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Distributing and Handling Grain-Feeds in New Hampshire

II. Problems in Retail Distribution

by

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Distributing and Handling Grain-Feeds in New Hampshire

II. Problems in Retail Distribution *

by

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and

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1. Introduction

THIS is the second in a series of bulletins dealing with the area of marketing and handling grain-feeds in New Hampshire. The first bulletin dealt with the characteristics of firms engaged in milling and/or distributing grain-feeds in the State. Field work on the project was completed in early 1954. Hence, the data obtained on the bulk delivery method were largely confined to conventional auger-type bulk delivery equipment. Since that time, bulk trucks using pneumatic equipment have come into common usage in New Hampshire. In addition, some companies are now using an alternative method consisting of a hopper and elevating mechanism attached to a regular bagged delivery truck. If the study of bulk handling could be extended, it would now be possible to make more precise comparisons between regular bulk delivery equipment using either the auger or pneumatic mechanisms and the alternative method.

Some of the principal problem areas confronting retail grain-feed units directly and/or their parent companies or supplying mills are the following: volume, fair pricing practices, retail unit and delivery route efficiency, and the choice between bulk and bagged feed. This bulletin discusses such problems as the preceding and presents data, analysis, and methodology which can be used to arrive at solutions for them. Discussion will be phrased largely in terms of retail units, but the joint nature of most of these problems is recognized and specifically inferred.

2. Obtaining Volume

THE key to obtaining operating efficiencies and to lowering distribution costs (and, by inference, feed costs to producers) lies initially in choosing locations and practices which will promote volume operations. The trend in the retail grain feed business away from the country store, hardware store, or retail unit specializing in lines other than grain feeds has made possible certain operating economies. With the expansion of the New Hampshire poultry industry, many retail units have been able to thrive in their old locations even though at present such locations may be somewhat less than ideal (or central) in relation to the

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* Professor Woodworth initiated this study and started much of the field work prior to his death on September 18, 1953.

trade area they now cover. New units have opened in many towns and cities; some older units have gone out of business due to company measures to consolidate territories, inopportune management decisions, unfavorable locations for securing, on an economical basis, a proportionate share of the expanding market, or proprietary inclinations or deaths. The point is rapidly being reached where the opportunities for opening additional retail feed units and obtaining volume without excessive resort to certain undesirable competitive practices may be more limited than in the past two decades. To achieve additional economies in the future, it will be necessary to place increased emphasis upon relocating existing units according to detailed and careful locational analyses.

Location as Related to Railroads and Present Units

Optimum locations for retail grain-feed units might be determined in part by reference to Figure 1. Utilization of railroad transportation to a point as close to the center of the trade area as possible is desirable. Long hauls by railroad being generally cheaper than by truck, and with the added advantage of equalization through the milling-in-transit privilege, it is economical to cover as much of the distance to the customer by rail as can be accomplished.* Figure 1 is useful to determine where other retail units have seen fit from experience to locate. It also shows the extent of competition likely in and around a given area in terms of numbers of retail units.

However, the assumption of past experience as a locational criterion presupposes static conditions with respect to the availability of railroad service and to location of the quantitative centers of consuming areas (herein the number, type, and size of accounts serviced). For many commodities, truck transportation is steadily displacing rail transportation to many points. At the time of writing one additional railroad route in the State (Plymouth to Woodsville) was under study for discontinuance. There are likely to be others in future years where overall revenue, use, or need is below the level required by the railroad to justify continued operation. In most instances, discontinuance of railroad service is likely to be to the disadvantage of retail feed units serving the area. Actually many present locations may be due to traditional or institutional factors, or to the immobility of invested capital. For example, a retail grain-feed unit may continue to operate at a given point in the short run if the net disadvantage in operating costs is not significantly more than the depreciated value of the cost of a unit at an optimum location less the salvage value on the present unit (or similar comparisons involving rent at one or both points). Eventually, however, present location may yield to other influences such as those discussed below, or to those related to overall business in the areas (such as the continuance or discontinuance of railroad services).

Number, Size, and Type of Farm as Related to Location

Some of the additional criteria which need to be considered from a locational standpoint are the number, type, and size of producing units; the relative concentration of grain-feed tonnage required; and the relative

* Out of 178 grain-feed dealers spotted on Figure 1, only 15 were located in towns without rail facilities in 1954. More than half of this number had been served by rail until fairly recent years.

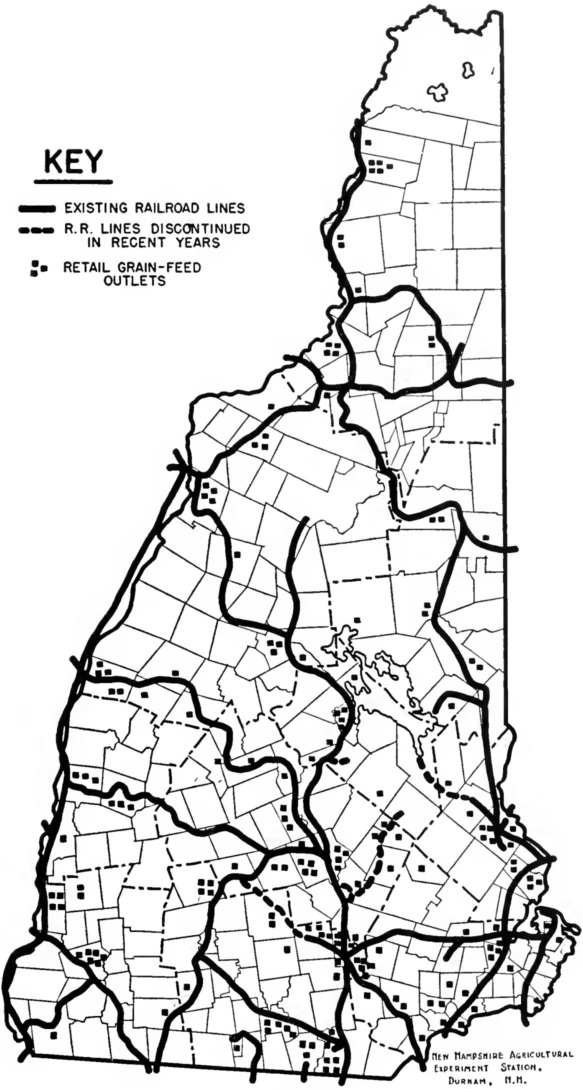

Figure 1. Railroad lines serving New Hampshire and the location of 178 retail grain-feed outlets in 1954.

Table 1. Numbers of Farms in New Hampshire by Counties, and by Total Value of Products Sold, 1950

Total Value of Products Sold	The State	Belknap	Carroll	Cheshire	Coos	Grafton	Hillsboro	Merrimack	Rockingham	Strafford	Sullivan
Number of Farms											
Up to $599	6,470	515	334	558	268	788	857	991	1,115	516	528
$600 - 2,499	2,622	140	170	193	192	382	482	372	354	183	154
2,500 - 5,999	1,950	91	25	124	248	330	373	218	270	123	148
6,000 - 9,999	1,014	35	35	74	122	124	227	118	151	59	69
10,000 and over	1,335	64	42	96	87	125	236	200	316	90	79
Total	13,391	845	606	1,045	917	1,749	2,175	1,899	2,206	971	978
Percentage of Area Total											
Up to $599	48.2	60.9	55.0	53.3	29.3	34.1	39.5	52.2	50.6	53.0	53.9
$600 - 2,499	19.6	16.6	28.1	18.5	20.9	21.8	22.1	19.6	16.1	18.9	15.7
2,500 - 5,999	14.6	10.8	4.2	11.9	27.0	18.9	17.1	11.5	12.2	12.7	15.2
6,000 - 9,999	7.6	4.1	5.8	7.1	13.3	7.1	10.4	6.2	6.8	6.1	7.1
10,000 and over	10.0	7.6	6.9	9.2	9.5	7.1	10.9	10.5	14.3	9.3	8.1

Source: 1950 Census of Agriculture.

travel distances, stops, and quantities likely to be involved on delivery routes. This section and those following will treat these points.

Data to illustrate these criteria should be for small areas (towns and subdivisions and individual farms) but for the most part they are not available in this form. For detailed locational analyses, census data by towns, supplemented by information on individual units such as was obtained in the Gilmanton-Barnstead area*, would be desirable, and should form an important part of the background material. Deviations from the county patterns inherent in Tables 1-3 are likely to be widespread. However, these data are useful to point up some of the characteristics to be analyzed in locational problems.

Of the 13,391 farms† in New Hampshire listed by the 1950 Census, about 60 percent were in four counties: Rockingham, Hillsboro, Merrimack, and Grafton. Over 80 percent of the farms in the State as a whole sold products valued at under $6,000 annually. In only three counties, Coos, Rockingham, and Hillsboro, did the proportion of farms with annual sales of $6,000 or over annually exceed 20 percent. Table 1 shows the numbers of farms and percentages of farms grouped by total value of products sold.

The preceding data once again point out the predominance of small units among the customers available to retail feed outlets. Moreover, there is not likely to be any sudden or extensive shift in this pattern. True, the average size of "commercial" farms may continue to increase, but New Hampshire will probably continue to have large numbers of "part-time" or "residential" farms. Hence many sales to small units will continue to be a characteristic of retail distribution of grain-feeds in the State, and one which will play a significant role in determining: (a) the extent to which bulk feed can be economically distributed; and (b) the practices and economies which may evolve in bagged feed distribution.

Data on the numbers and proportions of farms under various 1950 census classifications are contained in Table 2. Less than half of the total number of farms in the State are classified as "commercial"; and in only three counties, Coos, Hillsboro, and Grafton do numbers of "commercial" farms exceed 50 percent of the county total. All counties were contained in the range of 13-24 percent "part-time" farms, and all counties, except Coos, fell in the range of 26-46 percent "residential" farms. The largest percentages of large "commercial" farms (value of products sold annually $10,000 or over) were found in Rockingham, Hillsboro, and Merrimack counties.

In terms of appraising a county as a market for grain-feeds, numbers of farms are likely to be somewhat misleading unless tied to type of farm. Table 3 shows numbers of farms by type. From these data it can be observed that the largest numbers of poultry farms are in Hillsboro, Rockingham, and Merrimack counties; and the largest numbers of dairy farms in Grafton, Coos, Hillsboro, Rockingham, and Merrimack counties. It is apparent that the distribution of dairy farms over the State is somewhat more general than the distribution of poultry farms. Grain-feed needs of poultry and dairy cattle would generally outweigh grain-feed needs of other classes of livestock in locational analysis.

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* N. H. Agr. Exp. Sta. Bul. 426, July, 1956, Tables 12 and 13.

† The 1950 census definition of a farm was: "places of 3 or more acres — if the value of agricultural products in 1949, inclusive of home gardens, amounted to $150 or more."

Table 2. Number of Farms by Counties, and by Economic Class, 1950

Economic Class	The State	Belknap	Carroll	Cheshire	Coos	Grafton	Hillsboro	Merrimack	Rockingham	Strafford	Sullivan
					Number of Farms						
Commercial farms	6,393	301	237	444	596	896	1,217	834	1,029	415	424
Class I[1]	324	24	5	43	10	14	72	62	66	15	13
II[2]	995	39	37	53	76	110	164	132	245	74	65
III[3]	1,458	70	32	102	175	210	324	163	200	69	113
IV[4]	1,506	56	28	96	195	244	276	173	221	113	104
V[5]	1,334	61	103	100	105	192	223	195	186	80	89
VI[6]	776	51	32	50	35	126	158	109	111	64	40
Other farms	6,998	544	369	601	321	853	958	1,065	1,177	556	554
Part-time[7]	2,278	157	143	188	162	230	384	344	375	136	159
Residential[8]	4,689	386	226	413	158	622	564	715	797	414	394
Abnormal[9]	31	1	—	—	1	1	10	6	5	6	1
				Percentage of Area Total							
Commercial farms	47.7	35.6	39.1	42.5	65.0	51.2	56.0	43.9	46.6	42.7	43.4
Class I[1]	2.4	2.8	.8	4.1	1.1	.8	3.3	3.3	3.0	1.5	1.3
II[2]	7.4	4.6	6.1	5.1	8.3	6.3	7.5	7.0	11.1	7.6	6.6
III[3]	10.9	8.4	5.3	9.7	19.1	12.0	14.9	8.6	9.1	7.1	11.6
IV[4]	11.2	6.6	4.6	9.2	21.2	13.9	12.7	9.1	10.0	11.7	10.6
V[5]	11.0	7.2	17.0	9.6	11.5	11.0	10.3	10.2	8.4	8.2	9.1
VI[6]	5.8	6.0	5.3	4.8	3.8	7.2	7.3	5.7	5.0	6.6	4.1
Other farms	52.3	64.4	60.9	57.5	35.0	48.8	44.0	56.1	53.4	57.3	56.6
Part-time[7]	17.0	18.6	23.6	18.0	17.7	13.2	17.7	18.1	17.0	14.0	16.3
Residential[8]	35.0	45.7	37.3	39.5	17.2	35.6	25.9	37.7	36.2	42.7	40.3
Abnormal[9]	.3	.1	—	—	.1	.0	.4	.3	.2	.6	.0

Commercial farms divided on basis of total value of farm products sold:
[1] $25,000 or more; [2] $10,000 to $24,999; [3] $5,000 to $9,999; [4] $2,500 to $4,999; [5] $1,200 to $2,499; [6] $250* to $1,199.
*provided operator worked off farm less than 100 days and provided the income the farm operator and members of his family received from nonfarm sources was less than the value of all farm products sold.
[7] Farms with value of sales of $250 to $1,199 classified as part-time provided operator worked 100 or more days off the farm in 1949, or nonfarm income received by him and members of his family was greater than value of farm products sold.
[8] All farms except abnormal farms with total value of sales of farm products of less than $250.
[9] Public and private institutional farms, community enterprises, experiment station farms, grazing associations, etc.

Source: 1950 Census of Agriculture.

Table 3. Types of Farms in New Hampshire by Counties, 1950

Type	The State	Belknap	Carroll	Cheshire	Coos	Grafton	Hillsboro	Merrimack	Rockingham	Strafford	Sullivan
					Number of Farms						
Dairy farms	2,963	133	64	259	445	552	380	347	339	187	257
Poultry farms	2,080	93	83	113	15	149	594	337	476	119	101
Livestock farms[1]	273	14	11	13	20	45	44	59	35	11	21
General farms:											
Primarily livestock	51	9	—	4	5	13	9	—	—	11	—
Crop and livestock	177	5	17	8	35	36	13	10	27	11	15
Primarily crop	155	—	6	4	16	31	26	22	13	27	10
Crop farms[2]	370	19	10	13	40	10	120	21	95	27	15
Other[3]	7,322	572	415	631	341	913	989	1,103	1,221	578	559

[1] Other than dairy and poultry.
[2] Vegetable, fruit and nut, field crops.
[3] Miscellaneous and unclassified.

Source: 1950 Census of Agriculture

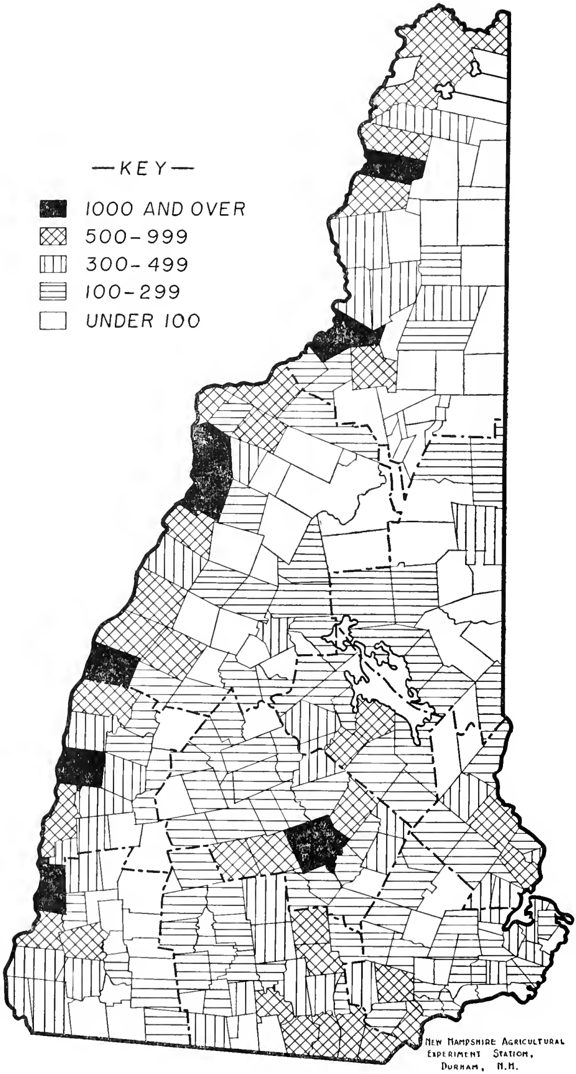

Figure 2. Annual grain-feed requirements in tons for milk cows, by towns, 1950.

