would be equivalent to a unit cost of 7.22 cents for the variable truck cost category. The formula for variable truck costs by road types under this formulation would be:

$$(5.4)\quad VTC_2 = D\left[10.69\ R_1C_1 + 10.04\ R_1C_2 + 15.52\ R_1C_3 + 22.74\ R_2C_1 + 23.39\ R_2C_2 + 44.19\ R_2C_3 + 39.85\ R_3C_1 + 35.67\ R_3C_2 + 61.65\ R_3C_3\right]$$

Fixed costs including truck, tank, labor and other costs were $3,389.95. If these costs were distributed uniformly over the total miles driven (36,510), they would have been equivalent to 9.28 cents per mile. For 24,610 route miles, total fixed cost would be $2,541.76, giving a per mile rate of 10.33 cents.

Total truck costs for any given route, based on assumed unit costs, would be equivalent to the distance multiplied by the per mile rate of fixed route costs (10.33) added to VTC_2 (Formula 5.4).

$$(5.5)\quad TC = D\ (10.33) + D\left[10.69\ R_1C_1 + 10.04\ R_1C_2 + 15.52\ R_1C_3 + 22.74\ R_2C_1 + 23.39\ R_2C_2 + 44.19\ R_2C_3 + 39.85\ R_3C_1 + 35.67\ R_3C_2 + 61.65\ R_3C_3\right]$$

Total Costs Per Mile

Total costs per mile for trucks and labor, based on assumed unit costs, are summarized in Table VII and Figure 5. These costs are based on formulae 5.2 and 5.4 and include only actual driving costs. They do not cover such costs as check-in, unloading or clean-up.

In Figure 5 the costs for the various classes of roads average as follows: 25.52 cents per mile for pavement, 49.25 cents per mile for gravel, and 63.66 cents per mile for dirt. The total cost of traveling on a dirt road was over twice as great as on a highway road. It should be noted that these are costs based on specific assumptions with respect to conditions during late winter months. During periods when dirt roads are wet and muddy, actual truck costs can skyrocket above the normal costs. Approximately half the sample was taken under these conditions. The costs

TABLE VII

COST PER MILE FOR TRAVEL ON SAMPLE ROUTES, BASED ON ASSUMED UNIT COSTS, CLASSIFIED BY TYPE AND CONDITION OF ROAD, PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA; MARCH, 1958

