An Analysis of Farm Equipment Accidents on North Carolina Public Roads

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About the Author

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ABSTRACT

This is an exploratory study to determine the patterns of highway accidents in North Carolina involving farm tractors and other farm equipment. A total of 1806 farm equipment accidents occurring in 1966, 1968, 1969, 1970, and 1971 were used in this study (the 1967 accident files were not available), and certain comparisons were made using all North Carolina accidents in 1969. In addition, several other comparisons were made using the 1972 accident and driver license files.

It was found that farm equipment operators in accidents suffer more fatalities and injuries than do other drivers. Farm equipment accidents follow a pattern of seasonal agricultural use and are more likely to occur in clear weather, during daylight hours, in open country, and on straight, level, paved roads. Farm equipment involved in highway accidents is more likely to be lacking proper lighting equipment than are other vehicles involved in farm equipment crashes.

Farm equipment operators involved in accidents are almost exclusively male, while about three-fourths of all accident drivers are male. Above the age of sixteen, operators of farm equipment are older than are drivers of the other vehicles.

Almost one-half of all collisions involving farm equipment and other motor vehicles occur when both vehicles are going straight, and another one-fourth occur when the tractor turns left while being passed by another vehicle.

Adult tractor operators involved in collisions are more likely to be sober than accident drivers in general, but nearly 18 percent of adult tractor drivers involved in single-vehicle non-collision accidents have been drinking.

On the basis of the results, the author makes the following recommendations:

1. A requirement that the slow-moving vehicle emblem be affixed to farm equipment operating on public roads.

2. A requirement that adult farm equipment operators possess a valid driver's license.

3. A requirement such as exists in some other states whereby underage persons may qualify for a special license for agricultural purposes. Such persons could be required to demonstrate competence in handling farm equipment before operating such equipment on public roads.

4. A requirement that directional signals and some type of rear-view mirror be present on farm equipment while on public highways.

5. A requirement that farm equipment being towed by tractors be properly lighted when on public roads during periods of darkness. In addition, existing requirements that farm tractors on public roads be properly lighted should be more strictly enforced.

6. Stronger enforcement of all other existing laws governing the operation of farm equipment on the public highways.

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ACKNOWLEDGMENTS

The author wishes to acknowledge the assistance of a number of persons and organizations who made this study possible. The North Carolina Department of Motor Vehicles supplied the information, and the University of North Carolina Highway Safety Research Center (HSRC) supplied technical assistance. The data processing was done by Cecile Alston, Statistical Analyst with the Health Statistics Branch, North Carolina Department of Human Resources. Other persons who contributed in some way include: John Freeman, Steve Gehlbach, Nancy Garrett, Judy Little, and Faye Stancil (all with the Epidemiology Section, Division of Health Services, Department of Human Resources); Patricia F. Waller, J. Richard Stewart, and William Hunter (from HSRC); and Joe Register and Lola Denning (from the North Carolina Department of Motor Vehicles).

I. INTRODUCTION

During this century, mechanization has made major inroads into the industry of agriculture. The biggest contribution of this mechanization has been the replacement of draft animals with more powerful and efficient sources of power; the "workhorse" of agriculture is now the farm tractor. Recent estimates place the number of farm tractors in North Carolina at approximately 152,000 (U.S. Bureau of the Census, 1970). Besides fulfilling the role of beast of burden in the field, the farm tractor provides a means of transporting persons and products from field to field, and also from farm to market. To further assist the farmer, North Carolina has more miles of rural paved roads than any other state in the nation (North Carolina State Highway Commission, 1973). Because farm tractors and all other motor vehicles use these roads, highway accidents frequently occur between farm equipment and other motor vehicles.

Each year there are approximately 360 accidents on North Carolina highways involving farm equipment. Of these, 3.2 percent are fatal, 33.6 percent involve non-fatal injuries, and another 63.2 percent involve property damage only (based on averages for the five-year study period 1966, 1968, 1969, 1970, and 1971). For all other North Carolina motor vehicle accidents for the year 1969, 1.3 percent were fatal, 29.8 percent resulted in personal injury, and 68.9 percent involved property damage. Thus, a striking difference exists in the fatality proportions; accidents involving tractors and farm machinery are 2.5 times as likely to result in a fatality than are other crashes (North Carolina Department of Motor Vehicles, 1970).

The motor vehicle laws of North Carolina (North Carolina Department of Motor Vehicles, 1972) govern the use of motor vehicles on public roads in the state. All motor vehicles must meet certain registration and safety equipment requirements, and all drivers must be licensed to operate motor vehicles. Farm tractors are exempt from these motor vehicle laws, and drivers of farm machinery do not need a driver's license. Examples of these laws and the exemptions for the farmer include:

G.S. 20-8 (2) exempts operators of farm vehicles or machinery from being required to have a driver's license.

G.S. 20-51 (3) and (7) exempt farmer machinery, and trailers and wagons used for hauling tobacco from motor vehicle registration.

G.S. 20-183.2 omits farm equipment from the requirement for annual state safety inspection.

G.S. 20-279.1 exempts farm equipment from financial responsibility (automobile insurance) requirements.

There is one law that expressly includes farm tractors and machinery:

G.S. 20-120 (f) states that farm tractors must be equipped with at least one white lamp visible five hundred feet to the front, and one red lamp or two four-inch reflectors visible from the rear for at least five hundred feet.

It has generally been thought that the majority of farm tractor accidents that take place on public roads occur as a result of the tractor being struck from the rear by another motor vehicle. To counter this tendency, much emphasis has been placed on efforts to make tractors and other farm equipment more visible while on the highways, especially to traffic approaching from the rear. Several bills have been introduced in the North Carolina General Assembly to require the display of the triangular slow moving vehicle emblem on farm equipment, but none has been passed as of this writing.

Because of the structure of the motor vehicle laws, and because of the differences in injuries and fatalities between all motor vehicle accidents and those highway accidents involving farm tractors, this study was performed to analyze the accident patterns of the farm equipment-related accidents with respect to the accident environment, the drivers, the vehicles, etc., to determine if present efforts are adequate or if other alternative measures are needed.

II. METHOD

Data were analyzed on all highway accidents involving farm equipment in North Carolina during the years 1966, 1968, 1969, 1970, and 1971 (the 1967 accident files were not available for this study). A total of 1806 such accidents were investigated by law enforcement officers during

these five years. The information these officers entered on the official standard accident report forms was keypunched and put on computer tape. The Statistical Package for the Social Sciences (SPSS) was used in the data analysis.

Investigated in this study are the driver, vehicle, and environmental (time, weather, roadway, etc.) variables relating to all farm equipment accidents. In those accidents where collisions occurred between farm equipment and other motor vehicles, the variables relative to both vehicles are examined. In investigating other relationships, the 1969 Census of Agriculture (U.S. Bureau of the Census, 1970) is used to determine the farm tractor population, and the 1969 North Carolina Traffic Accident Summary (N.C. Department of Motor Vehicles, 1970) is consulted for comparisons of the farm equipment accidents to the overall highway accident situation in North Carolina.

The roles of driver licensure and sobriety are examined in depth as these variables relate to the farm equipment operator. To accomplish this, 1972 data were collected and tabulated from both the accident and driver license files of the North Carolina Department of Motor Vehicles.

III. RESULTS AND DISCUSSION

Severity by Year

Table 1 shows the severity of accidents involving farm machinery by the year of occurrence.

The yearly breakdown reveals a consistent pattern for non-fatal injuries and for property damage crashes. The yearly difference in fatal crashes approaches statistical significance (χ^2=15.37, 8 df, p = 0.052), but this is probably due to 1966 being an unusual year for farm equipment fatalities.

The Accident Environment

Month of the year.

Farm tractors and machinery are implements of agriculture, and accident patterns reflect a seasonal fluctuation of use consistent with agricultural activity.

Table 1. Farm machinery accident severity by year.

YEAR	FATAL	INJURY	PROPERTY DAMAGE	TOTAL
1966	20 (1.1)[1]	111 (6.1)	214 (11.8)	345
1968	7 (0.4)	117 (6.5)	221 (12.2)	345
1969	8 (0.4)	120 (6.6)	242 (13.4)	370
1970	10 (0.6)	147 (8.1)	230 (12.7)	387
1971	12 (0.7)	112 (6.2)	235 (13.0)	359
Total	57	607	1142	1806

[1] (percent of total)

Source: Public Health Statistics Branch
North Carolina Department of Human Resources

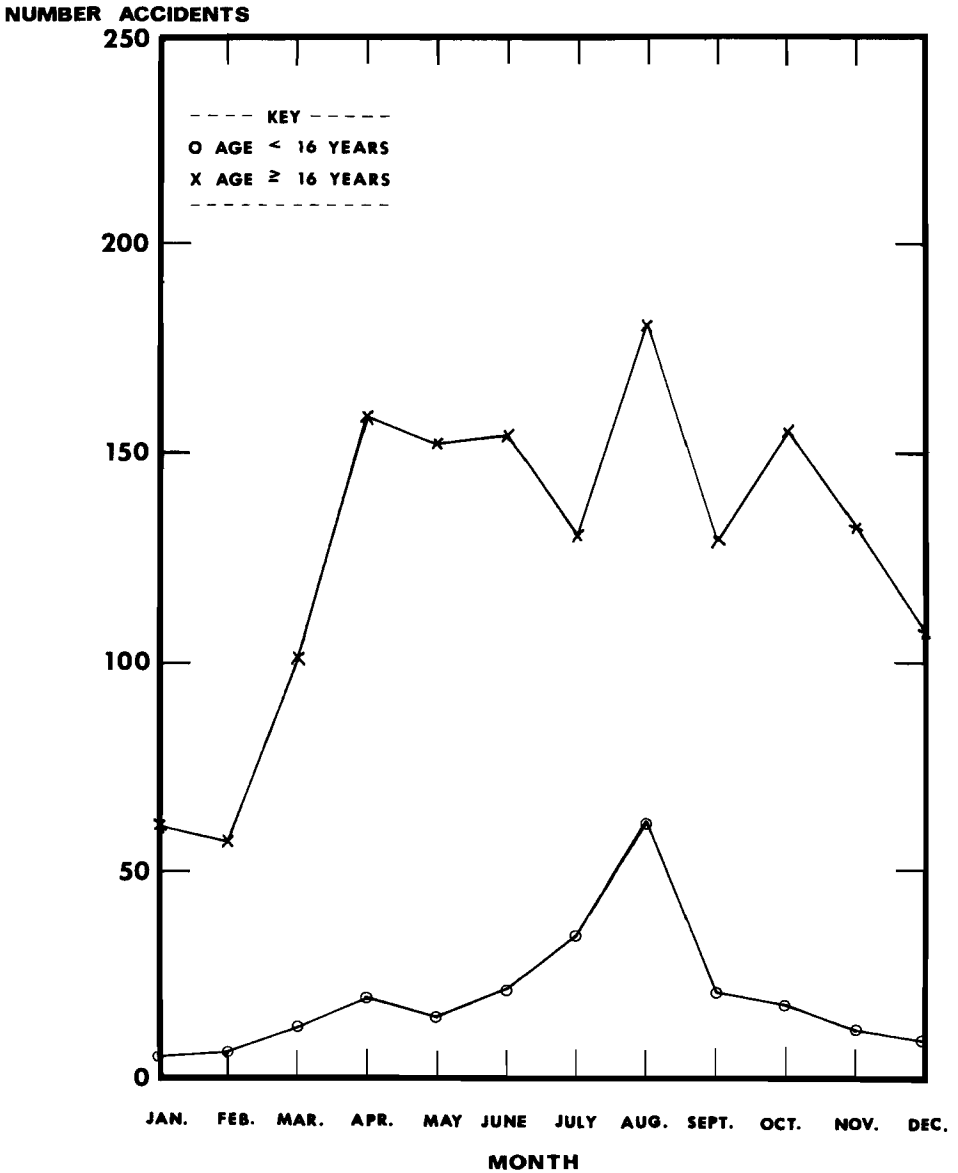

Figure 1. The frequency distribution of farm equipment highway accidents during the five-year study period by month of year and age (<16, ≥16 years) of operator. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

