A STUDY OF FARM TRUCKS AND THEIR USE FOR HANDLING AGRICULTURAL MATERIALS

Thesis for the Degree of M. S.
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This is to certify that the

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A Study of Farm Trucks and Their Use For
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F. H. Buelow, Assoc. Prof.

Major professor

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A STUDY OF FARM TRUCKS AND THEIR USE FOR HANDLING AGRICULTURAL MATERIALS

by

John Andrews True

AN ABSTRACT

Submitted to the Colleges of Agriculture and Engineering of Michigan State University of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE
in
AGRICULTURAL ENGINEERING

Department of Agricultural Engineering

Approved F H Bucklow

AN ABSTRACT

The number of trucks on farms in the United States has increased steadily since 1920 with the exception of the depression years of the 1930's. This increase has appeared both in the percentage of farms reporting trucks and in the number of trucks per farm. The changing of agricultural patterns to fewer and larger farms has helped to increase the demand for the farm truck.

The overall purpose of this research was to study the use of trucks on farms and to form a basis for: (1) recommendations for the use of trucks for handling agricultural materials; (2) information for publication concerning farm materials handling; and (3) design of future vehicle models.

A sample of 255 truck owners was surveyed to get information concerning the number and size of trucks used, maximum load carried, miles driven per year, materials handled, special equipment used, and general comments regarding the trucks in use and the type of equipment desired. Farmers of above average efficiency were selected for the sample to observe the greatest possible number of successful adaptations of trucks into the various materials handling systems.

The sample represented 633 trucks, many of which were overloaded at least part of the time. Truck use was very

limited on many of the farms with 34 per cent of the trucks being driven less than 4,000 miles per year.

The use of specialized unloading equipment on truck bodies has further limited the use of some trucks since a truck equipped for one type of material is unable to handle other types. Dismounting one specially equipped body and mounting another on the truck chassis is a time consuming and often dangerous job.

A proposed solution to the farm truck problem involved the use of small semi-trailers. The truck-tractor equipped with a modified pickup body would serve for light hauling and run-about duty, while the semi-trailers provide easily interchangeable bodies for handling larger loads.

It was concluded that the cost of owning and operating farm trucks was often excessive due to limited use of the trucks. Increasing the efficiency of the farm truck must be accomplished through greater adaptability of the vehicle and through more complete integration of the truck into the materials handling system.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The farmer today, while possessing many talents, must also be proficient in the art of materials handling. Once the variety of seed or livestock is selected and the planning details completed, farming then becomes largely a matter of moving materials. The seed and fertilizer must be moved from storage to the soil; the harvest must be taken to the feedlot, storage, or market; and finally the end product of the farming enterprise must be delivered to market.

At one time the horse and wagon was used to transport most of the materials needed or produced on the farm. This mode gave way, eventually, to the tractor and wagon combination and the truck. The tractor and wagon has proved itself for short distance and off-the-road hauling, while truck use has increased with the development of the highway system to reach an ever expanding market. These two modes have developed simultaneously. As special handling and unloading equipment appeared in one it soon found a counterpart in the other.

The changing of agricultural patterns to fewer and larger farms has increased the demand for trucks on the farm. As distances from field to farmstead increase the tractor and wagon becomes less efficient than the truck.

A farmer who has only a short distance to haul small amounts of material sacrifices little time and fuel by using a tractor and wagon. However, as distances grow longer and amounts larger, the expenditures of time and operating costs also increase; in many instances a truck is not available, but the tractor and wagon is--thus the inefficient practice continues. Regardless of which method of transportation is used its ultimate efficiency is determined by how well it is incorporated into the overall materials handling system.

In any consideration of a farm materials handling system three vital aspects must be examined. The first aspect, and perhaps the most important, is that of volume. The amounts of material that must be transported in order to harvest a crop are large. Fertilizer applications of from 300 to 1,000 pounds per acre are common. While the volumes of seed planted are relatively small, the volumes of the harvested crops can be measured in hundreds and even thousands of tons per farm. Small grains yield from 1 to 2-1/2 tons per acre; hay 6 to 8 tons per acre; sugar beets and silage crops produce from 12 to 20 tons per acre.

Four farming enterprises and the amounts of material handled for each type are listed in Table I. These farming enterprises are currently considered by agricultural engineers to be of one-man size.

The amounts and kinds of material handled, for any given farming operation, can indicate many requirements in

the materials handling program. It is at this point that the second aspect of the materials handling system must be examined. Specialized equipment is necessary to move the various quantities and types of material on any given farm. The materials handled may be classified into three categories: (1) free flowing material such as small grains, pellets, and liquids; (2) semi-flowing materials such as silage and chopped hay or straw; and (3) non-flowing materials which are represented by manure or baled hay or straw. Each of these categories, and even different materials within a category requires specialized handling equipment.

TABLE I

Some One-Man Farming Operations and the Amount of Materials Handled for Each

Farming Enterprise	Amounts of material handled (tons per year)
40 dairy cows	1,000
400 beef feeders	2,300
1,000 feeder pigs	700
10,000 bu. corn	1,200

In many farm operations three, four, or more pieces of equipment may be used during a normal working day. The third and final aspect of the farm materials handling system under consideration is that equipment is used frequently and for short periods of time. This may be easily pointed out by the use of a hypothetical situation which

might arise in any livestock feeding program. In the morning the farmer will feed his cattle using a self-unloading forage box. Later he may need a livestock rack to haul some of his cattle to market. In the afternoon his chores include hauling and spreading manure or bringing home the hay he purchased at auction. Before his day is done he must again use his power feeder box to feed the cattle.

Heretofore much of the specialized equipment has been mounted on wagons using the farm tractor for power. Changing from one piece of equipment to another involved only a change of wagons behind the tractor. Today, however, expanding farm size, often to non-contiguous acreage, longer hauling distances, and accelerated harvesting methods make the truck a more efficient vehicle.

Although the farm truck is superior to the wagon for rapid hauling over increasing distances, it has failed to equal or even approach the versatility of the tractor in changing materials handling units. As a result, if farmers are to use trucks, they are forced to maintain a separate truck for each piece of materials handling equipment. This allocation of trucks to specific chores has resulted in their intermittent and sporadic use. Attempts to extend the use of these vehicles often exceed their designed capabilities and result in the misuse of farm trucks.

PURPOSE OF STUDY

The research undertaken for this thesis was to study these problems and to form a basis for (1) recommendations for use of trucks for handling agricultural materials, (2) information for publications concerning farm materials handling, and (3) designs for future vehicle models.

LITERATURE REVIEW

Much of the published information concerning farm trucks is outdated and of limited use today. The rapid evolution of agricultural processes and equipment has emphasized certain advantages of the farm truck and also invoked new demands upon it. However, many of the factors that determine truck use are still applicable. .

The number of trucks on farms in the United States has increased steadily since 1920, with the exception of the depression years of the 1930's. This increase has appeared both in the per cent of farms reporting trucks and in the number of trucks per farm as reported in the 1954 Census. Surveys since the Census indicate a continuation of this rise.

Cromarty (1959) analyzed 1954 Census data to determine some of the factors affecting truck distribution. He found a significantly larger number of trucks on farms selling products valued over $10,000 than on farms with sales under $10,000. Poultry farms consistently appeared to have the lowest number of trucks per farm. Dairy farms were also low, while vegetable and livestock farms were fairly high in the number of trucks per farm. Cash grain farms rated near the top.

He also found a significant difference in the number of trucks per farm among geographical areas for farms classified as cotton, cash grain, livestock, other field crops, and general. However, farms classified fruit and nut, vegetable, dairy, and poultry showed no difference in the number of trucks per farm between geographical areas.

The type of truck purchased also varied by geographical area. Of the trucks purchased by farmers in the southern states, 91 per cent were pickups; in the northern and western states, 70 and 80 per cent of the trucks purchased by farmers were pickups. A breakdown by capacity shows 45 per cent, 35 per cent, and 60 per cent of the trucks rated at 1/2 ton or less for the north, south, and west, respectively.

The distribution of trucks was heaviest in areas centered around the cities of San Jose, Los Angeles, Seattle, Denver, Jacksonville, Atlanta, and Fargo. The lowest concentration of trucks per farm occurred around Omaha, the Davenport-Des Moines area, St. Louis, and the Lansing-Indianapolis area. One reason for the low number of trucks per farm in these areas may be the well developed custom trucking industry which reduces the need for farmer-owned vehicles. Also, the development of rubber tires on tractors and wagons has tended to preclude truck use in areas where markets are close to the farm.

Approximately 1/3 of the 498,000 farm trucks purchased in 1955 were new and the remaining 2/3 were used.

Capstick (1961) also reported a 1/3 to 2/3 split between new and used farm truck purchases. He also presented cost data for 1/2 ton and 1 1/2 ton trucks in Eastern Arkansas as of 1958 as shown in Figures 1 and 2.

These curves indicate a decrease in the cost per mile as either the miles per year or the years of use increase. The decrease is small, however, after reaching a truck life of 60,000 miles.

The major factors in the decreasing cost per mile are: (1) a decreasing rate of depreciation as the years of use increase, and (2) a reduction of fixed costs per mile, such as license, interest, and insurance, as the miles per year increase. This reduction of costs per mile is partially offset by an increase in variable costs per mile as truck mileage increases.

Willett's (1953) data for commercial trucks show a similar decrease in costs per mile to approximately a 40,000 mile point and then increases slightly with increased years of use (Figure 3). The difference between these curves and those in Figures 1 and 2 is partially due to the unequal rates of depreciation used in the two sets of data as seen in Figure 4.

The costs per mile in these two sets of data cannot be compared directly because the various included costs are different. Similarly, no individual truck study would produce the same cost per mile data. However, the trend of the curves is significant and universally applicable.

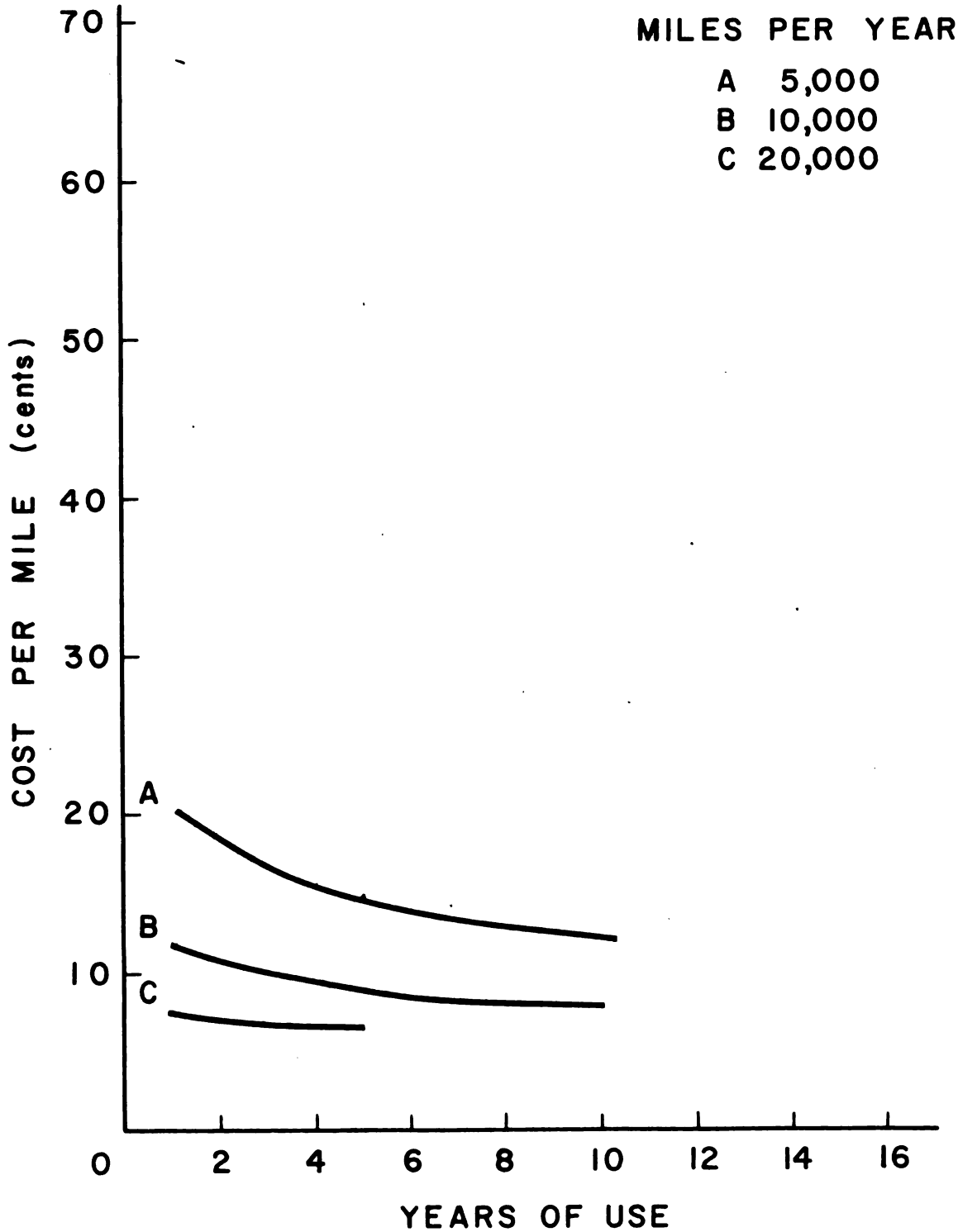

Fig. 1. Cost of owning and operating 1/2 ton farm truck. From Capstick (1961)

