AGRICULTURAL TRACTOR-RELATED INJURIES: A 35-STATE SUMMARY

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Introduction

Within the diversity of tasks and chores necessary to run a modern farm or ranch successfully, there are certain activities that pose special hazards. Among these are operating agricultural machinery and tractors, driving trucks or other vehicles, handling animals, and using tools. In studies that did not distinguish between fatal and nonfatal outcomes of farm-related injuries, agricultural machinery (except tractors) was usually the most common agency involved (Pennsylvania Department of Public Instruction, 1957; Gadalla, 1962; Jensen, 1972; Novack, 1971; and Paterson, Novack & Bertrand, 1972). The 35 state farm surveys also list machinery as the leading agency accounting for 19.6 per cent of all injuries.

When confined to fatal injuries, however, the studies usually identified tractors as the most common agency involved. The Wisconsin Department of Health and Social Services (1970) attributed 35 per cent of farm deaths to tractors. Jepsen (1981) and Murphy (1985) reported that tractors accounted for at least 50 per cent of the deaths in their studies. And the 35 state farm surveys indicated that more than one fourth of the reported deaths involved tractors. It was estimated that about 400 tractor-related deaths occurred nationwide in 1986 (National Safety Council, 1987).

The analysis of tractor-related farm work injuries reported here was undertaken because of the frequent involvement of agricultural tractors in fatal accidents and because of their widespread use in farm and ranch work. The objectives of the analysis were to identify the role of tractors in farm work injuries and to try to identify intervention measures that, if implemented, could reduce the number or severity of such injuries.

Two related analyses of the farm survey data were performed in conjunction with the work reported here. One was a general analysis of all occupational injuries including a comprehensive literature review and suggestions for interventions (Hoskin,

Miller, Hanford, & Landes, 1988a). The other was an in-depth analysis of the survey data on machinery-related work injuries similar to this report on tractor-related cases (Hoskin, Miller, Hanford, & Landes, 1988b).

Literature Review

Almost all the literature dealing with farm accidents mentions the role of tractors as an agency of injury. The studies reviewed here will include only those which have more detail on tractor accidents than merely a listing of the most common agencies of farm accidents. For a more complete review of general farm studies the reader may refer to Hoskin, Miller, Hanford, and Landes (1988a). Most of the studies reviewed in this section represent results of original data-gathering efforts. Also reviewed are articles which present useful descriptions of the tractor injury problem or propose countermeasures without reporting statistical data. The studies were grouped as follows--tractor fatality studies, those dealing with nonfatal injury as well as fatalities, those concerned with specific tractor accident types, and nonstatistical reviews of tractor safety and accident prevention.

Tractor Fatalities

There are a variety of sources for information about fatal tractor accidents. Among these are death certificates, medical examiners' reports, newspaper accounts and traffic records. The studies reviewed here used one source or a combination of sources which were cross-checked to increase accuracy and completeness.

Studies dealing specifically with tractor fatalities on a nationwide scale are very limited in number. The National Safety Council Farm and Statistics Departments (1967) collected data on almost 800 tractor fatalities which occurred in 13 states between 1960 and 1965. A rate of 22 deaths per 100,000 tractors was calculated, and over 1,000 deaths per year involving tractors in the United States were estimated. Those aged 45 to 64 were the most common victims of tractor fatalities with about one third of the deaths. Those aged 15 to 44 had about one third of the total, and the remaining one third was evenly split between those less than 15 and those 65 and over.

About 97 per cent of the victims were male, and nine out of ten died before medical attention was obtained. The most common accident type was tractor overturn (58 per cent), followed by falls (13 per cent), crushed other than run over (9 per cent), run over (8 per cent), motor vehicle (6 per cent), power takeoff (3 per cent), and other (3 per cent).

The National Safety Council still collects information from a selection of states to gauge the national scope of the tractor fatality problem (National Safety Council, 1987, p. 95). The latest data from 1986 show that the estimated tractor fatality rate has dropped to 9.3 per 100,000 tractors, yielding an estimated 400 annual tractor-related deaths on the farm nationwide. In 1986, overturns remained the leading tractor accident type, accounting for 44 per cent of tractor fatalities. Run overs represented 23 per cent, power takeoff injuries accounted for 6 per cent, and the remainder were other types.

A study of Canadian data from 1952 to 1966 showed that of approximately 600 farm machinery fatalities, almost 80 per cent involved tractors (Donaldson, 1968). Crushed chest was the most common nature of injury followed by skull fracture. Together these two injury types accounted for about two thirds of the deaths.

The remainder of the reviewed studies of tractor fatalities involved data collection at the state level. The deaths were usually identified by farm safety personnel within the state using reports from police authorities, newspaper accounts, medical examiners, vital statistics authorities or tabulations, or information relayed directly through witnesses or family members. Where statewide or national estimates were developed from these data, estimates may be understated due to the possibility of tractor fatalities not identified and reported using these methods.

Knapp (1961) identified 63 tractor fatalities in Iowa during a 17-month period in 1960 and 1961. Over half were estimated to have been preventable using simple overturn protection. The remainder were associated with high speed auto impacts, other

violent forces, or medical conditions such as heart attacks.

Information on 212 tractor fatalities in Ohio during the years 1956 through 1960 was collected by McClure, Johnson, and Lamp (1963). All types of overturns combined constituted 57 per cent of the tractor deaths, with sideways overturns accounting for 39 per cent of the tractor fatality total, and backward overturns accounting for 14 per cent. Other major accident categories were thrown or fell from tractor (19 per cent) and highway collision (11 per cent). Distributions of deaths by month and hour of day were similar to patterns of tractor usage.

Wide front end tractors had a significantly higher accident rate than tricycle types based on the number of each type in use. However, the researchers speculated that wide front end tractors were operated more often on hillsides and sloping ground. Over half the victims who were thrown or fell from the tractor were under 16 years old, and less than one fifth of these were driving the tractor. Accident rates were also calculated for various ranges of tractor horsepower.

Tractor fatalities in Ohio were also the subjects of a study by Stuckey (1969). During the 12-year period from 1956 through 1967, 459 fatal farm tractor accidents were identified. The deaths were evenly split between tricycle and wide front end types, and about 63 per cent were caused by overturns. Slightly over one fifth occurred on the highway. By age of victim, 19 per cent were under age 16 and 22 per cent were over age 65. Weather was indicated as a factor in the accident for 11 per cent of the cases, and mechanical failure contributed to about 6 per cent.

Tractor deaths were included in a report on Iowa farm fatalities during the 25-year period from 1947 to 1971 (Wardle & Hull, 1975). The researchers identified 1,326 tractor-related fatalities during the survey period, of which about 62 per cent were caused by overturns. The next most common accident types were driver or rider fell or jumped (9 per cent), run over other person (7 per cent), collision with motor vehicle (6 per cent), and power

takeoff (5 per cent). Although collision with motor vehicle represented a small portion of the accidents by type, about one third of the accidents occurred on roads or highways.

Those under age 20 represented about 28 per cent of the deaths, while those aged 65 and over had about 18 per cent of the total. The researchers estimated that the number of tractors in use increased 87 per cent during the 25-year period ending in 1971.

Of 40 farm machinery deaths identified in North Carolina during 1974, 37 were associated with tractors (LeGarde & Hudson, 1975). Only one of the deaths was an extra rider; the remainder were tractor drivers. More than two thirds of the deaths were from overturns. The researchers concluded that alcohol played a large part in the fatalities in the study. Of 22 adult victims tested, 9 were found to have a blood alcohol level of at least 0.10 per cent, the legal presumption of driving under the influence when operating a motor vehicle.

Tractor deaths to male farm residents in Wisconsin during the time period from 1961 through 1975 were reported by Karlson and Noren (1979). Death rates on a population basis showed a steady increase during the period. By age, death rates based on population for the latest five-year period in the study were highest for older age groups, especially those aged 70 and over. Overturns were associated with the greatest number of deaths, 45 per cent of the total for the years 1971 through 1975. Deaths involving power takeoff devices increased over the survey period, reaching 13 per cent of the total for the latest five-year interval. Almost one third of the deaths occurred on public roads, with overturns predominating for this location as well as on farms.

Although the previous study reported increases in tractor death rates on a population basis in Wisconsin before the 1970s, later research in that state showed that fatal tractor accidents per 100,000 farm workers declined by 50 per cent from 1970 through 1978 (Buckingham, 1981). Credited for this decline were the introduction and purchase of tractors with rollover protective

structures (ROPS), and safety education programs.

Research in Nebraska also reported the effectiveness of ROPS-equipped tractors during the 1970s. Overturn fatalities in that state were reduced from over 20 per year during the 1960s to an average of less than 10 per year from 1974 to 1982 (Schnieder, 1983). Using data from fatal and nonfatal overturn accidents, the author reported that prior to the introduction of ROPS, approximately 40 per cent of all tractor overturn accidents resulted in a fatality. Information from approximately 50 overturn accidents involving tractors equipped with ROPS showed that no fatalities occurred in those accidents.

A study of tractor fatalities in Kansas from 1976 through 1980 (Jepsen, 1981) produced results that agreed with studies previously cited. Over 100 fatalities were identified during the five-year period. Overturns were the leading accident type with over one half of the deaths, followed by run overs (29 per cent), and power takeoff (8 per cent). More than one third of the deaths occurred to those under age 14 or aged 65 and over.

Tractor deaths in Georgia during the 11-year period from 1971 through 1981 were studied by Goodman, Smith, Sikes, Rogers, and Mickey (1985). Of the 202 deaths, more than three fourths were caused by overturns. Rates increased with age and averaged 23 deaths per 100,000 male farm residents overall. Rates for the 60 and older age group were about double those for the next younger age group. Crushed chest was the cause of death in over 80 per cent of the cases.

Pugh (1984) continued the earlier research of Ohio tractor fatalities and reported on 847 such deaths for the 27-year period from 1956 through 1982. Tractors were associated with over half the deaths of farmers on the farm. Only 18 per cent of the tractor deaths occurred on the highway. Overturns were the major type overall, and two thirds of these were sideways overturns. Conditions which were often cited for overturn accidents were driving too fast on a narrow road, turning too fast, hitting a

rock, running into a ditch, crossing a slope or creek, getting stuck in the mud, and hitching a chain too high.

A study of farm fatalities in Pennsylvania during 1980 through 1984 also confirmed the special hazards that tractors present for the elderly (Murphy, 1985). Although tractors were associated with over half of farm deaths for all ages combined, for those aged 65 and older they accounted for almost two thirds of the deaths. Since about 70 per cent of tractor deaths for all ages combined were from overturns, and another 10 per cent from falls, the author stressed the value of ROPS and seat belts.

Studies of Fatal and Nonfatal Tractor Accidents

Data from tractor fatalities can be collected from death certificates, medical examiners' reports, or newspaper accounts. However, nonfatal injury information is more difficult to gather and usually involves either surveying farmers or collecting data from medical treatment facilities. Workers' compensation data is another source of information about tractor accidents, but it was not used in any of the studies reviewed. Two studies of hospital data are summarized first, followed by those involving farm surveys.

A study of 42 farm machinery injury cases hospitalized in Saskatoon, Saskatchewan, during 1980 showed that tractors were most frequently involved (Simpson, 1984). About 25 per cent of the persons in the study were injured by the tractor itself, and another 20 per cent were injured by the power takeoff (PTO). For tractor-related cases, fractures were the most common injury type. For PTO cases, amputations were most common. The PTO cases also differed from other injuries by age of victim, with a median age of 17 versus 33 for other accident types. Due to the more severe nature of PTO injuries, median length of hospital stay for PTO cases was 13.5 days compared to 6 for all farm machinery cases combined.

Of 375 patients admitted to one hospital in Wisconsin due to farm injuries during a six-year period ending in 1983, tractors were the second leading agency of accident after animals (Cogbill & Busch, 1985). About 24 per cent of the injuries in the study were associated with the tractor itself and another 8 per cent resulted from PTO injuries. For the tractor-related injuries, about 35 per cent were due to overturns, about 24 per cent by run overs, 21 per cent from falls, with the remainder miscellaneous types. The most common injuries, in order, were rib fractures, pelvic fractures, pulmonary contusions, renal contusions, pneumothorax, closed head injury, and facial fractures. The average time between injury and treatment at the scene was 1 hour and 40 minutes. Smith and Andrews (1986) discussed the types of injuries most frequently associated with tractor overturns and the need for specialized emergency care of those injuries in the field and during transport for treatment.

Of the PTO injuries in the Wisconsin study, hand and arm injuries were most common, with the mechanism of injury almost always involving a piece of loose clothing being caught by the poorly guarded shaft. About 21 per cent of the PTO injuries resulted in severe long term disability compared to 10 per cent overall.

Information gathered from surveys of farms forms the basis for the remainder of the studies in this section. One early survey of farm accidents in Pennsylvania investigated the relative safety of tricycle type tractors and 4-wheeled, or wide front end types (Pennsylvania Department of Public Instruction, 1957). Rates for tricycle types were calculated to be 11.6 accidents per 1,000 tractors, about twice the rate for 4-wheeled types (5.9 per 1,000 tractors).

Jensen (1972) studied tractor accidents in Wisconsin using the standardized farm survey techniques developed by the National Safety Council and detailed bi-level reporting data generated from that survey. Although tractors were not one of the most common

agencies of farm accidents in the survey, 47 were identified including 16 involving tricycle tractors, 27 with wide front end, and 4 other types or unclassified. Only a few of the tractors were equipped with rollover protective frames and seat belts, which was not surprising given the time period of the survey (1969 to 1970). More than 75 per cent of the operators involved in tractor accidents had over 5 years experience driving tractors. Three extra riders were accident victims.

Detailed information on tractor accidents from the standardized farm accident survey conducted in Iowa during 1981 was reported by Williams (1983). Size of farm and type of agricultural operation were found to significantly affect the presence or absence of tractor and agricultural machinery accidents. Those farms of 200 acres or larger reported more tractor and machinery accidents than expected, while smaller farms reported fewer than expected. Beef and dairy farms were also positively correlated with presence of tractor and farm machinery accidents. The occurrence of tractor and farm machinery accidents was not significantly associated with years of formal education of the operator or completion of tractor and farm machinery safety instruction programs.

The number of tractors equipped with ROPS was investigated by researchers conducting a survey of Ohio farms in 1982 (Napier, Goe, & Pugh, 1985). Of the tractors owned by survey respondents, 23.4 per cent were equipped with ROPS. This was an increase in ROPS usage from an earlier 1977 Ohio study which showed usage at 12.5 per cent. Farming status was significantly related to ROPS usage, with full-time farmers reporting 26.5 per cent of tractors as equipped with ROPS and part-time farmers reporting only 15.0 per cent. However, the researchers felt that differences in size of farm and age of equipment for full-time versus part-time farmers were more responsible for differences in ROPS usage than characteristics of farming status itself.

Nonfatal tractor injury information on a nationwide scale was summarized in reports of the National Safety Council farm accident survey data pooled from participating state surveys. General descriptive data on tractor accidents were reported in the 8-state and 10-state summaries (Hanford & Conrath, 1972; Conrath & Hanford, 1973). Researchers in the 10-state summary found that the most common accident type for tractors was caught in or between objects, with about 31 per cent of the total, followed by falls with 23 per cent. Those aged less than 15 years were involved in 19 per cent of the injuries, while those 65 and older accounted for only 5 per cent of the total. Fractures were the most common injury type with 21 per cent of the cases, followed by sprains with 13 per cent.