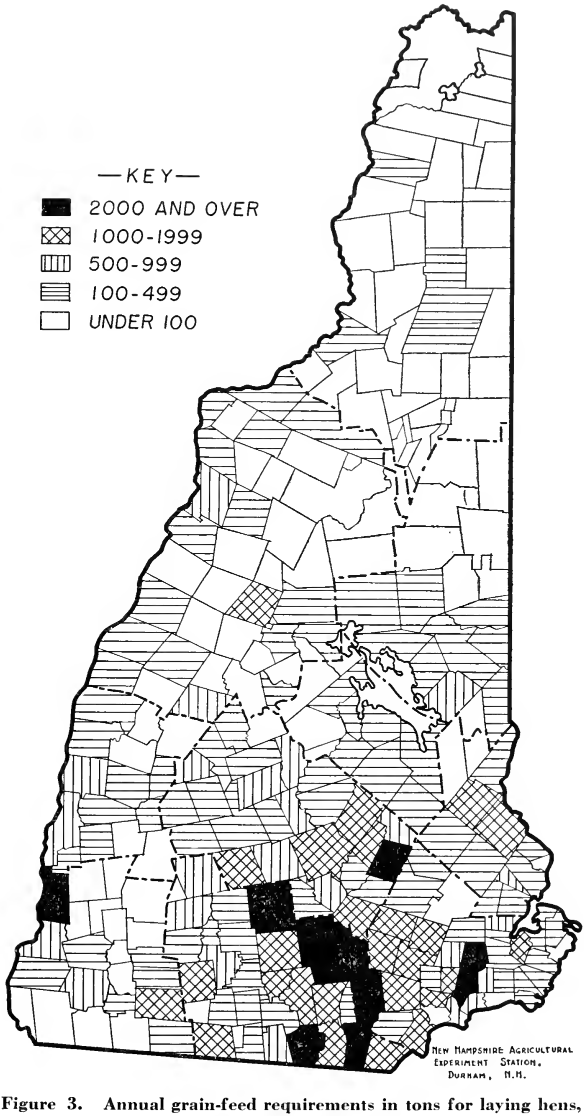

Figure 3. Annual grain-feed requirements in tons for laying hens, by towns, 1950.

Table 4. Towns Requiring Largest Amounts of Grain-Feed for Milk Cows and Laying Hens, by Areas, 1950

	Annual Tonnage of Grain-Feed for:			
	Milk Cows		Laying Hens	
Area	1,000 and over	500-999	2,000 and over	1,000-1,999
Connecticut River Valley	Colebrook Lancaster	Stewartstown Jefferson Columbia Pittsburg		
	Haverhill Bath Lebanon	Piermont Monroe Lyme Lisbon Hanover Littleton Canaan		
	Claremont	Charlestown Plainfield		
	Walpole	Westmoreland Keene	Walpole	
Lakes Region and Central New Hampshire		Gilford Belmont		Rumney
Merrimack River Valley and South central New Hampshire	Concord	Loudon Hopkinton Henniker	Epsom	Concord Loudon Henniker Chichester
		Hollis Bedford Pelham Goffstown Hudson Milford Nashua	Weare Goffstown Hudson Bedford Manchester Hollis	Nashua New Ipswich New Boston Amherst Mont Vernon Peterborough Merrimack Pelham Jaffrey
Southeastern New Hampshire		Dover Rochester Derry Salem	Brentwood Kingston	Farmington Rochester Stratham Candia Raymond Auburn Chester Derry Danville Hampstead Salem

Grain-Feed Requirements by Towns as Related to Location

As noted previously, county data are unfortunately somewhat too general for detailed locational analysis. Hence, for milk cows and laying hens, estimates of grain-feed requirements by towns have been derived, based on data from the State Tax Commission.* It would be possible to derive similar estimates for some other classes of livestock by the methods used for the preceding.† However, tax data do not include young chickens, commercial broilers, or turkeys, and town census data were not available, so one of the major grain-feed consuming classes of livestock (chickens raised for meat or replacements) could not be taken into account. This omission will certainly alter some of the conclusions which could be drawn about the grain-feed requirements of particular towns from the data shown in Figures 2 and 3.

Table 4 lists the towns, by areas, requiring annually 500 tons or over of grain-feed for milk cows and 1,000 tons or over of grain-feed for laying hens. The principal concentrations of these towns using large amounts of grain-feed for milk cows are in the Connecticut River Valley and the Merrimack River Valley and South central New Hampshire. For laying hens, the greatest concentrations of towns using large amounts of grain-feed are in the Merrimack River Valley, South central, and Southeastern New Hampshire.

Delivery Routes as Related to Volume

Inasmuch as more than four-fifths of the tonnage of grain-feeds sold by a typical retail outlet is likely to be delivered, the territory so served and the routes established are inherent in studying the question of volume. Data such as those presented in Table 5 illustrate some of the comparative expectations of density of stops, travel distances, and average purchases per unit in various areas of the State. Comparing two counties, Rocking-

Table 5. Annual Tonnage Requirements of Grain-Feed, by Counties, Related to Area Characteristics

County	Area (1,000 Acres)	Road Miles[1]	Tons Required Annually per: 1,000 Acres	Road Mile	Farm (all)[2]	Farm (Livestock)[3]
Belknap	256.0	782.44	38.1	12.7	11.5	38.9
Carroll	600.3	1,092.76	15.2	8.3	15.0	54.6
Cheshire	458.9	1,337.89	44.1	15.1	19.4	51.5
Coos	1,166.1	894.28	12.2	15.9	15.5	28.3
Grafton	1,098.2	1,943.57	24.9	14.1	15.7	35.2
Hillsboro	569.6	2,287.08	118.2	29.4	30.9	65.2
Merrimack	594.6	1,877.71	69.6	22.5	21.8	55.3
Rockingham	442.2	1,623.59	124.9	34.0	25.0	63.9
Strafford	241.3	809.73	102.4	30.5	25.4	74.2
Sullivan	343.7	1,007.91	36.3	12.4	12.8	32.4

[1] As of March 1, 1953. Source: N. H. Highway Department.
[2] Total number of farms reported in 1950 census.
[3] Total of dairy, poultry, livestock farms, general farms predominantly livestock, plus one-half number of general farms, crop and livestock.

* Fortieth Annual Report of the New Hampshire State Tax Commission, Tax Year of 1950.

† Proration of the U.S.D.A. series among towns in proportion to numbers reported for tax purposes times assumed level of grain consumption.

ham and Coos, which lie close to the extremes of these data, it can be observed that for Rockingham County, the requirements per land area unit, per road mile, and per farm are high. For Coos County, the reverse is true. The conclusions which could be reached on the basis of Table 5 are somewhat modified from those which could have been reached on the basis of Tables 1-3 alone, due to the introduction of the questions of dispersion of customers and quantitative grain-feed requirements.

However, in order to explore these matters on a more specific basis, data are summarized in Tables 6 and 7 from 60 grain-feed delivery routes in the southeastern quarter of New Hampshire. Volume per route (measured in terms of 100-lb. units) achieved in this area averaged relatively close to 5 tons for all routes. Bulk routes averaged close to 6½ tons; bagged routes better than 4½ tons. These figures represent a high percentage of the capacity of typical delivery equipment used.

In terms of number of stops per route, the average of 7.2 appears relatively high despite the substantial number of routes with only 1 or 2 stops, there being only one observation at the 3-stop interval and none at the 4-stop interval. If, therefore, the 3-stop and over data is averaged, 11.2 stops per route is derived. This is further illustrative of the coexistence of routes involving one or two large customers and those involving large numbers of small-unit customers. The latter group is a clue to the efforts of retail grain-feed units to reach out considerable distances to achieve volume and/or meet "competition". All bulk routes show an average of 1.3 stops per route as compared to 8.1 stops per route for all bagged routes. Obviously, bulk feed routes concentrate exclusively on the larger accounts.

Table 6. Analysis of Quantity, Stops, and Mileage on 60 Grain-Feed Delivery Routes in Southeastern New Hampshire

Number of 100 lb. Bags Per Route		Number of Stops Per Route		Number of Miles Per Route	
Interval	Frequency	Interval	Frequency	Interval	Frequency
0- 19	3	1	18	0- 9	6
20- 39	5	2	6	10-19	8
40- 59	4	3- 5	8	20-29	7
60- 79	5	6- 8	8	30-39	12
80-109	15	9-11	4	40-49	6
110-139	17	12-14	6	50-59	9
140-159	6	15-17	3	60-69	1
160-179	3	18-20	4	70-79	7
180-199	2	21 up	3	80 up	2
98.2[1]	60[2]	7.2[1]	60[2]	38.8[1]	58[2]
93.3[3]	52[4]	8.1[3]	52[4]	36.6[3] [9]	52[4]
130.0[5]	8[6]	1.3[5]	8[6]	58.3[5] [10]	6[6]
10-197[7]	—	1-28[7]	—	6-91.0[7]	—
61-174[8]	—	1- 2[8]	—	10-81.9[8]	—

[1] Average all routes.
[2] Total all routes.
[3] Bagged routes average.
[4] Bagged routes total.
[5] Bulk routes average.
[6] Bulk routes total.
[7] Range, bagged routes.
[8] Range, bulk routes.
[9] Average miles per bagged route: 1 stop, 24.8; 2 stops, 30.5; 3 stops and over, 41.2.
[10] Average miles per bulk route: 1 stop, 49.3; 2 stops, 76.1.

The marked difference between one- and two-stop routes and the three-stop-and-over routes is again noticeable in the data in Table 7 relative to the number of 100-lb. units delivered per stop. For the former group, the average observed was 93.0 units per stop; for the latter group only 7.6.

Table 7. Analysis of Quantity per Mile and per Stop on 60 Grain-Feed Delivery Routes in Southeastern New Hampshire

Number of 100-lb. Units Per Mile		Number of 100-lb Units Per Stop				
		3 Stops and Over Per Route		1 and 2 Stops Per Route		
Interval	Frequency	Interval	Frequency of Routes	Interval	Frequency 1 Stop	2 Stop
0.0- 0.9	6	0.0- 3.9	4	Under 12.0	1	
1.0- 1.9	17	4.0- 5.9	13	12.0- 59.9	0	
2.0- 2.9	14	6.0- 8.9	7	60.0- 79.9	2	6
3.0- 3.9	8	9.0-11.9	5	80.0- 99.9	3	
4.0- 5.9	5	12.0-20.9	2	100.0-119.9	2	
6.0- 9.9	2	21.0-29.9	3	120.0-139.9	3	
10.0-14.9	2	30.0-38.9	1	140.0-159.9	5	
15.0 up	4	39.0 up	1	160.0 up	2	
2.5[1]	58[2]	7.6[1]	36[2]	93.0[1]	18[2]	6[2]
2.5[3,9]	52[4]	7.6[3]	36[4]	87.5[3]	12[4]	4[4]
2.1[5,10]	6[6]	—	—	104.0[5]	6[6]	2[6]
0.5-18.7[7]	—	2.6-39.2[7]	—	10-150[7]	—	—
0.8-14.0[8]	—	—	—	60-174[8]	—	—

[1] Average all routes.
[2] Total all routes.
[3] Bagged routes average.
[4] Bagged routes total.
[5] Bulk routes average.
[6] Bulk routes total.
[7] Range, bagged routes.
[8] Range, bulk routes.
[9] Average number of 100-lb. units delivered per mile on bagged routes: 1 stop, 4.2; 2 stops, 4.1; 3 stops and over, 2.1.
[10] Average number of 100 lb. units delivered per mile on bulk routes: 1 stop, 2.3; 2 stops, 1.1.

Introduction of route mileage into the analysis yields some interesting results for these data. The average number of miles observed per route for all routes was 38.8; for all bagged routes, 36.6; for all bulk routes, 58.3. For the bulk routes included in the survey, this is indicative of only partial conversion of larger customers to bulk feed and/or the scattered location of these customers. Accordingly, mileage per route for 1- and 2-stop bulk routes is about double the corresponding mileage for 1- and 2-stop bagged routes, and for both 1- and 2-stop bulk routes in excess of average mileage on 3-stop-and-and-over bagged routes. The average number of 100-lb. units delivered per mile was 4.2 for 1-stop bagged routes, 4.1 for 2-stop bagged routes, and 2.1 for 3-stop-and-over bagged routes. In contrast, the average number of 100-lb. units delivered per mile on 1-stop bulk routes was 2.3, and on 2-stop bulk routes, 1.1. Thus, for the routes surveyed, there was evidence of excessive travel distance per 100-lb. unit delivered on bulk routes as well as on those bagged routes where there were large numbers of small-unit customers.

Multiple-outlet firms (either company-owned units or agents) are characteristic of grain-feed distribution in New Hampshire, and are likely to so remain because of economies of scale. Hence there will continue to be marked differences between units in different territories. Some territories will continue more economical than others, but within territories there is room for selection of better locations. It is within this concept that the matter of locational selection can be related to volume. The achievement of better locations within territories is more significant than attempting to minimize differences between outlets selling the same brand in different territories. The eventual minimization of distribution costs lies in the application of the principles suggested in this and in succeeding sections unit-by-unit. Assuming continuation of a substantial degree of delivery-route-cost equalization on a firm basis as now practiced, the problem becomes more one of maximizing efficiency in each territory serviced step-by-step in order to achieve a higher degree of efficiency for the combined territories.

3. Determining Fair and Equitable Pricing Practices

HAVING established a retail grain-feed unit at a location within a particular territory which promises the opportunity for securing maximum volume, a second problem for examination is that of determining fair and equitable pricing practices. This section concerns primarily those aspects of pricing other than the base price. Base price, as used herein, is the cost to or the transfer value of grain-feed arriving at the retail distribution point plus all added charges for a non-delivered sale of a single 100-lb. unit with payment within 30 days. It is assumed already to include the cost of central office or local unit overhead and "service". It was not a purpose of this study to appraise base prices in terms of the relative nutritional values of different brands nor to judge the issue of "service". With respect to the latter, it can be pointed out that "service" actually is an overhead cost, but that it probably costs the individual producer who makes extensive use of it less than if he actually hired such work done. This is because the offering of extensive "service" is done on the basis that relatively small numbers of customers actually take full advantage of it, with the cost assigned over the entire number of customers, keeping the per unit addition minimized. Hence, "service" contributes toward goodwill and may be a good investment for the company and the extensive user, so long as use is not universal, while costing the user, non-user or partial-user only a small amount per unit.

Service, as used hereafter, will refer to those operations performed in the course of actual sale or delivery. Any distribution system results from the interaction of the demand for such services by the consumer (in this case the producer buying grain-feeds) and the willingness of one or more distributors (in this case the grain dealers) to provide such services at a minimum or no direct cost. In the distribution of grain-feeds, providing the maximum in sales and delivery service and in convenience to the producer is the rule rather than the exception. Furthermore, it can be asserted with justification that the sales and delivery services, and the convenience to the producer, are generally in disequilibrium with the costs actually paid for them. In general, some producers are subsidized and some are penalized.

Inconvenience

The common reason given for doing things like unloading at difficult spots, carrying bags to upper floors or over long distances, and dumping bags was "competition would do these things if we didn't." Yet such things unquestionably add to the cost of distribution, though the cost is spread over all customers with the charge to the recipient small. It would be rather difficult to justify an "inconvenience" charge, particularly if auxiliary equipment could be had at a minimum cost which would alleviate the situation. Some further discussion of these problems is contained in a later section. Minimizing the cost effects of inconveniences to the delivery personnel and of excessive wear-and-tear on delivery equipment might most expeditiously come about through an informal "gentlemen's agreement" or a legally binding fair trade practices agreement entered into by feed companies and/or dealers. True, progress has been made in working with producers to correct difficult situations, and some companies have been known to drop customers or to lose them over some of these points. In the final analysis, however, a few non-cooperative producers, or one company wishing to secure advantage in a given situation, could stand in the way of general improvement in the absence of an agreement among all companies and/or dealers operating in the State.

Such an agreement might, or might not be broadened to include standard charges for delivery, credit, and quantity, and discounts for cash. These are more determinate areas, though there is considerable variability in values assigned to them by retail outlets. In a number of instances, values observed in the study were obsolete (low) when measured against the charges made by most companies, or without sufficient breakdowns (example: some quantitative discounts did not start until purchases reached 5 tons). It is extremely doubtful, however, if breakdowns could become very numerous without becoming a burden and a significant additional bookkeeping and billing cost.

Credit vs. Cash

Data were not collected in this study which would enable a precise appraisal of the costs of handling "credit" and "cash" accounts. Hence, no exact values, charges, or discounts are suggested. Data were obtained on collecting time on routes, but in order to make a numerical analysis, additional data would be needed on office time and carrying charges. However, it is probably reasonable to assume that there should be little difference in time collecting the bill at the farm or at the office where both are done efficiently. Thus, the measurable difference is probably in carrying charges.

It is suggested that three breakdowns would be equitable within the credit-cash area:

(1) Payment in full within 7-10 days.

(2) Payment in full between 7-10 days and 30 days.

(3) Payment at some time after 30 days.

The first alternative might carry a specific discount on either a dollars-and-cents or percentage basis; the third, interest at a specified rate per each additional 30 days or fraction thereof on the unpaid balances. The second, payment between 7-10 and 30 days, is assumed to be a characteristic of the base price, as discussed herein.

Few transactions are made in distributive channels wherein "spot cash" is involved. A usual courtesy period of 5, 7, 10, or some other number of days is allowed between delivery or billing and payment. In the case of farm purchases of feed, payment for these is generally related to receipt of a periodic check for eggs or milk. This interval in most instances would correspond to the 7-10 day period suggested as qualifying for a "cash" discount.