$\chi^2 = 23.99$, 11 d.f., $p < .02$

Figure 1 indicates a sharp increase in accidents in the spring, a peak in late summer, and a decline as winter approaches. Of special interest and concern is the peak for the month of August, the time of peak activity related to harvesting and marketing of farm products, especially tobacco. Another factor in this August peak is the availability of youths during the summer months as additional farm labor, as is reflected in the July-August peak for drivers under 16 years of age. Although August is the month of greatest accident occurrence for farm equipment operators of all ages, 25.5 percent of these August accidents were incurred by operators under 16 years of age.

Day of the week.

Farm machinery accidents by day of week are outlined in Figure 2. With the exception of Sunday, the daily number of accidents is fairly consistent, with a slight elevation on Fridays and Saturdays, which may be partly due to an increase in overall traffic volume.

Time of the day.

Figure 3 represents accidents by time of day. This trend appears to fit an expected level of farm equipment use as well as traffic volume. The late afternoon hours are those of greatest risk, with the accidents peaking between 5:00 p.m. and 6:00 p.m. This phenomenon is consistent throughout the year; therefore, it appears that the afternoon "rush hour" traffic density may be more closely associated with these accidents than is the approach of darkness at sunset.

Weather.

Weather is associated with farm equipment accidents as illustrated in Figure 4. More than three-fourths of all farm machinery highway mishaps occurred during clear weather, and an additional 15 percent took place under cloudy skies. Rain, snow, sleet, hail, or fog were present in 7 percent of all crashes. Operation of farm machinery is at a minimum during periods of inclement weather.

Light conditions.

Light conditions are depicted in Figure 5. As expected, most accidents occurred during daylight hours. However, one-sixth of all these accidents occurred in darkness on unlighted roads. A large proportion of farm machinery is not equipped with front and rear lights, and therefore, is not suited for operation on highways during hours of darkness.

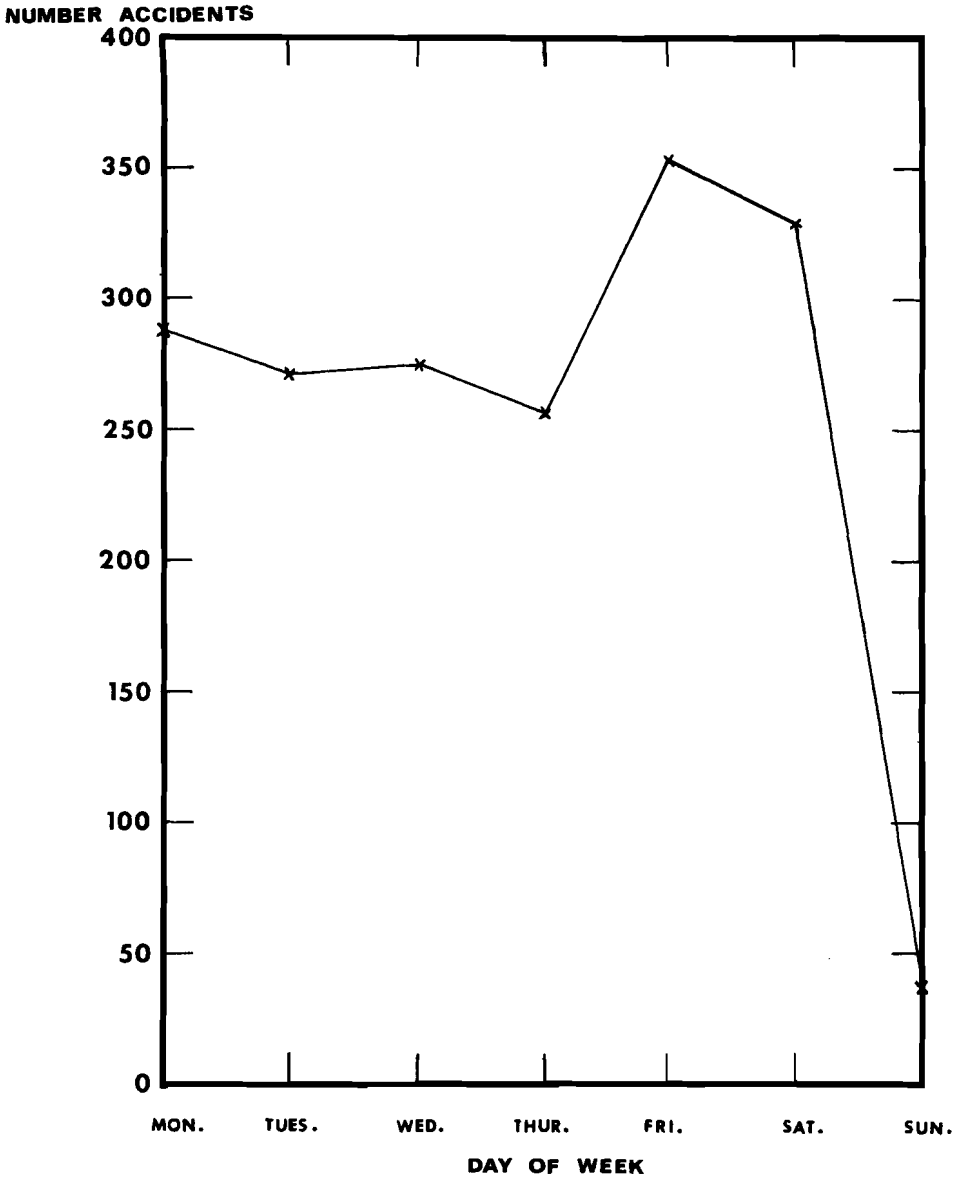

Figure 2. The frequency distribution of farm equipment highway accidents over the five-year study period by the day of the week. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

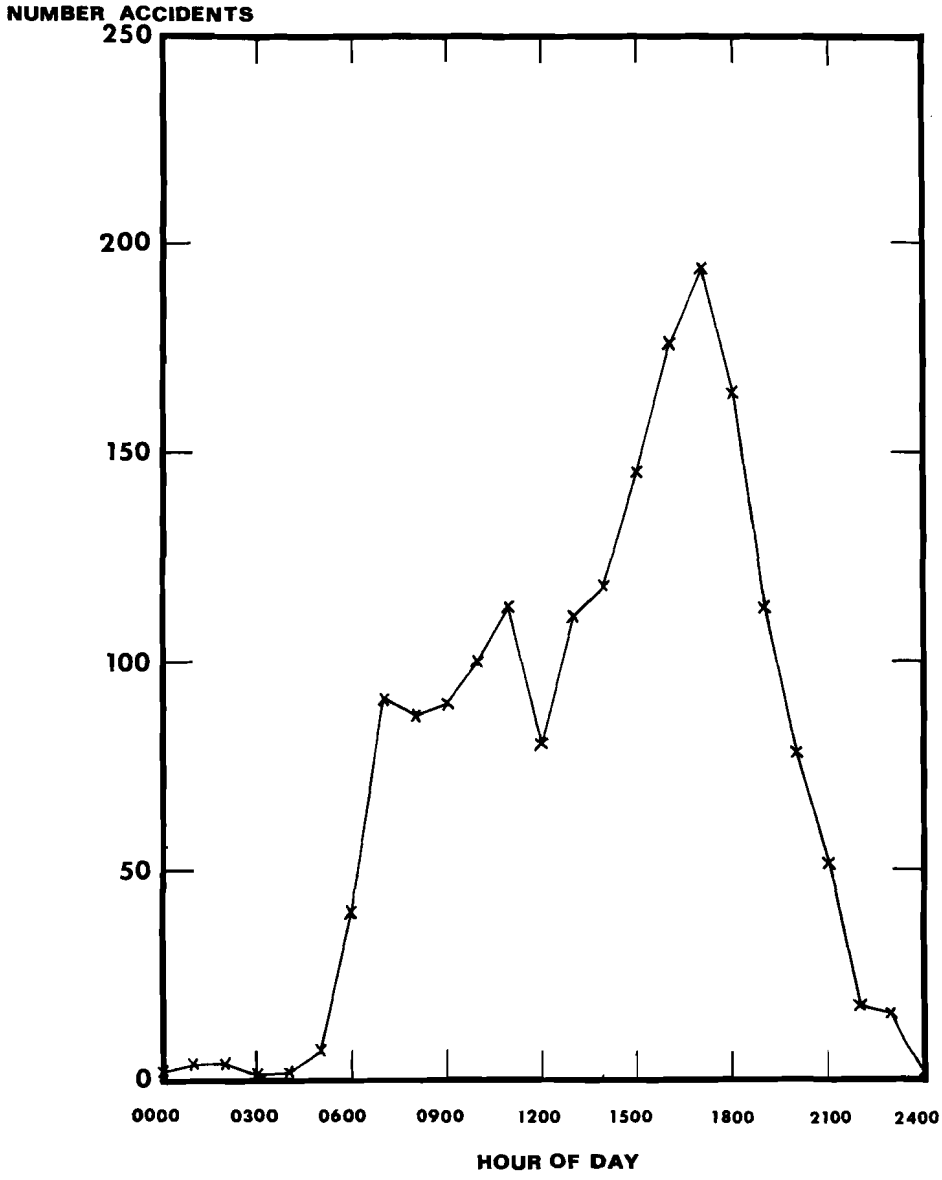

Figure 3. The frequency distribution of farm equipment highway accidents during the five-year study period by the hour of the day. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

