August 1982

A.E. Ext. 82-26

USING THE TI-59 PROGRAMMABLE CALCULATOR TO ESTIMATE OPERATING COSTS AND HAULING RATES FOR BULK MILK ASSEMBLY

William Lesser

Walter Wasserman

Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York 14853

It is the policy of Cornell University actively to support equality of educational and employment opportunity. No person shall be denied admission to any educational program or activity or be denied employment on the basis of any legally prohibited discrimination involving, but not limited to, such factors as race, color, creed, religion, national or ethnic origin, sex, age or handicap. The University is committed to the maintenance of affirmative action programs which will assure the continuation of such equality of opportunity.

PREFACE TO THE SECOND REVISED EDITION

This bulletin is a revision of an earlier one of the same name dated June 1980 (A.E. Res. 80-12--yellow cover). This edition contains two changes over its predecessor--a removal of income tax considerations from the program and an updating of the cost figures in the example. In all other respects, the two bulletins are identical, and this one should be used in place of the earlier version.

Reasons for the Revision

The Economic Recovery Tax Act of 1981 incorporated several fundamental changes in federal tax codes, including the allowances for depreciation and investment credits. These two factors are important for bulk milk assembly because they affect the after-tax returns from the enterprise. In the original or 1980 program, the "savings" due to investment credits and depreciation allowances were credited against the hauling costs. That is, the calculated route costs were reduced by the amount that taxes were reduced. Thus, that program provided a partial after-tax cost estimate.

The 1981 Tax Act changed substantially the allowable amounts of depreciation and investment credits. The effect of this change is to make the tax savings more sensitive to the incomes (and hence effective tax rates) of individual users. The TI-59 program in its present form is not designed to provide the appropriate analysis for calculating individual benefits. Instead, a decision was made to omit tax considerations altogether so that this revised program provides a before-tax estimate of costs.

Effects of the Change

Changing from partial after-tax cost estimates to pre-tax estimates increases the calculated hauling costs. This is because the hauler will realize additional cash flow after taxes which, in the revised program, is not credited against expenses. The increased cash flow is the result of investment tax credits and depreciation allowances applied against income tax liability. These sums must be reinvested back into the business if the hauler is to have sufficient reserves to replace the truck and tank when needed.

The dollar amounts of the change in the program can be seen using the input data from the 1980 example. The original estimate of fixed costs was $33,885 96. With the present revision, using the same cost data, the estimated value is $36,848.10. Thus the annual fixed hauling cost estimate rose by nearly $3,000.00 due to the program change. Variable costs are unaffected.

It is also interesting to see what effect the 1981 Tax Act would have. This Act reduced the depreciation period for rolling stock to three years. Thus the tax savings are greater. In dollars, using the same 1980 figures applied above, the new tax codes provide approximately $2,000 additional dollars annually in tax savings at the assumed tax rates. Haulers with higher and lower tax rates would find their after-tax savings had to be adjusted accordingly.

INTRODUCTION AND PURPOSE

The New York State dairy industry is vitally dependent on an efficient and competitive transportation system for assembling and transporting milk from farms to processing plants. Much of the state's milk assembly operation is carried out by independent contract haulers who operate their own truck(s). The independent owner-operator has often proved the best as well as the lowest-cost option for accomplishing the hauling function. The use of a relatively large number of independent haulers over a wide range of route conditions does, however, create significant coordination needs for the participants. This publication is directed to assisting with one aspect of the coordination requirements; the determination of equitable hauling rates.

The rate paid to haulers for bulk milk assembly is, ideally, negotiated on a route-by-route basis. Typically in practice the request for a rate change is initiated by a hauler and justified on the basis of an increase in labor, fuel or other costs. But since many cost increases affect all haulers, what began as a request for a rate change by an individual hauler often becomes a concurrent request by all haulers. If the handler agrees to a rate increase while lacking specific information about the effect of the cost increase on individual routes, the increase is often applied as a flat, across-the-board adjustment. Such uniform rate changes in assembly systems with highly divergent route conditions tend to favor some haulers over others. As a result some assembly routes can be substantially more profitable than others, while the system as a whole is neither efficient nor equitable for either the dairymen or the haulers. A detailed knowledge of assembly costs is essential for operating an efficient system.

At the same time, rapidly rising transportation costs have placed the small contract hauler at a competitive disadvantage to larger operators as the management function becomes more critical. The small operator, who drives and maintains the truck, has less time available for analyzing the business. A quick means of

estimating changing route costs should prove an essential management tool during these inflationary times.

The purpose of this publication is to present a ready means of estimating the effect of a change in the cost of one factor, like fuel, on overall operating costs. The resultant estimates are useful to both handlers and haulers. Handlers may use the estimates in planning for anticipated future cost changes. Haulers must keep track of costs to be sure that rates are sufficient to accumulate capital for timely replacement of the tank truck fleet. Together the estimates provide a common basis from which rate negotiations can be started.

