AGRICULTURAL MACHINERY-RELATED INJURIES: A 35-STATE SUMMARY

Alan F. Hoskin
Terrence A. Miller
William D. Hanford
Steven R. Landes

National Safety Council
444 North Michigan Avenue
Chicago, Illinois 60611

Prepared under
NIOSH Contract No. DSR-87-0943

May 6, 1988

Prepared for

U. S. Department of Health and Human Services
National Institute for Occupational Safety and Health
Division of Safety Research
Morgantown, West Virginia 26505

Acknowledgement

The authors wish to express appreciation to Ursula Zuehlke who handled all of the data processing; to Robert Marecek and Violeta Bernadas for their assistance in the literature search; to Mary Johnston and Ramona Redding who did all of the word processing; and to the researchers, state extension safety leaders, and volunteers who organized and conducted the surveys.

National Safety Council Disclaimer

Although the information and recommendations contained in this publication have been compiled from sources believed to be reliable, the National Safety Council makes no guarantee as to, and assumes no responsibility for, the correctness, sufficiency or completeness of such information or recommendations. Other or additional safety measures may be required under particular circumstances.

NIOSH DISCLAIMER

The contents of this report have been reviewed and approved by the NIOSH Project Officer as a final report, and are reproduced herein as received from the contractor. Approval does not signify that the opinions, findings, and conclusions expressed herein necessarily reflect the views and policies of the National Institute for Occupational Safety and Health. The mention of company names or products does not constitute an endorsement by the National Institute for Occupational Safety and Health.

NIOSH Project Officer: John R. Myers

Project Manager and Principal Investigator: Alan F. Hoskin

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

Introduction

Agricultural machinery is involved in all major aspects of crop production and handling and many aspects of livestock production. For crops, there are tillage tools, planting tools, pesticide, herbicide, and fertilizer application equipment, harvesting equipment and haying tools, and grain handling equipment. For livestock, there are feed handling equipment, animal handling equipment, and manure handling equipment. And there are numerous miscellaneous or general purpose machines such as ladders, skip loaders, fork lifts, and irrigation equipment. All of these machines, which greatly increase the labor productivity of farmers and ranchers, can present significant hazards to the people using them.

Perhaps because of its extensive involvement in the everyday chores and major, seasonal activities of farming, agricultural machinery has been identified often as the most common agency involved in farm work injuries. Studies of fatal and nonfatal injuries by the Pennsylvania Department of Public Instruction (1957), Gadalla (1962), Jensen (1972), Novack (1971), and Paterson, Novack, and Bertrand (1972) all identify machinery as the most frequent agency of accident. Several studies of fatal injuries have also ranked machinery, together with tractors, as the leading agencies of injuries (Fritsch, 1976; Fritsch & Zimmer, 1980; Wardle & Hull, 1975; Baker & Stuckey, 1973; and Kansas State Department of Health and Environment, Bureau of Registration and Health Statistics, 1978). Data from the 35 state farm surveys indicated that agricultural machinery was the leading agency of accident accounting for 17.6 per cent of the injuries, followed by animals with 16.9 per cent.

The analysis of agricultural machinery-related farm work injuries reported here was suggested by the frequent involvement of machines in farm work injuries and by their widespread use in farm and ranch work. The objectives of the analysis were to

identify the role of agricultural machines in injuries and to identify possible interventions that, if implemented, could reduce the frequency and 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 tractor-related work injuries similar to this report on machinery-related cases (Hoskin, Miller, Hanford, & Landes, 1988b).

Literature Review

Most comprehensive studies of farm accidents mention the role of farm machinery as an important agency of accident. The studies reviewed in this section include only those which have more detail on agricultural machinery 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).

Many studies reviewed in this section exclude tractors as a type of agricultural machine. Other studies include tractors when estimating aggregate deaths or injuries due to agricultural machines, or treat them as one of many agricultural machine types with estimates for each. The studies in this section do not include any dealing with tractors exclusively, since these were reviewed in a separate study (Hoskin, Miller, Hanford, & Landes, 1988b). The separate tractor study also included injuries associated with power takeoff (PTO) drive shafts since these are usually classified with tractor-related injuries rather than machinery-related.

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 agricultural machinery problem or propose countermeasures without reporting statistical data. The studies are grouped as follows: machinery fatality studies, those dealing with nonfatal injury as well as fatalities, those concerned with specific agricultural machines, and nonstatistical reviews of machinery safety and accident prevention.

Studies of Machinery-Related Fatalities

Studies on a national scale of fatalities involving agricultural machines are very limited in number. The National Center for Health Statistics publishes tabulations of all accidental deaths in the U.S. by type of accident and location of

accident, with farm as one of the location values. (Farm excludes farm home and home environs). Fritsch and Zimmer (1980) analyzed these data for the 1970 through 1976 period and found 377 machinery accidents (including tractors) on farm locations for the latest year, 1976. This was the most common agency of nontransport fatalities for farm locations. Age groups less than 35 years had fewer than expected machinery fatalities based on the distribution of all farm fatalities by age. Age groups of 35 years and over had greater than expected. Those 55 years and over accounted for almost half of the farm machinery fatalities.

Farm machinery fatalities (including tractors) based on National Center for Health Statistics data are also published by the National Safety Council (1987). The latest published figures show that of 989 nontransport fatalities on farms in 1984, 469 were machinery-related. This was the most common agency for all accidental fatalities. Unpublished data (National Center for Health Statistics, 1987) show 477 machinery-related nontransport fatalities on farms for 1985. It should be noted that these figures include deaths from all types of machinery--tractors, agricultural machinery and other nonagricultural machinery such as bulldozers, cranes, and power saws. Tabulations are understated because not all death certificates indicate place of accident.

The National Center for Health Statistics also tabulates a figure specifically for agricultural machinery deaths. This includes tractors but excludes transport deaths and other nonagricultural machinery deaths. It is not available by location, but rather includes farm and nonfarm locations. For 1985 (the latest year available), 693 such agricultural machinery deaths were tabulated.

Although these death figures in the U.S. are not distributed by type of machine, information from Canada has shown that only about 22 per cent of such deaths involve machines other than tractors (Donaldson, 1968). Of 598 farm machinery deaths tabulated from 1952 to 1966, 466 involved tractors. Combines and balers were

the next most common specified machines, with 17 deaths each. For nontractor fatalities, skull fracture was the most common nature of injury followed by crushed chest.

Fatality information is much more likely to be collected at the state level than nationally. State studies are based on deaths identified by farm safety personnel using death certificates or reports from police authorities, newspaper accounts, medical examiners, vital statistics authorities, witnesses or family members. Figures may be understated due to the possibility of machinery-related fatalities which are not identified and reported using these methods.

Of 241 farm fatalities in Wisconsin from 1965 through 1967, 41 nontractor machinery-related deaths were identified (Wisconsin Department of Health and Social Services, 1970). This was the second leading agency of fatalities after tractors. Corn pickers were the most common specified type of machine followed by wagons, balers, manure spreaders, hay mowers, and forage choppers. Almost half of the machinery fatalities occurred to those aged 45 years or older.

Fatalities in Iowa from 1947 to 1971 were analyzed by Wardle and Hull (1975). Of 457 nontractor machinery-related fatalities on farms during those years, the most common machine was wagon or trailer, associated with about one fourth of the cases. Next highest were elevator or auger (11 per cent), corn picker (8 per cent), electrical equipment (8 per cent), baler (6 per cent), grinder or mixer (5 per cent), tractor loader or blade (4 per cent), combine (4 per cent) and forage harvester (3 per cent). Almost 90 per cent of the machinery fatalities occurred on the farm; the remainder occurred on roads, highways or other locations. In about 20 per cent of the cases, the victim was less than 10 years of age. The researchers estimated that while the number of corn pickers in use in Iowa has dropped about 12 per cent from 1947 to 1971, the number of combines has almost tripled and the number of pickup balers has almost quadrupled.

Researchers in Kansas reported that of 211 fatalities in agricultural accidents during the 5-year period from 1976 through 1980, 11 involved combines (Jepsen, 1981). Over half the accidents occurred in the header area, with most victims being crushed when the header fell on them. Researchers in Nebraska identified 7 fatalities involved with haying during the period 1975 through 1978, with 4 fatalities resulting from victims caught up in balers, and 3 resulting from tractors moving large round bales (Schnieder, 1983). The author identified only 4 fatalities from corn pickers for the ten years 1973 through 1982.

Of 253 farm fatalities in Pennsylvania from 1980 through 1984, 34 were machinery-related (Murphy, 1985). This was the second leading agency of accident after tractors. The most common operations for machinery fatalities were forage harvesting, manure handling, grain combining and hay baling. Only about 8 per cent of the fatalities occurred to those 65 years of age and older.

Studies of Fatal and Nonfatal Machinery-Related Accidents

Nonfatal injury information about machinery-related accidents is more difficult to gather than information about deaths. It usually involves collecting information from medical treatment facilities, workers' compensation authorities (for hired labor), or surveying farmers themselves. The data collection effort can be national in scope, or localized to one state or even one treatment facility.

Rivara (1985) used information collected from a sample of hospital emergency rooms in the U.S. by the Consumer Product Safety Commission to study farm injuries nationwide to children and adolescents. For farm equipment-related injuries to persons aged 0 to 19 years, the most common machinery involved was tractors (26 per cent of the total), followed by wagons (14 per cent), combines (11 per cent), tillage equipment (8 per cent), forklifts (7 per cent), silo unloaders (4 per cent), elevators (4 per cent) and tow chains (4 per cent). By severity of injury, the author found that

silo unloaders produced especially severe injuries, with hospitalization or death occurring in about 12 per cent of silo unloader cases compared to 2 per cent for all equipment types combined.

Using information from 3 hospitals in Saskatoon, Saskatchewan, Simpson (1984) identified 42 farm machinery-related hospitalized injuries in 1980. The most common machine type was tractor and PTO (43 per cent of the total), followed by auger (17 per cent), combine (9 per cent), and baler (7 per cent). The most common injury types were fractures and crushing injuries. Of the nontractor cases, only 1 resulted in amputation.

Cogbill and Busch (1985) collected information on 375 patients at one hospital in Wisconsin who were admitted for treatment of agricultural injuries. After tractor- and animal-related injuries the most common types were auger (9 per cent of the total), corn picker (6 per cent), and other farm machinery (13 per cent). For corn picker accidents, the most common scenario involved an attempt to unjam the rolls of the machine by removing stalks without first turning off the machine. About 58 per cent of the corn picker accident patients were left with serious permanent disabilities, the highest proportion of any agency of accident.

Workers' compensation information from California in 1976 showed that of 14,709 injury and illness claims by agricultural workers, 1,140 (8 per cent) involved machines other than tractors (California Department of Industrial Relations, 1978). Machines were the fifth leading agency of accident after working surfaces, vehicles (including tractors), hand tools, and containers. By specific machine type, those involved most often in injuries were harvesters (including combines, pickers, and viners), mowers, plows (including harrow and tillage equipment), presses, spray rigs, and grinders. Of 6 fatalities reported, 3 involved hay stackers or loaders, 2 with combines, and 1 with a front-end loader.

The most common accident types for machinery injuries in the data base were struck by or against an object and caught in or

between an object, each accounting for about 35 per cent of the total. Strains or overexertions represented about 17 per cent of the cases.

The remainder of the studies dealing with nonfatal farm machinery injuries report the analysis of data gathered from surveys of farmers. A sample of Michigan farmers was surveyed during a one-year period in 1969 and 1970, and information was gathered on 280 work and nonwork injuries (Hofmeister & Pfister, 1968; Pfister & Hofmeister, 1969). Of the 144 farm work injuries, 40 (28 per cent) involved farm machinery other than tractors. Farm machinery was the agency most often involved in farm work injuries. Specific machine types most often named as agencies of injury were wagons (9 cases), balers (5 cases), combines and elevators (each with 4 cases), and corn pickers (3 cases).

Information from 4 surveys of Ohio farmers between 1957 and 1972 was reported by Stuckey and Pugh (1973). Farm machinery (excluding tractors) represented about 16 per cent of the cases for the first survey in 1957, but dropped to between 9 and 11 per cent for the later three surveys. For all four surveys of work and nonwork injuries, farm machinery was one of the four leading agencies of accident along with motor vehicles, tools and animals. For the latest survey reported (1972), farm machinery was the second leading agency after motor vehicles. Specific machines most often cited were wagons, corn pickers, elevators, and balers.

Schafer and Kotrlik (1986) surveyed farm operators in one parish in Louisiana about various practices including farm machinery usage. Although all farmers reported using tractors, the other major equipment most commonly used was hay equipment (used by about 57 per cent of farmers surveyed), planter or drill (44 per cent), wagons (38 per cent), combine or picker (27 per cent), and feed equipment (10 per cent). About 79 per cent of the farmers reported that all or most of their combines and other equipment had seat belts, and about 35 per cent said their combines were equipped with fire extinguishers. About 90 per cent reported

that they always or usually turned off their combine while refueling, although almost 60 per cent said they occasionally rode combines with more than one rider.

A special class of surveys are those which collect information on hours of exposure to the farm machine as well as injuries involving it. Using this information, accident rates based on hours of exposure for specific farm machines can be compared with each other, with rates for tractors, or with rates for farm or industrial work in general. Gadalla (1962) surveyed farmers in Missouri during 1959 and 1960, who were asked to keep a log of several items including the number of hours major items of farm machinery were in use. The study found that corn pickers had the highest accident rate, 208.4 accidents per million work hours, followed by combines (185.2), hay balers (106.5), and harvesters (82.7). All these rates were significantly higher than the rate for tractors (47.6). Seasonal variation in injuries was observed which closely matched patterns of use.

Farm machinery usage of Michigan and Ohio farmers was studied in a 1971 survey (Doss & Pfister, 1972, 1974). Over 95 million hours of farm machinery use (excluding tractors) for the two states was projected from survey data. Of the major types of agricultural machines, wagons were the most commonly used, with about 15 per cent of the total farm machinery hours. Corn pickers, balers, and combines each had about 5 per cent of the total.

Rates of accidents per million hours of exposure were much higher for farm machinery than for farm work in general. Farm machinery accident rates for all machines combined were calculated as 40.9 per million work hours in Michigan and 40.1 per million work hours in Ohio, both about twice the rate for all farm work established by an earlier Michigan survey (Hofmeister & Pfister, 1968). In contrast, rates for tractors were much lower than the overall rate for farm work. By specific machine type, rates in Michigan were as follows: elevators (573.6), combines (112.0), balers (106.4), wagons (71.9), and corn pickers (48.6). In Ohio,

the following rates were calculated: elevators (981.5), combines (90.1), corn pickers (62.3), and wagons (51.0). In both states, elevators had by far the highest rates, followed by combines. There was insufficient data to calculate a rate for balers in Ohio.

Nonfatal farm machinery injury information on a multi-state scale was summarized in reports of the National Safety Council farm accident survey data pooled from participating state surveys. General descriptive data on farm machinery accidents, and detailed analysis of wagon, elevator, and combine 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 farm machinery (excluding tractors) was the leading agency of accident, involved in about 15 per cent of the cases. Wagons were the machine type most often involved followed by elevators or augers, and combines.

For wagon injuries, about 44 per cent resulted from falls and about 20 per cent resulted from being caught in or between objects. Fractures resulted in about 25 per cent of the wagon-related cases. For elevator or auger injuries, the most common accident types were caught in or between objects (47 per cent), and struck by or against object (20 per cent). Cuts and bruises were the most common injury type for elevators or augers, followed by amputations. Fingers were involved in over 40 per cent of the cases. Cuts, bruises, and amputations were also the most common injury types for combine-related accidents.