Information from the detailed tractor bi-level reports in the national pool of standardized farm surveys was summarized in two reports (Hanford, Burke, Fletcher, Recht, Hoskin, & Miller, 1979; Hanford, Burke, Fletcher, Hoskin, & Miller, 1982). The latter summary represented data from 31 states, 28 of which provided detailed bi-level reports on tractor injuries. It was reported that tractors were involved in about 8 per cent of farm work injuries. Due to the increase in usage of wide front axle tractors, this tractor type accounted for nearly two thirds of the injuries on the file, an increase from earlier studies. Approximately 50 per cent of the tractors involved in accidents were gasoline-powered.

While overturns were usually the most common accident type cited in studies of tractor fatalities, for this file of fatal and nonfatal cases from 31 states overturns were associated with only 12 per cent of the total. Falls were the most common specified accident type with about 17 per cent. PTOs were involved in about 6 per cent of the cases, a decrease from earlier studies of this data base.

Of the overturn cases, about 85 per cent were sideways and approximately 70 per cent involved a roll of 180 degrees or less. More than 70 per cent of the side overturn cases occurred on slopes

exceeding a grade of 20 per cent, and about one in five involved a ditch. About 6 per cent of the tractors involved in all accidents were equipped with a ROPS frame, and an additional 7 per cent were equipped with a cab with overturn protection.

Of the PTO-related accidents, the guard was reported to have been removed in nearly 58 per cent and damaged in an additional 8 per cent. About 25 per cent indicated that the shield had not been provided. For the tractors involved in all accidents, about 53 per cent were reported as PTO-equipped.

A special class of surveys are those which collected information on hours of exposure to the tractor as well as injuries involving it. Using this information, accident rates based on hours of exposure for tractors were compared with rates for other types of farm or industrial work or with rates for other agricultural machine types. Gadalla (1962) surveyed farmers in Missouri during 1959 and 1960, who were asked to keep logs of several items including the number of hours major items of machinery were used on the farm. The study found that tractor accidents occurred at a rate of 47.6 per million hours of exposure, much lower than that for other farm machinery types. The next highest rate was more than 3 times as high. Tractor rates were consistently lower than all other machine types for each of five regions of the state.

Tractor and farm machinery usage of Michigan and Ohio farmers was studied in a 1971 survey (Doss & Pfister, 1972, 1974). Over 163 million hours of tractor use for the two states was projected from survey data, with family labor responsible for about 87 per cent of the total. For hired males, those under age 25 accounted for about 37 per cent of the hours of use, versus only 19 per cent for family males under age 25. Females accounted for only about 3 per cent of the tractor use.

Data by age of tractor showed that much of the exposure was to older machines. Only 42 per cent of the use of tractors by family labor was logged on tractors manufactured within 7 years of

the survey period. About 60 per cent of all tractor use was with wide front end types, with narrow front end (tricycle) types accounting for about 39 per cent. Crawler types represented about 1 per cent of tractor use.

Tractor accident rates per million hours use were estimated as 8.4 in Michigan and 7.4 in Ohio. This was considerably lower than the rate of 20 accidents per million work hours for all farm work established by an earlier Michigan study (Hofmeister & Pfister, 1968). In contrast, rates for other types of agricultural machines (besides tractors) were found to be much higher than the overall rate for farm work. In both Michigan and Ohio, accident rates for tricycle type tractors were higher than those for wide front end by a considerable margin. Accident frequency rates on public roads were found to be four times higher than those for average tractor work.

By age, those less than 15 years had the highest rates, 43.0 accidents per million hours in Michigan compared to 8.4 for all ages. Those aged 65 and over had a rate of 29.7, also much higher than average. Those aged 25 to 64 had lower than average rates.

Specific Tractor Accident Types

A study of PTO accidents was undertaken by researchers in Iowa by identifying 110 such cases during a 20-month period in that state during the early 1960s (Knapp & Piercy, 1966; Knapp, 1968). Injuries included those requiring medical treatment and any case involving clothing entanglement regardless of whether an injury resulted. Of the 110 total cases, 100 involved clothing entanglements. These were analyzed further, with 44 occurring while the equipment was stationary, 27 while semi-stationary (equipment could be operated while stationary or moving), and 29 while nonstationary.

Of the 100 clothing entanglement cases, 21 occurred with all shielding recommended by the manufacturer in place. In 12 accidents clothing became entangled in a PTO for which standard

shielding was not available. The remaining 67 accidents formed the largest group--those which occurred because one or all of the manufacturer's available shields were missing. Of these, about half of the occurrences were directly related to absence of the tractor master shield, and half related to absence of inverted trough or other shield for the PTO shaft.

The researchers noted that for most PTO-related injuries, clothing usually became entangled on a protrusion from the PTO shaft such as a bolt, cotter pin, spring-loaded pin, or other type of pin. Of special concern was the frequency of involvement of the spring-loaded pin commonly used to attach the PTO assembly to the tractor. Type of clothing was found to be a very important factor in PTO injuries, since the amount of yield in clothing directly affected severity of injuries. During winter, when heavy clothing was worn, researchers found that it was very difficult for victims to maintain an upright position after entanglement. Victims were thrown against equipment or around
the PTO shaft resulting in very severe injuries.

Over two thirds of the cases resulted in hospitalization, and 5 amputations were recorded. Lacerations and fractures were by far the leading injury type, and severe abrasions and bruising were also common. PTO accidents resulted in five fatalities in the study, and it was apparent that medical attention for accident victims was critical. The researchers estimated that several more fatalities were avoided because another worker was present to obtain medical aid.

Since most PTO accidents require medical treatment, hospitals provide a good source of data on these injuries. Histories of 49 patients with 117 different PTO-related injuries treated at Mayo Clinic during a 15-year period from the late 1950s to the early 1970s were reviewed by McElfresh and Bryan (1973). About 70 per cent of the accidents occurred during the fall and winter months of October to February, and patient age ranged from 4 to 75.

Of the injuries, the most common type was fractures (46 per cent), followed by soft tissue lesions (33 per cent), and traumatic amputations (9 per cent). More than half of the patients were standing on the ground near the equipment when the injury occurred. About one fourth were mounting or dismounting the tractor. About 90 per cent of the accidents were caused by clothing entanglements.

The tractor master shield was not in place in 22 of 46 specified instances. In only 17 cases was all the shielding in proper use. The most common point of entanglement was the spring-loaded pin (28 per cent), followed by the shaft itself (21 per cent), the universal joint (11 per cent), and belts, wires, or chains (9 per cent).

Hospital data were also used in a study of PTO injury cases in the Netherlands (Heeg, ten Duis, & Klasen, 1986). Over an 8-year period, 14 such patients were treated at one hospital. Fractures were the most common injury, with a total of 38 different fractures for the 14 patients. As opposed to other studies which cited winter clothing as a factor, over 70 per cent of the accidents occurred during summer months. The PTO was fully protected according to safety regulations in about half the cases.

Use of PTO master shields was investigated by Sell and Field (1984). This shield is mounted on the tractor and protects the tractor-PTO connection. During parts of 1983 and 1984, 578 late model John Deere tractors in Indiana were examined to evaluate usage of three different types of master shields--bolt-on, flip-up, and quick-attach types. In addition, 279 non-John Deere tractors were inspected as a comparison. John Deere tractors were chosen for the study so that all three types could be compared for one manufacturer.

Of the tractors in the study, 62 per cent were manufactured to use the quick-attach type master shield, 24 per cent were manufactured with flip-up types, and 14 per cent had bolt-on types. This distribution closely matched the distribution by master shield type of all tractors manufactured from 1960 to 1983. In 51 per

cent of the John Deere tractors surveyed, the master shield was found to be removed. This percentage varied by shield type as follows: flip-up type (11 per cent removed); bolt-on type (42 per cent removed); quick-attach type (69 per cent removed). Percentages for non-John Deere tractors followed a similar pattern, with 55 per cent removal overall.

Researchers also surveyed used tractors on dealer lots and found similar percentages of master shield removal. For tractors on farms, master shield damage was found to be greater than anticipated. Of the three types of shields, the authors found the most favorable attitude regarding flip-up type shields.

Tractor overturns have also been the subject of several specialized studies. Knapp (1968) reported on the frequency of overturn accidents on highway locations. In a study of 77 highway accidents involving tractor fatalities, it was estimated that three fourths would not have occurred if the operator had had overturn protection. In a separate analysis of 43 fatal and nonfatal overturns to those under age 17, the highway was the most common location, followed by field and farmstead. About half of the overturns to this age group resulted in fatalities.

Various causes of overturns have been studied extensively at the Scottish Institute of Agricultural Engineering (Hunter, 1981; Owen & Hunter, 1983). In one report of 560 overturn cases in Scotland, England, and Wales during the eight-year period from 1968 to 1976, accidents were classified as tractor-related, driver-related, or miscellaneous. Tractor-related cases, which represented the largest portion of the file (55 per cent), were those in which the driver had taken the tractor beyond its safe operating limits. Driver-related accidents represented 26 per cent of the total and were defined as those in which the operator made an error of judgement while the tractor was within safe operating limits. Miscellaneous types, which included traffic accidents, represented 19 per cent of the total.

Since tractor-related cases were most numerous, these were extracted for further analysis and subdivided into stability loss cases and control loss cases. The leading cause of stability loss accidents was excessive slope (17 per cent of all cases on file), followed by excessive speed (10 per cent), and rough ground (6 per cent). Control loss cases represented 22 per cent of the total. Typical of control loss cases were those in which the tractor slid out of control before overturning, so that the cause of the accident was the loss of control at the start of the slide, not the stability loss on overturning.

Roadway accidents involving tractors with other vehicles have also been the subject of several studies. Knapp and Hindman (1962) performed several investigations of these types of accidents from information gathered from witnesses, family members, police, or analysis of state motor-vehicle accident records. In an analysis of 268 tractor-motor-vehicle accidents in Iowa during 1958, the researchers found that about 47 per cent occurred on straight nonintersection locations. About 25 per cent were associated with an intersection or driveway and about 19 per cent occurred on a hill. In about 40 per cent of the cases, the tractor and motor vehicle were traveling in the same direction. In about 20 per cent, they were traveling in opposite directions, and the remaining 40 per cent were unspecified.

Detailed information on 48 tractor-motor-vehicle accidents during the summer months of 1960 was obtained by the same researchers via interviews with persons knowledgeable of such accidents. The researchers estimated that about 30 per cent of the accidents were related to improper driving judgement by the tractor operator and an additional 23 per cent were other tractor-related causes (width of equipment, mechanical failure, or lights). About 38 per cent of the cases were auto-related, and the remaining 9 per cent were related to weather or roads. The most common tractor-motor-vehicle accident scenario involved contact with the left rear tractor tire and subsequent overturn of the tractor.

LeGarde (1975) studied over 1,800 accidents on public roads in North Carolina during a 5-year period in the late 1960s and early 1970s. The farm tractor was the item of farm machinery most often involved. Over 60 per cent of the cases studied involved accidents on straight level roads. Absent or defective headlights or rear lights on tractors were the most commonly named vehicle defect involved in accidents. The most common scenario (about 43 per cent of the cases) involved the tractor and other vehicle both going in the same direction. The next most common (24 per cent) involved the motor vehicle passing a left-turning tractor. Center rear and left rear were the two most common points of contact for the farm equipment involved in accidents.

Tractor Safety and Accident Prevention

Knapp (1961) first described the interaction of the man, the machine and the environment in studying tractor accidents and the necessity for interventions involving all three areas. Most literature has suggested a combination of prevention efforts aimed at making tractors themselves safer, making users more educated as to safe practices, and making the environment more hazard-free. ROPS and shielding of PTOs have already been discussed as efforts to make the machines inherently safer.

Aherin, Schultz, and True (1981) discussed these and other preventive measures. Among the measures directed at tractor operators were that they should be physically and mentally fit, use tractors for intended purposes, be familiar with the operator's manual, and check the tractor before operating. The authors suggested that all operators be specially trained when using front-end loaders or large four-wheel drive tractors with articulated steering. Operators should use engine braking when going downhill with heavy loads, should counterbalance loads by adding weights when applicable, and should increase baseline stability by spacing rear wheels as far apart as possible.

Elwell, Brown, and Schnieder (1981) suggested that protective devices for tractors should be simple and automatic, should eliminate human error and be designed so that they cannot be circumvented. Such devices would include those which render machinery inoperable if safety devices are faulty or absent, and shutoff devices. Shutoff devices would stop the engine when an operator is thrown from the vehicle or when the tractor reaches angles from which overturn is likely. The authors also called for extension of safety legislation to cover the farmer and his family as well as employees. Retrofitting of safety devices for older tractors and OSHA-inspection for smaller farms were discussed but the authors felt that inherent problems with these approaches made them unlikely.

Hammond, Tyson, and Kay (1984) proposed emergency stop mechanisms for tractors. This concept would allow shutoff of fuel or air to an engine from various locations by applying tension on a small continuous cable or "lifeline". The authors proposed that the cable be accessible from various hazardous points of the tractor or towed implement.

Sevart and Berry (1986) discussed engine stoppage devices that detect presence of the operator and shut off the engine if no operator is at the controls. Also discussed were associated systems which involve power transmission disconnect instead of engine shut-off. In a separate publication, these authors discussed the development and implementation of interlocked PTO master shields. These systems would require that the shield be in place before the PTO can be utilized (Sevart & Berry, 1985).

The need for a tractor stability indicator was discussed by Murphy, Beppler, and Sommer (1985). This tractor-mounted instrumentation would provide instantaneous cues to the operator as to relative tractor stability. The proposed system would also indicate in display form the reason for instability--a turn, hill inclination, ground roughness, tractor speed, or a combination of these factors. The surveillance system would be used primarily as

an aid to the tractor operator in learning safe tractor operation.

Other studies not specifically cited in this review because they could not be located or because of similarities to other research may nevertheless be valuable to the reader. Among the various topics of these studies are: human factors (Adams, Boyd, & Buchele, 1975); stress (Field, 1980); stability (Bottoms, 1983; Gilfillan, 1979); overturns (Owen, 1986; Schnieder & Baker, 1972); and PTOs (New Zealand Department of Labour, 1976; Sell, Campbell, & Field, 1985; Tristram, 1969).

Method

The survey design, data collection, and data processing involved in the management and execution of the farm surveys was described in detail in the procedures manual (National Safety Council, 1979) and in Hoskin, Miller, Hanford, and Landes (1988a). Important details concerning the tractor bi-level and related issues are reviewed here.

The Survey

All data were collected by trained, volunteer interviewers in face-to-face interviews with randomly selected farm or ranch families in 35 state surveys.

The General Accident and Illness Report (F2) form (Figure 1) was used to collect basic data about each person injured in an accident and the circumstances surrounding the event. It was also used to indicate which bi-level forms were to be used to obtain additional detailed information on certain kinds of injury cases.

The Medical and Cost Information (F3) bi-level (Figure 2) was used to acquire data on the health status of the injured person before and after the accident and on the costs related to the episode. An F3 form was completed for 55 per cent of the work injuries.

Most of the remaining bi-level forms used in the farm survey were designed to identify the specific agent involved in the accident and to determine any hazardous conditions or unsafe acts that contributed to the accident.

The Agricultural Tractors (F4) bi-level (Figure 3) was used to obtain data on the type, age, configuration, and use of the tractor; the specific type of accident and location; if a rollover accident, the amount of roll and the surface slope; and the hazardous conditions or unsafe acts contributing to the accident. Thirty-one states used the form and 304 forms were completed.

The interviewers mailed all completed forms to the county extension agent in charge of his or her territory. The agent checked the forms to see that none was missing and that the forms were complete and free of contradictory statements. He then sent the forms to the project staff. The project staff re-checked and re-edited the forms and returned them to the extension agent for follow-up when necessary.

The project staff in each state was responsible for preparing its own statewide summary report of the survey results. Some states included an analysis of the tractor bi-level data and these were discussed in the literature review section. When the state had completed its work, the survey data were sent to the National Safety Council in machine readable form.