The estimates are developed using economic engineering techniques by combining individual item costs, from fuel and tires to purchase price and maintenance, into uniform operating costs per unit of product, time and distance. These estimates may be broken out into fixed and variable cost components. To make the calculations speedy and accurate a TI-59 programmable calculator is used*/(1). With its assistance the effect of a fuel price increase on total per mile costs, to mention one example, can be determined within seconds.

The program is kept relatively short by omitting much of the detail and special considerations which are a part of day-to-day operations. Thus the results should be viewed as approximations only. The estimates include operating costs only; other factors such as returns to management and risk are not included. The appropriate payments for management and risk vary widely from firm to firm so that no rule-of-thumb figure can be established. Allowances for these factors and other items specific to particular routes must be established during negotiations.

In past years it was common for rates to reflect the haulers out-of-pocket costs plus a premium for management and risk. This meant among other things that

---

*/The bracketed numbers refer to additional information on this point included with the footnotes on page 17 following the text.

haulers were compensated based on what they actually paid for their truck. During periods of relatively stable prices this approach proved adequate but problems began to appear when replacement truck prices started moving up sharply. The hauler who had to replace his truck with a much more expensive new one found that he had no accumulated reserves to use to allow purchase at the higher price and had to drop out of the industry. One solution to this situation would be to raise the rate whenever a new truck is purchased. This would, however, not be equitable and would provide a strong incentive for all haulers to buy new equipment! A second and preferable procedure is to provide on going payments with which the hauler may build some equity for the time when a replacement must be purchased. A reasonable improvement in equity should be assured if the rates are periodically adjusted to reflect the "current replacement" of a similar vehicle. This "replacement cost" approach is used in this bulletin. It will generally give a good approximation to the long term costs faced by a hauler but may not be appropriate in some cases, such as a route which would not be economical once the present truck wears out (2).

Data requirements for the program are substantial. In some cases a considerable initial effort will be required to establish a system for collecting and updating the necessary information. If it is done properly this data collection procedure should lead to better record keeping and an improved understanding of the hauling system and the major factors influencing costs. If not, the estimates provided by the program will be inaccurate and misleading.

This report is organized as follows. The first section involves the estimation of hauling costs and includes a description of the basic program, an example application, suggested procedures for collecting data, and an overview of ways of adapting the model for a range of different conditions. The second section describes the use of the program to calculate stop charges and allocation of costs based on time, distance and volume. The program itself is included in the Appendix.

SECTION I

Estimating Hauling Costs

Steps for operating the TI-59 program are detailed in Figure 1. This figure also includes an example which may be run to check to see that the program has been typed in correctly. The data for the example have been developed from information supplied by a group of handlers and haulers in upstate New York, as well as from a study of milk hauling in New York State by Professor Bruce Anderson (3). They represent with reasonable accuracy the aggregate cost conditions for that area for mid-1982. These data do not, however, necessarily represent actual costs for any one specific route and are not intended to be used in any application of the program to an actual situation.

Definitions and Guidelines for Data Collection

The results of the program are, of course, only as good as the data which are entered by the user. A strict adherence to the definitions and collection guidelines listed below will help to assure that the program results are valid and compatible for cross-firm comparisons.

01. Average Daily Route Miles - Use the total average daily miles traveled from garage to garage. In the case where more miles are traveled one day than another, total the two days and divide by two.

Ex.	Day 1 -	110 miles
	Day 2 -	170 miles
	Total	280/2 =140 Avg. miles per day

02. Average CWT Delivered Per Day - Use average daily deliveries over the entire year taking into consideration all routes and the flush period, if any.

03. Truck Costs - Truck are available with an extremely large selection of optional equipment from engines, axles and transmissions, down to radios, air conditioners and seats. To standardize cost estimates the specifications of a serviceable truck must be agreed upon by haulers and handlers. Examples of such specifications are listed in Figure 2. With these specifications, prices can be collected from cooperating new truck dealers. In most cases fleet prices will be assumed to apply.

Truck investment costs are frequently lumpy with a large initial investment (down payment), a stream of interest and repayment costs and finally a return in the form of the salvage value (trade-in or scrap value). In order to make a nonuniform series of costs and returns comparable they are converted to an equivalent uniform annual series of payments (4).

Figure 1: Operating Instructions for Part I of the TI-59 Program

Entering the Program from Magnetic Cards:

Turn calculator off. Turn calculator on.
Press Key 1. insert side 1
Press Key 2. insert side 2