Within the concepts outlined, it is suggested that an average charge be included in feed prices which would be sufficient to permit the carrying of a share of accounts up to 30 days without penalty in the form of "additional charges". However, in the interests of financial stability for both the producer and the feed dealer, long-term credit (over 30 days) should be carefully watched. For most producers, credit needs can be met more reasonably by regular lending agencies than through customary store credit rates. In the long run, the feed dealer would be doing the producer a service by suggesting this approach, and would also cut down on one of the big headaches in the feed business today. The preceding observations relate particularly to enterprises producing eggs or milk, which yield regular returns. There is probably a place for some extension of credit on rearing laying flock replacements, particularly where the grower can finance to a point where credit needed to complete the growing period is equal to or less than the meat value. Feed credit is widely used in broiler financing, both in contract growing and by independent producers. Here, returns are obtained in total several times a year. Certainly, feed credit has been a necessary adjunct to the rapid expansion of broiler production, but just as certainly, such credit has not always been wisely extended.

Quantity Discounts and Charges for Delivery on Bagged Feed

These two areas may be somewhat related, i.e., charges for delivery sometimes vary with quantitative amounts. Generally, they are not well developed in terms of breakdowns, at least from posted or printed price sheets. It is known that in actual practice there are many separate and varying bases used for determining prices, even between producers of comparable size. The objective in these areas should be to standardize and break down discounts and charges in some detail and roughly in relationship to relative costs for handling various quantities.

It was mentioned previously that some quantity discounts do not start until purchases reach 5 tons. Others apply to "1 ton and over". There appear to be a number of points at which quantity discounts could logically be established to bear some relationship to relative costs. These are shown in Table 8.

In the absence of comprehensive data, the "steps" in Figure 4 were interpolated at the points listed in Table 8 from the curve of calculated values using loading time (converted to time per ton) as the dependent

Table 8. Points for Consideration in Establishing Quantity Discounts

Quantity	Discount Per Ton	Reason
Under 1 ton	none	Below minimum
1.0- 2.9 tons	$1.00	Upper 15% of customers
3.0- 4.9 tons	2.00	Large customer
5.0- 9.9 tons	3.00	Truckload
10.0-14.9 tons	4.00	2 truckloads
15.0-19.9 tons	5.00	3 truckloads
20.0-24.9 tons	5.50	Minimum to average carload
25.0 tons and over	6.00	Full carload

variable and quantity as the independent variable. It was assumed that the rationale for quantity discounts lies in the progressive operating economies realized by handling larger and larger unit sales up to the full carload level, and that the economies bear a rough relationship to handling times (i.e., herein loading times as derived from data summarized elsewhere in the bulletin). The tentative amounts were interpolated from the values reported by a number of retail units. Some units also distinguish between mixed carloads and straight carloads of one feed in determining quantity discounts. There are undoubtedly economies on the latter vs. the former.

It is not intended to suggest that the entire list of points in Table 8 be applied to all situations, but rather that quantity discounts be made progressive by several stages, and alike for comparable unit purchases. There is admittedly a problem of variation (or adjustment) when purchases of a given producer vary seasonally, or for other reasons, and of specifying the time period involved.

From data obtained in the study, the values in Figure 5 were interpolated. It is apparent that there are progressive economies obtained as size of delivery increases. The rate of decrease after 2½ tons (50 bags), however, is probably slight. The suggestion of decreasing per unit delivery costs with increasing size of delivery points toward the equity of "actual delivery costs" or a graduated system of charges rather than a constant per unit charge. The idea of a minimum delivery charge is widely practiced in the distribution of other commodities. For the retail grain-feed unit,

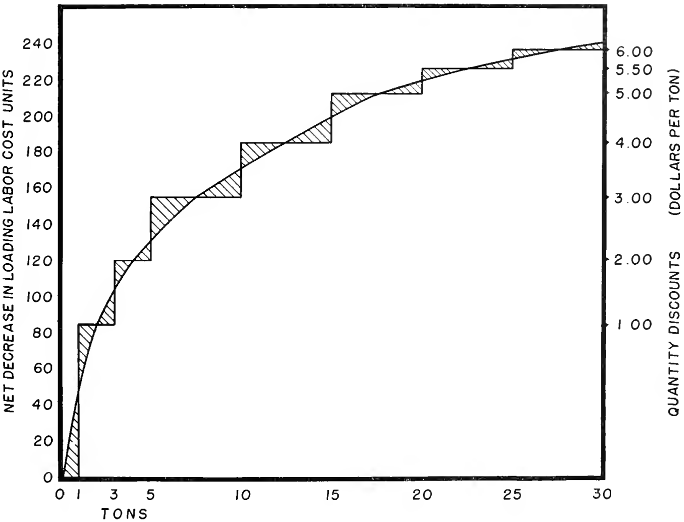

Figure 4. Comparison of assumed quantity discounts with net decreases in loading labor cost units.

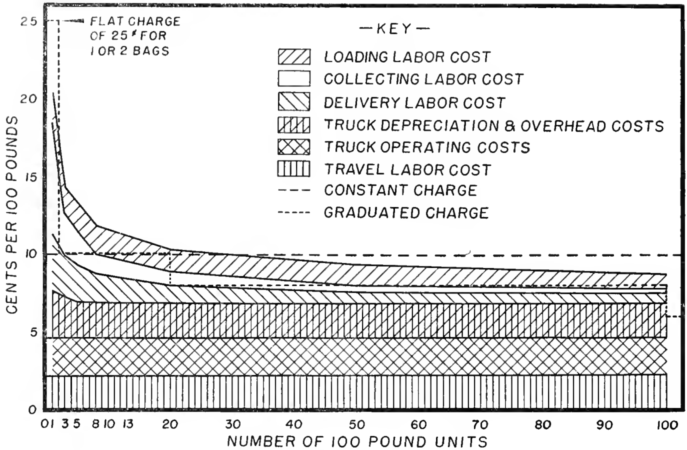

Figure 5. Comparison of constant and graduated delivery charges with per unit costs by size of order.

it could justifiably be applied to very small purchases of grain-feed as well as to minimum deliveries of other lines where no grain-feed is delivered at the same time.

The graduated delivery charges indicated in Figure 5 are not necessarily those which best fit the data shown, or any individual situation, but are a composite of several sets observed. However, the graduated principle can be well supported by the results obtained in the study. Some graduated steps and charges per unit which might be interpolated from Figure 5 are shown in Table 9.

Figure 5 also shows costs per 100-lb. units according to number of units, as calculated from data obtained in the study. Calculations are based on bagged feed, 70 miles daily travel, labor at $1.50 per hour, and the use of one man on delivery and two men in loading. Travel labor cost (driving time) and truck operating costs (gasoline, oil, repairs, tires, etc.) were treated as fixed costs; i.e., total value divided by total units (200). Truck depreciation and overhead costs were allocated in proportion to loading and travel time per unit. Labor cost of delivery, collecting time, and loading time were interpolated from per unit averages. The four top costs on the chart were variable. Greatest per unit variability occurs in collection costs and delivery costs, and only very slight variability in depreciation and overhead costs.

Discounts for Bulk Feed

The preceding discussions have been concerned primarily with bagged feed. Present experience is much less extensive with distributing and pricing bulk feed than with bagged feed. However, there are a number of points about pricing bulk feed which require mention. There is little reason to

Table 9. Points for Consideration in Establishing Delivery Charges

Quantity (No. of 100-lb. units)	Charge Per 100-lb. Unit[1]	Reason
1- 2	$.25 flat charge	Minimum delivery charge on small orders
3- 9	.10	Above minimum; unit cost declines rapidly
10-19	.09	Half ton or over; unit cost still declining rapidly
20-49	.08	One ton or over, but under half truckload; unit cost savings decreasing
50 and over	.07	Half truckload and over; savings per unit small beyond 50 units

[1] These unit charges might be smoothed to equate total charges at the quantitative breaking points.

expect any difference in the two methods concerning the credit-vs.-cash area. With respect to the subject of inconvenience, there is the chance with bulk that arrangements and facilities, being new, can be initially worked out to be convenient to both dealer and producer. While the same would be true of new plants which would receive bagged feed, it is not generally as true of older plants.

Relative to quantity discounts and charges for delivery, data collected in the study were not extensive enough to permit for bulk feed analyses parallel to those made for bagged feed. Somewhat indicative of the ideas of companies selling bulk feed regarding relative costs were the figures in use. These paralleled the discounts and charges in effect on bagged feed, except, of course, that the minimums were higher since bulk service was not made available to smaller customers. From the cost projections subsequently made, the potentional differences in per ton delivery costs are probably not sufficient to justify differential treatment on that item. In the absence of detailed information, the same quantity discounts could well be applied to bulk and bagged feed, within operational limits.

At the time this study was made, two additional discounts were listed for bulk feed by companies offering this service, i.e., "bag savings" and "bulk discount". The former is not a net saving in the aggregate. Against the unit value of new bags there is a partial offset in the form of "bag return credit". The extent to which the latter is offsetting depends upon the price allowed for No. 1 bags returned and upon the percentages of No. 1 and undergrade bags (these at a substantial discount per unit).

"Bulk discount" represented a sharing with the producer of the aggregate potential savings to the company on bulk feed and/or an incentive to convert customers to bulk. Because of the difficulty of maintaining both efficient bulk and bagged routes in many territories preliminary cost appraisals indicate the likelihood of little or no potential average savings on delivery cost exclusive of loading. There may be some long-run savings at the mill and in loading. Hence, it is possible that real savings to feed companies on bulk feed are less than the discounts offered by feed companies when this study was made.

4. Achieving Delivery Route Efficiency

OVER four-fifths of the grain-feed sold by the average retail unit is delivered on scheduled routes or to on-call customers. This pattern is typical of the majority of retail units, though not of carlot distributors or of units whose primary business is in lines other than grain-feed. Certain costs are common to both delivered and non-delivered sales; i.e., receiving, warehousing (if any), collecting, and credit (if any). Credit was previously discussed; receiving and warehousing, where they occur, probably involve identical cost factors whether the sale is delivered or non-delivered. Collecting, as previously noted, should be about equal for both delivered and non-delivered sales. However, in this study, as will be subsequently developed, observed route collecting time was generally excessive.

There are a number of physical and institutional factors which bear upon the efficiency of delivery routes. Among these are those relating primarily to volume, i.e., location of the retail unit, number, size, and types of farms, and area and characteristics. Some additional factors are geographical barriers, roads and driveways, company and/or retail unit characteristics and policies, and farm facilities. There is also the area of route rearrangement. Physical and institutional factors and route rearrangement are treated first, followed by discussions of loading and delivery efficiencies and costs.

The area of route rearrangement was studied through a survey of dealers in Belknap County and those who were located outside, but sold within the county.

In order to study the efficiency of route delivery of grain-feeds, data were collected on over 60 separate routes. Such data covered the loading, hauling, and delivery phases, and involved the number of men used, number of orders, quantity of grain-feed, route mileage in the aggregate and between stops, time required in loading, time required to place truck in position for unloading, unloading time, collecting time, delay time and causes, and the equipment used. These were recorded by field observers accompanying the delivery truck. In addition, certain basic cost data were obtained.

Physical and Institutional Factors

A study of any good relief map of New Hampshire will readily suggest areas and directions from distribution points wherein the delivery of grain-feeds would appear the easiest. Relief features now determine to a considerable extent the locations of improved roads. However, in studying routes, there is usually little opportunity to record precise data except on loads, stops, and mileages. The ton-mile cost of delivery is undoubtedly modified by relief features and roads, though it is difficult to measure these effects statistically.

In the Belknap County area and surrounding territory, it is apparent that Lake Winnipesaukee constitutes a geographical barrier between dealers on one shore and prospective customers on the other. To a lesser extent, hilly or mountainous country and difficult roads are a barrier to dealers in Laconia, for example, who might serve customers in Barnstead or Ashland. Distances from Laconia to these points, in terms of miles, are no greater than to points currently reached.

While the association of moderate relief features with improved roads is generally positive, there are numerous exceptions to the positive association of the better potential farms and improved roads. The location of better agricultural lands and/or farms has apparently been given only minor consideration in the building of improved roads. There has been little change in this respect since 1942, when it was concluded that:

"Inadequate rural road services in New Hampshire have contributed to an uneconomic use of rural land and to an incomplete realization of agricultural and recreational opportunities....a large majority of the so-called 'declining areas' are those districts most inaccessible in a town.... many of the declining areas are made unfit for agriculture by uncontrollable natural factors. . . . Nevertheless, too many areas in the state are declining because they are not readily accessible. . . . "*

Hence, while some farm units may have gone out of production because of inaccessibility, many have continued to operate. These oftentimes present a problem to the feed dealer from the standpoint of added route mileage, the fact that roads may be impassable at certain seasons, or the load limits involved may require at times substitute delivery equipment. Although such units are in the minority, their importance is significant.

Table 10 shows distributions of distances to farms over dirt or unimproved roads and kinds of roads on which farms are located. Belknap, Carroll, Coos, and Grafton counties have a lower percentage of their farms located where travel distances over dirt or unimproved roads is less than a mile than the percentage for the state as a whole. On the other hand, Cheshire, Coos, Merrimack, Rockingham, and Strafford counties have lower percentages of farms actually located on dirt or unimproved roads than the percentage for the state as a whole.

The condition and location of roads is a paramount consideration in determining route efficiency. Road condition, as will be discussed later, is also a limiting factor to the extension of bulk feed delivery. The promotion

Table 10. Distances to Farms Over Dirt or Unimproved Roads and Kinds of Roads on Which Farms are Located, New Hampshire and Counties

Area	Distances to Farms Over Dirt or Unimproved Roads				Kinds of Roads on Which Farms Are Located		
	0.0-0.2	0.3-0.9	1.0-4.9	5.0 mi. and over	Hard Surface	Gravel Shell, Shale	Dirt or Unimproved
	Percentage of Area Total						
The State	64.9	10.7	22.0	2.4	64.2	14.6	21.2
Belknap	53.6	17.0	27.2	2.2	48.2	19.2	32.6
Carroll	61.9	10.5	25.5	2.1	69.0	6.2	25.8
Cheshire	61.1	14.9	20.8	3.2	66.3	17.8	15.9
Coos	62.8	5.6	30.7	.9	66.3	20.1	13.6
Grafton	60.4	10.3	26.2	3.1	64.2	11.5	24.3
Hillsboro	67.6	9.4	20.7	2.3	62.4	13.3	24.3
Merrimack	65.9	10.1	22.5	1.5	66.0	17.3	16.7
Rockingham	77.0	7.3	13.6	2.1	76.5	9.1	14.4
Strafford	66.7	12.3	19.9	1.1	63.3	16.2	20.5
Sullivan	51.8	16.4	25.8	6.0	45.2	22.2	32.6

Source: 1950 Census of Agriculture.

* Parks, W. R., and J. C. Holmes, *New Hampshire Rural Town's Comparative Road Burdens and Road Services*, N. H. Agr. Exp. Sta. and Bur. Agr. Econ. Cooperating. Bul. 339, June, 1942, p. 6.

of improved. all-weather rural roads is of importance to both feed dealers and producers; for the former such a program will make possible further efficiencies in delivery service, and for the latter enable adoption of technological improvements in receiving and handling grain-feeds.

Company and/or retail unit characteristics and policies directly affect route efficiency. These effects come about through the attitudes of management toward serving customers at scattered locations or under inconvenient circumstances on a regular basis, and through the pricing arrangements made. The decision on whether or not to go into bulk feed may also have a definite bearing on route efficiency, as will be subsequently shown.

Farm facilities, i.e., farm roads and driveways, receiving platforms, location and number of grain storage points, as well as the attitudes of producers, affect route efficiency. Variation in these matters shows up in time required to set the truck in position and to unload.

Most of the preceding factors are not likely to be solved in the short run, but rather form the framework within which short-run changes can be made. In effect the physical and institutional factors, plus a number of locational considerations are conditions of imperfect competition more or less fixed in short-run analysis.

Route Rearrangements

Recognizing the existence of certain conditions of imperfect competition fixed in the short run precludes from the study of short run route rearrangements any assumptions relative to redistributing customers and establishing an exclusive territory system.* The very nature of the present distributive system for grain-feeds in New Hampshire makes such possibilities extremely unlikely in the absence of a national emergency requiring very strict rationing of gasoline, tires, etc., and like regulation of the use of manpower and equipment. Hence, in this study, route rearrangement is developed in terms of present units retaining the bulk of present customers. Obviously some turnover in customers occurs, but on the basis of considerations other than delivery route efficiency. The question herein is how to improve route efficiency; first from the standpoint of route rearrangement, and second, in terms of operating economies on the individual routes.

Belknap County, New Hampshire, was selected as the focal area in the study of route rearrangement. Although the county ranks next to last in the State in terms of tons of grain-feed purchased, principles observed in a smaller area are equally applicable elsewhere, and the field work is less arduous. County boundaries obviously have little relationship to trade areas (Figure 6).

