Bulk Distribution of Fertilizer and Lime in the Northeast

BY WARREN K. TROTTER

FARMER COOPERATIVE SERVICE,
U. S. DEPARTMENT OF AGRICULTURE

Based on experience of affiliates of Cooperative G.L.F. Exchange, Inc., Ithaca, N. Y.

General Report 24

September 1956

FARMER COOPERATIVE SERVICE
U. S. DEPARTMENT OF AGRICULTURE
WASHINGTON 25, D. C.

Joseph G. Knapp, Administrator

The Farmer Cooperative Service conducts research studies and service activities of assistance to farmers in connection with cooperatives engaged in marketing farm products, purchasing farm supplies, and supplying business services. The work of the Service relates to problems of management, organization, policies, merchandising, product quality, costs, efficiency, and membership.

The Service publishes the results of the studies; confers and advises with officials of farmer cooperatives; and works with educational agencies, cooperatives, and others in the dissemination of information relating to cooperative principles and practices.

CONTENTS

FINDINGS

Farmer Cooperative Service recently made a study of operating practices, costs, and equipment used by Cooperative G. L. F. Exchange, Inc., Ithaca, N. Y., and its affiliates in distributing fertilizer and lime in bulk. Findings of this study can be useful to farmer-directors and managers of cooperatives and others that now provide or plan to provide a bulk distribution service for farmers. Principal findings which relate to farm conditions, equipment, and economics of operation follow:

Farm Conditions

1. Fertilizer and liming practices and type of farming. --A bulk distribution service is mainly used where large amounts of lime or dry fertilizer are broadcast on the soil. Rates of application should be sufficient to permit uniform spreading and economical operation. In G. L. F. territory broadcast applications of lime and fertilizer were applied to all types of crops, including pasture, hay, small grain, row crops, and orchard crops. In other areas, however, broadcast application of fertilizer for row crops may not yet be accepted.

2. Size of farms and fields. --Individual farms must use sufficient fertilizer at one time to permit purchases in bulk truck loads. Small fields increase costs of hauling and spreading.

3. Weather, soil and topographic conditions. --Weather and field conditions present major obstacles to efficient operation. Rain, wind, and wet soil conditions may cause equipment to remain idle even during the heavy spreading season. Morning spreading of fertilizer is often prevented because of heavy dew on grass or crops. Rough terrain and steep slopes also hamper operations in certain areas, increasing repair and operation costs. Rocks slow operation and may damage equipment.

It is important that the driver be familiar with soil conditions and capabilities of his truck. Operations in wet weather may be limited to fields on high ground with good drainage.

Road conditions were not a major problem for G. L. F., although several managers said a few bridges in their territory had to be avoided with full loads because of weight limitations.

4. Soil compaction. --Soil compaction presents a problem, particularly with plowed or wet ground. Several G. L. F. managers reported receiving complaints from farmers on soil compaction, but they believed such damage was not as great as most farmers seemed to think. In fact, one manager stated that tests had shown compaction from a 10-wheel truck was no greater than that from an ordinary farm tractor.

G. L. F. has made considerable progress in reducing the amount of soil compaction by (1) shifting to 10-wheel trucks, and (2) reducing the number of trips across a field by increasing the width of spread. Early spreaders had widths of 16 to 25 feet compared to 75 feet for the latest equipment using moist lime. Use of granulated fertilizer makes possible a wider spread--80 to 100 feet compared to 24 feet for conventional powdered fertilizer and hoods.

G. L. F. drivers also were instructed to adjust their load to soil conditions so as to further reduce compaction. One manager stated that complaints were tied to the use of

extra heavy trucks. Most G. L. F. trucks, however, were of medium weight as they seemed to be more satisfactory than either the heavier or the lighter trucks.

Equipment

1. Trucks. --In an area comparable to that served by G. L. F., trucks of medium weight with tandem-axle drive will probably be most satisfactory. This cooperative found operating costs higher on light trucks because of low-gear operation and high repair costs. Heavy trucks brought more complaints of soil compaction. Single-rear-axle trucks were unsatisfactory because of too little traction and flotation. Under different soil and topographic conditions, however, a single rear axle may be all that is needed.

2. Equipment on trucks. --Having the right equipment is half the battle. G. L. F. improved the quality of their service by installing (1) an auxiliary motor to drive fans at constant speed, (2) a conveyor chain synchronized with wheel speed, (3) three-speed transmission for conveyor chain, (4) large-diameter fans, (5) adjustable fan blades to compensate for different characteristics of materials handled, (6) adjustable plates to control flow of material onto fans, and (7) tachometer for checking fan speed.

3. Uniformity of spreading. --Rate of application and type of equipment influence spreading. G. L. F. has devoted a great deal of time and money to improving equipment for their fertilizer spreading services. However, several G. L. F. managers indicated they still had difficulty getting uniform spreading with rates of fertilizer application below 400 to 500 pounds per acre. Some stated they would apply fertilizer at rates lower than these, but they did not guarantee uniformity. G. L. F. 's recent use of granular fertilizer has made possible a more uniform spread at lower rates of application because of greater width of spread and a more free flowing material.

At the time of the FCS study, G. L. F. was using 163 trucks in bulk distribution. Of these 97 were tandem-axle, 37 were army 6X6's, and 29 were standard.

4. Maintenance of equipment. --Next to tonnage handled, low repair cost for equipment is probably the most important factor in successful operation of a bulk hauling and spreading service. Good preventive maintenance is necessary to keep this cost at a minimum. Corrosion is serious in fertilizer spreading. Sulphates attack copper, the chlorine in potash attacks iron, and phosphorous attacks aluminum. In addition, fertilizer gathers moisture which causes short circuits.

Some maintenance practices in addition to routine lubrication and servicing that need special emphasis are (1) frequent cleaning of engine and spreader body, (2) testing and replacing brake and fuel lines, (3) replacing stop and signal lights and wiring, (4) oiling conveyor chain, and (5) frequent painting.

5. Driver selection and training. --G. L. F. preferred truck operators with a farm background because they were more familiar with soil conditions. If the operator was not alert, variation in physical condition of the material, lumpiness, and improper settings might cause inaccurate applications or damage equipment. G. L. F. recommended that drivers have a week of intensive training by a qualified operator.

Economics of Operation

1. Lime, fertilizer, or both? --A service including both lime and fertilizer makes for more efficient use of labor and equipment.

2. To own or to contract spreaders? --G. L. F. preferred to do its own hauling and spreading. Advantages to farmers of this practice were the dependable service resulting from adequate equipment and replacement of equipment when needed. Local G. L. F. managers were not in a position to provide necessary direction and leadership to outside haulers. At the same time, any contract which required, or resulted in, exclusive performance for the cooperative caused the contractor to be considered an employee for

purposes of workmen's compensation and personal and property damage liability where insurance of the contractor was insufficient.

3. Type of distribution service dependent on economies in transportation. --G. L. F. retail outlets handling bulk lime used three main operating methods: (1) Direct plant-to-farm operation of spreader trucks, (2) field spreader operation using dump trucks to haul lime from plant to farm and then self-loading spreader trucks, and (3) local stockpile operations with spreader truck hauling lime from local stockpile to farm and spreading it.

At service stores within 30 miles of the lime or fertilizer plant G. L. F. generally operated a direct plant-to-farm service. At stores from 30 to 75 miles from the source of material, either a field spreader or local stockpile type service might be offered. Within this latter range dump trucks generally were used to haul material to the local stockpile or farmer's field. At points beyond 75 miles from the plant, rail transportation of lime to stockpiles was found more economical. For bulk fertilizer transport, G. L. F. used trucks almost exclusively.

4. Location of equipment. --G. L. F. has found it better to locate two spreader trucks in separate communities within their service area rather than to put both trucks at one agency to serve the same area.

5. Volume. --Tonnage is the key to successful operation. G. L. F. experience indicated their breakeven point was between 2,500 and 3,000 tons of lime and 1,000 to 1,500 tons of fertilizer annually per truck. One ton of fertilizer is approximately equivalent to three tons of lime. These standards are based on large volumes by G. L. F. --in fiscal 1954-55, it distributed in bulk 381,340 tons of lime and an estimated 25,000 tons of fertilizer. These tonnages were substantially all the lime and about 11 percent of the fertilizer distributed by G. L. F.

6. Seasonality of demand. --Idle equipment during a large part of the year and frenzied overtime activity during a short period increase costs to the farmer. The highly seasonal nature of demand for spreading services was the major problem of most G. L. F. managers. Demand for both lime and fertilizer came in a relatively short period during the spring planting season.

G. L. F. managers agreed there was urgent need to develop summer and fall volume for both fertilizer and lime. They had made some progress toward this end--especially in increasing summer volume of lime. It appeared that this was essentially an educational problem as there is no particular agronomic advantage to spring application of lime. It can be applied anytime during the rotation with equally satisfactory results. But several G. L. F. managers said many farmers believed they needed to apply lime at the time grain was planted.

7. Costs of operation. --Costs of trucking and spreading for direct plant-to-farm operations at 15 local retail outlets in 1953-54 averaged $2.65 a ton. At 17 local retail outlets in 1954-55 the cost was $2.84 a ton. This cost varied from an average of $3.45 a ton at points handling under 3,000 tons per truck to $2.17 a ton at points handling 4,000 tons and over per truck.

At 24 stores having bulk lime stockpiles, costs for trucking from stockpile to farm and spreading averaged $2.24 a ton in 1953-54 and $2.26 a ton for 23 stores in 1954-55. This cost varied from an average of $2.92 a ton at points handling under 3,000 tons per truck to $2.05 a ton at points handling 4,000 tons and over per truck.

Costs of hauling and spreading approximately 12,000 tons of bulk fertilizer by four fertilizer plants in the study averaged $5.74 a ton. Such costs were much higher than those at local outlets having direct plant-to-farm operations because these four plants spread only fertilizer. Their volume per truck was about one-third of that at local outlets

spreading both lime and fertilizer. More care also was taken in spreading fertilizer because of its higher cost per ton, lower rates of application, and emphasis on a uniform spread.

Wages and salaries accounted for approximately one-third the cost of distribution from the four fertilizer plants and depreciation accounted for about one-fourth of the total. Other expenses including insurance, taxes and unclassified items accounted for almost 6 percent of the total.

8. Inventory control. --Inventory control may be difficult in stockpiling operations because of dust loss with lime or gathering of moisture by fertilizer. Caking of fertilizer may result if turnover is not sufficiently rapid. The more formulas stocked, the slower the turnover and the higher the cost. At the same time, a limited number of grades stocked does not allow for much flexibility in fitting fertilizer grades to specific soil requirements. Local bulk blending plants as developed in the Midwest have an advantage over mixed fertilizer stockpiles in this respect.

Grades and quantities of fertilizer demanded also change with the season. This may cause inventory problems if care is not taken in analyzing the market before ordering supplies.

9. Other problems. --Other problems include (1) small orders, (2) customers, not knowing what the truck will do, may allow grain or alfalfa to become too high before ordering, and (3) no one at home when truck arrives at farm. It is always advisable to make sure the farmer will be at home or otherwise get directions on location of field and rate of application before leaving the plant or retail store.

BULK DISTRIBUTION OF FERTILIZER AND LIME IN THE NORTHEAST

Based on Experience of Affiliates of Cooperative Grange League Federation Exchange, Inc., Ithaca, N. Y.

By Warren K. Trotter
Farm Supplies Branch
Purchasing Division

Declining farm prices have emphasized the need and the desire among farmers to reduce production costs. Fertilizer and lime account for an important part of these costs. Bulk distribution of these items, by eliminating bagging and reducing handling costs, offers an opportunity to reduce farm expenditures.

Because many farmers do not have and cannot afford facilities for storing and handling fertilizer and lime in bulk, a spreading service is an important feature of a cooperative bulk distribution program. By patronizing such a service, the farmer avoids an investment in equipment operated only a few days of the year and eliminates an unpleasant farm job. For these reasons, more and more farmers are turning to their supply cooperatives to take advantage of the economies offered by bulk distribution and spreading.

Such services for lime became popular in the late 1930's after the Agricultural Conservation Program brought about greatly increased use of this material. Scarcity of labor during World War II gave stimulus to bulk delivery and spreading service for fertilizer, but only in the past few years has this service become a common practice among farm supply cooperatives.

Bulk distribution programs have developed along different patterns in different areas. Many of the methods and practices employed are temporary or experimental in nature. In some instances the fertilizer program has been integrated with lime hauling and spreading programs. In others it has developed independently. In the North Central States, local bulk blending plants for fertilizer materials are being established to serve relatively small areas. These small plants permit direct plant-to-farm operations and adaptation of mixes to specific soil and crop requirements. In the East, one large regional cooperative has supplemented its fertilizer program with the use of multihopper spreaders. These machines, in essence, perform the mixing operation as the material is applied to the field. In other instances, facilities for bulk handling and spreading have been provided as adjuncts to existing manufacturing facilities. In areas near the lime or fertilizer plant, direct plant-to-farm operation of the spreader truck is common. More distant areas may be served from local bulk depots or stockpiles of lime and mixed fertilizer.

A bulk distribution and spreading program fits well into the general patterns of fertilization practices and types of farming in G. L. F. territory. Small grain, hay, and pasture crops are important in most sections of the territory and broadcast applications are generally accepted for these crops. Vegetable crops are important in southern New Jersey, and receive a large part of the bulk fertilizer spread in that area, mostly as a preplanting application. In the potato area of Long Island, however, fertilizer is usually applied at planting time, and broadcast application does not fit well into this program. In the Hudson Valley and Lake Plains area of New York State, a bulk distribution service is well adapted to orchard crops.

Note: The writer wishes to express appreciation to officials of Cooperative G. L. F. Exchange, Inc., for providing information for this report.

PURPOSE AND METHOD OF STUDY

The purpose of this report is to provide information on equipment, operating practices, costs, and other factors. Such material will enable farmer cooperatives and others to provide for their farmer patrons an effective and efficient bulk fertilizer and lime delivery and spreading service. In addition, it endeavors to point out effects and benefits, if any, of such a service in (1) lowering production costs, (2) reducing labor requirements of the farmer, (3) helping improve farm fertilization practices, and (4) facilitating more efficient fertilizer manufacturing plant operations.

This report deals with the bulk distribution program of the Cooperative G. L. F. Exchange, Inc., Ithaca, N. Y. This organization, hereafter referred to as G. L. F., has distributed lime in bulk and spread it for patrons for some 20 years. It has been one of the pioneers in this field. Success with lime led to development of a bulk distribution program for fertilizer. Of special interest is the way in which lime spreading equipment has been adapted to the more exacting requirements of fertilizer spreading.

Because of G. L. F.'s experience and its detailed and uniform operating records, a report on its bulk handling and spreading program should be of benefit to cooperatives and others throughout the United States interested in a bulk distribution service.

Plans for conducting the study on which this report is based were made with the Director of Research and the operating personnel of G. L. F. Complete operating statements on bulk fertilizer and lime hauling and spreading were available from the G. L. F. Service Agencies Division on 54 service points in 1953-54 and 56 points in 1954-55. These data pertained only to those points where G. L. F. service stores owned and operated the spreading equipment.