DATA INPUT

Item*	Example Value	Press Key	Example Display	Your Value	Press Key	Your Display
Fixed Costs						
Average Daily Route Miles	139	STO 01	139		STO 01	
Average CWT Delivered Per Day	477	STO 02	477		STO 02	
Truck Chassis Cost ($)	55000	STO 03	55000		STO 03	
Chassis Expected Life (years)	6	STO 04	6		STO 04	
Chassis Salvage Value ($)	11000	STO 05	11000		STO 05	
Tank Cost ($)	20000	STO 06	20000		STO 06	
Tank Expected Life (years)	10	STO 07	10		STO 07	
Tank Salvage Value ($)	4000	STO 08	4000		STO 08	
Insurance	1400	STO 09	1400		STO 09	
Registration Fees	280	STO 10	280		STO 10	
Highway Tax	120	STO 11	120		STO 11	
Interest Rate	.16	STO 12	.16		STO 12	
Miscellaneous Costs	1300	STO 13	1300		STO 13	
Driver Hourly Wage ($/hr.)	7.50	STO 14	7.50		STO 14	
Hours/Day for Driver(s)	9	STO 15	9		STO 15	
Variable Costs						
Miles Per Gallon	5	STO 20	5		STO 20	
Fuel Cost ($/gallon)	1.20	STO 21	1.20		STO 21	
Cost New Tire	225	STO 22	225		STO 22	
Cost Recapped Tire	100	STO 23	100		STO 23	
Number of Tires	10	STO 24	10		STO 24	
Bias or Radial Ply Tires - Enter 1 if Radial, 0 if Bias	0	STO 25	0		STO 25	
Ton-Mile Tax Rate	.017	STO 26	.017		STO 26	
Annual Maintenance	1000	STO 27	1000		STO 27	
Average Annual Repair in $/Mile	.12	STO 28	.12		STO 28	
Miscellaneous Variable Costs	0	STO 29	0		STO 29	

OUTPUT

Press Key	Value Output	Example Display	Your Display
A	Total Annual Fixed Costs (TFC)	45389.00	
R/S	TFC/Mile	.895	
R/S	TFC/CWT	.261	
R/S	TFC/Minute	.230	
B	Total Annual Variable Costs (TVC)	22875.24	
R/S	Total Annual Costs (TC)**	68264.31	
R/S	TC/CWT	.392	
R/S	TC/Mile	1.346	
R/S	TVC/CWT	.131	
R/S	TVC/Mile	.451	

*Definitions of these terms and suggested sources of information are included in the following section.

**TC = TFC + TVC.

Figure 2: Truck Specificaitons: Single Chassis

Specifications for a Single Chassis Truck
Suitable for a 4,000 Gallon, Farm Pickup Truck

Cab:	151" conventional	
Wheel base:	Approx. 218"	
Engine:	Detroit diesel - 671 N	Engine heater
	Low oil pressure warning	Vertical exhaust
	Spin-on oil filter	Luberfiner - 750
	Spin-on water filter	Farr air cleaner
	Plastic fan blade	Delco Remy H.D. alternator
	Jake brake	Ammeter
Clutch:	14" double disc	
Transmission:	Fuller R.T.O. 915	
Rear Axle:	Timken 38,000# 4:44 ratio	
Suspension:	Hendrickson spring & saddle mount. Extended leaf, 50" aluminum beam	
Front Axle:	Rockwell FL 901 - 18,000 lb., Shepard power steering	
Brakes:	S-Cam. Rear - 16 1/2" x 7 8" dia.	
	Front - 16 1/2" x 5"	
	Hand valve for all wheels	
	Front wheel limiting valve	
	Alcohol kit	
Tires:	Front - General high miler - 11:00 x 20	
	Rear - General D.C.L. 10:00 x 20	
Other Options:	Double frame or frame reinforcement	
	Dual 50 gal. step tanks	
	Stemco hubs	
	Tow hooks, front and rear	
	Bostrom Viking driver seat	
	Passenger seat	
	Air horn	
	Electric wiper motor	
	Radiator shutters	
	West Coast mirrors	

Source: Dennis R. Lifferth and Walter C. Wasserman, Milk Transportation and Processing: Analysis of Alternative Milk Marketing Systems USDA Farmer Cooperative Service, mimeograph, undated, p. 139.

04. Truck Life - The expected number of miles of service would be available from service managers. Dividing this figure by the annual route miles will give the expected life in years.

05. Truck Salvage Value - This figure will perhaps be one of the more difficult to estimate accurately. Dealers can give a good indication of what a particular five year old truck is worth today. This, however, will not necessarily indicate future salvage values since new truck prices have been rising rapidly in recent years, carrying used and junk truck prices up with them. The problem of estimating future salvage values is therefore one of projecting the rate of inflation for this equipment. Individual judgment must be used. A 20% of replacement cost rule-of-thumb is being used by some individuals in the industry.

06 & 07. Tank Cost and Tank Life - Available from the suppliers. Annual costs are calculated in the same manner as truck costs (see above).

08. Tank Salvage Value - Use current scrap metal values which have remained relatively constant over time, or if tanks are rehabilitated, use expected net value.

09. Insurance - Annual rates for liability and cargo, available from insurance agents and brokers. A standardized policy should be used. Such a policy might include $300,000 - $500,000 liability, collision for the value of the truck with $200 - $500 deductible and cargo coverage in case of upset. Some states, like New York, mandate other coverage.

10. Registration Fees - Annual fees available from the New York State Department of Motor Vehicles or comparable department in other states.

11. Highway Tax - Listed in New York State Department of Taxation and Finance Highway Tax Law Bulletin, October 1, 1974, or similar bulletins from other states, and in Federal tax codes. The tax should be calculated on an annual basis.