Within Belknap County itself, dealers whose places of business were located within the county served areas composing portions of Gilford, Alton, Gilmanton, Belmont, Tilton, Sanbornton, Laconia, Meredith, and New Hampton without substantial competition from out-of-county dealers (Figure 7). Belknap County dealers had substantial competition from out-of-county dealers in much of the remainder of the county and in Sandwich, Moultonboro, Tuftonboro, and Franklin. County dealers delivered as far away as

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* This type of aproach is well developed in the following bulletin: MacLeod, A., and C. J. Miller, *Efficiency of Milk Marketing in Connecticut, 7. Milk Delivery in Rural Connecticut*, Storrs Ag. Exp. Sta. Bul. 279, July, 1943.

Tamworth, Ossipee, Boscawen, and Epsom. In the southeastern and northwestern portions of Belknap County, out-of-county dealers had about all of the business.

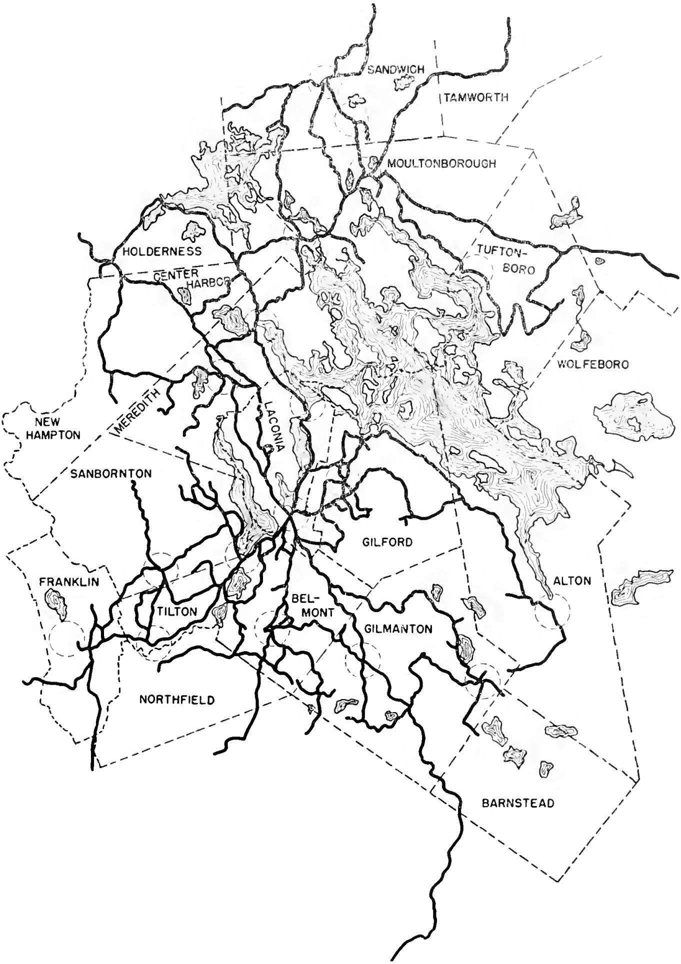

Figure 6. Delivery routes of Belknap County grain dealers.

Two or more dealers (both in-county and out-of-county) were competing in all areas mapped within and without the trade area of Belknap County dealers. The areas of heaviest competition observed in terms of numbers of dealers — were in portions of Laconia, Meredith, Center Harbor, Alton, Belmont, Gilmanton, and Tilton where five or six dealers made deliveries (Figure 8).

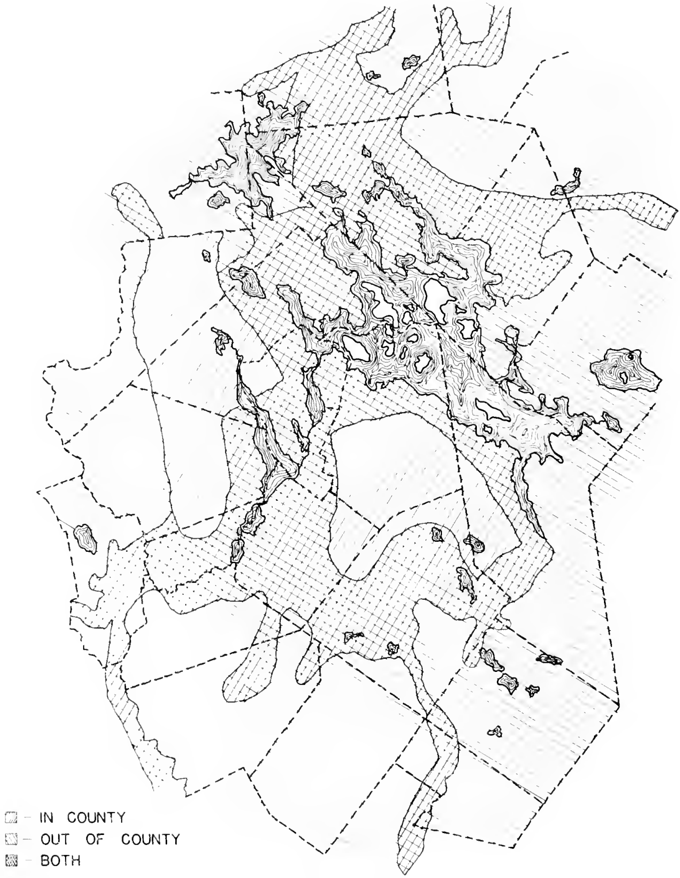

Figure 7. Areas served by Belknap County and out-of-county grain dealers.

The six dealers in Belknap County rather thoroughly covered the towns of Laconia, Gilford, Belmont, Gilmanton, Meredith, Center Harbor, Tilton, and Moultonboro. They also delivered in Holderness, Sandwich, Tamworth, Tuftonboro, Ossipee, Alton, Barnstead, Epsom, Northfield, Loudon, Canterbury, Boscawen, Franklin, Sanbornton, New Hampton, and Ashland. The

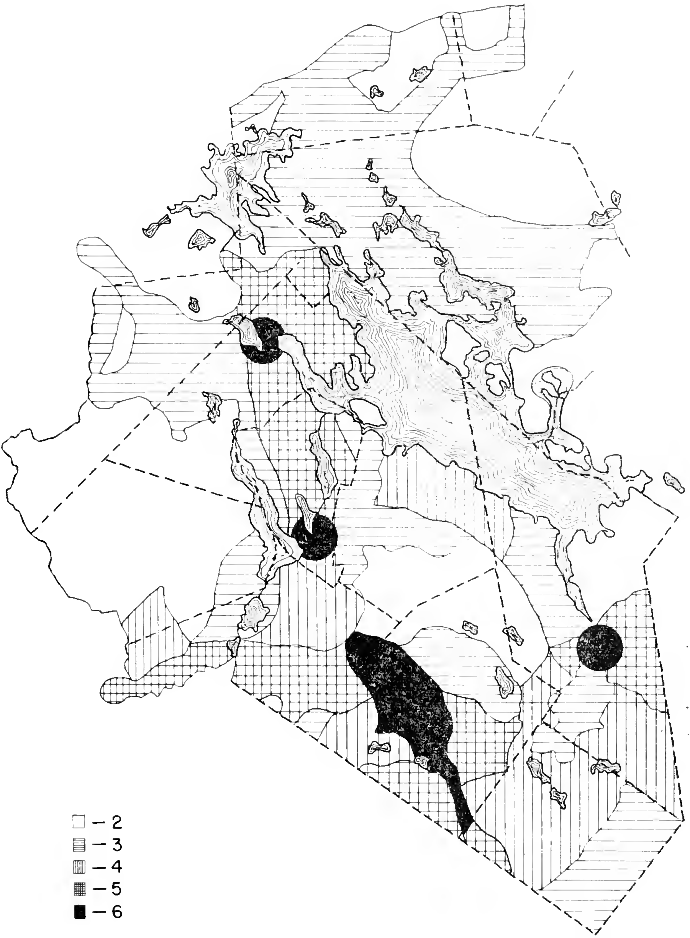

Figure 8. Numbers of grain dealers operating in Belknap County and adjacent areas.

areas of greatest route travel were between Laconia and Meredith, Laconia and Belmont, and Meredith and Moultonboro.

The grain delivery routes diagrammed in Figure 6 represent an estimated weekly travel of 1,612 miles for the six dealers. By route rearrangements this weekly mileage could be reduced to 1,312, a saving in travel distance of 18.6 percent. With the same territories, customers, and quantities delivered being held constant for each dealer, percentage savings in travel distances ranged from virtually none for two carlot distributors whose route business was a minor factor to 37.1 percent for one dealer. Percentage savings in travel distances for the other three dealers were 8.7, 13.7, and 20.0 percent, respectively.

The approach to savings in travel distance through route rearrangement necessarily must be made on an individual dealer basis. For example, one dealer with 21 delivery routes had 18 routes where the outgoing truckload was 5 tons or over; another dealer with 8 delivery routes had only 1 route where the outgoing truckload was 5 tons or over. Hence, in the latter instance, route rearrangement must also concern itself with maximum outgoing truckloads. One dealer made local deliveries six days per week while other dealers performed these deliveries once or twice per week. Here, cutting down the number of routes became a primary concern.

The requirements for studying route rearrangement are relatively few:

1. Large scale maps with roads and farm dwellings. The N. H. Highway Department can furnish county maps suitable for this purpose at a nominal cost.
2. Information on the location of each customer obtaining delivery service and the average quantity purchased by each customer. Customers can be located on the map by numbered pins or by pencil coding.
3. The precise directions taken on each delivery route. Each route can be plotted on the map.
4. A map measure or a piece of string for measuring revised route mileage (and present route mileage in the absence of accurate speedometer readings).

For dealers where present outgoing truckloads are relatively near truck capacity, the problem is essentially one of shifting customers from one route to another to find the combination which will minimize travel distances. For dealers where present outgoing truckloads are less than truck capacity, minimization of travel distances and maximization of truckloads should both be achieved. This can be done through shifting customers, combining two or more present routes, and/or instituting less frequent delivery.

Following are three examples of route rearrangements which could be made. The original data were taken from records of actual routes operated by retail grain-feed dealers.

Example A

Route 1 serves 9 customers purchasing an average of 42 bags of grain weekly. The round trip covers 53 miles. Roughly 80 pounds are delivered per mile of travel.

By initiating delivery every other week, the load can be increased to 84 bags per trip, or 160 pounds per mile of travel. One trip of 53 miles is eliminated — saving 26.5 miles per week.

Example B

Routes 2 and 3 serve two adjacent towns. The former involves 5 stops and 20 bags with 34 miles of travel. The latter involves 9 stops, 29 bags, and 36 miles of travel.

By combining Routes 2 and 3, 13 customers could receive 49 bags of grain, with travel distance totalling 42 miles. This would represent a savings of 28 miles per week.

If every other week delivery was initiated, 13 customers could receive 98 bags. The aggregate saving in travel would then equal 49 miles per week:

$$\begin{array}{lll} 2\ (34 + 36) & = & 140 \\ 1\ (42) & = & 42 \\ \hline & & 98 \div 2 = 49 \end{array}$$

As the routes are now, 59 and 81 pounds are delivered weekly per mile of travel on Routes 2 and 3, respectively. Combined into one weekly route, 117 pounds would be delivered per mile of travel. With every other week delivery, 233 pounds would be delivered per mile of travel.

Example C

Routes 4-9 inclusive involve local deliveries with the smaller of two trucks owned by the store. There is one local route daily. The aggregate mileage is 31.0, and the respective quantities 12, 12, 20, 20, 25, and 20 bags.

By combining these local deliveries into two routes, one Monday and one Thursday, the loads could equal 57 and 52 bags, respectively. A saving of 10 miles travel per week could be realized.

The preceding examples are concerned with reducing route mileages and increasing pay loads. By route rearrangement, there are also likely to be significant savings in time, thus reducing the labor cost of delivering grain-feed. Subsequent sections will explore this matter more fully.

Less frequent delivery has been mentioned as a technique which can be employed to aid in rearranging routes and delivery schedules to minimize travel distance and time. But the question of defining the limits of less frequent delivery cannot be answered herein on the basis of present evidence. Aside from the wishes of producers, who may well demand and get weekly or semi-weekly deliveries of grain-feeds because of inclination and/or management decisions, the issue is essentially one of the keeping characteristics of grain-feeds. How long can grain-feeds be kept safely under various storage conditions and in different seasons without undue loss of palatability and/or nutritional value?

Answers to this question were sought by questionnaire from nutritional specialists at the six New England colleges and a number of feed companies. The replies indicate substantial differences of opinion and a lack of experimental data applicable to the specific formulas and the range in farm storage conditions on New Hampshire farms. The matter calls for controlled experimentation before a precise answer can be formulated, or these answers translated into recommended practices.

From a number of replies to the questionnaire, it would appear that there is little danger of adverse effects from bi-weekly deliveries of grain-feeds, but whether less frequent periods can or should be used is a matter of considerable difference of opinion.

Efficiency of Truck Loading

Most stores and warehouses visited did not experience excessive delays in loading from unsystematic piling of the various kinds of grain-feed handled. Admittedly, the loading of a truck with a number of different items is somewhat less efficient than where one or two items are involved, but this is a problem common to all retail units and, hence, one which is difficult of microscopic study for purposes of observing differences in performance.

It was possible to secure sufficient observations to compare roughly the efficiency of loading bagged feed with different numbers of men. In general (Table 11) retail units do not utilize additional men efficiently in loading. While the elapsed time in loading a truck may be reduced, there is a general tendency for the man minutes per 100 pounds to increase as additional men are added. There are some variations from this pattern, as can be observed in Table 12. Here, an attempt was made to compile the data for "loading mostly by carrying bags" to measure the effect of not only number of men, but also number of bags and number of orders. These data suggested the following:

(1) For a relatively small number of bags and few orders, one man was most efficient in loading.

(2) As the number of bags loaded increased, one man became less efficient, and on larger orders two men were most efficient.

(3) In all unit intervals related to number of bags, two men were more efficient than three; three than four.

(4) As the complexity of loading increased (as measured by number of orders) efficiency steadily fell where one, two, or three men were used. Four men appeared most inefficient where there were very few or very many orders in the load.

Table 11. Comparative Efficiency in Loading Grain Delivery Trucks by Various Methods

No. of Men	No. of Loads	Average No. of Bags Per Load	Average Weight Per Load (lbs.)	Average No. of Orders Per Load	Average Weight Per Order (lbs.)	Man Minutes Required Per Load	Man Minutes Per 100 Lbs.	100 lb. Units Loaded Per Man Minutes
				Loading Mostly by Carrying Bags				
1.3	4	85.75	8,575	8.8	980	55.1	.64	1.56
2.1	19	94.74	9,474	6.8	1,395	62.1	.66	1.53
3.0	6	119.66	11,966	11.3	1,056	104.7	.88	1.14
4.0	7	91.86	9,186	10.0	933	134.6	1.44	.69
				Loading Mostly by Hand Truck and Chute				
3.2	2	134.00	13,400	1.0	13,400	55.0	.41	2.44
				Loading Bulk Trucks from 100 lb. Bags[1]				
2.1	2	98.00	9,800	1.0	9,800	112.5	1.15	.87
				Loading Bulk Truck from Overhead Bins				
				Poultry Feeds:				
1.0	3	——	10,816	1.3	8,112	12.7	.12	8.52
				Dairy Feed:				
2.0	1	——	6,100	1.0	6,100	50.0	.82	1.22

[1] Bags hand trucked, opened, dumped into overhead bulk bin; spouted into bulk truck bin; or bags hand trucked, opened, dumped into bulk truck bin.

Examing the data in Tables 11 and 12 from another angle, it appeared possible to increase efficiency by using a hand truck and other devices to minimize carrying. In terms of man minutes per unit in loading, the filling of bulk trucks from overhead bins, where one man handles the operation and feed flows freely, appeared to be the most efficient method. However, where bulk feed bridged rather badly (as dairy feeds may do), where it was necessary to use more than one man, and particularly where bulk trucks were loaded from bags, loading efficiency was very low. Those types of situations represent some of the problems with bulk feed handling.

In seeking a more controlled answer to time savings from use of a hand truck, the data from Table 11 "loading mostly by hand truck and chute", could more properly be weighed against the two men data in Table 12. The combination of one stop and over 130 bags with two men hand loading should yield a figure somewhere between .44 and .67 man minutes per bag as compared to the .41 man minutes from Table 12 for loading by hand truck and chute. Another indication of this general trend can be observed from Table 13. Here, it took one man .20 man minutes per bag to load a truck from a railroad car using a hand truck. Two men loading by hand took .33 man minutes per bag. Both were loading for one destination, but the different number of bags per load probably accounted for some of the previous difference.