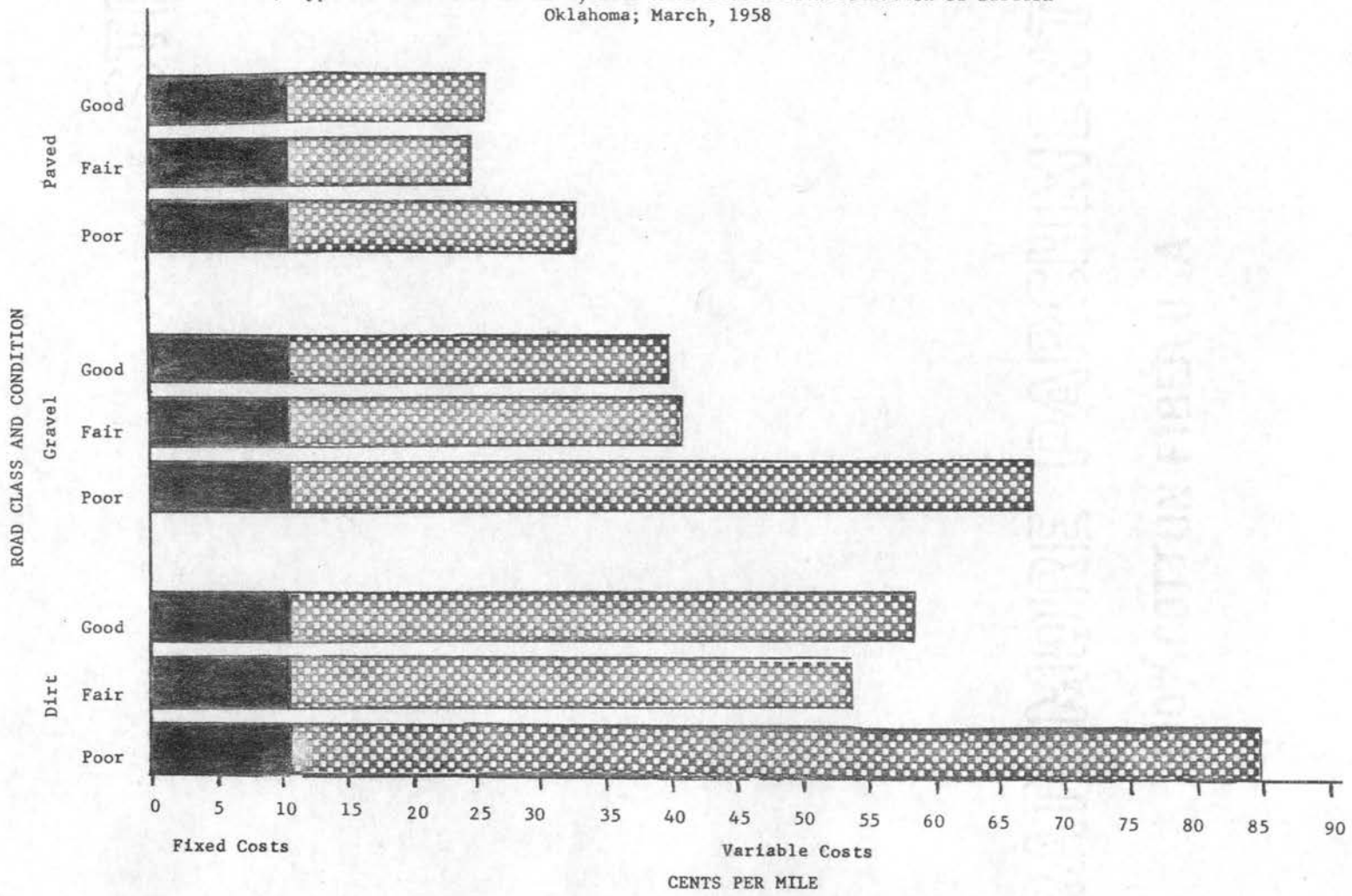
Road Class and Condition	Fixed Cost	Variable Costs		Total Costs
		Labor	Truck	
	(cents per mile)			
Paved				
Good	10.33	4.41	10.69	25.43
Fair	10.33	4.14	10.04	24.51
Poor	10.33	6.41	15.52	32.26
Gravel				
Good	10.33	6.26	22.74	39.33
Fair	10.33	6.44	23.39	40.16
Poor	10.33	12.16	44.19	66.66
Dirt				
Good*	10.33	8.22	39.85	58.40
Fair	10.33	7.36	35.67	53.36
Poor	10.33	12.72	61.65	84.70

*Based on less than 25 mile sample. Considered unreliable for reporting.

Source: Computed from survey data obtained from Pure Milk Producers Association of Eastern Oklahoma, December 30, 1957 through February 1, 1958, and from an Association audit report of March, 1958.

Figure 5

Cost per Mile for Travel on Sample Routes, Based on Assumed Unit Costs, Classified by Type and Condition of Road, Pure Milk Producers Association of Eastern Oklahoma; March, 1958



indicated in Figure 5 may overestimate average conditions and normal costs and underestimate costs incurred in periods of bad weather conditions. Bad roads not only take extra time, extra fuel, and occasional assistance from a farm tractor or commercial winch truck, but they also mean that the equipment may sustain internal damage which shows up later in motor overhauls and increased maintenance.

Total costs per mile, based on actual time, are summarized in Table VIII. These costs are based on formulae 5.2 and 5.3.

Route Costs

The average route in the Tulsa milkshed in March, 1958, included 10 producer stops and was 175.2 miles in length. The average time and cost for performing each function on this route is listed in Table IX. The total cost per route was $70.59 for March, 1958.