Information from the detailed farm machinery 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 report summarized data from 31 states, of which 29 provided detailed bi-level reports on agricultural machinery injuries. It was reported that farm machinery (excluding tractors) was the second leading agency of farm injuries after animals, and accounted for about 16 per cent of the cases on file. Of the farm machinery

cases, harvesting equipment and haying tools together accounted for about 39 per cent of the injuries, and grain, feed, and fruit handling equipment represented about 16 per cent of the total. For harvesting equipment, the most common specific machines associated with injury were combines with grain head, combines with corn head, and corn pickers. For haying tools, the predominant types were balers, forage harvesters, and mowers. Auger elevators and chain elevators were the most common grain, feed and fruit handling machines associated with injuries.

Field work was involved in 39 per cent of the farm machinery injuries while machinery maintenance accounted for 30 per cent. Prior to the accident, the victim was operating the machine in 20 per cent of the cases, repairing or installing (17 per cent), adjusting (15 per cent), cleaning or lubricating (11 per cent) and hitching up (5 per cent). The most common contributing factors were reaching over, under, or into machine (18 per cent), loss of balance (13 per cent), and unsafe position or posture (12 per cent). Extra riders were a factor in less than one per cent of the cases. Approximately one half of the farm machinery involved in accidents was less than 5 years old.

Specific Farm Machinery Types

A study of over 4,000 persons injured in corn harvest accidents in Iowa over a 16-year period from 1947 through 1962 showed that over two thirds of the injuries involved corn pickers (Wardle, 1963). The researchers found that corn harvest injuries were especially severe, with amputations being the most common type, accounting for about 47 per cent of the cases. Most often involved were fingers, hands, and arms.

By type of corn picker, mounted pickers accounted for about two thirds of the cases, and pull-type pickers about 30 per cent. Accident rates of corn picker injuries per 1,000 pickers in use decreased over 75 per cent during the 15-year period 1948 to 1962, from 4.73 to 0.94. Despite the common belief that snapping rolls

were the most hazardous part of the machine, the researchers found that husking rolls and stalk ejector rolls were both associated with more injuries. Belts, pulleys, gears, and chains were also found to be involved in an increasing number of accidents.

Regarding contributing factors, unsafe methods by the operator were cited in about two thirds of the injuries, and operator haste in about one third. Fatigue was noted as a factor in only about 5 per cent of the cases.

Nachlas and Schlenker (1981) described medical treatment of three corn picker accident patients with crushed or amputated fingers, hands, and arms, and noted a decline in corn picker accidents in Illinois from 300 per year in the 1950s to less than 20 per year in the late 1960s. The researchers attributed this decline to three factors--changes in the corn plant itself to a smaller, more easily harvested plant; safety education programs; and increased use of the corn combine, a more powerful machine with less susceptibility to clogs.

A study of 51 patients injured by corn pickers and treated at Mayo Clinic found that only 40 per cent received medical treatment within 1 hour of injury, with amount of time caught in the machine averaging 27 minutes (Campbell, Bryan, Cooney, & Ilstrup, 1979). About 65 per cent of farmers required help extricating themselves from the machines.

Virtually all the patients injured parts of hands or arms when attempting to clear stalks from a clogged machine. Fractures occurred in 60 per cent of the cases, and amputation at time of injury occurred in 36 per cent. Length of hospitalization averaged 19 days, and average length of disability was 135 days. Almost 90 per cent of the patients experienced some permanent impairment of hand function.

Carelessness of the operator was cited as a cause of the accident by 58 per cent of patients. In only one case did a patient cite inexperience as a contributing factor. Corn pickers in this study averaged 10 years in age.

Injuries involving hay balers have been the subject of several studies. Hardin (1967) discussed medical treatment of two patients injured by standard square bale machines. Both patients had arms caught in the intake mechanism and required forequarter amputation. Gainor (1983) discussed medical treatment of three patients injured by the newer technology round baling machines. All three patients had arms caught in the intake rollers or bale-forming belts. Two patients were adjusting the twine-feeding apparatus and the third was inspecting the machine. All three patients suffered a combination of crushing and burn injuries with amputations either at the time of accident or eventually as part of treatment.

Baker, Fletcher, and Zeglen (1977) discussed the history of new round baling technology and its safety implications. Information on 14 accidents involving round bales or balers was collected and separated into machinery-related (5 cases) and bale handling (9 cases). Bale handling cases were of three types--bales rolling down hills causing property damage, raising bale too high on front-end loader with bale rolling upon operator, and overturn of tractor while transporting bale. Machinery-related cases most often involved an attempt to clear a plugged machine. All machinery-related injuries were serious, involving death or amputation of one or both arms.

McCarthy, Robinson, and Brand (1985) attempted to quantify the safety impact of round bale technology by calculating and comparing injury rates for three hay baling technologies. Numbers of fatalities for the various types were collected using information from the Consumer Product Safety Commission, cross-checked with other sources. Numbers of injuries were estimated using the Consumer Product Safety Commission's survey of hospital emergency rooms. Rates were based on the amount of hay baled for each technology, estimated by two methods.

The researchers found that the proportion of hay baled by large round bale technology increased over the survey period (1976 to 1980) so that by the end of the period usage of large round and

square bale technologies were approximately equal. Only a small portion was baled using stacker-type balers, the third technology investigated. Rates demonstrated a marked safety advantage of large round balers over other technologies.

Elevator and auger accidents were the subject of a study which collected information on 100 fatality and injury cases involving such equipment from 9 states (McFarland & Fletcher, 1969; Fletcher, 1969, 1982). Injuries were quite severe, with fatalities in 18 cases and amputations in an additional 26 cases. By age, two thirds of the victims were between 30 and 70 years, and 20 per cent were less than 20 years of age. Augers were involved in 15 cases.

Lacerations, amputations and fractures accounted for 75 per cent of the injuries, with the most commonly injured parts of body being fingers (30 per cent), legs (16 per cent), and hands and feet (10 per cent each). The most common activities at time of accident were picking up spilled ear corn, unloading corn from wagon into elevator hopper, and trying to start auger or elevator.

The authors also formulated operating procedures and equipment changes or additions which would have prevented a significant portion of the elevator and auger injuries encountered. Among the operating procedures were keeping clear of PTO shafts, adjusting belt tensions, keeping children away from the work area, and not using hands to unplug machines. Among the equipment modifications were provision of fully shielded or guarded PTO shaft, tumbling rod, V-belt, pulley, driver chain and auger intake.

Grain auger injuries involving 24 patients treated at one medical facility were the subject of researchers in Illinois (Beatty, Zook, Russell, & Kinkead, 1982). All the injuries involved soft-tissue crushing and compound fractures, with 19 injuries to the upper extremities and 5 to lower extremities. Many of the injuries were at multiple levels because of the spiral arrangement of auger blades. Many amputated fingers, hands, and arms were successfully reattached.

Thirteen of the 24 patients were involved in a reaching activity when the accident occurred. About 50 per cent admitted that protective devices had been removed or altered, although the true incidence of removal or tampering may be as high as 95 per cent based on observations by the authors. Almost 50 per cent of the patients suffered significant permanent disability. It was estimated that use of grain augers has tripled since large combines began to be used to harvest corn instead of corn pickers. While this has reduced corn picker injuries, the authors noted a marked increase in grain auger injuries.

Grain auger injuries were also studied by researchers in Canada (Small & Dennis, 1975). Of 198 such injuries requiring hospitalization over a 2 1/2 year period in Saskatchewan, about 6 per cent involved children under 10 years of age. Teens and those aged 40 to 59 years were most commonly injured. For all persons injured, fractures and lacerations each accounted for more than 30 per cent of the total and 22 per cent were amputations. About 20 per cent involved the lower extremity; the remainder were primarily upper extremity or head injuries.

Accidents involving the intake mechanism of the auger accounted for the greatest number of cases, about 40 per cent of the total. The next most common portions of the machine associated with injury were the V-belt (16 per cent), winch (10 per cent), and drive shaft (9 per cent). The intake accidents resulted from such actions as the operator tripping, sliding into the intake without realizing it, or stepping into an intake covered with grain. The authors determined that virtually all these injuries would have been avoided had a suitable guard been present.

Moving grain from a bin was the most common task at time of injury and accounted for more than twice as many injuries as moving grain to the bin. Time of hospitalization for all injuries averaged 7 days, and average time to resumption of normal work activities was 53 days.

Because of the physical dimensions of elevators and augers, the problem of electrocution due to contact with overhead power lines has been studied by researchers. Fletcher (1974) found that of 66 electrocution cases identified as involving farm equipment, elevators and augers were by far the leading type representing about 45 per cent of the cases. Youths less than 20 years of age were victims in over 60 percent of the farm electrocutions identified by the study.

Machinery Safety and Accident Prevention

Many publications have discussed accident countermeasures aimed at making agricultural machines safer by design, urging users to follow safer practices, or adjusting environmental conditions to maximize safety. Hanford (1985) stressed that farm machinery accidents can be avoided through the use of properly installed shields and guards. Operators should replace these when they are damaged or removed for maintenance. When purchasing used equipment, any missing shields should also be replaced.

The author also felt that training of operators should be emphasized since young and inexperienced workers are especially vulnerable to machinery accidents. Personal protective equipment such as hard hats, gloves, safety glasses, ear plugs, safety shoes, and respirators when appropriate should be used by all operators.

The practice of always shutting off power before adjusting, lubricating, unclogging, clearing, refueling, or servicing a machine has been stressed by other authors (Canada Safety Council, undated; Manitoba Workplace Safety and Health Division, undated). After turning off power, the authors stated the importance of waiting until all moving parts (flywheels, belts, etc.) have stopped before working around the machine. Any hydraulically raised parts should be blocked before working on or under them. When the machine is running, the authors stressed keeping persons and tools clear of moving parts, wearing close fitting clothing not likely to be snagged, never stepping over belts or PTOs, watching

for slippery conditions around moving parts, and never pulling hay, corn, or other material from intake mechanisms.

Other articles ("Safe hay harvest," 1967) have suggested that equipment be run only as intended and stated in the owner's manual. Machinery should be kept in good repair, with replacement of belts and cables when appropriate. Children should be kept away from machinery and extra riders should be forbidden on all types of machines. Watching field conditions for bumps and holes, adjusting speed to conditions, availability of fire extinguishers, and use of slow-moving vehicle emblems when on roads were also suggested.

Several authors have discussed the importance of correct extrication procedures and medical treatment at the scene of the accident. Murphy, Grottenthaler, Lindstrom, and Rapp (1980) suggested that basic life support, if necessary, and first aid for serious bleeding are immediate concerns to a rescuer. When these are accomplished, help should be summoned with specific directions to the scene. Victims should be moved only when there is a probability of fire or other life-threatening hazard, since movement may aggravate bleeding or injury. The author suggested that at least one person on every farm should be trained in cardio-pulmonary resuscitation techniques.

Due to the variation in types of injuries from one farm machine to another, extrication procedures may also vary (National Safety Council Farm Department, 1981). For balers, in addition to open wounds caused by getting caught up in the baler mechanism, there are also burns associated with moving belts. Suffocation and fires may also be problems with this machine. For combines, falling headers present a major problem along with reaching or falling into the combine. Many injuries occur when farmers run fingers or hands through the belts. For augers and elevators, injuries are associated with electrocution from contact with power lines, toppling due to wind or uneven ground, or being caught in the power drive or flighting. For this machine, stoppage of bleeding and shock are important first aid considerations.

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 machinery 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 Farm Machinery (F5) bi-level (Figure 3) was used to identify the specific type of machine including its power source, mounting or hitching requirements, age, condition, and safety features; the specific part of the machine that was the source of injury; how and where the machine was being used and what the injured person was doing; and any unsafe act that may have contributed to the accident. Thirty-two states used the form and

727 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 were 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 state-wide summary report of the survey results. Some states included an analysis of the machinery 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 machinery-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 F5 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 machinery bi-level form.

The matching process resulted in the loss of some otherwise usable F2/F3 and F5 bi-level records when one half of the pair could not be found. The work injury file contained 721 machinery-related injuries and there were 727 machinery (F5) bi-levels, but the matched file contained only 555 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 necessarily construct scenarios which are most common, only those which occur with a statistically greater than expected frequency.

Table 1 shows a treesearch on the activity variable for combines with grain heads. About 15 maintenance-related injuries, with a range of 7 to 23, would have been expected based on the distribution of all machinery injuries. Injuries during machinery maintenance occurred more frequently than expected and were also the most frequent in absolute numbers, though the most frequent occurrences do not always show up as HI's in a treesearch. The researcher may then examine another variable, such as unsafe act or use of the machine, using the two criteria combine with grain head and machinery maintenance. 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.

A 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 in the 1970's and 1980's. New equipment models and new methods introduced over that time may have influenced the injury patterns. In particular, because the make and model of machinery were not recorded, it was not possible to associate injury patterns with particular machines. 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

DATE EDITED _____
(Office use)

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

DATE EDITED_____
(Office use)

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

DATE EDITED_____
(Office use)

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

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.

DATE EDITED_____
(Office use)

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 ☐ 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

DATE EDITED_____
(Office use)

FIGURE 3

SUPPLEMENTAL ACCIDENT REPORT FORM

Form No. NSC-F5(Rev.) 1-2

FARM MACHINERY

ACCIDENT REPORT IDENTIFICATION NUMBER

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

Machine Identification:

Make _____

Model _____

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. Check type of farm machinery involved in accident:

11,1 ☐ Chemical, Fertilizer
2 ☐ Grain & Feed Handling
3 ☐ Haying Tools
4 ☐ Harvesting Equipment
5 ☐ Manure Handling
6 ☐ Seed planting
7 ☐ Tillage tools
8 ☐ Miscellaneous, specify_____
9 ☐ Unknown

2. Check the farm machine that was involved in the accident:

2-A. Chemical, Fertilizer

12,1 ☐ Duster
2 ☐ Distributor, spreader
3 ☐ Sprayer
4 ☐ Airplane
5 ☐ Other, specify_____

2-B. Grain, Feed & Fruit Handling

13-14,01 ☐ Blower--forage, grain
02 ☐ Bunk feeder
03 ☐ Conveyor, auger
04 ☐ Conveyor, belt
05 ☐ Conveyor, chain
06 ☐ Corn sheller
07 ☐ Dryer, grain
08 ☐ Elevator, auger
09 ☐ Elevator, chain
10 ☐ Feed grinder
11 ☐ Feed grinder-mixer

2-B Grain, etc. Handling (con't.)

13-14,12 ☐ Feed Mixer/blender
13 ☐ Silo unloader
14 ☐ Other, specify_____

2-C. Haying Tools

15-16,01 ☐ Baler, hay
02 ☐ Forage harvester
03 ☐ Hay conditioner
04 ☐ Mower, sickle bar
05 ☐ Mower, sickle bar w/conditioner
06 ☐ Mower, rotary
07 ☐ Rake, hay
08 ☐ Hay cuber
09 ☐ Windrower
10 ☐ Other, specify_____
11 ☐ Round baler, hay

2-D. Harvesting Equipment

17-18,01 ☐ Combine w/corn head
02 ☐ Combine w/grain head
03 ☐ Corn picker
04 ☐ Corn picker-sheller
05 ☐ Cotton picker
06 ☐ Cotton stripper
07 ☐ Sugarbeet harvester
08 ☐ Fruit harvester
09 ☐ Vegetable harvester
10 ☐ Threshing machine
11 ☐ Other, specify_____

Sheet 1 of 4

DATE EDITED_____ (Office use)

FIGURE 3
(continued)

NSC-F5(Rev.)