Table 12. Effect of Number of Men, Number of Bags, and Number of Orders on Man Minutes per Bag in Loading Grain

Unit Intervals (No. of Bags)	Average Number of Bags	Man Minutes per Bag	Unit Intervals (No. of Orders)	Average Number Orders	Man Minutes per Bag
1 man			1 man		
Under 50	10.0	.33	1- 2	1.0	.33
50- 90	—	—	3- 6	5.0	.61
90-130	111.0	.65	7-12	—	—
Over 130	—	—	Over 12	14.5	.68
2 men			2 men		
Under 50	35.5	.88	1- 2	1.4	.44
50- 90	72.4	.78	3- 6	5.0	.64
90-130	112.6	.67	7-12	8.4	.75
Over 130	159.0	.39	Over 12	19.0	1.08
3 men			3 men		
Under 50	20.0	1.28	1- 2	—	—
50- 90	88.0	1.36	3- 6	5.5	.81
90-130	108.5	.84	7-12	11.0	.84
Over 130	146.5	.76	Over 12	17.5	.98
4 men			4 men		
Under 50	—	—	1- 2	1.0	1.80
50- 90	75.3	1.76	3- 6	4.5	1.14
90-130	97.0	1.39	7-12	11.0	1.06
Over 130	136.0	1.03	Over 12	16.3	1.76

Table 13 is interesting in another respect. Comparing the man minutes required per bag with data from Tables 11 and 12 leads to the conclusion that there are decided economies in operating routes from railroad cars as against delivery from retail units. These are in addition to the elimination of the extra handling, i.e., railroad car —> truck —> farm storage vs. railroad car —> warehouse —> truck —> farm storage. (See also Figure 11 for diagramatic presentation of alternative methods of distribution observed in the study.) Obviously, the method of operating from railroad cars cannot be universally used since it requires more advanced ordering and planning than could be obtained from most farm customers. Where it can, however, it is certainly productive of economies in distribution in terms of more efficient truck loading, elimination of one handling, and elimination of retail unit warehousing space.

One of the problems common to truck route operations is that of making the fullest use of the truck (or trucks). In the loading phase, this is concerned with minimizing the delay time during loading and between completion of loading and departure. Total loading time in man minutes for 36 observations was 2,971. Predeparture delays totalled 535 man minutes additional, or an amount 18 percent as large as total loading time. On the 19 observations where predeparture delays occurred, loading time totalled 1,836 man minutes; delay time was almost 30 percent as large as actual loading time.

The most common causes of predeparture delays were servicing the truck (gas, oil, water), getting bills and change at the office, sweeping, waiting on customers, and side trips to get additional supplies. These are not functions which can be eliminated entirely, but it should be possible by better scheduling and division of work (particularly in multiple-employee retail units) to prevent these delays from tying up the loaded truck.

Table 13. Comparative Efficiency in Unloading from Railroad Cars onto Trucks

No. Observations	Average No. Men	Average No. Bags Per Load	Elapsed Time (Minutes)	Total Man Minutes	Man Minutes in Preparation	Man Minutes in Unloading	
						Total	Per 100 lbs.
			By Using Hand Truck				
4	1	154	31.25	31.25	2.25	29.00	.20
			By Carrying Bags				
4	2	100	20.75	41.50	8.60	32.90	.33

Efficiency of Delivering and Unloading at the Farm

The various observed methods of delivering and unloading grain-feeds at the farm are summarized in Table 14. The data were collected in such a manner as to separate the various operations involved, i.e., setting truck in position for unloading and preparing to unload where auxiliary equipment was involved, unloading, collecting and obtaining orders, plus time lost through various circumstances and time used in bag returns.

With respect to unloading time only, Table 14 indicates the possibility of effectuating time savings through use of bulk unloading equipment, portable conveyors, and body jack arrangements for use on second floor deliveries. However, when portable conveyors were used, it took two men on the truck and a considerable amount of extra time to put the conveyor on the load, place it in position, shift it as the load was reduced, and retie on the load. This extra time more than cancelled the time saved in unloading. In the instance where the body jack arrangement was used, two men were

Table 14. Comparative Efficiency in Making Deliveries of Grain by Various Methods

No. of Ob.	Average Weight of Load (lbs.)	Number Men on Truck	Truck Travel Time (min.)	Route Mileage	Number Stops	Man Min. Per Load In: Position[1]	Unloading	Collecting	Man Min. per 100 lbs. in Unloading	Man Min. per 100 lbs. for Position[1]	Total Man Min. per 100 lbs. Unloading and Position[1]
Unloading by Hand:											
26	6,720	1	83.3	36.0	11.2	9.3	37.9	33.4	.56	.14	.70
22	11,810	2	92.3	40.0	6.5	21.1	76.4	27.7	.65	.18	.83
2	11,000	3	25.0	7.0	1.5	20.2	147.0	—	1.34	.18	1.52
Conveyor Unloading of Bagged Feed:											
2	13,400	2	124.0	64.8	1.0	52.0	63.0	5.0	.47	.39	.86
2nd. Floor Unloading with Double-jack Truck Body Attachment:											
1	9,000	2	45.0	16.0	1.0	4.0	50.0	6.0	.55	.05	.55
Unloading Bulk Feed:											
8	12,995	1	111.6	58.3	1.25	15.3	37.0	4.6	.29	.12	.41

[1] Setting truck in position for unloading and preparing for unloading.

[2] Auger-type system.

on the truck. This unit had two practical limitations, i.e., the maximum elevation of 5 feet above normal truck platform level, and the maximum lift of 90 bags (60 was preferable). Time consumed in preparing to unload bulk feed was not excessive, and unloading was, on the average, fast and done by one man.

Just as the use of a hand truck offered certain economies in loading bagged feed on delivery trucks, so it could offer economies in unloading. The principal drawback to wider usage of hand trucks in unloading is the variable and improper height of unloading platforms at the farm. For best results such platforms should be close to truck platform level.

There would appear to be a definite place in the delivering and unloading of grain-feed on many routes for a system intermediate between a complete bulk setup and the traditional method of handling bagged grain by hand. Admittedly, there are many technical and cost problems involved in developing a system which will permit the maximum flexibility with economical operation. Two alternatives appear worthy of investigation:

(1) A conventional bag conveyor modified in such a way that it could be attached to a base on the truck. This would eliminate tying, untying, lifting, shifting, etc., as is now necessary with portable conveyors used on some loads. It could be placed in position by power rather than by hand. Two men would still be needed. one at each end of the conveyor. Feed could be stored in bags or the bags dumped into bulk bins.

(2) A hopper and elevating mechanism attached to a base on the truck, to be placed in position by power rather than by hand. Feed would be hauled in bags and the bags dumped into the hopper, the feed then being deposited in bulk in the farm bins. This system should be worked out so it could be handled by one man and used only on orders where quantities justified. One problem would be to assure the clearance of one type of feed from the system before another was introduced.

The cost limitations of alternatives such as the two mentioned above can be roughly defined. First, depreciation and maintenance charges should be less than those experienced on the conventional bulk delivery equipment. Secondly, total route operating costs should not exceed those experienced on the most efficient bagged feed routes.

Data on making deliveries of grain in bulk, shown in Table 14, were recorded on the auger-type body. Recently the pneumatic-type of body has been introduced into the state. The pneumatic system makes it possible to reach points more distant from the truck-setting position than is possible with the auger system. This is accomplished by means of pipes (probably stove-pipe) sealed at the joints and running from the outside of the house to the storage bins. It may prove somewhat easier in operation to hook on a short length of outlet pipe.

Even where bagged feed was unloaded by hand, the location of many farm grain storage points required a considerable amount of time to maneuver the truck into position for unloading. Extra men were largely "dead weight" in this instance, as on collecting, travel, etc. In general the additional men did not reduce the man minutes per 100 pounds in unloading. Hence, as with loading, it must be concluded that additional men are, on the average, not utilized efficiently.

The preceding conclusion is further substantiated by Table 15. Here the primary purpose was to analyze the effect of size of delivery on time requirements, but while the results show a steady decline in time per 100 pound bag as the size of the individual delivery increases, at no point is it conclusive that additional men are utilized efficiently.

There is little reason to expect that the average time required to place the truck in position for unloading, or to collect and obtain orders, would be substantially different on larger orders than on smaller orders. Thus, these items are relatively fixed in total irrespective of size of delivery, but decline somewhat in relation to additional units unloaded at the stop. Time needed to set the truck in position for unloading is more properly a function of the number of separate settings of the truck, whether one or more per farm, whereas collecting and reordering time is more properly a function of the number of farms (or orders).

Just as the "position" time requirements appear excessive, so do the time requirements for collecting and reordering. Both are a result of attitudes and policies and can only be reduced by cooperation between the feed dealer and the farmer. "Position" time is a direct result of the location of farm grain storage points and the extra carrying the farmer expects or the feed dealer is forced to do by competition. Collecting and reordering time is affected by the regularity of delivery time, credit considerations, and the

Table 15. Effect of Number of Men and Size of Delivery on Man Minutes per Bag Required in Making Deliveries of Grain

Size of Delivery (No. of Bags)	No. of Men	No. of Del.	No. of Bags	No. Bags per Del.	Man minutes per bag spent on: Setting Truck in Position	Unloading	Collecting and Reorders	Total of 3 Items
1- 3	1	141	246	1.74	.30	.96	2.13	3.39
	2	50	87	1.74	.31	1.64	3.05	5.00
	Av. 1.26	191	333	1.74	.31	1.14	2.34	3.79
4- 9	1	72	454	6.31	.15	.58	.62	1.35
	2	28	167	5.96	.33	.87	.83	2.03
	Av. 1.28	100	621	6.21	.20	.66	.68	1.54
10-19	1	38	502	13.21	.09	.47	.35	.91
	2	25	319	12.76	.22	.69	.52	1.43
	Av. 1.40	63	821	13.03	.14	.55	.42	1.11
20-39	1	11	268	24.36	.09	.44	.22	.75
	2	14	360	25.71	.25	.70	.20	1.15
	Av. 1.56	25	628	25.12	.18	.59	.21	.98
40-79	1	2	81	40.50	.05	.38	.03	.46
	2	15	826	55.07	.12	.58	.06	.76
	Av. 1.88	17	907	53.35	.12	.56	.06	.74
80 and over	1	1	123	123.00	.05	.43	.02	.50
	2	7	804	114.86	.06	.53	.08	.67
	3	3	310	103.33	.15	.98	.17	1.30
	4	1	100	100.00	.08	.24	—	—
	Av. 2.33	12	1337	111.42	.08	.60	.05	.73

amount of time the feed dealer is willing to have his driver spend in "good will" and "service work". These two operations can contain decided inefficiencies; solving them can only come about through cooperation and mutual savings.

While on the average, delay time on the route amounted to only 2.5 percent of other route time, there was wide variation due to circumstances. Some factors, which were actually delaying, were measured in some instances as part of other operations. Some examples of these were:

(1) Included under "position": "car stuck in drive"; "locked door"; "very poor and crooked drive"; "inquire where to unload".

(2) Included under "unloading": "empty the bags"; "long carry"; "difficult locations"; throwing or carrying to upper floors; "had to carry around tools in barn floor"; "stop on main road, carry in on back"; "carry 75 feet to dairy".

(3) Included under "collect and reorder": "lonesome old man, wanted to visit"; "new calf born while at this farm"; "leave advertising material"; "bags for return".

Some of the situations actually recorded as "delays", and for which time was segregated were as follows: "get Town Report"; "stuck in soft ditch"; "find party"; "inquire where to unload"; "place for sale — customer moved away"; "call on old customers"; "stop at bank"; "talk with Field Representative"; "bags returned"; "assist the farmer in the field"; "wait for truck to unload and clear driveway"; "shut doors on inside and wait for man"; "in Post Office"; "inquire location of new customers".

Most of the factors causing delays or slower rates of accomplishment cannot be measured in averages because of their very nature. However some of the unloading problems are compared in Table 16. These data, while based on only a few parallel observations, are indicative of the excessive time required under difficult unloading conditions.

Table 16. Relative Unloading Times Under Specified Circumstances, Selected Data

Circumstances	Index Number of Unloading Time per 100 lbs.
1st floor unloading, average condition	100
Carrying to 2nd floor	125
Carrying to 3rd floor	300
1st floor unloading, emptying bags	250
Long carrying distance from truck to grain room	400

The procedures for returning used grain bags differed between companies. Some gave the producer the alternative of shipping to a bag company or returning bags via the grain truck; other companies left the matter entirely up to a bag plant. In some instances the initiative for counting, bundling, and tagging bundles of bags rested with the producer; in others the grain dealer performed this service. In the latter situation, route time was increased once again by the willingness of the grain dealer to perform additional services without charge to keep accounts.

The most efficient way of handling the return of used grain bags would generally be one under which the producer counted, bundled, and tagged bundles of bags, and the grain truck picked them up for assembly at a central point or delivery to the bag plant. Such a procedure, provided producers did not cause extra work by incomplete identification of bundles, as was reported in some cases, would minimize route time involved. It would also utilize the return trip of the truck in a productive way. It would further eliminate many route miles over which the grain truck and the bag plant truck would otherwise both travel. However, under such a system it would be necessary that both the producer and the grain dealer receive equitable compensation for their services. One possible exception to the preceding arrangement might occur where the grain dealer, for other reasons, finds it feasible to dump bags for the producer. Here it would be just as economical for the grain dealer to handle the counting, bundling, tagging, and accounting. Considerations relative to the dumping of bags by the grain dealer were discussed previously.

One other type of situation which causes inefficiency in delivery route operation is catering to small orders. The time attendant to travel, position, unloading, and collecting are oftentimes incurred on a sale of less dollar value than a bag of grain. Some examples of small orders observed were as follows: 12 lbs. oyster shells; 25 lbs. chick feed; towels, cleaner, filter disks; one package of vegetable seeds; 5 lbs. dog food; 3 cans of dog food — 47c. Many of the people making such purchases are old customers; some may seasonally or in the future buy larger quantities. In any event, catering to small orders is costly and more sizeable orders must bear a share of this cost. Such small orders could best be bought at the store.

Formulating Route Time

The man minutes per route, necessary to calculate the labor cost of delivery, can be expressed by the following equation:

$$Rt = N\,[(M.m) + (P.p) + (S.c) + (Q.u)] + N[\text{[illegible]}\ d(T)]$$

In the preceding equation, the symbols are indicative of the following:

Rt — route time in aggregate man minutes
N — number of men on truck
M — route miles round trip
m — average miles per hour expressed as $\frac{60}{m}$
P — number of separate settings of truck
p — average time per setting in minutes
S — number of stops on route
c — average collection time per stop in minutes
Q — number of 100 pound units
u — average unloading time in minutes per 100 pound unit
T — total man minutes in preceding bracket
d — average percentage of route delay time

There are presented in Table 17 a series of factors for use in the examples which follow the table and Figure 9. Data in Table 17 were derived from Tables 14 and 15 and from examination of the individual observations upon which those tables were based.

Table 17. Comparison of Average and "Most Efficient" Performances of Certain Delivery Operations[1]

Method of Unloading	No. of Men	p (position)		c (collecting and recording)		u (unloading)	
		Data Average	"Most Efficient"	Data Average	"Most Efficient"	Data Average	"Most Efficient"
		Mins. per Setting		Mins. per Stop		Mins. per 100 Pounds	
Hand	1	0.8	0.5	3.0	1.0	0.56	0.39
	2	1.4	0.5	2.1	1.0	0.33	0.18[2]
Conveyor	2	3.3	1.5	2.5	1.0	0.24	0.20[3]
Bulk (auger-type)	1	5.1	2.0	4.6	1.0	0.29	0.19

[1] Times can be converted to aggregate man minutes by multiplying by number of men.
[2] Carrying to upper floors almost eliminated.
[3] Includes partial unloading to upper floors.

Figure 9 was designed for use with the preceding formula. In effect it is the (M.m) position; route mileage can be read vertically to the curve and the product (M.m) in minutes horizontally from that point. The curve was interpolated from plottings of interval averages from actual bagged and bulk routes. The interpolated curve exhibits the logical behavior of increasing average miles per hour with greater route length. It can logically pass through the origin since it covers only truck travel time and no other time factors.

Following are some examples of the use of the route time formula, utilizing data from Table 17 and the interpolated curve in Figure 9.

Examples

Assume the following:

(1) Route 40 miles round trip
(2) 6 stops on route, 9 settings
(3) 100 bags on load
(4) Average amount of delay for data average route; none for most efficient

(A) *With one man on truck*

Data Average:

Rt = 1[95 + 9(0.8) + 6(3.0) + 100 (0.56)] + 1[.025 (176.2)]
Rt = 180.6 minutes

"Most Efficient":

Rt = 1[95 + 9(0.5) + 6(1.0) + 100(0.39)] + 1[.025(0)]
Rt = 144.5 minutes

(B) *With two men on truck*

Data Average:

Rt = 2[95 + 9(1.4) + 6(2.1) + 100 (0.33)] + 2[.025 (1532)]
Rt = 2 (157.0) = 314.0

"Most Efficient":

Rt = 2[95 + 9(0.5) + 6(1.0) + 100 (0.18)] + 2 [.025 (0)]
Rt = 2(123.5) = 247.0

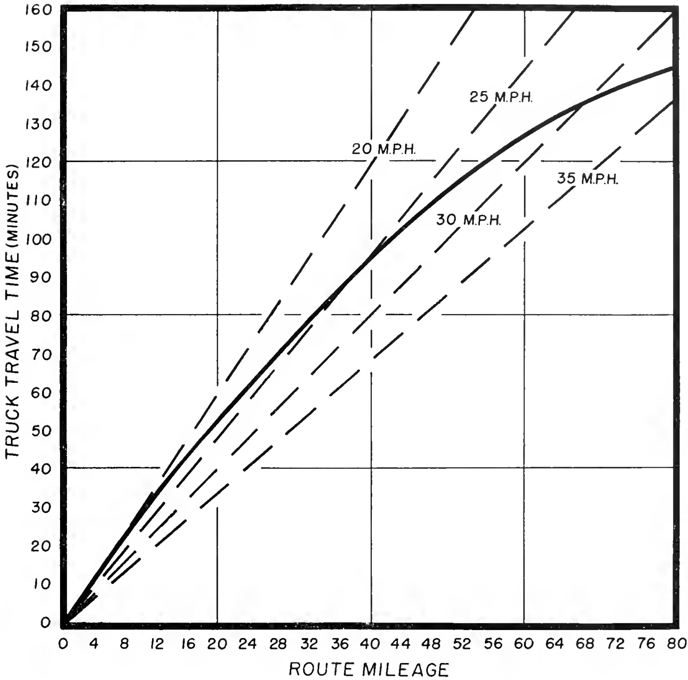

Figure 9. Relationship between route mileage and truck travel time.