12. Interest Rate - The interest rate reflects the value and cost of capital tied up in the truck and tank over their service lives (5). Due to continued interest rate fluctuation, no standardized procedure is recommended for determining the appropriate rate. Your local lending institution can assist you in determining the appropriate current rate.

13. Miscellaneous Fixed Costs - These costs should include annual garaging, bookkeeping, heat, office, and other expenses which are necessary to operate the milk hauling business. These items are likely to differ from operator to operator so that the actual costs should be used if available. Other fixed costs which do not fit into the above categories may also be included here. A lease contract on trucks or tanks may be included here on an annual cost basis. See the following section for several examples.

14. Drivers' Wages - The average hourly wage rate including fringe benefits should be used. If a significant number of drivers are unionized the rate stipulated in the contract may be used. Wages should include the value of all fringe benefits and payroll taxes. If the drivers are not unionized or a significant number are independent owner-operators, then the prevailing local rate (including fringes) must be used. In a situation where there is

more than one driver during the day and the hourly rates are different, use a weighted average hourly rate:

Ex.	Driver 1 -	$ 7.40/hr. x 8 hrs. =	$ 60
	Driver 2 -	$10.00/hr. x 7 hrs. =	$ 70
			$130 ÷ 15 hrs. = $8.67/hr.

Relief driver wages should be included in calculating the average rate.

15. Hours/Day for Driver - An eight-hour day may be assumed unless information from the hauler or contract specifications indicate that a different length of day should be used.

20. Fuel Consumption in MPG - Available from operators or as estimates from truck dealers.

21. Fuel Cost ($/Gallon) - Use average local pump prices.

22 & 23. Cost of New Tire and Cost of Recapped Tire - Use fleet prices collected from local dealer (6).

24. Number of Tires - Part of the specifications under (03) above.

25. Type of Tire (Bias Ply or Radial) - Indicate most common type of tire used by pressing 0 for bias ply or 1 for radials (7).

26. Ton-Mile Tax Rate - Rates are listed in the New York State Department of Taxation and Finance Truck Mileage Tax and Fuel. Use Tax bulletin, Regulations 21, April 1, 1970, or similar publications for other states. If fuel is bought outside the state of operation a fuel use tax must also be paid (not included in program).

27. Annual Periodic Maintenance - This figure includes oil, chassis lubrication, filters, plugs and points (if necessary). This cost is available from local service stations and can be calculated on an annual basis according to expected mileage and service intervals recommended by the manufacturer.

28. Average Annual Repair Cost Per Mile - Repair costs are among the most difficult costs to determine. The rate would be best determined for several trucks over more than one year. Repair costs should include parts and labor on an annual basis divided by annual miles driven. If field data are not available applicable cost information may be collected from fleet service managers with similar type hauls.

29. Miscellaneous Variable Cost - To be used for items related to operating the truck but included elsewhere. Examples included mileage based rental rates for the truck or tank.

After punching in all these values, you can easily check to see that the correct numbers were entered by punching in the following sequence of steps:

01

INV

2nd LST

This will cause the calculator to print out a list of values stored in each register beginning with the first. These numbers can be checked with the values you intended to enter. In case of an error, simply press the correct figure and STO --. To stop the list once it is running simply press R/S.

ADAPTING THE MODEL FOR DIFFERENT CONDITIONS

The basic program applies to the simplest possible bulk hauling situation; the hauler follows one or more route per day using self-owned equipment. This section contains explanations for adapting the basic program for different conditions such as leased rather than owned equipment. The changes include straightforward modifications in the input data and increase in complexity up to permanent changes in the program itself. The following examples indicate how several kinds of changes may be made. They should be used as guidelines for other modifications of the program to meet specific user requirements.

Changing Constants Incorporated in the Program: Tire Life

To keep the user-supplied data inputs down to a reasonable number, several values are stored internally in the program as "constants." An example is tire life. The stored values, however, may not be appropriate for all routes and would need to be changed; routes with many hills and curves, for example, may give tire life below the assumed averages. These changes may be made by following the example below.

Example: Tire Life

On a rough, curvey route a hauler finds that radial tires last on average only 90,000 miles rather than the 100,000 miles assumed. To make the adjustment the proper program location must first be found and the following changes made:

Press	Display	Object
GTO 229	---	Locate part of program requiring change
LRN	229 04	Put calculator in mode to make changes
3	230 00	Insert new number which reduces life by 10,000 miles. (The calculator automatically shows you the next step, not the one you have just completed. To see it push BST - you should get 229 03).
LRN		Return to operating mode

The way this change works is to reduce 40,000 to 30,000; pushing 3 replaces the 4. The 30,000 is the difference in mileage of a radial over the 60,000 miles assumed for a bias ply. The new total is thus 90,000 rather than 100,000 miles.

If this change is to be permanent it may be stored on a magnetic card by following these steps:

Press 1 2nd WRT - insert card, turn over
Press 2 2nd WRT - insert card

If the display number does not flash the program has been transferred properly.