2-E. Manure Handling

19,1 ☐ Barn cleaner
2 ☐ Gutter cleaner
3 ☐ Liquid manure pump
4 ☐ Manure loader, tractor
5 ☐ Manure spreader
6 ☐ Manure spreader, tank
7 ☐ Other, specify_____

2-F. Seed Planting

20,1 ☐ Broadcaster
2 ☐ Grain drill
3 ☐ Planter--cotton, corn, etc.
4 ☐ Other, specify_____

2-G. Tillage Tools

21,1 ☐ Cultivator
2 ☐ Disc harrow
3 ☐ Plow, disc
4 ☐ Plow, moldboard
5 ☐ Rotary tiller
6 ☐ Other, specify_____
7 ☐ Plow, chisel
8 ☐ Spring tooth harrow

2-H. Miscellaneous Equipment

22-23,01 ☐ Engine, power unit
02 ☐ Implement carrier
03 ☐ Irrigation equipment
04 ☐ Ladders
05 ☐ Skiploaders
06 ☐ Forklifts
07 ☐ Truck
08 ☐ Pruning equipment
09 ☐ Pump jack
10 ☐ Stalk shredder
11 ☐ Wagon(w/grain box) *
12 ☐ Wagon(w/flat bed) *
13 ☐ Wagon, self-unloading*
14 ☐ Other, specify_____

*If item with * is checked, complete Supplemental Form, NSC-F11, also.

2-I. Animal Handling Equipment

24,1 ☐ Squeeze Chutes
2 ☐ Branding
3 ☐ Shears
4 ☐ Other, specify_____

3. Approximate age of machine:

25,1 ☐ One year or less
2 ☐ 2 to 5 years
3 ☐ 6 to 10 years
4 ☐ Over 10 years
5 ☐ Unknown

4. Machine mounting or hitching:

26,1 ☐ Does not apply
2 ☐ Integral
3 ☐ Mounted, front
4 ☐ Mounted, rear
5 ☐ Self-propelled
6 ☐ Semi-mounted
7 ☐ Towed
8 ☐ Other, specify_____

5. Use of machine at time of accident:

27,1 ☐ Harvesting
2 ☐ In-transit
3 ☐ Loading
4 ☐ Planting
5 ☐ Spreading
6 ☐ Stopped, not running
7 ☐ Stopped, but running
8 ☐ Tillage
9 ☐ Other, specify_____

6. Equipment powered by(Check one):

28,1 ☐ Does not apply
2 ☐ Electric motor
3 ☐ Engine, gas, diesel, LP
4 ☐ Ground drive
5 ☐ Hand
6 ☐ Hydraulic
7 ☐ PTO
8 ☐ Other, specify_____

DATE EDITED_____
(Office use)

Sheet 2 of 4

FIGURE 3
(continued)

NSC-F5(Rev.)

7. Portion of machine causing injury:

29-30,01 ☐ Auger
02 ☐ Bale ejector
03 ☐ Cable or linkage
04 ☐ Chain & sproket
05 ☐ Control devices(pedals, levers, etc)
06 ☐ Cutterhead
07 ☐ Feeding mechanism
08 ☐ Gears
09 ☐ Hammers
10 ☐ Hitch or drawbar
11 ☐ Hydraulic fluid
12 ☐ Hydraulic hose
13 ☐ Knife blade
14 ☐ Knotter mechanism
15 ☐ Lifting mechanism
16 ☐ PTO shaft and/or knuckles
17 ☐ Plungerhead
18 ☐ Rolls, snapping, husking, crusher
19 ☐ Rotating shaft, except PTO
20 ☐ Spindles
21 ☐ Tire or wheel
22 ☐ V-belt & Pulley
23 ☐ Other, specify_____
24 ☐ None

8. Condition at time of accident:

31-32,01 ☐ Damaged guard
02 ☐ Equipment failure
03 ☐ Good condition
04 ☐ Grease, oil present
05 ☐ Guard not provided
06 ☐ Guard removed
07 ☐ Improper hitch
08 ☐ Leaking or spilled fuel
09 ☐ No brakes
10 ☐ Poor brakes
11 ☐ Other, specify_____

9. Safety features in place at time of accident:

33 ☐ Flag
34 ☐ Lights
35 ☐ SMV emblem
36 ☐ Reflectors
37 ☐ Other, specify_____

10. Activity of injured person prior to accident:

38-39,01 ☐ Adjusting
02 ☐ Bystander
03 ☐ Cleaning
04 ☐ Feeding material
05 ☐ Filling seed boxes, etc.
06 ☐ Lubricating
07 ☐ Operating
08 ☐ Refueling
09 ☐ Repairing, installing equip.
10 ☐ Riding
11 ☐ Other, specify_____
12 ☐ Hitching-up
13 ☐ Unknown

11. Act permitting the accidental injury:

40-41,01 ☐ Distracted
02 ☐ Failure to use protective equipment(guards, shields)
03 ☐ Horseplay
04 ☐ Improper use of equipment
05 ☐ Inattentive
06 ☐ Jumped
07 ☐ Lost balance
08 ☐ Permitted extra rider(s)
09 ☐ Reaching(over, under, into)
10 ☐ Too fast for conditions
11 ☐ Unsafe position or posture
12 ☐ Other, specify_____
_____
13 ☐ Unknown

DATE EDITED_____
(Office use)

Sheet 3 of 4

FIGURE 3
(continued)

NSC-F5(Rev.)

12. Specific scene of accident:

42-43 30 1 ☐ Barn
02 ☐ Bridge
03 ☐ Cattle shed
04 ☐ Corn or cotton field
05 ☐ Driveway, lane
06 ☐ Feedlot
07 ☐ Grain field
08 ☐ Granary or feed storage
09 ☐ Greenhouse
10 ☐ Hay field
11 ☐ Hog house
12 ☐ Highway
13 ☐ Machine shed
14 ☐ Orchard
15 ☐ Pasture
16 ☐ Poultry house
17 ☐ Shop
18 ☐ Silo
19 ☐ Woods
20 ☐ Other, specify_____
21 ☐ Unknown

Sheet 4 of 4

DATE EDITED _____
(Office use)

TABLE 1
TREESEARCH ON ACTIVITY FOR
COMBINE WITH GRAIN HEAD

ACTIVITY	ALL MACHINERY INJURIES	COMBINE WITH GRAIN HEAD INJURIES				
		Expected (x)	-2S.D. ($x-2\sqrt{x}$)	+2S.D. ($x+2\sqrt{x}$)	Observed	Sig.
Building maintenance	6	0.5	-0.9	2.0	0	
Field work	205	18.3	9.7	26.9	20	
House work	0	0.0	0.0	0.0	0	
Machinery maintenance	168	15.0	7.2	22.7	28	HI
Recreation	1	0.1	-0.5	0.7	0	
Routine chores	67	6.0	1.1	10.9	0	LO
Treating livestock	5	0.4	-0.9	1.8	0	
Yard work	6	0.5	-0.9	2.0	0	
Other	91	8.1	2.4	13.8	1	LO
Total	549				49	

Note: Six cases were not classified by activity.

Results

The bi-level reporting system utilized in the farm surveys permitted the creation of a separate file of detailed farm machinery 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 555 machinery-related work injury cases. This represents information from 32 states and approximately 14 per cent of the original 4,105 work injury cases in the farm survey file. (3 states from the entire farm survey file did not use machinery bi-level forms). Frequency and per cent distributions for all variables in the machinery-related work injury file are included in the Appendix.

Of the 555 cases in the farm machinery work injury file, about 78 per cent were family members (Table 2). Family and hired males made up over 92 per cent of the injury cases, with family males accounting for about 72 per cent of all injuries. Female family members were involved in 6 per cent, and female hired workers in 1 per cent.

The distribution of injuries by age revealed that about two thirds of the injured persons were aged 25 to 64 years and about 24 per cent were 15 to 24 years. The 5 to 14 year age group accounted for 5 per cent of the injuries, and persons 65 years and older were involved in 5 per cent of the cases. For family members, those aged 25 to 64 years accounted for 72 per cent of the cases for that group. Persons aged 15 to 44 years, however, made up 82 per cent of the hired worker injuries. Family members of both sexes in the 5 to 14 year age group experienced a higher percentage of injuries than did their hired counterparts.

The distribution of injuries by type of agricultural operation and size of farm is shown in Table 3. Grain farms experienced the greatest percentage of machinery-related injuries of all operations (nearly 31 per cent of the total). The "other" category, which

included a large variety of operations, accounted for the next highest portion with 27 per cent. Dairy, beef, and fruit farms had 25 per cent, 12 per cent, and 5 per cent of the total, respectively.

Farms of 200 to 499 acres in size accounted for about 41 per cent of all machinery injuries; more than twice the number of cases of any other acreage group. Operations of 500 to 999 acres had about 20 per cent, and farms of 1,000 acres and more had about 18 per cent of the cases. Within each of the agricultural operation categories, the 200 to 499 acre group accounted for the largest number of injuries.

Table 4 lists the distribution of injuries by nature of injury and part of body. Cuts were the most common injury type, representing about 35 per cent of all injuries. Fractures and bruises followed with 14 per cent and 13 per cent, respectively. Fingers were the most common part of body injured (26 per cent of the total). Injuries to the hand accounted for about 14 per cent and leg injuries another 12 per cent.

Fingers were the most common part of body injured for amputations, cuts, and fractures. More than 70 per cent of the amputations were to fingers. Hands ranked second for both amputations and cuts. Legs were involved in about 20 per cent of bruise injuries and 18 per cent of sprains. Foot injuries accounted for about 22 per cent of sprains, 20 per cent of fractures and 18 per cent of bruises. Back injuries represented more than 42 per cent of the sprains, and head injuries accounted for 13 per cent of cuts.

Activity at the time of accident was examined in relationship to age (Table 5). Field work accounted for about 37 per cent of all injuries, followed by machinery maintenance with 30 per cent. Chores and other activities accounted for the remaining one third of the cases.

Field work was the most common activity at time of injury for all age groups except those 45 to 64. For those aged 45 to 64,

field work and machinery maintenance both had about 35 per cent of the injuries. In the 5 to 14 year age group, machinery maintenance accounted for a much smaller percentage than that for all ages, and chores accounted for a much larger percentage.

Table 6 shows the distribution of injuries by type of machine and use of machine at time of accident. Harvesting equipment accounted for the greatest percentage of all machine types with 24 per cent of all injuries. Grain and feed handling equipment and haying tools followed with about 15 per cent and 12 per cent, respectively. For machine use, the stopped (not running) category accounted for the greatest number of cases, 31 per cent of the total. The stopped (running) category was next highest with 17 per cent, and harvesting accounted for 15 per cent. Combining the two stopped categories, stopped machines were involved in almost half the cases.

By type of machine, stopped (not running) accounted for the greatest percentages of injuries for chemical and fertilizer equipment, haying tools, manure handling, and tillage tools. Stopped (running) was associated with the greatest number of grain and feed handling machine injuries.

General machine type was further examined as it related to the type of accident (Table 7). For all machine types combined, caught in object was the most common accident type accounting for about 21 per cent of all injuries. Caught between objects was the next most frequent accident type (20 per cent), followed by struck by or against object (12 per cent). For grain and feed handling equipment, haying tools, and harvesting equipment, the most common accident type was also caught in object. For the remaining machine types, caught between objects generally accounted for the greatest number of injuries for the category.

For haying tools, contact with sharp object accounted for twice the number of injuries as expected from the distribution for all machine types. Similarly falls from different level were overrepresented for manure handling equipment.

Sixteen specific types of machines, representing 48 per cent of all machinery-related injuries, were evaluated in terms of several variables. Table 8 shows one such distribution of injuries by specific machine type and severity. Combines with grain head were associated with almost 9 per cent of the cases in the machinery work injury file, more than twice that for any other specific machine. Next highest were baler (4 per cent), auger elevator (4 per cent), hay harvester (3 per cent), and combine with corn head (3 per cent).

For all machine types, about 26 per cent of the injuries were slight, 67 per cent were severe and 5 per cent were permanent. Another 0.5 per cent were reported as fatal and about 2 per cent were of unknown severity. In total, farm machinery work activities accounted for 3 fatalities, one of which was attributed to a hay baler. About 31 per cent of corn picker injuries were permanent, as were 18 per cent of hay harvester injuries. More than three fourths of the injuries for the following categories were reported as severe: baler, auger elevator, combine with corn head, cultivator, seed planter, grain unloader, and manure loader.

Specific machine types were similarly evaluated by activity at time of accident (Table 9). Field work was the leading activity for most categories of machines. The exceptions included grain grinders and mixers, for which chores accounted for the greatest number of injuries, and grain unloaders and seed drills, for which machinery maintenance was the most common activity at time of injury. Although most combine with corn head accidents occurred during field work, about 57 per cent of accidents involving combines with grain heads occurred during maintenance.

Table 10 lists the number of injury cases by specific machine type and portion of machine involved. The hitch or drawbar was involved in the greatest number of injuries for all machine types combined. Chain and sprocket assemblies were the next most numerous specified group, and augers ranked third highest. For combines with grain heads, v-belts, pulleys and cutterheads

accounted for the greatest number of specified injuries. The greatest number of corn picker injuries were related to the rolls, and many of the self-unloading wagon related injuries were associated with PTOs. For balers, the most common portion was the bale ejector and for hay harvesters, the feed mechanism. A number of the flat-bed wagon injuries were identified under the "none" category, suggesting fall-related causes.

The distribution of injuries by portion of machine and severity is shown in Table 11. About 18 per cent of the permanent injuries were attributed to chain and sprocket assemblies, while another 14 per cent were associated with rollers. Rolls also accounted for one of the reported fatalities. The greatest number of severe injuries involved the hitch or drawbar, followed by augers, chain and sprocket assemblies, and "none." None and hitch or drawbar accounted for the greatest number of the identified slight injuries.

Portion of machine was further evaluated in terms of part of body injured (Table 12). Augers accounted for about 12 per cent of arm injuries and tires or wheels were involved in 10 per cent. The hitch or drawbar was associated with about 21 per cent of foot injuries, 12 per cent of back injuries, and 12 per cent of finger injuries. Chain and sprocket assemblies accounted for nearly 13 per cent of hand injuries and 12 per cent of finger injuries. V-belts and pulleys were associated with another 13 per cent of hand injuries. The greatest number of injuries (42 per cent) were attributed to other specified and unspecified portions of the machine.

Many different variables were examined as they related to the farm machine itself. For example, the age of the machine was reported to be 5 years or less in about 47 per cent of the incidents. Machines 6 to 10 years old were involved in another 25 per cent of the cases, while those older than 10 years were associated with 15 per cent.

The number of days experience with the farm machine prior to the accident was also evaluated. An operator with less than 1 day of experience was involved in 33 per cent of the injury cases. Those with 1 to 7 days experience were involved in 11 per cent, while 8 to 181 days experience was associated with 27 per cent of the cases. Individuals with more than 6 months of experience were involved in 29 per cent of the accidents.

Exposure refers to the amount of time spent with the farm machine on the day of the accident. Exposure of one hour or less was reported in about 52 per cent of the injury cases, 30 per cent occurred after 2 to 4 hours, and 14 per cent followed 5 to 8 hours of exposure. Over 8 hours of exposure was associated with nearly 5 per cent of the farm machine injuries.

Environmental conditions did not appear to play an important role in the occurrence of farm machinery-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 54 per cent of the specified cases. Only about 5 per cent occurred at temperatures below freezing, and slightly more than 20 per cent occurred at temperatures greater than 85^{0}F. The weather was described as clear in more than 90 per cent of the cases, and rainy conditions were reported in less than 4 per cent of the accidents.

Wind was also not an important factor, as only 8 per cent of the cases reported winds in excess of 9 mph. Light conditions were described as "daylight" in 88 per cent of the cases and as dawn or dusk in another 3 per cent.

Survey data were also available in slightly over half the cases regarding the consequences of farm machinery 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 28 per cent of the specified cases, while 69 per cent required more than one contact. The remaining 3 per cent

of the injury cases required no treatment or were treated at home. About 41 per cent of all injuries were treated at a doctor's office, while 36 per cent were treated in hospital emergency rooms. The injured person was admitted to the hospital in about 9 per cent of the incidents.