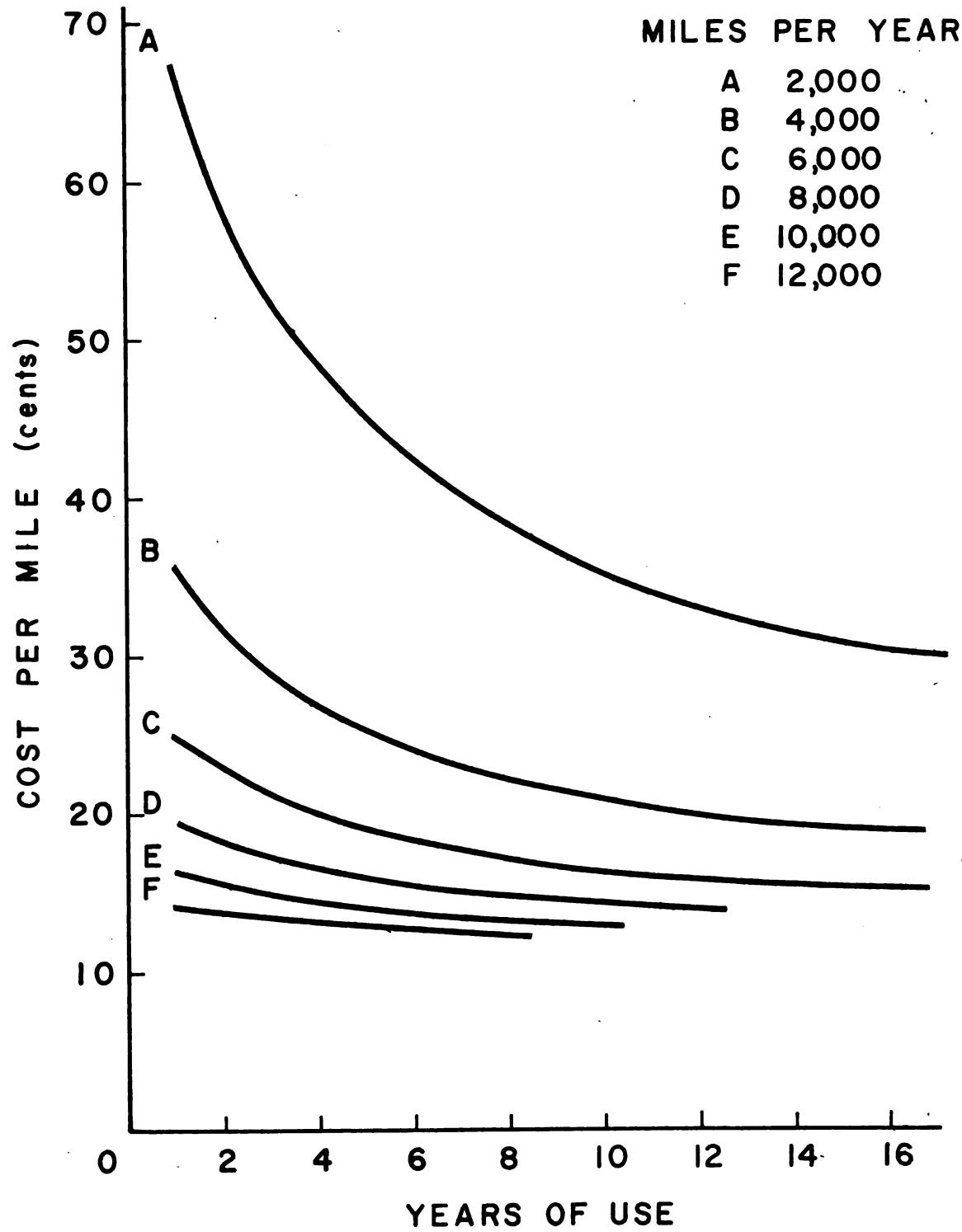

Fig. 2. Cost of owning and operating 1-1/2 ton farm trucks. From Capstick (1961)

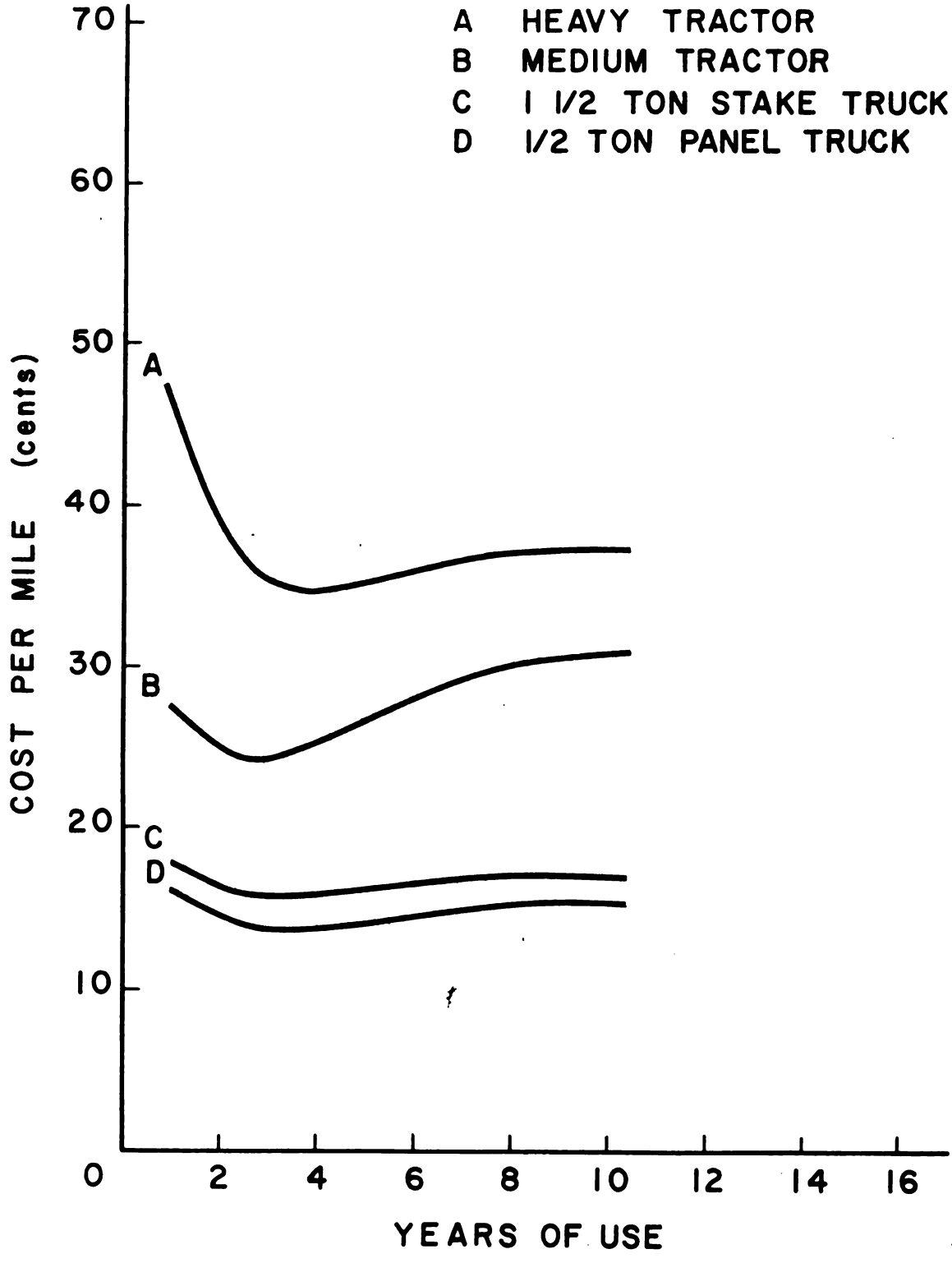

Fig. 3. Operating costs for commercial trucks. From Willet (1953)

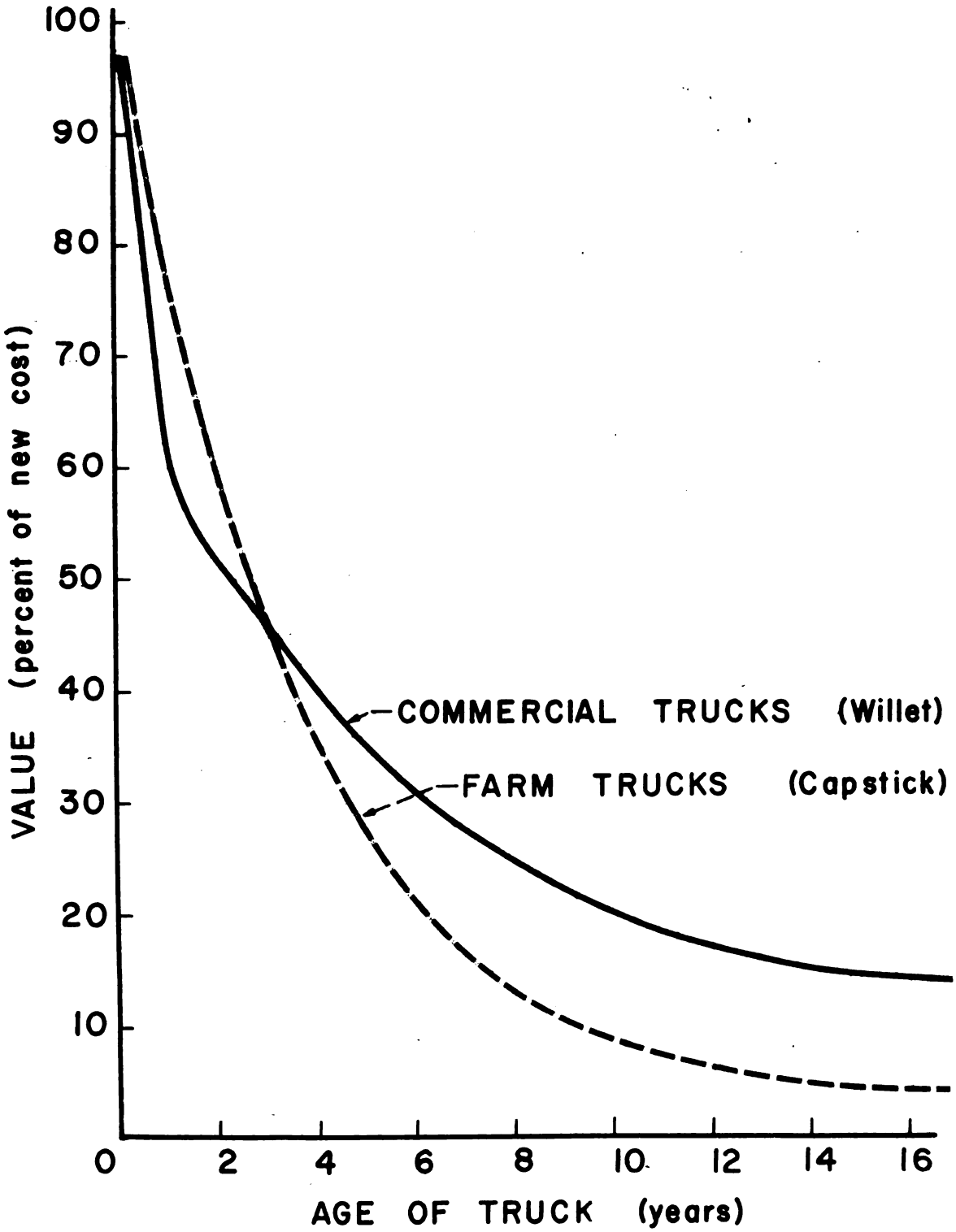

Fig. 4. Value versus age of trucks.

The rapid reduction in cost per mile leading to a low point or leveling off with increased use per year and/or years of use will apply to any truck. The low point in the curve indicates the most economical replacement period.

Articles concerning current usage of trucks on farms are largely descriptions of new or unusual adaptations published in papers or magazines or in advertising matter put out by equipment manufacturers. One such article by Carmody (1961) described a cattle feeding operation in Arizona. A feedlot was designed to handle 15,000 head and had a turnover of 3,000 head per month. The truck mentioned had a self-unloading feeder box and a built-in scale. The scale beam was situated in the truck cab enabling the operator to weigh his load before and after feeding each pen of cattle and record the exact amount fed. The truck's $12,000 price tag seems less formidable when one notes that its precise metering of special high energy feeds helped to produce more economical gains. This is but one of many examples of specialized bodies that adapt the truck to farm mechanization programs.

In an article titled "Tower Silos and Mechanical Feeding," Farm Mechanization (1961) magazine describes a "Blowerloader"--a piece of silage handling equipment used in England. While it was not used on, or as part of the truck, it could be used with trucks and is presented here for reference later in the paper. The Blowerloader resembled a self-unloading, side delivery forage wagon as

used in this country with rear wheels and tailgate removed. In use it was positioned so that its discharge chute emptied into a blower hopper with the opposite end of the bed (the rear of the forage wagon) resting on the ground. The mechanism was powered by any convenient means, usually an electric power unit or tractor power-take-off, and material placed on the bed was moved by chain-and-slat conveyor to the beaters and a cross conveyor that fed the blower hopper. Thus any tipping trailer or truck body could be used to fill the Blowerloader and return for a refill while the Blowerloader "digested" its load. Future models were to have wheels and a drawbar for use as a self-unloading forage trailer.