These data are analyzed in a subsequent section to show costs for different types of operations and the influence on costs of volume per truck. The Service Agencies Division did not maintain operating records on contract or agent-buyer operated points.

This report considers fertilizer and lime separately wherever feasible. However, it was not possible to do this in analyzing costs at retail points because the same trucks were used for both fertilizer and lime and costs were not separated.

Detailed information on equipment and operating practices was obtained by personal interview from 13 service points, including 3 fertilizer plants. These points were selected with the aid of G. L. F. operating personnel to represent different types of operations and farming areas found in G. L. F.'s 3-State territory.

Within this territory different situations exist in types of farming, fertilization practices, and distances from sources of supply. For example, Southern New Jersey is an important vegetable farming area with high rates of fertilization and relatively level topography. Central New York, on the other hand, is an important dairy and poultry area with rather moderate rates of fertilization and rough topographic conditions.

Operating practices used in the G. L. F. bulk distribution program varied with the distance from sources of supply. At service points near supply sources the spreader truck could be used to haul material from fertilizer or lime plant. At more distant points, bulk lime and fertilizer were stockpiled. That is, supplies of lime and mixed fertilizer were hauled in bulk to local distribution points by rail or truck and stored there until sold to patrons.

G. L. F.'s FERTILIZER AND LIME PROCUREMENT AND DISTRIBUTION SYSTEM

A few highlights of the G. L. F. distribution system and its source of fertilizer and lime are first presented as background information for this report.

On June 30, 1955, G.L.F. had 640 affiliated retail outlets consisting of the following types:

Types of retail outlets	Number
G.L.F. retail service stores (including 5 full branches and 3 zero food branches)	245
G.L.F. agent-buyers	277
G.L.F. retail petroleum cooperatives	69
Independent local cooperatives	24
Supplementary agents	18
Farmer agents	7
Total	640

Source: Mather, J. Warren and Scearce, Jane L. "Handbook on Major Regional Farm Supply Cooperatives, 1953 and 1954". U. S. Farmer Cooperative Service. June 1955. Page 2.

The retail service stores and petroleum cooperatives were cooperative corporations managed by G.L.F. However, policies were in large measure controlled by their elected member committees. Agent-buyers were private business operators who had been granted franchises to handle G.L.F. farm supplies in accordance with the association's policies. The independent local cooperatives were locally controlled farmer cooperatives handling G.L.F. farm supplies on the same basis as agent-buyers. Supplementary agents were merchants, or others, who handled certain G.L.F. products such as fertilizer or seed but not the complete line.

To serve these various retail outlets with fertilizer, G.L.F. owned warehouse and manufacturing facilities at strategic points throughout its territory. Among these were 13 fertilizer mixing plants--8 in New York State, 4 in New Jersey, 1 in Pennsylvania. It was also part owner, along with two other regional cooperatives, of a plant at Baltimore, Md. Figure 1 shows locations of G.L.F.'s fertilizer plants, sources of lime, and retail points where spreading services are offered.

G.L.F. obtained its lime supplies principally from 20 independently owned and operated stone quarries and lime plants located throughout its territory and adjacent areas. Of these, 13 were in New York State, 2 in New Jersey, 2 in Western Massachusetts, 1 in Eastern Ohio, and 2 in Eastern Pennsylvania.

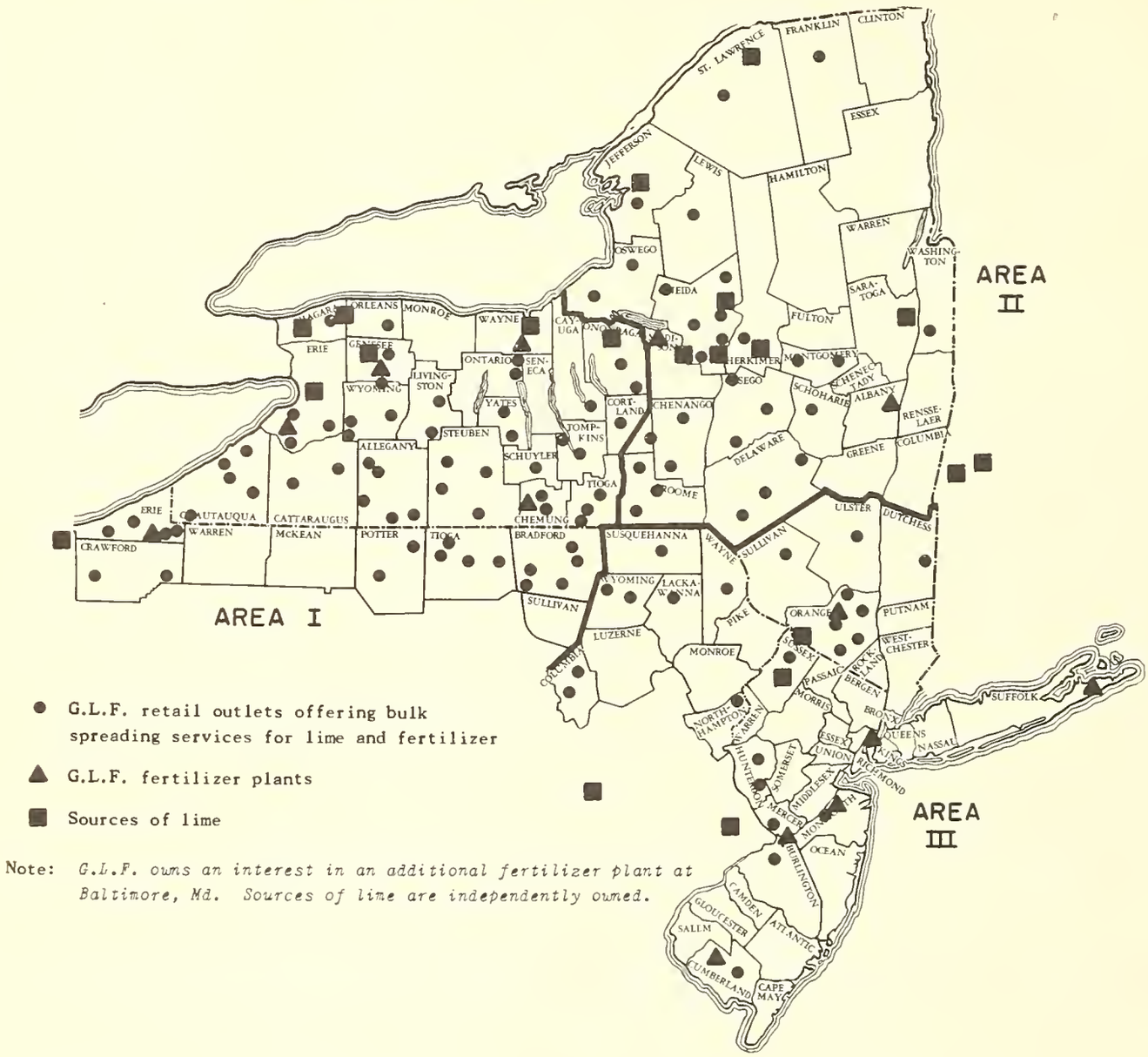
G.L.F. offered bulk delivery and spreading services at 105 retail outlets and 4 fertilizer plants located at strategic points throughout its trade territory. A total of 163 spreader trucks were operated at these points--12 of them at the 4 fertilizer plants.

The spreading service at one location might serve several retail outlets. The service might be owned and operated either by the service store or agent-buyer, or provided under contract with an independent operator. The types of ownership and operation of equipment at the 105 retail outlets were as follows:

Owner and operator of equipment:	Number of retail outlets
G.L.F. service stores	57
Contract operators	34
G.L.F. agent-buyers	14
Total	105

Figure 1

Locations of G.L.F. retail outlets offering bulk spreading services for fertilizer and lime, fertilizer plants and sources of lime, May 21, 1956



G.L.F.'s Service Agencies Division supervised hauling and spreading operations at retail points. Operation at fertilizer plants were the responsibility of the Association's Soil Building Division. This division also was responsible for purchasing and controlling quality of fertilizer and liming materials, engaging in research and development of improved spreading equipment, assembling new equipment, and counseling with the Service Agencies Division and local outlets on matters relating to the Agricultural Conservation Program.

VOLUME OF BULK LIME AND FERTILIZER DISTRIBUTED

G. L. F. Soil Building Division records indicated the volume of lime hauled and spread at all points during the 5 fiscal years ended on June 30, 1955, as follows:

Year	Tons
1950-51	274,951
1951-52	325,410
1952-53	333,105
1953-54	305,900
1954-55	381,340

A complete record of the volume of bulk fertilizer delivered and spread at all points was not available. However, the volume spread by the 4 G. L. F. fertilizer plants offering this type service for the 5 years ended June 30, 1955, follows:

Year	Tons
1950-51	7,519
1951-52	10,734
1952-53	13,006
1953-54	12,552
1954-55	11,168

G. L. F.'s Service Agencies Division records on bulk distribution of fertilizer through service-store operated points showed the following volume for the 2 years ended June 30, 1955:

Year	Tons
1953-54	7,963
1954-55	7,584

Records were not kept on bulk fertilizer distributed at contract and agent-buyer operated points, but their bulk volume each of these 2 years was estimated to be around 5,000 tons. This brought the total bulk fertilizer for all points to approximately 25,000 tons a year for each of the 2 years which represented about 11 percent of G. L. F.'s total fertilizer volume.

TRUCKS AND EQUIPMENT USED

The latest equipment used by G. L. F. in their bulk distribution and spreading operations was a product of 20 years experience in hauling and spreading lime and around 10 years experience with fertilizer. From the beginning continued improvements were made to obtain greater economy of operations and better quality service.

Trucks

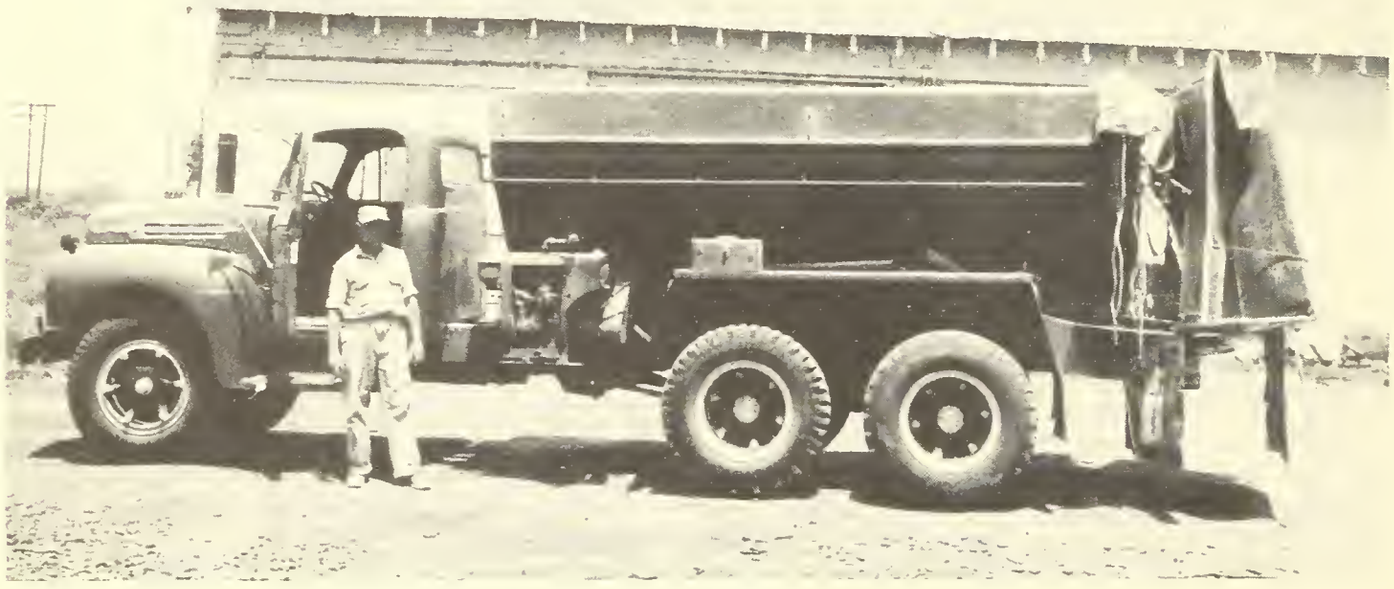
At the time of the study, three types of trucks were being used by G. L. F. in lime and fertilizer trucking and spreading operations. These were (1) army 6X6 trucks, (2) tandem-drive trucks of various makes, and (3) standard trucks. Of 151 trucks operated at retail service points in the summer of 1955, 37 were army 6X6 trucks, 85 were tandem-drive trucks, and 29 were standard trucks (single rear axle). All 12 spreader trucks G. L. F.'s Soil Building Division operated at 4 fertilizer plants were tandem-drive.

Army 6X6 [1]

These trucks had one front and two rear axles all driven by the motor. They were mounted with spreader bodies and were used primarily for field spreading after the material was delivered to the farm by standard dump trucks. When equipped with a hydraulic powered scoop, these army 6X6 trucks loaded themselves at the farm. Since no long hauls were involved in this type of operation, smaller loads were practical. This made it easier on the truck and resulted in less soil compaction. A 6-wheel drive permitted spreading under terrain and moisture conditions which would have prevented operation of ordinary trucks.

Tandem-Drive

Most new G.L.F. spreaders were mounted on tandem-drive trucks. These trucks might be of any popular make with a regular front axle, and dual rear axles both of which were live or powered. In army terminology they were referred to as 4X6 trucks (6-wheels with 4 powered). The front axle of these trucks was not powered as in the case of the army 6X6's. G.L.F. officials reported that these trucks would operate most places a regular farm tractor would.



A tandem-drive truck showing auxiliary motor for driving spreader fans and hood in traveling position.

The conveyor chain which carried the material to the fans was driven from an auxiliary transmission so that the speed of the chain was proportional to the ground speed of the truck. This made it possible to obtain a constant rate of application regardless of the gear in which the truck was operated. This hook-up was not possible with an ordinary standard truck or an army 6X6. For this reason G.L.F. did not recommend the latter type trucks for use in fertilizer trucking and spreading where a constant rate of application was especially important.

Tandem-drive trucks were used mainly at service points where the spreader truck itself was used to haul material from the plant or local stockpile to the farm and then to spread it on the land.

G.L.F. experience was that gasoline consumption was actually less for these trucks than for light ones because the lighter trucks had to be operated in a lower gear. Greater wear and tear also occurred on the lighter trucks.

[1] The army term "6X6" designates a 6-wheeled vehicle (3 axles) with all 6 wheels powered. The two rear axles may carry either single or dual tires.