Certain functions performed on the route were classified as fixed functions. That is, the number of producers per route did not affect either the time or the costs of performing these functions. Fixed functions included: (1) time spent at the Association prior to departure, (2) lunch, coffee, waiting, etc., (3) unloading and pump-off, and (4) trouble. The total of these costs was $4.48 per route. This was an average of $.45 per producer. If a proportionate share of overhead driving were included as a fixed function then the average cost per producer would be $2.61. Overhead driving was defined as the distance traveled from the Association to the first producer plus the distance traveled from the last producer to the Pure Milk Producers Association plant. Almost all this travel was on paved roads, so the weighted average

TABLE VIII

COST PER MILE FOR TRAVEL ON SAMPLE ROUTES, BASED ON ACTUAL TIME, CLASSIFIED BY TYPE AND CONDITION OF ROAD, PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA; MARCH, 1958

Road Type and Condition	Fixed Cost	Variable Cost		Total Cost
		Labor	Truck	
	(cents per mile)			
Paved				
Good	10.33	4.41	12.84	27.59
Fair	10.33	4.14	12.07	26.54
Poor	10.33	6.41	18.66	35.40
Gravel				
Good	10.33	6.26	18.23	34.82
Fair	10.33	6.44	18.75	35.52
Poor	10.33	12.16	35.41	57.90
Dirt				
Good*	10.33	8.22	23.96	42.51
Fair	10.33	7.36	21.44	39.13
Poor	10.33	12.72	37.06	60.11

*Based on less than 25 mile sample. Considered unreliable for reporting.

Source: Computed from survey data obtained from Pure Milk Producers Association of Eastern Oklahoma, December 30, 1957 through February 1, 1958, and from an Association audit report of March, 1958.

TABLE IX

AVERAGE DAILY TIME AND COST FOR EACH FUNCTION PERFORMED ON THE AVERAGE ROUTE, PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA; MARCH, 1958

Function	Time (minutes)	Variable Labor Cost	Total Driving Cost	Total Cost Per Route	Total Cost Per Producer
Fixed Functions					
Time spent at Association prior to departure	13.2	$ .39	--	$ .39	$ .04
Lunch, Coffee, Waiting, etc.	51.2	1.52	--	1.52	.15
Unloading and Pump-off	52.9	1.58	--	1.58	.16
Trouble	33.1	.99	--	.99	.10
Total	150.4	$4.48	--	$4.48	$ .45
Variable Functions					
Driving					
Overhead	(103.6 miles)	--	26.14	--	(2.61)
Between Producers	(71.6 miles)	--	27.70	--	(2.77)
Total Miles	(175.2 miles) 311.757	(9.29)*	$53.84	$53.84	5.38
Farm Stops	100.2	2.98	--	2.98	.30
Total	411.947	2.98	53.84	56.82	5.68
Total Time and Cost Per Route	562.3	7.46	53.84	61.30	6.13

*Labor costs of driving are included in total driving cost.

Source: Computed from survey data and audit report of Pure Milk Producers Association of Eastern Oklahoma, March, 1958. Date of survey, December 30, 1957 through February 1, 1958.

cost (25.53 cents) for paved roads was used to compute the cost of 103.6 miles of overhead driving on an average route of 175.2 miles with an average of ten producers.

Per Stop Costs

At each producer stop the actual cost depended on the volume of milk. The time at the stop as given in formula 4.3 contained a fixed and a variable time element. Labor costs at 2.98 cents per minute would give the following variable labor costs per stop (VLC_s):

(5.6) $\quad VLC_s = 17.8¢ + .61\ V_s$

where V_s is the volume of milk in hundredweights.

The cost per stop for a 1,000 pound pickup would be 17.8 cents plus 6.1 cents $\left[17.8 + (.61 \times 10)\right]$ or 23.9 cents. For the average stop with 1,976 pounds of milk, the cost would be 29.9 cents.

If fixed labor costs plus a proportionate share of office overhead were included with variable labor costs, the formula would be:

(5.7) $\quad LC_s = 20.9 + .72\ V_s$

Using this formula the cost per stop for 2,000 pounds of milk would be 20.9 cents plus 14.4 cents ($.72 \times 20 = 14.4$) or 35.3 cents. The formula was determined in the following manner. Fixed labor costs plus office overhead labor costs were .524 cents per minute of driver time. The fixed time element was 5.969 minutes and the variable time element was .205 minutes per hundredweight of milk. With a fixed labor cost of .524 per minute, this added 3.1 cents to the fixed element of equation 5.4 and .11 to the constant portion of the variable.