Most injuries, 74 per cent of the total, involved seven or fewer lost workdays. About 10 per cent of the injuries resulted in lost time lasting one to three months. Of the cases classified, 4 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 86 per cent of the specified cases, there was no expenditure for replacement labor. Likewise, there were no property damage costs associated with approximately 93 per cent of the cases. Medical costs were reported at less than $500 for about 88 per cent of all classified cases, but greater than $1,000 in about 8 per cent of the injury incidents.

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

AGE	FAMILY MEMBERS		HIRED HELP		ALL PERSONS
	Male	Female	Male	Female	
5-14	5.1	11.4	0.9	0.0	4.7
15-24	17.3	20.0	44.3	57.1	23.6
25-44	36.5	37.2	36.3	42.9	36.6
45-64	35.8	31.4	15.0	0.0	30.4
65+	5.3	0.0	3.5	0.0	4.7
Total	100.0%	100.0%	100.0%	100.0%	100.0%
All Ages	71.7	6.4	20.6	1.3	100.0%

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

ACREAGE	AGRICULTURAL OPERATION					ALL FARMS
	Beef	Dairy	Grain	Fruit	Other	
1-49	4.5	2.9	0.0	14.3	6.7	3.8
50-99	8.9	0.7	5.8	10.7	3.4	4.3
100-199	20.9	23.0	10.5	10.7	6.0	13.5
200-499	28.4	54.0	37.8	35.7	38.9	40.9
500-999	20.9	14.4	23.2	28.6	17.5	19.7
1,000+	16.4	5.0	22.7	0.0	27.5	17.8
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
All Injuries	11.7	25.1	30.8	5.0	27.4	100.0%

TABLE 4

MACHINERY-RELATED WORK INJURIES

BY NATURE OF INJURY AND PART OF BODY

PART OF BODY	NATURE OF INJURY							ALL INJURIES
	Amputation	Bruise	Fracture	Cut	Sprain	Multiple	Other	
Arm	0.0	8.5	13.2	8.2	6.7	2.9	4.6	7.4
Back	0.0	9.8	0.0	1.0	42.2	2.9	4.6	6.1
Chest	0.0	4.2	10.5	0.0	0.0	0.0	0.9	2.0
Eye	0.0	2.8	1.3	0.0	0.0	0.0	17.4	4.0
Finger	72.0	8.5	22.4	35.9	0.0	17.7	25.7	26.1
Foot	4.0	18.3	19.7	3.1	22.2	5.9	5.5	9.6
Hand	12.0	8.5	6.6	23.1	0.0	8.8	11.9	13.5
Head	0.0	8.5	1.3	12.8	0.0	2.9	4.6	6.8
Leg	8.0	19.7	10.5	10.3	17.7	11.8	11.0	12.3
Shoulder	0.0	4.2	4.0	0.0	4.5	0.0	0.0	1.4
Multiple	4.0	4.2	1.3	1.5	2.2	41.2	4.6	5.0
Other	0.0	2.8	9.2	4.1	4.5	5.9	9.2	5.8
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
All Injuries	4.5	12.8	13.7	35.2	8.1	6.1	19.6	100.0%

TABLE 5
MACHINERY-RELATED WORK INJURIES
BY AGE AND ACTIVITY

ACTIVITY	AGE					ALL AGES
	5-14	15-24	25-44	45-64	65+	
Field work	44.0	34.1	38.8	34.9	44.0	36.9
Machinery maintenance	12.0	27.9	30.9	34.9	24.0	30.3
Chores	24.0	16.3	10.4	10.7	4.0	12.1
Other	20.0	21.7	19.9	19.5	28.0	20.7
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
All Activities	4.7	23.6	36.6	30.4	4.7	100.0%

TABLE 6

MACHINERY-RELATED WORK INJURIES

BY GENERAL MACHINE TYPE AND USE AT TIME OF ACCIDENT

USE OF MACHINE	GENERAL MACHINE TYPE								ALL MACHINE TYPES
	Chemical, Fertilizer	Grain, Feed Handling	Haying Tools	Harvesting Equipment	Manure Handling	Seed Planting	Tillage Tools	Misc., Other	
Harvesting	0.0	3.7	19.4	43.5	0.0	0.0	0.0	6.4	14.8
In transit	14.3	2.4	3.0	0.0	0.0	3.4	3.8	3.5	2.7
Loading	19.0	19.5	3.0	2.3	9.7	6.9	0.0	9.2	7.8
Planting	4.8	1.2	0.0	0.0	0.0	34.5	0.0	1.4	2.5
Stopped, not running	38.1	17.1	35.8	28.2	48.4	24.1	50.9	29.1	31.2
Stopped, running	0.0	32.9	22.4	16.8	22.6	0.0	5.7	14.9	17.1
Tillage	0.0	0.0	1.5	0.0	0.0	0.0	22.6	0.7	2.5
Other	23.8	23.2	14.9	9.2	19.3	31.1	17.0	34.8	21.4
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
All Uses	3.8	14.8	12.1	23.6	5.6	5.2	9.5	25.4	100.0%

TABLE 7
MACHINERY-RELATED WORK INJURIES BY
GENERAL MACHINE TYPE AND TYPE OF ACCIDENT

TYPE OF ACCIDENT	GENERAL MACHINE TYPE								ALL MACHINE TYPES
	Chemical, Fertilizer	Grain, Feed Handling	Haying Tools	Harvesting Equipment	Manure Handling	Seed Planting	Tillage Tools	Misc., Other	
Caught in object	14.3	46.3	23.9	27.5	12.9	10.4	5.7	11.4	21.4
Caught between objects	9.5	15.9	20.9	18.3	25.8	31.1	18.9	21.3	19.8
Struck by or against object	14.3	7.3	10.4	14.5	9.7	10.4	7.5	16.3	12.3
Fall, different level	4.8	3.7	3.0	9.9	12.9	6.9	3.8	11.4	7.8
Fall, same level	4.8	0.0	1.5	1.5	0.0	0.0	3.8	0.7	1.3
Contact with sharp object	0.0	4.9	14.9	9.2	6.5	3.4	9.4	5.0	7.4
Caught under object	4.8	8.5	3.0	3.8	9.7	3.4	17.0	8.5	7.2
Struck by falling object	9.5	4.9	7.4	2.3	9.7	10.4	13.2	7.1	6.7
Struck by flying object	4.8	0.0	3.0	3.1	3.2	3.4	3.8	3.5	2.9
Overexertion	0.0	0.0	3.0	2.3	3.2	3.4	7.5	2.1	2.5
Foreign object	0.0	2.4	3.0	1.5	3.2	3.4	1.9	2.1	2.2
Other	33.2	6.1	6.0	6.1	3.2	13.8	7.5	10.6	8.5
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
All Injuries	3.8	14.8	12.1	23.6	5.6	5.2	9.5	25.4	100.0%

TABLE 8
MACHINERY-RELATED WORK INJURIES
BY SPECIFIC MACHINE TYPE AND SEVERITY

SPECIFIC MACHINE TYPE	SEVERITY						ALL INJURIES
	Slight	Severe	Permanent	Fatal	Unknown	Total	
Combine with grain head	28.6	67.4	2.0	0.0	2.0	100.0%	8.8
Baler	13.7	77.3	4.5	4.5	0.0	100.0%	4.0
Elevator, auger	15.0	80.0	5.0	0.0	0.0	100.0%	3.6
Hay harvester	17.6	64.8	17.6	0.0	0.0	100.0%	3.1
Combine with corn head	0.0	93.8	6.2	0.0	0.0	100.0%	2.9
Harrow	43.8	56.2	0.0	0.0	0.0	100.0%	2.9
Cultivator	20.0	80.0	0.0	0.0	0.0	100.0%	2.7
Seed planter	0.0	85.8	7.1	0.0	7.1	100.0%	2.5
Wagon, flat bed	38.5	61.5	0.0	0.0	0.0	100.0%	2.3
Grain grinder, mixer	23.1	69.2	7.7	0.0	0.0	100.0%	2.3
Grain unloader	23.1	76.9	0.0	0.0	0.0	100.0%	2.3
Corn picker	30.8	38.4	30.8	0.0	0.0	100.0%	2.3
Irrigation equipment	38.5	61.5	0.0	0.0	0.0	100.0%	2.3
Seed drill	36.4	63.6	0.0	0.0	0.0	100.0%	2.0
Wagon, self-unloading	27.3	72.7	0.0	0.0	0.0	100.0%	2.0
Manure loader	20.0	80.0	0.0	0.0	0.0	100.0%	1.8
Other, unknown	28.0	63.7	5.2	0.7	2.4	100.0%	52.2
All Machine Types	25.8	67.0	5.1	0.5	1.6	100.0%	100.0%

TABLE 9
MACHINERY-RELATED WORK INJURIES
BY SPECIFIC MACHINE TYPE AND ACTIVITY

SPECIFIC MACHINE TYPE	ACTIVITY					ALL ACTIVITIES
	Field Work	Machinery Maintenance	Chores	Other	Total	
Combine with grain head	40.8	57.1	0.0	2.1	100.0%	8.8
Baler	68.2	31.8	0.0	0.0	100.0%	4.0
Elevator, auger	20.0	5.0	15.0	60.0	100.0%	3.6
Hay harvester	41.2	41.2	17.6	0.0	100.0%	3.1
Combine with corn head	56.3	37.5	0.0	6.2	100.0%	2.9
Harrow	62.5	31.3	0.0	6.2	100.0%	2.9
Cultivator	33.3	33.3	0.0	33.4	100.0%	2.7
Seed planter	50.0	14.3	7.1	28.6	100.0%	2.5
Wagon, flat bed	61.5	7.7	0.0	30.8	100.0%	2.3
Grain grinder, mixer	0.0	15.4	69.2	15.4	100.0%	2.3
Grain unloader	7.7	53.8	38.5	0.0	100.0%	2.3
Corn picker	53.8	46.2	0.0	0.0	100.0%	2.3
Irrigation equipment	61.5	30.8	0.0	7.7	100.0%	2.3
Seed drill	36.4	54.5	0.0	9.1	100.0%	2.0
Wagon, self-unloading	45.5	18.2	9.1	27.2	100.0%	2.0
Manure loader	20.0	10.0	20.0	50.0	100.0%	1.8
Other, unknown	32.2	27.0	14.8	26.0	100.0%	52.2
All Machine Types	36.9	30.3	12.1	20.7	100.0%	100.0%

TABLE 10

NUMBER OF MACHINERY-RELATED INJURIES BY

SPECIFIC MACHINE TYPE AND PORTION OF MACHINE

SPECIFIC MACHINE TYPE	PORTION OF MACHINE																
	Auger	Bale Ejector	Chain, Sprocket	Control Devices	Cutterhead	Feed Mechanism	Gears	Hitch, Drawbar	Knife Blade	Lifting Mechanism	PTO Shaft, Knuckles	Rolls, Snapping, Husking	Tire, Wheel	V-belt, Pulley	None	Other	TOTAL
Combine with grain head	3	0	2	0	4	2	1	0	1	0	0	1	0	6	3	26	49
Baler	0	7	1	0	0	1	0	0	1	1	0	0	0	0	1	10	22
Elevator, auger	11	0	1	0	0	1	1	0	0	0	1	0	0	2	0	3	20
Hay harvester	1	0	3	0	2	4	1	1	2	2	0	0	0	0	1	0	17
Combine with corn head	1	0	2	0	0	0	0	0	0	0	0	2	1	1	2	7	16
Harrow	0	0	0	0	0	0	0	2	0	0	0	0	2	0	2	10	16
Cultivator	0	0	0	0	0	0	0	6	0	2	0	0	0	0	1	6	15
Seed planter	0	0	1	0	0	0	0	4	0	2	0	0	0	0	0	7	14
Wagon, flat bed	0	0	0	0	0	0	0	2	0	0	1	0	3	0	5	2	13
Grain grinder, mixer	3	0	0	0	0	0	1	2	0	2	0	0	1	2	0	2	13
Grain unloader	2	0	1	0	0	1	0	0	0	0	0	0	0	1	0	8	13
Corn picker	0	0	0	0	0	0	0	0	1	0	0	5	0	1	0	6	13
Irrigation equipment	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	11	13
Seed drill	0	0	0	0	0	1	0	2	0	1	0	0	1	0	0	6	11
Wagon, self-unloading	0	0	1	0	0	1	1	2	0	0	4	0	1	0	0	1	11
Manure loader	0	0	0	1	0	0	0	2	0	1	0	0	1	0	3	2	10
Other, unknown	11	1	23	9	4	6	4	26	11	8	12	2	8	9	29	126	289
All Machine Types	32	8	35	10	10	17	9	49	16	19	18	10	19	22	48	233	555

TABLE 11
MACHINERY-RELATED INJURIES BY
SEVERITY AND PORTION OF MACHINE

PORTION OF MACHINE	SEVERITY					ALL INJURIES
	Slight	Severe	Permanent	Fatal	Unknown	
Auger	1.4	7.5	7.1	0.0	0.0	5.8
Bale ejector	1.4	1.6	0.0	0.0	0.0	1.4
Chain, sprocket	2.1	7.3	17.8	0.0	0.0	6.3
Control devices	2.8	1.4	0.0	0.0	11.1	1.8
Cutterhead	2.8	1.4	3.6	0.0	0.0	1.8
Feed mechanism	4.2	2.4	3.6	0.0	11.1	3.1
Gears	2.8	0.8	7.1	0.0	0.0	1.6
Hitch, drawbar	8.4	9.9	0.0	0.0	0.0	8.8
Knife, blade	0.7	3.2	7.1	0.0	11.1	2.9
Lifting mechanism	2.1	4.0	3.6	0.0	0.0	3.4
PTO shaft, knuckles	1.4	3.5	10.7	0.0	0.0	3.2
Rolls, (snapping, husking)	0.7	1.1	14.3	33.3	0.0	1.8
Tire, wheel	4.9	3.0	3.6	0.0	0.0	3.4
V-belt, pulley	3.5	4.3	3.6	0.0	0.0	4.0
None	14.7	6.7	3.6	0.0	11.1	8.6
Other, unknown	46.1	41.9	14.3	66.7	55.6	42.1
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
All Injuries	25.8	67.0	5.1	0.5	1.6	100.0%

TABLE 12
MACHINERY-RELATED INJURIES
BY PART OF BODY AND PORTION OF MACHINE

PORTION OF MACHINE	PART OF BODY										ALL INJURIES
	Arm	Back	Eye	Finger	Foot	Hand	Head	Leg	Multiple	Other	
Auger	12.2	0.0	0.0	9.7	7.5	5.3	0.0	4.4	3.6	2.0	5.8
Bale ejector	2.4	2.9	0.0	1.4	0.0	2.7	0.0	1.5	0.0	2.0	1.4
Chain, sprocket	2.4	2.9	0.0	11.7	0.0	13.3	0.0	2.9	3.6	5.8	6.3
Control devices	0.0	2.9	4.6	0.7	0.0	2.7	2.6	4.4	3.6	0.0	1.8
Cutterhead	0.0	5.9	0.0	3.4	0.0	2.7	0.0	1.5	0.0	0.0	1.8
Feed mechanism	4.9	0.0	0.0	2.1	5.7	4.0	5.3	4.4	0.0	2.0	3.1
Gears	0.0	2.9	4.6	2.8	0.0	1.3	2.6	1.5	0.0	0.0	1.6
Hitch, drawbar	2.4	11.8	0.0	11.7	20.7	6.7	0.0	8.8	7.1	5.8	8.8
Knife, blade	0.0	2.9	9.0	4.8	0.0	5.3	2.6	0.0	3.6	0.0	2.9
Lifting mechanism	0.0	8.8	0.0	4.1	5.7	1.3	7.9	1.5	3.6	2.0	3.4
PTO shaft, knuckles	4.9	5.9	0.0	3.4	3.8	0.0	0.0	10.3	0.0	0.0	3.2
Rolls (snapping, husking)	0.0	0.0	0.0	2.8	0.0	4.0	2.6	1.5	0.0	2.0	1.8
Tire, wheel	9.8	5.9	0.0	0.0	5.7	2.7	0.0	5.9	3.6	5.8	3.4
V-belt, pulley	4.9	0.0	0.0	4.8	3.8	13.3	0.0	0.0	3.6	0.0	4.0
None	4.9	2.9	40.9	4.1	9.4	1.3	13.2	7.3	10.7	21.6	8.6
Other	51.2	44.3	40.9	32.5	37.7	33.4	63.2	44.1	57.0	51.0	42.1
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
All Portions	7.4	6.1	4.0	26.1	9.6	13.5	6.9	12.3	5.0	9.1	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.