From the foregoing it is evident that the effects of doubling man minutes in travel, position, and collection are hardly likely to be offset by increases in loading efficiency eventually realized by using two men instead of one man on delivery trucks.

The "most efficient" factors when used in the formula with actual route specifications should provide a basis for comparison with actual route times being experienced. Such a comparison, of present results against efficiency standards constructed from actual observations, is a fair test of current performance against a goal of more-or-less ideal conditions.

Under certain circumstances, a savings in elapsed time would be more important than savings in man minutes per unit. If the savings in route time by using additional men were sufficient to permit the utilization of less equipment to cover a given territory, and the amount saved on equipment and operating costs were greater than the savings in labor cost (man minutes), additional men would be profitable. In terms of the results of this study such does not appear to be the case when comparing one and two man routes.

In the preceding examples the elapsed times on the "average" routes for one and two men, respectively, were 180.6 and 157.0 minutes, or an elapsed time saving with two men of 23.6 minutes. The additional cost in man minutes, however, was 133.4 minutes. For the "most efficient" routes, the elapsed times for one and two men, respectively, were 144.5 and 123.5 minutes, or an elapsed time saving with two men of 21.0 minutes. The additional cost in man minutes with two men was 102.5.

Comparative Delivery Route Costs

The minimization of delivery route costs is the summation of the efficiencies realized from maximizing volume, rearranging routes to minimize travel distance and time, minimizing loading time, and minimizing delivering and unloading time. The most significant indicators of delivery route efficiency are the following: number of 100-lb units, number of miles on route, number of stops, number of 100-lb units delivered per mile and per stop, man minutes spent per 100-lb unit, and cost of delivery per 100-lb unit. Costs per mile or per ton-mile are likely to be misleading, in that they yield unfavorable comparisons on shorter routes, somewhat irrespective of what other measures show, and even though shorter routes are generally desirable.

In Table 18, 3 routes were selected which approximate the extremes and the modal area for the 60 routes on which comprehensive data were obtained. Cost projections were made on the basis of preceding and succeeding information. In terms of the data in the study the routes can be described as follows:

Item	Route A	Route B	Route C
Quantity (units)	Low	Medium	High
Miles (No.)	High	Medium	Low
Stops (No.)	High	Medium to High	Low
Units/stop	Low	Medium	High
Units/mile	Low	Medium to Low	High
Time/unit	High	Medium	Low
Cost/unit	High	Medium	Low

This type of comparison has the obvious limitation of a number of variables, the effect of each of which upon the final result (cost per unit) is difficult to appraise. There are other variables such as truck size which are frequently hidden in many sets of data based upon observed route costs. Fortunately, this factor is not a variable in the three examples presented.

For analyzing many cost problems, and for that of grain-feed delivery route costs in particular, more significant appraisals can be made through a budgetary approach, wherein as many as possible of the variables can be held constant, and varied one at a time. Hence, with respect to the problem of analyzing relative costs of bagged and bulk delivery routes, "average cost" comparisons for a number of combined routes or direct comparisons of individual routes, similar in some respects but different in others, have been avoided. In attempting to analyze the relative efficiencies of the two methods the budgetary approach has been followed, holding most factors constant.

The two questions which Hypothesis 1 and Hypothesis 2, respectively, are designed to analyze are the following:

(1) Given a constant load, routes of equal distance, like numbers of stops and settings, and relatively high efficiency, which is cheaper — distribution of bagged feed or bulk feed?

(2) If each type of equipment is fully used under similar conditions, which is cheaper — distribution of bagged feed or bulk feed?

Table 18. Comparison of the Efficiency of Three Selected Bagged Feed Routes

Item	Route A: Low Efficiency	Route B: Medium Efficiency	Route C: High Efficiency
Quantity (100-lb bags)	21.0	81.0	150.0
Route miles	45.0	37.0	8.0
No. of stops	8.0	7.0	1.0
Elapsed time (man minutes)	146.5	201.0	124.0
Bags per stop	2.63	11.57	150.0
Bags per mile	.47	2.19	18.75
Man minutes per bag	6.98	2.48	.83
Route costs:			
Fixed[1]	1.49	2.04	1.26
Labor[1]	3.66	5.02	3.09
Other variable[2]	3.15	2.59	.56
Total	8.30	9.65	4.91
Cost per 100 lbs.	.395	.119	.033
Cost per mile	.184	.261	.614
Cost per ton mile	.174	.065	.082
Cost per ton	7.90	2.38	.66

[1] Proportional to time.
[2] Proportional to mileage.

The assumptions made under Hypothesis 1 were as follows:

(1) Two loads per day for each truck; payload of 5 tons.
(2) One stop and one setting per load.
(3) Each route 40 miles round trip.
(4) Routes efficient from time aspects.
(5) One man used in loading and unloading.

The assumptions made under Hypothesis 2 were as follows:

(1) As many routes as practicable to utilize an 8 hour day for 1 man. For bagged feed this was calculated to be 2 loads of 5 tons each over 40 mile routes and 1 load of 1½ tons over a 9 mile route. For bulk feed, two loads of 5 tons each over 40 mile routes and 1 load of 7 tons over a 49 mile route were used.
(2) One stop and one setting per load.
(3) Routes efficient from time aspects.
(4) One man used in loading and unloading.

One of the primary problems in building efficient bulk delivery routes is the higher daily depreciation costs on equipment. These costs for bulk equipment may be two to three times those for bagged delivery equipment. Hence, bulk equipment must be used extensively before route time savings are sufficient to offset the higher depreciation costs. Depreciation costs for bagged and bulk delivery trucks in use by one firm are presented in Table 19.

Under Hypothesis 1, the operating costs of a 3-ton bagged delivery truck, other than labor, were assumed to equal 13 cents per mile. Gasoline consumption was established at 7 miles per gallon for the bagged truck

Table 19. Comparative Costs of Depreciation on Bagged and Bulk Delivery Trucks

	Bagged Truck		Bulk Truck	
New cost chassis	$4000.		$8600.	
Less Trade-in Value	1000.		2600.	
Cost for depreciation	3000.		6000.	
Annual rate depreciation	25%	$750.	25%	$1500.
Cost of body, etc.	500.		6000.	
Annual rate depreciation	10%	50.	10%	600.
Total depreciation annual		800.		2100.
monthly		66.67		175.
daily[1]		2.86		7.50

[1] 280 working days per year.

and 6.55 miles per gallon for the bulk truck. A small additional amount was included under "other variable costs" for greater maintenance costs on the bulk equipment. Driver's time was included at $1.50 per hour.

Under Hypothesis 2, "gas and oil" and "other variable costs" were projected from Hypothesis 1 on the basis of the increased mileage; driver cost on the basis of the increased time.

The time calculations used were as follows:

Bagged truck:

Route miles, 40, 9

$$Rt = 1[95 + 1(.5) + 1(1.0) + 100(.39)] + 1[.025(0)]$$
$$Rt = 135.5 \text{ min.}$$

$$Rt = 1[27.5 + 1(.5) + 1(1.0) + 30(.39)] + 1[.025(0)]$$
$$Rt = 41.0 \text{ min.}$$

	Route Miles	Quantity per Load	Time per Route	Time per Route Adjusted for No. of Routes	Adjusted for No. of Routes: Loading Time	Office Time	Total Time
Hypothesis 1:	40	10,000	135.5	271.0	98.0	40.0	409.0
Added for Hypothesis 2:	9	3,000	41.0	41.0	10.0	20.0	71.0
Full day	89	23,000	——	312.0	108.0	60.0	480.0

Bulk Truck:

Route miles, 40, 49

$$Rt = 1[95 + 1(2.0) + 1(1.0) + 100(.19)] + 1[.025(0)]$$
$$Rt = 117.0 \text{ min.}$$

$$Rt = 1[112 + 1(2.0) + 1(1.0) + 140(.19)] + 1[.025(0)]$$
$$Rt = 145.0 \text{ min.}$$

	Route Miles	Quantity per Load	Time per Route	Time per Route Adjusted for No. of Routes	Adjusted for No. of Routes: Loading Time	Office Time	Total Time
Hypothesis 1:	40	10,000	117.0	234.0	24.0	40.0	298.0
Added for Hypothesis 2:	49	14,000	145.0	145.0	17.0	20.0	182.0
Full day	129	34,000	——	379.0	41.0	60.0	480.0

Under the conditions assumed for Hypothesis 1, it is apparent that the delivery cost per ton (or coincidentally, per mile) is cheaper for bagged feed than for bulk feed. The delivery cost per ton derived in Table 20 was $2.06 for the former; $2.29 for the latter, at the 80-mile, 10-ton level. If we calculate for comparative purposes, the number of bags per stop (100.0); the number of bags per mile (2.5); and the man minutes per bag (2.04) for the bagged routes in Table 20 seems slightly better than that in Example B, Table 18 (from the modal area of the route data). Hence, this suggests the following application: If bulk equipment is used to the extent

Table 20. Daily Operating Costs of Bagged and Bulk Delivery Trucks Under Assumed Conditions

Cost Item	Bagged Truck	Bulk Truck
Hypothesis 1:		
Fixed costs:		
Truck depreciation	$2.86	$7.50
Other fixed costs	2.00	2.00
Variable costs:		
Driver	10.22	7.44
Gas and oil	3.05	3.25
Other variable costs	2.50	2.75
Total operating costs:	20.63	22.94
Cost per mile:	.258	.287
Cost per ton:	2.06	2.29
Cost per ton mile:	.0258	.0287
Tons delivered per day:	10.0	10.0
Truck miles per day:	80.0	80.0
Hypothesis 2:		
Fixed costs:		
Truck depreciation	2.86	7.50
Other fixed costs	2.00	2.00
Variable costs:		
Driver	12.00	12.00
Gas and oil	3.39	5.23
Other variable costs	2.75	4.40
Total operating costs:	23.00	31.13
Cost per mile:	.258	.241
Cost per ton:	2.00	1.83
Cost per ton mile:	.0224	.0142
Tons delivered per day:	11.5	17.0
Truck miles per day:	89.0	129.0

of average use of bagged equipment, the latter is more efficient in terms of overall delivery costs per unit.

However, under Hypothesis 2, each type of equipment is used to feasible capacity (full 8-hour day for the operator), and the cost per ton (or coincidentally, per mile) appears lower for delivering bulk feed than bagged feed. Here, the performance of the bagged delivery operation was not changed much from that in Hypothesis 1 in terms of the cost per ton ($2.00 vs. $2.06); number of bags per stop (76.6 vs. 100.0); number of bags per mile (2.58 vs. 2.50); and man minutes per bag (2.09 vs. 2.04). It was not possible to do much with the bagged truck beyond the original premise of 80-miles, 10-tons. But with the bulk equipment, performance could be stepped-up considerably, and economies in operation resulted from the substantial advantage in tonnage over the bagged equipment.

This result concurs with conclusions reached by Rickey on the basis of data for a west coast cooperative using bulk delivery for a number of years.* With the bulk equipment it is possible to deliver more feed in a day, and when the full advantage can be had, unit costs become lower than for bagged feed delivery.

The achievement of this result under New Hampshire conditions is difficult in many areas. There is also the further problem of trying to maintain efficient routes for delivering bagged feed where the two systems exist simultaneously. Here, if the larger customers are skimmed off to make efficient bulk routes, the remaining customers must be re-grouped into efficient bagged routes if the aggregate result is to be advantageous to the company.

To construct hypothetical average cost curves with which to illustrate the effect of the introduction of bulk feed delivery into an area, all conditions except those varying with tonnage were held constant. Territory route mileage was initially assumed at 80 and it was further assumed there were two routes of approximately the same length and complexity (three stops and settings). Thus, tonnage was the only variable up to the points where full use was being made of the equipment (in terms of feasible tonnage and full utilization of the drivers' time). As in the preceding examples, calculations were based on one man per truck. When the points of full use were reached, it was assumed that a small truck would be added to carry bagged feed on short local routes, in lieu of adding another piece of large equipment (which would have abruptly jumped the average cost curves). The costs assumed for the small truck are presented in Tables 21 and 22.

The route time formula was combined with loading time and office time to compute the time component of total costs. For purposes of calculating loading time, an average loading time of .12 man minutes per 100 pounds was used for bulk feed. For bagged feed, the following estimates of loading time in man minutes per 100 pounds, as derived from Table 12 were used: up to 50 bags, .47; 50-90, .55; 90-130, .63; over 130, .71. These figures are averages from the 1-man data classified by numbers of 100-pound bags and by stops (in this example, 3).

From the average cost curves in Figure 10, the importance of securing maximum utilization of bulk equipment is apparent. Only when this is done does the average cost per ton for delivery fall below that for bagged feed

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* Rickey, L. F., *Delivering Feed in Bulk,* Farm Credit Administration, U.S.D.A., Circ. C-143, January, 1952, p. 19.

delivery. Or, to restate an earlier premise, only then are the route time savings sufficient to more than offset the higher equipment depreciation cost.

Table 21. Costs of Depreciation on Small Truck Delivering Bagged Grain

Item	Value	
New cost chassis	$2000.	
Less trade-in value	500.	
Cost for depreciation	1500.	
Annual rate depreciation	25%	$375.
Cost of body, etc.	100.	
Annual rate depreciation	10%	10.
Total depreciation: annual		385.
monthly		32.08
daily[1]		1.37

[1] 280 working days per year.

Table 22. Daily Operating Costs of Small Truck Delivering Bagged Grain Under Assumed Conditions

Fixed costs:		
Truck depreciation	$1.37	$1.37
Other fixed costs	1.00	1.00
Variable costs:		
Driver	2.37	4.74
Gas and oil[1]	.53	1.05
Other variable costs	1.00	1.00
Total operating costs:	6.27	9.16
Cost per mile:	.3135	.2290
Cost per ton:	3.135	2.290
Cost per ton mile:	.1570	.0572
Tons delivered per day:	2.0	4.0
Truck miles per day	20	40

[1] Gasoline mileage — 10 miles per gallon; oil consumption — 1 qt./400 mi.

With Figure 10 as a working basis some of the theoretical competitive aspects of the introduction of bulk delivery into an area can be explored. Suppose, for example, that Company A decides to buy bulk equipment and has arranged to shift over some of its largest customers to this method. If, for example, Company A now has 3 trucks equipped for delivering bagged feed and nearly maximum use is being made of these trucks the average delivery cost per ton for 40 tons daily $\left(\begin{array}{l} 2 \times 14 = 28 \\ 1 \times 12 = \underline{12} \\ \qquad\qquad\; 40 \end{array}\right)$ is $1.82. If 10 tons daily can be delivered in bulk (average delivery cost per ton — $2.32), then the 3 bagged trucks divide 30 tons between them (average delivery cost per ton for 10 tons — $2.15). Whereas, the average cost for all deliveries was formerly $1.82 per ton, it is now $2.19, per ton, i.e.,

New		Old	
10 x $2.32 =	$23.20	28 x $1.79 =	$50.20
30 x 2.15 =	64.50	12 x 1.88 =	22.60
40 x (2.19) =	87.70	40 x (1.82) =	72.80

Suppose, however, that Company A sells one of its trucks now used in bagged deliveries and is able to convert 16 tons to bulk, dividing the remainder between the two bagged trucks. Under such conditions the former average cost for all bagged feed delivery was $1.82 per ton, but the new arrangements would result in a new average cost for all deliveries of $1.73 per ton, i.e.,

New		Old	
24 x $1.88 =	$45.12	28 x $1.79 =	$50.20
16 x 1.51 =	24.16	12 x 1.88 =	22.60
40 x (1.73) =	69.28	40 x (1.82) =	72.80

In both of the preceding examples, equipment is used at relatively high efficiency. Use at less efficient rates would increase the likelihood that diseconomies would result from the superimposing of bulk feed delivery on top of an established bagged feed delivery system.