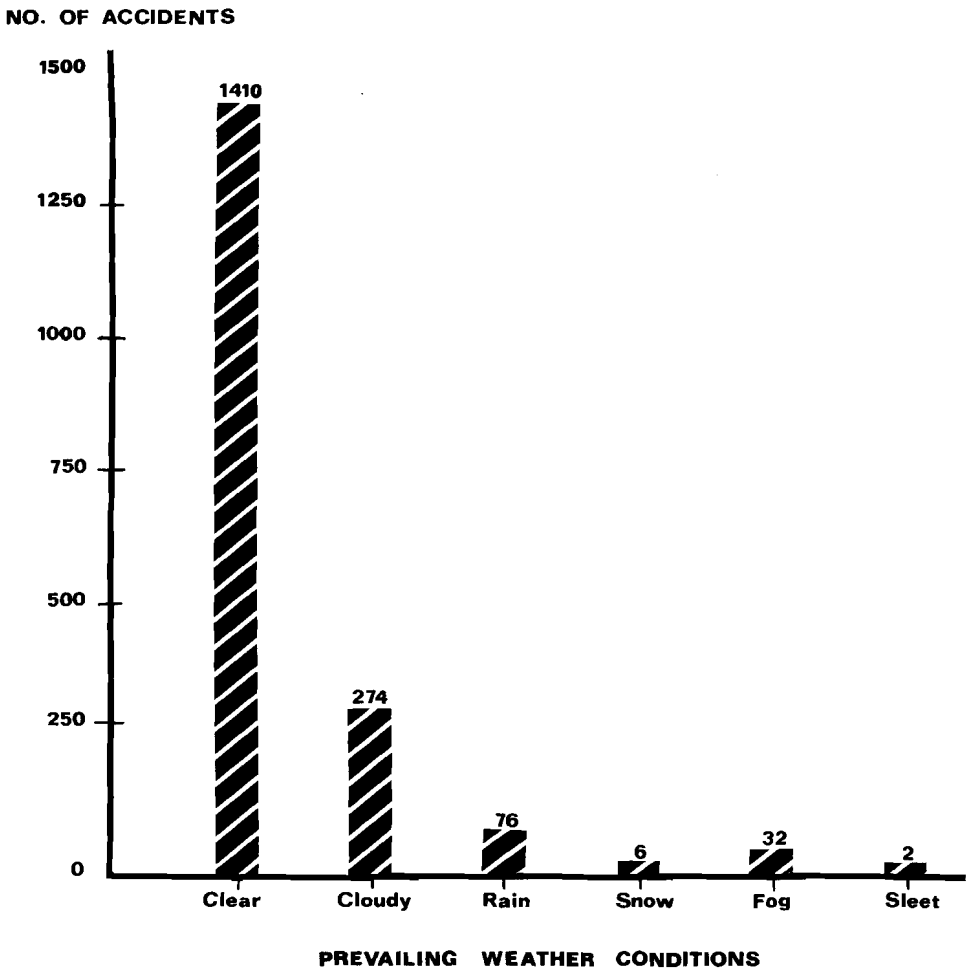

Figure 4. The frequency distribution of farm equipment highway accidents during the five-year study period by prevailing weather conditions. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

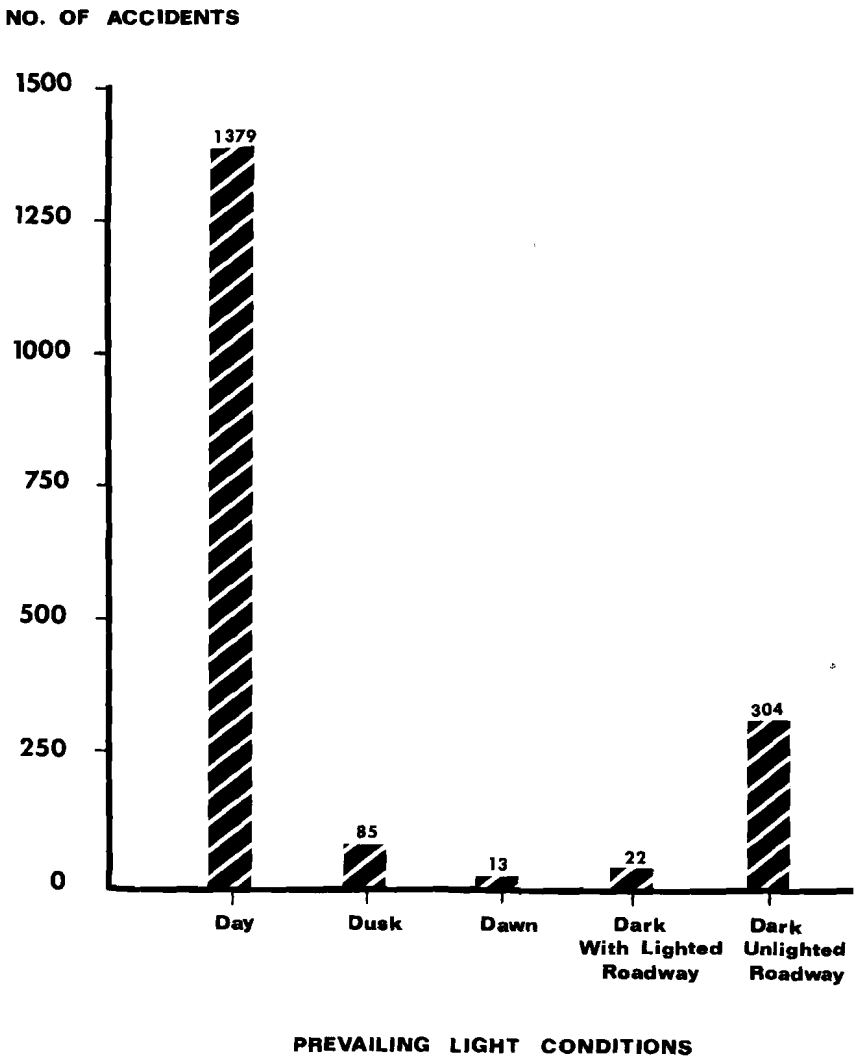

Figure 5. The frequency distribution of farm equipment highway accidents during the five-year study period by prevailing light conditions. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

The Road

As can be seen from Figures 6 through 8, most farm equipment accidents occurred on paved, dry roads without defects (paved, 92.6 percent; dry pavement, 90.7 percent; no defects, 94.9 percent). The posted speed limit was 55 miles per hour in about two-thirds of all crashes and in over three-fourths of all fatal crashes. Almost one-half of all crashes occurred on rural paved secondary roads, while approximately one-fourth took place on North Carolina primary highways. Figures 9 and 10 present these roadway variables.

Road character.

The road character is another factor which may operate in farm equipment crashes; whether the road is straight or curved, or whether the road is level or on a grade may affect both the visibility of farm equipment and the braking ability of overtaking traffic. Road character is presented in Figure 11. Over 60 percent of farm equipment accidents occur on straight level roads, with an additional 18 percent occurring on straight downhill grades. This suggests that the majority of farm machinery accidents are not primarily affected by road characteristics blocking the vision of traffic approaching from the rear; however, 30 percent do occur on uphill or downhill grades.

Locality.

Because the farm tractor is a vehicle used primarily in rural areas, accident exposure is greatest in open country. The data presented in Figure 12 indicate that over 85 percent of these accidents occur in open country.

The Vehicles

The farm tractor is the item of farm machinery most often involved in highway crashes. Towed equipment, such as plows and wagons, and occasionally a self-propelled farm machine (such as a combine) may be involved, but the farm tractor is the source of motive power for nearly all farm equipment on the road. In the following discussion, "other vehicle" refers to the other vehicle in a farm equipment-other vehicle collision unless otherwise indicated.

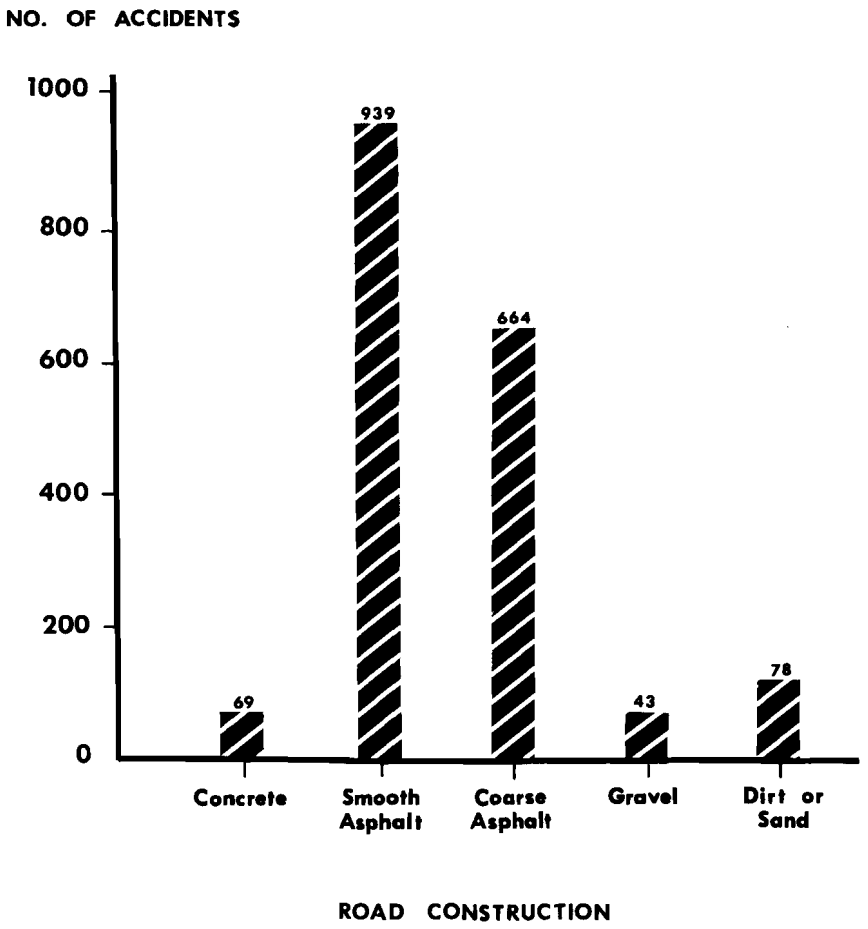

Figure 6. The frequency distribution of farm equipment highway accidents during the five-year study period by road construction. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