I. Caught In Object (119)

A. Resulting in amputation, cut, or mangle to finger or hand (59)

1. Involving grain/feed handling equipment, haying tools, or harvesting equipment (50) with no dominant activity.
2. While feeding, adjusting, or operating (31) with no dominant machine type.

II. Caught Between Objects (110)

A. Resulting in fracture, cut or mangle to finger or hand (46)

1. While repairing, adjusting, operating, hitching, or cleaning (33) with no dominant machine type.
2. involving harvesting equipment, misc. equipment, or grain/feed handling equipment (31) with no dominant activity.

III. Struck By or Against Object (68)

A. Resulting in bruise or cut to leg (11) with no dominant pattern of activity or machine type.

B. Resulting in cut to head (8) with no dominant pattern of activity or machine type.

IV. Fall, Different Level (43)

A. Involving harvesting equipment (13) with no dominant pattern of nature of injury, part of body, or activity.

B. Involving misc. equipment (9) with no dominant pattern of nature of injury, part of body, or activity.

V. Contact with Sharp Object (41)

A. Resulting in cut to arm, finger, or hand (20)

1. Involving harvesting equipment (11) with no dominant activity.

2. While cleaning or repairing (10) with no dominant machine type.

VI. Caught Under Object (40)

A. Resulting in bruise or cut or fracture to foot (10) involving tillage tools or misc. equipment (7) with no dominant activity.

VII. Struck by Falling Object (37)

A. Resulting in bruise, cut or fracture to head (9) while operating (5) with no dominant machine type.

VIII. Struck by Flying Object (16)

A. While operating or adjusting (11) with no dominant pattern of nature of injury, part of body, or machine type.

IX. Overexertion (14)

A. While hitching (3) with no dominant pattern of nature of injury, part of body, or machine type.

X. Foreign Object (12)

A. With no dominant pattern of nature of injury, part of body, activity, or machine type.

Additional scenarios were generated for each of the most common specific types of machine. The scenario descriptions follow the same format as those above, but additional information about the use of the machine, unsafe acts, and the machine part involved is also given in some cases.

MACHINE TYPE (n)

I. Type of Accident (n)

A. Resulting in [nature of injury] to the [part of body] while performing [specific activity](n). Injuries involved [use (n)]; [unsafe act (n)]; and [machine part (n)].

COMBINE WITH GRAIN HEAD (49)

I. Struck By or Against, Falling or Flying Object, Sharp Object (18)

A. Resulting in cut to finger or hand (10) while repairing or cleaning (7). Injuries involved the cutterhead (2), v-belt (2), auger (1), sprocket chain (1), none (1), or other parts (3).

B. Resulting in bruise to head or shoulder (4) while operating (2).

II. Caught In or Between Objects (14)

A. Resulting in amputation, bruise, fracture, cut or mangle to arm, finger, or hand (11)

1. while adjusting (3).
2. while operating (3).
3. while repairing (3).
4. while cleaning (2).

--Scenarios 1, 2, and 4 occurred while harvesting (5) or stopped but running (3). All involved v-belt (4), sprocket chain (1), gears (1), rolls (1), or other parts (4).

III. Falls, Same or Different Levels (11).

A. Resulting in cut, sprain, bruise, or fracture to arm, back, leg, hand, or head (11).

IV. Overexertion (3)

A. No dominant pattern.

BALER (22)

I. Caught In or Between Objects (11)

A. Resulting in cut or mangle to arm, finger, or hand (8) while adjusting (5). Injuries involved reaching over, under, or into (4); harvesting (3) or stopped but running (1); and the ejector (3) or knotter (2).

II. Struck Against, Falling Object, or Sharp Object (8)

A. No dominant patterns.

ELEVATOR, AUGER (20)

I. Caught In, Between, or Under Objects (16)

A. Resulting in amputation, fracture, or cut to arm, finger, or hand (8)

1. While feeding (3) or operating (2). Injuries involved reaching over, under, or into (2) and the auger (4).
2. While adjusting (2). Injuries involved the cable link (1) or sprocket chain (1).

HAY HARVESTER (17)

I. Caught In or Between Objects (12)

A. Resulting in amputation, cut, mangle, pinched, or puncture to finger or hand (10). Injuries involved harvesting or stopped but running (7) and the sprocket chain (3) or feeding mechanism (3).

II. Struck Against or Sharp Object (4)

A. Resulting in cut to arm or hand (3) while adjusting, cleaning, or repairing. Injuries involved the cutter head, feeding mechanism, or blade.

COMBINE WITH CORN HEAD (16)

I. Caught In or Between Objects (9)

A. Resulting in amputation, cut, fracture, or pinched to arm, finger, or hand (8). Injuries involved harvesting (5) or stopped but running (3); reaching over, under, or into (4); and the sprocket chain (2), v-belt, auger, or rolls.

HARROW (16)

I. Struck Against, Falling Object, or Sharp Object (6)

A. Resulting in bruise, cut, or puncture to leg or arm.

II. Caught Between or Under Objects (5)

A. Resulting in cut, bruise or pinch to arm, finger, hand, leg, or foot (5).

III. Fall, Same or Different Level (4)

A. Resulting in bruise, fracture, or sprain to arm, back, chest, or foot.

CULTIVATOR (15)

I. Caught In, Between, or Under Objects (11)

A. Resulting in bruise, cut, or pinch to finger or hand (5). Injuries involved stopped not running (5), and the hitch or lifting mechanism (3).

B. Resulting in fracture to foot (3) while hitching (3). Injuries involved the hitch (2) or lifting mechanism

(1).

SEED PLANTER (14)

I. Caught In or Between Objects (6)
   A. Resulting in amputation or cut to finger (3).
   B. Resulting in cut or pinch to foot (3).

II. Struck Against Object (3)
   A. No dominant pattern.

WAGON, FLAT BED (13)

I. Caught Between or Under Objects (6)
   A. Resulting in bruise, mangle, pinch, or fracture to leg, foot, or toe (4).

II. Fall, Different or Unknown Level (3)
   A. Resulting in fracture to arm or shoulder (2).

GRINDER/MIXER (13)

I. Caught In, Between, or Under Objects (9)
   A. Resulting in amputation, bruise, fracture, cut, or mangle to finger (7) while adjusting, feeding, operating, or repairing (6). Injuries involved stopped, but running (5) or loading (2); reaching over, under, or into (3); and the auger (3), v-belt (2), gears, or hammers.

UNLOADER (13)

I. Caught In, Between, or Under Objects (6)
   A. Resulting in cut to finger or hand (4).

II. Struck Against or Falling Object (5)

A. Resulting in cut to hand, head, or leg (4).

CORN PICKER (13)

I. Caught In, Between, or Under Objects (9)

A. Resulting in amputation or cut to finger or hand (9). Injuries involved stopped, running (6) or harvesting (2); improper use (3) or reaching over, under or into (2); and the rolls (5).

II. Struck Against, Flying Object, or Sharp Object (4)

A. No dominant pattern.

IRRIGATION EQUIPMENT (13)

I. Struck Against, Falling or Flying Object, Sharp Object (5)

A. No dominant pattern.

II. Caught In or Between Objects (4)

A. Resulting in fracture or cut to finger (4) while operating (2) or repairing (2).

SEED DRILL (11)

I. Caught Between Objects (4)

A. Resulting in cut to finger (2).

II. Falling Object, Flying Object, Sharp Object (3)

A. No dominant pattern.

WAGON, SELF-UNLOADING (11)

I. Caught In or Between Objects (7)

A. Resulting in fracture, pinch, or puncture to finger (3).

MANURE LOADER (10)

I. Fall, Different or Unknown Level (5)

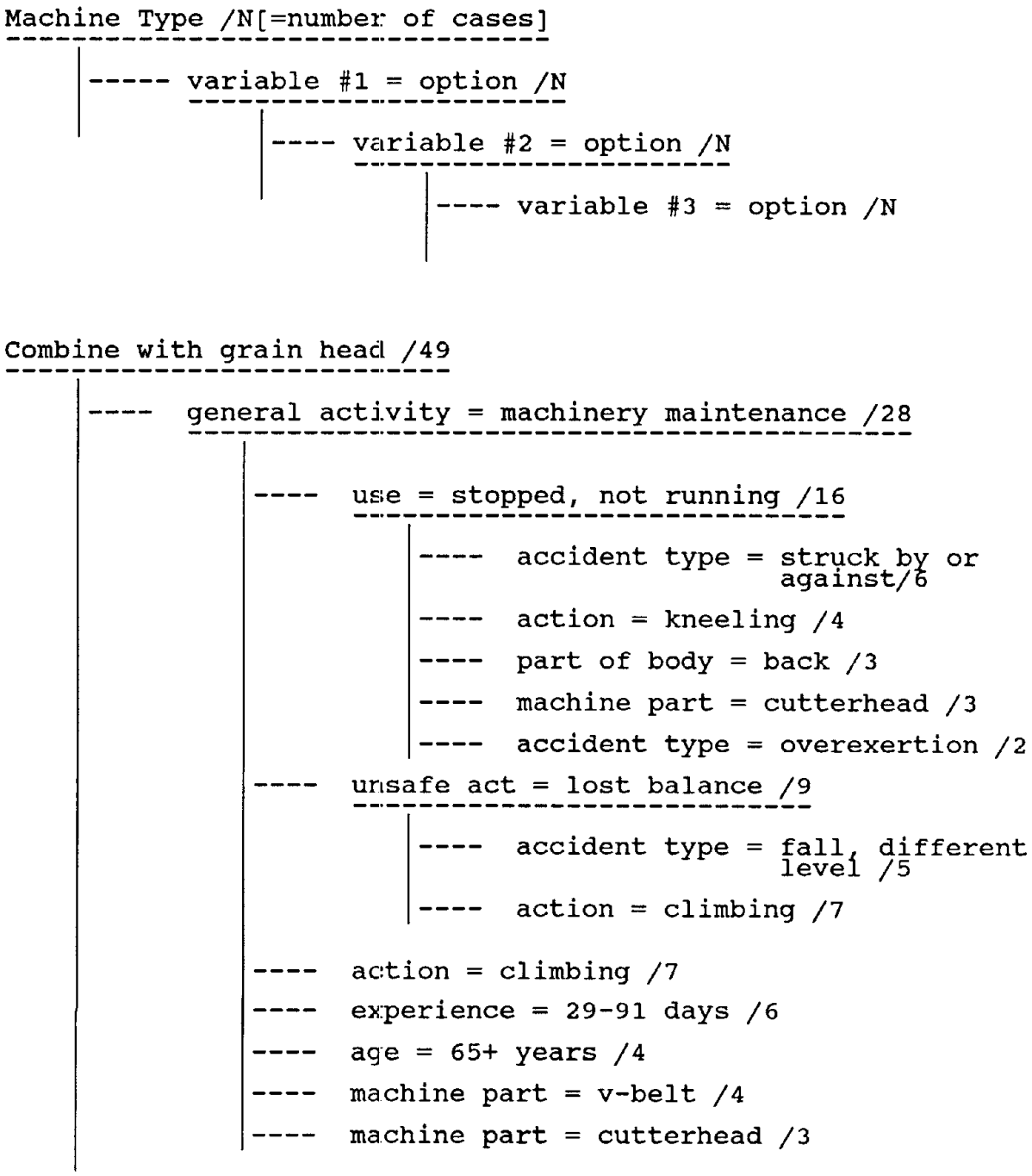
A. Resulting in fracture (3).

II. Caught Between or Under Objects (3)

A. Resulting in fracture or cut to finger (2).

Based on Treesearches

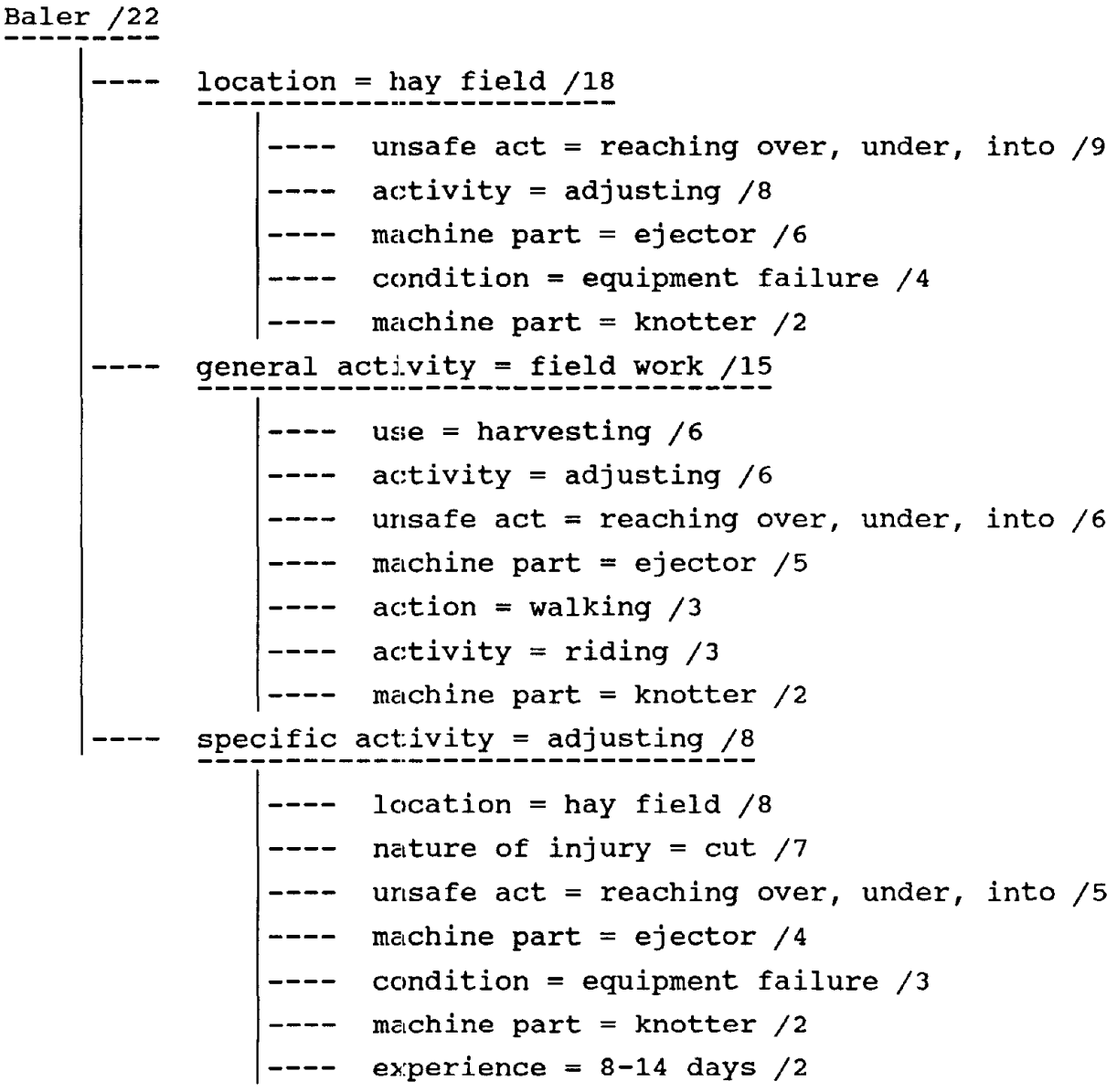
The treesearches of the machinery-related injury file are displayed in the format shown on the next page. Starting with each of the most common machine types in the file, a treesearch was done on four variables: general activity, specific activity, accident type, and location. HI's on these variables together with the number of cases are shown at the first branch (variable #1). These HI's were added to the machine type criterion and treesearches were run against 14 more variables: age, sex, employment status, action, type of accident, nature of injury, part of body, severity, exposure, experience, use of machine, machine part, unsafe act, and condition of machine. HI's on these are shown at the second branch (variable #2). These HI's were in turn added to the first two criteria and run against several other variables including some of those already mentioned. The selection of variables for the third and final treesearch run depended on the results of the first two runs. HI's identified on these runs are shown at the third branch (variable #3).