Incorporating Different Operating Characteristics: Leased Equipment

If equipment is leased rather than owned the lease rate may be included in register 13 or 29, or if the lease includes both fixed and variable aspects both may be used. (If all equipment is leased with a service contract an interest rate - register 12 - still must be entered for the program to operate.) A fixed rental rate should be entered in register 3. If the rate is established on a monthly basis it must be adjusted to reflect the actual annual fee (8). Rates which vary according to distance or other factors should be included as a variable cost in register 29. Costs which are variable by the mile must be multiplied by total annual miles or, if the tank payment is based on the volume of milk delivered, by the cwt. delivered. Instructions for inserting into the program new instructions for calculating variable costs per mile and similar changes are described following the example.

Example

A hauler signs a seven-year lease for a bulk tank which includes a $1,500 nonrefundable payment plus one-half cent per hundredweight delivered.

There are two steps needed to incorporating these new conditions. First, the initial payment is a partial payment for the tank and should be treated as any other cost by inserting the payment, $1,500, into register 06 with the life

established at 7 years placed in register 07. Second, the cwt rental rate must be multiplied by hundred pounds delivered to determine the rental fee. Average daily pounds delivered is stored in register 02 which must be multiplied by 365 to calculate the annual total. These steps can be accomplished as follows:

Press	Display	Function Performed
GTO 261	---	Locate appropriate place in the program
LRN	261 95	Put in learn mode
2nd INS	261 00	Clear space (this instruction moves all the following steps ahead by one place)
x	262 95	Multiply rate times capacity (the calculator automatically advances you by one step so that you do not see what was just inserted)
2nd INS	262 00	Clear space
RCL	263 95	Recall average daily cwt delivered
2nd INS	263 00	Clear space
02	264 95	Completes RCL command
2nd INS	264 00	Clear space
x	265 95	Multiply by 365 to give annual value
2nd INS	265 00	Clear space
3	266 95	Begin inserting 365
2nd INS	266 00	Clear space
6	267 95	
2nd INS	267 00	Clear space
5	268 95	
LRN	---	Exit learn mode

When using this modification it is important that register 29 is not used for anything but the rental rate. If it is the entire value stored in this register will be treated as the rental rate, leading to a substantial overestimate of the cost.

If this change is to be permanent it may be stored on a magnetic card by following these steps:

Press 1 2nd WRT - insert card, turn over
Press 2 2nd WRT - insert card

If the display number is not flashing, the program was transferred properly.

SECTION II

Determining Hauling Rates from the Program Estimates

Hauling costs may be divided into three categories - on-farm, travel, and volume - based on where they are incurred. These categories take account of variable costs of travel (fuel, tires and maintenance) and the fixed costs of the tank, truck, insurance and the scheduled driver. Fixed costs including labor are substantial, comprising approximately two-thirds of total assembly route costs, and must be allocated across a full day's activities on a cost per minute basis.

On-farm costs are fixed costs which include the time required to perform routine chores at each stop. These chores include hooking up, agitating the milk, sampling, and rinsing the farm tank. The driver's personal time for lunch and rest breaks is also included with the on-farm costs.

Travel or mileage costs include both fixed and variable cost segments. The variable costs are related to the miles traveled while the fixed costs include the proportionate share of the overhead costs for the time the truck is traveling. The final category, volume costs, involves pumping time at the farm and plant.

These three components of the hauler rate are summarized in Figure 3 below. For completeness, this figure also indicates how the producer rate is related to hauler payments. Producers are assessed in a slightly different fashion than the haulers are paid so that there is not a direct pass-through of each cost item, as shown in the Figure.

Figure 3: Cost Components Included in the Hauler Rate and Producer Payment

Hauler Rate	Route Costs	Producer Rate
Stop Payment	On-farm labor, excluding pumping time, plus share of fixed cost, plus waiting and personal time	Stop Charge
Mileage Payment	Transport (garage to first farm, last farm to plant and plant to garage) cost	Location Differential
	Assembly (first to last farm) costs plus share of fixed cost and labor	
Volume Payment	Plant pumping and wash time plus farm pumping time	Volume Charge

Steps for making these calculations using the TI-59 program are outlined in Figure 4.

This portion of the program uses estimates from the program described above and consequently cannot be run unless steps A and B have been run previously. The steps for this program are included in the Appendix beginning at 322.

Figure 4: Operating Instructions for Part II of the TI-59 Program After Running Part I:

DATA INPUT

Item	Example Value	Press Key	Example Display	Your Value	Press Key	Your Display
Number of Farm Stops	14	STO 30	14	_____	STO 30	_____

OUTPUT

Press Key	Value Output	Example Display	Your Display
C	Stop Payment	3.54	_____
R/S	Mileage Payment/Mile	.727	_____
R/S	Volume Payment/cwt	.076	_____

The procedure followed in the program can best be explained by manually running through the calculating it makes internally.