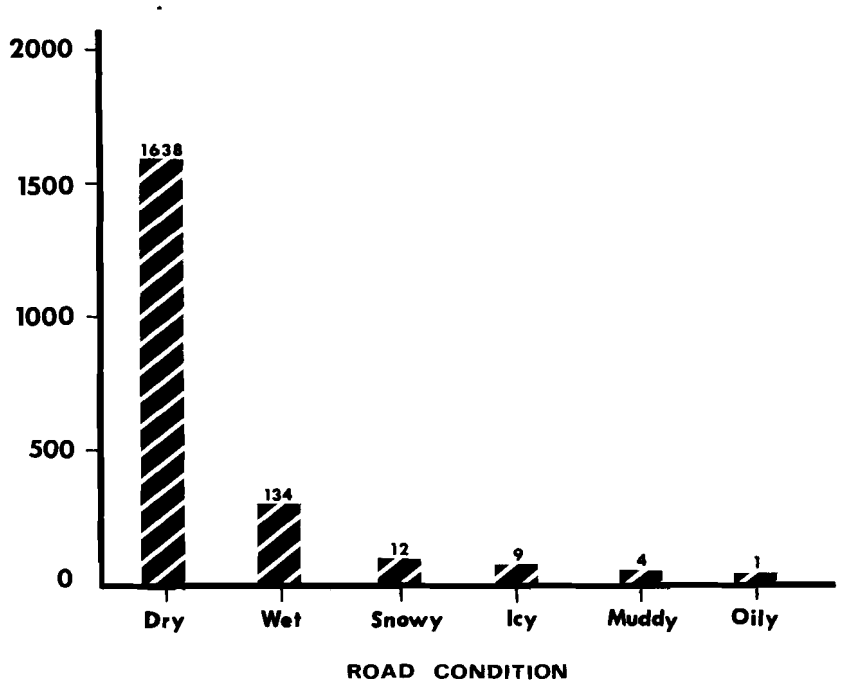

Figure 7. The frequency distribution of farm equipment highway accidents during the five-year study period by condition of the roadway surface. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

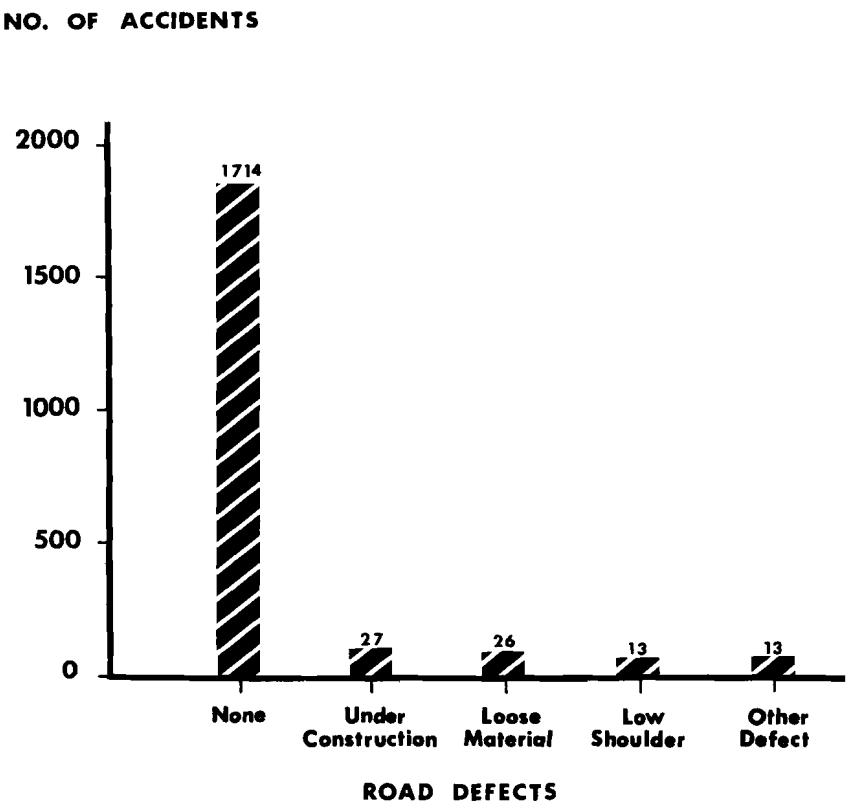

Figure 8. The frequency distribution of farm equipment highway accidents during the five-year study period by defects in the roadway surface. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

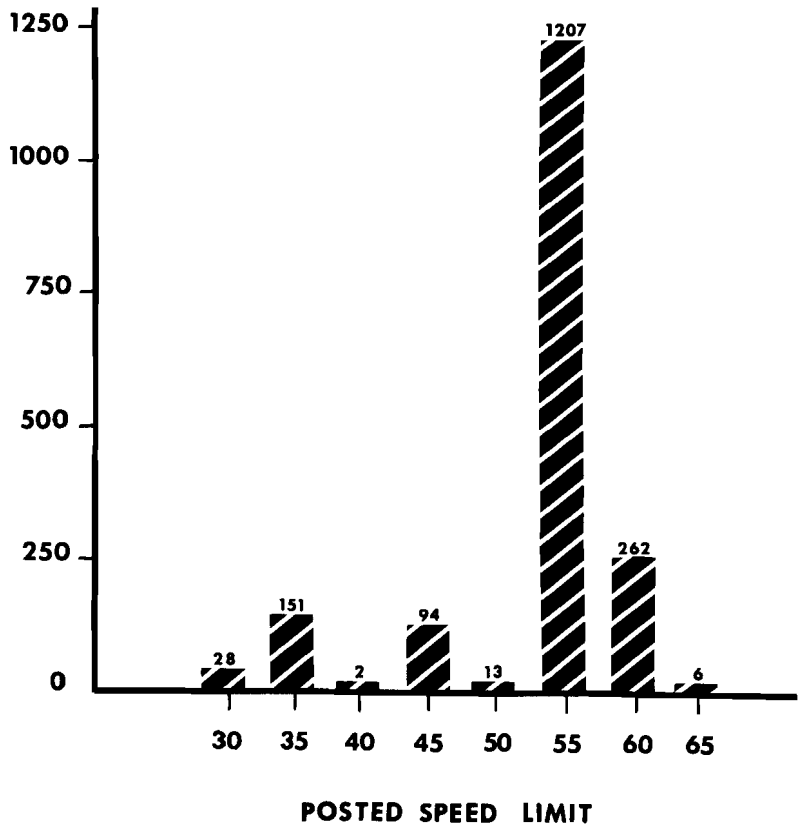

Figure 9. The frequency distribution of farm equipment highway accidents during the five-year study period by the posted speed limit. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

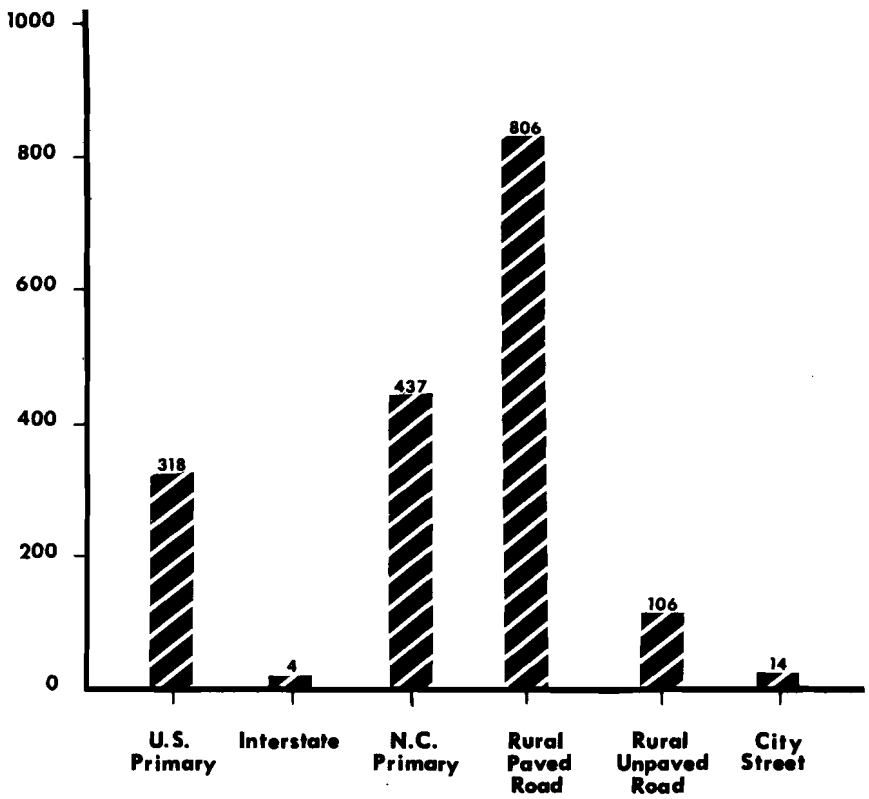

Figure 10. The frequency distribution of farm equipment highway accidents during the five-year study period by highway class. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

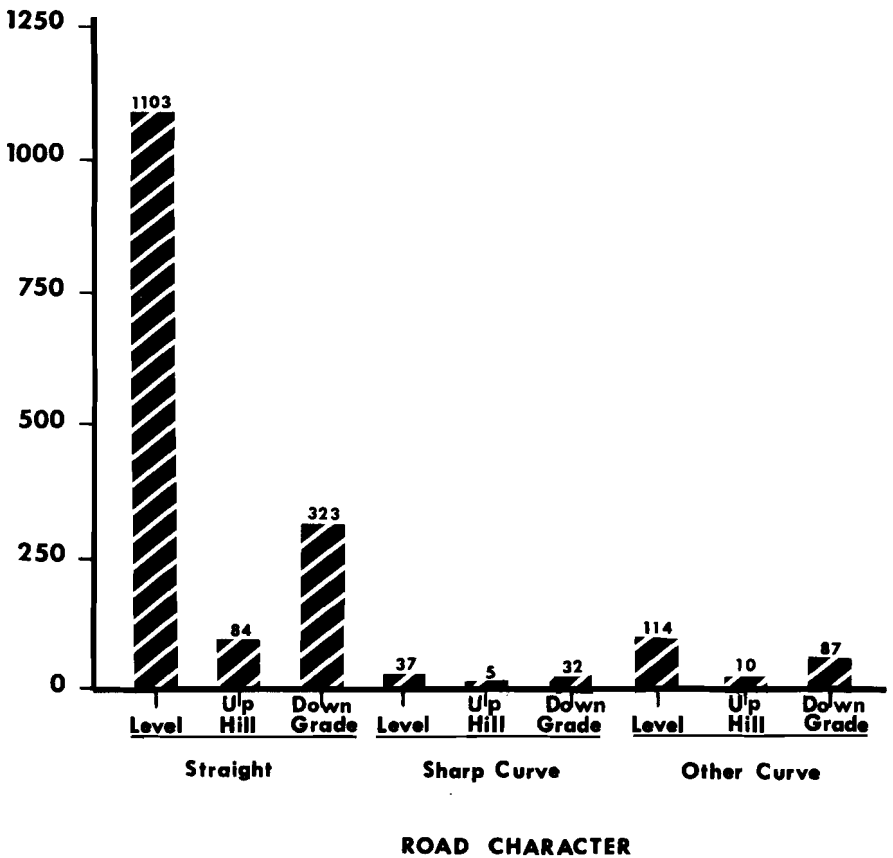

Figure 11. The frequency distribution of farm equipment highway accidents during the five-year study period by road character. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