Data Processing

At the Council, the survey data were further edited and then combined with other states into pooled data files. A file was maintained for the combined general accident/illness report (F2) and medical and cost (F3) bi-level data.

Creating the general injury/illness file out of the F2 and F3 data required matching the two forms using the state, county, interviewer, household, and accident numbers. This matching process resulted in discarding a number of the F3 forms because they could not be matched with F2's.

In addition to the general injury/illness file, a special work injury file was created by extracting from the general file those records for which the "work or leisure?" question had the "work" response and the "injury or illness?" question had the "injury" response. Of the 5,753 total cases in the general file, 4,105 were work injuries (and 2,242 of these had matching F3's). This was the data file used in the analysis of general farm work injuries (Hoskin, Miller, Hanford & Landes, 1988a).

A matched bi-level file was also created for this analysis of tractor-related work injuries. To build this file, the state,

county, interviewer, household, and accident numbers on the F2/F3 records in the work injury file were matched with the corresponding numbers on the F4 bi-level forms. When an exact match was found, the two records were combined and written to the special file. The combined records then contained all of the basic data from the general accident/illness and medical/cost forms plus the specialized, detailed data from the tractor bi-level form.

The matching process resulted in the loss of some otherwise usable F2/F3 and F4 bi-level records when one half of the pair could not be found. The work injury file contained 323 tractor-related injuries and there were 304 tractor (F4) bi-levels, but the matched file contained only 228 records.

Analysis Techniques

Multi-dimensional crosstabulations and treesearches were used for most of the data analysis. In particular, all of the scenarios were developed using these two techniques.

Treesearch is a computer program developed at the National Safety Council (Hoskin & Miller, 1979). It is used to identify frequencies that are statistically higher or lower than expected. It does this by comparing the observed frequency distribution of cases meeting selected criteria to the expected frequency based on the distribution of all cases in the file. The expected value is determined by applying the percentage distribution of all cases to the total of cases that meet the criteria. An approximate 95 per cent confidence interval of two standard deviations about the expected value is calculated. (Each expected value is considered to be an independent Poisson variate so that its standard deviation is the square root of its mean or expected value.) If the actual value is greater than the upper bound of the interval, then the value is statistically greater than expected and is labeled "HI." Similarly, if the actual value is less than the lower bound, the value is statistically less than expected and the value is labeled "LO." The treesearch procedure is effective at identifying items

of statistical significance only. The researcher must determine if the item is of practical significance in the investigation. Treesearch also does not construct scenarios which are most common, only those which occur with a statistically greater than expected frequency.

Table 1 shows a treesearch on the type of accident variable for tricycle-style tractors. Based on the distribution of all tractor-related injuries, about 5 side overturns, with a range of 0 to 9, would have been expected for tricycle-style tractors. Side overturns occurred more frequently than expected for tricycle-style tractors (10 out of 47) even though side overturns were not the most common type of accident for this style of tractor. The researcher may then examine another variable, such as unsafe act, using the two criteria tricycle-style tractor and side overturn. In this way he or she may follow one or more branches identified by the "HI" and "LO" labels and so build a "tree."

Limitations

There are several factors that limit the interpretation or generalizability of the results of these analyses. First is the representativeness of the sample of farms. Each state sample was selected to be representative of the state, but the states together were not necessarily representative of the total United States.

Data quality is another limiting factor. Some of the questions were not clearly worded or were misinterpreted by the interviewers.

There were some problems with inconsistent responses. The most obvious involved situations where the reported sex does not agree with the family status, e.g., female sons or male wives. These cases do not affect the outcome of the analysis, but there are also less obvious cases that might affect the analysis.

The change in the content of the general injury/illness report form in 1979 affects the interpretation of crosstabulations that involve one variable that appears only on the original F2 versus

another variable that appears on both the original and revised F2's.

There is the problem mentioned before of matching bi-level forms with the general injury/illness forms. If there is any systematic bias in the rejection of unmatched forms, then that could affect the representativeness of the cases on the matched file.

The number of cases, while large to start with, diminished rapidly as more criteria were added to the crosstabulation or treesearch specifications. Generally, not more than three or four criteria could be used. This limited the specificity of the scenarios generated in the analyses.

The number of statistical tests performed in the treesearches meant that a number of spurious associations were probably identified. These were, for the most part, culled out and discarded using the judgement of the investigators. Some may have been missed, and some true associations may have been discarded.

The state surveys were performed over a period of more than ten years during the 1970s and 1980s. New tractor models and new farming methods introduced over that time may have influenced the injury patterns. In particular, because the make and model of tractors were not recorded, it was not possible to associate injury patterns with particular tractors. This made it difficult to recommend specific engineering countermeasures or interventions.

Definitions

Some of the important definitions used in the farm surveys are restated here.

A farm is a place consisting of 10 or more acres of land and selling $50 or more of agricultural products annually, or consisting of less than 10 acres and selling $250 or more of agricultural products annually.

A reportable accident is an occurrence that results in death, an injury requiring professional medical care, or loss of one half

day or more from usual activities (work, school, etc.) that involves a person (a) living on a farm, regardless of where the accident happened, (b) working on a farm when the injury happened, or (c) visiting a farm when the injury happened.

Professional medical care is one or more contacts with a physician either by telephone or in person. The service may be given by the physician, a nurse, or by another person acting under the physician's supervision.

The levels of severity of injury are defined as follows: Slight injuries require no medical treatment except bandage, antiseptic, etc. Severe injuries include broken bones, cuts requiring medical care, sprained backs, etc. Permanent injuries include any loss of full use of any body part, amputation, etc. Fatal injuries are those that result in death during the survey period.

FIGURE 1

ACCIDENT AND ILLNESS REPORT FORM
GENERAL

Form No. NSC-F2(Rev.) 1-2

Accident/Illness Report IDentification Number

3-4 County No. | 5-6 Interviewer No. | 7-8 Household No. | 9-10 Accident/Illness No.(CIRCLE Event)

Date of event(Fill-in)_____

Name of person involved:

(First name only) _____

Check bi-level report(s) used to complete this report:

11 ☐ F3 15 ☐ F7 19 ☐ F11
12 ☐ F4 16 ☐ F8 20 ☐ F12
13 ☐ F5 17 ☐ F9 21 ☐ F13
14 ☐ F6 18 ☐ F10 22 ☐ F14

Read instructions before filling out the form below.

1. Use a separate Report Form for each injury or each illness for each person
2. Fill-in your County No. and Interviewer No.. The Household No. is obtained from the Household IDentification List.
3. Assign the Accident or Illness number in the order that each is investigated.
4. The ID Number assigned to this report is to be used for identifying the bi-level accident or illness report form also, if they are required to complete the report investigation.

1. Injured or Ill person identity:

1-A. Resident Class

23,1 ☐ Husband
2 ☐ Wife
3 ☐ Son
4 ☐ Daughter
5 ☐ Other, specify_____
6 ☐ Employee(full-time)
7 ☐ Employee(part-time)
8 ☐ Visitor
9 ☐ Guest

1-B. Age

24-25 _____(Fill-in)years

2-C. Sex

26,1 ☐ Male
2 ☐ Female

2. If this is an accident report, check the number of persons injured in this accident(check one):

27,1 ☐ One
2 ☐ Two
3 ☐ Three
4 ☐ Four or more
5 ☐ Unknown

3. When injured or taken ill, individual was doing(check one):

28,1 ☐ Work
2 ☐ Leisure(not work related)
3 ☐ Unknown

4. Time of Accident or Illness:

4-A. Month event occurred:

29-30,01 ☐ Jan.
02 ☐ Feb.
03 ☐ Mar.
04 ☐ April
05 ☐ May
06 ☐ June
07 ☐ July
08 ☐ Aug.
09 ☐ Sept.
10 ☐ Oct.
11 ☐ Nov.
12 ☐ Dec.
13 ☐ Unknown

4-B. Day accident or illness occurred:

31,1 ☐ Sunday
2 ☐ Monday
3 ☐ Tuesday
4 ☐ Wednesday
5 ☐ Thursday
6 ☐ Friday
7 ☐ Saturday
8 ☐ Unknown

4-C. Time(Check nearest time):

	A.M.	P.M.	A.M.	P.M.
32-33,01	☐ 1:00	13 ☐	07 ☐ 7:00	19 ☐
02	☐ 2:00	14 ☐	08 ☐ 8:00	20 ☐
03	☐ 3:00	15 ☐	09 ☐ 9:00	21 ☐
04	☐ 4:00	16 ☐	10 ☐ 10:00	22 ☐
05	☐ 5:00	17 ☐	11 ☐ 11:00	23 ☐
06	☐ 6:00	18 ☐	12 ☐ 12:00	24 ☐

25 ☐ Unknown

Sheet 1 of 4

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FIGURE 1
(continued)

NSC-F2(Rev.)

5. Was the Person:

34,1 ☐ Injured
2 ☐ Ill(If ill, complete NSC-F10, also)

6. If injured, how serious?(Check one)*

35,1 ☐ Slight(no medical treatment except bandage, antiseptic, etc.)
2 ☐ Severe(broken bones, cuts requiring treatment, sprained back, etc.)
3 ☐ Permanent(any loss of full use of part of body--amputation, etc.)
4 ☐ Fatal
5 ☐ Unknown

*Complete Supplemental Medical & Cost(F3) Data Form when information is available.

7. What was activity of victim when accident/illness occurred?

7-A. Type(Check one):

36,1 ☐ Building maintenance & repair
2 ☐ Field work
3 ☐ Housework
4 ☐ Machinery maintenance & repair
5 ☐ Recreation
6 ☐ Routine chores
7 ☐ Treating livestock
8 ☐ Yard work
9 ☐ Other, specify_____

7-B. Action(Check one, if applicable):

37-38,01 ☐ Climbing
02 ☐ Driving
03 ☐ Jumping
04 ☐ Kneeling
05 ☐ Lifting
06 ☐ Lying down
07 ☐ Riding
08 ☐ Running
09 ☐ Sitting
10 ☐ Standing
11 ☐ Walking
12 ☐ Other,_____

8. Who administered first aid?

39,1 ☐ Doctor
2 ☐ Family member
3 ☐ Nurse
4 ☐ Self-treatment
5 ☐ More than one, specify_____
6 ☐ Other, specify_____

9. Professional treatment by doctor:

40,1 ☐ Not required
2 ☐ One time
3 ☐ Two or more times

10. Type of injury(Check one):
(NOTE: If illness report, skip to Q. 11.)

41-42,01 ☐ Amputation
02 ☐ Asphyxiation
03 ☐ Bruise
04 ☐ Burn
05 ☐ Cracked, fractured or broken bones
06 ☐ Cut or laceration
07 ☐ Eye injury
08 ☐ Mangled
09 ☐ Pinched
10 ☐ Puncture
11 ☐ Sprain
12 ☐ Multiple, specify_____
13 ☐ Other, specify_____

11. What part of the body was involved?

43-44,01 ☐ Arm
02 ☐ Back
03 ☐ Chest
04 ☐ Eye
05 ☐ Finger
06 ☐ Foot
07 ☐ Genital
08 ☐ Hand
09 ☐ Head
10 ☐ Leg
11 ☐ Neck
12 ☐ Shoulder
13 ☐ Toe
14 ☐ Trunk
15 ☐ Multiple, specify_____
_____
16 ☐ Other, specify_____

Sheet 2 of 4

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FIGURE 1
(continued)

NSC-F2(Rev.)

12. How did injury or illness occur?(Check response closely describing event):

46,01 ☐ Caught part of body in object
02 ☐ Caught part of body between objects
03 ☐ Caught part of body under object
04 ☐ Struck against or by object, etc.
05 ☐ Struck by falling object or material
06 ☐ Struck by flying object or material
07 ☐ Contact with sharp object(knife, etc.)
08 ☐ Foreign object or material struck or lodged in victim
09 ☐ Fall, same level*
10 ☐ Fall, different level*
11 ☐ Fall, unknown
12 ☐ Contact with electrical current
13 ☐ Contact with fire or hot object
14 ☐ Contact with hot substance(steam, etc.)
15 ☐ Contact with corrosive or toxic item
16 ☐ Contact with other harmful liquid (fuel, paint, etc.)
17 ☐ Overexertion(strain exhaustion)
18 ☐ Inhaling gas or vapor
19 ☐ Exposure to or reaction from material
20 ☐ Other, specify_____

*If this is a factor and Item 7-B. involved running, walking or climbing, complete Supplemental Form NSC-F9.

13. Where was person treated?

47,1 ☐ Clinic
2 ☐ Doctor's office
3 ☐ Home
4 ☐ Hospital, admitted
5 ☐ Hospital, emergency
6 ☐ No treatment
7 ☐ More than one place, specify_____

14. Scene of accident or illness:

14-A. Weather conditions(time of event)

1. Temperature

48,1 ☐ 0° or below
2 ☐ 1° to 32°
3 ☐ 33° to 50°
4 ☐ 51° to 85°
5 ☐ 86° to 100°
6 ☐ Over 100°

2. Precipitation

49,1 ☐ Clear
2 ☐ Fog
3 ☐ Ice
4 ☐ Rain
5 ☐ Snow
6 ☐ Threatening
7 ☐ Other, specify_____

3. Wind

50,1 ☐ Calm
2 ☐ Light breeze
3 ☐ 10 to 25 mph
4 ☐ 26 to 40 mph
5 ☐ Over 40 mph

14-B. General location:

51-52,01 ☐ Barn
02 ☐ Barnyard
03 ☐ Driveway
04 ☐ Front/back yard/garden
05 ☐ Farm building, other(not house)
06 ☐ Field(cropland)
07 ☐ Highway, state or federal
08 ☐ House
09 ☐ Land(pasture, range, woods)
10 ☐ Lagoon, manure pit
11 ☐ Pond, pool, stream, river
12 ☐ Public place
13 ☐ Road, county or township
14 ☐ Other, specify_____

14-C. Surface condition:

53,1 ☐ Dry
2 ☐ Icy
3 ☐ Muddy
4 ☐ Straw, hay, sawdust, etc. covered
5 ☐ Other, specify_____
6 ☐ Oily or greasy
7 ☐ Snow covered
8 ☐ Wet

Sheet 3 of 4

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FIGURE 1
(continued)

NSC-F2(Rev.)

14. Scene of accident or illness(con't.)

14-D. Surface type:

54,1 ☐ Asphalt
2 ☐ Brick
3 ☐ Concrete
4 ☐ Floor covering(carpet, vinyl, etc.)
5 ☐ Metal
6 ☐ Soil(clay, sand, etc.)
7 ☐ Vegetation
8 ☐ Wood
9 ☐ Other, specify_____

14-E. Light conditions:

55,1 ☐ Artificial light, good
2 ☐ Artificial light, poor
3 ☐ Daylight
4 ☐ Dark
5 ☐ Dawn or dusk
6 ☐ Reduced due to dust, smoke or fog

14-F. Thing involved(check one):

56-57,01 ☐ Agricultural machinery* (F5) (except tractors)
02 ☐ Animal* (F6)
03 ☐ Another person
04 ☐ Chemical* (F7)
05 ☐ Electrical power
06 ☐ Firearms
07 ☐ Gas or vapor
08 ☐ Hand tool* (F8)
09 ☐ Household items
10 ☐ Power tool* (F8)
11 ☐ Sports
12 ☐ Tractor* (F4)
13 ☐ Truck* (F14)
14 ☐ Auto, Bus, other vehicle
15 ☐ None
16 ☐ Powered lawn &/or garden equipment*(F12) Also Snowmobile or other recreational equipment.

*If item with * is checked, complete appropriate Supplemental Form.