Standard

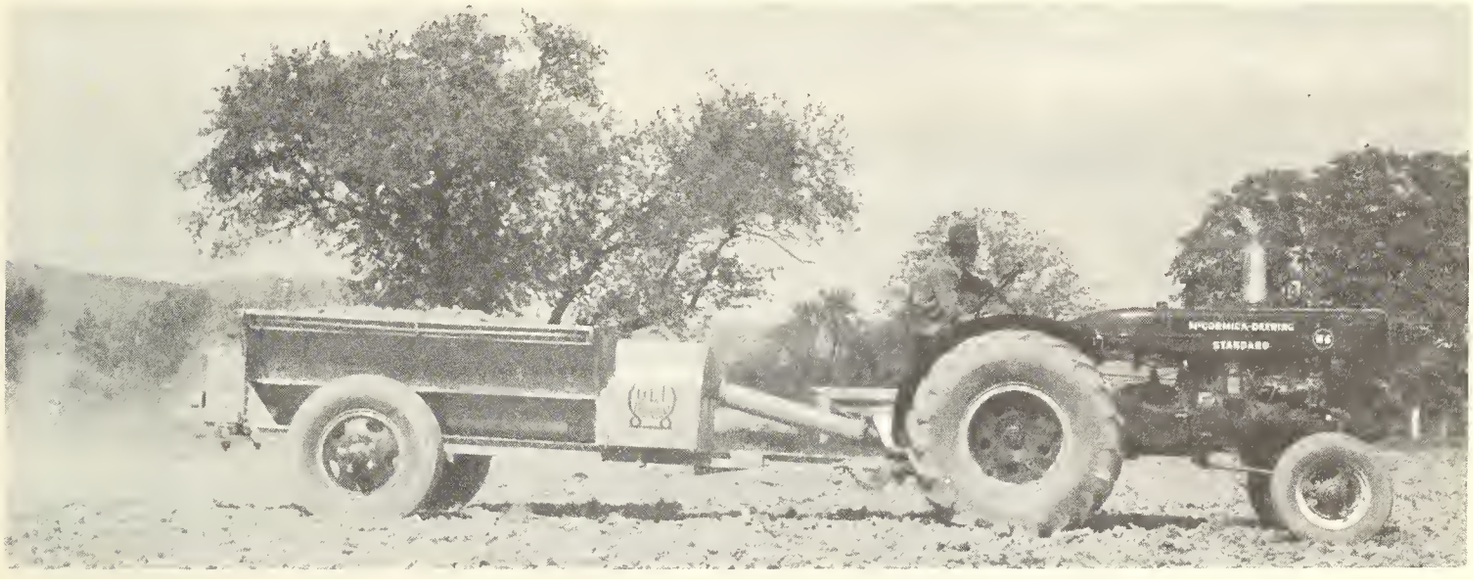
Of the 29 standard trucks (single rear axle) used in G. L. F. spreading operations, 24 were located at contract points, 4 at agent-buyer points, and only 1 was owned and operated by a G. L. F. service store. Experience with such trucks at the time of this study had not been satisfactory. Because of inadequate traction, they could not operate under adverse conditions of moisture or terrain. Also, less flotation resulted in more soil compaction. G. L. F. will probable replace those now in operation by the more flexible tandem-drive trucks.

Early Development of Equipment

G. L. F. first offered a lime spreading service to its patrons in 1935. Byproduct moist lime could be obtained at a favorable price from a steel company in the territory. However, equipment then available was not suitable for moist lime because it clogged the mechanism and failed to spread uniformly. Since this early beginning, G. L. F. has carried on extensive experimentation to develop equipment which would be suitable for both lime and fertilizer spreading.

The original purchased equipment was designed for horse-drawn use, and the two spreader fans were driven from the wheel of the spreader. A change in the spreader's speed resulted in a change in the width of spread. In a later spreader, the fans were propelled by a power takeoff from the tractor which pulled the mechanism. Although this performed a better job of lime spreading, the tractor was slow in traveling from farm to farm.

After World War II, G. L. F. obtained surplus army trucks with 6-wheel, tandem-axle drives and equipped them with lime spreading bodies. These proved satisfactory, since they could operate under adverse moisture and terrain conditions. Half-track trucks of the type used by the Army were also tried but considerable trouble developed when mud accumulated on the tracks.



An early lime spreader. Spreader fans and auger type conveyor were driven by a power takeoff from the tractor. Unit was slow getting from farm to farm.

Adapting Liming Equipment for Fertilizer Spreading

Success with lime spreading led to demand for a similar type service for fertilizer. But fertilizer, being a more highly valued product than lime, required a spreader which would give more uniform spread at lower rates of application. Improvement in spreaders to permit fertilizer spreading would at the same time improve quality of the lime spreading service.

In early lime spreading equipment, spreading fans were driven by a power takeoff from the truck motor. Since speed of the fans was proportional to motor speed, variations in the width of spread resulted.

G. L. F. engineers solved this problem by installing an auxiliary motor on the side of the spreader body to provide power for the fans. This made possible a constant fan speed regardless of either truck motor or ground speed.

Also, in the early lime spreading equipment, the chain mechanism that conveyed material to the spreader fans was geared to the motor. Each change in motor speed caused a change in speed of the chain and thus variation in rate of application. This, of course, was not satisfactory for fertilizer, where maximum benefit depended upon a uniform distribution of material throughout the area covered.

To provide for uniform rates of application, conveyor chains in the newer G. L. F. spreaders were driven by a power takeoff synchronized with the wheel speed. This hookup insured a flow of material to the spreader fans which was in proper proportion to the ground area covered. Some trouble, however, was reported by local managers due to wheel slippage under wet soil conditions, but this was not a major problem. With dual-tired, tandem-axle, 4-wheel drive trucks carrying 10.00 X 20 tires, slippage was not serious except under extremely unfavorable soil conditions.

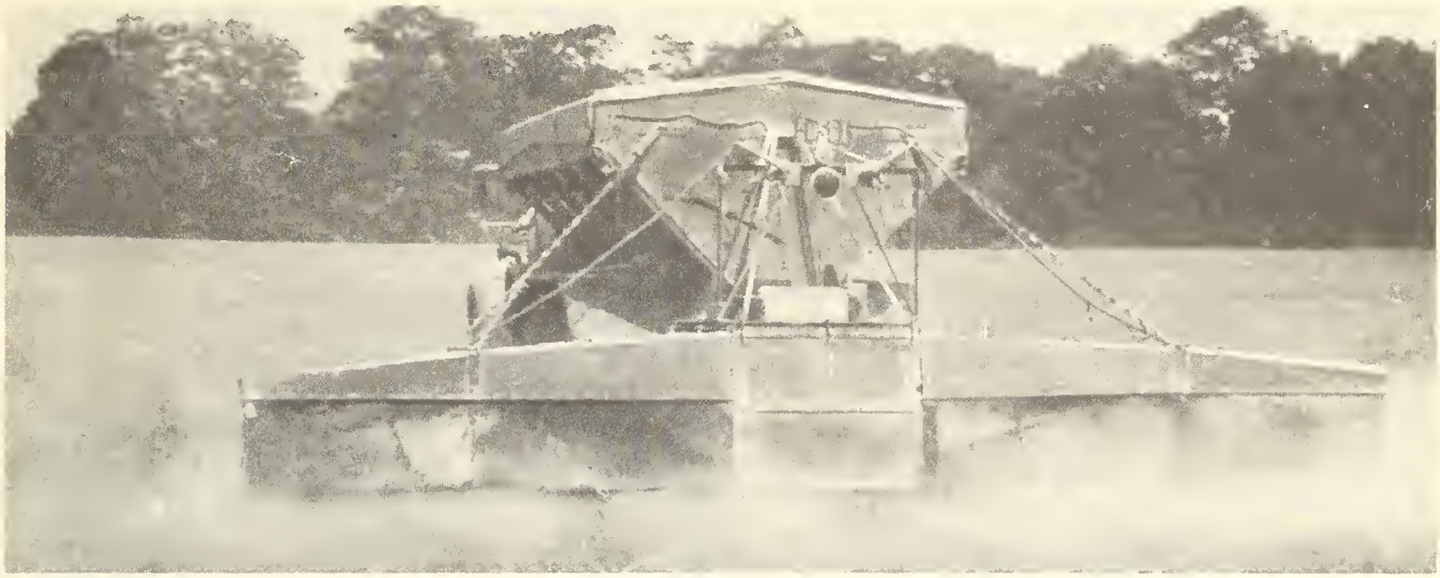
Another problem encountered in developing equipment suitable for both fertilizer and lime spreading was the necessary wide range in rates of application per acre. While the minimum amount of lime spread per acre in G. L. F. territory was around 1 ton, fertilizer was applied at much lower rates. The latest G. L. F. equipment spread from 300 pounds up to 3 and 4 tons an acre. This range was achieved by installing a 3-speed transmission on the conveyor chain drive shaft. This made it possible to reduce ratio of chain speed to wheel speed for low rates of application and to increase the ratio for higher rates of application.

A sliding gate in the rear of the spreader body further controlled flow of material to the spreader fans. By reducing size of the opening and lowering the chain to wheel speed ratio, minimum rates of 300 or 400 pounds per acre could be obtained.

This operator is adjusting the rear gate of the spreader for proper application rate by means of a calibrated rule.

Hoods Used To Reduce Blowing

At G.L.F. service points where a considerable quantity of fertilizer was spread each year, spreader trucks were equipped with hoods to reduce blowing. Even though these hoods were cumbersome, expensive, and short lived, they permitted spreading fertilizer even on days with moderate breeze. They were not used for spreading granular fertilizer or lime.



Hoods reduce blowing and make it possible to spread powdered fertilizer on days with moderate breeze. They are not essential for moist lime or granular fertilizer.

Width of Spread Increased

Where hoods were used, width of spread was controlled by width of the hood. Hoods used at service points studied were 24 feet wide. Without hoods, the latest G.L.F. equipment spread moist lime in a band 75 to 80 feet wide and granular fertilizer up to 100 feet wide. This improved efficiency over older G.L.F. equipment where width of spread was 16 to 20 feet. The greater spreading widths were about equivalent to the turning radius of the truck which permitted the driver to better judge the area covered and thus improved the quality of service. Since the truck made fewer trips over a field, there was less soil compaction--an important advantage of the newer equipment.

The wide spreads were achieved by using a more powerful auxiliary motor and increasing diameter of the fans.

Fan Assembly

Two fans were used on all G.L.F. spreaders. The fan consisted of a metal disc on which were mounted either three or six blades. Three blades were used for lime spreading and six for fertilizer.

The spreading pattern varied with different materials depending on such factors as moisture content, condition, and texture. Some materials fell behind the truck, others fell far out at the sides. By regulating the point at which the material fell on the fan (nearer or farther away from the center), the spreading pattern could be changed to compensate for differences in materials. Adjustable plates were provided on the fan assembly to permit this adjustment. The position of each blade on the fan was also adjustable so as to permit further control of the spreading pattern.

Cost of Trucks and Equipment

Estimated cost in 1955, of a completely rebuilt army 6X6 truck was between $3,000 and $4,000. The complete unit equipped with spreader body and self-loader ran around $8,000.

The cost of a heavy tandem-drive truck was around $9,000. Cost of spreading equipment including a standard lime spreading body, auxiliary motor, auxiliary transmission, oil-bath clutch, and fan assembly was estimated at around $3,000. This commonly represented about one-fourth the cost of the complete trucking and spreading unit. The hood used for fertilizer spreading was $500 to $600 extra. Thus the price of a complete truck and equipment with hood was approximately $12,500 in 1955.

OPERATING PRACTICES

This section covers types of operations in bulk lime and fertilizer distribution, rates charged, area served, driver training, and repair and maintenance practices.

Bulk Lime Distribution

Lime hauling and spreading operations at the 105 service points under the supervision of G. L. F. 's Service Agencies Division were divided into four general types. These were (1) spreader truck direct from plant to farm, (2) field spreader, (3) local stockpile, and (4) combination of plant-to-farm and local stockpile.

Direct Plant-to-Farm Operations

Direct plant-to-farm operations involved the use of the spreader truck to haul lime or fertilizer from the plant to the farm and then to spread it on the patron's field. This type of operation was generally used in situations where the local agency was within a radius of 30 or 40 miles from the lime plant. Because they were especially well adapted for the dual purpose of over-the-road hauling and operating in the field, tandem-drive trucks were commonly used for this type operation.

Handling of materials was reduced to a minimum. Loading at the lime plant was accomplished by means of a chute or conveyor under which the bulk spreader truck could be driven. Since the truck traveled directly to the farm, no handling was involved at the local agency. Upon arriving at the farm, the driver contacted the farmer to obtain information on rates of application, fields to be covered, and related items.

Field Spreader Operations

At distances of 30 to 75 miles from the lime plant, dump trucks were commonly used to haul lime from the plant direct to the farmer's field. These trucks might be owned by the local agency, or the services of an independent trucker might be obtained. The lime was later spread by an army 6X6 self-loading spreader truck or by a tandem-drive truck. In the latter case the spreader truck was loaded in the field by a tractor-mounted scoop. The tractor-mounted scoop was towed to the farm on a trailer.

An advantage of the field spreader type operation was that the spreader truck did not have to be loaded as heavily as when longer hauls were involved. Lighter loads were easier on the truck and resulted in less soil compaction.

A self-loading spreader mounted on a rebuilt army 6X6 truck loads lime in the field.

Local Stockpile Operations

Local service stores too far from the lime plant for direct plant-to-farm operation of the spreader truck could stockpile bulk supplies of this material at the local agency or service point. About half G. L. F.'s local agencies offering a spreading service maintained a lime stockpile. These were open stockpiles containing up to 2, 000 tons of material. The stockpile was generally built up in the spring ahead of the peak demand period for lime spreading services and in the early summer before the summer and fall rush.

Shipments of lime to the local stockpile were either by rail or truck. At agencies 30 to 75 miles from the lime plant, truck transportation was generally found to be most economical. At points 75 miles and beyond, rail transportation was commonly used. Because it cost from 25 to 30 cents a ton to unload a rail car, local agencies could afford to pay this much more for truck transportation.

Rail cars were unloaded by conveyors or power clams. Conveyors were used where lime was shipped by hopper car. One local G. L. F. agency used an undercar conveyor and two portable belt conveyors to move the lime to the stockpile. Three others used power clams to unload material from the top of the car. In these cases flat-bottom gondola cars were used. At one of these agencies the operator drove the clam to an elevated dock so that he could see into the car better. Other clams were operated from track level. The local agency did not own the power clams but hired the services of independent agencies.

For stockpiling lime G. L. F. officials recommended dry ground near the store with a set of scales convenient for weighing loads. Other costs in stockpiling, in addition to that of unloading, included rent of land for the stockpile and interest on money tied up in inventory.

Inventory control was a problem. G. L. F. officials recommended setting up a perpetual inventory and suggested that the stockpile be cleaned up several times yearly. This helped keep material in the best possible condition for spreading. They also suggested that the stockpile be kept peaked in the center to help shed rain and that it not be allowed to become a "muddy puddle underfoot."

Tandem-drive trucks were used to haul lime from the stockpile to the farm and then to spread it. These trucks were loaded at the stockpile by a tractor with scoop mounted in front. One agency manager estimated the time required to load a truck as about 2 minutes per ton of material.

Reported benefits of stockpiling were:

1. No waiting for rail car or truck shipments to arrive; thus the spreader truck could operate more efficiently every day the weather was right.