Alternatively, if the additional cost of fixed costs and office overhead were considered in a completely fixed context and averaged over all

stops, the additional cost for the average stop would be 5.26 cents. Hence, the average labor cost per stop in equation 5.7 would be as follows:

(5.8) $\quad LC_s = 23.1 + .61\ V_s$

For a 2,000 pound stop the cost would be 35.3 cents. In the interest of simplicity, and since it is really nearer the usual economic concept, this formulation will be used throughout this analysis.

Designation of a specific per stop cost depends on the problem under consideration. If consideration is given only to the extra labor cost of going through the pickup operations at the farm then the per stop cost would be a marginal cost. For some problems it may also be necessary to give consideration to certain overhead costs entailed in the bulk milk transportation service. The larger the number of these overhead costs included, the greater will be the per stop cost. In addition, the more nearly will the per stop cost approach an average cost figure.

In the Tulsa milkshed, the marginal cost of going through the pickup operation at the farm was 17.8 cents (Formula 5.6). This was based on variable labor cost and does not consider the volume of milk pumped. Generally some volume of milk pumped should also be included in a per stop cost. If the average volume pumped were 2,000 pounds of milk, the extra cost based on variable labor cost would be 12.2 cents (this volume is slightly larger than the average used in Table IX). This would make a per stop cost of 30.0 cents (Formula 5.6).

Some consideration might be given to the fixed operations of running the route such as lunch and coffee, unloading and pump-off, and trouble. In Table IX the average of these items was 45 cents per producer. If

these costs were added to the aggregate per stop costs for the 2,000 pound producer, the March, 1958, per stop costs would range from 75.0 cents for marginal salary cost to 80.3 cents for average salary costs. If the proportionate share of overhead driving costs were also included ($2.61 per producer) the March, 1958, per stop costs would be $3.36 and $3.41 respectively.

Generally, it would appear that the hauling charge for each producer should cover the primary cost of extra travel to his farm plus a share of the overhead items associated with labor and truck costs. Using this principle, the addition of any new producer to a route should add enough income to cover the extra driving costs plus a per stop cost. At a minimum, this per stop cost should include the cost for time at the farm plus a share of the costs of running the route such as check-in, unloading, and checkout. The per stop charge could be about 80 cents per average producer per pickup. Such a charge might be collected for each delivery or it might be collected the first of each month on a flat $12.00 per month basis.

Summary

With a per-minute labor cost of 2.98 cents the fixed operations of running the route were $4.48 per route. Driving operations cost $9.29, and the functions performed at farm stops cost $2.98 per route. This totaled $16.75 charged for the labor used in driving an average route. Total route labor cost in March was $2,654.26.

Truck and tank costs for driving the average route with the average proportions of road conditions totaled $53.84. This included the assumed variable depreciation cost for route equipment, the actually variable cost

for maintenance, fuel, lubrication, and tires, and the fixed cost of mechanics' salaries, licenses, insurance, interest and LP gas equipment depreciation. During March, truck and tank variable costs totaled $3,777.62, and truck and tank fixed costs were $1,405.62 for routes.

All other costs were assumed to be fixed with road classification. The route portion of these amounted to $1,136.14. Costs per mile were computed on basis of the data collected in the sample. Average labor costs per mile were 4.425 cents for paved roads, 8.398 cents for gravel roads and 9.119 cents for dirt roads. Truck costs per mile were 21.095 cents for paved roads, 40.852 cents for gravel roads, and 54.541 cents for dirt roads. Summing these gave the following total costs per mile.*

Paved Roads	25.52 cents
Gravel Roads	49.25 cents
Dirt Roads	63.66 cents

Route costs were allocated in the following proportions: Labor, $7.46; truck and tank, $53.84. This meant that for each of the ten producers on the average route, the average cost incurred was $.75 for labor and $5.38 for trucks and tanks or a total of $6.13.

At each producer stop, there were a number of fixed functions performed by the driver. Based on regression analysis, these functions consumed an average of 5.969 minutes. At the rate of 2.98 cents per minute, this cost would be 17.8 cents. The additional fixed cost of overhead labor (5.3 cents per stop) was added to this to give a fixed element of 23.1 cents per stop. The only consistent variable function at the farm stop was pumping. Logically, time spent in pumping depends on the amount of milk pumped. The regression analysis gave a value of .205 minutes per hundredweight of milk.

---

*These costs are based on the assumed unit costs.