[continued on next page]

Combine with grain head /49 [continued]

- location = grain field /27
  - residency = husband /22
  - use = harvesting /18
    - part of body = hand /7
    - action = kneeling /4
    - machine part = v-belt /4
    - accident type = fall, same level /2
  - part of body = hand /9
  - action = climbing /7
  - action = kneeling /5
  - machine part = v-belt /4
  - accident type = fall, same level /2
- specific activity = cleaning /9
  - age = 45-64 years /7
  - use = harvesting /4
  - accident type = fall, different level /3


Baler /22
location = hay field /18
unsafe act = reaching over, under, into /9
activity = adjusting /8
machine part = ejector /6
condition = equipment failure /4
machine part = knotter /2
general activity = field work /15
use = harvesting /6
activity = adjusting /6
unsafe act = reaching over, under, into /6
machine part = ejector /5
action = walking /3
activity = riding /3
machine part = knotter /2
specific activity = adjusting /8
location = hay field /8
nature of injury = cut /7
unsafe act = reaching over, under, into /5
machine part = ejector /4
condition = equipment failure /3
machine part = knotter /2
experience = 8-14 days /2

```
Elevator, auger /20
-------------------
     |
     |----  location = granary /13
     |      ----------------------
     |          |
     |          |----  unsafe act = reaching over, under, into /8
     |          |---- accident type = caught in /7
     |          |----  part of body = arm /4
     |
     |----  accident type = caught in /11
     |      ------------------------------
     |          |
     |          |----  machine part = auger /8
     |          |----  unsafe act = reaching over, under, into /6
     |          |----  use = stopped but running /5
     |          |----  nature of injury = multiple /4
     |          |----  condition = guard removed /2

Hay harvester /17
-----------------
     |
     |---- accident type = caught in /8
     |---- location = cattle shed /3
     |---- location = shop /2

Combine with corn head / 16
---------------------------
     |
     |---- location = corn field /7
     |---- specific activity = cleaning /4

Harrow /16
----------
     |
     |---- location = grain field /7
     |---- specific activity = lubricating /3
     |---- accident type = fall, same level /2

Cultivator /15
--------------
     |
     |---- specific activity = hitching /6
     |---- location = machine shed /4
     |---- accident type = struck by flying object /2
```

Seed planter /14

|---- location = machine shed /4
|---- specific activity = bystander /3

Wagon, flat bed /13

|---- accident type = caught under /4
|---- location = hayfield /3

Grinder/mixer /13

|---- general activity = chores /9
|---- location = granary /4
|---- location = feed lot /3

Unloader /13

|---- location = silo /8
|---- general activity = chores /5
|---- specific activity = adjusting /5

Corn picker /13

|---- location = corn field /8

Irrigation equipment /13

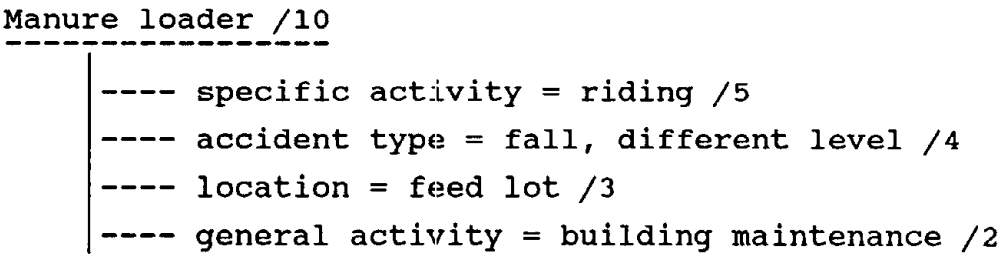
|---- accident type = struck by flying object /2

Seed drill /11

|---- location = grain field /7

Wagon, self-unloading /11

|---- location = silo /3


Manure loader /10
---- specific activity = riding /5
---- accident type = fall, different level /4
---- location = feed lot /3
---- general activity = building maintenance /2

Interventions

Interventions aimed at reducing the number or severity of agricultural machinery-related injuries can be classified in a variety of ways. The target of the intervention can center on the machinery operator, the machine itself, or the environment in which the machine 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 machinery operator or his family but the safety information that is conveyed may relate to the machine itself, the operator, or the environment in which the machine 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 machine 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 agricultural machinery-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 first listing refers to machinery in general and 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.

The second listing of countermeasures is arranged by specific machine. Countermeasures are listed for those accident types which differ from the scenarios for machines in general.

Caught In Object

To avoid being caught in agricultural machinery, operators should follow manufacturers' recommended procedures for adjusting and operating agricultural equipment. All shields or guards should be kept in place and in operating condition. Machines should be stopped before adjusting or lubricating. Operators should wear proper fitting clothing to prevent accidental entanglement. Gloves should always be worn to protect the hands.

Engineering countermeasures include interlocks to prevent operation of machines without guards in place. Improved design in shields would eliminate the desire or ability of the farmer to remove them and better protect those portions of the machine which are implicated in entanglements. Shutoff mechanisms which activate when no operator is present may be used in some instances.

Should entanglement occur, emergency stop mechanisms can reduce the severity of injuries. The presence of an assistant who can summon medical personnel or administer first aid and CPR can also reduce the severity of injuries.

Caught Between Objects

Countermeasures for being caught between objects involving agricultural machinery include stopping the machine before repairing, adjusting or lubricating. All guards and shields should be in place before a machine is placed in operation. Manufacturers' recommended operating procedures should be observed at all times. Many of the engineering countermeasures for "caught in object" accidents can be followed.

Struck By or Against Object

Interventions for being struck by or against agricultural machinery include the wearing by operators of protective headgear to reduce head injuries. The manufacturers' recommended safety procedures should be followed when servicing or operating any machine.

To avoid being struck by or against the machine during machinery maintenance, all hydraulic or mechanical equipment should be lowered before leaving the operator's platform. All servicing should be performed before starting the machinery, 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.

Fall, Different Level

To avoid different level falls involving machinery, operators should wear protective skid-resistant footwear and keep all working surfaces (platform, pedals, steps) free of dirt, grease, trash, and all foreign materials. The operator should be alert when mounting, dismounting, or operating a machine.

Platform and steps should be constructed of slip-resistant surfaces and in such a way that reduces or eliminates the accumulation of foreign material. Steps should be used as

intended, facing the steps when dismounting.

Contact with Sharp Object

Countermeasures for contact with sharp objects involving agricultural machinery include the wearing by operators of protective clothing, and stopping the machine before attempting to clean out, adjust or service it. Guards should be provided for sharp objects located in areas where the operator may be working. Personal protective equipment for hands and arms should be worn.

Engineering countermeasures include improved design on guarding of sharp objects and locking mechanisms to keep sharp objects from falling. Automatic locking devices could be activated when the machine is not running such as during machinery maintenance.

Caught Under Objects

To avoid being caught under agricultural machinery, operators should not attempt to dismount the machine while it is still moving. Safety shoes should be worn at all times. Equipment should be lowered to the ground before dismounting from the platform.

Struck by Falling Object

To avoid being struck by falling objects involving agricultural machinery, bump caps or hard hats should be worn to protect the head. The machine should be completely stopped before operator begins to service or adjust the unit.

Struck by Flying Object

Countermeasures for being struck by flying objects involving agricultural machinery include the use of safety goggles and protective headgear. Operating procedures should be followed and the machine should be stopped before approaching it to uncover or open doors to rotating parts. Design of the machine could be

modified to disallow movement when covers or doors are opened.

Overexertion

To avoid overexertion involving agricultural machinery, heavy hitches should not be manually lifted. Hydraulic or mechanical jacks should be used. Design of machines should facilitate operation so that strenuous tasks are reduced.

Foreign Object

To protect against foreign objects requires that the operator wear the correct personal protective equipment such as safety shoes, goggles, bump cap or hard hat, and a proper respirator when applicable. Manufacturers' recommended operating procedures should be followed.

COMBINE WITH GRAIN HEAD

Caught In or Between Objects

The combine should be stopped before adjusting, repairing or cleaning. V-belt tension should be kept in proper adjustment to prevent slippage, and operators should never pull on the belt. All guards should be kept in place until the machine has stopped.

Struck By or Against, Falling or Flying Object, Sharp Object

When performing machinery maintenance, the operator should always wear protective gloves. The machine should always be in the stopped position before work is begun. Operators should also wear safety headgear at all times.

To avoid being struck by a lifted cutterhead, blocks should be put under the cutterhead or locking devices should be utilized to keep the cutterhead from falling. Design changes could make locking devices automatic during servicing.

Fall, Same or Different Level

All working surfaces should be kept free of foreign materials. Proper protective and slip-resistant footwear should be worn and operators should be alert when mounting or dismounting the combine. The platform and steps should be constructed of slip-resistant surfaces and in such a way that reduces or eliminates the accumulation of foreign material. Steps and handrails should be provided and used as intended.

Overexertion

Operators should not attempt to move or lift heavy objects without assistance from hydraulic or mechanical jacks or another person. Design of the machine should facilitate operation so that strenuous tasks are reduced.

BALER

Caught In or Between Objects

The PTO should be completely stopped before attempting to unplug or clear the baler. Operators should stay clear of moving parts and make sure bystanders are clear before operating the bale ejector or opening or closing the rear gate on big round balers.

Guards should always be kept in place and interlock systems can be utilized to prevent operation of the machine when guards are removed. Knotter heads should not be adjusted while the machine is running but rather, the machine should be turned over manually. Bale ejectors should have screens or guards in place before operating.

ELEVATOR, AUGER

Caught In, Between, or Under Objects

Auger elevators should always be stopped before servicing. Operators should keep clear of blades, the PTO shaft, and other moving parts when working near them, especially when picking up

spills. V-belt tension should be kept in proper adjustment to prevent slippage, and operators should never pull on the belt.

Hands should never be used to help the machine along when it clogs or slips. Children should be kept away from the work area. Guards or shields should always be in place while the machine is in operation. Interlock devices may be utilized to prevent operation of the machine when guards are removed.

HAY HARVESTER

Caught In or Between Objects

Hay harvesters should always be stopped before servicing or repairing, and operators should keep clear of all moving parts, especially the sprocket chain and feeding mechanism. Shields should be provided and the machine should be in operation only when all shields are in place. Children and bystanders should be kept away from the work area.

Struck Against or Sharp Object

Hay harvesters should be completely stopped before attempting to service the cutterhead or blade. Shielding should be provided to prevent contact with the sharp edge of the knife. Interlocks can prevent machine operation without all guards in place.

COMBINE WITH CORN HEAD

Caught In or Between Objects

Combines should be completely stopped before performing any kind of servicing operation. Hands or feet should never be used to unplug rolls. Guards should always be kept in place while combines are operating.

CULTIVATOR

To avoid getting caught in, between, or under objects when hitching a cultivator, the operator should stay clear of pinch points. The cultivator needs to be in a stable position on smooth, level ground while the hitching operation is taking place so that no shifting occurs. Engineering countermeasures include the design and utilization of hitching mechanisms so that cultivators can be hitched to the tractor hydraulically without the operator leaving the platform.

WAGON, FLAT BED

To avoid injuries to the feet from getting run over by flat bed wagons, the tractor driver should be able to see his assistant at all times when backing up to hitch the wagon. Quick-connect hitches could also be used to eliminate the need for manual hitches. Wagons should be hitched on smooth, level ground and should be blocked so they stay firmly in place during the hitching operation.

GRINDER, MIXER

To prevent finger injuries that occur during adjusting, feeding, or operating a grinder or mixer, shields for all v-belts, augers, and gears should be in place while the machine is operating. Adjusting or repair should be done only when the machine is stopped. Hands should be kept away from the feeding or throat area.

CORN PICKER

To prevent amputations and cuts to the hands and fingers while operating corn pickers, plugged rolls should never be cleared while the machine is running. Machines should always be turned off before cleaning out clogs and hands should never be used. Design

changes have produced corn pickers which can be mechanically or hydraulically controlled so that rolls can be opened up or reversed to unclog material without the operator leaving the platform. Increased use of these newer machines will eliminate many hand and finger amputations.

Discussion

Today's modern farms are equipped with both engine- and PTO-driven machines for producing and handling farm commodities and other materials. These machines are used in almost all aspects of farm work. Unfortunately, each year many farm workers are injured by these machines.

Most of the farm population is well aware of the hazards of working with farm machinery. Warning signs and decals are placed on the equipment, most hazardous areas are guarded or shielded, and there are more tractor and machinery safety programs and materials available to farmers and ranchers than ever before. And yet, tractors and machinery continue to be major sources of accidental farm work deaths and serious injury. While the farm tractor is involved in many accidents, agricultural machines have higher injury rates in terms of hours of use (Gadalla, 1962; Doss & Pfister, 1972).

Studies of farm machinery-related deaths and injuries generally agree on the most common machine types with respect to their involvement in farm work injuries. Wagons were cited as the most common type in five studies. While wagons would not seem to be particularly hazardous, farmers may be exposed to them more than other machine types. Doss and Pfister found that wagons were the most commonly used implement--about 15 per cent of total machinery hours. Other machine types were used for no more than 5 per cent of the hours. Other studies of farm injuries, including the 35-state survey, consistently report four machine types (in addition to wagons) as being most often involved: combines, balers, corn pickers, and auger elevators.

Gadalla and Doss and Pfister also computed injury frequency rates per million hours of use for specific machine types. On the basis of these rates, elevators, corn pickers, combines, wagons, and balers were the most hazardous. This agrees with the result based on frequency alone.

The age, sex, and employment status of persons injured in machinery accidents is significantly different from all farm work injuries. Family males are overrepresented and family females are underrepresented. This is not unexpected in view of the data reported in Doss and Pfister which show that females accounted for only 2.5 per cent of the machinery exposure hours.

The distribution of machinery-related work injuries by acreage and agricultural operation is also significantly different from that for all work injuries. Grain farms and "other" farms (i.e., other than beef, dairy, grain, or fruit) were overrepresented. By size, farms of less than 100 acres, 200-499 acres, and 1,000 or more acres were overrepresented. No other studies examined the effect of these two variables so it is difficult to put this finding into perspective.

Hay baler injuries result from a few basic injury scenarios. Reaching over, under, or into the intake rollers or ejector mechanism and adjusting the knotter were the principal hazard patterns. Schnieder (1983) described the most common scenario as being caught up in the baler. Hardin (1967) was more specific--arms caught up in the intake rollers. Gainor (1983) added to the scenario--arms caught in intake rollers while adjusting the twine feeding apparatus or inspecting the machine. Baker, Fletcher, and Zeglen (1977) described clearing a plugged machine as the most common scenario for the big round baler. Despite the hazards associated with big round bales and balers, McCarthy, Robinson, and Brand (1985) found that it was the safest of the three baling technologies that they evaluated.

Corn pickers were associated with particularly severe injuries. Wardle (1963) found that amputations accounted for nearly half the injuries and in the 35 state surveys 30 per cent resulted in permanent impairments (the most of any machine type). In all studies of this machine, the snapping, husking, and stalk ejector rolls were the principal hazard points. Most injuries occurred while attempting to clear stalks from a clogged machine

(Cogbill & Busch, 1985).