2. Shipments could be scheduled on a more orderly basis.

3. More tons could be spread per spreader truck. One agency manager operating on a direct plant-to-farm basis reported that he could draw only 4 or 5 loads a day with the lime plant open from 7:00 a.m. to 4:00 p.m. He was considering establishing a stockpile because he believed he could increase his tonnage considerably.

4. Stockpiles built up in advance of the rush season made possible a larger tonnage, permitted better service during the period of peak demand, and evened out the work.

5. Small orders could be handled more efficiently than when longer hauls were involved.

6. Service to patrons was more prompt.

7. Cost of demurrage was less than if cars had to wait to be unloaded direct to spreader trucks.

Disadvantage of stockpiling were reported as follows:

1. More equipment was needed, including scale and loading equipment.

2. Extra handling was involved.

3. Money was tied up in inventory.

4. The problem of inventory control increased.

5. Some farmers objected to stockpiled lime because they believed it might have lost some of its beneficial qualities.

Two methods of receiving and unloading lime. Left: Lime received in a hopper car and unloaded by an undercar conveyor and two portable elevators. Right: Lime received in a gondola car and unloaded by power clam.

Combination Stockpiling and Plant-to-Farm Operations

Several of G.L.F.'s service points maintained stockpiles of lime and also offered a direct plant-to-farm service. The stockpile was used mainly for small orders and also helped improve service to patrons during peak periods.

Stockpile should be located near scales for convenient weighing of loaded trucks. Peaked stockpiles shed rain.

Use of Moist Lime

Moist lime was preferred in G.L.F. lime trucking and spreading because (1) there was less blowing, (2) a wider spread could be obtained, (3) it did not vex the neighbors as badly as dry lime, (4) it was easier on motors, and (5) it was not as irritating to drivers as dry lime.

Dust loss from using dry lime was estimated at 2 to 3 percent. This at least partially compensated for the difference in weight between moist and dry lime. Aside from the weight difference there was little to choose between the two materials as far as the farmer was concerned.

Bulk Fertilizer Distribution

G.L.F. distributed fertilizer in bulk through retail service points and from fertilizer plants. Some was delivered directly from plant-to-farm and some from stockpiles.

Operations at Retail Service Points

Most of the 105 local points where lime spreading services were offered also spread some fertilizer. G.L.F. officials estimated the average volume to be around 100 tons of fertilizer per service point. This varied a great deal, however, as one retail point spread 721 tons in 1953-54 compared with only 44 tons by another.

Volume apparently was dependent on a number of factors. Among these were the type of farming and fertilization practices in a particular area and how well the spreading program fit into this pattern, the extent to which the service had been promoted, and facilities and equipment available for handling and spreading bulk fertilizer. A number of stores still had the older spreaders which were not equipped specifically for fertilizer spreading although they could be used to some extent for that purpose.

Most of the fertilizer spread by G.L.F. was in areas where direct plant-to-farm operation of the spreader truck was feasible. This was generally within a radius of 30 or 40 miles of the fertilizer plant. Several local agencies, however, had established low-cost shed type facilities for stockpiling bulk fertilizer, and more of such facilities probably will be established in the future. Three of 10 retail agencies had definite plans for, or had given serious consideration to, establishing stockpiling facilities. Two agencies had already established bulk fertilizer stockpiles and three others were operating on a direct plant-to-farm basis. Even at one of these latter points the manager felt that a bulk fertilizer stockpile would be a definite asset to his business, particularly in handling small orders.

Fertilizer Stockpiling Operations.--At the two agencies just mentioned, bulk fertilizer was stockpiled in open sheds having several bins for different grades. One of these sheds was 40 by 60 feet and contained 6 bins each with a capacity of 50 tons of mixed fertilizer. The other shed was approximately 30 by 40 feet and contained 3 bins with capacities of

Shed for stockpiling mixed fertilizer. It is approximately 30 by 40 feet and contains 3 bins, each with 45-ton capacity.

about 45 tons each. Both sheds were of concrete block construction with sheet metal roofing and concrete floors. They were so constructed that dump trucks could unload directly to the stockpile without the need for conveyors or other handling facilities.

In both instances fertilizer was hauled from the fertilizer plant to the local agency by an independent trucker. One of the agencies was some 30 miles from the fertilizer plant and the other about 85 miles.

Tandem-drive spreader trucks were used to haul fertilizer from the local stockpile to the farm and then to spread it. These trucks had a capacity of from 7 1/2 to 10 tons. Loads, however, were varied to meet specific soil conditions. Tractors with hydraulic scoops mounted in front were used to load tandem-drive spreader trucks at the local stockpile.

Reported advantages of stockpiling fertilizer were:

1. It permitted prompt service to patrons.
2. It helped to promote latest and best agronomic practices.
3. It permitted service on smaller lots than when fertilizer was hauled direct from plant to farm.
4. Stockpiling in advance of the rush season permitted better service during the period of peak demand.
5. Larger tonnage could be spread per spreader truck because truck was on the road less time and there was no waiting at the plant.
6. Larger loads could be hauled from the plant to stockpile than could be hauled when trucks had to spread on patrons' fields.

Trucks are loaded at the stockpile by a hydraulic scoop mounted on the front end of a tractor.

7. Spreader trucks could be used to stockpile in advance of rush season and at other times when not spreading.

Disadvantages of stockpiling fertilizers were reported as follows:

1. Extra equipment and facilities increased costs.
2. Extra handling was involved.
3. Only a few grades could be carried in inventory.
4. Inventory control might be difficult due to dust loss or gathering of moisture by fertilizer. Caking might result if turnover was not sufficiently rapid. The more

formulas stocked, the slower the turnover was and the higher the cost. At the same time, the limited number of grades stocked did not allow for much flexibility in adapting grades to specific soil requirements.

5. Money was tied up in inventory.

Direct Plant-to-Farm Operations. --Three local agencies were so situated with respect to the fertilizer plant as to permit direct plant-to-farm operations of spreader trucks. One other indicated that it would be able to operate in this manner as soon as the G.L.F. fertilizer plant in its area got back into operation. The plant had been closed for remodeling and installation of new continuous ammoniating, mixing, and granulating equipment. Temporarily, the local agency was using bagged fertilizer entirely in its spreading program.

In direct plant-to-farm operations, custom mixing to meet specific soil requirements was possible. The order could be placed, the mix prepared, and the spreader truck loaded direct from the mixer. Cured fertilizer was not essential for this type operation.

Other Operations. --At five local agencies methods of handling bulk fertilizer were not fully developed--being either temporary or experimental in nature. Two of these agencies had army 6X6 self-loading spreaders designed for field spreading lime and were not especially adapted to fertilizer spreading. In addition, one manager pointed out that field loading fertilizer with self-loading trucks was not too satisfactory because of the corrosion problem from fertilizer falling on the cab and body of the truck. He also reported that the average size fertilizer order in his area was around 3 tons and it was not economical to haul this size order from the plant--a distance of 70 miles. For this reason he had considered establishing a bulk fertilizer stockpile.

Two of the five local agencies used bagged fertilizer entirely in their spreading operations. One of these was contemplating bulk storage and the other planned a direct plant-to-farm operation as soon as the fertilizer plant in its area got back into operation.

The last of the five agencies hauled bulk fertilizer from the fertilizer plant to its local warehouse by dump truck and there transferred it to the spreader truck with a portable elevator. This agency manager had also considered establishing bulk stockpiling facilities.

Operations at G.L.F. Fertilizer Plants

Four of G.L.F.'s 14 fertilizer mixing plants offered bulk spreading services to farmers in their area. Orders for this service were handled or billed through G.L.F. retail agencies in the area, although the farmer might come direct to the plant to place his order.

The four plants together operated 12 spreaders--all mounted on tandem-drive trucks. These trucks were used to spread 11,578 tons of mixed fertilizer during the 1953-54 fiscal year.

All spreading was on a direct plant-to-farm basis with the spreader truck generally being used to haul material to the farm. One plant, however, operated a "feeder" truck when a large tonnage of fertilizer was involved. This feeder truck was a large over-the-road tractor and semi-trailer capable of carrying 25 tons of material. However, under the State law the truck could carry only 19 tons. It had a belt conveyor on its side for transferring fertilizer to the spreader truck in the field. The same truck was also used to transport materials to the plant for use in mixing operations.

At two plants spreader trucks were driven onto a scale inside the plant and loaded from a chute directly over the scale. At one plant material was fed into the chute by a

"Feeder" truck used to transport bulk fertilizer to spreader trucks in the field when large tonnages are involved. Note belt conveyor on side used to transfer materials to spreader trucks in the field. This truck is also used to transport inbound materials.

belt conveyor leading from the mixer. At the other, material was fed into the chute directly from the mixer. Payloaders dumped the material into a hopper over a bucket elevator which fed mixer.

Loading chute on outside of plant is fed by belt conveyor leading from mixer. Fertilizer is weighed in payloader before being dumped into bucket elevator that feeds mixer.

At the third plant, the fertilizer was weighed in payloaders before being dumped into a bucket elevator, which in turn emptied into the mixer. The bulk fertilizer was conveyed to an outlet over the truck on the outside of the building. At this plant, bagging operations had to be stopped to load bulk trucks. To avoid this situation the manager would like to have another mixer and bucket elevator unit to handle bulk fertilizer.

Advantages to the Plant of a Bulk Service. --Managers reported advantages to the fertilizer plant of a bulk spreading service as follows:

1. Less storage space was required in a plant of given capacity.
2. Savings on labor resulted.
3. Savings on cost of conditioner resulted.
4. Grades could be made up to fit specific soil and crop requirements.

Less storage space was required because "green" fertilizer could be used in spreading operations. Because fertilizer was spread on the field direct from the mixer, no

curing period was required. Thus storage space which would normally be used for curing this fertilizer could be used for storage of raw materials or for curing fertilizer which was to be bagged. In effect this increased mixing capacity of a given size plant because generally the amount of storage space determines plant capacity. One manager stated that the spreading service had increased the capacity of his plant by 7,500 tons, or about 75 percent.

A spreading service saved labor in the plant because of less handling. This was possible because cured fertilizer, whether to be bagged or distributed in bulk, required regrinding after the curing period. Fertilizer spread direct from the mixer, however, was mixed and ground only once and did not involve handling to and from curing bins.

Because no storage period was involved, savings could be made on conditioner when fertilizer was spread direct from the mixer. Conditioner is an inert material and its absence from mixed fertilizer detracts nothing from its plant food content. Its presence is essential, however, if the fertilizer is to be stored in the plant, at the local warehouse, or on the farm. Because no curing period was required, G.L.F. plant managers had more flexibility as to the grades which they could make. They were able to make up special mixes to meet specific soil and crop requirements. Only a few fast moving grades could be mixed when both curing and storing were required.

Rates Charged for Lime Delivery and Spreading

Cost to the patron of lime spread on his field at the several G.L.F. retail stores studied ranged from $6.75 to $8.50 a ton and averaged $7.67 (Table 1). This price includes the cost of lime at the quarry, truck or rail delivery charges, usually an unloading charge where lime was received by rail, a charge for spreading, and the local store's margins.

Charges for trucking and spreading at the 10 local stores ranged from $2.75 to $5.30 a ton. Trucking charges at six points where these charges were separated varied from $1.50 to $2.80 a ton and spreading from $1.25 to $2.80 per ton. These charges at the stores visited remained fixed regardless of distance traveled or rate of application.

Table 1.--Schedule of per ton charges for lime, and lime trucking and spreading by 10 G.L.F. retail stores, spring, 1955.

Store number and type of operation [a]	Price f.o.b. plant	Price delivered by rail	Charges per ton				Total cost to patron
			Unloading	Trucking to farm	Spreading	Store margin	
1-T.....	$3.00	-	-	[b] $3.50		$ .75	$7.25
2-T.....	3.00	-	-	$2.00	$1.25	.50	6.75
3-F.....	3.00	-	-	2.40	1.70	.65	7.50
4-F.....	1.35	-	-	2.50	2.80	.35	7.00
5-F.....	2.75	-	-	2.80	2.00	.70	8.25
6-S.....	-	$4.70	.30	[b] 3.00		.50	8.50
7-S.....	-	4.25	.25	[b] 3.00		.50	8.00
8-S.....	-	4.78	.32	1.50	1.25	.35	8.20
9-S.....	-	4.78	-	[b] 2.80		.46	8.04
10-C.....	3.00	-	-	1.90	2.00	.35	7.25
Average.....	2.68	4.63	.29	2.18 [b] 3.08	1.83	.51	7.67

[a] T-trucked direct from plant to farm; F-field spreading; S-local stockpile; C-combination of direct plant-to-farm and stockpile.
[b] Includes both trucking to farm and spreading.

Highest rates for trucking and spreading were charged at points having field spreader operations. Charges at three such points varied from $4.10 to $5.30 a ton. Field spreader operations were generally located a considerable distance from the source of supply and independent truckers commonly hauled the lime from the plant direct to the farm.

A 6X6 self-loading truck spreading lime on a patron's field.

Lowest rates for trucking and spreading were charged at points with stockpiling operations. Rates at four such points varied from $2.75 to $3.00 per ton. These rates included only trucking from the local stockpile to the farm. For field spreader and direct plant-to-farm operations, the rate included trucking from lime plant to the farm.

At the four stockpiling operations included in this report lime was delivered to the stockpile by rail. Three of these points included a charge varying from $0.25 to $0.32 per ton for unloading lime from rail cars to stockpile.

Store margins varied from $0.35 to $0.75 per ton, averaging $0.51.

Rates Charged for Fertilizer Delivery and Spreading

Charges for spreading fertilizer were commonly made on a per acre basis, rather than on a per ton basis. This was the case at 8 of the 10 retail points visited and at the 3 fertilizer plants that offered a bulk spreading service. The practice was to add a spreading charge of so much an acre to the delivered price of the same grade of bagged fertilizer. The patron was billed as follows:

5 tons 10-10-10 (delivered) @ $60	$300
Spreading 20 acres (500 pounds an acre) at 50¢ an acre	10
Total	$310

Per acre spreading rates ranged from $0.50 to $2 (Table 2). At the three fertilizer plants and four local stores studied the rate was $0.50 per acre. One local store charged $0.60, one $0.75, and two $2 an acre for spreading fertilizer. One of the latter two stores used the price of bagged fertilizer at the local store as the basis for pricing rather than the delivered price of bagged fertilizer. In other words the $2 an acre spreading charge in this instance covered delivery of the fertilizer to the farm.

Per acre charges were not normally set up to cover the entire cost of spreading. In computing spreader income the difference in cost of bulk and bagged fertilizer was taken into account. This differential was figured at $3 a ton at 7 of the 8 retail stores using a per acre rate and at all 3 fertilizer plants (Table 2). The other retail store figured the bulk-bag differential at $2.50 a ton.

Table 2. --Charges for spreading fertilizer and allowances for computing spreading income at 10 G.L.F. retail stores and 3 fertilizer plants, spring, 1955.