At 2.98 cents per minute, the cost for pumping each hundredweight of milk would be .61 cents. Thus, per stop costs could be computed on the basis of a fixed and a variable element.

CHAPTER VI

A NEW PRODUCER

Suppose there were a producer considering the installation of a bulk tank who was located northeast of the nearest point along any established route. This producer is now shipping about 600 pounds of milk per day in cans. However, if he converts to bulk, there is reason to believe that he may increase present production by 25 percent. If he succeeds in increasing production, he will ship about 1,500 pounds per pickup on an every other day basis. For this production he may have a herd of about 39 cows averaging 7,000 pounds per cow per year. Assume that this producer is located in a zone in which he will be charged 28 cents per 100 pounds for hauling. At this rate, the Association would gross $4.20 per pickup.

Can the Association afford to let this producer install a bulk tank? The answer depends, of course, on a number of factors. The first question obviously is "how much extra driving would be necessary?" If this producer is located 9 1/2 miles from the established route and if, in view of the road conditions, it will be necessary to back track on the route, a total of 19 miles would be added to the route.

The second question is "What kind of roads must be traveled?" In this case, consider that 3 1/2 miles are fair highway, 1 mile is poor highway, 3 miles are fair gravel, and 2 miles are poor gravel. Since the road must be back tracked, total travel will be 7 miles on fair highway, 2 miles on poor highway, 6 miles on fair gravel, and 4 miles on poor gravel.

The added costs to the Association can be determined from Table VII as follows:

Fair highway	7 miles at 14.18 cents =	$ .99
Poor highway	2 miles at 21.94 cents =	.44
Fair gravel	6 miles at 29.83 cents =	1.79
Poor gravel	4 miles at 56.33 cents =	2.25
Extra cost of driving		$5.47
Extra labor cost at the farm		.30
Total of extra costs		$5.77

These extra costs include the wear and tear on trucks and tanks but they include no contribution whatsoever to other overhead costs of running the bulk tank pickup service. In addition, they do not provide for the fixed labor costs such as laundry and driver supplies. If these costs were included, the total cost of adding this producer would be $5.77 plus $2.38 for fixed costs of driving plus 5 cents for fixed costs of labor at the farm to make a total of $8.15. Even at this higher cost the producer is not sharing the route costs of check-in, and other items.

With income at $4.20 per pickup and costs at $8.15 per pickup, a loss to the Association would be inevitable. It is not so much the actual distance which will make this unprofitable as it is the kind of roads traveled. If the gravel roads were paved, the total extra costs would have been $4.15 which would be slightly less than income. A slight contribution would be made to the overhead.

Obviously, the Association could not afford to install a bulk tank in a situation such as this, and just as obviously, the producer could

not afford to pave five miles of gravel road. Three alternatives are open. These are as follows: (1) boost the hauling rate of this particular producer to at least 39 cents per hundredweight. A 39 cent hauling charge would bring a per stop revenue of $5.85--eight cents greater than total extra costs. However, an increase in the hauling rate to 54 cents per hundredweight of milk would be necessary for the producer to assume his full share of costs ($8.15); (2) the producer may increase production. An increase of 300 pounds per day--600 pounds per stop--would increase Association income to $5.88 per stop. This would give a slight contribution to overhead driving costs and fixed labor costs. However, the producer would have to increase production to about 1,455 pounds per day (2,910 pounds per stop) to cover his full share of $8.15; or (3) if an additional producer of equal size located near the producer in question or between him and the existing route could be induced to install a bulk tank, the problem could be solved. Assume that another producer of equal size is located just across the road from the producer considering the installation of a bulk tank. If both install bulk tanks, the Association receives $8.40 income from their combined volume of 3,000 pounds every other day. The extra cost of adding one producer is $5.77. If this producer is to carry his full share of costs, this figure is $8.15. However, the extra cost of adding <u>both</u> producers is $5.77 plus $0.30 extra labor cost at the second farm plus some small extra cost of driving from one barn to the other. This gives a total extra cost of just over $6.07. If each is to share equally with all other producers in the costs of overhead driving, $2.18 must be added to each producers' costs. Also, 5 cents must be added to each producer's costs for fixed costs of labor at the farm. This brings

the total cost share of both producers to $10.53. These producers would still lack $2.13 paying their full share of costs, but they do make a substantial contribution to fixed costs of the running of the route.