Sheet 4 of 4

14. Scene of accident or illness(con't.):

14-G. Approximate time victim was with "Thing involved" on day of accident or illness prior to event:

58,1 ☐ One hour or less
2 ☐ 2 to 4 hours
3 ☐ 5 to 8 hours
4 ☐ Over 8 hours

14-H. Estimate experience with the "Thing involved":

59-61 _____(Fill-in approx. no. days)

15. General Information:

15-A. Major type of agricultural operation:

62-63,01 ☐ Beef
02 ☐ Corn
03 ☐ Cotton
04 ☐ Grain
05 ☐ Rice
06 ☐ Soybeans
07 ☐ Sugar cane
08 ☐ Tobacco
09 ☐ Beef & hogs
10 ☐ Fruit
11 ☐ Truck crops
12 ☐ Dairy
13 ☐ Seed Crops
14 ☐ Other, specify_____
15 ☐ Hogs
16 ☐ Poultry
17 ☐ Corn & Beef
18 ☐ Corn & Hogs
19 ☐ Corn & Soybeans
20 ☐ Dairy & Hogs
21 ☐ Sheep
22 ☐ Nuts
23 ☐ Cut flowers
24 ☐ Field flowers
25 ☐ Nursery
26 ☐ Container Plants
27 ☐ Field Crops

15-B. Acreage in agricultural operation:

64-69 _____(Fill-in actual acreage)

15-C. Do you produce $1,000 or more of agricultural products annually?

70,1 ☐ Yes 2 ☐ No

16. Additional information concerning the accident or the cause of the illness will be helpful--how event happened, victim's action or movement, thing involved, etc.
Check here ☐ if you supply information on another sheet.

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FIGURE 2

SUPPLEMENTAL

ACCIDENT AND ILLNESS REPORT FORM

Form No. NSC-F3(Rev.) 1-2

MEDICAL AND COST INFORMATION

Accident/Illness Report IDentification Number

3-4 County No. 5-6 Interviewer No. 7-8 Household No. 9-10 Accident/Illness No. (CIRCLE Event)

Read instructions before filling out the form below.

1. Use Report ID Number from the General Accident and Illness Report(NSC-F2-Rev.)
2. Completed form to be attached to Accident and Illness report referred to above.

1. Health status of person involved (before injury or illness):

11 ☐ 1 Good
☐ 2 Under doctor's care
☐ 3 Taking medication
☐ 4 Ill on day of accident*
☐ 5 Mentally handicapped
☐ 6 Physically handicapped
☐ 7 Other, specify_____
☐ 8 Unknown

*If a factor, complete Illness Report Form No. NSC-F10, also.

2. Total days lost from usual activities:

12-14 _____(Fill-in actual number) Days

3. Days in hospital due to injury or illness:

15-17 _____(Fill-in actual number) Days

4. Medical expense(doctor, medicine, hospital, etc., including that paid by insurance)incurred as a result of this injury or illness:

18-22 $_____(Fill-in actual amount of expenses)Dollars

5. Total property damage(all parties involved)--injuries only:

23-27 $_____(Fill-in actual amount of damage)Dollar

6. Number of days hired help was used to replace injured or ill person:

28-30 _____(Fill-in actual number)Days

7. Cost of replacement labor:

31-35 $_____(Fill-in actual cost)Dollars

8. What was the health status of victim following recovery from injury or illness?

36 ☐ 1 Good
☐ 2 Mentally handicapped
☐ 3 Physically handicapped
☐ 4 Other, specify_____

9. If handicapped, were rehabilitation services necessary before returning to gainful employment?

37 ☐ 1 Yes
☐ 2 No
☐ 3 Unknown

10. If victim suffered loss of full use of part of the body, did they return to farming?

38 ☐ 1 Yes
☐ 2 No, to other occupation
☐ 3 No, unable to work
☐ 4 Unknown

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FIGURE 3

SUPPLEMENTAL ACCIDENT REPORT FORM

Form No. NSC-F4(Rev.) 1-2

AGRICULTURAL TRACTORS

ACCIDENT REPORT IDENTIFICATION NUMBER

3-4 County No. 5-6 Interviewer No. 7-8 Household No. 9-10 Accident No.

Tractor Identification:

Make:_____ Model:_____

Fuel type:

11,1 ☐ Gas 2 ☐ Diesel 3 ☐ LP

Read instructions before filling out the form below.

1. Use Accident Report ID Number from the General Accident Report(Form No. NSC-F2) previously completed for this injury.
2. This form, when completed, will be attached to the report referred to above.

1. Type or tractor involved in accident:

12,1 ☐ Tricycle
2 ☐ Wide front axle, adj.
3 ☐ Wide front axle, std.
4 ☐ Hi-crop
5 ☐ Crawler
6 ☐ 4-wheel-drive, articulated

2. Approximate age of tractor:

13,1 ☐ One year or less
2 ☐ 2 to 5 years
3 ☐ 6 to 10 years
4 ☐ Over 10 years

3. Was tractor a standard production model at time of accident?

14,1 ☐ Yes
2 ☐ No
3 ☐ Unknown

4. Indicate type of accident:

15-16,01 ☐ Collision, from the side
02 ☐ Collision, head-on
03 ☐ Collision, rear
04 ☐ Equipment failure
05 ☐ Fall
06 ☐ Fire
07 ☐ Overturn, backward
08 ☐ Overturn, sideways
09 ☐ PTO
10 ☐ Unknown
11 ☐ Other, specify_____

5. Wheel spacing at time of accident:

17,1 ☐ Narrow
2 ☐ Normal or mid-setting
3 ☐ Wide or extended

6. Tractor use at time of accident:
(Note: If other machinery involved, complete items 1 through 4 of Form NSC-F5, also.)

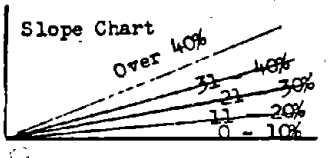
18-19,01 ☐ Freeing mired equipment
02 ☐ Harvesting, tillage
03 ☐ Herding cattle
04 ☐ Loading, unloading
05 ☐ Parked
06 ☐ Planting, sowing
07 ☐ Runaway or coasting(w/out driver)
08 ☐ Stationary(belt or PTO operating)
09 ☐ Stuck
10 ☐ Traveling to or from field
11 ☐ Other, specify_____
12 ☐ Unknown

7. If tractor over-turn, indicate degrees roll:

20,1 ☐ 90°
2 ☐ 180°
3 ☐ 270°
4 ☐ 360°
5 ☐ Over 360°

8. Slope of surface at accident(Check only one):

21,1 ☐ 0 to 10%
2 ☐ 11 to 20%
3 ☐ 21 to 30%
4 ☐ 31 to 40%
5 ☐ Over 40%



Sheet 1 of 2

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FIGURE 3
(continued)

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9. Check the condition that was the initial cause of the accident event:

22-23,01 ☐ Crossing slope
02 ☐ Damaged PTO guard or shield
03 ☐ Faulty brakes
04 ☐ Going down hill
05 ☐ Going up the hill
06 ☐ Guard not provided
07 ☐ Guard removed
08 ☐ Hidden object--struck it
09 ☐ Hitched to axle
10 ☐ Struck hole or rough ground
11 ☐ Slipped into open ditch
12 ☐ Slippery surface
13 ☐ Other, specify_____
14 ☐ Unknown

10. Identify the act permitting the accidental injury:

24-25,01 ☐ Disobeyed traffic rules
02 ☐ Driving too fast for conditions
03 ☐ Failed to disengage PTO
04 ☐ Failed to shut-off tractor engine before dismounting
05 ☐ Failed to lock brakes or transmission before dismounting
06 ☐ Failed to use protective equipment
07 ☐ Failed to engage clutch slowly
08 ☐ Failed to wear safe personal attire
09 ☐ Horseplay
10 ☐ Jumped
11 ☐ Lack of front or rear weights
12 ☐ Moving tractor w/loader bucket high
13 ☐ Permitted extra rider
14 ☐ Permitted hitching to other than
15 ☐ Reaching(over, under, into)
16 ☐ Smoking while refueling
17 ☐ Turning at high speed
18 ☐ Overloading
19 ☐ Other, specify_____
20 ☐ Unknown

11. Specific scene of accident:

26-27,01 ☐ Barn
02 ☐ Bridge
03 ☐ Cattle shed
04 ☐ Corn or cotton field
05 ☐ Driveway, lane
06 ☐ Feedlot
07 ☐ Grain field
08 ☐ Hay field
09 ☐ Highway
10 ☐ Pasture
11 ☐ Shop or machine shed
12 ☐ Woods
13 ☐ Other, specify _____
14 ☐ Unknown

12. Check each component on tractor at time of accident:

28 ☐ Cab
29 ☐ Cab w/overturn protection & seat belt
30 ☐ Dual wheels
31 ☐ Fenders
32 ☐ Flashing light(s)
33 ☐ Front-end weights
34 ☐ Front wheel drive
35 ☐ Front wheel weights
36 ☐ Head lights
37 ☐ Hydraulic brakes
38 ☐ Power steering
39 ☐ PTO shield
40 ☐ Protective frame w/seat belt
41 ☐ Reflectors
42 ☐ Rearview mirror(s)
43 ☐ Rear wheel weights
44 ☐ Safety starting switch
45 ☐ SMV emblem
46 ☐ Tail light(s)
47 ☐ Tires filled w/liquid
48 ☐ Weather shield

13. Seat belt in use at time of accident:

49,1 ☐ Yes 2 ☐ No

DATE EDITED_____
(Office use)

Sheet 2 of 2

TABLE 1
TREESEARCH ON TYPE OF ACCIDENT FOR
TRICYCLE-STYLE TRACTORS

TYPE OF ACCIDENT	ALL TRACTOR INJURIES	TRICYCLE-STYLE TRACTOR INJURIES				
		Expected (x)	-2S.D. ($x-2\sqrt{x}$)	+2S.D. ($x+2\sqrt{x}$)	Observed	Sig.
Collision from side	4	0.9	-1.0	2.7	0	
Collision, head-on	3	0.6	-1.0	2.2	0	
Collision, rear	4	0.9	-1.0	2.7	1	
Equipment failure	10	2.1	-0.8	5.1	1	
Fall	66	14.1	6.6	21.6	14	
Fire	4	0.9	-1.0	2.7	1	
Overturn, backward	4	0.9	-1.0	2.7	0	
Overturn, sideways	22	4.7	0.4	9.0	10	HI
PTO	13	2.8	-0.6	6.1	2	
Unknown	3	0.6	-1.0	2.2	0	
Other	87	18.6	10.0	27.2	18	
Total	220				47	

Note: Eight tractor injuries were not classified by type of accident.

Results

The bi-level reporting system utilized in the farm survey permitted the creation of a separate file of detailed tractor injury data. Combining the bi-level records with corresponding general accident and illness reports resulted in the loss of certain records for which no match was found and reduced this file to 228 tractor-related work injury cases. This represents information from 31 states and approximately 6 per cent of the original 4,105 work injury cases in the farm survey file.

Of the 228 cases in the tractor work injury file, 76 per cent were family members (Table 2). Family and hired males made up 94 per cent of the injury cases, with family males accounting for about 70 per cent of all injuries. Female family members were involved in about 6 per cent of the cases, and no tractor-related injuries were reported for hired females.

The distribution of injuries by age revealed that 64 per cent of the injured persons were aged 25 to 64. About 21 per cent were 15 to 24, and about 6 per cent were 5 to 14 years old. When the family and hired worker categories were compared, certain differences became apparent. Although about 81 per cent of injured hired workers were in the 15 to 44 age group, only 44 per cent of injured family males were in the same age bracket. Conversely, family males were more likely to be in the 5 to 14 and 45 and over age groups than were their hired counterparts.

The distribution of injuries by type of agricultural operation and size of operation is shown in Table 3. Grain farms experienced the greatest percentage of tractor-related work injuries for all operations (about 31 per cent). The "other" category, which included a large variety of operations, accounted for the next highest level with 28 per cent. Dairy, beef, and fruit farms followed with considerably lower percentages of the total--about 19 per cent, 16 per cent, and 6 per cent, respectively.

Farms of 200 to 499 acres in size accounted for about 37 per cent of tractor injuries, almost twice the number of cases of any other acreage group. Operations of 500 to 999 acres experienced the next highest percentage (20 per cent), and farms of 100 to 199 acres followed with about 17 per cent of the cases.

For all types of operations except fruit farms, the 200 to 499 acre group accounted for the largest number of injuries. For fruit farms, those less than 50 acres had the greatest number of injuries.

Table 4 lists the distribution of injuries by nature of injury and part of body. Fractures were the most common injury type, representing about 23 per cent of all injuries. Bruises and sprains followed with 15 per cent each, and cuts accounted for another 14 per cent. Feet were the most common body part injured (15 per cent of the total), followed closely by legs and fingers with about 14 per cent and 13 per cent, respectively.

The chest (ribs) was the most common part of body injured for fractures, representing about 19 per cent of all fractures. The head was injured most often for cuts, representing about 32 per cent of all cuts. Legs were involved in about 19 per cent of the cut injuries, and about 30 per cent of bruises. Foot injuries accounted for about 36 per cent of sprains, 21 per cent of bruises, and 17 per cent of fractures.

Table 5 lists the distribution of work injuries by tractor type and severity of injury. Wide front axle tractors were the most common type, and were involved in about two thirds of the accidents. Adjustable wide front types accounted for about 43 per cent of the total and standard, wide front types had about 25 per cent. Tricycle tractors were associated with about 23 per cent of the cases. The remaining types--four-wheel drive articulated, crawler, and hi-crop--represented 4 per cent, 4 per cent, and 1 per cent of the injury cases, respectively.

For all tractor types combined, about 24 per cent of the injuries were described as slight and 69 per cent were reported as

severe. Injuries led to permanent impairment in about 3 per cent of the cases, while a fatality occurred in about 4 per cent of the total (8 cases). Within each tractor category, the distribution of injuries by severity followed a similar pattern.

Severity of injury was also examined as a function of accident type (Table 6). Sideways overturns accounted for 50 per cent of fatal injuries, while PTOs were associated with nearly 29 per cent of permanent injuries. Falls, however, were associated with the highest percentages of slight and severe injuries, with about 28 per cent and 32 per cent, respectively. For all severity categories combined, most injuries were due to falls (29 per cent) followed by sideways overturns (10 per cent), PTOs (6 per cent), and equipment failure (4 per cent).

Accident type was further examined in relation to tractor type (Table 7). For each tractor type, falls accounted for the highest percentage of specified injuries. Overturns were associated with the next highest percentages of injuries for tricycle tractors (20 per cent), however, overturns accounted for a much smaller percentage of injuries for wide front axle tractors. For adjustable wide front axle types, overturns accounted for about 12 per cent of the cases, and for standard wide front types only about 5 per cent. PTOs were involved in about 8 per cent of adjustable wide front axle injuries and about 5 per cent of standard wide front axle cases. Rear end collisions accounted for about 4 per cent of standard wide front axle tractor accidents. Equipment failure was reported in about 7 per cent of standard wide front axle accidents.

Using information not shown in the tables, several patterns emerged when type of accident was examined against initiating conditions (those circumstances that were reported as the initial cause of the accident event). For example, 45 per cent of sideways overturns occurred while the tractor was crossing a slope, traveling downhill, or when it slipped into an open ditch. Of the PTO-related injuries, removal of the guard was associated with 54

per cent of the cases. In 23 per cent of the PTO cases, it was reported that no guard was provided. A slippery surface was reported as initiating 39 per cent of the falls-related accidents.

Table 8 shows a distribution of injuries by use of the tractor and location of accident. In the greatest number of cases (about 32 per cent), the tractor was parked at the time of injury. Traveling to and from the field was associated with 10 per cent of the total, harvesting and tillage with another 10 per cent, and loading or unloading operations with 8 per cent. Pastures and fields of all types were the location of about one third of the injuries. Shops were associated with about 12 per cent of the total, and driveways had about 10 per cent.