COLLECTION OF DATA

Data concerning truck use for any given type or size of farm had to come from the farmers themselves. A sample of truck owners was desired that could supply data concerning truck use patterns including deficiencies as well as desirable practices and innovations. It was assumed that the deficiencies of farm trucks found in a sample of more-efficient-than-average truck owners would indicate the problems faced by the majority of farmers, and at the same time disclose efficient truck use practices and innovations that might be missed through random sampling. The biased sample was also expected to reflect desirable combinations and interactions of various styles and sizes of truck bodies. For these reasons a biased sample of above-average-efficiency truck owners was sought.

A request (see Appendix A) was made of each of the 3,050 County Agricultural Extension offices in the United States to supply the names and addresses of farmers known to be making efficient use of trucks. From the 468 replies to this request (a return of 15.4 per cent), a mailing list of 1,331 truck users was obtained. The list included full and part-time farmers, farmers doubling as custom haulers, commercial truckers serving farmers, and other businessmen serving farmers.

A four page questionnaire (see Appendix B) was sent to each truck user on the mailing list. The questionnaire was designed to reveal the number, size, body type, and age of trucks owned, size of farm, materials handled, changes made in the truck or body since purchase, dissatisfaction with present trucks, and desires in future models. Space was provided for comments concerning the adequacy of farm trucks.

The 19.7 per cent response to the questionnaire was considered, by the author, to be poor, but provided a large enough sample for the survey. Were the survey to be done again, follow-up cards or letters would be used in an attempt to improve the response. Most of the responses received, however, were complete with applicable and apparently well considered details. Only 4 per cent of the replies received were considered incomplete.

The questionnaire failed to provide some of the desired information. An indication of average load carried as well as the maximum load should have been included to more clearly define the problem of overloading. Also, in order to categorize farms by type of enterprise, an additional question should be included. Question 3 was intended to indicate farm type, but often indicated crops grown when the farm type appeared to be livestock. It was helpful, however, by indicating the crops and materials handled. The answers to questions 20 through 23 were often vague. Desires were expressed for "larger," "lower," or "longer" equipment without a reference point from which to initiate the change.

Each respondent was asked to indicate whether or not he was willing to discuss his truck use program in a personal interview (Question 24 in Appendix B). The purpose of this question was twofold: to obtain replies from those who might not answer through fear of unwanted callers, and to avoid the expenditure of time and money to interview uncooperative respondents. Several exercised the option to decline the personal interview.

The interview option was helpful in selecting farmers for personal interviews and considered partially responsible for the excellent cooperation received in making the interviews.

Personal interviews were considered necessary to properly visualize truck use within the overall materials handling system, and to obtain pictures of unusual adaptations. Any attempt to have obtained the information by additional questionnaires would have imposed extensive reports upon the farmer which he might have been unwilling or unqualified to write.

The farmers selected for personal interviews were chosen for type of farming, scope of truck use, and geographical location. Limited time and budget restricted the interviews outside Michigan to a single circuitous route. The middle-northwest area of the United States was chosen because it provided a greater number of fleet operations and an opportunity to study the use of various types of truck bodies in relation to one another.

A total of 20 farmers were visited in Michigan, Wisconsin, Minnesota, South Dakota, Idaho, Utah, Nebraska, Illinois, and Indiana. Their products included dairy, beef, hogs, sheep, poultry, grain, vegetables, and fruit. The smallest farm in terms of size was 40 acres and the largest was 3,850 acres with an average farm size of 930 acres. The number of trucks per farm on the farms visited ranged from 1 to 11.

The results from the questionnaire and personal interviews were compared with data from previous investigations (note Resume of Previous Investigations), and current engineering practices. The following results and conclusions are based upon the information thus derived.

RESULTS

Data from the Written Questionnaires

The questionnaire was sent to 1,331 farmers in 49 of the 50 states with Alaska excluded. The number sent to each state varied from one in Vermont to 79 in Texas. The distribution generally increased as the number of farms per state increased, and decreased as the distance from Michigan increased.

Two-hundred sixty-two replies to the questionnaire were received--250 of them were from full or part-time farmers, five from businessmen serving farmers, and one with too little information to be of use. The remaining six arrived too late to be included in the compiled results. The types of farming included dairy, beef, hogs, poultry, cash grain, vegetables, tobacco, and cotton, both individually and in various combinations. A breakdown of farms by type was not attempted because this information was not accurately discernable. Question 3 of the questionnaire, listing major crops or products was designed to indicate farm type, but many answers listed crops such as grain and hay when the type of farm apparently was livestock.

The 250 farmers reported 615 trucks with an average of 2.06 trucks per farm. Figure 5 shows the number of

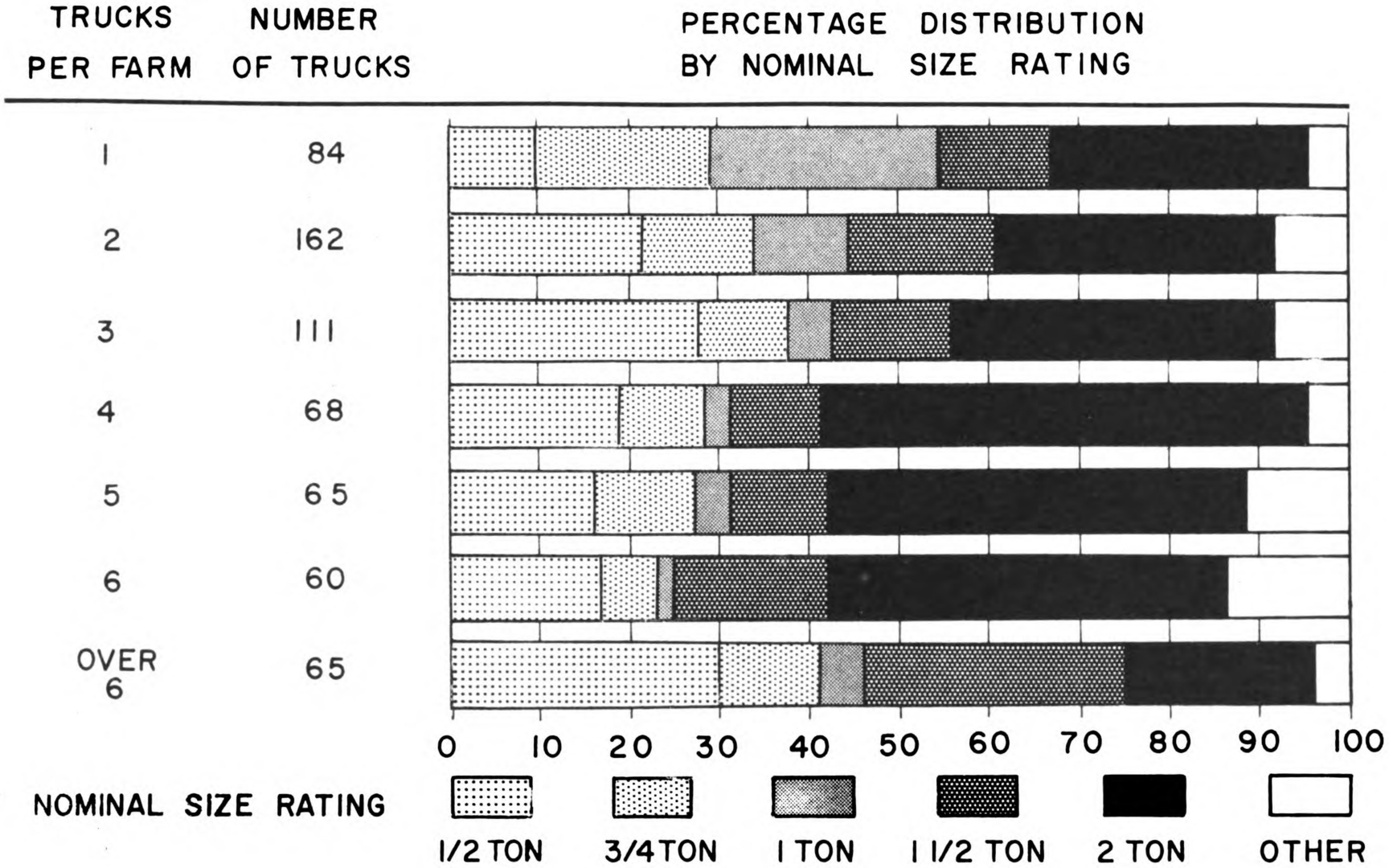

Fig. 1. Farm truck distribution by nominal size rating

trucks per farm and the distribution of those trucks by nominal size rating. Figure 6 shows the distribution by body style. The platform body style includes the stake, grain, livestock, and van bodies--all basically a flat bed with sides and top added. Of this group, 40 per cent were equipped with hydraulic hoists. The special bodies included self-unloading forage boxes, manure spreaders, lime spreaders, auger unloading grain boxes, tanks, sprayers, and one portable feed mill. Three-fourths of the farmers operating with one truck used a platform style body and favored the 3/4, 1, and 2 ton sizes with many choosing the smaller sizes for limited hauling requirements. As the number of trucks per farm increased, the per cent of platform bodies generally decreased with an increase in the pickup and specialized body styles.

The average age of the trucks reported was 7.7 years. Figure 7 shows the distribution of trucks by age. This longevity of farm trucks reflects the limited miles per year to which many farm trucks are subjected. Even farms supporting several trucks do not supply full-time employment for all of those vehicles. Table II shows the average yearly mileage and the percentage of trucks driven 2,000 and 4,000 miles or less annually. Of the 588 trucks for which the annual mileage was reported, 15 per cent were driven 2,000 miles or less per year and 19 per cent were driven between 2,000 and 4,000 miles per year.

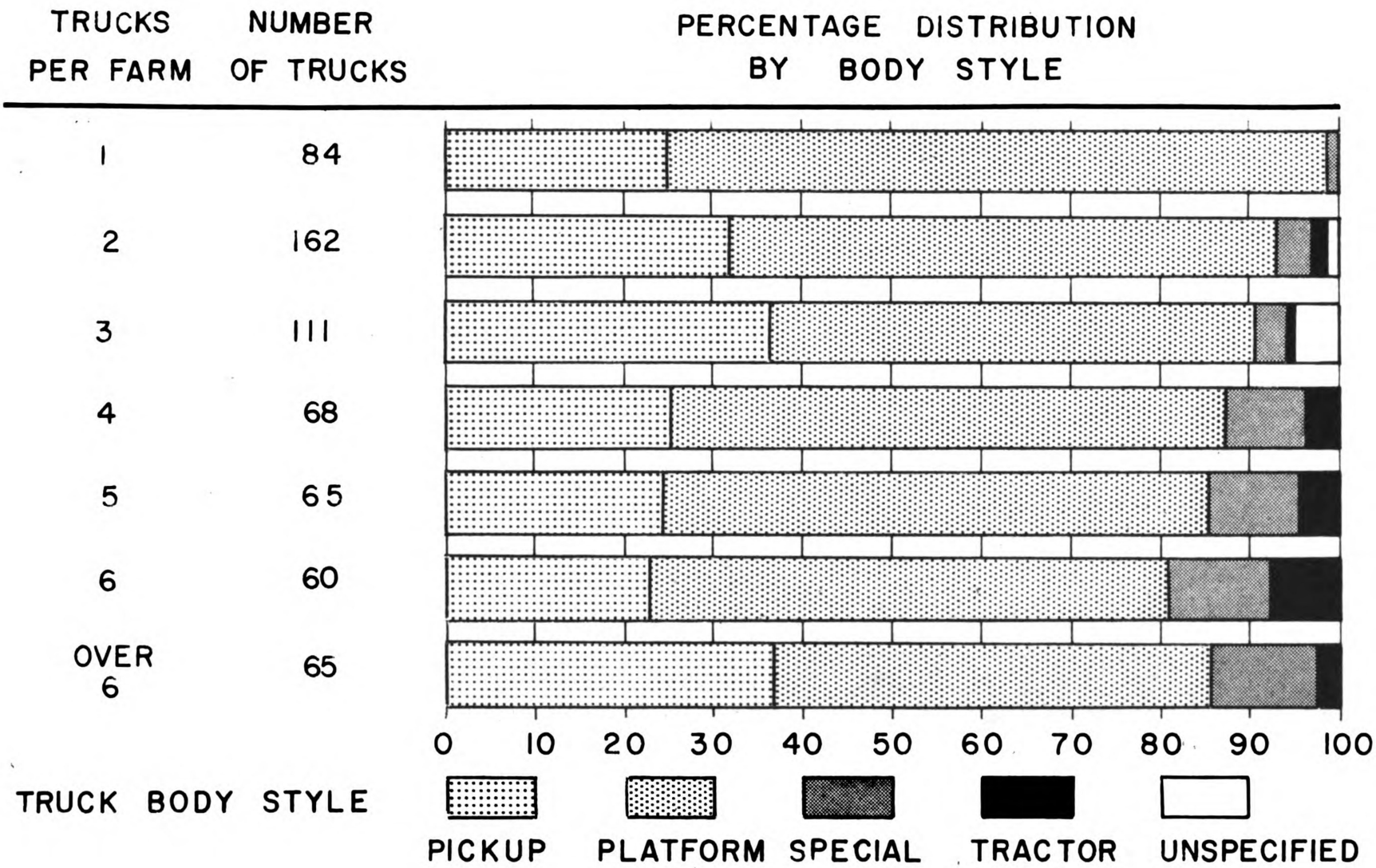

Fig. 6. Farm truck distribution by body style.