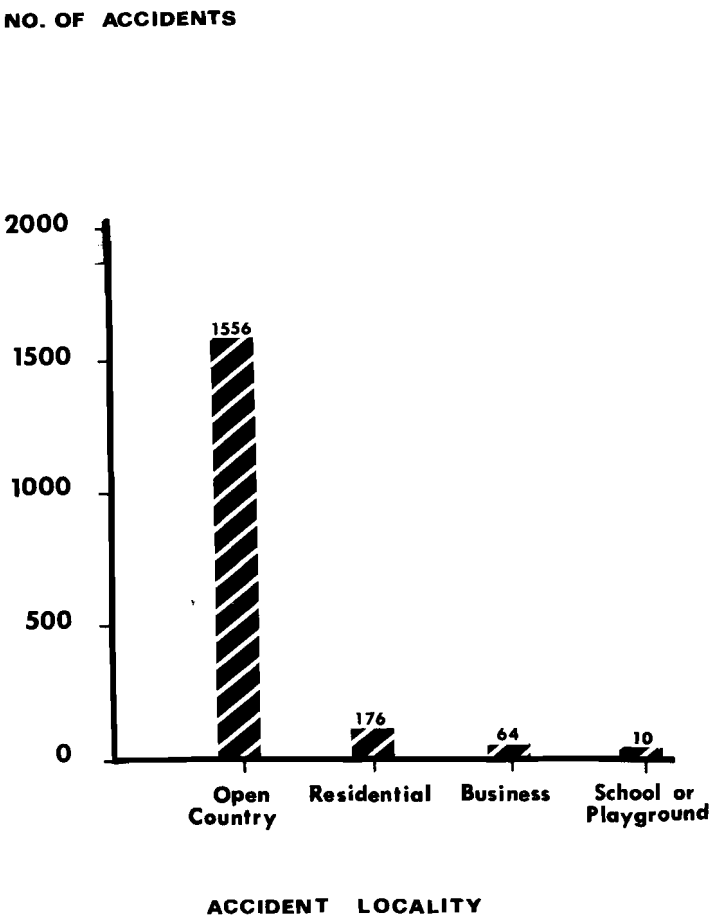

Figure 12. The frequency distribution of farm equipment highway accidents during the five-year study period by accident locality. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

Defects.

Farm tractors are not subject to motor vehicle inspection laws. Therefore, one might expect more mechanical defects found with farm equipment than with motor vehicles that are subject to annual safety inspection. Figure 13 outlines defects detected and reported by accident investigators that were considered to have been contributory to the crash.

Absent or defective lights were the major defects reported for tractors; rear lights were reported more often than were headlights as absent or defective.

Defective steering was also reported as present to a greater extent with farm machinery than with other vehicles involved in these crashes.

To identify other types of vehicle defects, inspection was made of a sample of hard copies of accident reports. On these, other defects reported for tractors included absence of turn signals and horn. These items are required in order to pass the annual motor vehicle safety inspection.

The only defect category in which the other vehicles involved in farm equipment collisions outranked farm tractors to an appreciable degree was defective tires. This, however, may be attributed to the fact that a large portion of tire defects are associated with tread depth and tractor tires have much deeper tread than automobile tires.

It must be pointed out that farm equipment is, by design, radically different from other motor vehicles, and this must be taken into consideration in the comparison presented in Figure 13; if farm equipment were subject to the annual inspection, many differences between vehicle types would remain although the proportions might change.

The Drivers

Sex.

As can be seen in Figure 14, most (96.4 percent) of the operators of farm machinery involved in these crashes were males. Drivers of the other vehicles involved in these farm equipment crashes were about three-fourths male and one-fourth female.

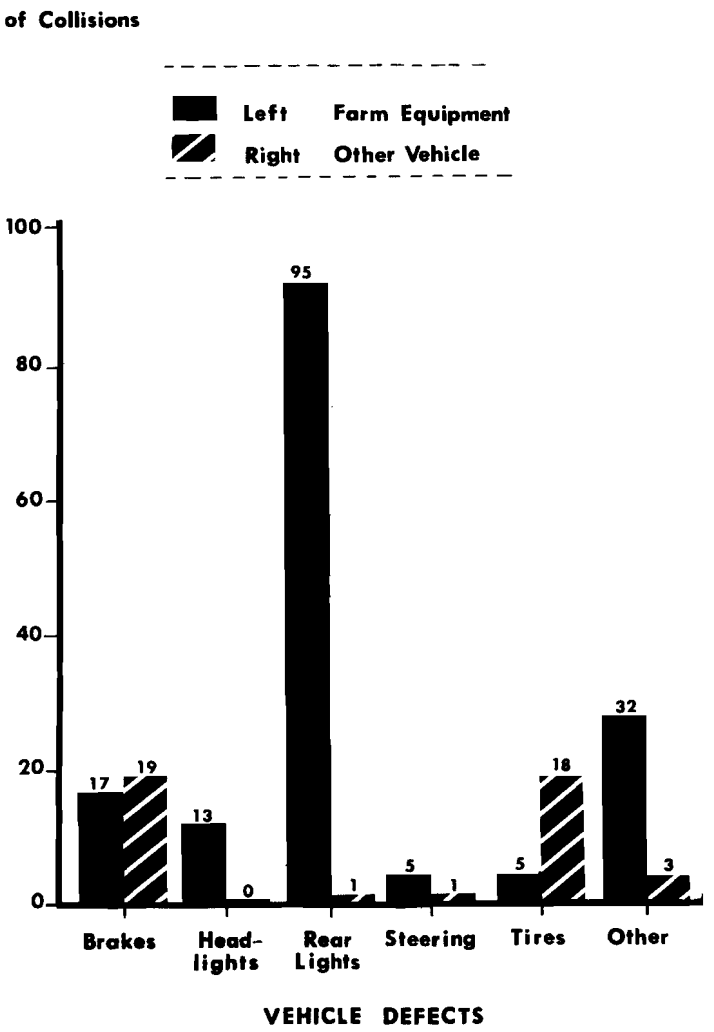

Figure 13. The frequency distributions of vehicle defects detected by investigators of farm equipment vs. other vehicle collisions during the five-year study period. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

$\chi^2 = 152.87$, 8 d.f., $p < .001$

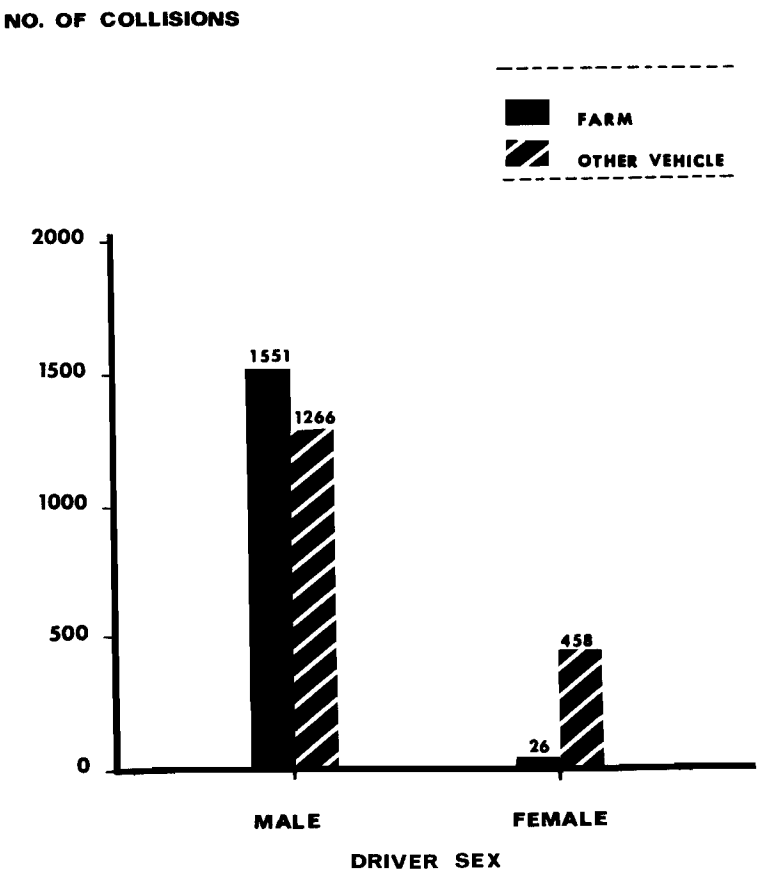

Figure 14. The frequency distribution of farm equipment vs. other vehicle collisions during the five-year study period by sex of driver. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

$\chi^2 = 344.10$, 1 d.f., $p < .001$

Age.

Driver age is illustrated in Figure 15. The most apparent difference between the drivers of tractors and the operators of other vehicles is in the under-16 age range; this finding is a reflection of motor vehicle licensing laws in that persons under age 16 cannot obtain a driver's license. Because the operation of farm machinery requires no license to drive, persons under age 16 may legally operate farm machinery on public roads. If median ages of the adult drivers involved in collisions are examined, the tractor operators are seven and one-half years older than the drivers of the other vehicles (41.1 vs. 33.6).

It must be pointed out, however, that a selection factor may be operating. The ages of the drivers of vehicles that collide with farm equipment may appear lower simply because younger drivers tend to drive at higher speeds, and have a greater risk of colliding with farm equipment as a result. If this is indeed the case, then the median age of the non-farm equipment drivers appears to be lower than it is in the actual driving population.

In order to test this possibility, age of driver was cross-tabulated with accident speed for the non-farm vehicles involved in these collisions. Because of the low number of cases in the cells in this cross-tabulation, a test of significance would be meaningless.

Licensure.

Because of a mobile and changing population, a fairly large proportion of drivers having accidents during the five years under investigation could not be located in the driver license files; these persons have since died, moved from North Carolina to another state, or have otherwise ceased to have a valid North Carolina driver's license. For this reason, all drivers involved in accidents during 1972 were checked for the possession of a valid North Carolina driver's license. Those drivers of farm equipment involved in accidents were compared to all the other 1972 accident drivers regardless of type of accident, and the results of this comparison appear in Table 2.