For parked tractors, nearly 30 per cent of the injuries occurred in the shop and 15 per cent in the driveway. The greatest number of accidents during travel to and from the field occurred on highways (30 per cent), while another 26 per cent took place in pastures. Grain fields were the scene of the greatest number of planting and sowing accidents.

Certain other tractor-related variables not shown in the tables were examined. In a number of cases, particular acts of the operator were identified as permitting the accidental injury. Among these were jumped (reported in about 9 per cent of the cases), reaching over, under, or into (6 per cent), driving too fast for conditions (4 per cent), failure to disengage PTO (4 per cent), and failure to lock brakes or transmission before dismounting (4 per cent). A more complete list of operator acts can be found in the Appendix under variable number 54.

Overturns represented about 12 per cent of all tractor accidents. Most were characterized by either a 90 degree roll (30 per cent) or a 180 degree roll (37 per cent), with 360 degree rolls accounting for 13 per cent of all rollovers. The slope of the ground was estimated at 11 degrees or more in about 88 per cent of all tractor overturn cases. More specifically, slopes of 11 to 20

degrees were associated with 15 per cent of rollovers, 21 to 30 degrees with 19 per cent, and 31 to 40 degrees with 23 per cent. Slopes of greater than 40 degrees accounted for about 30 per cent of all rollover accidents.

The number of days experience with the tractor prior to the accident was also evaluated. An operator with less than 1 day of experience was involved in 36 per cent of the injury cases. Those with 1 to 7 days experience were involved in 9 per cent, while 8 to 181 days experience was associated with 23 per cent of the cases. Individuals with more than 181 days of experience were involved in 32 per cent of the accidents.

Exposure refers to the amount of time spent with the tractor on the day of the accident. Exposure of one hour or less was reported in 52 per cent of the injury cases, 24 per cent occurred after 2 to 4 hours, and 18 per cent followed 5 to 8 hours of exposure. Over 8 hours of exposure was associated with 5 per cent of the tractor injuries.

Many different variables were examined as they related to the tractor itself. For example, the age of the tractor was reported to be 5 years or less in about 39 per cent of the incidents. Tractors 6 to 10 years old were involved in another 28 per cent of the cases, while those older than 10 years were associated with 33 per cent.

Environmental conditions did not appear to play an important role in the occurrence of tractor-related work injuries. In fact, most injuries occurred under what would be considered optimal environmental conditions. For example, outside temperatures were reported to be between 51^0 F and 85^0 F in 57 per cent of the specified cases. Only about 11 per cent occurred at temperatures below freezing, and slightly more than 15 per cent occurred at temperatures greater than 85^0 F. The weather was described as clear in nearly 84 per cent of the cases, and rainy conditions were reported in only 7 per cent of the accidents.

Wind was also not an important factor, as only 5 per cent of the cases reported winds in excess of 9 mph. Light conditions were described as "daylight" in 90 per cent of the cases and as dawn or dusk in another 6 per cent.

Survey data were also available in slightly over half the cases regarding the consequences of tractor injuries in terms of medical treatment, lost workdays and costs. In the majority of reported cases, professional medical advice or treatment was sought. A single contact with a physician or nurse was reported in about 20 per cent of the specified cases, while 70 per cent required more than one contact. The remaining 10 per cent of the injury cases required no treatment or were treated at home. About 38 per cent of all injuries were treated at a doctor's office, while 31 per cent were treated in hospital emergency rooms. The injured person was admitted to the hospital in about 15 per cent of the incidents.

Most injuries, 55 per cent of the total, involved seven or fewer lost workdays. More than 19 per cent of the injuries resulted in lost time lasting one to three months. Of the cases classified, 7 per cent reported a physical handicap after recovery from injuries.

Cost information from the survey is of limited usefulness because it was collected over a time period of many years, and does not reflect changing costs, inflation, and so forth. Nonetheless certain general aspects of the data may be helpful. For instance, in about 80 per cent of the specified cases, there was no expenditure for replacement labor. Likewise, there were no property damage costs associated with approximately 84 per cent of the cases. Medical costs were reported at less than $500 for about 82 per cent of all classified cases, but greater than $1,000 in about 12 per cent of the injury incidents.

TABLE 2
TRACTOR-RELATED WORK INJURIES
BY AGE, SEX AND FAMILY STATUS

AGE	FAMILY MEMBERS		HIRED HELP		ALL PERSONS
	Male	Female	Male	Female	
5-14	5.6	14.3	1.9	-	5.5
15-24	13.8	28.6	40.7	-	21.3
25-44	30.0	21.4	40.7	-	31.5
45-64	40.0	35.7	11.1	-	32.9
65+	10.6	0.0	5.6	-	8.8
Total	100.0%	100.0%	100.0%	-	100.0%
All Ages	70.2	6.1	23.7	*	100.0%

*There were no reported tractor-related work injuries for hired females.

TABLE 3
TRACTOR-RELATED WORK INJURIES
BY ACREAGE AND AGRICULTURAL OPERATION

ACREAGE	AGRICULTURAL OPERATION					ALL OPERATIONS
	Beef	Dairy	Grain	Fruit	Other	
1-49	13.5	0.0	2.9	38.4	10.9	8.4
50-99	5.4	9.1	1.4	0.0	3.1	4.5
100-199	21.6	27.3	11.4	15.4	15.6	17.3
200-499	35.2	52.3	40.0	30.8	28.2	37.4
500-999	16.2	9.1	22.9	15.4	25.0	19.6
1,000+	8.1	2.2	21.4	0.0	17.2	12.8
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
All Injuries	16.2	19.3	30.7	5.7	28.1	100.0%

TABLE 4
TRACTOR-RELATED WORK INJURIES
BY NATURE OF INJURY AND PART OF BODY

PART OF BODY	NATURE OF INJURY								ALL INJURIES
	Amputation	Bruise	Burn	Fracture	Cut	Sprain	Multiple	Other	
Arm	0.0	8.8	14.3	9.6	3.2	0.0	4.3	0.0	4.8
Back	0.0	8.8	0.0	3.9	0.0	18.2	0.0	11.6	7.0
Chest	0.0	5.9	0.0	19.2	0.0	0.0	0.0	2.3	5.7
Eye	0.0	0.0	14.3	0.0	3.2	0.0	0.0	18.6	4.4
Finger	60.0	5.9	0.0	11.5	22.6	6.1	8.7	16.3	12.7
Foot	20.0	20.6	0.0	17.3	9.7	36.3	0.0	4.7	14.9
Hand	0.0	2.9	14.3	7.7	9.7	0.0	4.3	4.7	5.3
Head	0.0	0.0	0.0	1.9	32.3	0.0	4.3	4.7	6.1
Leg	20.0	29.5	14.3	7.7	19.3	9.1	13.1	11.6	14.5
Shoulder	0.0	5.9	0.0	5.8	0.0	9.1	0.0	0.0	3.5
Multiple	0.0	2.9	28.5	1.9	0.0	0.0	56.6	2.3	7.9
Other	0.0	8.8	14.3	13.5	0.0	21.2	8.7	23.2	13.2
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
All Injuries	2.2	14.9	3.1	22.8	13.6	14.5	10.1	18.8	100.0%

TABLE 5
TRACTOR-RELATED WORK INJURIES
BY TYPE OF TRACTOR AND SEVERITY

	TRACTOR TYPE						
SEVERITY	Tricycle	Adjustable Wide Front Axle	Standard Wide Front Axle	Hi-Crop	Crawler	4-Wheel Drive, Articulated	ALL TRACTOR TYPES
Slight	17.3	18.6	36.2	33.3	22.2	22.2	23.7
Severe	75.0	70.1	58.7	66.7	66.7	66.7	68.8
Permanent	3.9	4.1	1.7	0.0	0.0	0.0	3.1
Fatal	1.9	5.1	1.7	0.0	11.1	0.0	3.5
Unknown	1.9	2.1	1.7	0.0	0.0	11.1	0.9
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
All Injuries	22.7	42.7	25.3	1.3	4.0	4.0	100.0%

TABLE 6
TRACTOR-RELATED WORK INJURIES
BY SEVERITY AND TYPE OF ACCIDENT

ACCIDENT TYPE	SEVERITY					ALL INJURIES
	Slight	Severe	Permanent	Fatal	Unknown	
Collision from side	1.9	1.9	0.0	0.0	0.0	1.8
Collision, head-on	1.9	0.0	14.3	12.5	0.0	1.3
Collision, rear	3.7	0.6	0.0	12.5	0.0	1.8
Equipment failure	3.7	5.1	0.0	0.0	0.0	4.3
Fall	27.7	31.9	0.0	0.0	50.0	28.9
Fire	1.9	1.9	0.0	0.0	0.0	1.8
Overturn, backward	0.0	1.9	0.0	12.5	0.0	1.8
Overturn, sideways	7.4	8.3	14.3	50.0	0.0	9.6
PTO	3.7	5.7	28.6	0.0	0.0	5.7
Other, unknown	48.1	42.7	42.8	12.5	50.0	43.0
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
All Types	23.7	68.8	3.1	3.5	0.9	100.0%

TABLE 7
TRACTOR-RELATED WORK INJURIES
BY TRACTOR TYPE AND ACCIDENT TYPE

ACCIDENT TYPE	TRACTOR TYPE						ALL TRACTOR TYPES
	Tricycle	Adjustable Wide Front Axle	Standard Wide Front Axle	Hi-Crop	Crawler	4-Wheel Drive, Articulated	
Collision from side	0.0	4.1	0.0	0.0	0.0	0.0	1.8
Collision, head-on	0.0	3.1	0.0	0.0	0.0	0.0	1.3
Collision, rear	1.9	1.0	3.5	0.0	0.0	0.0	1.8
Equipment failure	1.9	4.1	6.9	0.0	11.1	0.0	4.3
Fall	26.9	25.8	31.0	33.3	44.5	44.4	28.9
Fire	1.9	0.0	3.5	0.0	11.1	0.0	1.8
Overturn, backward	0.0	3.1	1.7	0.0	0.0	0.0	1.8
Overturn, sideways	19.2	9.3	3.5	0.0	11.1	0.0	9.6
PTO	3.9	8.3	5.1	0.0	0.0	0.0	5.7
Other, unknown	44.3	41.2	44.8	66.7	22.2	55.6	43.0
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
All Types	22.7	42.7	25.3	1.3	4.0	4.0	100.0%

TABLE 8
TRACTOR-RELATED WORK INJURIES
BY USE OF TRACTOR AND SPECIFIC LOCATION

SPECIFIC LOCATION	TRACTOR USE								ALL INJURIES
	Harvesting, Tillage	Loading, Unloading	Parked	Planting, Sowing	Runaway, Coasting (No Driver)	Stationary (Belt or PTO Operating)	Traveling To or From Field	Other, Unknown	
Barn	0.0	11.1	5.5	0.0	0.0	0.0	0.0	7.5	4.8
Corn, cotton field	21.7	5.5	1.4	0.0	0.0	0.0	0.0	3.0	3.9
Driveway	4.4	5.5	15.3	11.1	0.0	9.1	13.1	7.5	10.1
Feedlot	0.0	11.1	5.5	0.0	0.0	9.1	0.0	7.5	5.3
Grain field	21.7	5.6	11.1	44.5	20.0	9.1	0.0	11.9	12.3
Hay field	26.1	5.6	2.8	0.0	60.0	0.0	8.7	8.9	8.8
Highway	0.0	5.6	0.0	0.0	0.0	0.0	30.4	3.0	4.4
Pasture	0.0	5.6	1.4	11.1	0.0	9.1	26.1	16.4	9.2
Shop	4.4	0.0	29.2	22.2	0.0	9.1	0.0	4.5	12.3
Other, unknown	21.7	44.4	27.8	11.1	20.0	54.5	21.7	29.8	28.9
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
All Locations	10.1	7.9	31.6	3.9	2.2	4.8	10.1	29.4	100.0%

Work Injury Scenarios

Based on Crosstabulations

Scenarios were developed by first running a 3-way crosstabulation of nature of injury by part of body by type of accident; second, identifying the cells or cell combinations with the largest frequencies and running a crosstabulation of activity versus agency of accident for each; and third, identifying the most frequent combinations of activity and agency for the given type of accident/nature of injury/part of body combinations. The scenarios are given in the following general format:

I. Type of Accident (N_1)

   A. Resulting in [nature of injury] to the [part of body] (N_2) while performing [activity] involving [agency of accident] (N_3).

   B. Resulting in [nature of injury] to the [part of body] (N_4)

      1. while performing [activity] involving [agency of accident] (N_5).

      2. while performing [activity] involving [agency of accident] (N_6).

N_1 is the total number of cases of the accident type; N_2 and N_4 are the number of cases of the accident type/nature of injury/part of body combination; and N_3, N_5, and N_6 are the number of cases of the accident type/nature of injury/part of body/activity/agency of accident combination.

Reading I-A, I-B-1, and I-B-2 gives complete statements of three accident scenarios. If there are no cells or cell combinations in a particular crosstabulation that indicate a pattern, then that is stated in the scenario and the largest marginal frequencies may be identified instead.

The accident types and combinations of characteristics within each type are listed in descending order of frequency.

I. Struck By or Against Object (41)

A. Resulting in bruise or fracture (22) with no dominant part of body

1. while performing field work involving tractor (13).
2. while performing machinery maintenance involving tractor (4).

B. Resulting in cut to head (5) while performing field work, chores, or machinery maintenance involving tractor (4). [Three of these four cases involved overturns: one while freeing, one while harvesting, and one while herding.]

II. Fall, Different Level (41)

A. Resulting in fracture or sprain to foot (10) while performing field work involving tractor (4). [Nine of the 10 cases occurred while tractor was parked or stationary.]

B. Resulting in fracture to chest (5)

1. while performing field work or chores involving tractor (3).
2. While performing machinery maintenance involving tractor (2). [All five cases occurred while tractor was parked.]

III. Caught Between Objects (35)

A. Resulting in amputation, cut, fracture, mangle, or pinch to finger (12) while performing field work or chores (8) involving tractor.

IV. Caught Under Object (27)

A. Resulting in fracture or mangle to leg (4) while harvesting, herding, or traveling (3) involving tractor. [Two of the three cases involved side

overturns].

V. Caught In Object (19)

A. Injury to finger or hand (10) involving field work or chores (8).

B. Injury to foot or leg (6) with no dominant pattern of activity.
[Four of the six involved the PTO. All were while parked or stationary.]

Based on Treesearches

Two approaches were used to identify additional injury scenarios for tractor-related injuries. The first approach was to start with the various types of tractors; the second involved starting with the age of the injured person. These approaches were used on the assumption that intervention programs would be targeted for specific types of tractors or for specific age groups of operators. Other treesearch approaches may be appropriate for other intervention targets.

For each type of tractor, nine variables were examined in the first round of treesearches: age, sex, employment status, activity, action, general type of accident, tractor-specific type of accident, tractor use, and specific location. Seven HI's were identified on the first round of treesearches by type of tractor (Figure 4). Six of the seven involved fewer than ten cases.

Because side overturns involving tricycle tractors had ten cases, it was run against 13 more variables: age, sex, employment status, use, roll, slope, initial cause, unsafe act, specific location, cab, cab with ROPS, ROPS, and seat belt in use. An additional HI was found on one of the variables--pasture as a specific location was involved in four cases. The two HI's did not suggest a scenario and there were too few cases left to perform additional treesearches.

For each age group, eight variables were examined in the first round: activity, action, general type of accident, tractor-specific type of accident, tractor use, unsafe act, exposure, and experience. If at least ten cases were involved in an item identified as having higher than expected frequency, then additional treesearches were done to identify additional characteristics of the event. Six HI's were identified on the first round of treesearches by age of victim (Figure 5). Four of the six did not involve enough cases for follow up.