CHAPTER VII

SUMMARY AND CONCLUSIONS

In this study, the basic problem was in the allocation of the costs of the bulk milk assembly operations of the Pure Milk Producers Association of Eastern Oklahoma among the various functions performed in these operations. This problem was examined from the standpoint of varying cost conditions.

The study was complicated by the milk diversion operations of the Association, the costs for which were included in Association audits along with route costs or the costs of bulk milk assembly. Throughout the study, costs which could be charged specifically to either category have been attributed to either "route costs" or to "total costs." However, the majority of costs were chargeable to both route operations and to diversion operations. These have been allocated arbitrarily on the basis of mileage driven on routes or in milk diversion.

Throughout the study, costs have been tied to time spent and to road conditions on the Association routes. Since costs have been tied to road conditions in route operations, some costs which are normally considered variable in an economic framework have been treated as fixed costs. These costs are actually unaffected by road types and conditions, and hence with respect to roads are actually fixed costs.

Drivers were compared on the basis of efficiency in performing functions at the farm stops. However, analysis of variance indicated that there were no significant differences between drivers in the performance of the overall farm stop operations.

Unexpected delays and courtesy functions were responsible for additions to normal route time. For example, one driver was observed to lend aid in the milk-house of one producer who was ill. The producer's wife was responsible for performing all the chores involved in dairy farming. Also, there were numerous observations of farmers being present in the barn when a pickup was made. The interruption of the normal pickup process would often detain the driver. Generally, however, the additional time represented a public relations function for the Association and may have been quite valuable to the Association.

The time and motion data were integrated with income and cost accounting information for March, 1958, to obtain estimates of unit costs of performing specific functions. It was estimated that the average cost was $61.30 for the average route of 175.2 miles in length with ten producers. This represents a cost of $6.13 per producer. The cost of driving depended on three factors; (1) distance traveled, (2) road type or classification, and (3) road condition. Based on the distribution of miles driven in the sample taken in early 1958, average costs per mile were as follows: 25.72 cents for highway, 49.25 cents for gravel, and 63.66 cents for dirt.

One of the greatest questions present in a bulk milk assembly operation has been the addition of producers to bulk tank routes. Travel on dirt and gravel roads has been expensive and in numerous instances, producers who have been located on these road types have not shared in the full cost of transportation services.

The decision to add a producer who is located on a dirt road should be made with full recognition of the consequences. Normally, the person

in charge of the transportation department should make this decision. Some factors to be considered in this decision might be as follows:

1. Is the farm located on an all-weather road?
2. Are all bridges adequate for loaded tanks and trucks?
3. Are the farm entrances sufficiently wide to accommodate present truck and tank equipment?
4. Is the farm driveway classified as all-weather?
5. Is the income from the volume of milk per stop sufficient to cover the cost of driving the additional mileage for this producer?
6. Is the farm bulk milk parlor layout accessible and convenient?

A negative answer to any of these points could be sufficient to rule against adding a new producer.

In the Tulsa milkshed, farm driveways were responsible for as much difficulty as poor roads. One particular route was observed three times. All three times, the truck was stuck in one producer's drive. Care should be exercised to insure that all producers--both old and new in terms of using bulk tank facilities--meet a minimum driveway specification.

Additional studies should compare the expense of leased trucks with the expense of Association owned and operated trucks. The Central Oklahoma Milk Producers Association of Oklahoma City at the present time follows the practice of leasing trucks. Also, the revenue and cost of leased routes might be compared with revenue and cost of Association owned and operated routes. The practice of leasing routes has been a recent innovation in the Tulsa milkshed. The effect of weather and the density of location of producers upon costs of bulk milk assembly might

also be investigated. The extent of additional costs and depreciation rates because of variable weather conditions are not known. Some of the effects which might result from greater or lesser producer density have been implied in the preceding section dealing with the addition of a new producer, but the actual effects are unknown.

BIBLIOGRAPHY

(1) Baum, E. L. and Pauls, D. E., A Comparative Analysis of Costs of Farm Collection of Milk by Can and Tank in Western Washington, 1952, Washington Agricultural Experiment Station, Technical Bulletin No. 10.