Item	Includes	Amount	
Stop Payment	On-farm labor time (excluding pumping time) plus share of waiting and personal time (9)	10	mns. per farm labor time
		x 14	no. farm stops
		140	
		+ 75	waiting and personal time
		215	total stop time
		x.2302	FC/Mn (from Figure 1)
		49.49	total stop cost
		÷ 14	stops
		$ 3.54	stop payment
Mileage Payment	Assembly time plus mileage costs	540	total minutes in day
		- 215	stop time
		- 85	farm pump time (10)
		- 43	plant pump time (11)
		- 30	wash time (12)
		167	total route time
		x .2302	FC/Mn (from Figure 1)
		$ 38.44	time cost

Item	Includes	Amount	
		139	miles
		x .45	VC/mile (from Figure 1)
		62.55	mileage cost
		62.55	mileage cost
		+38.44	time cost
		100.99	total cost
		÷ 139	miles
		.727	mileage payment/mile (13)
Volume Payment	Plant pumping and washing time plus on-farm pumping time	85	farm pump time (10)
		+ 43	plant pump time (11)
		+ 30	wash time (12)
		158	total volume time
		x.230	FC/Min.(from Figure 1)
		36.34	total volume cost
		÷ 477	cwt delivered
		.076	volume payment

CONCLUSIONS

The calculated hauling cost of 39 cents per hundredweight must be used only as a base or guideline rate. There are numerous other factors that should be considered in arriving at an actual rate. The actual rate must include a return for hauler management and risk not included in the cost estimates as well as including differentials for specific route characteristics such as road conditions and grade. Thus each route or group of routes served by a hauler must be analyzed separately with the final rate determined through individual negotiations.

The procedure described above if properly implemented is a means of achieving a closer correlation between hauling rates and actual route costs. It should provide an incentive for both producers and haulers to improve efficiency in the milk assembly system and serve the long-run interests of all participants.

FOOTNOTES

1/ The program is readily transferable to another programming language such as that used on the HP-97 calculator. Some knowledge of programming is needed.

2/ More precisely the appropriate rate should fall somewhere between the replacement cost and the "actual" cost based on current equipment costs. The replacement cost figure is utilized here because there is often a substantial lag in incorporating replacement cost figures in the hauling rate. This lag is a result of the time necessary to assemble the cost figures and negotiate rates, which then remain in effect for a year. At the end of this period during a time when equipment costs are rising rapidly the rate is actually below the true replacement cost rate and is assumed to approximate the minimum rate needed to keep haulers in the industry.

3/ Anderson, B., "The Structure and Characteristics of the Milk Assembly System in New York State." Cornell University, Department of Agricultural Economics, A.E. Res. 81-16, September 1981.

4/ The Annual Equivalent Cost (AEC) formula used in the program is:

$$AEC = EC\,\frac{i(1+i)^n}{(1+i)^n-1} - SV\,\frac{i}{(1+i)^n-1}$$

EC - equipment cost
SV - salvage value at end of n^{th} year
i - interest rate

Source: Gerald W. Smith, Engineering Economy: Analysis of Capital Expenditures. Iowa State University press, Ames, 1968, p. 99.

For further information see Smith or another book on engineering economy.

5/ With the annual equivalent cost figure the annuity represents partially debt servicing and partially an increase in equity. Thus over the life of the good the interest rate must represent, in different proportions, both the cost of borrowed capital and the value of equity to the owner. Typically for small operators equity has a higher opportunity cost than borrowed capital because the risk is greater, and it should receive a higher return.

6/ Tire costs are calculated assuming that an average carcass is retreadable once and that a bias ply carcass has a total service life of 60,000 miles and a radial a life of 100,000 miles. These are averages for all the tires on a truck since the actual mileage depends on which axle it is placed on as well as road conditions, etc.

7/ Operationally, this entry provides a "switch" which changes the base of the cost from 60,000 miles for bias ply tires to 100,000 miles for radials.

8/ Some leases require a substantial payment at the beginning of the contract. If this payment is nonrefundable it should be entered in register 3 or 7 as equipment cost. Even if the payment is refunded at the expiration of the lease the compounded interest figure over the period can be substantial. This amount too, should be entered as a cost.

9/ The figures for this example are based on a 1978 study of hauling routes in the New York State order area and on the Anderson study.

10/ On the farm milk is assumed to be pumped at the rate of 560 pounds/minute.

11/ At the plant milk is assumed to be pumped at the rate of 1,100 pounds/minute.

12/ A truck is assumed to be washed only once a day.

13/ Figures may not match exactly these in Figure 4 because of rounding error.

TI-59
Bulk Milk Hauling Cost
Worksheet

TRUCK NO._____

DATE_____

REP. ROUTE DATA	INDIVIDUAL HAULER DATA	PRESS	DESCRIPTION
		STO 01	Average Daily Route Miles
		STO 02	Average CWT Delivered Per Day
		STO 03	Truck Chassis Cost ($)
		STO 04	Chassis Expected Life (years)
		STO 05	Chassis Salvage Value ($)
		STO 06	Tank Cost ($)
		STO 07	Tank Expected Life (years)
		STO 08	Tank Salvage Value ($)
		STO 09	Insurance Payments (liability & cargo)
		STO 10	Registration Fees
		STO 11	Highway Tax (federal)
		STO 12	Interest Rate
		STO 13	Miscellaneous Costs (garage, bookkeeping, etc.)
		STO 14	Driver Hourly Wage ($/hr.)
		STO 15	Hours/Day for Driver (s)
		STO 20	Miles Per Gallon
		STO 21	Fuel Cost ($/gallon)
		STO 22	Cost New Tire
		STO 23	Cost Recapped Tire
		STO 24	Number of Tires
		STO 25	Bias or Radial Ply Tires - Enter 1 if Radial, 0 if Bias
		STO 26	Ton-Mile Tax Rate
		STO 27	Annual Maintenance
		STO 28	Average Annual Repair in $/Mile
		STO 29	Miscellaneous Variable Costs