Following up on the 18 cases involving 15-24 year olds driving, we found HI's on two additional variables--side overturns, and "too fast." This suggests a scenario of young persons driving too fast resulting in side overturns.

Following up on the 10 case involving the elderly with 2-4 hours of exposure resulted in another HI on pasture. Three of the five cases in the pasture involved falling and two involved side overturns. No clear scenarios emerged from these findings and there were not enough cases left for further probing.

FIGURE 4
SUMMARY OF RESULTS OF TREESEARCHES
BY TYPE OF TRACTOR

	HI's		
Type of Tractor	Variable	Option	N
4-wheel drive	employee status	full time employee	6
wide standard	action	sitting	5
tricycle	action	kneeling	3
tricycle	accident type	side overturn	10
crawler	use	harvesting	3
crawler	location	grain field	5
crawler	age	25-44 years	6

FIGURE 5
SUMMARY OF RESULTS OF TREESEARCHES
BY AGE OF VICTIM

	HI's		
Age of Victim	Variable	Option	N
5-14 years	action	riding	6
15-24 years	action	driving	18
15-24 years	accident type	side collision	3
15-24 years	accident type	back overturn	3
65 or more years	unsafe act	reaching	4
65 or more years	exposure	2-4 hours	10

Interventions

Interventions aimed at reducing the number or severity of tractor-related injuries can be classified in a variety of ways. By the target of the intervention, they center on the tractor operator, the tractor itself, or the environment in which the tractor operates. By method, interventions can utilize educational techniques, engineering techniques, or enforcement techniques.

Education is the responsibility of the safety educator. He or she can assist farmers and their families in understanding how to deal with work-related hazards around the farm and ranch by recognizing and eliminating them. Educational techniques are aimed at the tractor operator or his family but the safety information that is conveyed may relate to the tractor itself, the operator, or the environment in which the tractor operates.

Enforcement techniques often involve the machine by requiring manufacturers to provide certain safety equipment or design machines according to safety standards. The farmer and his operations may also be subject to enforcement through workplace safety legislation, but historically the small farmer has been unaffected by interventions of this type. Enforcement or regulation is a phase of agricultural accident prevention that is not well accepted by the agricultural population. However, many voluntary standards and recommendations for agricultural regulations are supported and complied with by the agricultural industry.

Engineering interventions almost always involve the tractor itself--improving its design or implementing safety equipment. They often relate to the operator as well, however, improving his ability to operate the machinery in a safe capacity.

With this in mind, the following represents an inventory of possible countermeasures for the various tractor-related work injuries discussed in this report. Most of the countermeasures listed consist of operating procedures that can be utilized by the

farmer himself. As such they fall into the realm of education or enforcement countermeasures. Engineering countermeasures in the form of design changes can also be utilized by the farmer in many instances, but most must be implemented by equipment manufacturers.

The listing is arranged by accident type. Listed first are those accident types identified by the scenarios in the previous section as being most common. Within each accident type, countermeasures are given for the most common activities or agencies of accident identified by the scenarios.

Struck By or Against Object

Being struck by or against the tractor while doing field work or chores can occur when the tractor overturns injuring the operator, when the victim falls from the operating platform, or when a nonoperator is struck by a tractor.

To avoid being struck by or against the tractor due to an overturn, tractors should be equipped with rollover protective structures (ROPS) and seat belts should be worn. ROPS provide operators with a zone of safety should an overturn occur. To prevent overturns from occurring, several engineering countermeasures have been mentioned previously. These include stability indicators for the operators and shutoff devices that stop the engine when the tractor reaches angles from which overturn is likely. There have been many improvements in tractor design intended to make tractors inherently more stable, and continued emphasis in this area is needed. Tractor tipping hazards can also be reduced by spreading the rear wheels as far as possible, operating tractors at safe speeds, and taking special care around steep ground, ditches, or when making turns. Operators should wear a bump cap to assure adequate head protection.

To avoid being struck by or against the tractor due to falling, the operator's platform should be kept free of mud or other slippery materials. Tractors should be built with slip-resistant surfaces on the platform and with ladders or steps with

handholds for mounting and dismounting. Personal protective devices such as hard hats or bump caps, gloves, and safety shoes will reduce the severity or number of these injuries.

Countermeasures for accidents involving the striking of nonoperators by moving tractors include the use of machinery for intended purposes and always keeping children away from tractors and other equipment. Tractors must be operated at safe speeds for conditions by operators who are physically and mentally fit.

Interventions for being struck by or against a tractor during machinery maintenance include lowering all hydraulic or mechanical equipment before leaving the tractor platform. PTOs or other equipment should be disengaged before leaving the platform. All servicing of equipment, such as oiling, greasing, or adjusting should be performed before starting the tractor, not while it is running. Engineering countermeasures could also be implemented such as engine stoppage devices that detect the presence of an operator and shut off the engine when no operator is at the controls. Personal protective equipment should be worn such as hard hats or bump caps.

Fall, Different Level

To avoid different level falls involving the tractor while doing field work, chores, or machinery maintenance, operators should wear skid-resistant footwear and keep all working surfaces (tractor platform, pedals, and steps) free of dirt, trash, grease and all foreign material. The operator should be alert, mounting and dismounting the tractor with care.

Platforms and steps should be constructed of slip-resistant surfaces and in such a way that reduces or eliminates the accumulation of foreign material. Ladders or steps with handholds should be provided.

Caught Between Objects

Countermeasures for being caught between objects while doing field work or chores involving the tractor include lowering all equipment before leaving the platform and disengaging PTOs and other equipment before dismounting. When hitching or unhitching equipment, the operator or his assistant should always stand on the side of the hitch, not straddling it. Hands should be kept clear of pinch points and protective gloves should be worn.

Wheels should be blocked before hitching to prevent implement movement. If an operator is assisted, the operator should make certain the assistant is in view at all times. If an operator dismounts to hitch an implement, he should shift the transmission to neutral and lock the brakes before dismounting.

Caught Under Object

Interventions aimed at injuries caused by being caught under a tractor while harvesting, herding, or traveling, center around the prevention of overturns or amelioration of injury should an overturn occur.

To prevent overturns, operators should stay alert while operating on slopes, rough ground, near ditches or embankments. Speed should not be excessive for working conditions and should always be reduced before making a turn. When traveling on public roads or from field to field, right and left brake pedals should be locked together to prevent uneven braking of rear wheels and possible overturn accidents. The use of slow-moving vehicle emblems can reduce motor-vehicle-tractor collisions which may results in overturns. When working in fields, tractor wheels should be spread to maximum allowable width to increase stability.

To reduce injuries when overturns do occur, all tractors should be equipped with ROPS or crush-resistant cabs equipped with seat belts.

Caught In Object

To avoid being caught in objects while doing field work or

chores involving the tractor, all shielding for PTOs should be provided and kept in place during operation. PTOs and other equipment should be disengaged before dismounting from the tractor platform, and machines should not be operated unless the operator is on the platform. Operators and bystanders should stay safely away from all moving parts, and children especially should not be in the work area.

Proper maintenance of the shields is also essential, and damaged shields should be repaired before the machinery is allowed in operation. Integral shields should be able to rotate freely. When operating PTOs, well-fitting work clothing should be worn with slip-resistant footwear. Loose clothing is a significant factor in PTO entanglements.

Several engineering countermeasures can also be implemented. The design of the PTO and its shield can be improved to eliminate or modify the portions of the machine most often implicated in entanglements. Shutoff mechanisms which activate when no operator is present and interlock systems which disallow operation without PTO shielding in place can be utilized.

Should a PTO entanglement occur, emergency stop mechanisms can reduce the severity of injuries. These mechanisms have several forms including a line or button which can be activated from various hazardous locations around the tractor, or even a shutoff device that responds to verbal commands. The presence of an assistant who can summon medical personnel or administer first aid and CPR can also reduce the severity of injuries.

Discussion

The situation with respect to fatalities involving agricultural tractors seems to be improving. The death rate per 100,000 tractors in use has fallen nearly 60 per cent in the past 20 to 25 years. In the early 1960s the death rate was 22 per 100,000 tractors. By 1986 the rate was estimated to be about 9.3 (National Safety Council Farm and Statistics Departments, 1967; National Safety Council, 1987). About 1,000 deaths per year were due to tractor accidents in the early 1960s and this has dropped to about 400.

Much of this improvement may be attributed to two areas: overturns and run overs. The proportions of tractor deaths due to these types of accidents have decreased while the proportion due to PTO entanglement has remained constant and all other accident types increased (National Safety Council, 1987).

Even though the proportion of overturns has decreased, it is still the principal type of fatal accident involving tractors. Ten studies cited earlier reported that from one half to three fourths of the deaths studied were due to overturns.

Rollover protective structures (ROPS) were specifically designed to reduce injuries and fatalities from tractor overturns when used in combination with a seat belt. Schnieder (1983) found no fatalities in 50 overturns involving ROPS-equipped tractors. Knapp (1968) estimated that three fourths of the fatalities in overturn accidents on highways that he investigated could have been prevented by ROPS. In spite of the evidence of the effectiveness of ROPS and the length of time (20 years) that they have been available, Napier, Goe, and Pugh (1985) found that less than one fourth of the tractors on Ohio farms were equipped with ROPS. Since 1986 ROPS have been standard equipment on all agricultural tractors. This will, in the long term, lead to continued improvement, as non-ROPS-equipped tractors are retired from service.

Work by Hunter (1981) and Owen and Hunter (1983) suggests that a supplement to ROPS may lie in improving tractor stability or in improving the information conveyed to the operator regarding the stability and control of the tractor. More than half of the overturns they studied occurred when the operator took the tractor beyond its safe operating limits. Extending the safe limits or providing the operator with a visual or audio warning when approaching the safe limits could prevent a large number of overturns. Murphy, Beppler, and Sommer (1985) also point out the desirability of stability warning devices, especially for training tractor operators. Aherin, Schultz, and True (1981) stress the importance of using the widest possible setting for adjustable axles to maximize stability.

The second and third most common fatal injury types are not as clearly defined as the most common (overturns). Some studies indicate that falls rank second and other studies list run over as second. One study lists "fell and run over" as a single category, and another study uses "extra rider" and "thrown, fell." It is not clear if a person who fell from the tractor and was subsequently run over would be included in the "fell" or "run over" category. It is also not clear how run over cases would be recorded in the standardized state farm surveys. If the victim first fell from the tractor, then it would probably be recorded as a "fall." If not, then it would probably be recorded as "struck by," although it might be recorded as "caught under." In any case, both types of accident, fall and run over, are important and require intervention to reduce their numbers.

Several authors have suggested that tractors be equipped with some kind of emergency shutoff device either activated by the operator or automatically activated by absence of an operator (Elwell, Brown, & Schnieder, 1981; Hammond, Tyson, & Kay, 1984; and Sevart & Berry, 1986).

Highway accidents are the fourth leading cause of tractor-related injuries. Depending on the study, from 5 to 30 per cent

of the cases studied occurred on highways. The detailed investigations by Knapp and Hindman (1962) and LeGarde (1975) provide a good basis for understanding this accident type and for determining the direction of future research. The slow-moving vehicle emblem was recommended by LeGarde as a means to reduce highway collisions between motor vehicles and farm equipment.

Power takeoff or PTO-related injuries generally account for 3 to 8 per cent of the tractor-related injuries, although one study of hospitalized cases (Simpson, 1984) puts the figure at 20 per cent. Clothing entanglement on a protrusion from the unshielded PTO shaft was the most common scenario. The spring-loaded pin used to attach the PTO assembly to the tractor seems to be a particular problem.

The importance of shielding the PTO shaft has been known for at least 20 years and yet a recent study of the use of PTO master shields found that more than half had been removed (Sell & Field, 1984). Importantly, however, one particular type of shield, the flip-up type, was removed in only 11 per cent of the tractors observed. Apparently the flip-up shield is much more acceptable to farmers than other shield types. The design of PTO shields may be less than adequate. Three studies reported that from 21 to 50 per cent of the PTO-related injuries happened when all shields were in place (Knapp & Piercy, 1966; McElfresh & Bryan, 1973; and Heeg, ten Duis, & Klasen, 1986). Further investigation is needed to find out the reasons why entanglement occurred in these cases.

Williams (1983) found that size of farm had a strong influence on the incidence of tractor-related work injuries. The same was true for the 35 state surveys. Farms of 200 or more acres experienced more tractor injuries than expected while smaller farms had fewer. He also found that beef and dairy farms were overrepresented. In the 35 state surveys, beef and grain farms were overrepresented and dairy farms were somewhat under-represented.

Tractor-related injuries were generally more severe than all work injuries. About 30 per cent of all injuries were slight but only 24 per cent of tractor cases were of slight severity. For all injuries and tractor injuries, about two thirds were rated severe. Permanent impairments resulted from 1.9 per cent of all injuries but from 3.1 per cent of tractor injuries. And while only 0.7 per cent of all cases were fatal, 3.5 per cent of the tractor cases resulted in death.

The most common nature of injury in tractor-related cases of all severities was fractures with 23 per cent of the cases. Most fractures involved the chest, foot, or fingers. Bruises, sprains, and cuts were also quite common. Conrath and Hanford (1973) also reported fractures and sprains as the most frequent injury types in the ten-state survey review. Cogbill and Busch (1985), in their study of hospitalized cases, found fractures of the ribs and pelvis to be the most frequent. Crushed chest was most frequent in two studies of fatal cases (Donaldson, 1968; Goodman, Smith, Sikes, Rogers, & Mickey, 1985). Given that overturns were the predominant fatal accident type, the resulting injuries are not surprising.

Tractor-related work injuries are strongly associated with age and sex. Males account for more than 90 per cent of tractor use and tractor injuries. The young and the old are over-represented based both on their proportions of total farm work hours and their tractor operation hours. Doss and Pfister (1974) found the injury rate per million tractor-use hours for persons under 15 years of age was five times greater than the all ages average. They also found that the rate for persons 65 and over was 3.5 times the average.

Tractor use also appears to be more hazardous for hired workers than for family members. While no studies computed involvement rates by employment status, it is possible to draw a conclusion from the data in Doss and Pfister and Table 2 of this report. Doss and Pfister found that 13 per cent of the tractor exposure hours were for hired help and 87 per cent for family

members. Table 2 shows that 24 per cent of tractor-related injuries were to hired help and 76 per cent to family members.

The design of the tractor seems to influence its accident involvement. Wide front end tractors generally have a lower involvement rate than tricycle-style tractors. One study found a higher rate for wide front end style but attributed this to greater use on hillsides and sloping ground (McClure, Johnson & Lamp, 1963). Not enough data were available to draw any conclusions about the relative safety of other tractor styles such as adjustable front end, hi-crop, crawler, or four-wheel drive.

The work injury scenarios were constructed to define the most common hazard patterns in tractor-related farm work as documented in the 35 state farm surveys. The various combinations of accident characteristics, taken together, create outlines of the injury events. The outlines are not complete because some elements are not defined. But sufficient information is present to suggest possible countermeasures as set forth in the section on interventions. The scenarios were presented in descending order of importance as measured by the frequency of injury. Interventions aimed at high ranking scenarios should be considered first for implementation because they have the greatest potential benefits.

A broad range of possible interventions were given. Each one needs to be examined to assess its value in an overall injury prevention program. Although all three types of interventions have a place in a comprehensive injury prevention program, research has shown that engineering approaches are more effective than enforcement, and enforcement more effective than education (National Research Council Committee on Trauma Research, 1985). Many factors must be considered in evaluating each potential intervention. Among those factors are potential effectiveness, cost, feasibility, effect on productivity, time required to begin implementation, time required for full implementation, and acceptability by those affected.