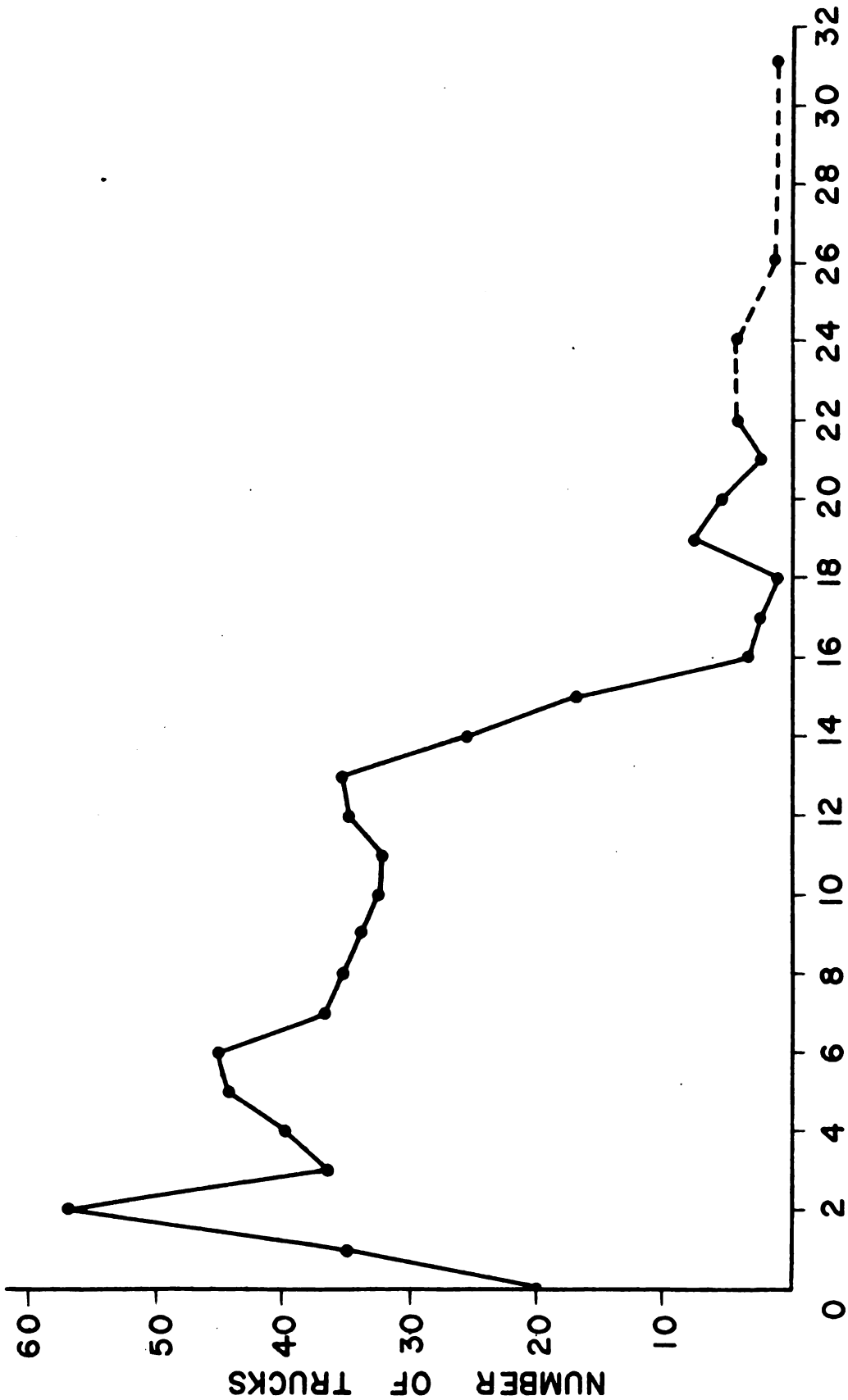

Fig. 7. Truck distribution by age.

TABLE II

Annual Farm Truck Mileage

Nominal Truck Size	Number of Trucks	Average Miles Per Year	2,000 M.P.Y. or Less (Percent)	4,000 M.P.Y. or Less (Percent)
1/2 ton	129	10,782	9	16
3/4 ton	68	7,453	7	22
1 ton	48	7,081	17	35
1 1/2 ton	93	4,806	30	60
2 ton	218	8,079	14	36
over 2 ton	32	8,563	25	41

The maximum loads reported were compared with manufacturers' recommendations to determine the number of trucks being overloaded. Manufacturers' ratings were used as presented in "Ford Competitive Comparison, 1960 Truck, 100 through 800 Series," prepared by the Truck Sales Promotion and Training Department, Ford Division, Ford Motor Company. Table III shows the standards used for this comparison.

The 255 users reported 633 trucks of which 20 were semi-trailer units, for which no recommended load was calculated, and 30 for which no load or size information was given. Tables IV and V give the number of trucks overloaded and the amount of the overload. The overloads were calculated from the reported maximum loads carried, and may or may not be the customary loading.

In a few cases trucks were altered by adding spring leaves and/or heavier tires to compensate for the overload.

Figures 8 through 13 show the number of trucks and the maximum loads carried. Many of the maximum loads reported appeared to be estimates and fell into groups of even numbered thousands of pounds. This is shown clearly in Figure 9. The larger trucks were grouped into classes of 2,000 pounds to eliminate this effect. The graphs for 1/2 and 3/4 ton pickups show secondary peaks at less than rated load reflecting their use as transportation and service vehicles.

Though many trucks were being overloaded, this condition did not create a great desire for more power. Of those

TABLE III

Manufacturers Rated Maximum Payload in Pounds, as Given in Ford Competitive Comparisons, 1960 Truck, 100 through 800 Series. Prepared by the Truck Sales Promotion and Training Department, Ford Division, Ford Motor Company

	Nominal Size of Truck						
Make of Truck	1/2 Ton	3/4 Ton	1 Ton*	1 Ton**	1 1/2 Ton	2 Ton	2 1/2 Ton
Ford	1700	3550	3350	5075	9425	14,700	16,000
Chevrolet	1550	3150	3350	5150	8700	15,000	16,000
Dodge	1850	3700	5000	4925	9900	13,975	16,200
GMC	1350	3250	5500	500	8265	15,700	16,000
International	1400	2850	4500	3950	8760	12,070	15,400
Studebaker	1800	3450	--	--	--	--	--
Average	1608	3325	4620		9010	14,149	15,920

*Pickup body
**Stake body

TABLE IV

The Number of Trucks Overloaded

Size of Trucks	1/2 Ton	3/4 Ton	1 Ton	1 1/2 Ton	2 Ton	Over 2 Ton	All Trucks
Total trucks reported	128	68	44	83	227	33	583
No. of trucks overloaded	80	33	28	61	111	12	325
% of trucks overloaded	63	50	64	74	49	36	56

TABLE V

Amount of Overload

Size of Truck	1/2 Ton	3/4 Ton	1 Ton	1 1/2 Ton	2 Ton	Over 2 Ton
Maximum overload, lbs.	6450	5450	14,050	13,240	13,000	12,600
Average overload, lbs.	346	1500	3,282	3,829	3,585	4,290
Average % of rated load	53	45	71	43	25	--

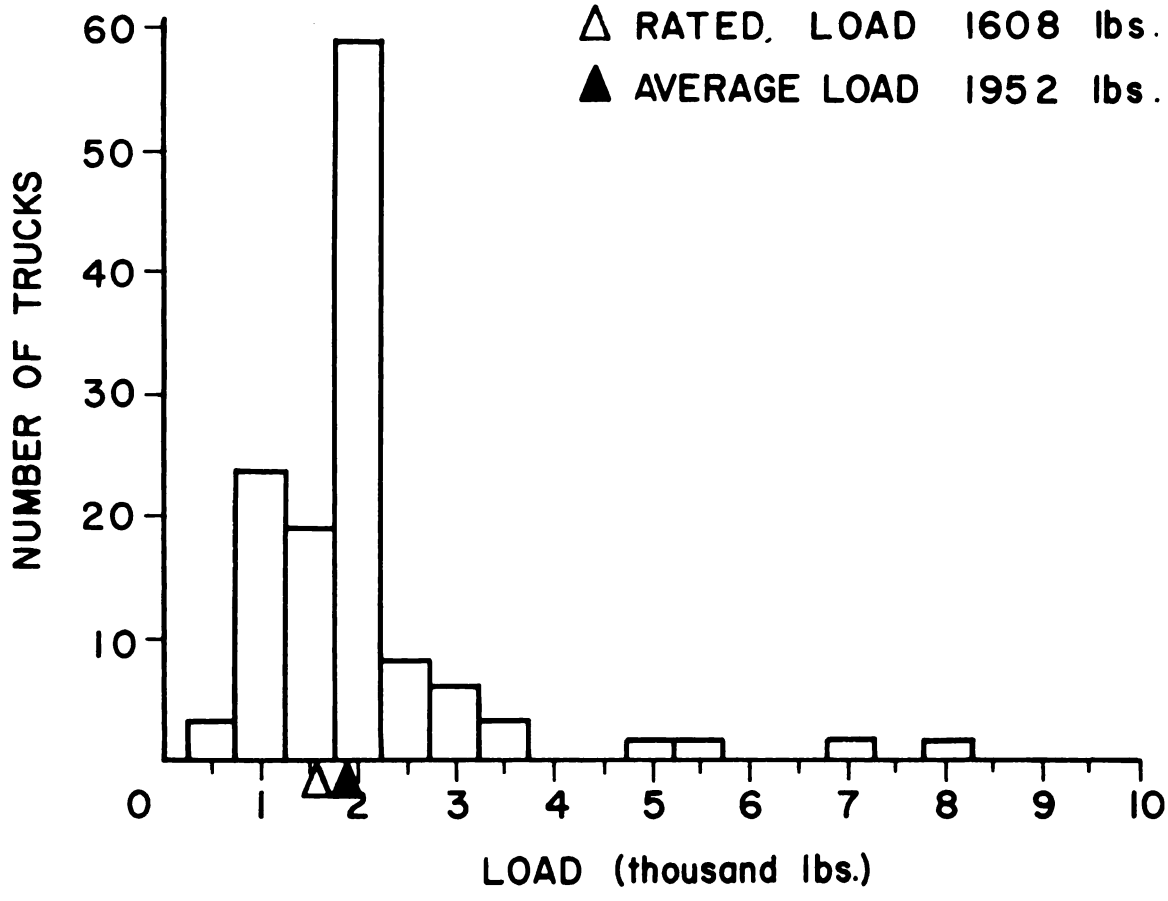

Fig. 8. Maximum load hauled on 1/2 ton trucks.

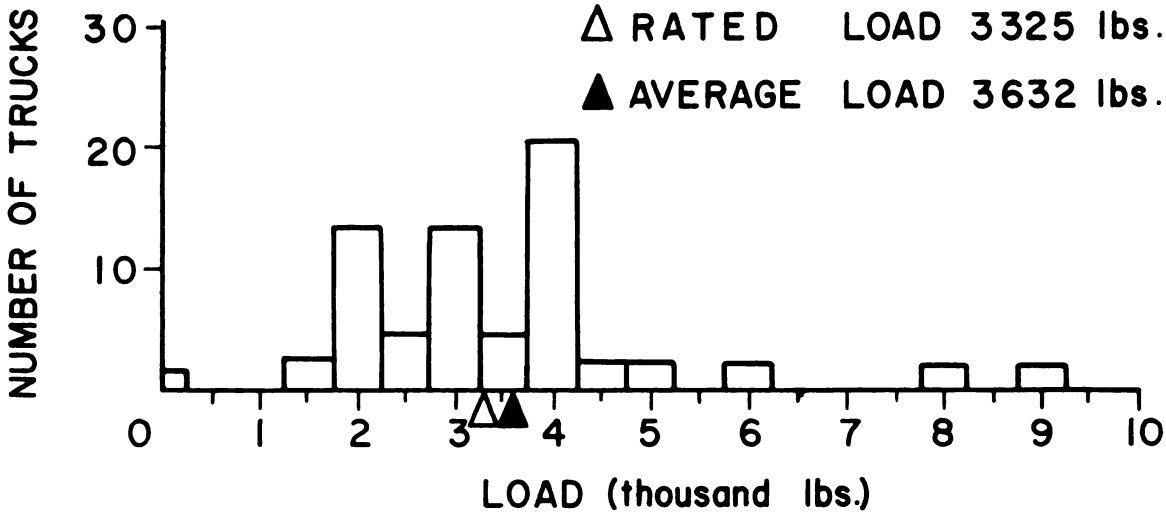

Fig. 9. Maximum load hauled on 3/4 ton trucks.