REP. ROUTE	INDIVIDUAL HAULER	PRESS	DISPLAY/PRINT
_____	_____	A	Total Annual Fixed Costs (TFC)
_____	_____	R/S	TFC/Mile
_____	_____	R/S	TFC/Cwt.
_____	_____	R/S	TFC/Minute
_____	_____	B	Total Annual Variable Costs (TVC)
_____	_____	R/S	Total Costs (TC)
_____	_____	R/S	TC/Cwt.
_____	_____	R/S	TC/Mile
_____	_____	R/S	TVC/Cwt.
_____	_____	R/S	TVC/Mile
_____	_____	C	Stop Payment
_____	_____	R/S	Mileage Payment/Mile
_____	_____	R/S	Volume Payment/Cwt.

Guide For Calculating
Individual Basic Hauling Cost Rate

A. Stop charge x avg. no. of stops per day = Daily cost of truck and labor while stopping at farms.

_____ x _____ = _____

B. 1. Daily route miles x mileage payment/mile (TC/mile) = Daily cost of running the truck and fixed cost of truck and labor while driving.

_____ x _____ = _____

C. Daily cwt. of milk x volume payment/cwt. = Volume related cost at plant & farm.

_____ x _____ = _____

Total Daily Route Cost (TDRC) = _____
(A + B + C = TDRC)