The most striking difference between the two vehicle-type groups is in the proportional difference between the unlicensed adults rather than between the juvenile populations. An unlicensed adult is a North Carolina resident 16 years of age or older who has no valid North Carolina driver's license on record at the time of his accident. Almost one in four farm equipment operators involved in an accident in 1972 was an unlicensed adult. More extensive investigation revealed

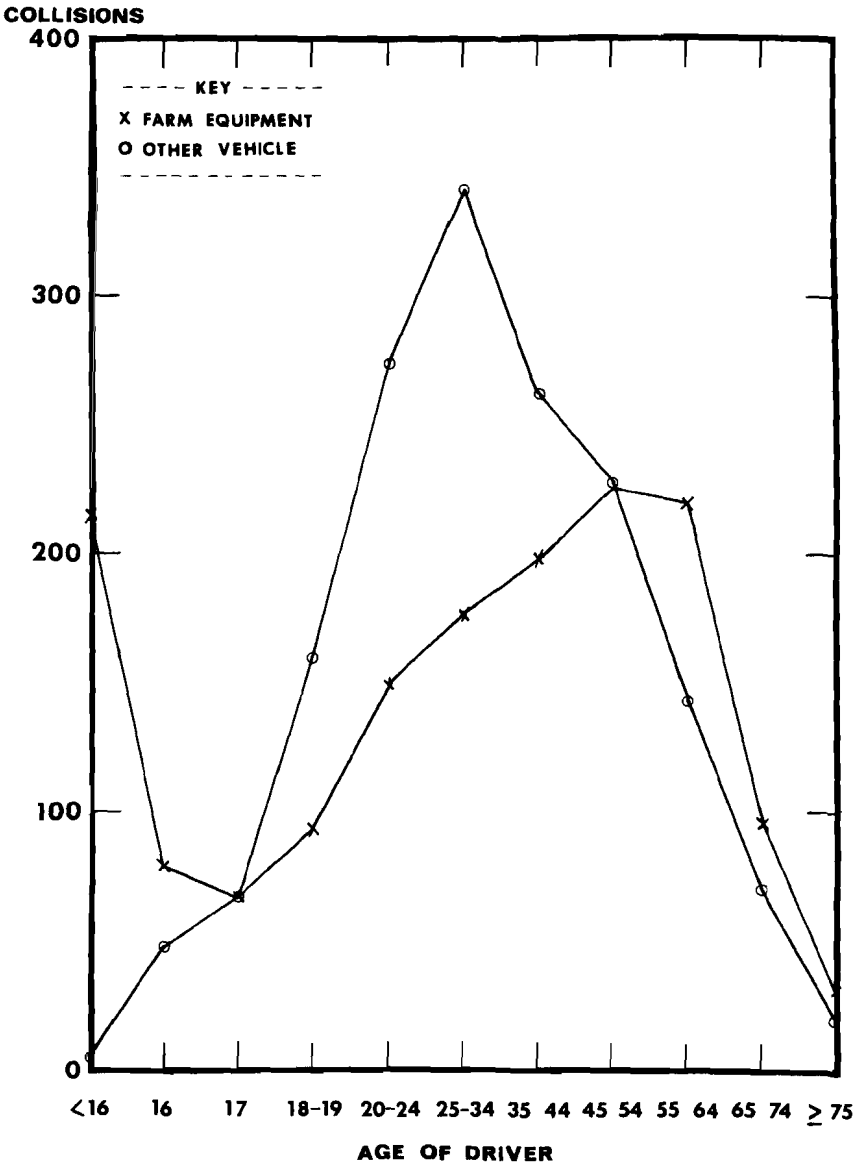

Figure 15. The frequency distribution of farm equipment vs. other vehicle collisions during the five-year study period by age of driver. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

$\chi^2 = 2205.64$, 8 d.f., $p < .001$

Table 2. Licensure of North Carolina resident accident drivers, 1972: farm equipment vs. all others.

ACCIDENT DRIVERS[1]				
VEHICLE TYPE	JUVENILES[2]	ADULTS NO LICENSE	ADULTS VALID LICENSE	TOTAL
Farm Equipment	42 (13.4)[3]	72 (22.9)	200 (63.7)	314
All Others	438 (0.2)	3711 (1.9)	193,986 (97.9)	198,135
TOTAL	480	3783	194,186	198,449

[1]Persons residing in North Carolina who had accidents in North Carolina

[2] <16 years of age

[3]Row percent

that of the 72 farm equipment operators in this category, 27 (37.5 percent) were involved in crashes while their licenses were in a state of revocation or suspension. The remaining 45 operators had no license on record for the following five reasons:

1. Death between the time of the accident (1972) and the time of the license record check (1973).
2. Voluntary surrender of license.
3. Denial of a license due to medical or psychiatric reasons.
4. Failure to pass the license examination.
5. Never having applied for a license.

The proportional difference between the unlicensed adult populations (farm equipment vs. all other vehicles) can be explained by farm equipment operators needing no license to operate this equipment on public roads. If a driver license were required of these adult farm equipment operators, then there should be little difference, if any, between the unlicensed adult populations in Table 2.

Because a large proportion of farm equipment operators involved in accidents have revoked or suspended licenses, the validity of the agricultural purposes of the equipment involved in accidents may be questioned. There is evidence (although circumstantial at this writing) to indicate that in some cases farm equipment is being used for general transportation rather than for agricultural purposes.

For instance, of the 27 farm equipment operators with a suspended or revoked license who were involved in a highway accident in 1972, 13 had been drinking to some degree at the time of the accident; of these 13 drinking drivers, 3 were killed. Of the remaining 10 who survived the crash, 8 were charged with driving under the influence (DUI). It is possible, therefore, that these persons were using the farm equipment for transportation other than agricultural in nature. Their use of this equipment on a public road was "legal" while these operators were without a valid license, as no license is required.

The Accident

In the following analyses of accident speed, vehicle maneuver and point of contact, single-vehicle farm equipment crashes have been

excluded. The comparisons made are those between farm equipment and other motor vehicles that collided with farm equipment on the highway. There were no farm equipment vs. farm equipment crashes on record.

Accident speed.

Farm machinery for the most part is restricted by design to speeds of 25 miles per hour or less, while other vehicles usually operate near the posted speed limit. The estimated speeds at the time of the accident of these two types of vehicles are outlined in Figure 16.

Of concern here is not necessarily speed per se, but rather the difference in speed between the farm machinery and the other vehicles.

Vehicle maneuver and point of contact.

Table 3 outlines the accident type by vehicle maneuver in collisions. There are two maneuvers by farm equipment and by other vehicles that are involved in 86 percent of all these crashes. Over two-fifths of all tractor-motor vehicle collisions occurred when both vehicles were heading straight (43.1 percent). This is the type of accident in which the motor vehicle usually runs into the rear of the tractor. The point-of-contact information in Table 4 indicates that most farm machinery is struck from the rear (53.8 percent), while the other motor vehicle usually makes contact in the front (75.9 percent). This suggests that the "rear-end collision" is the predominant type of collision. The second most frequent type of collision occurs when the tractor makes a left turn while being passed; almost one-fourth (23.8 percent) of all crashes involve this combination of vehicle maneuvers. The point-of-contact data support this, with 41.6 percent of left side contact for farm equipment, and high percentages of front (75.9 percent) and right side (41.6 percent) contact for the other motor vehicles. These two combinations, rear-end collision and left turn while passing, appear to account for about two-thirds of all farm machinery collisions involving other vehicles on the highway.

Sobriety [1]

The imbibing of spiritus fermenti has been known for many years to be highly correlated with highway crashes. In 1969, 8.8 percent of all

[1]*Sobriety was determined by the opinion of the investigating officer. In most instances an objective measure of blood alcohol level was not available.*

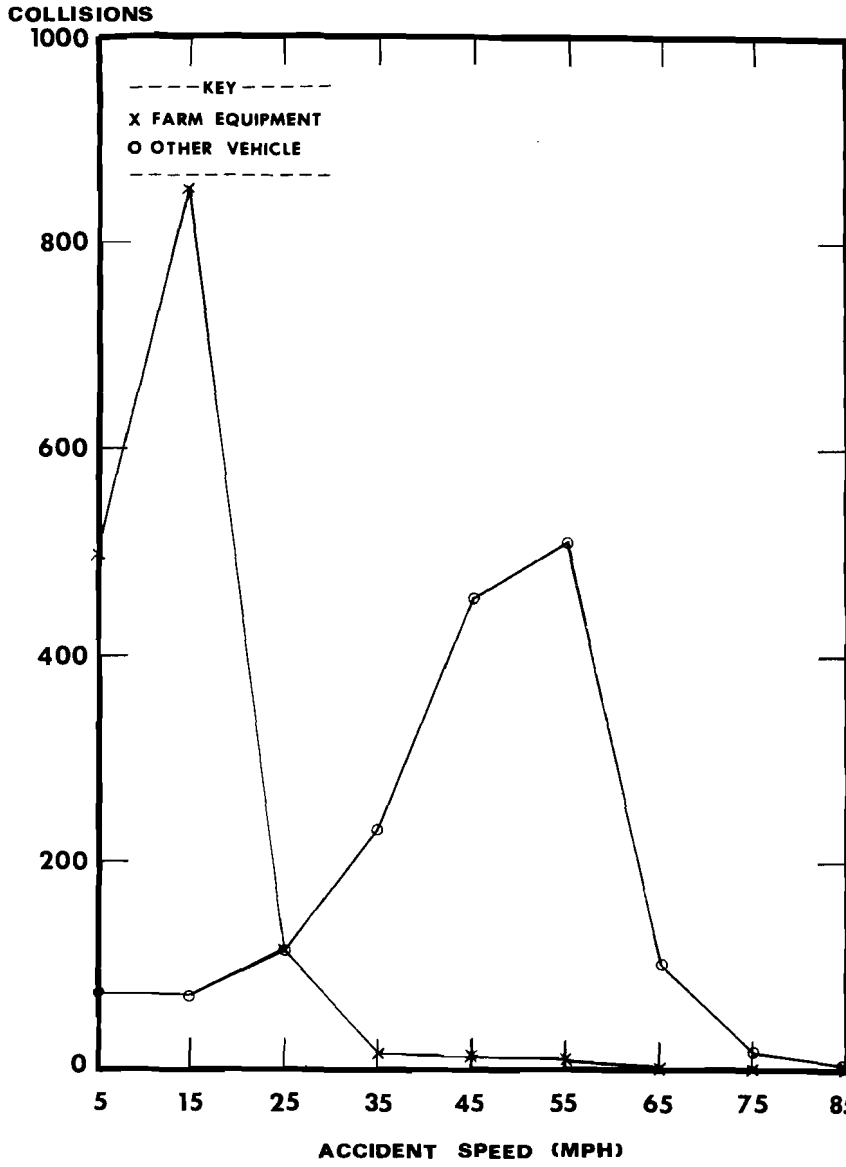

Figure 16. The frequency distribution of farm equipment vs. other vehicle collisions during the five-year study period by accident speed. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

Table 3. Vehicle maneuver: farm equipment vs. other vehicles.