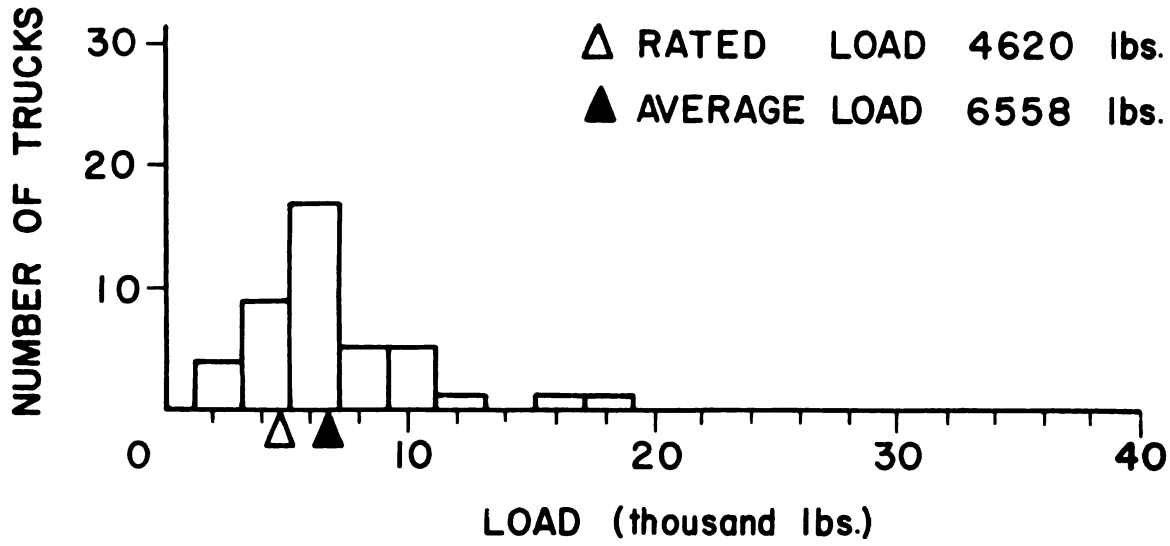

Fig. 10. Maximum load hauled on 1 ton trucks.

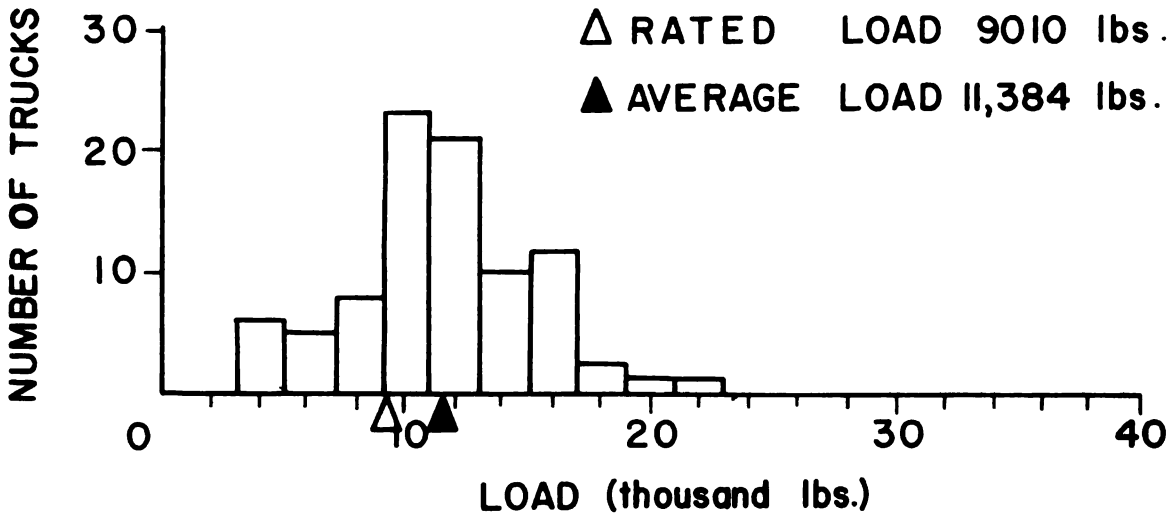

Fig. 11. Maximum load hauled on 1 1/2 ton trucks

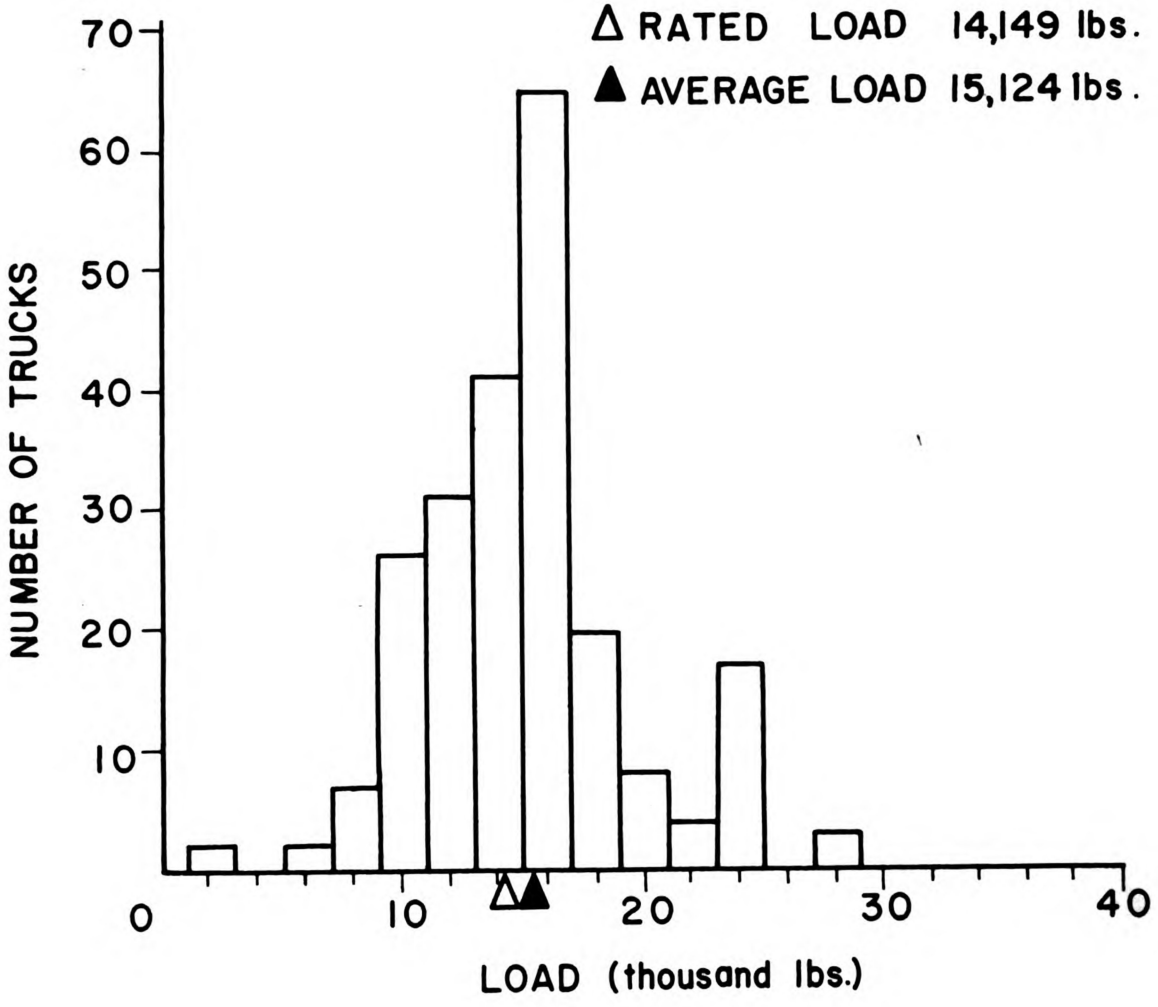

Fig. 12. Maximum load hauled on 2 ton trucks.

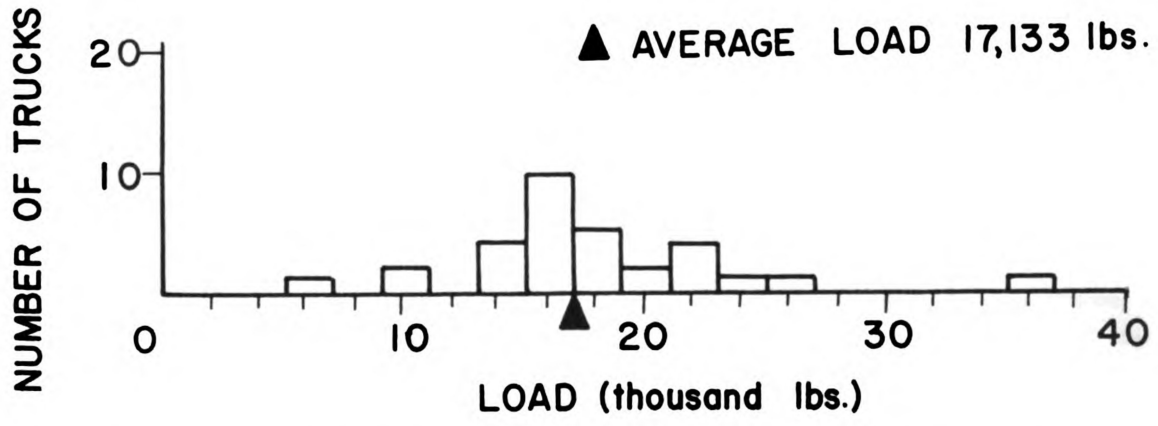

Fig. 13. Maximum load hauled on trucks larger than 2 ton.

users reporting overloads, 15 per cent did not state any preference for power change, 56 per cent were satisfied with the amount of power they had, 9 per cent wanted less power, and 20 per cent wanted more power. Results were very similar for those not over-loading; 21 per cent did not state a preference, 54 per cent were satisfied with the power they had, 9 per cent wanted less power, and 16 per cent wanted more power.

Trucks were loaded in the field by 81 per cent of the farmers. Of those that loaded in the field, 52 per cent were satisfied with their truck power while 21 per cent wanted more power and 9 per cent wanted less power. Of those that did not load in the field, 75 per cent were satisfied, 8 per cent wanted more power, and an additional 8 per cent wanted less power.

A comparison of field loading and wheel slippage data (Table VI) showed that 20 per cent of those loading in the field experienced difficulty with excessive wheel slippage; while only 8 per cent of the non-field-loaders reported such difficulty. Lack of serious trouble was specifically attributed by 7 farmers to the use of mud and snow tires, 4 gave credit to the four-wheel drive, and 2 others to the locking differential.

Thirty-seven truck owners (14.4 per cent) indicated they did not get what they wanted when purchasing their trucks, although most of the features desired but not obtained are available in new trucks. The reasons for not

getting the desired equipment were mainly the high cost of new equipment and the non-availability of used equipment with the desired features. Of notable interest were desires for more tool carrying space, better durability of cabs, and emphasis on utility rather than styling frills.

TABLE VI

Field Loading vs. Wheel Slippage
Number of Users

	Load in the Field	Do not Load in the Field	Did Not Answer	Total
Excessive Slippage	41	3	0	44
Not Excessive Slippage	162	33	1	196
Did Not Answer	5	0	11	16
Total	208	36	12	256

One hundred forty-four truck owners indicated they would use interchangeable bodies if the conversion was quick and easy. Of these 144, 37, or 26 per cent owned 1 truck; 55, or 38 per cent owned 2 trucks; 23, or 16 per cent owned 3 trucks; and 29, or 20 per cent owned 4 or more trucks.

Most of the owner-built and/or installed equipment that was reported is available commercially. Such owners preferred to buy a truck (often a used vehicle) and make or install their own equipment. The changes made and the number reporting each change are as follows:

Built or installed bodies:	
Type not specified	6
Sides and/or roof	5
Low platform	3
Stock rack	3
Combination grain and stock rack	2
Tank	2
Dump body	2
Lime and fertilizer spreader	1
Overshot rack for hay	1
Changes to facilitate materials handling:	
Power hoists	24
Auger unloaded body	3
Grain unloading ports	2
Air system for unloading bulk grain	1
Changes to increase load capacity:	
Added leaves or overload springs	12
Heavier and/or larger tires	12
Lengthened wheelbase	4
Reinforced the frame	2
Lengthened the body	1
Changes in the power train:	
Installed two speed axle	4
Installed larger engine	3
Added auxiliary transmission	3
Changed to wider gear range	3
Installed a heavier transmission	1
Rebored cylinders	1
Changes in traction and braking:	
Increased braking power	4
Changed to traction tires	2
Added front wheel drive	1
Miscellaneous changes:	
Added trailer hitch	18
Added mirrors	5
Added extra fuel tanks	3
Added power take off	3
Relocated the spare tire carrier	2
Installed tool boxes	2
Braced the rear of pick-up body	2
Added tie-down loops	2
Installed metal flooring	2
Installed a winch	2
Wheel flaps in front of rear wheels	1
Heavy front grill	1
Screened radiator	1
Power steering	1
Extra heater	1
Tow bar on front	1

Truck Use and Innovations

Most of the personal interviews were made at harvest time--a time of peak demand for trucks. The innovations observed were designed (1) to extend the truck usefulness to handle additional chores, (2) to match the truck to particular materials handling systems, and (3) to eliminate hand labor. Much of the home-made equipment was patterned after available machinery but assembled from junk parts to cut expenses. Each of the home-made machines was designed to perform a specific function in an individual system, but many could easily be employed in other materials handling systems. The ones shown in the following figures could be used to advantage on many farms.