Any attempt to subdivide a given share of the market between two systems obviously will increase average costs in the short run. Thus, following the same approach as the preceding, any new firm entering a given market and taking customers away from the established firms because it offers bulk delivery may: (1) experience difficulty even in the short run in obtaining enough volume to cut its own costs to a reasonable level; (2)

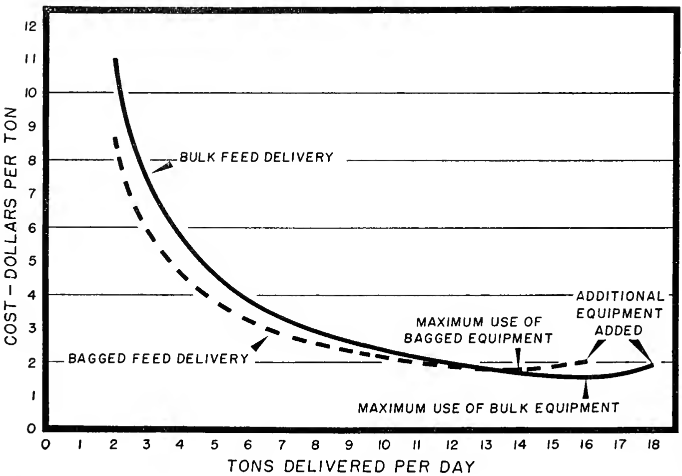

Figure 10. Average cost curves for bagged and bulk feed delivery under assumed conditions.

raise average delivery costs for the other firms. In order to keep customers, some of the other firms might also go into bulk, but their short-run position may turn out to be even worse than the new firm entirely on bulk or the established firms which do not go into bulk, inasmuch as they are split between two systems.

With the present alternatives of bagged or bulk delivery as used in this section, the long-run picture will be dependent upon whether full use can be made of either or both types of systems. In many areas of New Hampshire it would be difficult to carve out efficient bulk routes without going beyond the radius of feasible operation. In others, where efficient bulk routes and efficient bagged routes can be developed, average delivery costs could possibly be reduced in the long run.

An Alternative Method of Distributing Feed

A promising alternative intermediate between regular bagged or bulk delivery, lies in the development of a hopper-and-elevating mechanism attached to a base on the truck, and which can be placed in position for unloading by power rather than by hand. This would in effect be a combination method, making bulk feed available to those customers who want it, but permitting others who do not, or who have units of smaller size, to be served with bagged feed.

Such a method would eliminate handling of bags by the farmer, but would entail the opening and dumping of bags at the farm by the dealer's crew in instances where this is not now done in unloading bagged feed. However, it would be desirable and quite possible to sew bags in such a fashion that they could be opened more rapidly than is possible with some systems now in use. Bags could be taken back to the loading point without entering the farm grain storage area. Several companies have for some time been interested in a system of this general type to provide the option of bulk or bagged feed to their customers. It is likely that such a unit could be made considerably cheaper than conventional bulk bodies and mechanisms. However, units of this type which have materialized from years of development work still require two men. As such, they do not offer the potential economies which would exist if but one man could be used.

Using some of the time and cost data presented earlier, it is possible to make rough estimates of the cost effects of a combination system. In Table 23 there are presented estimates of the depreciation costs of such delivery equipment. Since knowledge about the truck chassis is limited the costs used are the extremes — bagged truck and bulk truck — and the midpoint. Suppose further that submitted with the specifications to the engineers is the provision that the body cost for the hopper-elevating unit shall not exceed $3,000. In terms of depreciation, therefore, the truck and unit cost will lie between those in Table 23 for regular bagged and bulk trucks.

Basic to realizing the full economies of the hopper-elevating method is the specification that it can be operated by one man. In the absence of data regarding operating time, it can be further assumed that the truck and mechanism can be readied for unloading at the farm in about the same time as with regular bulk units. So far as unloading time is concerned, actual unloading time per unit should probably not differ greatly from that for a conveyor (see Table 17), except that one man rather than two can do the job under our assumptions. If it is made easy for that one man to open bags, he should be able to open and dump a bag into the hopper in about the same time it would take him to lift a bag and place it on a conventional conveyor. For purposes of uniformity of analysis, let us assume further that the truck will be loaded by hand truck, and that one man would do the loading (as for regular bagged and bulk comparisons). In Table 13 it was observed that one man using a hand truck could unload a railroad car onto a truck at a rate of 0.20 man minutes per 100 pounds. But since the loading of a delivery truck might be more complex, 0.30 man minutes per 100 pounds has been used herein. Note that this rate is actually only slightly lower than was achieved in certain instances of efficient loading by hand.

In order to attempt to offset in part the time savings of gravity loading of regular bulk feed, it would probably pay to mechanize loading, perhaps to the extent of using a chute, conveyor, and additional men. This would not tie up the truck for as long as having one man do the loading, but the final decision would be based upon comparison of man minutes and truck time involved.

Table 23. Estimated Costs of Depreciation on Hopper-Elevating Delivery Truck

Item	Assumptions: Use of Bagged Truck Chassis (dollars)		Use of Bulk Truck Chassis (dollars)		Use of Truck Chassis Intermediate Between Bagged and Bulk (dollars)	
New cost chassis	4,000		8,600		6,300	
Less Trade-in value	1,000		2,600		1,800	
Cost for depreciation	3,000		6,000		4,500	
Annual rate depreciation	25%	750	25%	1,500	25%	1,125
Cost of body, etc.	3,000		3,000		3,000	
Annual rate depreciation	10%	300	10%	300	10%	300
Total depreciation:						
annual		1,050		1,800		1,425
monthly		87.50		150		118.75
daily[1]		3.75		5.36		5.09

[1] 280 working days per year.

Having outlined the assumptions of the analysis, they can be tested in two ways:

(1) Using the hopper-elevating system as a pure method, paralleling the calculations presented in Table 20 for regular bagged and bulk feed as pure methods. This will test the costs of the hopper-elevating method against the regular systems. (Hypothesis 3.)

(2) Since the hopper-elevating system offers greatest promise where there may be a mixture of bagged and bulk customers, but perhaps not enough of either to keep separate delivery units occupied at capacity, a second test can be made of average costs (see Figure 10). Here, for sim-

plicity, it is assumed that the customers and volume are divided 50-50 between bagged and bulk feed, except that loading will be done by one man using a hand truck. (Hypothesis 4.)

Under the first test, the same conditions can be used as under Hypotheses 1 and 2, and calculate time according to the delivery route formula and other assumptions previously stated:

Hopper-elevating truck:

Route miles, 40, 28 +

$$Rt = 95 + 1(20) + 1(1.0) + 100(.20) + 1(.025(0))$$
$$Rt = 118.0 \text{ min.}$$

$$Rt = 71 + 1(2.0) + 1(1.0) + 100(.20) + 1(.025(0))$$
$$Rt = 94$$

Thus, with the hopper-elevating method as a pure system, it appears from the preceding and succeeding calculations that the time requirements for a route of 40 miles and 5 tons would be less than with the regular bagged system, but more than those for the regular bulk system. In terms of full use of the truck and driver, it seems probable that with the hopper-elevating method, more miles and more tonnage would be indicated than with the regular bagged system, but less miles and less tonnage than with the regular bulk system. Admittedly, the precise values of miles and tons in Tables 20 and 24 could be varied with different combinations chosen, but herein the totals have been forced to equal 480 minutes, and an attempt made to stay within reasonable mileage and quantities. The particular mileages and quantities seem to work out rather conveniently in terms of the various time rates considered. The reconciliation to 480 minutes follows:

	Route Miles	Quantity per Load	Time per Route	Time per Route Adjusted for No. of Routes	Adjusted for No. of Routes: Loading Time	Office Time	Total Time
Hypothesis 3:	40	10,000	118.0	236.0	60.0	40.0	336.0
Hypothesis 4:	28	10,000	94.0	94.0	30.0	20.0	144.0
	108	30,000	——	330.0	90.0	60.0	480.0

Combining the time analysis with the depreciation estimates and estimates of variable costs other than labor results in the data in Table 24. Comparing these results, particularly cost per ton, with those in Table 20, indicate that for the 80 mile-10 ton calculations (Hypothesis 3) the hopper-elevating method is cheaper than bulk, but may be more or less than bagged, depending upon the truck chassis cost.

With full use of driver's time (Hypothesis 4), the hopper-elevating method appears cheaper than bagged, and may even be cheaper than bulk if the assumptions of the analysis hold and truck chassis can cost less than that for regular bulk equipment. If this be true, then the hopper-elevating method, operated efficiently by one man, would be an alternative well worth exploration.

Table 24. Daily Operating Costs of Hopper-Elevating Truck under Assumed Conditions

	Minimum Cost Unit	Maximum Cost Unit
		Hypothesis 3:
Fixed Costs:		
Truck depreciation	3.75	5.36
Other fixed costs	2.00	2.00
Variable Costs:		
Driver	8.40	8.40
Gas and oil	3.10	3.20
Other variable costs	2.60	2.70
Total operating costs	19.85	21.66
Cost per mile	.248	.271
Cost per ton	1.98	2.17
Cost per ton mile	.0248	.0278
Tons delivered per day	10.0	10.0
Truck miles per day	80.0	80.0
		Hypothesis 4:
Fixed Costs:		
Truck depreciation	3.75	5.36
Other fixed costs	2.00	2.00
Variable Costs:		
Driver	12.00	12.00
Gas and oil	4.18	4.32
Other variable costs	3.51	3.64
Total operating costs	25.44	27.32
Cost per mile	.236	.253
Cost per ton	1.70	1.82
Cost per ton mile	.0157	.0169
Tons delivered per day	15.0	15.0
Truck miles per day	108 +	108 +

To test the probable cost position of the hopper-elevating method where it is used for both bagged and bulk deliveries, it is assumed that in actual practice it is possible to mount the mechanism on a truck chassis intermediate in price between the regular bagged and bulk trucks. Implicit are the same conditions with respect to territory route mileage (80 per day), number of routes (2 per day), and complexity of routes (3 stops and settings each). Calculated delivery costs per ton for bagged, bulk, and the alternative method, where quantity is the primary variable, are presented in Table 25.

In Table 25 the alternative method shows up as intermediate in cost per ton between regular bagged and bulk methods through the 10-ton level. At that point it is equal to bagged delivery costs, but cheaper than the regular bulk method. At the 14-ton level, it appears to be characterized by the lowest per ton costs.

Route Income

Some feed companies appraise the efficiency of grain delivery routes by comparing the "net income" from the various routes. "Net income" is the difference between gross income from delivery charges and calculated costs. Gross income is calculated by: (a) multiplying the number of units delivered by a constant delivery charge per unit, or (b) totalling units times variable charges where delivery charges vary with quantity. Calculated costs are generally derived by adding equipment costs (mileage times an average per mile value for fixed and operating costs) and labor costs (driver and helpers' time at given rates per hour).

Such an analysis will aid to a degree in spotting some problem routes. However, without further analysis it does not show the comparison of each route with its potential efficiency. Use of estimated values for delivery charges would in itself bias conclusions reached about particular routes. It is felt that delivery charges per unit should evolve from cost analysis. Hence, it is suggested that time-breakdown studies are a better approach to studying route efficiency, and likely to yield more dependable results than the route income approach.

Table 25. Costs per Ton of Loading[1] and Delivering Feed by Alternative Methods, Assumed Conditions

	Tons Delivered								
Method	2	4	6	8	10	12	14	16	18
Regular bagged feed delivery	$8.61	$4.53	$3.20	$2.52	$2.15	$1.88	$1.79	$1.98	
Bulk feed delivery	11.00	5.58	3.77	2.87	2.32	1.96	1.70	1.51	1.58
Bagged feed: 50% unloaded by hand, 50% by hopper-elevating mechanism	9.83	5.17	3.48	2.68	2.20	1.89	1.66		

[1] Regular bagged feed loaded by one man by hand; bulk feed loaded by gravity from overhead bins; bagged feed loaded for combination method by one man using hand truck.

5. Handling Bulk vs. Bagged Feed

THE distribution of grain-feed in bulk has substantially increased since the method was introduced into New Hampshire a few years ago. As of December 1, 1952, it was estimated that about 3 percent of the total grain consumed in the State was delivered in bulk.* For 1953, it was estimated that the proportion was about 3¼ percent on an annual average basis. On the basis of data obtained during the early part of 1954, the annual average rate of bulk feed deliveries in 1954 probably exceeded 5 percent of total usage of grain-feeds in New Hampshire.

The development and operation of bulk feed distribution in New Hampshire to early 1954 was largely confined to the southeastern area of the State, in the counties of Hillsboro, Rockingham, Merrimack, and Strafford. This area offered the most fruitful field to convert present customers or obtain new customers in sufficient numbers to permit some of the economies of bulk feed to be realized.

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* Woodworth, H. C., *Handling Grain in Bulk on New Hampshire Poultry Farms*, N. H. Agr. Exp. Sta., Ag. Ec. Research Mimeograph No. 11, Jan. 1, 1953, p. 1.

Further extension of the conventional bulk delivery method, and the rate of that growth is dependent upon the size of the "potential market" and upon the evaluation made of the advantages and disadvantages by dealers and producers. Some dealers may add bulk service to follow the lead of competitors, rather than on the basis of expected savings. This section will discuss the "potential market" and the "pros and cons" of bulk feed from the dealer's standpoint.

The "Potential Market" for Bulk Feed

Considerable interest has been manifested by feed companies in the size of the "potential market" for bulk feed in New Hampshire. A gross evaluation of the "potential" can be obtained from examination of data on unit size distribution, but the attainable market for bulk feed at any one time will be smaller to the extent of a number of limiting factors.

Table 26 shows the numbers of farms, by unit size, having particular classes of livestock. Calculations with these data and per unit feed requirements indicate insufficient unit size and volume on a statewide basis to justify carrying bulk feed for hogs and sheep (Table 26). The same is probably true of horses and beef cattle. Indeed, carrying bulk feed for turkeys also might prove impractical in almost all instances because of the relatively small number of farms with minimum unit size justifying bulk feed delivery. The feed company concerned should count up the number of customers whose requirements meet its minimum delivery policy, and then

Table 26. Numbers of Farms Having Specified Livestock Classes, by Unit Size Intervals, New Hampshire, 1950

Type of Stock	Total	No. of Farms Reporting by Intervals					
			Under 10	10-24	25-49	50-99	100 and over
Cattle, all ages[1]	8,287		4,941	1,905	1,088	311	42
		Under 5	5-14	15-29	30-49	50-99	100 and over
Cows, including heifers that have calved[1]	7,843	4,503	2,005	1,039	242	48	6
Milk Cows[1]	7,585	4,342	1,954	1,005	235	47	2
		Under 100	100-399	400-799	800-1,599	1,600-3,199	3,200 or more
Chickens on hand[1]	6,973	4,283	1,080	627	428	167	108
Chicken eggs sold[1]	4,066	1,766	970	627	428	167	108
Turkeys raised[2]	306	189	56	33	9	19[5]	
		Under 5	5-9	10 and over			
Sows and gilts for spring farrowing[3]	542	431	64	47			
		Under 25	25-49	50-99	100-299		
All sheep and lambs[4]	348	298	34	15	1		

[1] Number on hand April 1, 1950
[2] Number raised
[3] Number reported
[4] Number shorn
[5] 1,600 and over

Source: 1950 Census of Agriculture

decide whether the aggregate justified tying up a bulk bin for the time needed to fill and unload it in the course of regular deliveries of grain-feed for that class of livestock (such as turkeys) and for other classes.

Thus, it appears that the "potential market" for bulk feed is limited in most areas to dairy cattle, laying hens, and chickens for replacement and/or meat. Even with these items there are areas where the number of units of desired size will be insufficient to justify bulk feed operations for one or more of the preceding classes of livestock. Hence the "potential market" for bulk feed for dairy cattle, laying hens, and chickens for replacement and/or meat is smaller than could be inferred from the data in Table 26 and per unit feed requirements, but the exact relationship cannot be stated in the absence of a comprehensive survey of the area served by each distributing unit. The existence of a number of sellers in each area further reduces the "potential" at least in the short run, the customers of sufficient size for bulk feed service being spread among these several sellers.

Data collected for southeastern New Hampshire in the course of route efficiency studies are interesting from the standpoint of suggesting the unadjusted "potential market" for bulk feed in one area. For 60 bagged and bulk delivery routes, 40 percent of the routes, or 24, were 1- and 2-stop routes. These routes involved only 7 percent of the total number of stops, but over 47 percent of the total tonnage. The average number of 100-pound units delivered on 1-stop bagged routes was 104.3; on 1-stop bulk routes, 128.2. On 2-stop bagged routes, an average of 62.5 100-pound units were delivered per stop; for 2-stop bulk routes, the comparable figure was 67.5. In general, these are the types of routes which would receive first consideration for conversion to bulk feed.

Data tabulated for 408 deliveries (stops) of grain-feed on bagged routes involved a total of 4,647 100-pound units. Deliveries of 40 bags (2 tons) or over, involved only 7.1 percent of the stops, but 48.2 percent of the total tonnage (see Table 27). Apparently, most of the large customers are supplied via 1- or 2-stop routes (regularly scheduled or on call). With deliveries of 20 bags (1 ton) or over, 13.2 of the customers and 61.7 percent of the tonnage were covered.

These data are totals for all units operating in the area. It is unquestionably incorrect to assume that the preceding data are indicative of the proportion of customers or tonnage it would be possible to convert to bulk feed for a number of reasons. It is known that the percentages should be reduced somewhat to account for the inclusion of several kinds of feed in some of the orders. Neither is the area covered in the data typical for other areas of the State.

Table 27. Analysis of 408 Deliveries of Grain-Feed in Southeastern New Hampshire

No. of 100-pound Bags per Delivery	Percent of Total Deliveries	Percent of Total Number of Bags Delivered	Average Number of Bags per Delivery
1- 3	46.9	7.2	1.74
4- 9	24.5	13.4	6.21
10-19	15.4	17.7	13.03
20-39	6.1	13.5	25.12
40-79	4.2	19.5	53.55
80 and over	2.9	28.7	111.42
	100.0	100.0	11.29

At this point it might be well to elaborate on a number of considerations which limit the size of the "potential market" for bulk feed aside from unit size and number of sellers. These are: (1) accessibility of farm and farm storage; (2) inclination of the producer or specifications of contractors or hatcheries; (3) feeding program followed; (4) feed company policy relative to size of minimum delivery; and (5) keeping characteristics of feed, i.e., determining frequency of delivery.