It is essential, too, to plan for the administrative and effectiveness (impact) evaluations of the interventions that are finally implemented. The fact is that there has been virtually no formal evaluation of injury prevention measures on the farm. The extensive literature review undertaken for this study identified only a few research reports that could be considered to be evaluations. None of the studies reviewed, however, were true evaluations using experimental or even quasi-experimental designs.

A systematic, scientific approach to the farm work injury problem consisting of injury surveillance and intervention selection, implementation, and evaluation will bring about the most effective results and the most prudent use of limited resources.

The need for further research is evident in several areas. Data on the make and model of a tractor would help to identify possible design flaws or unusual operating limits peculiar to specific models or manufacturers. The work by Owen and Hunter should be extended to an analysis of, and perhaps standards for, the safe operating limits of tractors. And the identification, classification, and analysis of true causal factors would lead to more effective intervention strategies.

Finally, an issue raised by LeGarde and Hudson (1975) needs further exploration and verification. They reported the blood alcohol concentration (BAC) test results of 22 adults killed in tractor accidents and found that 9 (41 per cent) had a BAC of 0.10 per cent or greater. If these tractor operators had been driving motor vehicles, they would have been presumed to be impaired. The average BAC of the 9 cases was 0.20 per cent and two others had been drinking but had BACs less than 0.10 per cent. The authors stated that there was no bias in the selection of cases in favor of situations where alcohol use was suspected. This is the only study identified that addressed alcohol impairment as a contributing factor in farm injuries. It should be taken seriously and it should stimulate further research in this area.

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APPENDIX

FREQUENCY AND PER CENT DISTRIBUTIONS

VARIABLE: 01...STATE FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...ALABAMA	8	3.51	3.51
02...CALIF	11	4.82	4.82
03...MARYLAND	9	3.95	3.95
04...MISSOURI	0	.00	.00
05...UTAH	3	1.32	1.32
06...ARIZONA	1	.44	.44
07...IDAHO	5	2.19	2.19
08...GEORGIA	2	.88	.88
09...KANSAS	17	7.46	7.46
10...PENNA	7	3.07	3.07
11...WISCONSN	0	.00	.00
12...IOWA	36	15.79	15.79
13...OKLAHOMA	0	.00	.00
14...MONTANA	3	1.32	1.32
15...S DAKOTA	7	3.07	3.07
16...INDIANA	3	1.32	1.32
17...N MEXICO	2	.88	.88
18...NEW YORK	8	3.51	3.51
19...VERMONT	6	2.63	2.63
20...NEW HAMP	4	1.75	1.75
21...DELAWARE	0	.00	.00
22...NEBRASKA	9	3.95	3.95
23...COLORADO	3	1.32	1.32
24...ARKANSAS	18	7.89	7.89
25...CONN	0	.00	.00
26...WASHNGTN	3	1.32	1.32
27...OREGON	21	9.21	9.21
28...VIRGINIA	3	1.32	1.32
29...UTAH II	1	.44	.44
30...MICHIGAN	2	.88	.88
31...TENNESSE	3	1.32	1.32
32...KANS II	0	.00	.00
33...GEOR II	4	1.75	1.75
34...S CALINA	6	2.63	2.63
35...IOWA II	23	10.09	10.09
TOTAL	228	100.03	100.03

VARIABLE: 02...RESIDENCY FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...HUSBAND	122	53.51	53.51
02...WIFE	9	3.95	3.95
03...SON	32	14.04	14.04
04...DAUGHTER	7	3.07	3.07
05...OTHER	7	3.07	3.07
06...FT EMPL	31	13.60	13.60
07...PT EMPL	20	8.77	8.77
08...VISITOR	0	.00	.00
09...GUEST	0	.00	.00
TOTAL	228	100.01	100.01

VARIABLE: 03...AGE FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01... 1- 4 YR	2	.88	.88
02... 5-14 YR	12	5.26	5.26
03...15-24 YR	46	20.18	20.18
04...25-44 YR	68	29.82	29.82
05...45-64 YR	71	31.14	31.14
06...65, OVER	19	8.33	8.33
07...UNKNOWN	10	4.39	4.39
TOTAL	228	100.00	100.00

VARIABLE: 04...SEX FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	1	.44	
01...MALE	211	92.54	92.95
02...FEMALE	16	7.02	7.05
TOTAL	228	100.00	100.00

VARIABLE: 05...NMBR INJRD FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...ONE	224	98.25	98.25
02...TWO	3	1.32	1.32
03...THREE	0	.00	.00
04...4, MORE	0	.00	.00
05...UNKNOWN	1	.44	.44
TOTAL	228	100.01	100.01

VARIABLE: 06...WK-LEISURE FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...WORK	228	100.00	100.00
02...LEISURE	0	.00	.00
03...UNKNOWN	0	.00	.00
TOTAL	228	100.00	100.00

VARIABLE: 07...MONTH FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	1	.44	
01...JANUARY	10	4.39	4.41
02...FEBRUARY	15	6.58	6.61
03...MARCH	16	7.02	7.05
04...APRIL	26	11.40	11.45
05...MAY	37	16.23	16.30
06...JUNE	25	10.96	11.01
07...JULY	19	8.33	8.37
08...AUGUST	19	8.33	8.37
09...SEPTEMBR	10	4.39	4.41
10...OCTOBER	27	11.84	11.89
11...NOVEMBER	13	5.70	5.73
12...DECEMBER	10	4.39	4.41
13...UNKNOWN	0	.00	.00
TOTAL	228	100.00	100.01

VARIABLE: 08...DAY/WEEK FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	39	17.11	
01...SUN.	6	2.63	3.17
02...MON.	19	8.33	10.05
03...TUES.	29	12.72	15.34
04...WED.	34	14.91	17.99
05...THURS.	36	15.79	19.05
06...FRI.	25	10.96	13.23
07...SAT.	29	12.72	15.34
08...UNKNOWN	11	4.82	5.82
TOTAL	228	99.99	99.99

VARIABLE: 09...TIME/DAY FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	39	17.11	
01... 1 A.M.	1	.44	.53
02... 2 A.M.	3	1.32	1.59
03... 3 A.M.	3	1.32	1.59
04... 4 A.M.	2	.88	1.06
05... 5 A.M.	2	.88	1.06
06... 6 A.M.	1	.44	.53
07... 7 A.M.	2	.88	1.06
08... 8 A.M.	8	3.51	4.23
09... 9 A.M.	10	4.39	5.29
10...10 A.M.	30	13.16	15.87
11...11 A.M.	11	4.82	5.82
12...NOON	0	.00	.00
13... 1 P.M.	7	3.07	3.70
14... 2 P.M.	16	7.02	8.47
15... 3 P.M.	25	10.96	13.23
16... 4 P.M.	23	10.09	12.17
17... 5 P.M.	18	7.89	9.52
18... 6 P.M.	10	4.39	5.29
19... 7 P.M.	5	2.19	2.65
20... 8 P.M.	1	.44	.53
21... 9 P.M.	1	.44	.53
22...10 P.M.	0	.00	.00
23...11 P.M.	0	.00	.00
24...MIDNIGHT	2	.88	1.06
25...UNKNOWN	8	3.51	4.23
TOTAL	228	100.03	100.01

VARIABLE: 10...INJRY/ILL FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...INJURED	228	100.00	100.00
02...ILL	0	.00	.00
TOTAL	228	100.00	100.00

VARIABLE: 11...SEVERITY FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...SLIGHT	54	23.68	23.68
02...SEVERE	157	68.86	68.86
03...PERM.	7	3.07	3.07
04...FATAL	8	3.51	3.51
05...UNKNOWN	2	.88	.88
TOTAL	228	100.00	100.00

VARIABLE: 12...ACTIVITY FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	2	.88	
01...BLDG MNT	3	1.32	1.33
02...FLD WORK	108	47.37	47.79
03...HSE WORK	0	.00	.00
04...MACH MNT	33	14.47	14.60
05...RECREATN	0	.00	.00
06...CHORES	41	17.98	18.14
07...LIVESTCK	3	1.32	1.33
08...YRD WORK	3	1.32	1.33
09...OTHER	35	15.35	15.49
TOTAL	228	100.01	100.01

VARIABLE: 13...ACTION FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...CLIMBING	38	16.67	16.67
02...DRIVING	55	24.12	24.12
03...JUMPING	11	4.82	4.82
04...KNEELING	4	1.75	1.75
05...LIFTING	12	5.26	5.26
06...LYING DN	0	.00	.00
07...RIDING	26	11.40	11.40
08...RUNNING	1	.44	.44
09...SITTING	8	3.51	3.51
10...STANDING	45	19.74	19.74
11...WALKING	12	5.26	5.26
12...OTHER	16	7.02	7.02
TOTAL	228	99.99	99.99

VARIABLE: 14...1ST AID BY FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	44	19.30	
01...DOCTOR	100	43.86	54.35
02...FAMILY	28	12.28	15.22
03...NURSE	5	2.19	2.72
04...SELF	28	12.28	15.22
05...MULTIPLE	9	3.95	4.89
06...OTHER	14	6.14	7.61
TOTAL	228	100.00	100.01

VARIABLE: 15...MD TREATED FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	42	18.42	
01...NOT REQD	17	7.46	9.14
02...ONE	38	16.67	20.43
03...2, MORE	131	57.46	70.43
TOTAL	228	100.01	100.00

VARIABLE: 16...TYPE INJRY FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	3	1.32	
01...AMPUTATN	5	2.19	2.22
02...ASPHYXIA	0	.00	.00
03...BRUISE	34	14.91	15.11
04...BURN	7	3.07	3.11
05...FRACTURE	52	22.81	23.11
06...CUT	31	13.60	13.78
07...EYE INJ	7	3.07	3.11
08...MANGLED	10	4.39	4.44
09...PINCHED	5	2.19	2.22
10...PUNCTURE	2	.88	.89
11...SPRAIN	33	14.47	14.67
12...MULTIPLE	23	10.09	10.22
13...OTHER	16	7.02	7.11
TOTAL	228	100.01	99.99

VARIABLE: 17...PART BODY FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	1	.44	
01...ARM	11	4.82	4.85
02...BACK	16	7.02	7.05
03...CHEST	13	5.70	5.73
04...EYE	10	4.39	4.41
05...FINGER	29	12.72	12.78
06...FOOT	34	14.91	14.98
07...GENITAL	2	.88	.88
08...HAND	12	5.26	5.29
09...HEAD	14	6.14	6.17
10...LEG	33	14.47	14.54
11...NECK	5	2.19	2.20
12...SHOULDER	8	3.51	3.52
13...TOE	0	.00	.00
14...TRUNK	10	4.39	4.41
15...MULTIPLE	18	7.89	7.93
16...OTHER	12	5.26	5.29
TOTAL	228	99.99	100.03

VARIABLE: 18...HOW OCCURD FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	2	.88	
01...C'T IN	19	8.33	8.41
02...C'T BTWN	35	15.35	15.49
03...C'T UNDR	27	11.84	11.95
04...AGNST OB	41	17.98	18.14
05...FALL OBJ	8	3.51	3.54
06...FLY OBJ	4	1.75	1.77
07...SHARP OB	5	2.19	2.21
08...FOR OBJ	2	.88	.88
09...FALL SL	4	1.75	1.77
10...FALL DL	41	17.98	18.14
11...FALL UNK	1	.44	.44
12...ELEC CUR	0	.00	.00
13...FIRE/OBJ	4	1.75	1.77
14...HOT SUBS	1	.44	.44
15...CORROSIV	0	.00	.00
16...LIQUID	2	.88	.88
17...OVEREXRT	4	1.75	1.77
18...GAS/VAPR	0	.00	.00
19...MATR EXP	1	.44	.44
20...OTHER	27	11.84	11.95
TOTAL	228	99.98	99.99

VARIABLE: 19...WHERE TRTD FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	42	18.42	
01...CLINIC	6	2.63	3.23
02...DOCT OFF	71	31.14	38.17
03...HOME	10	4.39	5.38
04...HOSP ADM	28	12.28	15.05
05...HOSP EMR	57	25.00	30.65
06...NO TREAT	6	2.63	3.23
07...MULTIPLE	8	3.51	4.30
TOTAL	228	100.00	100.01

VARIABLE: 20...TEMPERATUR FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	45	19.74	
01...0/BELOW	3	1.32	1.64
02... 1-32	18	7.89	9.84
03...33-50	29	12.72	15.85
04...51-85	105	46.05	57.38
05...86-100	27	11.84	14.75
06...101/OVER	1	.44	.55
TOTAL	228	100.00	100.01

VARIABLE: 21...PRECIPITN FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	47	20.61	
01...CLEAR	152	66.67	83.98
02...FOG	3	1.32	1.66
03...ICE	3	1.32	1.66
04...RAIN	13	5.70	7.18
05...SNOW	3	1.32	1.66
06...THREATNG	6	2.63	3.31
07...OTHER	1	.44	.55
TOTAL	228	100.01	100.00

VARIABLE: 22...WIND FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	52	22.81	
01...CALM	100	43.86	56.82
02...BREEZE	67	29.39	38.07
03...10-25MPH	9	3.95	5.11
04...26-40MPH	0	.00	.00
05...OVER 40	0	.00	.00
TOTAL	228	100.01	100.00

VARIABLE: 23...GENRL LOC FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	4	1.75	
01...BARN	4	1.75	1.79
02...BARNYARD	42	18.42	18.75
03...DRIVEWAY	20	8.77	8.93
04...YRD/GRDN	6	2.63	2.68
05...FRM BLDG	26	11.40	11.61
06...FIELD	85	37.28	37.95
07...HIGHWAY	5	2.19	2.23
08...HOUSE	0	.00	.00
09...LAND	19	8.33	8.48
10...LAGOON	0	.00	.00
11...PND/STRM	1	.44	.45
12...PUB AREA	1	.44	.45
13...ROAD	4	1.75	1.79
14...OTHER	11	4.82	4.91
TOTAL	228	99.97	100.02

VARIABLE: 24...SURF COND FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	43	18.86	
01...DRY	130	57.02	70.27
02...ICY	8	3.51	4.32
03...MUDDY	9	3.95	4.86
04...STRAW &C	5	2.19	2.70
05...OTHER	8	3.51	4.32
06...OIL/GRSY	1	.44	.54
07...SNOW	6	2.63	3.24
08...WET	18	7.89	9.73
TOTAL	228	100.00	99.98

VARIABLE: 25...SURF TYPE FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	41	17.98	
01...ASPHALT	6	2.63	3.21
02...BRICK	0	.00	.00
03...CONCRETE	9	3.95	4.81
04...FLR COVR	0	.00	.00
05...METAL	6	2.63	3.21
06...SOIL	119	52.19	63.64
07...VEGETATN	34	14.91	18.18
08...WOOD	0	.00	.00
09...OTHER	13	5.70	6.95
TOTAL	228	99.99	100.00

VARIABLE: 26...LIGHT COND FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	43	18.86	
01...GD ARTFL	4	1.75	2.16
02...PR ARTFL	0	.00	.00
03...DAYLIGHT	166	72.81	89.73
04...DARK	2	.88	1.08
05...DWN/DSK	12	5.26	6.49
06...REDUCED	1	.44	.54
TOTAL	228	100.00	100.00

VARIABLE: 27...THING INV FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	3	1.32	
01...AGR MACH	10	4.39	4.44
02...ANIMAL	3	1.32	1.33
03...PERSON	1	.44	.44
04...CHEMICAL	0	.00	.00
05...ELCTRCTY	0	.00	.00
06...FIREARMS	0	.00	.00
07...GAS/VAPR	0	.00	.00
08...HND TOOL	1	.44	.44
09...HSHLD IT	0	.00	.00
10...PWR TOOL	0	.00	.00
11...SPORTS	0	.00	.00
12...TRACTOR	204	89.47	90.67
13...TRUCK	1	.44	.44
14...OTH VEH	3	1.32	1.33
15...NONE	2	.88	.89
16...GRDN EQP	0	.00	.00
TOTAL	228	100.02	99.98