When trucks are used for hauling silage from the field they are usually driven beside the chopper as illustrated in Figure 14. This eliminates the need for hitching and unhitching a wagon and when enough trucks are available it provides non-stop chopper operation. This system does require a separate driver for the truck and in dry seasons may create dusty conditions around the tractor and truck. The addition of a slanted roof, as in Figure 15, allows unhampered loading and prevents loss of material due to blowing while traveling to the silo.

Because nearly any truck body can be loaded from a field chopper, the most suitable body style is determined by the type of storage and receiving equipment used. A

Fig. 14. Truck with self-unloading feeder body being loaded with corn silage.

Fig. 15. Truck with roof to prevent wind loss while traveling being loaded with corn silage.

Fig. 16. Truck with self-unloading feeder body in a trench silo.

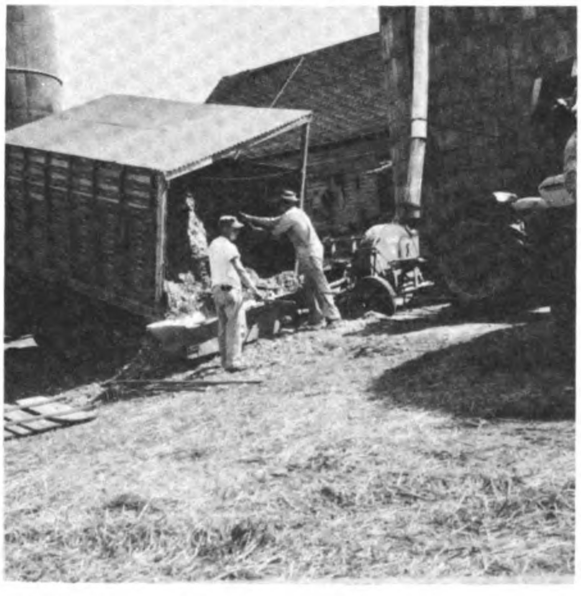

Fig. 17. Unloading a truck with dump body into a blower. (Note that the angle of tilt is insufficient for material flow.)

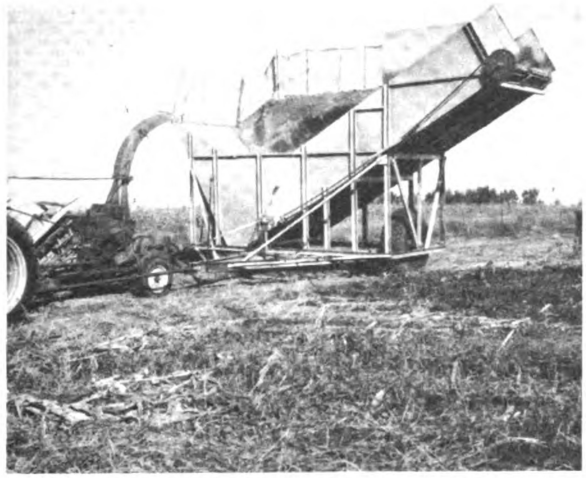

Fig. 18. Trailer used behind a field chopper as a material collector.

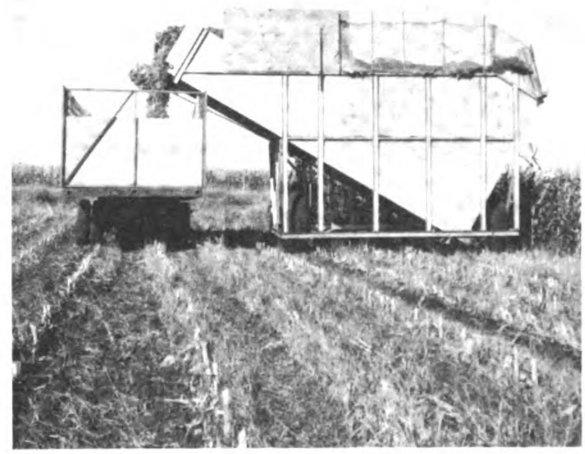

Fig. 19. Chopper trailer unloading into a truck.

self-unloading forage body, shown in Figure 16, can deliver its load directly into a trench silo or into a blower at a tower silo. This type body is better suited to feeding a blower since its discharge rate is slower than desirable for use in a trench silo. The platform dump body is better suited to the trench silo operation. Its discharge is too fast when dumped into a blower and usually the rear edge drops too low to dump into a blower hopper unless the truck is put on a ramp. Figure 17 shows a dump body being unloaded into a blower hopper. The height to which the body can be raised and stay above the hopper is insufficient to make the material slide. In this case a 4-inch by 4-inch beam is placed at the front of the load and pulled back by a tractor and chain to slide the load off. Hand labor is required to loosen the material at the rear of the truck to provide an even flow into the blower.

One farmer's solution involved the use of other equipment to increase the efficiency of his platform dump truck body. The trailer in Figure 18 was built to be pulled behind the field chopper and eliminate the need for tying up a truck and driver while the load was being chopped. The trailer held a truckload of material and was unloaded by means of a chain and slat conveyor on the inclined floor. Power was received through a drive shaft from the field chopper. Truck loading time was less than a minute and could be accomplished while chopping.

Fig. 20. Truck with dump body unloading at the end of a trench silo.

Fig. 21. Power scoop spreading and packing corn silage in a trench silo.

Fig. 22. Power feeder truck made from used parts.

Unloading was equally as fast at the silo. The truck load was dumped on the ground (Figure 20) at the end of a trench silo to be pushed into the silo and packed by a power scoop (Figure 21). The truck tailgate operated automatically as the body raised, to eliminate manual operations as the load was dumped. The tailgate was mounted at its top on an arm which was pivoted about four feet forward of the rear of the body (see Figure 20). The arm extended forward of the pivot point and was fastened by a cable to the truck frame. With the body in the lowered position the cable was slack and the weight of the tailgate held it in place against the truck body. As the body was raised to dump position the cable tightened, rocked the arm on its pivot, and pulled the tailgate up and away to release the material in the truck. Lowering the truck body returned the tailgate to its closed position. The driver could dump the load and be ready to reload without leaving the truck cab. The power scoop in Figure 21 was used to load a truck mounted power feeder (Figure 22) and complete the mechanized handling equipment from field to the feed bunk.

A machine such as the Blowerloader, mentioned in the Literature Review, could be used in such a system to fill a tower silo and still utilize the platform dump body for transporting silage from the field.

One Idaho grain farmer uses a grain body to haul grain and fertilizer to his drill at planting time and has made use of hydraulic power to fill the grain drill or

Fig. 23. Truck with grain body on which the diverter valve in Fig. 24 is mounted.

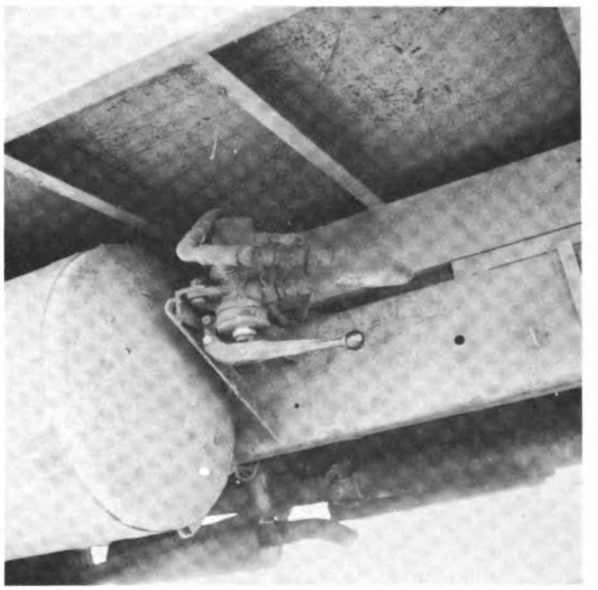

Fig. 24. Valve used to divert oil from the truck hydraulic system for operation of auxiliary motors.

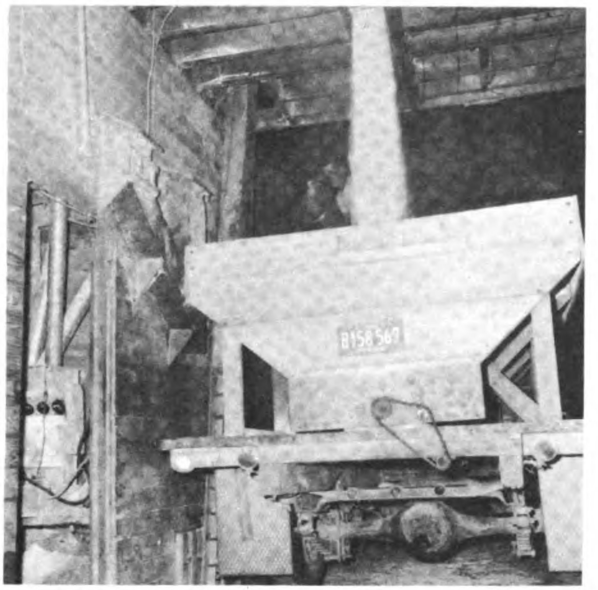

Fig. 25. Truck with auger body being loaded from an automatic feed handling system.

Fig. 26. Unloading the auger body into self feeders.

Fig. 27. Trucks used by an Idaho grower to deliver fruit.

Fig. 28. Truck used to service farm machinery in the field.

fertilizer spreader. By placing a valve in the power hoist's hydraulic circuit he is able to divert the oil flow to operate a hydraulic motor on an auger conveyor. The auger is mounted vertically in the rear corner of the truck body. Its discharge spout reaches over the side and can be positioned over the box being filled. In use the truck body is elevated so that the grain flows to the rear of the body and the auger delivers grain to the grain drill. The system also works for bulk fertilizer provided the auger is allowed to empty itself before it is stopped. The hydraulic motor on this installation did not produce sufficient torque to start the auger filled with fertilizer. Figure 23 shows the truck at harvest time loaded with grain on its way to the elevator for storage. The diverter valve under the truck bed is shown in Figure 24.

An Illinois farmer uses a home-made body on a 1 ton truck to link an automated grain handling system (Figure 25) on one farm to a hog feeding operation (Figure 26) on another farm 2 1/2 miles away. The truck is also used to handle small grains and is proclaimed ". . . the most useful tool on the farm."

A Utah fruit farmer finds one style of truck body very satisfactory since his trucks are used only for delivering fruit in boxes to wholesale and retail markets. He is still selective, however, in choosing the right truck for each delivery. In reaching his goal of supplying quality fruit he finds that a truck rides smoother when properly loaded.

He, therefore, maintains the three trucks shown in Figure 27, to provide a truck the proper size to carry the load and deliver a pampered product with maximum truck efficiency.

Field service trucks like the one in Figure 28 are used in situations where many field machines must be serviced and where field operations are some distance from the farmstead. Pickup trucks perform this chore where the size of operation does not warrant a specially outfitted truck. The present trend to non-contiguous acreage will increase the need for a service type truck body, which might well be achieved by including compartments in the pickup body for tools, lubricants, and repair parts.

DISCUSSION OF RESULTS

This survey shows marked differences from results reported by Cromarty (1959). This is to be expected since the sample requirements were not the same, but the results in view of the sample differences are indeed interesting. Cromarty's data was taken from a survey conducted jointly by the USDA and Bureau of Census in 1956 covering approximately 11,000 farms selected to provide estimates for the continental United States. The results are regarded as national averages. The sample for this survey was limited to truck owners and to those believed to be making efficient use of their trucks. The interpretation of the degree of efficiency was left to the individual County Agricultural Agent supplying the names. Thus this sample is biased to a degree that is difficult to measure, and certainly does not reflect a national average. It might, however, reflect a future average considering the present trend to larger and more completely mechanized farms.

One notable difference is in the predominant truck body style. Cromarty shows 63 per cent pickup, 22 per cent platform, and 15 per cent other style bodies, while this survey shows 31 per cent pickup, 61 per cent platform, and 9 per cent others.

A rated capacity comparison indicates a trend to larger trucks with 46 per cent of the larger sample rated 1/2 ton or less and 21 per cent of this survey's biased sample rated 1/2 ton or less. This change is to be expected--as truck use is increased on a small farm, replacement vehicles will be of larger capacity, and a swing to specialized bodies will, by present standards, require greater than a 1/2 ton capacity. As seen in Figures 5 and 6, a change from one to two trucks per farm brought an increase in the percentage of 1/2 ton trucks and the pickup body.

Other differences in the two surveys are in the number of trucks per farm (1.18 national average, 2.06 this survey) and miles per truck per year (6,997 national average, 8,100 this survey). Correlating these and body style differences shows that a large percentage of farmers not represented in this sample have one truck with a pickup body and drive relatively few miles per year. The problems described in this paper for farm truck owners either are more serious for this group or will be an important consideration in plans for expansion.

As the number of trucks per farm increased, the number of 1/2 ton trucks increased to an average of slightly under one per farm. Also, as the trucks per farm increased to 4, the percentage of 2 ton trucks increased from 29 to 54 per cent. The over 6 trucks per farm group represented only 8 farms and its validity as a representative group is doubtful. Generally for limited hauling a medium-sized truck was

selected where both light and heavy duty were required of a single unit. As the truck use increased, a large truck was used for heavy loads and bulky material and the run-about chores were handled with a pickup.