Store or plant number and type of operation[a]	Spreading charge above delivered price of bagged fertilizer		Allowance per ton for computing spreading income	
	Rate per acre	Rate per ton	Trucking	Bulk-bag differential
Retail stores:				
1 - T	$0.50	-	$2.75	$3.00
2 - T	.50	-	2.00	3.00
3 - T	.60	-	2.00	3.00
4 - S	.50	-	1.75	3.00
5 - S	2.00	-	1.50	3.00
6 - F	2.00	-	3.00	3.00
7 - F	.75	-	3.00	3.00
8 - D	.50	-	2.75	2.50
9 - B	-	$4.00 to $5.00	-	-
10 - B	-	4.00 to 5.00	-	-
Fertilizer plants:				
1 - T	.50	-	1.50	3.00
2 - T	.50	-	[b] $1.50-$2.30	3.00
3 - T	.50	-	1.50	3.00

[a] Types of operation: T-trucked direct from plant to farm; S-local stockpile; F-field spreading; D-dumptruck to retail store where transferred to spreader truck; B-use bagged fertilizer.
[b] Varies by district.

Where spreader trucks were used in hauling, as was usually the case, the trucking charge was also added to spreading income. Trucking charges at the points studied ranged from $1.50 to $3 a ton. Thus, in a typical case spreader income per ton of fertilizer would be computed as follows:

Bulk-bag differential	$3 a ton
Trucking from plant	2 a ton
Spreading charge (500 pounds an acre) @ 50¢ an acre	2 a ton
Total spreading income	$7 a ton

Two local stores charged a straight price per ton for trucking and spreading. This charge was from $4 to $5 a ton depending on rate of application. These two stores used bagged fertilizer entirely in their spreading operations.

G.L.F. officials pointed out several advantages to the per acre basis for pricing spreading services. These were: (1) The low per acre rate, such as $0.50 an acre spreading, sounded attractive to the farmer; (2) the charge was proportional to the acreage covered and time required; and (3) it gave the farmer a better basis for comparing costs of bulk-spread and bagged fertilizer.

Disadvantages claimed for the per ton basis for pricing were: (1) The high price necessary was apt to discourage farmer use; and (2) it was not easy to make the rate proportional to the acreage covered.

Area Served by Spreader Trucks

Service points visited in making the study generally serviced an area within a radius of 20 to 25 miles of the local store. They did not, however, have a set limit and the distance trucks traveled might vary in different directions from the local store. It was largely dependent on location and area covered by other G.L.F. agencies offering spreading services.

There might be several G.L.F. agencies in the same county and one agency might provide spreading services for two or three other agencies. In general, however, when volume was sufficient, G.L.F. found it more economical to locate two spreaders in two separate communities rather than to base both at one agency to service the two communities.

Driver Training

Quality of any trucking and spreading service is dependent to a large extent on the truck driver. G.L.F. officials recommended to local agencies 1 week of intensive training by a qualified operator for new drivers. Where service was being started at a new point, the driver might be sent to another agency for training. Cost of this training was borne by the local agency. G.L.F. preferred drivers with farm experience. This association's experience was that such drivers were more familiar with field conditions and the need to vary the load to meet these conditions. They also were more careful to obtain a uniform spread. Ability to judge distances is also important because for some materials it is difficult to see the area covered and the driver must be guided by the truck marks from the previous run. If the driver is not alert, incorrect settings or lumpy material may damage equipment or result in inaccurate applications.

Repair and Maintenance Practices

G.L.F. maintained three central garages which carried spare parts and repaired G.L.F. spreader bodies. Repairs on the trucks generally were made at local garages--preferably by an authorized dealer for the particular make of truck. However, one of the fertilizer plants studied had its own shop for performing repair and maintenance work. This was a large operation with 6 spreader trucks spreading from 6,000 to 8,000 tons of fertilizer each year.

Preventive maintenance on spreader trucks is especially important in avoiding breakdowns. Corrosion and dust may cause serious trouble if the truck and spreader are not thoroughly cleaned at regular and frequent intervals. Proper lubrication, frequent cleaning of air filters, and changing of oil as needed are especially important. G.L.F. local managers were encouraged to establish with their drivers a definite preventive maintenance routine wherein certain points were checked or serviced at regular daily, weekly, or monthly intervals. A suggested maintenance schedule is presented on the following page.

BUSINESS ANALYSIS OF BULK DISTRIBUTION OPERATIONS

Operating statements on fertilizer spreading were obtained from 4 G.L.F. fertilizer plants and 54 G.L.F. service stores for the fiscal year 1953-54, and from 56 service stores for 1954-55. Data on service store operations are presented for 2 years to indicate the degree of variation that existed from year to year. The data have been analyzed for the four different types of bulk distribution operations of the stores, and on the basis of tons of lime and fertilizer spread per truck so as to show the influence of volume on costs.

MAINTENANCE OF EQUIPMENT

Daily

Truck

Check - oil.
- water.
- gas.
- tires with hammer.
- brakes. Push hard with motor running to test for weak break lines.
- stop lights.
- turn signals for loose or broken parts.

Spreader

Check - oil) in auxiliary motor
gas)
- fans every load. Should be clean and tight.
- for loose or broken parts.

Oil conveyor chain after spreading fertilizer. Use thin oil mixed with solvent or kerosene.
Grease bearing in bevel gear boxes.

Weekly

Truck

Check - lubricant in transmissions and differentials.
- tires with gauge.

Change motor oil. Change filter every other week.
Grease chassis.
Clean and use new oil on all air intakes--carburetor, crankcase breather, and vacuum brake intake.
Wash truck and clean chassis.
Tighten loose bolts.

Spreader

Check - oil in spreader gear boxes.
- conveyor chain tightness. 2 feet or more clearance before it touches guide.
- Vee belt tightness

Change oil in air cooled motor.
Clean air filter and add clean oil.
Oil crank so it won't stick to motor shaft and strike driver.
Grease sealed ball bearings with hand gun, small amounts only to push lime out. Don't break the grease seal.

Monthly

Clean engines (Steam clean, or spray on 1 part Dua Sol or Gunk to 4 parts solvent. After one-half hour, wash with hose).
Tighten nuts on chassis and spreader.
Clean radiator. If air or water is used, force out from the inside.
Tune both motors--points, plugs, valve clearance, and carburetor.

Special

The spreader body may need cleaning and painting twice a year.

A tandem drive chassis needs special attention and lubrication at certain points.

Operations at Four G. L. F. Fertilizer Plants

Data on book value of trucks and equipment, tonnage distributed and operating margins and costs were available from the four G. L. F. fertilizer plants offering bulk delivery and spreading service. An analysis of this data is presented in the following sections.

Book Value of Trucks and Equipment

All spreading operations at these fertilizer plants were on a direct plant-to-farm basis. The depreciated value of trucks and equipment at the four plants was $41,755 on June 30, 1954. This was an average of $3,480 a truck and $3.33 a ton of material spread for the year 1953-54.

Tonnage Distributed

The 12 spreader trucks operated by the fertilizer plants delivered and spread a total of 12,552 tons of material--11,578 tons of fertilizer and 974 tons of lime--for the fiscal year 1953-54. One plant spread all the lime. The total volume spread per truck averaged 1,046 tons--965 tons of fertilizer and 81 tons of lime.

Total tonnage spread at these 4 plants during the 5 fiscal years ended on June 30, 1955, follows:

Fiscal Year	Tonnage
1950 - 51	7,519
1951 - 52	10,734
1952 - 53	13,006
1953 - 54	12,552
1954 - 55	11,168

Operating Margins and Costs

Table 3 shows revenue, expenses, and net margins on a per truck and per ton basis at the 4 fertilizer plants studied. The total revenue attributed to the spreading service was $70,645, or an average of $5,887 per truck. Total expenses amounted to $72,056 or $6,005 per truck. These figures show a net loss from spreading fertilizer at the four plants of $1,411, or $118 per truck. Revenue per ton amounted to $5.63. Expenses of $5.74 resulted in a net loss per ton of $0.11.

Table 3.--Revenue, expenses, and net margin on spreading operations at four G.L.F. fertilizer plants, 1953-54

Item	Total dollars	Dollars per truck	Dollars per ton	Percent
Revenue	$70,645	$5,887	$ 5.63	100
Expenses	72,056	6,005	5.74	102
Net margin.....	$-1,411	$ -118	$-0.11	-2

Approximately one-third of delivering and spreading cost was made up of salaries and wages and another third was depreciation (Table 4). These two items amounted to $1.95 and $1.92 a ton, respectively. Direct truck expenses was the third largest cost item

Table 4. --Average costs of spreading fertilizer at four G. L. F. fertilizer plants, 1953-54[1]

Cost item	Cost per truck	Cost per ton	Percentage distribution
Salaries and wages	$ 2,043	$ 1.95	34.0
Depreciation	2,004	1.92	33.4
Direct truck expense:			
Gas and oil	525	.50	8.7
Maintenance	984	.94	16.4
Tires and tubes	92	.09	1.6
Total direct truck expense	1,601	1.53	26.7
Other expenses:			
Insurance	139	.13	2.3
Taxes	202	.19	3.3
Miscellaneous[2]	16	.02	.3
Total other expenses	357	.34	5.9
Total expenses	6,005	5.74	100.0

[1] These data cover the operation of 12 spreader trucks spreading a total of 11,578 tons of fertilizer and 974 tons of lime or an average of 965 tons of fertilizer and 81 tons of lime per truck.
[2] Includes travel, telephone and telegraph, and unclassified expense.

amounting to $1.53 a ton, or approximately 27 percent of the total. Other expenses, including insurance, taxes, and unclassified items amounted to $0.34 a ton, or approximately 6 percent of total costs.

The largest item in direct truck expenses was maintenance cost, which amounted to $0.94 a ton or approximately 16 percent of total cost. Gas and oil cost was $0.50 a ton of material spread.

Although these figures show a net loss from spreading fertilizer, there were compensating gains from savings on conditioner and on handling, which plant managers believed were more than sufficient to offset this bookkeeping loss. As mentioned previously, these savings resulted from the following: (1) No curing period and less conditioner was necessary because fertilizer could be spread direct from the mixer; (2) there was less handling because the mixed fertilizer passed through the grinder only once; and (3) the capacity of a given size plant was increased because of less storage space requirements.

G. L. F. used chiefly tandem-drive trucks for spreading lime and fertilizer in bulk. Here is one on scales ready to be loaded from chute inside fertilizer plant.

Operations at G. L. F. Service Stores

Information presented in this section is based on data from 54 service stores for the year 1953-54 and 56 stores for the year 1954-55. Major topics covered are (1) initial cost and book value of trucks and equipment, (2) tonnages distributed and (3) margins and costs broken down by type of operation and within each type by volume of material spread per truck.

Initial Cost and Book Value of Trucks and Equipment

The 67 trucks and spreading equipment in use at 56 G. L. F. service stores as of June 1955, represented an initial cost of over $670,000 or $10,000 a truck and a current book value of about $333,000 or $5,000 a truck (Table 5).

Initial cost of equipment was greatest at stores having local stockpile operations. This reflects additional equipment, such as scales and loading and unloading equipment, required at such stores. Lowest initial cost per truck was at stores having field spreader type operations. This is because rebuilt army 6X6 trucks were frequently used at these stores.

Table 5. --Investment in lime and fertilizer spreading trucks and equipment at 56 G. L. F. stores by type of operation, June 1955

Type of operation	Number of stores	Number of trucks	Initial cost		Book value	
			Per truck	Total	Per truck	Total
Direct plant to farm.....	17	19	$10,144	$192,727	$5,874	$111,600
Field spreader	10	14	7,326	102,562	3,198	44,779
Local stockpile	23	26	11,447	297,622	5,139	133,607
Combination.....	6	8	9,658	77,267	5,319	42,551
Total all stores.....	56	67	10,003	670,178	4,963	332,537

Tonnage Distributed

Table 6 shows tonnage of lime and fertilizer delivered and spread at 54 G. L. F. service stores for the fiscal year 1953-54 and at 56 stores in 1954-55 averaged about 200,000 tons a year. Approximately 96 percent of this amount was lime and the remaining 4 percent mixed fertilizer. Tonnage for 1954-55 showed about a 12 percent gain over the previous year. The volume of lime spread by these stores represented from 55 to 60 percent of all lime spread by G. L. F. service points.

Each of 64 trucks averaged 2,960 tons in 1953-54, of which 120 tons was fertilizer and 2,840 tons was lime. The total for each in 1954-55 was 3,164 tons of which 113 tons was fertilizer and 3,051 tons lime.

Comparability of Cost Data for Different Types of Operation

Costs of hauling and spreading for different types of G. L. F. service store operation were not comparable because transportation services provided under each operation were not the same. Differences were as follows: (1) Cost data for direct plant-to-farm operations covered transportation from lime or fertilizer plant to farms because it was transported in the spreader truck; (2) in the field spreader type operation, material was transported to the farm in dump trucks so the cost of this transportation was not included in spreading costs; and (3) in stockpiling operations, the cost data covered transportation from local stockpile to farm, but not from plant to local stockpile. However, costs of unloading from rail car to local stockpile were included.

Table 6. --Volume of lime and fertilizer delivered and spread at G. L. F. service stores by types of operations, 1953-54 and 1954-55

Type of operation	Number of stores	Tons of lime spread	Percent lime was of total	Tons of fertilizer spread	Percent fertilizer was of total	Total tons spread
Direct plant to farm						
1953-54.....	15	52,710	95.8	2,287	4.2	54,997
1954-55.....	17	53,068	97.2	1,546	2.8	54,614
Field spreader						
1953-54.....	11	39,396	96.6	1,392	3.4	40,788
1954-55.....	10	41,140	97.2	1,170	2.8	42,310
Local stockpile						
1953-54.....	24	71,254	96.7	2,433	3.3	73,687
1954-55.....	23	91,483	97.2	2,676	2.8	94,159
Combination						
1953-54.....	4	18,415	92.1	1,581	7.9	19,996
1954-55.....	6	18,706	89.5	2,192	10.5	20,898
All stores						
1953-54.....	54	181,775	95.9	7,693	4.1	189,468
1954-55.....	56	204,397	96.4	7,584	3.6	211,981

Since it was not possible to show transportation costs as separate items, it did not appear advisable to show results for all four types of operation in one table.

Explanation of Cost Items Used Hereafter

Wages included supplements to wages such as social security taxes and workmen's compensation insurance. These may be referred as payroll taxes by other cooperatives.

Management fee was an allocation of 10 cents a ton to cover administrative costs.

Depreciation was figured at the rate of 25 percent a year on the spreader truck and equipment. This was the same rate charged on other automotive equipment.

For management control purposes the fiscal year was divided into 8 periods of 45 days each. Reports on operations were made by managers of service stores to the central office at the end of each 45-day period. For purposes of these reports depreciation was charged at the rate of 5 percent of initial cost for the 5 periods within the spreading season. No depreciation was charged for the three winter periods.

Interest was charged at the rate of 1 percent of book or depreciated value of the investment in trucks and equipment for each of the five 45-day periods during the spreading season. No interest was charged during the three winter periods. Thus the interest item amounted to approximately 5 percent of the average book value of spreader trucks and equipment for the year.