Several authors noted a decrease in corn picker injuries as farmers switched to combines for harvesting corn. This resulted in an increase not only in combine-related injuries, but also in auger-related injuries. Auger elevators, used to move the shelled corn produced by combines, replaced chain elevators which handled ear corn.

The combine, with either grain head or corn head, was not the subject of any special studies identified for the literature review. Perhaps this was because the consequences were not as dramatic as for corn pickers or augers. Nevertheless, combines were the most frequently named machine type in the 35 state surveys and among the most frequent in most other studies reviewed. There was no dominant hazard pattern for combines although Jepsen (1981) reported that more than half of the accidents happened in the header area, most when the header fell on the victim. Cuts and bruises while repairing or cleaning the machines were most common. But, there were also more serious cases resulting in amputation, fracture, or mangle while adjusting, operating, or cleaning during the harvesting operation. These cases involved v-belts, sprocket chains, gears, and rollers. Falls were also associated with this machine.

Auger-related injuries, however, result primarily from one hazard pattern--reaching into or slipping into the feed mechanism and being caught by the auger. Because of the avulsive nature of the injuries, they commonly result in amputation or other permanent disability. Many are fatal. The upper and lower extremities are involved almost exclusively.

Preventing these auger injuries would seem to be simple: guard the intake area. Small and Dennis (1975) said that virtually all of the grain auger intake injuries they reviewed could have been prevented by a guard. And yet, Beatty, Zook, Russell, and Kinkead (1982) reported that 50 per cent of their patients admitted removing or altering the guard on the auger that injured them.

Moreover, the authors inspected 100 grain augers in the area and found "95 per cent had shielding altered or removed" (p. 99).

Another elevator-related accident type that is less common but very often fatal is overhead electrical contact. According to Fletcher (1974), 45 per cent of the electrical contacts studied involved augers or elevators and 80 per cent were fatal. The most commonly recommended countermeasure is to "be careful" when around power lines. A more effective intervention would be to raise, shield, or bury the power line, or ground the equipment.

The last machine to be discussed is the farm wagon. Although it was named as one of the most common types of machines involved in farm work injuries, little detailed information has been published about these cases. Even this analysis of the machinery bi-level data provides little insight into the matter because detailed data on wagon-related injuries was recorded on a separate bi-level--Agricultural Wagons (F11). Nineteen states used the F11 and 89 forms were completed. These data, however, were not within the scope of this project.

The work injury scenarios in this report were constructed to define the most common hazard patterns in machinery-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.

When one thinks of machinery-related injuries, particularly in an industrial rather than agricultural environment, the most obvious intervention is guarding--i.e., physically separating the operator from the point of hazard. That approach would seem to be

the most effective. Where guards must be removed for access to parts for adjustment, service, or unjamming, then the guards can be interlocked with the power source to prevent access while the system is energized.

There are areas of the machines, however, that cannot be adequately guarded because the crop must feed into the machines. For these areas, instructions and warnings may be the only interventions possible. Lehto and Miller (1986) give a comprehensive analysis of the design and evaluation of warnings.

A broad range of interventions are possible. Each one must 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.

In recent years new technology in agriculture has resulted in new and different equipment and procedures. Changes from

traditional methods are often associated with new technology and equipment. As a result, the farmer is faced with new hazards. Recent examples include the big round and jumbo-sized square hay balers and their related equipment, increased quantities of on-farm grain processing and storage, and new systems for handling manure and other solid wastes associated with livestock (Young, 1980). Preventing injuries or deaths due to farm machinery is a constant challenge to all members of the farm family, their employees, and implement designers and manufacturers.

Some areas for further research are suggested by the analysis and discussion of machinery-related farm work injuries. More recent data on the amount of exposure to various machines would greatly increase our ability to interpret the injury frequency data and thus would increase our understanding of it. Our ability to establish priorities for the injury scenarios would also be enhanced. Doss and Pfister and Gadalla established the feasibility of obtaining detailed machinery exposure data through diaries.

It is also very important to collect data on the particular makes and models of machinery. There is a wide variety of equipment available with various designs and features. It is impossible to tell from the injury data whether the injury was attributable to a design element common to all machines of the given type or if it was due to an element unique to one model or manufacturer. Knowing this would directly influence the choice of intervention strategies.

Napier, Goe, and Pugh (1985) suggested that attention should be given to factors not usually studied. We agree that most studies of traditional factors have yielded as much information as can be expected and that a new approach is needed. It is necessary now to identify true causal factors that produce injuries. This means not just identifying a hazardous condition associated with an injury but finding out why it was not recognized or corrected. It means finding out if the person knew the safe way to perform the

job and why he or she deviated from that procedure. It means finding out if training and supervision were adequate, and if not, why not. Knowing the true causes of injuries will lead to more effective interventions.

References

Baker, D.E., Fletcher, W.J., & Zeglen, E.J. (1977). Big round bales--anatomy of a safety problem. St. Joseph, Michigan: American Society of Agricultural Engineers.

Baker, R.H., & Stuckey, W.E. (1973). Let's curb farm fatalities. Columbus: Ohio State University Cooperative Extension Service.

Beatty, M.E., Zook, E.G., Russell, R.C., & Kinkead, L.R. (1982). Grain auger injuries: replacement of the cornpicker injury? Plastic and Reconstructive Surgery, 69(1), 96-102.

California Department of Industrial Relations. (1978). Work injuries and illnesses in California agriculture, 1976. San Francisco: Author.

Campbell, D.C., Bryan, R.S., Cooney, W.P., & Ilstrup, D. (1979). Mechanical cornpicker hand injuries. Journal of Trauma, 19(9), 678-681.

Canada Safety Council. (Undated). Farm machinery safety. Ottawa: Author.

Cogbill, T.H., & Busch, H.M., Jr. (1985). Spectrum of agricultural trauma. Journal of Emergency Medicine, 3(3), 205-210.

Conrath, D., & Hanford, W. (1973). Ten state accident survey. Farm Safety Review, 31(3), 5-15.

Donaldson, G.F. (1968). Farm machinery safety: physical welfare effects of the man-machine interaction on farms. Ottawa: Queen's Printer.

Doss, H.J., & Pfister, R.G. (1972). Nature and extent of farm machinery use in relation to frequency of accidents in Michigan and Ohio. East Lansing: Michigan State University Agricultural Engineering Department.

Doss, H.J., & Pfister, R.G. (1974). Michigan accident survey. Farm Safety Review, 32(1), 10-13.

Fletcher, W.J. (1969). Avoiding elevator and auger accidents. Farm Safety Review, 27(6), 5-8.

Fletcher, W.J. (1974). Where are the electrical accidents happening on the farm? St. Joseph, Michigan: American Society of Agricultural Engineers.

Fletcher, W.J. (1982). Auger elevator accidents--they're still with us. Farm Safety Review, 39(2), 7-8.

Fritsch, C.F. (1976). Occupational and nonoccupational fatalities on U.S. farms. Washington, D.C.: Economic Research Service, U.S. Department of Agriculture.

Fritsch, C.F., & Zimmer, J.M. (1980). U.S. farm accident fatalities, 1970-1976. Washington: U.S. Department of Agriculture.

Gadalla, S.M. (1962). Selected environmental factors associated with farm and farm house accidents in Missouri. Columbia: University of Missouri Agricultural Experiment Station.

Gainor, B.J. (1983). Hay baler trauma to the upper extremity: a roller injury. Journal of Trauma, 23(12), 1069-1071.

Hanford, W.D. (1985). Shielding agricultural equipment. Chicago: National Safety Council.

Hanford, W.D., Burke, J.W., Fletcher, W.J., Hoskin, A.F., & Miller, T.A. (1982). 1982 farm accident survey report. Chicago: National Safety Council.

Hanford, W.D., Burke, J.W., Fletcher, W.J., Recht, J.L., Hoskin, A.F., & Miller, T.A. (1979). Farm/ranch standardized accident survey: an 18-state report. Chicago: National Safety Council.

Hanford, W., & Conrath, D. (1972). Eight state survey: zeroing in on farm accidents. Farm Safety Review, 30(3), 3-15.

Hardin, C.A. (1967). Hay baler injuries requiring forequarter amputation. Journal of Trauma, 7(1), 164-168.

Hofmeister, K.M., & Pfister, R.G. (1968). Michigan farm accident study: a report on accidents occurring to farm families and hired labor, 1967-68. East Lansing: Michigan State University.

Hoskin, A.F., & Miller, T.A. (1979). Farm accident surveys: a 21-state summary with emphasis on animal-related injuries. Journal of Safety Research, 11(1), 2-13.

Hoskin, A.F., Miller, T.A., Hanford, W.D., & Landes, S.R. (1988a). Occupational injuries in agriculture: a 35-state summary. (Submitted in fulfillment of NIOSH contract no. DSR-87-0942.)

Hoskin, A.F., Miller, T.A., Hanford, W.D., & Landes, S.R. (1988b). Agricultural tractor-related injuries: a 35-state summary. (Submitted in fulfillment of NIOSH contract no. DSR-87-0941.)

Jensen, D.V. (1972). Rural Wisconsin accidents. Madison: University of Wisconsin Cooperative Extension Programs.

Jepsen, R.L. (1981). Fatal agricultural accidents in Kansas, 1976-1980. Manhattan: Kansas State University Cooperative Extension Service.

Kansas State Department of Health and Environment Bureau of Registration and Health Statistics. (1978). Kansas agricultural accidental death report: 1977. Topeka: Author.

Lehto, M.R., & Miller, J.M. (1986). Warnings (Vol. 1). Ann Arbor, Michigan: Fuller Technical Publications.

Manitoba Workplace Safety and Health Division. (Undated). Harvesting equipment: good farming is no accident. Winnipeg: Author.

McCarthy, R.L., Robinson, J.N., & Brand, I. (1985). Quantitative safety comparison of three hay baling technologies. Fiche No. 85-5514. St. Joseph, Mich.: American Society of Agricultural Engineers.

McFarland, T.D., & Fletcher, W.J. (1969). Analysis of portable farm elevator and auger accidents to determine corrective measures. Chicago, Illinois: National Safety Council Farm Department.

Murphy, D.J. (1985). Pennsylvania farm fatalities during 1980-1984. University Park: The Pennsylvania State University Cooperative Extension Service.

Murphy, D.J., Grottenthaler, J., Lindstrom, D.J., & Rapp, R.W. (1980). Farm machinery accidents: a guide for the farm family. Farm Safety Review, 38(1), 10-14.

Nachlas, N., & Schlenker, J.D. (1981). The mechanical corn-picker. Illinois Medical Journal, 159(6), 371-374.

Napier, T.L., Goe, W.R., & Pugh, A.R. (1985). Incidence and predictive factors associated with farm accidents in Ohio. Wooster: The Ohio State University Agricultural Research and Development Center.

National Center for Health Statistics. (1987). Deaths and death rates for each cause, by race and sex: United States, 1985 (Table 1-22); and Deaths from nontransport accidents, by place of accident, cause of death, race, and sex: United States, 1985 (Table 212). [Computer tabulations.]

National Research Council Committee on Trauma Research. (1985). Injury in America: a continuing health problem. Washington, D.C.: National Academy Press.

National Safety Council. (1979). A procedure for collecting farm accident data (6th Revision). Chicago: Author.

National Safety Council. (1987). Accident facts, 1987 edition. Chicago: Author.

National Safety Council Farm Department. (1981). Farm accident victim extrication information. Chicago: Author.

Novack, J.A. (1971). Sociological perspective on farm accidents in Louisiana: an epidemiological approach. Baton Rouge: Louisiana State University and Agricultural and Mechanical College.

Paterson, K.W., Novack, J.A., & Bertrand, A.L. (1972). The distribution and characteristics of farm accidents in Louisiana. Baton Rouge: Louisiana State University Department of Rural Sociology.

Pennsylvania Department of Public Instruction. (1957). A study of accidents to Pennsylvania farm people. Harrisburg: Author.

Pfister, R.G., & Hofmeister, K.M. (1969). A study of accidents occurring to farm people in Michigan. Journal of Safety Research, 1(1), 28-41.

Rivara, F.P. (1985). Fatal and nonfatal farm injuries to children and adolescents in the United States. Pediatrics, 76(4), 567-573.

Safe hay harvest. (1967). Farm Safety Review, 25(2), 3-6.

Schafer, S.R., & Kotrlik, J.W. (1986). Factors affecting farm safety practices. Journal of Safety Research, 17(3), 123-127.

Schnieder, R.D. (1983). The Nebraska farm accident example, 1970-1982. St. Joseph, Michigan: American Society of Agricultural Engineers.

Simpson, S.G. (1984). Farm machinery injuries. Journal of Trauma, 24(2), 150-152.

Small, D.D., & Dennis, C.A. (1975). Investigations into the incidence, cause, effect and cost of farm accidents in Saskatchewan: an analysis of grain auger accidents. Regina, Saskatchewan: Prairie Institute of Environmental Health.

Stuckey, W.E., & Pugh, A.R. (1973). Accidental injuries to Ohio farm people, 1957-1972. Columbus: Ohio State University Cooperative Extension Service.

Wardle, N.J. (1963). A report of 4,058 Iowa corn harvest accidents, 1947-1962. Ames: Iowa State University.

Wardle, N.J., & Hull, D.O. (1975). Fatal accidents of Iowa farm people, 1947-1971. Ames: Iowa State University Cooperative Extension Service.

Wisconsin Department of Health and Social Services. (1970). Fatal farm accidents: Wisconsin, 1965-67. Madison: Author.

Young, C.W. (1980). Technology creates new hazards. Ohio Monitor, 53(3), 9-12.