Using Capstick's (1961) data to compare the cost per year of hauling materials with 1/2 ton and 1 1/2 ton trucks at various miles per year, Figure 29 was constructed. The double scale for miles per year allows for the extra travel required to haul a given amount of material with the 1/2 ton truck. Capacities of 1,500 pounds for the 1/2 ton and 9,000 pounds for the 1 1/2 ton truck were used in the calculations. A three cent per mile cost was added for driver's wages and becomes a significant factor in using a small truck with many trips to compete with a truck of larger capacity requiring fewer trips. In cases where the 1 1/2 ton truck can be fully loaded, its use is economically feasible with as little as 1,300 miles per year if the material must otherwise be hauled with a 1/2 ton truck. (The possibility of renting a truck should be weighed against the 30 cents per mile cost of owning a 1 1/2 ton truck for this amount of use.) For less than 1,300 miles per year for the 1 1/2 ton truck, the use of a 1/2 ton truck may be more economical, provided the material can be hauled in the smaller vehicle and the operator has time to make the extra trips. The superiority of the larger truck is further demonstrated by a cost per ton mile comparison in Figure 30--again using using Capstick's data.

The cost figures presented in Figures 1, 2, 3, 29, and 30 are for new trucks and do not represent the costs encountered by the 67 per cent of the farmers purchasing used equipment. Capstick (1961) reports costs for used trucks at about 75 per cent of new costs; therefore, many farmers are operating at costs less than the charts would indicate. The comparisons and cost fluctuation trends are similar, however, and also apply to used equipment. Many farmers are forced by economic pressure to the used truck lot. As a result they operate with less equipment than they need because that which is desired is not available. The predominant reasons given for doing without desired equipment were high costs of new equipment and the non-availability of the used equipment desired.

The solution to this problem is sought by some farmers in the farm shop. Many of the farm shop additions to trucks may be classified as equipment that is commercially available as optional equipment. A combination of discarded machinery and ingenuity is used to combat the economic pressure felt by most farmers.

On the other hand, some of the farm shop products should be classified as innovations. The product is not commercially available and is created to answer a specific need in the farm program. Again, discarded parts and ingenuity are combined to do a task for which there are no machines available. This has been the beginning for many of our present farm machines.

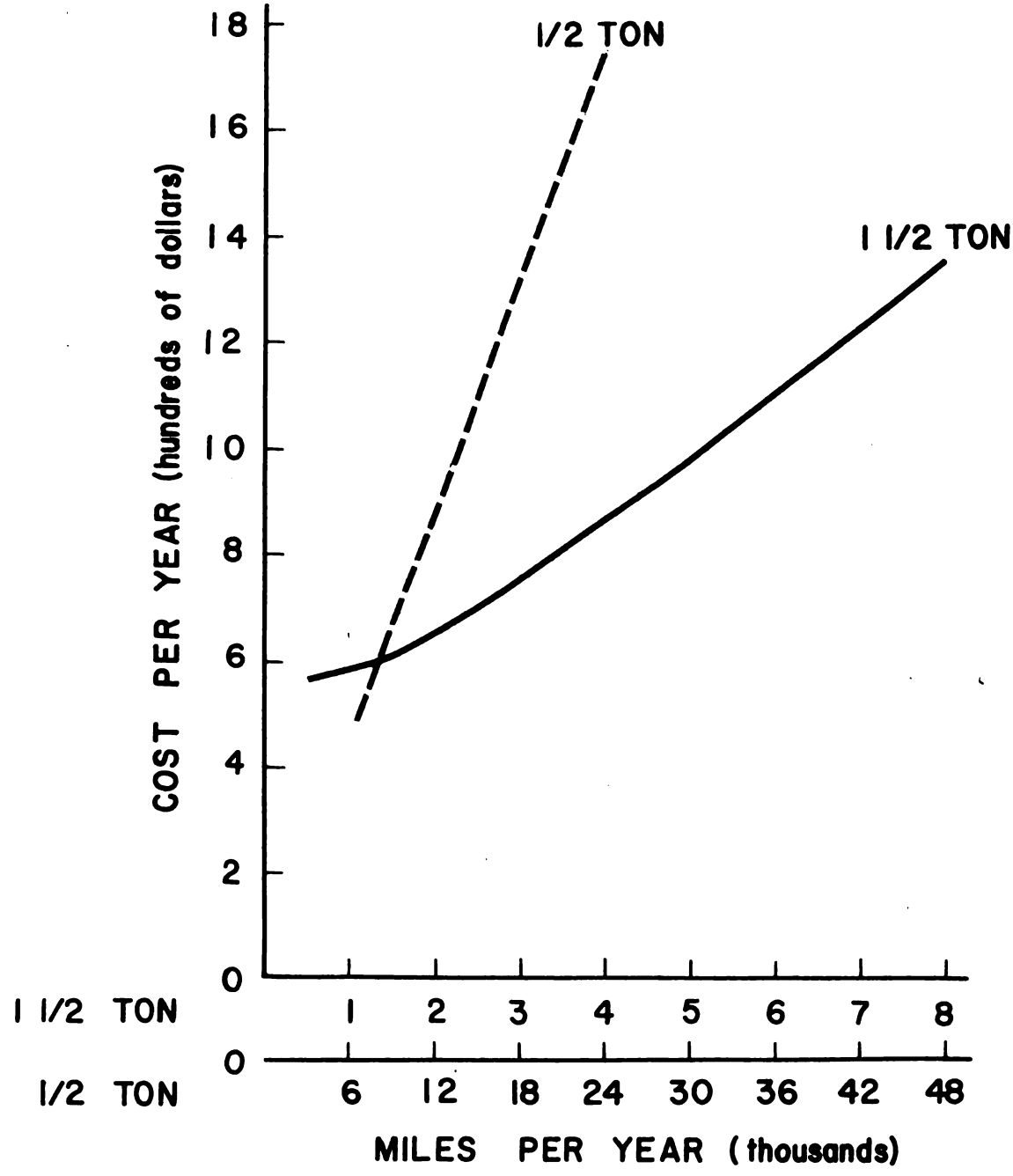

Fig. 29. Cost per year of moving equivalent amounts of material with 1/2 and 1 1/2 ton trucks. - from Capstick (1961)

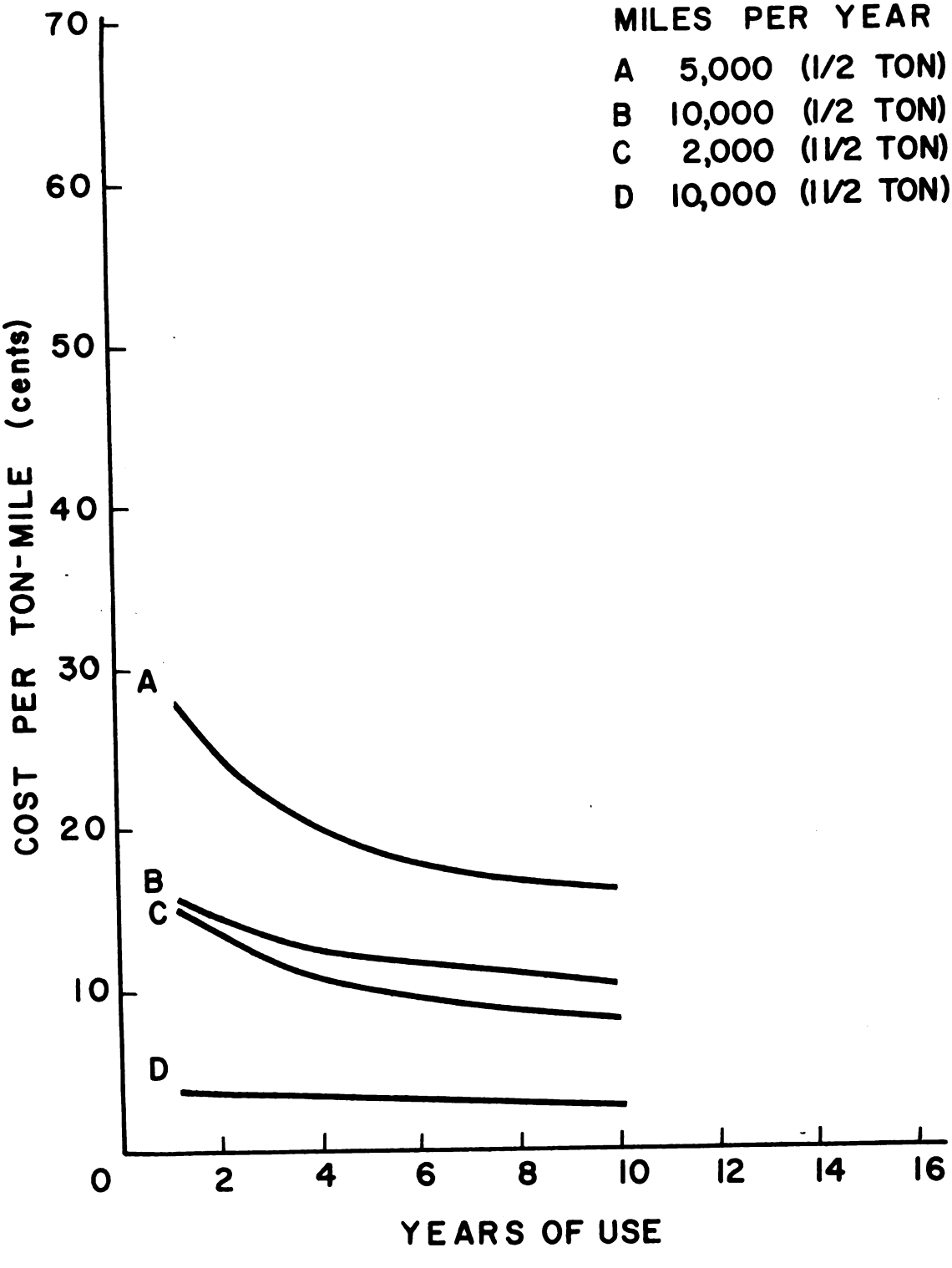

Fig. 30. Cost per ton mile of owning and operating trucks. - from Capstick (1961)

These innovations and unusual truck uses were of interest in this study as an indication of problem areas and also for possible answers to farmers' problems.

A PROPOSED SOLUTION TO THE FARM TRUCK PROBLEM

One solution to the farm truck problem might be through the use of small semi-trailers. These trailers would provide a selection of easily changed materials handling units to be operated by a single farm truck. The addition of trailers would enable the farmer to widen his scope of truck use and increase his truck efficiency. The increased use per year would provide a full truck life in a few years, thereby enabling the farmer to replace the power unit periodically and maintain up-to-date equipment. The materials handling trailers would not have to be altered to exchange power units.

The truck tractor would be of one ton nominal size with a low-sided pickup body. A suggested body style is shown in Figure 31. This body would incorporate the following features:

1. Space for carrying tools and service supplies.
2. A fifth wheel that was easily removable or would fold into the body floor to provide a smooth body floor for light hauling.
3. The fifth wheel standardized to fit all farm semi-trailers and not usable with the larger commercial trailers.

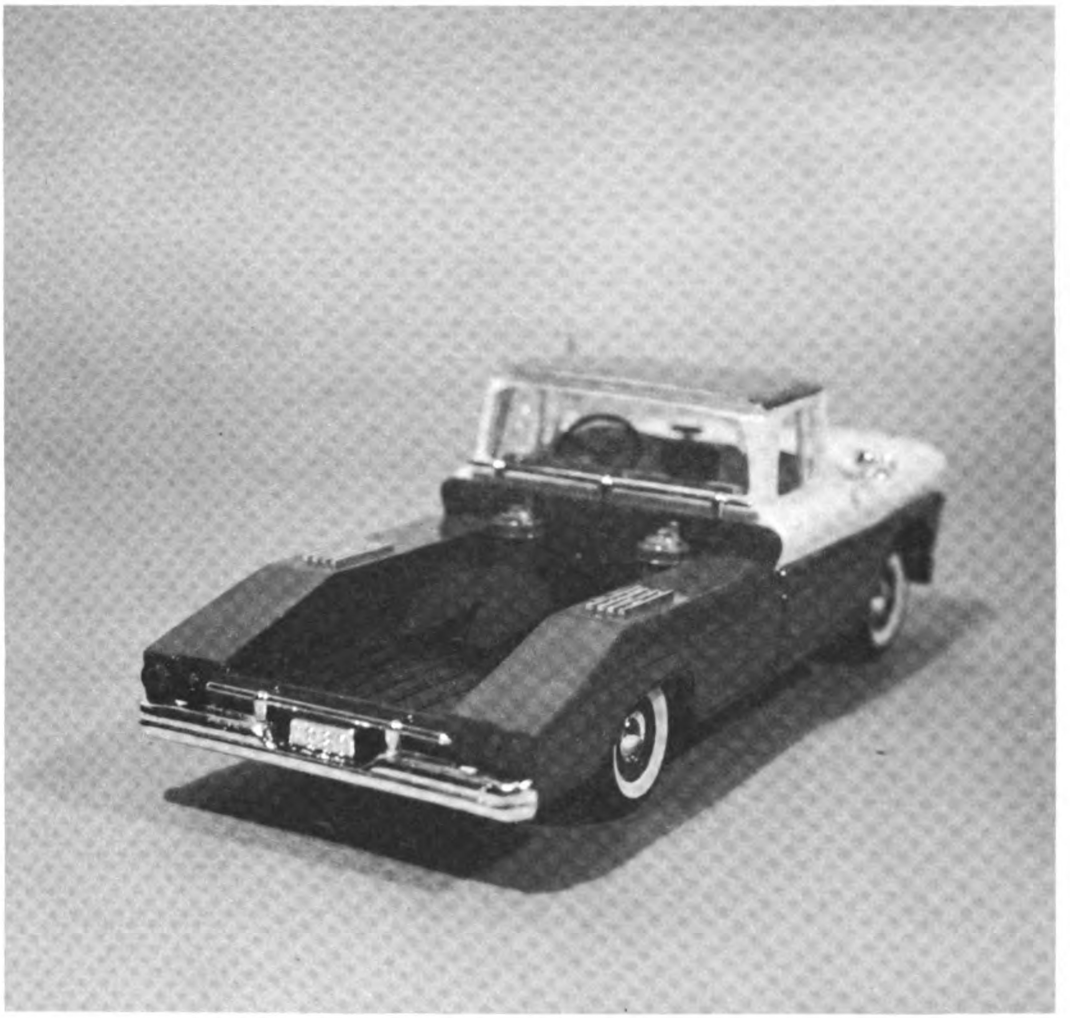

Fig. 31. Model showing proposed farm truck body style.