(2) Blakley, Leo V., Boggs, Kenneth B., and Rogers, Walter B., A Preliminary Report on an Analysis of Bulk Milk Transportation Costs of the Central Oklahoma Milk Producers Association, Departmental Report, Department of Agricultural Economics, Oklahoma State University, Stillwater, Oklahoma, January, 1958.

(3) Clark, D. A., Jr., A Comparative Analysis of Costs of Operating Milk Collection Routes by Can and Tank in California, Giannini Foundation of Agricultural Economics, Berkeley, California, Mimeographed Report 91, October, 1947.

(4) Cowden, Joseph M., Farm to Plant Bulk and Can Milk Hauling Costs, Farmer Cooperative Report 18, U. S. Department of Agriculture, Washington 25, D. C., March, 1956.

(5) _____, Comparing Bulk and Can Milk Hauling Costs, Farmer Cooperative Service Circular 14, U. S. Department of Agriculture, Washington 25, D. C., June, 1956.

(6) Johnson, Paul E., Olson, Harold C., and Von Gunten, Robert L., A Comparison of the Bulk and Can Systems for Hauling Milk on Farms, Oklahoma Agricultural Experiment Station, Bulletin B-346, Stillwater, Oklahoma, August, 1954.

(7) Kelley, Paul L., Cost Functions for Bulk Milk Assembly in the Wichita Market, Technical Bulletin 96, Kansas State College of Agriculture and Applied Science, Manhattan, Kansas, May, 1958.

(8) Leftwich, Richard H., The Price System and Resource Allocation, Rinehart and Company, New York, 1955.

APPENDICES

APPENDIX A

Date_____

Enumerator_____

Route No._____ Driver_____

Beginning Mileage_____ Ending Mileage_____ Net_____

Beginning Time_____ Ending Time_____ Net_____

Last Farm Highway to Scales_____

	Time Beginning	Time Ending	Time
Check Instructions			
Check truck (Oil, LP, etc.)			
Warm up truck			
Truck to building			
Sterilize tank			
Hook up pump			
Sterilize pump			
Ice			
Supplies			
Sample bottles			

Stop No._____ Producer_____ Date_____

Enumerator_____ Driver_____

Road Type	Condition	Beginning Mileage	Net Mileage	Beginning Time	Net Time
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				

Stop No. ________ Producer ____________________ Date ____________________

Enumerator ______________________________________ Driver ____________________

Road Type	Condition	Beginning Mileage	Net Mileage	Beginning Time	Net Time
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				

Stop No. _____ Producer _____ Date _____

Enumerator _____ Driver _____

Road Type	Condition	Beginning Mileage	Net Mileage	Beginning Time	Net Time
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				
	(G F P)				

Operations (Tank Type _____)

	Operation (Sequence)	Beginning	Net
1. Hook up Hose and Cord			
2. Write Ticket			
3. Weigh Milk(Pounds_____)			
4. Agitation			
5. Sample			
6. Pumping			
7. Put up Cord and Hose			
8. Washing Tank			
9.			
10.			
Other Operations:			
11. Delivery Service (Yes)			
12. Sterilize Hose (Yes)			
13. Agitator Off (No)			
14. Quality(Yes)			

APPENDIX B

TABLE I

POUNDS OF MILK PICKED UP AND TIME REQUIRED PER STOP FOR A HYPOTHETICAL ROUTE FOR THE PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA

Stop Number	Volume of Milk (pounds)	Fixed Time 6.0 (minutes)	Variable Time .205X* (minutes)	Total Time Required (minutes)
1	2,321	6.0	4.76	10.76
2	2,074	6.0	4.25	10.25
3	1,892	6.0	3.88	9.88
4	1,821	6.0	3.73	9.73
5	2,429	6.0	4.98	10.98
6	1,346	6.0	2.76	8.76
Pump-off				
7	1,620	6.0	3.32	9.32
8	1,660	6.0	3.40	9.40
9	1,727	6.0	3.54	9.54
10	1,924	6.0	3.94	9.94
Total	18,814	60.0	38.56	98.56**

*Estimates based on regression equation for time at the farm.

**This does not agree with the route average of 100.2 minutes because in computing the route average the overall average of just less than 2,000 pounds of milk per producer was used for all producer milk poundages.

Source: Computed from survey data obtained from the Pure Milk Producers Association of Eastern Oklahoma, December 30, 1957 through February 1, 1958.