VARIABLE: 28...EXPOSURE FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	43	18.86	
01...1/LESS	96	42.11	51.89
02...2-4 HRS	45	19.74	24.32
03...5-8 HRS	34	14.91	18.38
04...8/OVER	10	4.39	5.41
TOTAL	228	100.01	100.00

VARIABLE: 29...EXPERIENCE FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	44	19.30	
01...<1 DAY	67	29.39	36.41
02...1-7 DAYS	16	7.02	8.70
03...8-14	5	2.19	2.72
04...15-21	10	4.39	5.43
05...22-28	2	.88	1.09
06...29-91	19	8.33	10.33
07...92-181	7	3.07	3.80
08...182 OR >	58	25.44	31.52
TOTAL	228	100.01	100.00

VARIABLE: 30...PRIM.AG.OP FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	44	19.30	
01...BEEF	24	10.53	13.04
02...CORN	3	1.32	1.63
03...COTTON	3	1.32	1.63
04...GRAIN	22	9.65	11.96
05...RICE	3	1.32	1.63
06...SOYBEANS	1	.44	.54
07...SGR CANE	0	.00	.00
08...TOBACCO	1	.44	.54
09...BEEF/HOG	8	3.51	4.35
10...FRUIT	10	4.39	5.43
11...TRK CRPS	8	3.51	4.35
12...DAIRY	25	10.96	13.59
13...SEED CRP	4	1.75	2.17
14...OTHER	12	5.26	6.52
15...HOGS	4	1.75	2.17
16...POULTRY	2	.88	1.09
17...CORN/BF	10	4.39	5.43
18...CORN/HOG	6	2.63	3.26
19...CORN/SOY	15	6.58	8.15
20...DAIRY/HG	8	3.51	4.35
21...SHEEP	1	.44	.54
22...NUTS	1	.44	.54
23...CUT FLWR	0	.00	.00
24...FLD FLWR	0	.00	.00
25...NURSERY	1	.44	.54
26...PLANTS	0	.00	.00
27...FLD CROP	12	5.26	6.52
TOTAL	228	100.02	99.97

VARIABLE: 31...ACREAGE FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	39	17.11	
01... 1- 49	15	6.58	7.94
02... 50- 99	8	3.51	4.23
03...100-199	31	13.60	16.40
04...200-499	67	29.39	35.45
05...500-999	35	15.35	18.52
06...1000, >	23	10.09	12.17
07...UNKNOWN	10	4.39	5.29
TOTAL	228	100.02	100.00

VARIABLE: 32...HLTH BEFOR FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	105	46.05	
01...GOOD	119	52.19	96.75
02...MDS CARE	3	1.32	2.44
03...MEDICATN	0	.00	.00
04...ILL	0	.00	.00
05...MENTL HD	0	.00	.00
06...PHYSL HD	0	.00	.00
07...OTHER	0	.00	.00
08...UNKNOWN	1	.44	.81
TOTAL	228	100.00	100.00

VARIABLE: 33...DAYS LOST FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	105	46.05	
01...<1 DAY	26	11.40	21.14
02...1-7 DAYS	42	18.42	34.15
03...8-14	13	5.70	10.57
04...15-21	9	3.95	7.32
05...22-28	3	1.32	2.44
06...29-91	24	10.53	19.51
07...92-181	4	1.75	3.25
08...182 OR >	2	.88	1.63
TOTAL	228	100.00	100.01

VARIABLE: 34...HOSP DAYS FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	105	46.05	
01...<1 DAY	89	39.04	72.36
02...1-7 DAYS	22	9.65	17.89
03...8-14	6	2.63	4.88
04...15-21	3	1.32	2.44
05...22-28	2	.88	1.63
06...29 OR >	1	.44	.81
TOTAL	228	100.01	100.01

VARIABLE: 35...MEDIC COST FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	105	46.05	
01...< $10	21	9.21	17.07
02...$10-50	35	15.35	28.46
03...$51-100	24	10.53	19.51
04...$101-500	21	9.21	17.07
05...$501-1K	7	3.07	5.69
06...$1K-2500	11	4.82	8.94
07...$2500-5K	3	1.32	2.44
08...> $5000	1	.44	.81
TOTAL	228	100.00	99.99

VARIABLE: 36...PROP.DAMG. FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	105	46.05	
01...< $1	103	45.18	83.74
02...$1-100	8	3.51	6.50
03...$101-500	5	2.19	4.07
04...$501-1K	2	.88	1.63
05...> $1000	5	2.19	4.07
TOTAL	228	100.00	100.01

VARIABLE: 37...HELP DAYS FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	105	46.05	
01...<1 DAY	93	40.79	75.61
02...1-7 DAYS	11	4.82	8.94
03...8-14	4	1.75	3.25
04...15-21	2	.88	1.63
05...22-28	1	.44	.81
06...29-91	9	3.95	7.32
07...92-181	2	.88	1.63
08...182 OR >	1	.44	.81
TOTAL	228	100.00	100.00

VARIABLE: 38...HELP COST FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	105	46.05	
01...< $1	99	43.42	80.49
02...$1-100	9	3.95	7.32
03...$101-500	8	3.51	6.50
04...$501-1K	3	1.32	2.44
05...> $1000	4	1.75	3.25
TOTAL	228	100.00	100.00

VARIABLE: 39...HLTH AFTER FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	108	47.37	
01...GOOD	104	45.61	86.67
02...MENTL HD	1	.44	.83
03...PHYSL HD	8	3.51	6.67
04...OTHER	7	3.07	5.83
TOTAL	228	100.00	100.00

VARIABLE: 40...REHAB REQD FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	106	46.49	
01...YES	1	.44	.82
02...NO	44	19.30	36.07
03...UNKNOWN	77	33.77	63.11
TOTAL	228	100.00	100.00

VARIABLE: 41...BACK TO AG FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	106	46.49	
01...YES	29	12.72	23.77
02...NO/OTHER	5	2.19	4.10
03...NO/UNABL	0	.00	.00
04...UNKNOWN	88	38.60	72.13
TOTAL	228	100.00	100.00

VARIABLE: 42...F3 DATA FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	39	17.11	
01...F3 YES	123	53.95	65.08
02...F3 NO	66	28.95	34.92
TOTAL	228	100.01	100.00

VARIABLE: 43...REGION FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...REG 1	18	7.89	7.89
02...REG 2	19	8.33	8.33
03...REG 3	20	8.77	8.77
04...REG 4	8	3.51	3.51
05...REG 5	59	25.88	25.88
06...REG 6	36	15.79	15.79
07...REG 7	18	7.89	7.89
08...REG 8	32	14.04	14.04
09...REG 9	18	7.89	7.89
TOTAL	228	99.99	99.99

VARIABLE: 44...FUEL TYPE FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	15	6.58	
01...GAS	101	44.30	47.42
02...DIESEL	110	48.25	51.64
03...LP	2	.88	.94
TOTAL	228	100.01	100.00

VARIABLE: 45...TYPE FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	3	1.32	
01...TRCYCL	51	22.37	22.67
02...WD.ADJ	96	42.11	42.67
03...WD.STD	57	25.00	25.33
04...HI-CROP	3	1.32	1.33
05...CRAWLER	9	3.95	4.00
06...4WH.DR	9	3.95	4.00
TOTAL	228	100.02	100.00

VARIABLE: 46...AGE FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	3	1.32	
01...1 OR <	12	5.26	5.33
02...2 - 5	75	32.89	33.33
03...6 - 10	63	27.63	28.00
04...> 10	75	32.89	33.33
TOTAL	228	99.99	99.99

VARIABLE: 47...STANDARD FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	3	1.32	
01...YES	214	93.86	95.11
02...NO	7	3.07	3.11
03...UNKNOWN	4	1.75	1.78
TOTAL	228	100.00	100.00

VARIABLE: 48...ACC.TYPE FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	8	3.51	
01...COLL.SD.	4	1.75	1.82
02...COLL.HO.	3	1.32	1.36
03...COLL.RR.	4	1.75	1.82
04...EQ. FAIL	10	4.39	4.55
05...FALL	66	28.95	30.00
06...FIRE	4	1.75	1.82
07...OT.BCK.	4	1.75	1.82
08...OT.SD.	22	9.65	10.00
09...PTO	13	5.70	5.91
10...UNKNOWN	3	1.32	1.36
11...OTHER	87	38.16	39.55
TOTAL	228	100.00	100.01

VARIABLE: 49...SPACING FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	7	3.07	
01...NARROW	17	7.46	7.69
02...NORMAL	179	78.51	81.00
03...WIDE	25	10.96	11.31
TOTAL	228	100.00	100.00

VARIABLE: 50...USE FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	11	4.82	
01...FREEING	2	.88	.92
02...HRVSTING	23	10.09	10.60
03...HERDING	2	.88	.92
04...LOADING	18	7.89	8.29
05...PARKED	72	31.58	33.18
06...PLNTING	9	3.95	4.15
07...RUNAWAY	5	2.19	2.30
08...STNARY	11	4.82	5.07
09...STUCK	0	.00	.00
10...TRVLING	23	10.09	10.60
11...OTHER	50	21.93	23.04
12...UNKNOWN	2	.88	.92
TOTAL	228	100.00	99.99

VARIABLE: 51...ROLL FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	198	86.84	
01...90	9	3.95	30.00
02...180	11	4.82	36.67
03...270	3	1.32	10.00
04...360	4	1.75	13.33
05...> 360	3	1.32	10.00
TOTAL	228	100.00	100.00

VARIABLE: 52...SLOPE FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	81	35.53	
01...0 - 10	114	50.00	77.55
02...11 - 20	11	4.82	7.48
03...21 - 30	8	3.51	5.44
04...31 - 40	6	2.63	4.08
05...> 40	8	3.51	5.44
TOTAL	228	100.00	99.99

VARIABLE: 53...INIT.COND FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	14	6.14	
01...CROSS.SL	7	3.07	3.27
02...DMGED PT	1	.44	.47
03...BRAKES	4	1.75	1.87
04...DOWNHILL	6	2.63	2.80
05...UPHILL	3	1.32	1.40
06...NO GUARD	4	1.75	1.87
07...RMVD.GRD	7	3.07	3.27
08...STRCK.OB	8	3.51	3.74
09...HITCHED	0	.00	.00
10...HOLE	14	6.14	6.54
11...DITCH	4	1.75	1.87
12...SLIPPERY	29	12.72	13.55
13...OTHER	103	45.18	48.13
14...UNKNOWN	24	10.53	11.21
TOTAL	228	100.00	99.99

VARIABLE: 54...ACT FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	12	5.26	
01...DIS.RULE	1	.44	.46
02...TOO FAST	9	3.95	4.17
03...FLD. PTO	8	3.51	3.70
04...FLD.OFF	4	1.75	1.85
05...FLD.LOCK	8	3.51	3.70
06...FLD.EQ.	3	1.32	1.39
07...CLUTCH	4	1.75	1.85
08...ATTIRE	5	2.19	2.31
09...HRSPLAY	1	.44	.46
10...JUMPED	19	8.33	8.80
11...NO WTS.	2	.88	.93
12...BUCKET	6	2.63	2.78
13...RIDER	6	2.63	2.78
14...HITCHING	1	.44	.46
15...REACHING	14	6.14	6.48
16...SMOKING	0	.00	.00
17...TURNING	3	1.32	1.39
18...OVRLDING	1	.44	.46
19...OTHER	105	46.05	48.61
20...UNKNOWN	16	7.02	7.41
TOTAL	228	100.00	99.99

VARIABLE: 55...LOCATION FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	3	1.32	
01...BARN	11	4.82	4.89
02...BRIDGE	1	.44	.44
03...SHED	2	.88	.89
04...CORN/COT	9	3.95	4.00
05...DRVWAY	23	10.09	10.22
06...FEEDLOT	12	5.26	5.33
07...GRAIN	28	12.28	12.44
08...HAY	20	8.77	8.89
09...HIGHWAY	10	4.39	4.44
10...PASTURE	21	9.21	9.33
11...SHOP	28	12.28	12.44
12...WOODS	5	2.19	2.22
13...OTHER	53	23.25	23.56
14...UNKNOWN	2	.88	.89
TOTAL	228	100.01	99.98

VARIABLE: 56...CAB FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	31	13.60	13.60
02...NOT ON	195	85.53	85.53
TOTAL	228	99.13	99.13

VARIABLE: 57...CAB.W.OT FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	20	8.77	8.77
02...NOT ON	207	90.79	90.79
TOTAL	228	99.56	99.56

VARIABLE: 58...WHEELS FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	23	10.09	10.09
02...NOT ON	203	89.04	89.04
TOTAL	228	99.13	99.13

VARIABLE: 59...FENDERS FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	117	51.32	51.32
02...NOT ON	106	46.49	46.49
TOTAL	228	97.81	97.81

VARIABLE: 60...FLASH.LTS. FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	78	34.21	34.21
02...NOT ON	148	64.91	64.91
TOTAL	228	99.12	99.12

VARIABLE: 61...F.E.WTS. FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	51	22.37	22.37
02...NOT ON	172	75.44	75.44
TOTAL	228	97.81	97.81

VARIABLE: 62...F.W.DRV FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	17	7.46	7.46
02...NOT ON	211	92.54	92.54
TOTAL	228	100.00	100.00

VARIABLE: 63...F.W.WTS. FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	21	9.21	9.21
02...NOT ON	207	90.79	90.79
TOTAL	228	100.00	100.00

VARIABLE: 64...HDLTS. FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	144	63.16	63.16
02...NOT ON	79	34.65	34.65
TOTAL	228	97.81	97.81

VARIABLE: 65...BRAKES FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	67	29.39	29.39
02...NOT ON	157	68.86	68.86
TOTAL	228	98.25	98.25

VARIABLE: 66...STEERING FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	111	48.68	48.68
02...NOT ON	111	48.68	48.68
TOTAL	228	97.36	97.36

VARIABLE: 67...PTO FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	128	56.14	56.14
02...NOT ON	96	42.11	42.11
TOTAL	228	98.25	98.25

VARIABLE: 68...FRAME FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	14	6.14	6.14
02...NOT ON	214	93.86	93.86
TOTAL	228	100.00	100.00

VARIABLE: 69...RFLCTRS FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	87	38.16	38.16
02...NOT ON	139	60.96	60.96
TOTAL	228	99.12	99.12

VARIABLE: 70...R.V.MIRROR FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	35	15.35	15.35
02...NOT ON	191	83.77	83.77
TOTAL	228	99.12	99.12

VARIABLE: 71...R.W.WTS. FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	66	28.95	28.95
02...NOT ON	160	70.18	70.18
TOTAL	228	99.13	99.13

VARIABLE: 72...SWITCH FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	80	35.09	35.09
02...NOT ON	144	63.16	63.16
TOTAL	228	98.25	98.25

VARIABLE: 73...SMV FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	113	49.56	49.56
02...NOT ON	110	48.25	48.25
TOTAL	228	97.81	97.81

VARIABLE: 74...TL.LTS. FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	112	49.12	49.12
02...NOT ON	112	49.12	49.12
TOTAL	228	98.24	98.24

VARIABLE: 75...TIRES FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	102	44.74	44.74
02...NOT ON	123	53.95	53.95
TOTAL	228	98.69	98.69

VARIABLE: 76...SHIELD FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	0	.00	
01...ON	13	5.70	5.70
02...NOT ON	215	94.30	94.30
TOTAL	228	100.00	100.00

VARIABLE: 77...BELTS FILE: TRACWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	47	20.61	
01...ON	4	1.75	2.21
02...NOT ON	177	77.63	97.79
TOTAL	228	99.99	100.00