4. Hydraulic, brake, and electrical connections for operating the various trailer mechanisms.

The truck would conform to the following general specifications:

1. Have a payload capacity of approximately 5,000 pounds.
2. Have a cab to axle measurement of at least 60 inches to permit mounting the fifth wheel a few inches forward of the rear axle.
3. Have a dual range transmission or rear axle to provide economical operation as a light truck and pulling power when needed for hauling semi-trailers.
4. Have dual rear wheels.
5. The transmission would have power take off points and drive a hydraulic pump to operate remote mechanisms.
6. Four wheel drive would be optional for severe off-the-road hauling.

The trailers would:

1. Have payload capacity of approximately 10,000 pounds.
2. Attach to the truck with a pedestal mount to raise the trailer above the truck body.
3. Have approved brakes and lights for highway travel.
4. Be self unloading.

5. Be equipped with hydraulically-operated parking gear.

6. Provide temporary storage for materials.

Mounted on a front axle the trailers could be used behind a farm tractor and be fully operable on its hydraulic system. Under extreme conditions the trailer could be loaded in the field using the farm tractor and then transferred to the truck for highway travel.

The trailers could be incorporated into the materials handling system as collectors and/or dispensing units. As a collector a trailer could be loaded by low volume mechanisms without tying up the truck and driver. Other trailers could be used to meter their loads into automatic feeding systems eliminating the need for holding bins. Still other trailers could be parked in the feed lot and used as self-feeders, saving the time and power normally required to transfer the feed from the truck to the feeder.

Through the use of auxiliary power, the trailers would perform loading and unloading functions while detached from the truck leaving the truck free for other hauling chores.

Conversion to the semi-trailer materials handling program could be accomplished without discarding usable equipment. The purchase of a single truck-tractor would create the nucleus for the new system. The trailers, instead of being added equipment in the farm inventory, would replace the various farm wagons presently in use. Existing wagon-mounted equipment could either be trailer-mounted or

replaced with trailer-mounted equipment through a normal replacement program.

CONCLUSION

Much of the farm truck problem is reflected in the data showing truck age, miles per year, and cost per mile. The limited miles per year of use for many farm trucks results in high costs per mile and requires many years of ownership to realize full use of the truck--thus giving rise to complaints of insufficient durability. Many farm trucks deteriorate more from time and the elements than from miles of use.

Farm truck efficiency must be accomplished through greater adaptability of the vehicle and through more complete integration into the materials handling system.

When planning truck use in mechanization, the costs of trucks and bodies are not isolated considerations. Loading and unloading facilities are required and the entire materials handling system must be planned as a unit with the truck as an integral part.

While the platform body is adaptable to many materials and handling systems, other systems are designed around special truck bodies. The dump body delivers its load in a pile or batch while most special bodies are designed to distribute their loads or unload the material in a smooth, steady flow. These bodies are designed to handle a particular type of material and are usually not easy to adapt to

other types of materials. The result is a fleet of specialized bodies that see limited service in systems that require the movement of several types of materials.

The current trend to larger and more completely mechanized farms has hindered as well as helped the farm truck owner. Mechanization of harvesting operations and the development of specialized bodies has increased the total truck use on the farm. The increase, however, has not always resulted in the additional use of a truck already in service, but often required the addition of other trucks on which to mount the specialized bodies. These several trucks may each be less efficient than the original single vehicle in terms of use per year.

Though they may be of less than optimum efficiency, the specialized bodies are popular because they are more desirable than the alternate option of using manual labor. Farm labor in many areas is scarce and/or expensive--machinery, even if inefficient, is often the more feasible choice.

Although a farmer's present methods may be the least expensive of several options, improvements are often needed to reach a profitable level of efficiency. One solution may be forthcoming through the modification of the materials handled. The acceptance of pelleting in place of baling for hay harvest would simplify the handling of this product. Field shelling of corn has made it possible to use small grain equipment for the corn harvest. Other modifications of the material form may do more for the mechanization of

materials handling than attempting to develop specialized handling machinery.

Another solution to the limited truck use problem might be achieved through the use of interchangeable bodies, enabling a single truck to carry a variety of specialized equipment. The exchange of bodies would have to be quickly and easily performed by one man and provision made for convenient storage of equipment when dismounted from the truck.

Present methods of exchanging bodies on a truck chassis require as much as 10 man-hours. Storage of bodies not in use is often on make-shift supports making the exchange dangerous as well as tedious.

Milti-purpose truck bodies would solve the problem, but attempts along this line have thus far been less than successful.

RECOMMENDATIONS FOR FURTHER STUDY

The proposed semi-trailer materials handling system should be studied further for:

1. Comparative costs of straight truck and semi-trailers.
2. Mobility of semi-trailers with various ground conditions and various tractor units.
3. Adaptability of various materials handling body units to semi-trailer use.

Further studies should be made of interchangeable bodies on a straight truck chassis and the apparent advantages in mobility and maneuverability over the semi-trailer.

The new wide single wheels being used to replace duals should be investigated under farm conditions.

A guide to comparing truck rental fees with local price index or commodity prices would be beneficial to farmers in many parts of the country.

REFERENCES

Capstick, Daniel F. (1961). Cost of owning and operating farm trucks in eastern Arkansas. Ark. Agr. Exp. Sta. Bul. 639. 23 pp.

Carmody, Robert (1961). "Hot Feed." The Farm Quarterly. Spring, pp. 91-95.

Cromarty, William A. (1959). The market for farm trucks. Mich. Agr. Exp. Sta. Tech. Bul. 271. 40 pp.

Klies, Robert William (1957). An analysis of systems and equipment for handling materials on Michigan livestock farms. Thesis for Ph.D., Mich. State Univ., East Lansing. (Unpublished.)

Saal, Carl (1951). Truck road performance - actual vs. computed. SAE Quarterly Transactions, V. 5, No. 1.

"Tower silos and mechanized feeding." Farm Mechanization, vol. 13, No. 147, p. 407. Temple Press Limited, Bowling Green Lane, London, E.C. 1.

Willett, Howard Jr. (1953). How long should you run a truck to get the lowest combined depreciation and maintenance cost? Paper presented at the SAE Int. West Coast Meeting, Vancouver, B.C., Canada (unpublished).

1954 Census of Agriculture, V. 3, Pt. 4, pp. 80-84, Washington, D.C., 1956.

APPENDIX A

Letter Sent to County Agricultural Extension Agents Requesting the Names of Truck Users

The Agricultural Engineering Department of Michigan State University, with the cooperation and assistance of the Ford Motor Company, is studying the use of trucks on farms. Two of the questions to be answered are: how can trucks be more efficiently integrated into the farm system, and what size and style of truck is best suited to each farming enterprise. We feel that the farmers themselves must supply many of the answers.

We would like to contact a select group of men who have efficiently incorporated trucks into their materials handling systems. A cross-section of large and small farms is desired. Farm shop adaptations are of particular interest, in that they may indicate deficiencies in available equipment.

You can help in this study by supplying the names and addresses of men who are doing an outstanding or unique job of utilizing trucks, either on the farm or in related business. The people you select will be contacted by questionnaire, and those warranting further investigation will be interviewed personally.

Thank you for your cooperation.

John A. True, Research Assistant
Agricultural Engineering Dept.
Michigan State University

Name _____

Address _____

Type of operation _____

Nature of Truck use _____

Name _____

Address _____

Type of operation _____

Nature of Truck use _____

Your name and address _____

MICHIGAN STATE UNIVERSITY

AGRICULTURAL ENGINEERING DEPT.

TRUCK SURVEY

Dear Truck User:

The handling of produce, feeds, grain, fertilizer, etc., has become an important consideration in the planning of farming operations. Farmers can save a lot of time and money by setting up the proper materials handling system for their farm. Since motor trucks play an important role in any such system, Michigan State University is studying farm trucks to help determine how they can be used for the greatest benefit to the farmer. Are the trucks available today exactly what you need, or would a few changes make them better?

Many farmers all over the country and in all types of agriculture are being asked how they use their trucks and what changes would be helpful. You can be a part of this research by filling out the following questionnaire. Please answer the questions that apply to your business and return as soon as possible. The information you provide will be used only for our research unless we ask for and receive your written permission to do otherwise.

So that you may benefit from the study and to make it worth your time to study the questions and answers carefully, a report on the final results will be sent to those who answer the questionnaire. The study will, of course, take many months so the report will be delayed - but it will be sent to all contributors.

Print your name and mailing address below so we can send the report to you.

_____
(Name)

_____
(Number) (Street)

_____
(City) (State)

REMEMBER - The success of the study and the report you get depends upon prompt and accurate completion of this questionnaire. Fill it out tonight and mail it right away. Thank you.

---

1. List the trucks you use by make, size, type of body, etc., in the table below.

Make of Truck and Year	Size or Model	Type of Body	Maximum Load Carried	Miles Driven Per Year	Materials Carried
Example: '56 Dodge	½ Ton	Pickup	1800 lb.	6,000	Ground feed, calves, firewood, miscellaneous
'59 Ford	2 Ton	Stake with hydraulic dump	9000 lb.	2,500	Grain, cattle, fertilizer, hay, small implements

2. Select the answer below that describes your business.

- ☐ 1. Farming.
- ☐ 2. Farming plus custom hauling.
- ☐ 3. Farming plus a separate business.
- ☐ 4. A business serving farmers.
- ☐ 5. Custom hauling.

3. What are your main crops or products in the order of their importance, giving the most important one first.

_____

_____

4. How many acres do you farm?

_____ acres

5. Do you use your truck for trips to town or elsewhere with no load in it?

- ☐ No
- ☐ Yes

If yes, how many miles per year? _____

6. How many years do you usually keep a truck before replacing it with a new or newer unit?

_____ years

7. Did you get the features you wanted in your truck?

- ☐ 1. I got what I wanted.
- ☐ 2. I took something else because what I wanted was not available.

If you chose answer number 2, describe what you wanted that you couldn't get.

_____

_____

_____

8. Would you use more than one specialized body on your truck if they were easily interchangeable?

- ☐ No
- ☐ Yes

9. Do you load your truck in the field for hauling on public roads?

- ☐ No
- ☐ Yes

10. Do you haul produce from the field in another vehicle and reload to your truck for travel on public roads?

- ☐ No
- ☐ Yes

11. Do you process your produce on the farm? (Dry, sort, clean, store, etc.)

- ☐ No
- ☐ Yes, Explain _____

_____

12. How do you handle materials carried by truck?

- ☐ In bulk.
- ☐ In baskets or boxes.
- ☐ In bags.
- ☐ Other _____

13. Do you use a tractor and wagon for hauling on public roads?

- ☐ No
- ☐ Yes

If yes, how many miles per trip (average)?

_____

What materials do you haul?

_____

_____

_____

14. Check below the types of wagon boxes you use.

- ☐ 1. Self unloading.
- ☐ 2. Flat rack (with or without sides).
- ☐ 3. Hydraulic dump.
- ☐ 4. Hopper (gravity unload at the bottom).
- ☐ 5. Vented bottom for crop drying.
- ☐ 6. Mixer with auger unloader.
- ☐ 7. Spreader.
- ☐ 8. Tank.
- ☐ 9. Other _____

15. Do you use public roads to get to your fields?

- ☐ No
- ☐ Yes

If yes, how far is it from your farmstead to the field?

_____

16. How much trucking do you hire done?

Materials hauled _____

Trips per year _____

Average miles per trip _____

17. Is the feed, seed, and fertilizer you buy hauled to your farm by you or by the seller?

Feed _____

Seed _____

Fertilizer _____

18. Do you have excessive trouble with wheels slipping or getting stuck in normal truck use?

- ☐ No
- ☐ Yes

Under what conditions? _____

_____

19. Do you use your truck for jobs other than just hauling materials?

☐ No ☐ Yes, describe the job.

20. Describe the changes, if any, that you have made on your truck to suit your particular requirements. (Add more sheets if necessary.)

21. Would you like a change in the size of the truck body (length, width, height, etc.)? Describe the change.

22. Would you like a change in engine power?

☐ 1. More power with, perhaps, less economy.
☐ 2. Less power with better economy.
☐ 3. No change.

23. What other changes would you like made in farm trucks? (Add more sheets if necessary.)

24. Would you be willing to discuss your materials handling and truck use program with a project agricultural engineer from Michigan State University?

☐ No
☐ Yes

What time of day would be most convenient to have him call on you? _____