FARM EQUIPMENT	OTHER VEHICLE					
	Straight	Passing	Left Turn	Slowing, Stopping	All Others	TOTAL
Straight	654 (43.1)[1]	124 (8.2)	8 (0.5)	7 (0.5)	11 (0.7)	804 (53.0)
Left Turn	165 (10.9)	361 (23.8)	2 (0.1)	3 (0.2)	0 (0.0)	531 (35.0)
Starting in Road	85 (5.6)	2 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	87 (5.7)
Right Turn	22 (1.5)	10 (0.7)	1 (0.1)	0 (0.0)	0 (0.0)	33 (2.2)
Slowing, Stopping	12 (0.8)	2 (0.1)	0 (0.0)	2 (0.1)	1 (0.1)	17 (1.1)
Backing	12 (0.8)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.1)	13 (0.9)
All Others	24 (1.5)	4 (0.3)	2 (0.1)	0 (0.0)	1 (0.1)	31 (2.1)
TOTAL	974 (64.2)	503 (33.2)	13 (0.9)	12 (0.8)	14 (0.9)	1516 (100.0)

[1](percent of total)

Source: Public Health Statistics Branch, North Carolina Department of Human Resources

Table 4. Point of contact.

A. Farm equipment.

Front (29.7)

	Left	Center	Right	
Front	290 (15.9)	174 (9.6)	77 (4.2)	Front
Center	111 (6.1)		30 (1.6)	Center
Rear	356 (19.6)	553 (30.4)	69 (3.8)	Rear
	Left	Center	Right	

Left (41.6) — Right (9.6)

Rear (53.8)

B. Other vehicles

Front (75.9)

	Left	Center	Right	
Front	158 (9.2)	673 (39.0)	478 (27.7)	Front
Center	78 (4.5)		164 (9.5)	Center
Rear	54 (3.1)	41 (2.4)	76 (4.4)	Rear
	Left	Center	Right	

Left (16.8) — Right (41.6)

Rear (9.9)

accidents in North Carolina involved at least one driver who, in the opinion of the investigating officer, had been drinking (North Carolina Department of Motor Vehicles, 1970). In the farm equipment collisions in this study, 4.5 percent of the adult tractor operators were drinking, while 8.2 percent of the other drivers had been drinking. This difference is statistically significant ($\chi^2 = 23.81$, 1 df, $p < .001$). Figure 17 shows the distribution of all sober accident tractor drivers by age and the distribution of drinking accident tractor drivers by age.

A comparison between drinking farm equipment operators involved in highway collisions and drinking drivers of the other vehicles involved in farm equipment crashes is shown in Figure 18. It is interesting to note that the difference in the age distribution of these two groups of drinking drivers is greater than the median age difference between the two driver populations as a whole; the drinking tractor operators are, as a group, 11.6 years older than the group of drinking drivers of the other vehicles whereas the median age difference of the entire population is 7.5 years. This information is presented in Table 5. There are at least two possible explanations for this phenomenon: first, it could be a reflection of the age difference between both populations; Figure 15 bears a resemblence to Figure 18. Again, the sampling procedure may be having an effect here. The sample consists of drivers of cars and tractors who have collisions with each other. The young drinking automobile driver may be particularly susceptable to running over tractors, hence being in the sample and hence lowering the median age of drinking car drivers. This same sort of effect may also account for much of the overall age difference and perhaps other differences as well.

Another possible explanation is somewhat more involved. Since a license to drive is not required to operate a farm tractor on the highway, a person who has previously lost his license to drive (e.g., for driving under the influence) can still legally operate a farm tractor, unless, of course, he is intoxicated at the time.[1] After about age 50, drinking tractor operators appear to outnumber the drinking drivers of the other vehicles involved in farm vehicle collisions, further strengthening the possibility that such drink-and-drive activity is actually taking place on North Carolina highways with farm equipment serving as the vehicle.[2]

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[1] *A 1959 court decision makes it illegal to operate a farm tractor on the highway while under the influence of alcohol (State vs. Green, 251 N.C. 141, 110 S.E. 2d 805).*

[2] *This author has personally investigated several such accidents.*

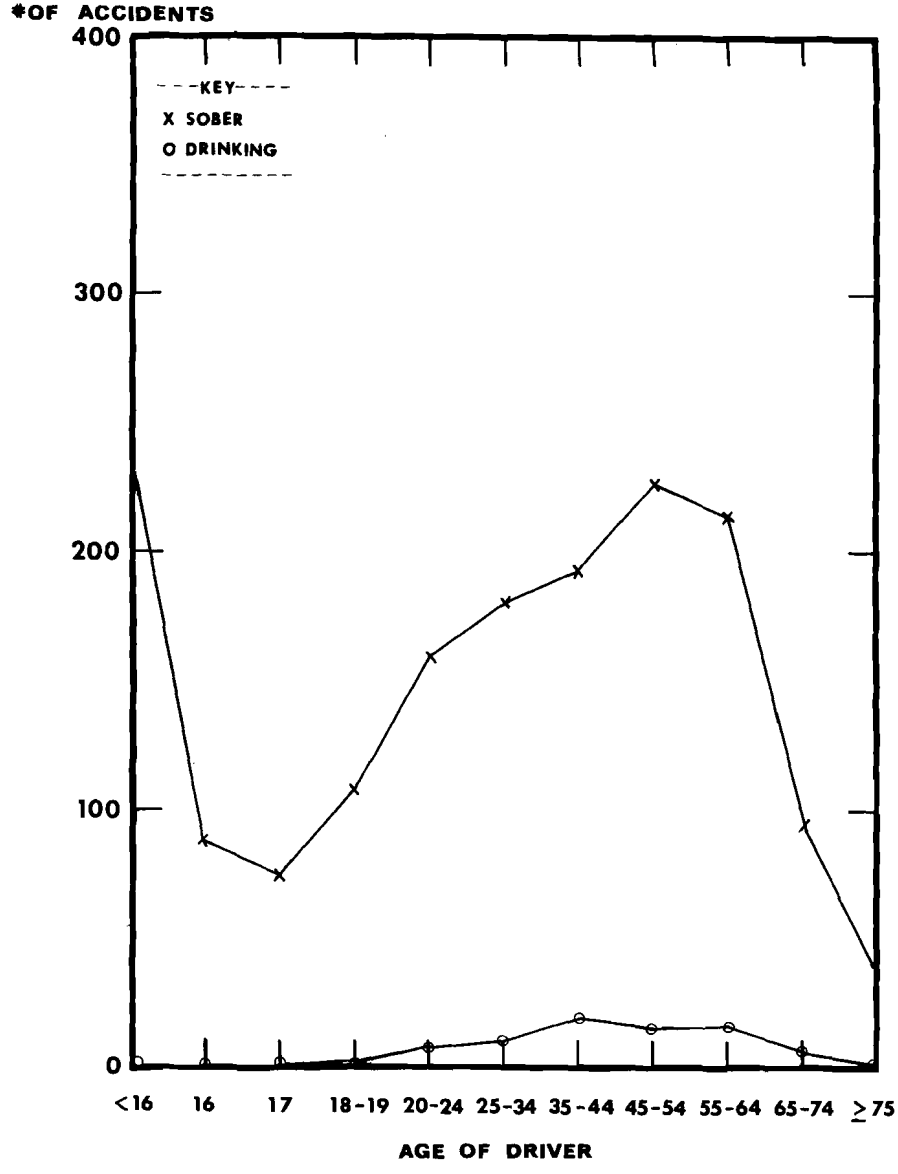

Figure 17. The frequency distribution of farm equipment highway accidents during the five-year study period by driver sobriety and age (<16, ≥16 years) of driver. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

χ^2(sobriety) = 13.22, 1 d.f., $p < .001$

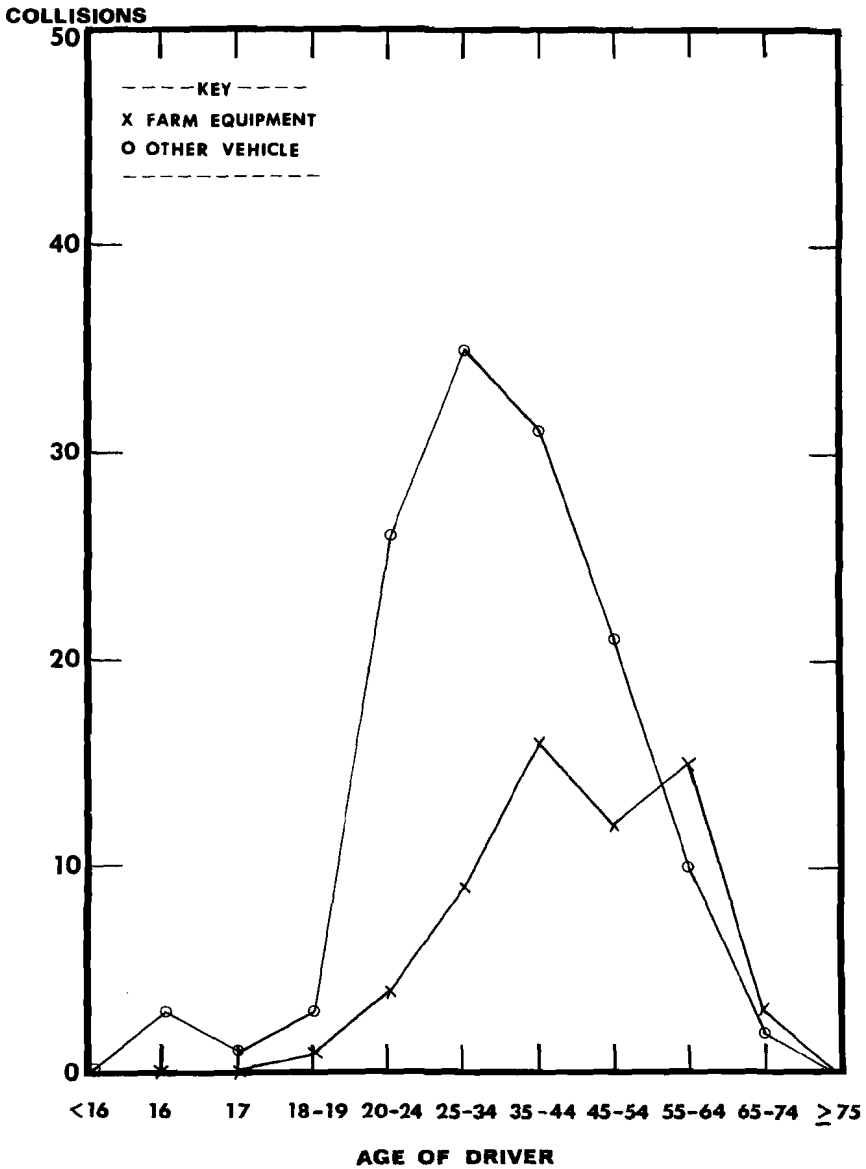

Figure 18. The frequency distribution of farm equipment vs. other vehicle collisions during the five-year study period of drinking drivers by age. (From Public Health Statistics Branch, N.C. Department of Human Resources.)