As previously noted, inaccessibility may exclude some farms from consideration for bulk feed delivery. A suggestion, attributed to J. C. Taylor, included the recommendation that a study of highway and farm driveway conditions should be the basis for determining the use of the new style of delivery, and the comment that a suitable truck road open the year round with at least a 12 foot clearance is a practical need.* Weight limits, width, overhead clearance, and seasonal variations in road and driveway conditions, as well as maneuvering room need to be taken into account.

Because of the heavier truck chassis required for the bulk feed body and unloading equipment, and the additional weight of those items themselves, the adoption of bulk feed delivery tends to increase tare weight. Use of aluminum bodies would help minimize this effect. If a customer taking 5 tons of feed per delivery is located on a road with a load limit of 8 tons gross weight, a truck of 2-3 tons empty weight could make the delivery. However, with a 3-ton truck chassis and a 2¼-ton bulk body and unloader, a load of 5 tons would gross 10¼ tons, or in excess of the road limit.

During the spring months many New Hampshire roads are virtually impassable due to mud. Hence, a customer normally receiving bulk service might need to be serviced by a small truck and with bagged feed for the duration of the difficult going. Such special arrangements are obviously less efficient than standardized operations, and coming in number at one time, might deter the introduction of bulk feed service to such units in the first place.

Under-emphasis by some farmers upon the building and maintenance of serviceable farm roads and driveways, which are frequently unsatisfactory for non-bulk delivery, would initially preclude them from being serviced by the heavier bulk feed delivery equipment. Somewhat more room is required for maneuvering bulk delivery equipment into position for unloading than is generally necessary for non-bulk delivery equipment. To provide adequate facilities with respect to the preceding might require cash outlay and/or time, rearrangement, building or rebuilding of a magnitude that a farmer would be unwilling or unable to undertake.

Some producers, whose farms are of sufficient unit size to warrant conversion to bulk feed, may not be inclined to make the move. As with most agricultural service innovations, the impetus to secure adoption rests largely with the supplier. Farmers generally have to be sold on the idea in terms of convenience or efficiency, but in the case of bulk feed or any other new method, requiring extensive building or remodelling, the presence of an additional incentive in the form of a substantial cash savings is a helpful inducement. However, matters other than bulk feed are likely to receive priority on some farms despite a convincing presentation of its merits.

A feed company may also find itself unable to extend bulk feed service to additional farm units because of the inclinations of and limitations im-

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* Benson, H. J., "Farm Delivery of Feed in Bulk," *Eastern Feed Merchant*, Jan., 1952, p. 67.

posed by broiler contractors or hatcheries with respect to brand of feed. feeding program, or installation of automatic feeders. Some broiler contractors appear opposed to the use of the latter because they want growers to work closely with their birds at all times and regard hand feeding as an integral part of the program. Hence, bulk feed coupled with mechanization, a strong selling point, cannot be pertinently suggested to the grower.

The type of feeding program which a producer follows on his own or under direction. bears directly upon the feasibility of extending bulk feed service to that farm. In general, the more complex the program — in terms of kinds of separate feeds used — the larger the unit size must be before bulk service can be used. For example, if it is proper to deliver about every two weeks, and the company's policy permits deliveries of not less than one ton of any one item at a time. then a producer feeding all-mash who has about 500 laying birds might qualify. However, with a mash-and-scratch program, and the same conditions of delivery. the flock would probably need to be twice as large.

Size of minimum delivery and frequency of delivery may be interrelated and thus are herein discussed together. The size of minimum delivery is partially a resultant of the equipment in use for loading, weighing, and hauling bulk feed. In weighing, it is impossible to stop the gravity flow on the exact figure every time. In the interests of efficiency the load may run over or under a few pounds. Below a ton, the same margin of error in pounds would become progressively greater percentagewise, and even though payment is on actual quantity, probably would be more troublesome to smaller than to larger producers. With most bulk trucks now in use in the State, bins hold about two tons each. It seems reasonable that one-ton deliveries be set as the minimum. though two is preferable from the cost standpoint. However, a few one-ton orders mixed in with larger orders would help keep the equipment operating close to capacity in many areas without too much additional outlay. The use of a one-ton minimum delivery in selected cases would not only help enlarge the "potential market", but would be within the quantitative discount breakdowns suggested earlier in the bulletin.

Frequency of delivery, as minimum delivery size, seems now to be largely a matter of company policy and/or opinion. As previously pointed out, controlled experimentation on the keeping characteristics of grain-feeds under New Hampshire farm storage conditions is needed. This work should concern itself with both bagged and bulk feed.

With producing stock (milk cows or laying hens), size of the animal and level of production introduce some variation into computations. In Table 29, however, a standard rate is used for milk cows, and variation for laying hens covers only a few levels of production. The latter. as well as body weight. actually effects only minor variation in laying flock calculations.

With growing stock. minimum unit size shifts with age, i.e., as feed consumption per unit increases. These shifts are obviously substantial (Table 28). However, if a company can justify very infrequent delivery for the first few weeks, or preferably, service with bagged feed, the minimum number of growing chickens needed to justify bulk feed service is rather low after that period. Hence, the bulk feed market could be enlarged. In practice, this adjustment on growing stock might involve the following:

(a) On farms where there is a laying flock:
  (1) bulk feed for layers
  (2) bagged feed for a few weeks for replacements carried on side racks of bulk truck
  (3) bulk feed for replacements after a few weeks.

(b) On farms where meat production predominates:
  (1) bagged feed for a few weeks out of the nearest store, and worked into regular routes
  (2) bulk feed after a few weeks.

Table 28. Cumulative and Weekly Feed Consumption for Selected Meat Chicken Flock Sizes

Week	Cumulative Feed Consumption (tons) Number of Birds			Weekly Feed Consumption (tons) Number of Birds		
	2,000	5,000	10,000	2,000	5,000	10,000
1	.2	.5	1.0	.2	.5	1.0
2	.5	1.25	2.5	.3	.75	1.5
3	1.0	2.5	5.0	.5	1.25	2.5
4	1.6	4.0	8.0	.6	1.5	3.0
5	2.4	6.0	12.0	.8	2.0	4.0
6	3.3	8.25	16.5	.9	2.25	4.5
7	4.4	11.0	22.0	1.1	2.75	5.5
8	5.6	14.0	28.0	1.2	3.0	6.0
9	7.0	17.5	35.0	1.4	3.5	7.0
10	8.6	21.5	43.0	1.6	4.0	8.0
11	10.3	25.75	51.5	1.7	4.25	8.5
12	12.2	30.5	61.0	1.9	4.75	9.5
13	14.2	35.5	71.0	2.0	5.0	10.0
14	16.4	41.0	82.0	2.2	5.5	11.0
15	18.8	47.0	94.0	2.4	6.0	12.0
16	21.3	53.25	106.5	2.5	6.25	12.5
17	23.8	59.5	119.0	2.5	6.25	12.5
18	26.2	65.5	131.0	2.4	6.0	12.0
19	28.5	71.25	142.5	2.3	5.75	11.5
20	30.8	77.0	154.0	2.3	5.75	11.5

In conclusion, it might be well to point out that the trend toward larger units will progressively enlarge the "potential market" for bulk feed, other things remaining equal. Also, any appraisal of the current situation relates to equipment, methods and conditions now in existence, and new innovations that will have their impact on this issue.

Advantages and Disadvantages to the Dealer

Bulk feed, where it can be introduced within the conditions set forth in the preceding section, results in simplification of the marketing channels for grain-feeds. In Figure 11 there are diagrammed the steps involved in the marketing of grain-feeds in New Hampshire, as observed in the study. In some other areas, bulk feed is shipped in railroad cars and at destination stored in bins or taken off directly onto trucks, but that method had not yet made its appearance in the State at the time of writing. Here, bulk feed thus far moves mostly directly from mill to producer via truck, except in some instances where bagged feed is emptied into bulk trucks in the absence of local milling of a particular brand. With the method of bulk handling predominant in New Hampshire, several operations are eliminated as compared to the most common method of handling bagged feed.

Not all of the advantages and disadvantages of bulk feed can be ascertained with reference to such a marketing channels chart. Cases in point relate to plant and equipment costs.

Obviously, the cost of facilities at the mill to handle bulk feed will vary with volume. The system may be installed rather simply in new mills, but costs of remodelling some of the older mills may be considerable.

One source reported a range of $1,300-35,000 in costs of converting mills to accommodate bulk feed.* Another study reported data for 3 mills, with a range in costs of installing bulk facilities of $11,821-55,000.† Annual charges for these mills ranged from $2,100-6,150, and costs per ton, with bulk volumes at that time from $117-493. The same study reported little additional investment for a New England mill which installed a by-pass from the second floor to divert feed from the sacking scale out through the side of the mill to a spot where trucks were loaded. Here, bulk feed was available by appointment only and had to be hauled in farmers' trucks or by local haulers.

Table 29. Number of Animal Units Required for Minimum Deliveries of Bulk-Feed under Assumed Conditions

Class of Livestock	Every Week 2 tons	Every 2 Weeks 2 tons	Every 3 Weeks 2 tons	Every 4 Weeks 2 tons
		Number of Head		
Milk Cows[1]	108	54	36	27
Laying Hens[2]				
30% production	2,041	1,020	680	510
50% "	1,905	952	635	479
70% "	1,786	893	595	446
Commercial Meat Chickens[2]				
1 week old	20,000	10,000	6,667	5,000
2 weeks old	13,333	6,667	4,444	3,333
3 " "	8,000	4,000	2,667	2,000
4 " "	6,667	3,333	2,222	1,667
5 " "	5,000	2,500	1,667	1,250
6 " "	4,444	2,222	1,481	1,111
7 " "	3,637	1,818	1,212	909
8 " "	3,333	1,667	1,111	833
9 " "	2,857	1,429	952	714
10 " "	2,500	1,250	833	625
11 " "	2,353	1,176	784	588
12 " "	2,105	1,053	702	526
13 " "	2,000	1,000	667	500
14 " "	1,818	909	606	454
15 " "	1,667	833	556	416
16 " "	1,600	800	533	400
17 " "	1,600	800	533	400
18 " "	1,667	833	556	416
19 " "	1,739	869	580	434
20 " "	1,739	869	580	434

[1] 1930 pounds of grain per cow annually, Table 3.
[2] Rates of consumption from: Frick, G. E., and W. K. Burkett, Farm Management Reference Manual, University of N. H. Ext. Service and BAE Cooperating, Ext. Circ. 307, Sept., 1953, p. 17.

* Benson, H. J., *op. cit.*

†Rickey, L. F., *op. cit.*, p. 6-7, 16, 19, 22.

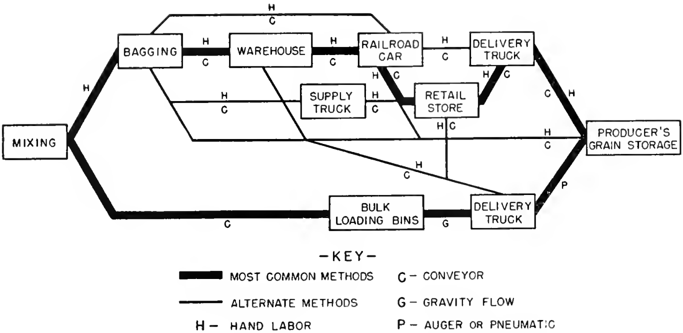

Figure 11. Handling grain-feeds in New Hampshire from mill to producer's grain storage.

The additional costs of the equipment for delivering bulk feed are substantial, i.e., from $3,000-6,000 for a mechanized bulk delivery body plus an additional cost for a heavier truck chassis.* In addition, costs of maintaining this equipment are likely to be higher than with bagged trucks. Maintenance problems involve specialized knowledge, possibly not available locally. Temporary breakdowns of bulk equipment may also involve the additional costs of securing replacement trucks, sometimes from considerable distances away, while repairs are made.

It would appear that the weight of evidence points to the existence of economies in handling grain-feeds in bulk as compared to bags. However, the stage of development of bulk distribution, the area, the particular company involved, and the extent to which the "potential market" can be and has been exploited, all affect the individual case. It is to be expected that in the early stages of development average costs are likely to exceed those for the long-established method. From this situation it may appear, as frequently contended, that "two methods cost more than one". But this may be a phenomenon of the short-run rather than the long-run, when adjustments have been made to bring both methods toward maximum efficiency. Obviously, this end result might come about only after rather drastic changes in capital and organizational structure of the particular company. As with the situation on delivery route costs, a newer company might have fewer overall problems to solve than an older company where vested interests and traditional methods pose formidable obstacles.

Some of the factors which presently appear as advantages and disadvantages in the matter of bulk vs. bagged feed are summarized below.

* Benson, H. J., *op. cit.*

	Advantage	Disadvantage
At the Mill:		
Investment in facilities		Unless the unit is to handle bulk feed only, there is likely to be a net increase in investment in plant facilities (bins, conveyors, scales).
Bagging	Operation eliminated. A probable saving of the time of one man for that volume handled in bulk.	
Transfer to storage	Grain transferred to storage bins mechanically. Net saving in labor, i.e., two men used to hand-truck bagged feed to storage section.	
Loading	Under proper conditions driver can load, but there may also be a dispatcher-weigher to assist. With bagged feed, two or more men may be used in loading, plus a dispatcher. Net saving in labor of at least the time of one man. Also, an additional saving in man minutes for the individuals involved, since bulk feed can be loaded faster than bagged feed under proper conditions.	
Delivery Routes:		
Investment in equipment		Depreciation on bulk equipment 2-3 times greater than on bagged equipment.
Equipment maintenance		Higher cost on bulk equipment. Repair involves specialized knowledge. Replacement trucks may have to be secured from considerable distance.
Labor	Bagged routes where more than one man has been used, can be served with bulk equipment using one man except where farm deliveries are difficult. Because bulk feed can be unloaded faster than bagged feed under proper conditions there is an additional net saving in man minutes for the individuals involved.	
Aggregate delivery costs	Potential savings when equipment used near capacity. Can deliver more bulk feed than bagged feed in working day.	Probably higher under present rates of usage in most instances.
Tare weight of equipment		Probably increased with bulk equipment. May preclude some farms from regular service in bulk.

	Advantage	Disadvantage
Other:		
Sales arguments	Lower cost to farmer; eliminating potential disease hazard from used bags; grain dealer saves farmer some chore time, with auxiliary equipment farmer can save substantial amounts of time; bulk feed may be fresher — dealers claim it is not held as long.	
Mixed orders		Bulk not adapted to situations where small-to-medium-sized units require several different types of feed.
Labor relations	Bulk feed eliminates most lifting — this will appeal to many workers. Can use older men when necessary.	
Grain bags	Bulk feed eliminates necessity for procurement; arrangements for handling used bags; and complaints about grading of used bags. Eliminates bag loss in dealer's storage.	
Pollution of grain	Possibility of somewhat less loss of feed through pollution by rats and mice with bulk feed.	
Established retail outlets and dealers		Bulk feed service may by-pass existing outlets and dealers, violate agreements on trade areas. May take the largest customers. May need additional servicemen to replace service furnished by local outlets and dealers. Short-run cost problems because of investment in present distribution setup for bagged feed.

In the early stages of the development of bulk feed handling in the East, a number of mechanical and technical problems (rather than the preceding tabulations which are predominently economic problems) were cited rather frequently as drawbacks to the new method. These related to bin construction (new feed drawing through and clogging of bins); uniformity of mixtures (feared separation of various-sized particles in storage and hauling); tagging and weighing (feared inaccuracies); and others of this type. However, these matters were rapidly resolved, and do not pose serious objections today toward extension of the bulk handling method.

Conclusions

IN the 1955 Census of Agriculture there is ample evidence of a decline in numbers of farms and an increase in unit size. Fewer small units to service should contribute toward increasing the efficiency of retail distribution.

Relocations and consolidations of retail feed stores are continually in evidence. Determining optimum locations and areas to be serviced from each is a matter of regular concern to feed companies. Much can be done by these companies in the locational area as well as on delivery route rearrangement and efficiency. Further economies could undoubtedly be realized by establishing an exclusive territory system if the institutional framework of the industry permitted.

Further work is needed on the relative efficiencies of delivering feed by auger-type bulk trucks, pneumatic-type bulk trucks, and the hopper-elevating attachment on regular bagged trucks. Each of these, as well as delivering feed in bags, may be the least cost method under different situations.

Larger farm units will accelerate the swing toward bulk feed. Farm bin plans can be developed for several typical situations, but the variation in farm layouts requires modification before most of them could be used for construction.

Recent changes in bulk feed pricing are indicative of a shift from the "incentive discount" toward a discount more nearly reflecting actual savings.

Further work is needed on the keeping characteristics of feeds under farm conditions. This is closely linked to the determination of frequency of delivery and may well vary seasonally.

DATE DUE

NOV 4 '64	
MAY 19 '65	
Sept 29	
OCT 23 '68	

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