Other cost items are self explanatory.

Margins and Costs for Direct Plant-to-Farm Operations

Average revenue per ton for 15 stores having direct plant-to-farm operations was $3.36 in the fiscal year 1953-54 and $3.48 a ton for 17 stores in 1954-55 (Table 7). Total hauling and spreading expenses of $2.65 and $2.84, respectively, left net margins of $0.71 and $0.64 a ton for the 2 years. These net margins amounted to approximately one-fifth of gross revenue from spreading.

The net margin at stores in the low volume group amounted to only about one-third to one-half of net margins for stores in the higher volume groups. Net margins in the low volume stores were from $0.31 to $0.36 a ton compared with $0.68 to $1.01 a ton in the higher volume groups. Percentagewise net margins were 8 to 10 percent in low volume stores compared with 22 to 29 percent in higher volume stores.

There was not a great deal of difference in net margins between stores in the two higher volume groups. However, revenue per ton was somewhat lower in the highest volume group indicating that more efficient use of equipment in this group permitted these stores to charge patrons a lower per ton rate.

Table 7.--Revenue, expense, and net margin per ton and per truck in relation to volume of lime spread per truck at G.L.F. service stores having direct plant-to-farm operations, 1953-54 and 1954-55

Tons spread per truck	Dollars per ton			Dollars per truck			Percent net margin was of revenue
	Revenue	Expense	Net margin	Revenue	Expense	Net margin	
Under 3,000 tons:							
1953-54	$3.46	$3.10	$0.36	$8,705	$7,790	$915	10.5
1954-55	3.76	3.45	.31	9,404	8,627	777	8.3
3,000 to 3,999 tons:							
1953-54	3.57	2.78	.79	11,909	9,277	2,632	22.1
1954-55	3.53	2.52	1.01	13,482	9,609	3,873	28.7
4,000 tons and over:							
1953-54	2.97	2.17	.80	13,041	9,540	3,501	26.8
1954-55	3.11	2.43	.68	13,527	10,579	2,948	21.8
All such operations:							
1953-54 (3,055 tons)	3.36	2.65	.71	10,275	8,111	2,165	21.1
1954-55 (2,874 tons)	3.48	2.84	.64	9,993	8,155	1,838	18.4

Table 8 gives a detailed breakdown of expense per ton in relation to volume. The increase in costs per ton from 1953-54 to 1954-55 reflected primarily increased direct truck expense, particularly tires and tubes, and increased depreciation costs. (Direct truck expense as used in this report includes gasoline, oil, grease, repairs, tires, and tubes). The rise in depreciation cost per ton resulted from a lower volume spread per truck in the latter year.

Appendix table 1 shows percentage distribution of spreading costs in relation to volume spread per truck. The three major items of cost were wages, depreciation, and direct truck expenses. These three items accounted for between 85 and 90 percent of total costs of spreading. Labor represented about 27 percent, depreciation 26 percent, and direct truck expenses averaged 33 percent.

Table 8.--Costs of spreading lime in relation to tons spread per truck at G. L. F. service stores with direct plant-to-farm operation of spreader trucks, 1953-54 and 1954-55.

Item	All service stores		Stores[1] where tonnage per truck was:					
			Under 3,000		3,000 to 3,999		4,000 and over	
	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55
Number of stores	15	17	4	7	5	3	4	4
Number of trucks	18	19	5	8	7	4	4	4
Average tons per truck	3,055	2,874	2,516	2,499	3,331	3,822	4,387	4,352
Expenses per ton:								
Wages	$0.74	$0.77	$0.85	$0.80	$0.70	$0.73	$0.70	$0.78
Depreciation	.69	.75	.80	.99	.73	.64	.56	.58
Direct truck expenses:								
Gasoline	.34	.35	.35	.40	.37	.33	.30	.30
Repairs, oil, lubrication	.43	.46	.61	.67	.49	.35	.25	.33
Tires and tubes	.10	.16	.09	.20	.13	.16	.06	.12
Total direct truck expense	.87	.97	1.05	1.27	.99	.84	.61	.75
Other expenses:								
Management fee	.10	.10	.10	.10	.10	.10	.10	.10
Insurance and license	.15	.15	.20	.18	.16	.13	.11	.11
Interest	.09	.09	.09	.11	.09	.07	.08	.07
Miscellaneous	.01	.01	.01	(2)	.01	.01	.01	.04
Total other expense	.35	.35	.40	.39	.36	.31	.30	.32
Total expense	$2.65	$2.84	$3.10	$3.45	$2.78	$2.52	$2.17	$2.43

1 Excludes stores operating trucks only part of the year.
2 Less than $.005.

Ranges in costs among all stores having direct plant-to-farm operations for the 2 years and ranges for the middle group or one-half of the stores--that is, after eliminating the upper and lower one-fourth--were as follows:

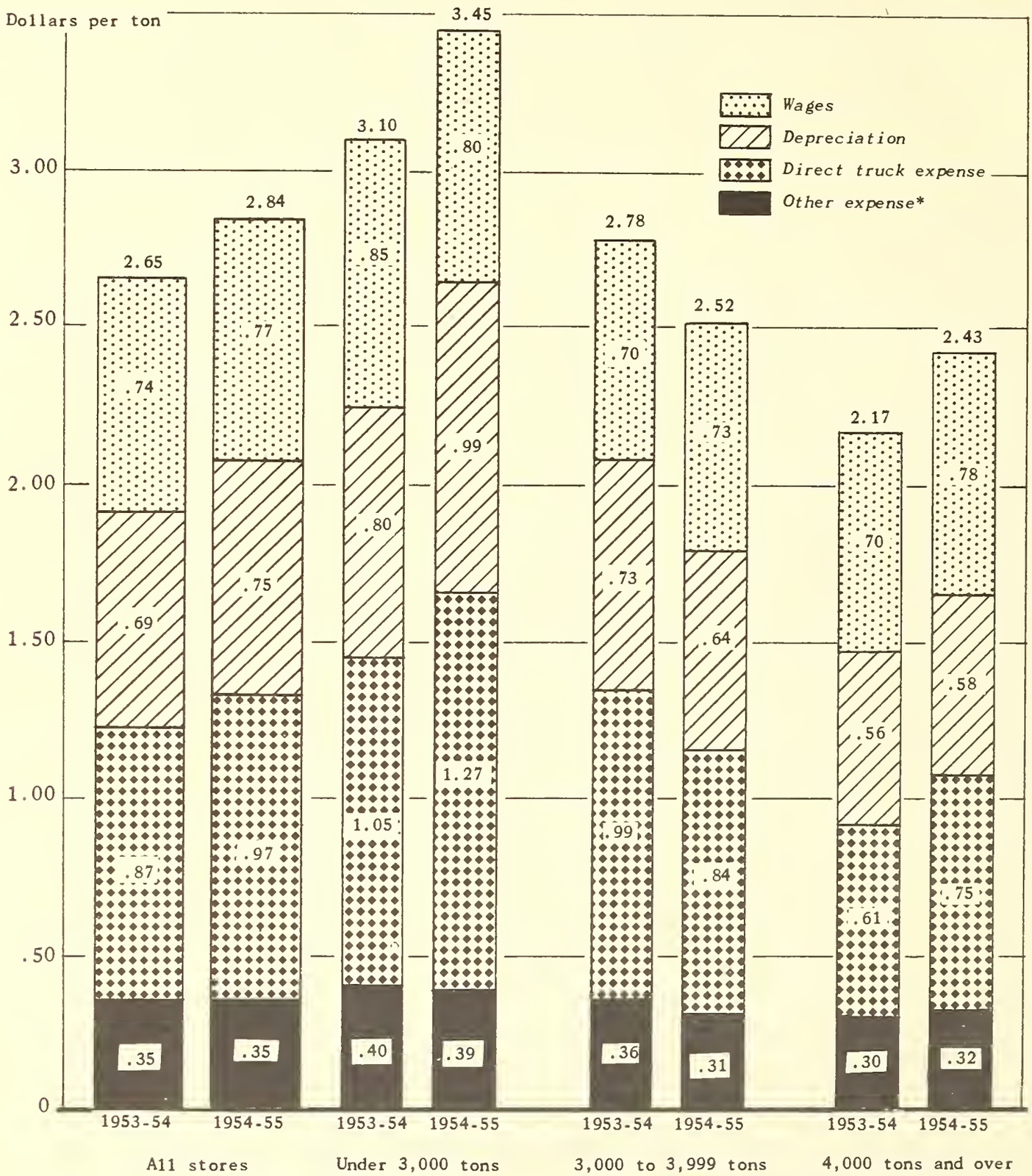
Fiscal year	Entire group of stores		Middle half of stores	
	Number of stores	Range in costs	Number of stores	Range in costs
1953-54	15	$2.02 to $4.54	8	$2.25 to $2.99
1954-55	17	1.95 to 4.49	9	2.38 to 3.44

Variation in costs among stores was a result of many factors. Among these were differences among stores in volume spread, terrain and road conditions, condition of equipment, distances from sources of supply, size of territory served, management abilities, field sizes and conditions, and wage rates.

Figure 2 shows the inverse relationship between volume of lime hauled and spread per truck and costs. Stores with an average volume spread per truck of less than 3,000 tons had costs of $3.10 and $3.45 a ton for 1953-54 and 1954-55, respectively. Stores with an average volume per truck between 3,000 and 3,999 tons had average per ton costs of $2.78 and $2.52 respectively for the 2 years. There was a marked decline in costs per ton for both depreciation and truck operation as volume spread per truck increased.

Figure 2

Costs of spreading lime, in relation to tons spread per truck at G.L.F. service stores with direct plant-to-farm operations, 1953-54 and 1954-55



*Other expense includes insurance, license, interest, management fees, travel, highway tax, and miscellaneous expenses.

Margins and Costs for Field Spreader Operations

Spreading revenue for 11 stores having field spreader operations in 1953-54 averaged $2.10 a ton. (Table 9.) Revenue for 10 stores in 1954-55 averaged $2.11 a ton. Expenses of $1.74 and $1.60 a ton, respectively, for the 2 years left net margins of $0.36 and $0.51 a ton.

Stores spreading less than 3,000 tons per truck showed a net loss of $0.11 and $0.25 a ton for the 2 years. This was the case even though average revenue per ton was somewhat higher for this group of stores than for the higher volume groups. Margin as a percent of revenue ranged from -9.4 percent for the low volume group in 1954-55 to 38.2 percent for the high volume group the same year.

Table 10 and figure 3 give a detailed breakdown of costs per ton. Average cost for the field spreader type operation was lower than for direct plant-to-farm service because of the smaller number of services involved. The lower cost in 1954-55 compared with 1953-54 reflects more efficient use of labor and lower repair, oil, and lubrication costs.

Table 9.--Revenue, expense, and net margins per ton and per truck in relation to volume of lime spread per truck at G.L.F. service stores having field spreader operations, 1953-54 and 1954-55.

Tons spread per truck	Dollars per ton			Dollars per truck			Percent net margin was of revenue
	Revenue	Expense	Net margin	Revenue	Expense	Net margin	
Under 3,000 tons:							
1953-54	$2.40	$2.51	$-.11	$3,991	$4,182	$-191	-4.8
1954-55	2.64	2.89	-.25	4,260	4,661	-401	-9.4
3,000 to 3,999 tons:							
1953-54	2.08	1.42	.66	7,635	5,195	2,440	32.0
1954-55	1.83	1.28	.55	6,294	4,405	1,889	30.0
4,000 tons and over:							
1953-54	1.96	1.51	.45	10,245	7,881	2,364	23.1
1954-55	2.14	1.32	.82	9,090	5,616	3,474	38.2
All such operations:							
1953-54 (2,913 tons	2.10	1.74	.36	6,110	5,063	1,047	17.1
1954-55 (3,022 tons	2.11	1.60	.51	6,367	4,843	1,524	23.9

The range in spreading costs a ton among stores having field spreader operations was as follows:

Fiscal year	Entire group of stores		Middle half of stores	
	Number of stores	Range in costs	Number of stores	Range in costs
1953-54	11	$1.25 to $2.95	5	$1.45 to $1.80
1954-55	10	1.03 to 5.95	5	1.20 to 1.91

Some, but by no means all, of this variation in costs among stores was explained by variation in tonnage spread per truck at the different stores. Table 10 and figure 3 show this variation. Costs of spreading at points averaging less than 3,000 tons a truck were $2.51 and $2.89 for the 2 years, respectively. Costs for the 3,000-ton to 3,999-ton group were somewhat lower than for the 4,000-ton and over group for respective years. Average costs for these two groups for the 2 years ranged from $1.28 a ton to $1.51 a ton. Lower average cost in the 3,000-ton to 3,999-ton group than in the 4,000-ton and over group seemed to indicate that the high volume group had approached the point of diminishing returns. However, the data were too limited to be conclusive on this point.

Wages, depreciation, and direct truck expenses again were major cost items accounting for from 84 to 88 percent of total cost of spreading (Appendix table 2). Labor represented about 28 percent, depreciation 26 percent, and direct truck expense 31 percent. There was a marked decline in the magnitude of these items between the low volume group of stores and the two higher volume groups.

Table 10.--Costs of spreading lime in relation to tons spread per truck at G.L.F. service stores with field spreader type operations, 1953-54 and 1954-55.

Item	All service stores		Stores[1] where tonnage per truck was:					
			Under 3,000		3,000 to 3,999		4,000 and over	
	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55
Number of stores	11	10	4	3	2	3	3	4
Number of trucks	14	14	6	5	2	5	4	4
Average tons per truck	2,913	3,022	1,667	1,613	3,665	3,443	5,214	4,257
Expenses per ton:								
Wages	$0.50	$0.45	$0.60	$0.65	$0.32	$0.41	$0.53	$0.40
Depreciation	.44	.42	.90	.96	.43	.25	.24	.35
Direct truck expense:								
Gasoline	.16	.15	.19	.19	.13	.16	.16	.12
Repairs, oil, lubrication	.34	.29	.41	.50	.21	.23	.35	.24
Tires and tubes	.06	.05	.05	.14	.10	.03	.04	.02
Total direct truck	.56	.49	.65	.83	.44	.42	.55	.38
Other expenses:								
Management fee	.10	.10	.10	.10	.10	.10	.11	.10
Insurance and license	.10	.10	.18	.22	.08	.08	.06	.07
Interest	.03	.04	.07	.12	.03	.02	.02	.02
Miscellaneous	.01	(2)	.01	.01	.02	(2)	(2)	(2)
Total other expense	.24	.24	.36	.45	.23	.20	.19	.19
Total expense	$1.74	$1.60	$2.51	$2.89	$1.42	$1.28	$1.51	$1.32

[1] Excludes stores operating trucks only part of the year.
[2] Less than $.005.