$\chi^2 = 13.68$, 2 d.f., $p < .05$

Table 5. Median ages of adult[1] drivers by sobriety: farm equipment vs. other vehicles.

Vehicle Type	Sobriety		
	Sober	Drinking	Combined
Farm Equipment	39.6 (1278)[2]	57.0 (60)	41.1 (1338)
Other Vehicles	33.3 (1481)	35.4 (132)	33.6 (1613)
Combined	36.1 (2759)	38.9 (192)	36.4 (2951)

[1] $\geq$ 16 years of age

[2] number of cases

Non-collision farm equipment accidents are also highly associated with alcohol consumption; over seventeen (17.6) percent of all single-vehicle non-collision farm tractor accidents on the highway involving adult drivers occurred while the driver was drinking.

Because of the slow speeds inherent in farm equipment design, excessive speed was not a factor correlated with the intoxicated tractor operator. However, excessive speed was a significant ($\chi^2 = 74.00$, 8 df, $p < .001$) factor in a comparison between the drunk and sober drivers of the non-farm vehicles involved in farm equipment crashes. These data are presented in Table 6.

To look more closely at the problem of driver sobriety, the 1972 sobriety information was examined to determine if the adult operators of farm equipment were drinking more heavily than were all other adult drivers during that year. This comparison is illustrated in Table 7.

This information again reflects the observations and opinions of the investigating officers at the accident scenes. The operators of farm equipment who had been drinking were believed to be impaired by their drinking more often than were the drivers of all other vehicles. This difference in adjudged impairment approaches statistical significance. This finding may be indicative of more "social drinking" by the drivers of the vehicles, and more serious drinking by the farm equipment operators. Because many serious drinkers are above age 40, this may support the data shown in Figure 18, whereby those persons who have lost their license to drive in a DUI arrest and who also have a farm tractor available, can and do continue to drink and drive. If this is indeed the case, then those persons who have lost their license through a DUI conviction are "removed" from the motor vehicle population. If these persons then use a farm tractor for motor transportation at a later date, they will reappear in the farm tractor population as indicated in Figure 18.

Table 8 outlines the 1972 DUI arrests in North Carolina for farm equipment operators and for all other drivers who were considered to have been impaired from drinking (Drinking/Impaired column from Table 5).

It can be seen in Table 8 that when collisions involving farm equipment and other vehicles are examined, the drinking operators of farm equipment are arrested for DUI no more often than are drivers of the other vehicles. Therefore, the risk of driving a farm tractor while intoxicated may not present a substantially greater risk of detection or arrest by law enforcement officers than would the operation of other motor vehicles while intoxicated. This may actually reinforce the use of a farm tractor for transportation while intoxicated and when the

Table 6. Sobriety[1] and accident speed: farm equipment vs. other vehicles.

Farm Equipment

	Accident Speed (mph)						
Sobriety[1]	0-9	10-19	20-29	30-39	40-49	50-59	Total
Sober	483	825	107	14	11	8	1448
Drinking	15	34	9	0	0	1	59
Total	498	859	116	14	11	9	1507

$\chi^2 = 7.90$, 5 df., $.20 > p > .10$

Other Vehicles

	Accident Speed (mph)									
Sobriety[1]	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80	Total
Sober	69	66	107	216	429	463	76	10	1	1437
Drinking	3	4	3	15	26	47	25	5	2	130
Total	72	70	110	231	455	510	101	15	3	1567

$\chi^2 = 74.00$, 8 df., $p > .001$

[1]Opinion of investigating officer

Table 7. Sobriety of accident drivers, 1972: farm equipment vs. all others.

	DRIVER SOBRIETY[1]			
VEHICLE TYPE	NOT DRINKING	DRINKING/ IMPAIRED	DRINKING/IM-PAIRMENT UNKNOWN	TOTAL
Farm Equipment	283 (90.1)[2]	19 (6.1)	12 (3.8)	302
All Others	189,913 (91.2)	8467 (4.0)	10,160 (4.8)	211,338
Total	190,196	8486	10,172	211,652

[1]opinion of investigating officer

[2]row percentage

χ^2 (drinking/impaired vs. unknown) = 3.13, 1 df,, .10 > p > .05

Table 8. DUI arrests, 1972: farm equipment vs. other vehicles in farm equipment - other vehicle collisions.[1]

VEHICLE TYPE	ARRESTED FOR DUI	NOT ARRESTED FOR DUI	TOTAL DRINKING IMPAIRED
Farm Equipment	10 (52.6)[2]	9 (47.4)	19
All Others	5211 (61.4)	5356 (38.6)	2467
Total	5221	3265	8486

[1]Restricted to drivers age 16 and older

[2]Row percent

$\chi^2 = 0.615$, 1 df, $.50 > p > .30$

driver's license is revoked, since licensure is not required for the operation of farm equipment on the highway.

IV. SUMMARY

Farm tractors and other farm machinery that use public roads in North Carolina are exempt from almost all motor vehicle laws -- laws designed for the safety of persons and vehicles using these public roads. In part, these exemptions for farm equipment and the operators thereof are reflected in an increased risk of death and injury. Furthermore, paved roads invite higher speeds than do unpaved roads. Because of the large proportions of paved rural roads in North Carolina, it is likely that many of the collisions involving farm equipment and other vehicles resulting in deaths and injuries are at least in part a reflection of these higher speeds.

Comparison of farm equipment traffic accidents with other traffic accidents resulted in the following findings:

Farm equipment accidents on public roads are "fair weather" crashes, more likely to occur in open country, during daylight hours, on clear days during the work week, and during yearly peak periods of agricultural activity.

The roads generally were straight and level, but about 30 percent occurred on hills or grades where perhaps overtaking traffic could not see the farm equipment ahead.

Probably because of exemption from motor vehicle inspection laws, farm equipment was found to have more mechanical defects than were other vehicles involved in farm equipment collisions. The majority of these defects were improper or nonexistent lighting devices, particularly rear lights.

Almost all (96.4 percent) of the farm equipment operators were male, and, excluding drivers under sixteen years of age, were somewhat older than the drivers of the other vehicles involved in farm equipment collisions. Because no license is required for farm equipment operation, many accidents occurred involving underaged drivers. These youths were especially involved during the summer months, and were associated with over one-fourth of all farm equipment highway mishaps during the month of August.

Two distinct vehicle maneuver combinations were found to occur in two-thirds of these farm equipment collisions. The largest portion (43 percent) of these accidents took place when both vehicles were going straight, resulting in a rear-end collision. The other most frequent accident type (24 percent) took place when the left-turning farm equipment was struck by a passing vehicle.

With respect to drivers of other vehicles involved in farm machinery accidents, the prevalence of alcohol is not significantly different (8.2 percent vs. 8.8 percent) from all motor vehicle accidents. On the other hand, alcohol use by operators of farm equipment involved in highway collisions with other vehicles was noticeably lower than for the drivers of other vehicles involved in farm equipment collisions (4.5 percent vs. 8.2 percent). In contrast, alcohol involvement in single-vehicle non-collision accidents involving farm equipment exceeded seventeen percent (17.6 percent).

V. CONCLUSIONS AND RECOMMENDATIONS

Almost one-half of all highway collisions involving farm machinery are rear-end. Because of the slow pace of the farm machinery contrasted with the speeds of the other vehicles, these collisions frequently occur with considerable impact, resulting in deaths and serious injuries, as well as considerable property damage. Often the motorist approaching farm machinery from the rear does not identify the machinery and is not aware of its slow rate of speed until the distance between the two vehicles is so small that a collision cannot be avoided. To counter this, several states, as well as the federal government, have passed or attempted to pass legislation requiring the display of the slow-moving vehicle emblem on the rear of all tractors and other farm machinery while moving on public roads. This emblem identifies those vehicles that are designed for speeds at or below 25 miles per hour. A bill to require the use of this emblem in North Carolina has been introduced several times in the North Carolina General Assembly without success.

Farm equipment usually operates at a high noise level, and vision to the rear is blocked if a wagon or other large equipment is attached to the drawbar of the tractor. These factors sometimes prevent the tractor operator from either hearing[1] or seeing a passing vehicle approaching from the rear. If the farm equipment operator is preparing to turn, he should have electric turn signals visible to overtaking

[1] *G.S. 20-149(b) requires the passing vehicle to give an audible warning of his intent to pass (N.C. Department of Motor Vehicles, 1972).*

traffic; hand signals may be blocked from view by a large load to the operator's rear, preventing overtaking traffic from knowing the tractor operator's intent to turn. Also, the use of a rear view mirror may assist the tractor operator to see other vehicles approaching from the rear as well as to check the condition of loads in tow. These safety equipment recommendations do not seem unreasonable since other vehicles are required by law to be so equipped. Because farm equipment must share the same roads with these other vehicles, then the responsibility for the installation and use of safety equipment should also be shared by the farm equipment owner.

Many farm equipment accidents involve drivers under 16 years of age. These underage drivers appear in the data especially in the summer months, particularly during August. Inexperience is probably at least a part of the problem of these young drivers. Furthermore, these youngsters have no certified knowledge (i.e., a driver's license) of the rules of the road. This author does not advocate a mandatory driver's license requirement for these young operators, but rather some required form of instruction in highway safety and rules as well as some form of off-the-road instruction in the safe handling of farm equipment. This instruction could be offered in the high schools in a manner similar to other Driver Education courses, and a certificate of successful completion of this course could serve as a "license" to operate farm equipment on the highway.

The adult farm equipment operator is not required to possess a valid operator's license, yet most of these persons do have a license to drive. However, there are many farm equipment operators who have no record of a valid license to drive. There are still others whose license has been suspended or revoked, yet who continue to operate a vehicle on the highways by using a farm tractor for transportation. Because these unlicensed adults constitute a minority, the author is of the opinion that requiring a valid license of adult farm equipment operators would encourage those persons currently without a license to obtain legal sanction to drive, and simultaneously would deter those whose licenses have been revoked or suspended from using a farm tractor for motor transportation. This requirement would have no effect on the majority of farm equipment operators who already possess valid licenses to drive.

In light of these findings, the author recommends that consideration be given to the following changes in the procedures presently governing the use of farm equipment on public highways:

1. A requirement that the slow-moving vehicle emblem be affixed to farm equipment operating on public roads.

2. A requirement that adult farm equipment operators possess a valid driver's license.

3. A requirement such as exists in some other states whereby underage persons may qualify for special license for agricultural purposes. Such persons could be required to demonstrate competence in handling farm equipment before operating such equipment on public roads.

4. A requirement that directional signals and some type of rearview mirror be present on farm equipment while on public highways.

5. A requirement that farm equipment being towed by tractors be properly lighted when on public roads during periods of darkness. In addition, existing requirements that farm tractors on public roads be properly lighted should be more strictly enforced.

6. Stronger enforcement of all other existing laws governing the operation of farm equipment on the public highways.

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