TDRC ÷ No. of miles = TDRC per mile = _____

TDRC ÷ No. of cwt. = TDRC per cwt. = _____

BULK MILK ASSEMBLY PROGRAM

```
000  76 LIL
001  11  11
002  43 RIL
003  03  113
004  65  ::
005  71 SIR
006  89  ''
007  75  .
008  43 RIL
009  05  115
010  65  ::
011  71 SIR
012  33 %
013  75  .
014  00  11
015  00  11
016  65  ::
017  53  :
018  53  :
019  43 RIL
020  03  113
021  75  .
022  43 RIL
023  05  115
024  54  :
025  55  ..
026  43 RIL
027  07  117
028  54  :
029  85  ..
030  43 RIL
031  06  116
032  65  ::
033  71 SIR
034  89  ''
035  75  .
036  43 RIL
037  08  118
038  65  ::
039  71 SIR
040  33 %
041  75  .
042  00  11
043  00  11
044  65  ::
045  53  :
046  53  :
047  43 RIL
048  06  116
049  75  .
050  43 RIL
051  08  118
052  54  :
053  55  ..
054  43 RIL
055  07  117
056  54  :
057  85  ..
058  43 RIL
059  09  119
060  85  ..
061  43 RIL
062  10   0
063  85  ..
064  43 RIL
065  11   1
066  85  ..
067  43 RIL
068  13   3
069  85  ..
070  43 RIL
071  14   4
072  65  ::
073  03  ::
074  06  ".
075  05  !:
076  65  ::
077  43 RIL
078  15   5
079  95  ::
080  42 S'D
081  50  !0
082  99 PIT
083  91 R'S
084  43 RIL
085  50  !0
086  55  ..
087  71 SIR
088  35 1.%
089  95  ::
090  99 PIT
091  91 R'S
092  43 RIL
093  50  !0
094  55  ..
095  53  :
096  43 RIL
097  02  112
098  65  ::
099  03  ::
100  06  ".
101  05  !:
102  54  :
103  95  ::
104  99 PIT
105  91 R'S
106  43 RIL
107  50  !0
108  55  ..
109  53  :
110  43 RIL
111  15   5
112  65  ::
113  02  ::
114  01
115  09  'I
116  00  11
117  00  11
118  54  :
119  95  ::
120  99 PIT
121  42 S'D
122  41  '1
123  91 R'S
124  61 G'D
125  02  112
126  00  110
127  00  11
128  00  11
129  00  11
130  76 LIL
131  89  ''
132  53  :
133  53  :
134  43 RIL
135  12   2
136  65  ::
137  71 SIR
138  34 [!
139  54  :
140  55  ..
141  53  :
142  43 RIL
143  49  '9
144  75  .
145  01
146  54  :
147  54  :
148  92 R'N
149  76 LIL
```

```
150  33 X!
151  53  :
152  43 R!L
153  12    2
154  55  ::
155  53  :
156  43 R!L
157  49  !9
158  75  '
159  01
160  54  :
161  54  :
162  92 R"N
163  76 LI!L
164  34 Γ!!
165  53  :
166  53  :
167  01
168  85  ::
169  43 R!L
170  12    2
171  54  :
172  45 Y!!
173  43 R!L
174  04  !!4
175  54  :
176  42 S"D
177  49  !9
178  43 R!L
179  07  !!7
180  48 E!!C
181  04  !!4
182  48 E!!C
183  07  !!7
184  43 R!L
185  49  !9
186  92 R"N
187  76 LI!L
188  35 1.%
189  53  :
190  43 R!L
191  01  !!1
192  65  !!
193  03  !!
194  06  !.
195  05  !!
196  54  :
197  92 R"N
198  76 LI!L
199  12  !!
200  71 SI!R
201  35 1.%
202  55  ::
203  43 R!L
204  20  !!0
205  65  !!
206  43 R!L
207  21  !!1
208  85  ::
209  53  :
210  53  :
211  53  :
212  43 R!L
213  22  !!2
214  85  ::
215  43 R!L
216  23  !!3
217  54  :
218  55  ::
219  53  :
220  06  !.
221  00  !!
222  00  !!
223  00  !!
224  00  !!
225  85  ::
226  43 R!L
227  25  !!5
228  65  !!
229  04  !.
230  00  !!
231  00  !!
232  00  !!
233  00  !!
234  54  :
235  54  :
236  65  !!
237  71 SI!R
238  35 1.%
239  65  !!
240  43 R!L
241  24  !!4
242  54  :
243  85  ::
244  43 R!L
245  26  !!6
246  65  !!
247  71 SI!R
248  35 1.%
249  85  ::
250  43 R!L
251  27  !!7
252  85  ::
253  43 R!L
254  28  !!8
255  65  !!
256  71 SI!R
257  35 1.%
258  85  ::
259  43 R!L
260  29  !!9
261  95  !!
262  42 S"D
263  51  !!1
264  99 PI!T
265  91 R.'S
266  43 R!L
267  50  !!0
268  85  ::
269  43 R!L
270  51  !!1
271  95  !!
272  99 PI!T
273  42 S"D
274  53  !!3
275  91 R.'S
276  43 R!L
277  53  !!3
278  55  ::
279  53  :
280  03  !!
281  06  !.
282  05  !!
283  65  !!
284  43 R!L
285  02  !!2
286  54  :
287  95  !!
288  99 PI!T
289  91 R.'S
290  43 R!L
291  53  !!3
292  55  ::
293  71 SI!R
294  35 1.%
295  95  !!
296  99 PI!T
297  91 R.'S
298  43 R!L
299  51  !!1
300  55  ::
301  53  :
302  43 R!L
303  02  !!2
304  65  !!
305  03  !!
306  06  !.
307  05  !!
308  54  :
309  95  !!
310  99 PI!T
311  91 R.'S
312  43 R!L
313  51  !!1
314  55  ::
315  71 SI!R
316  35 1.%
317  95  !!
```

```
318  99 PRT
319  42 STO
320  42  02
321  91 R/S
322  76 LBL
323  13  C
324  53  (
325  53  (
326  43 RCL
327  30  00
328  65  ×
329  01  1
330  00  0
331  85  +
332  07  7
333  05  5
334  54  )
335  65  ×
336  43 RCL
337  41  01
338  54  )
339  55  ÷
340  43 RCL
341  30  00
342  95  =
343  99 PRT
344  91 R/S
345  53  (
346  53  (
347  43 RCL
348  15  05
349  65  ×
350  06  6
351  00  0
352  75  -
353  53  (
354  43 RCL
355  30  00
356  65  ×
357  01  1
358  00  0
359  85  +
360  07  7
361  05  5
362  85  +
363  71 SBR
364  23 LBL X
365  85  +
366  71 SBR
367  32 X T
368  85  +
369  03  3
370  00  0
371  54  )
372  54  )
373  65  ×
374  43 RCL
375  41  01
376  85  +
377  43 RCL
378  01  01
379  65  ×
380  43 RCL
381  42  02
382  54  )
383  55  ÷
384  43 RCL
385  01  01
386  95  =
387  99 PRT
388  91 R/S
389  53  (
390  53  (
391  71 SBR
392  23 LBL X
393  85  +
394  71 SBR
395  32 X T
396  85  +
397  03  3
398  00  0
399  54  )
400  65  ×
401  43 RCL
402  41  01
403  54  )
404  55  ÷
405  43 RCL
406  02  02
407  95  =
408  99 PRT
409  91 R/S
410  76 LBL
411  23 LBL X
412  53  (
413  53  (
414  43 RCL
415  02  02
416  65  ×
417  01  1
418  00  0
419  00  0
420  54  )
421  55  ÷
422  05  5
423  06  6
424  00  0
425  54  )
426  92 RTN
427  76 LBL
428  32 X T
429  53  (
430  53  (
431  43 RCL
432  02  02
433  65  ×
434  01  1
435  00  0
436  00  0
437  54  )
438  55  ÷
439  01  1
440  01  1
441  00  0
442  00  0
443  54  )
444  92 RTN
```

NOTE: RTN is programmed as INV SBR