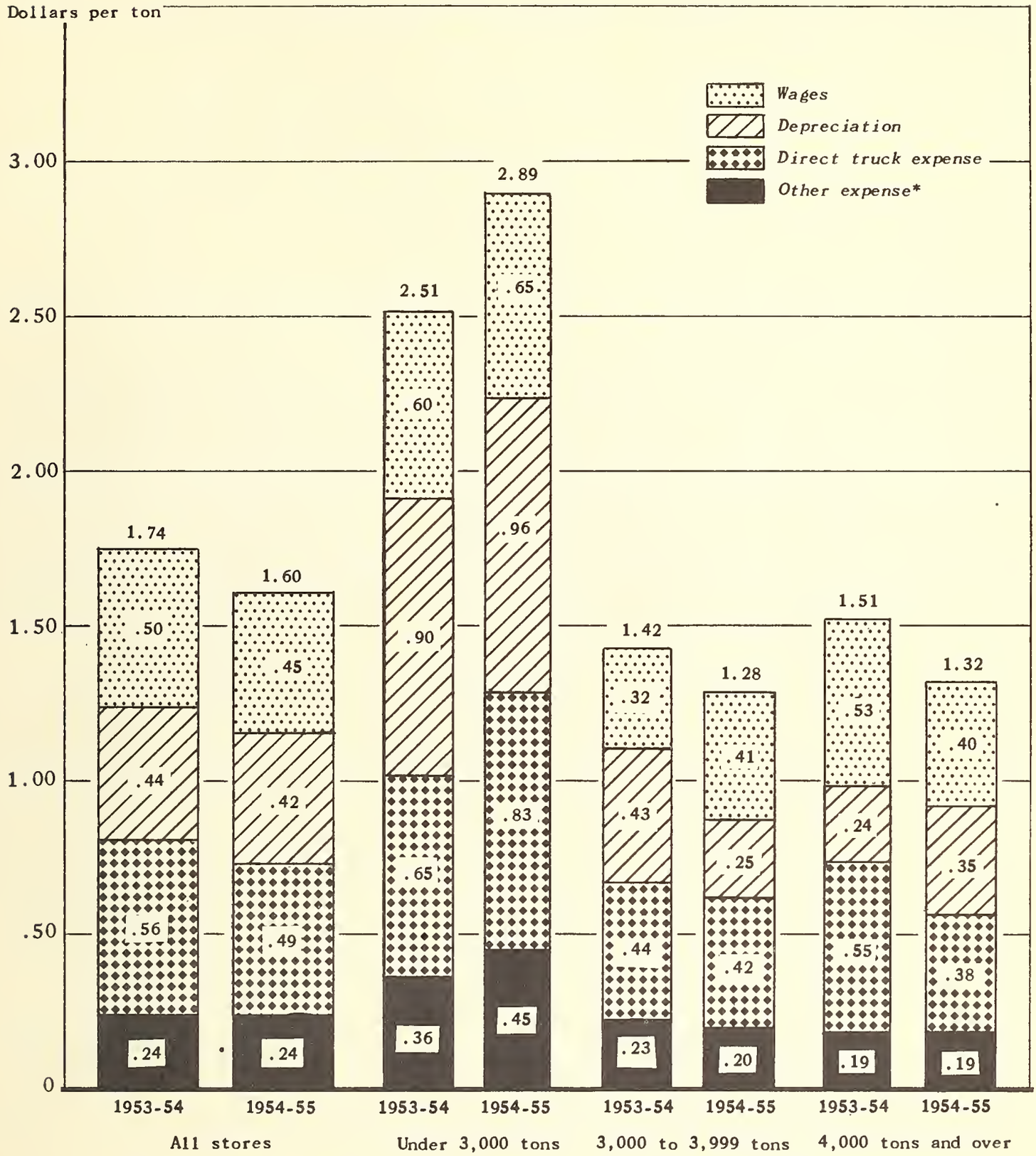
Margins and Costs for Local Stockpile Operations

Revenue from the spreading service for 24 stores having local stockpile operations averaged $2.93 a ton in 1953-54 compared with $2.84 a ton for 23 stores in 1954-55 (Table 11). Expenses of $2.24 and $2.26 for the 2 years left net margins of $0.68 and $0.58 a ton respectively. For the 2 years together, net margins averaged slightly over one-fifth of revenues.

Although per ton revenue was highest in low volume stores, net margins in these stores were only one-fourth to one-half of those in the high volume stores. Net margins

Figure 3

Costs of spreading lime, in relation to tons spread per truck at G.L.F. service stores with field spreader type operations, 1953-54 and 1954-55



*Other expense includes insurance, license, interest, management fees, travel, highway tax, and miscellaneous expenses.

ranged from $0.21 per ton in low volume stores in 1954-55 to $0.98 in high volume stores in 1953-54. Percentagewise, the range was from 6.6 percent to 35.3 percent for corresponding volume groups and years.

Table 11.--Revenue, expense, and net margin per ton and per truck in relation to volume of lime spread per truck at G.L.F. service stores having local stockpile operations, 1953-54 and 1954-55.

Tons spread per truck	Dollars per ton			Dollars per truck			Percent net margin was of revenue
	Revenue	Expense	Net margin	Revenue	Expense	Net margin	
Under 3,000 tons:							
1953-54	$3.21	$2.79	$0.42	$6,838	$5,952	$886	13.0
1954-55	3.13	2.92	.21	7,357	6,871	486	6.6
3,000 to 3,999 tons:							
1953-54	2.94	2.29	.65	11,212	8,712	2,500	22.3
1954-55	2.61	2.18	.43	9,547	7,969	1,578	16.5
4,000 tons and over:							
1953-54	2.79	1.81	.98	13,341	8,628	4,713	35.3
1954-55	2.90	2.05	.85	13,637	9,628	4,009	29.4
All such operations:							
1953-54 (2,729 tons)	2.93	2.24	.69	7,994	6,105	1,889	23.6
1954-55 (3,622 tons)	2.84	2.26	.58	10,289	8,205	2,084	20.3

Table 12 and figure 4 show detailed costs of hauling and spreading lime at G.L.F. service stores with local stockpile operations. Although total costs were about the same for the 2 years there was considerable variation in the makeup of these costs. This was true of direct truck expenses, which were higher in the latter year. Difference also existed in tons spread per truck between the 2 years. For 1953-54, 27 trucks spread an average of 2,729 tons each compared with an average tonnage of 3,622 for each of 26 trucks in 1954-55.

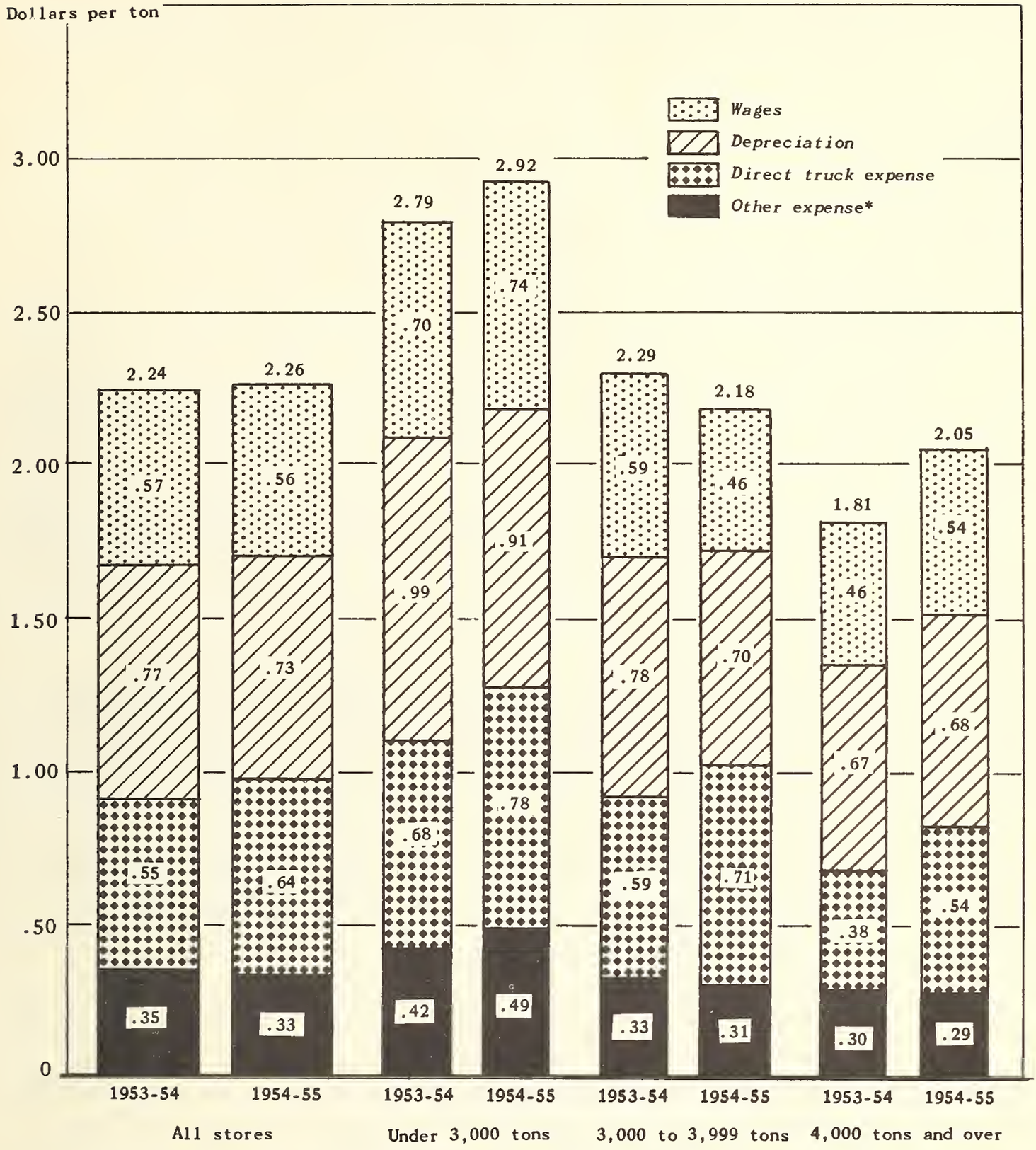
Ranges in costs among stores having bulk lime stockpiles for the 2 years were as follows:

Fiscal year	Entire group of stores		Middle half of stores	
	Number of stores	Range in costs	Number of stores	Range in costs
1953-54	24	$1.51 to $4.20	12	$2.00 to $2.58
1954-55	23	1.76 to 4.01	11	1.97 to 2.57

A principal cause of variation in costs among stores was the difference in volume spread per truck. The influence of this factor is graphically illustrated in figure 4. Spreading costs at stores averaging less than 3,000 tons a truck were $2.79 and $2.92 a ton for the years 1953-54 and 1954-55 respectively. This compares with $2.29 and $2.18 a ton for the 3,000- to 3,999-ton group and $1.81 and $2.05 a ton for the 4,000-ton and over group. Thus, there was approximately $1 a ton difference in costs between the low and the high volume groups.

Figure 4

Costs of spreading lime, in relation to tons spread per truck at G.L.F. service stores having local stockpiles, 1953-54 and 1954-55



*Other expense includes insurance, license, interest, management fees, travel, highway tax, and miscellaneous expenses.

Table 12.--Costs of spreading lime in relation to tons spread per truck at G.L.F. service stores having local stockpiles, 1953-54 and 1954-55.

Item	All such stores		Stores[1] where tonnage per truck was:					
			Under 3,000		3,000 to 3,999		4,000 and over	
	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55
Number of stores	24	23	9	7	5	8	5	8
Number of trucks	27	26	10	8	6	9	5	9
Average tons per truck	2,729	3,622	2,130	2,352	3,810	3,662	4,775	4,710
Expenses per ton:								
Wages	$0.57	$0.56	$0.70	$0.74	$0.59	$0.46	$0.46	$0.54
Depreciation	.77	.73	.99	.91	.78	.70	.67	.68
Direct truck expense:								
Gasoline	.23	.21	.29	.27	.24	.20	.17	.20
Repairs, oil, lubrication	.25	.35	.31	.42	.27	.43	.16	.26
Tires and tubes	.07	.08	.08	.09	.08	.08	.05	.08
Total direct truck	.55	.64	.68	.78	.59	.71	.38	.54
Other expenses:								
Management fee	.10	.10	.10	.10	.10	.10	.10	.10
Insurance and license	.14	.12	.19	.17	.12	.12	.11	.10
Interest	.10	.09	.13	.11	.11	.08	.08	.09
Miscellaneous	.01	.02	(2)	.11	(2)	.01	.01	(2)
Total other expenses	.35	.33	.42	.49	.33	.31	.30	.29
Total expense	$2.24	$2.26	$2.79	$2.92	$2.29	$2.18	$1.81	$2.05

[1] Excludes stores operating trucks only part of the year.
[2] Less than $.005.

Depreciation was the major cost item for stores having local stockpile operations--averaging $0.77 and $0.73 a ton for 1953-54 and 1954-55, respectively. Wages and direct truck expense were of about equal importance. Direct truck expense was $0.55 and $0.64 a ton for the 2 years, respectively, and wages during that period fell within this range. Other expenses including management or administrative insurance, license, interest, and miscellaneous were $0.35 and $0.33 a ton, respectively, for the 2 years.

As volume of material spread per truck increased, the magnitude of all cost items decreased. For example wages were highest--$0.74 a ton--in the low volume group of stores and lowest--$0.46 a ton--in the medium and high volume stores. Similarly, depreciation reached a high of $0.99 a ton in the low volume stores compared to a low of $0.67 a ton in the high volume stores. Differences in other costs between low and high volume stores were generally in the same direction.

Wages accounted for about 25 percent of costs in the lime stockpiling operation, depreciation was 33 percent, and direct truck expenses averaged about 26 percent (Appendix table 3). There did not appear to be a significant difference in the distribution of costs, percentagewise, between high and low volume stores. Contrary to what one would ordinarily think, depreciation made up about the same percentage of total costs in high volume stores as in low volume stores. This apparently resulted from low volume stores being inefficient in the use of all cost factors. As volume increased, per ton costs for all factors decreased in about the same proportion. This was true for all cost items except management fee which was a fixed charge per ton and thus was a higher proportion of total costs among high volume stores than among low volume stores.

Margins and Costs for Combination Type Operations

Revenue per ton at 4 stores having combination stockpile and direct-plant-to-farm operation in 1953-54 averaged $3.18 and in 1954-55 averaged $3.34 for 6 stores. (Table 13). Expenses of $2.89 and $2.75, respectively, for the 2 years resulted in net margins of $0.29 and $0.59 a ton. On a per truck basis, net margins amounted to $1,158 in 1953-54 and $1,544 in 1954-55. This was 9.1 and 17.7 percent, respectively, of spreading revenues for the 2 years.

Table 13.--Revenue, expense, and net margin per ton and per truck in relation to volume of lime spread per truck at G.L.F. service stores having combination of direct plant-to-farm and local stockpile operations, 1953-54 and 1954-55.