TABLE II

SCHEDULE OF LABOR COSTS, PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA; MARCH, 1958

	Total Cost (36,510 miles)	Route Cost (24,610 miles)
Variable Costs		
Driver's Salaries	$3,620.50	$2,437.50
Payroll Taxes	81.50	54.87
Coveralls and Laundry	142.10	95.78
Driver Expense	98.08	66.11
Total	$3,942.18	$2,654.26
Fixed Costs		
Office Overhead	$ 797.12*	$ 797.12*
Total of Fixed plus Variable	$4,739.30	$3,451.38

*Office overhead here has been computed with respect to routes. Hence, there is no reduction.

Source: Audit report, Pure Milk Producers Association of Eastern Oklahoma, for period March 1, 1958, through March 31, 1958.

TABLE III

SCHEDULE OF TRUCK COSTS, PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA; MARCH, 1958

	Total Cost (36,510 miles)	Route Cost (24,610 miles)
Variable Costs		
Truck and Tank Operations and Maintenance	$1,167.71	$ 787.11
LP Gas	1,147.81	773.69
Gasoline	1,013.49	683.15
Oil and Lubrication	100.14	67.50
Tires and Tubes	402.63*	271.40
Turnpike	101.45	101.45**
Total	$3,933.23	$2,684.31
Fixed Costs		
Truck Depreciation	$1,095.30	$ 738.30
Tank Depreciation	526.68	355.01
Truck and Tank Insurance	601.72	405.60
Truck and Tank Licenses	392.07	264.28
Federal Highway Use Tax	37.50	25.27
State Highway Use Tax	16.67	11.24
Interest	250.37	168.76
LP Gas Equipment Depreciation	48.72	32.84
Mechanics' Salaries	738.25	497.62
Total	$3,707.28	$2,498.92
Total of Fixed plus Variable	$7,640.51	$5,183.23

*Expenditures for tires and tubes was deceivingly low ($165.30) during March. For this reason, the 1957 monthly average of $402.63 was used in the analysis.

**This is solely a route cost. For this reason, there is no reduction.

Source: Audit Report for month of March, 1958, Pure Milk Producers Association of Eastern Oklahoma.

TABLE IV

SCHEDULE OF OTHER COSTS, PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA; MARCH, 1958

	Total Cost (36,510 miles)	Route Cost (24,610 miles)
Variable Costs		
Office Supplies	$119.26	$ 80.39
Utilities	235.98	159.06
Total	$355.24	$239.45
Fixed Costs		
Building Depreciation	$ 68.39	$ 46.10
Boiler Depreciation	4.58	3.08
Furniture and Fixtures Depreciation	9.23	6.22
Machinery and Equipment Depreciation	3.27	2.20
Land Improvements Depreciation	17.16	11.57
Interest	45.08	30.39
Total	$147.71	$ 99.56
Total of Fixed plus Variable	$502.95	$339.01

Source: Audit Report, Pure Milk Producers Association of Eastern Oklahoma, March, 1958.

VITA

John William Goodwin

Candidate for the Degree of

Master of Science

Thesis: COSTS OF BULK MILK ASSEMBLY FOR THE PURE MILK PRODUCERS ASSOCIATION OF EASTERN OKLAHOMA

Major Field: Agricultural Economics

Biographical:

Personal Data: Born at Durham, Oklahoma, January 1, 1935; the son of Robert Louis Goodwin and Obera Hatley Goodwin.

Education: Attended grade and high school at Durham, Oklahoma; graduated from Durham High School in May, 1953. Received the Bachelor of Arts Degree from Panhandle Agricultural and Mechanical College, Goodwell, Oklahoma, with a major in History, in July, 1956; engaged in postgraduate study toward the Master of Science Degree in Agricultural Economics at the University of Connecticut, Storrs, Connecticut, from September, 1956 to June, 1957; continued postgraduate study toward the Degree of Master of Science at Oklahoma State University, Stillwater, Oklahoma, from September, 1957, to September, 1958.

Professional Experience: Was Research Assistant in the Department of Agricultural Economics at the University of Connecticut from September, 1956, through July, 1957; was Research Assistant in the Department of Agricultural Economics at Oklahoma State University from September, 1957, to September, 1958.