Tons spread per truck	Dollars per ton			Dollars per truck			Percent net margin was of revenue
	Revenue	Expense	Net margin	Revenue	Expense	Net margin	
Under 3,000 tons:							
1953-54.....							
1954-55.....	$3.34	$2.95	$0.39	$8,954	$7,910	$1,044	11.7
3,000 to 3,999 tons:							
1953-54.....	3.39	3.13	.26	10,825	9,980	845	7.8
1954-55.....							
4,000 tons and over:							
1953-54.....	2.98	2.67	.31	15,511	13,883	1,628	10.5
1954-55.....	3.48	2.56	.92	21,011	15,464	5,547	26.4
All such operations:							
1953-54 (3,999 tons)	3.18	2.89	.29	12,700	11,542	1,158	9.1
1954-55 (2,612 tons)	3.34	2.75	.59	8,712	7,168	1,544	17.7

Table 14 and figure 5 show detailed costs of hauling and spreading at service stores having combination local stockpile and direct plant-to-farm operations for 1953-54 and 1954-55. There was considerable variation in the magnitude of various cost items between the 2 years. All items with the exception of direct truck expenses were higher in the latter year. Direct truck expenses, however, declined from $1.04 a ton in 1953-54 to $0.82 a ton for 1954-55.

Overall ranges in costs among stores having the combination type operation for the 2 years were as follows:

Fiscal year	Entire group of stores		Middle half of stores	
	Number of stores	Range in costs	Number of stores	Range in costs
1953-54.....	4	$2.25 to $3.31	2	$2.48 to $3.01
1954-55.....	6	1.11 to 3.15	4	1.81 to 2.92

Because of the small number of stores falling in this group, there is no clear indication of the influence of volume spread per truck on costs. This is shown graphically in figure 5. Appendix table 4 gives percentage distribution of costs related to volume spread per truck. Wages averaged about 31 percent, depreciation 24 percent, and direct truck expenses approximately 33 percent.

Table 14.--Costs of spreading lime in relation to tons spread at G.L.F. service stores with combination stockpile and direct plant-to-farm operations, 1953-54 and 1954-55.

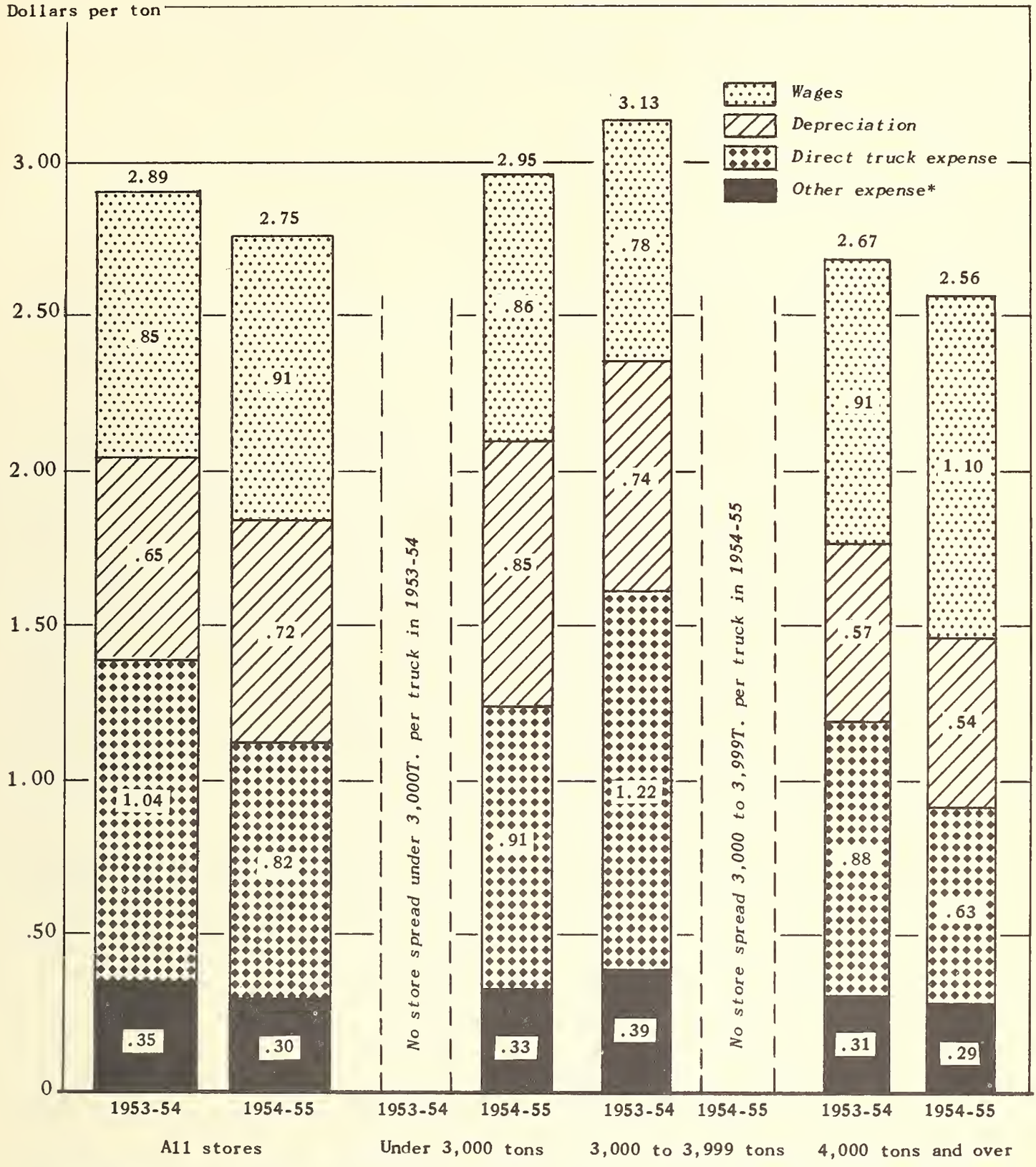
Item	All such stores		Stores[1] where tonnage per truck was:					
			Under 3,000		3,000 to 3,999		4,000 and over	
	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55
Number of stores	4	6	-	3	2	-	2	1
Number of trucks	5	8	-	5	3	-	2	1
Average tons per truck	3,999	2,612	-	2,678	3,192	-	5,211	6,042
Expenses per ton:								
Wages	$0.85	$0.91	-	$0.86	$0.78	-	$0.91	$1.10
Depreciation	.65	.72	-	.85	.74	-	.57	.54
Direct truck expense:								
Gasoline	.32	.32	-	.32	.31	-	.33	.34
Repairs, oil, lubrication	.56	.46	-	.54	.72	-	.42	.29
Tires and tubes	.16	.04	-	.05	.19	-	.13	(2)
Total direct truck	1.04	.82	-	.91	1.22	-	.88	.63
Other expenses:								
Management fee	.10	.09	-	.09	.12	-	.09	.10
Insurance and license	.14	.14	-	.16	.16	-	.11	.12
Interest	.10	.07	-	.08	.11	-	.09	.07
Miscellaneous	.01	(2)	-	(2)	(2)	-	.02	(2)
Total other expense	.35	.30	-	.33	.39	-	.31	.29
Total expense	$2.89	$2.75	-	$2.95	$3.13	-	$2.67	$2.56

[1] Excludes stores operating trucks only part of the year.
[2] Less than $.005.

Appendix table 5 shows costs of operating trucks on a per mile basis. Appendix table 6 shows man-hour requirements per ton of material spread and per truck.

Figure 5

Costs of spreading lime in relation to tons spread per truck at G.L.F. service stores with combination stockpile and direct plant-to-farm operations, 1953-54 and 1954-55



*Other expense includes insurance, license, interest, management fees, travel, highway tax, and miscellaneous expenses.

APPENDIX

Appendix table 1.--Percentage distribution of lime spreading costs at G.L.F. service stores with direct plant-to-farm operation of spreader truck, 1953-54 and 1954-55.

Cost item	All such stores		Stores where tonnage per truck was:					
			Under 3,000		3,000 to 3,999		4,000 and over	
	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55
Wages	27.9	27.1	27.4	23.2	25.2	29.0	32.2	32.1
Depreciation	26.0	26.4	25.8	28.7	26.3	25.4	25.8	23.9
Direct truck expense:								
Gasoline	12.8	12.3	11.3	11.6	13.3	13.1	13.8	12.3
Repairs, oil, lubrication	16.2	16.2	19.7	19.4	17.6	13.9	11.5	13.6
Tires and tubes	3.8	5.6	2.9	5.8	4.7	6.3	2.8	4.9
Total direct truck expense	32.8	34.1	33.9	36.8	35.6	33.3	28.1	30.8
Other expenses:								
Management fee	3.8	3.5	3.2	2.9	3.6	4.0	4.6	4.1
Insurance and license	5.7	5.3	6.5	5.2	5.7	5.1	5.1	4.5
Interest	3.4	3.2	2.9	3.2	3.2	2.8	3.7	2.9
Miscellaneous	.4	.4	.3	[1]	.4	.4	.5	1.7
Total other expense	13.3	12.4	12.9	11.3	12.9	12.3	13.9	13.2
Total expense	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Less than .05 percent.

Appendix table 2.--Percentage distribution of lime spreading costs at G.L.F. service stores with field spreader operations, 1953-54 and 1954-55.

Cost item	All such stores		Stores where tonnage per truck was:					
			Under 3,000		3,000 to 3,999		4,000 and over	
	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55
Wages	28.7	28.1	23.9	22.5	22.6	32.0	35.1	30.3
Depreciation	25.3	26.2	35.8	33.2	30.3	19.5	15.9	26.5
Direct truck expense:								
Gasoline	9.2	9.4	7.6	6.6	9.2	12.5	10.6	9.1
Repairs, oil, lubrication	19.5	18.1	16.3	17.3	14.8	18.0	23.2	18.2
Tires and tubes	3.4	3.1	2.0	4.8	7.0	2.3	2.6	1.5
Total direct truck expense	32.1	30.6	25.9	28.7	31.0	32.8	36.4	28.8
Other expenses:								
Management fee	5.8	6.3	4.0	3.5	7.0	7.8	7.3	7.6
Insurance and license	5.8	6.3	7.2	7.6	5.6	6.3	4.0	5.3
Interest	1.7	2.5	2.8	4.2	2.1	1.6	1.3	1.5
Miscellaneous	.6	[1]	.4	.3	1.4	[1]	[1]	[1]
Total other expense	13.9	15.1	14.4	15.6	16.1	15.7	12.6	14.4
Total expense	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Less than .05 percent.

Appendix table 3.--Percentage distribution of lime spreading costs at G.L.F. service stores having local stockpiles, 1953-54 and 1954-55.

Cost item	All such stores		Stores where tonnage per truck was:					
			Under 3,000		3,000 to 3,999		4,000 and over	
	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55
Wages	25.4	24.8	25.1	25.3	25.8	21.1	25.4	26.3
Depreciation	34.4	32.3	35.5	31.2	34.0	32.1	37.0	33.2
Direct truck expense:								
Gasoline	10.3	9.3	10.4	9.2	10.5	9.2	9.4	9.7
Repairs, oil, lubrication	11.2	15.5	11.1	14.4	11.8	19.7	8.8	12.7
Tires and tubes	3.1	3.5	2.9	3.1	3.5	3.7	2.8	3.9
Total direct truck expense	24.6	28.3	24.4	26.7	25.8	32.6	21.0	26.3
Other expenses:								
Management fee	4.5	4.4	3.6	3.4	4.4	4.6	5.5	4.9
Insurance and license	6.2	5.3	6.8	5.8	5.2	5.5	6.1	4.9
Interest	4.5	4.0	4.6	3.8	4.8	3.7	4.4	4.4
Miscellaneous	.4	.9	[1]	3.8	[1]	.4	.6	[1]
Total other expense	15.6	14.6	15.0	16.8	14.4	14.2	16.6	14.2
Total expense	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Less than .05 percent.

Appendix table 4.--Percentage distribution of lime spreading costs at G.L.F. service stores with combination stockpile and direct plant-to-farm operations, 1953-54 and 1954-55.

Cost item	All such stores		Stores where tonnage per truck was:					
			Under 3,000		3,000 to 3,999		4,000 and over	
	1953-54	1954-55	1953-54[1]	1954-55	1953-54	1954-55[1]	1953-54	1954-55
Wages	29.4	33.1		29.2	25.1		34.1	43.0
Depreciation	22.5	26.2		28.8	23.6		21.3	21.1
Direct truck expense:								
Gasoline	11.1	11.6		10.8	9.9		12.4	13.3
Repairs, oil, lubrication	19.4	16.7		18.3	22.9		15.7	11.3
Tires and tubes	5.5	1.5		1.7	5.9		4.9	([2])
Total direct truck expense	36.0	29.8		30.8	38.7		33.0	24.6
Other expense:								
Management fee	3.5	3.3		3.1	3.7		3.4	3.9
Insurance and license	4.8	5.1		5.4	5.2		4.1	4.7
Interest	3.5	2.5		2.7	3.7		3.4	2.7
Miscellaneous	.3	([2])		([2])	([2])		.7	([2])
Total other expense	12.1	10.9		11.2	12.6		11.6	11.3
Total expense	100.0	100.0		100.0	100.0		100.0	100.0

[1] No trucks with these volumes.
[2] Less than .05 percent.

Appendix table 5.--Average costs per mile of operating lime and fertilizer spreader trucks at G.L.F. service stores with different types of operations, 1953-54 and 1954-55[1]

[Dollars per mile]

Cost item	Type of operation[2]									
	Plant-to-farm		Field spreading		Stockpile		Combination		Average all operations	
	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55	1953-54	1954-55
Number of stores	15	11	4	4	20	22	2	5	41	42
Wages	$0.13	$0.15	$0.36	$0.45	$0.26	$0.25	$0.20	$0.18	$0.18	$0.21
Depreciation	.12	.15	.16	.24	.35	.33	.12	.17	.18	.24
Gasoline	.06	.07	.14	.14	.10	.10	.06	.07	.08	.08
Insurance and license	.03	.03	.05	.08	.06	.05	.03	.03	.04	.04
Repairs, oil, lubrication	.08	.08	.31	.23	.11	.16	.13	.11	.10	.13
Tires and tubes	.01	.03	.04	.02	.03	.04	.03	.01	.02	.03
Miscellaneous	([3])	.01	([3])	--	([3])	.01	([3])	--	([3])	.01
Sub-total	.43	.52	1.06	1.16	.91	.94	.57	.57	.60	.74
Administrative	.02	.02	.08	.09	.04	.04	.02	.02	.03	.03
Interest	.02	.02	.01	.03	.05	.04	.02	.01	.02	.03
Total	.47	.56	1.15	1.28	1.00	1.02	.61	.60	.65	.80

[1] Costs of the different types of operation are not comparable because they involve different amounts of services and are located at varying distances from the lime or fertilizer source.
[2] Columns may not add to totals because of rounding.
[3] Less than $.005.

Appendix table 6.--Man-hours required for spreading lime at G.L.F. service stores having different types of operations, 1953-54 and 1954-55.

Type of operation	Man-hours			
	Per ton spread		Per truck	
	1953-54	1954-55	1953-54	1954-55
Direct plant-to-farm	0.46	0.44	1,415	1,253
Field spreader	.26	.29	755	879
Local stockpile	.40	.36	1,099	1,302
Combination	.44	.46	1,903	1,198
All types of operation	.39	.38	1,176	1,187

GPO 910756