APPENDIX

FREQUENCY AND PER CENT DISTRIBUTIONS

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...ALABAMA	7	1.26	1.26
02...CALIF	17	3.06	3.06
03...MARYLAND	29	5.23	5.23
04...MISSOURI	0	.00	.00
05...UTAH	10	1.80	1.80
06...ARIZONA	5	.90	.90
07...IDAHO	41	7.39	7.39
08...GEORGIA	0	.00	.00
09...KANSAS	27	4.86	4.86
10...PENNA	28	5.05	5.05
11...WISCONSN	0	.00	.00
12...IOWA	78	14.05	14.05
13...OKLAHOMA	13	2.34	2.34
14...MONTANA	4	.72	.72
15...S DAKOTA	12	2.16	2.16
16...INDIANA	14	2.52	2.52
17...N MEXICO	4	.72	.72
18...NEW YORK	31	5.59	5.59
19...VERMONT	13	2.34	2.34
20...NEW HAMP	3	.54	.54
21...DELAWARE	0	.00	.00
22...NEBRASKA	26	4.68	4.68
23...COLORADO	4	.72	.72
24...ARKANSAS	22	3.96	3.96
25...CONN	0	.00	.00
26...WASHNGTN	8	1.44	1.44
27...OREGON	26	4.68	4.68
28...VIRGINIA	6	1.08	1.08
29...UTAH II	2	.36	.36
30...MICHIGAN	15	2.70	2.70
31...TENNESSE	11	1.98	1.98
32...KANS II	0	.00	.00
33...GEOR II	13	2.34	2.34
34...S CALINA	22	3.96	3.96
35...IOWA II	64	11.53	11.53
TOTAL	555	99.96	99.96

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	1	.18	
01...HUSBAND	272	49.01	49.10
02...WIFE	22	3.96	3.97
03...SON	102	18.38	18.41
04...DAUGHTER	12	2.16	2.17
05...OTHER	21	3.78	3.79
06...FT EMPL	58	10.45	10.47
07...PT EMPL	61	10.99	11.01
08...VISITOR	4	.72	.72
09...GUEST	2	.36	.36
TOTAL	555	99.99	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01... 1- 4 YR	1	.18	.18
02... 5-14 YR	25	4.50	4.50
03...15-24 YR	124	22.34	22.34
04...25-44 YR	192	34.59	34.59
05...45-64 YR	160	28.83	28.83
06...65, OVER	25	4.50	4.50
07...UNKNOWN	28	5.05	5.05
TOTAL	555	99.99	99.99

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	2	.36	
01...MALE	510	91.89	92.22
02...FEMALE	43	7.75	7.78
TOTAL	555	100.00	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...ONE	548	98.74	98.74
02...TWO	6	1.08	1.08
03...THREE	0	.00	.00
04...4, MORE	0	.00	.00
05...UNKNOWN	1	.18	.18
TOTAL	555	100.00	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...WORK	555	100.00	100.00
02...LEISURE	0	.00	.00
03...UNKNOWN	0	.00	.00
TOTAL	555	100.00	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	2	.36	
01...JANUARY	18	3.24	3.25
02...FEBRUARY	16	2.88	2.89
03...MARCH	29	5.23	5.24
04...APRIL	33	5.95	5.97
05...MAY	50	9.01	9.04
06...JUNE	68	12.25	12.30
07...JULY	88	15.86	15.91
08...AUGUST	56	10.09	10.13
09...SEPTEMBR	54	9.73	9.76
10...OCTOBER	75	13.51	13.56
11...NOVEMBER	52	9.37	9.40
12...DECEMBER	13	2.34	2.35
13...UNKNOWN	1	.18	.18
TOTAL	555	100.00	99.98

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	127	22.88	
01...SUN.	21	3.78	4.91
02...MON.	58	10.45	13.55
03...TUES.	75	13.51	17.52
04...WED.	67	12.07	15.65
05...THURS.	64	11.53	14.95
06...FRI.	60	10.81	14.02
07...SAT.	62	11.17	14.49
08...UNKNOWN	21	3.78	4.91
TOTAL	555	99.98	100.00

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	127	22.88	
01... 1 A.M.	2	.36	.47
02... 2 A.M.	2	.36	.47
03... 3 A.M.	8	1.44	1.87
04... 4 A.M.	12	2.16	2.80
05... 5 A.M.	11	1.98	2.57
06... 6 A.M.	8	1.44	1.87
07... 7 A.M.	9	1.62	2.10
08... 8 A.M.	9	1.62	2.10
09... 9 A.M.	38	6.85	8.88
10...10 A.M.	59	10.63	13.79
11...11 A.M.	40	7.21	9.35
12...NOON	13	2.34	3.04
13... 1 P.M.	21	3.78	4.91
14... 2 P.M.	33	5.95	7.71
15... 3 P.M.	45	8.11	10.51
16... 4 P.M.	43	7.75	10.05
17... 5 P.M.	24	4.32	5.61
18... 6 P.M.	12	2.16	2.80
19... 7 P.M.	12	2.16	2.80
20... 8 P.M.	8	1.44	1.87
21... 9 P.M.	4	.72	.93
22...10 P.M.	1	.18	.23
23...11 P.M.	1	.18	.23
24...MIDNIGHT	2	.36	.47
25...UNKNOWN	11	1.98	2.57
TOTAL	555	99.98	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...INJURED	555	100.00	100.00
02...ILL	0	.00	.00
TOTAL	555	100.00	100.00

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...SLIGHT	143	25.77	25.77
02...SEVERE	372	67.03	67.03
03...PERM.	28	5.05	5.05
04...FATAL	3	.54	.54
05...UNKNOWN	9	1.62	1.62
TOTAL	555	100.01	100.01

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	6	1.08	
01...BLDG MNT	6	1.08	1.09
02...FLD WORK	205	36.94	37.34
03...HSE WORK	0	.00	.00
04...MACH MNT	168	30.27	30.60
05...RECREATN	1	.18	.18
06...CHORES	67	12.07	12.20
07...LIVESTCK	5	.90	.91
08...YRD WORK	6	1.08	1.09
09...OTHER	91	16.40	16.58
TOTAL	555	100.00	99.99

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	7	1.26	
01...CLIMBING	35	6.31	6.39
02...DRIVING	19	3.42	3.47
03...JUMPING	18	3.24	3.28
04...KNEELING	37	6.67	6.75
05...LIFTING	68	12.25	12.41
06...LYING DN	5	.90	.91
07...RIDING	16	2.88	2.92
08...RUNNING	1	.18	.18
09...SITTING	19	3.42	3.47
10...STANDING	239	43.06	43.61
11...WALKING	29	5.23	5.29
12...OTHER	62	11.17	11.31
TOTAL	555	99.99	99.99

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	143	25.77	
01...DOCTOR	250	45.05	60.68
02...FAMILY	70	12.61	16.99
03...NURSE	12	2.16	2.91
04...SELF	51	9.19	12.38
05...MULTIPLE	13	2.34	3.16
06...OTHER	16	2.88	3.88
TOTAL	555	100.00	100.00

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	133	23.96	
01...NOT REQD	13	2.34	3.08
02...ONE	119	21.44	28.20
03...2, MORE	290	52.25	68.72
TOTAL	555	99.99	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	5	.90	
01...AMPUTATN	25	4.50	4.55
02...ASPHYXIA	0	.00	.00
03...BRUISE	71	12.79	12.91
04...BURN	6	1.08	1.09
05...FRACTURE	76	13.69	13.82
06...CUT	195	35.14	35.45
07...EYE INJ	20	3.60	3.64
08...MANGLED	22	3.96	4.00
09...PINCHED	11	1.98	2.00
10...PUNCTURE	18	3.24	3.27
11...SPRAIN	45	8.11	8.18
12...MULTIPLE	34	6.13	6.18
13...OTHER	27	4.86	4.91
TOTAL	555	99.98	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	1	.18	
01...ARM	41	7.39	7.40
02...BACK	34	6.13	6.14
03...CHEST	11	1.98	1.99
04...EYE	22	3.96	3.97
05...FINGER	145	26.13	26.17
06...FOOT	53	9.55	9.57
07...GENITAL	0	.00	.00
08...HAND	75	13.51	13.54
09...HEAD	38	6.85	6.86
10...LEG	68	12.25	12.27
11...NECK	3	.54	.54
12...SHOULDER	8	1.44	1.44
13...TOE	8	1.44	1.44
14...TRUNK	1	.18	.18
15...MULTIPLE	28	5.05	5.05
16...OTHER	19	3.42	3.43
TOTAL	555	100.00	99.99

VARIABLE: 18...HOW OCCURD FILF: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	8	1.44	
01...C'T IN	119	21.44	21.76
02...C'T BTWN	110	19.82	20.11
03...C'T UNDR	40	7.21	7.31
04...AGNST OB	68	12.25	12.43
05...FALL OBJ	37	6.67	6.76
06...FLY OBJ	16	2.88	2.93
07...SHARP OB	41	7.39	7.50
08...FOR OBJ	12	2.16	2.19
09...FALL SL	7	1.26	1.28
10...FALL DL	43	7.75	7.86
11...FALL UNK	6	1.08	1.10
12...ELEC CUR	3	.54	.55
13...FIRE/OBJ	3	.54	.55
14...HOT SUBS	0	.00	.00
15...CORROSIV	1	.18	.18
16...LIQUID	3	.54	.55
17...OVEREXRT	14	2.52	2.56
18...GAS/VAPR	0	.00	.00
19...MATR EXP	1	.18	.18
20...OTHER	23	4.14	4.20
TOTAL	555	99.99	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	132	23.78	
01...CLINIC	27	4.86	6.38
02...DOCT OFF	174	31.35	41.13
03...HOME	9	1.62	2.13
04...HOSP ADM	37	6.67	8.75
05...HOSP EMR	153	27.57	36.17
06...NO TREAT	8	1.44	1.89
07...MULTIPLE	15	2.70	3.55
TOTAL	555	99.99	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	143	25.77	
01...0/BELOW	1	.18	.24
02... 1-32	20	3.60	4.85
03...33-50	80	14.41	19.42
04...51-85	224	40.36	54.37
05...86-100	86	15.50	20.87
06...101/OVER	1	.18	.24
TOTAL	555	100.00	99.99

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	147	26.49	
01...CLEAR	369	66.49	90.44
02...FOG	2	.36	.49
03...ICE	2	.36	.49
04...RAIN	14	2.52	3.43
05...SNOW	3	.54	.74
06...THREATNG	13	2.34	3.19
07...OTHER	5	.90	1.23
TOTAL	555	100.00	100.01

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	154	27.75	
01...CALM	223	40.18	55.61
02...BREEZE	144	25.95	35.91
03...10-25MPH	31	5.59	7.73
04...26-40MPH	1	.18	.25
05...OVER 40	2	.36	.50
TOTAL	555	100.01	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	5	.90	
01...BARN	28	5.05	5.09
02...BARNYARD	94	16.94	17.09
03...DRIVEWAY	40	7.21	7.27
04...YRD/GRDN	14	2.52	2.55
05...FRM BLDG	81	14.59	14.73
06...FIELD	221	39.82	40.18
07...HIGHWAY	4	.72	.73
08...HOUSE	0	.00	.00
09...LAND	25	4.50	4.55
10...LAGOON	0	.00	.00
11...PND/STRM	1	.18	.18
12...PUB AREA	3	.54	.55
13...ROAD	5	.90	.91
14...OTHER	34	6.13	6.18
TOTAL	555	100.00	100.01

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	140	25.23	
01...DRY	335	60.36	80.72
02...ICY	4	.72	.96
03...MUDDY	21	3.78	5.06
04...STRAW &C	15	2.70	3.61
05...OTHER	15	2.70	3.61
06...OIL/GRSY	1	.18	.24
07...SNOW	5	.90	1.20
08...WET	19	3.42	4.58
TOTAL	555	99.99	99.98

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	139	25.05	
01...ASPHALT	10	1.80	2.40
02...BRICK	0	.00	.00
03...CONCRETE	39	7.03	9.38
04...FLR COVR	0	.00	.00
05...METAL	23	4.14	5.53
06...SOIL	256	46.13	61.54
07...VEGETATN	55	9.91	13.22
08...WOOD	14	2.52	3.37
09...OTHER	19	3.42	4.57
TOTAL	555	100.00	100.01

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	134	24.14	
01...GD ARTFL	26	4.68	6.18
02...PR ARTFL	5	.90	1.19
03...DAYLIGHT	370	66.67	87.89
04...DARK	5	.90	1.19
05...DWN/DSK	14	2.52	3.33
06...REDUCED	1	.18	.24
TOTAL	555	99.99	100.02

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	12	2.16	
01...AGR MACH	451	81.26	83.06
02...ANIMAL	2	.36	.37
03...PERSON	1	.18	.18
04...CHEMICAL	0	.00	.00
05...ELCTRCTY	5	.90	.92
06...FIREARMS	0	.00	.00
07...GAS/VAPR	0	.00	.00
08...HND TOOL	4	.72	.74
09...HSHLD IT	0	.00	.00
10...PWR TOOL	0	.00	.00
11...SPORTS	2	.36	.37
12...TRACTOR	35	6.31	6.45
13...TRUCK	7	1.26	1.29
14...OTH VEH	32	5.77	5.89
15...NONE	3	.54	.55
16...GRDN EQP	1	.18	.18
TOTAL	555	100.00	100.00

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	139	25.05	
01...1/LESS	216	38.92	51.92
02...2-4 HRS	123	22.16	29.57
03...5-8 HRS	58	10.45	13.94
04...8/OVER	19	3.42	4.57
TOTAL	555	100.00	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	168	30.27	
01...<1 DAY	127	22.88	32.82
02...1-7 DAYS	41	7.39	10.59
03...8-14	23	4.14	5.94
04...15-21	13	2.34	3.36
05...22-28	4	.72	1.03
06...29-91	46	8.29	11.89
07...92-181	19	3.42	4.91
08...182 OR >	114	20.54	29.46
TOTAL	555	99.99	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	139	25.05	
01...BEEF	40	7.21	9.62
02...CORN	13	2.34	3.13
03...COTTON	10	1.80	2.40
04...GRAIN	43	7.75	10.34
05...RICE	9	1.62	2.16
06...SOYBEANS	1	.18	.24
07...SGR CANE	1	.18	.24
08...TOBACCO	0	.00	.00
09...BEEF/HOG	9	1.62	2.16
10...FRUIT	16	2.88	3.85
11...TRK CRPS	2	.36	.48
12...DAIRY	93	16.76	22.36
13...SEED CRP	10	1.80	2.40
14...OTHER	35	6.31	8.41
15...HOGS	6	1.08	1.44
16...POULTRY	2	.36	.48
17...CORN/BF	26	4.68	6.25
18...CORN/HOG	24	4.32	5.77
19...CORN/SOY	22	3.96	5.29
20...DAIRY/HG	11	1.98	2.64
21...SHEEP	1	.18	.24
22...NUTS	5	.90	1.20
23...CUT FLWR	0	.00	.00
24...FLD FLWR	0	.00	.00
25...NURSERY	4	.72	.96
26...PLANTS	0	.00	.00
27...FLD CROP	33	5.95	7.93
TOTAL	555	99.99	99.99

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	127	22.88	
01... 1- 49	15	2.70	3.50
02... 50- 99	17	3.06	3.97
03...100-199	54	9.73	12.62
04...200-499	162	29.19	37.85
05...500-999	78	14.05	18.22
06...1000, >	71	12.79	16.59
07...UNKNOWN	31	5.59	7.24
TOTAL	555	99.99	99.99

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	253	45.59	
01...GOOD	290	52.25	96.03
02...MDS CARE	3	.54	.99
03...MEDICATN	3	.54	.99
04...ILL	0	.00	.00
05...MENTL HD	0	.00	.00
06...PHYSL HD	0	.00	.00
07...OTHER	2	.36	.66
08...UNKNOWN	4	.72	1.32
TOTAL	555	100.00	99.99

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	253	45.59	
01...<1 DAY	88	15.86	29.14
02...1-7 DAYS	136	24.50	45.03
03...8-14	27	4.86	8.94
04...15-21	10	1.80	3.31
05...22-28	5	.90	1.66
06...29-91	30	5.41	9.93
07...92-181	4	.72	1.32
08...182 OR >	2	.36	.66
TOTAL	555	100.00	99.99

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	253	45.59	
01...<1 DAY	241	43.42	79.80
02...1-7 DAYS	45	8.11	14.90
03...8-14	6	1.08	1.99
04...15-21	6	1.08	1.99
05...22-28	2	.36	.66
06...29 OR >	2	.36	.66
TOTAL	555	100.00	100.00

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	253	45.59	
01...< $10	59	10.63	19.54
02...$10-50	112	20.18	37.09
03...$51-100	51	9.19	16.89
04...$101-500	43	7.75	14.24
05...$501-1K	12	2.16	3.97
06...$1K-2500	19	3.42	6.29
07...$2500-5K	4	.72	1.32
08...> $5000	2	.36	.66
TOTAL	555	100.00	100.00

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	253	45.59	
01...< $1	280	50.45	92.72
02...$1-100	14	2.52	4.64
03...$101-500	4	.72	1.32
04...$501-1K	2	.36	.66
05...> $1000	2	.36	.66
TOTAL	555	100.00	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	253	45.59	
01...<1 DAY	257	46.31	85.10
02...1-7 DAYS	19	3.42	6.29
03...8-14	10	1.80	3.31
04...15-21	3	.54	.99
05...22-28	2	.36	.66
06...29-91	10	1.80	3.31
07...92-181	0	.00	.00
08...182 OR >	1	.18	.33
TOTAL	555	100.00	99.99

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	253	45.59	
01...< $1	261	47.03	86.42
02...$1-100	17	3.06	5.63
03...$101-500	15	2.70	4.97
04...$501-1K	6	1.08	1.99
05...> $1000	3	.54	.99
TOTAL	555	100.00	100.00

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	263	47.39	
01...GOOD	265	47.75	90.75
02...MENTL HD	0	.00	.00
03...PHYSL HD	13	2.34	4.45
04...OTHER	14	2.52	4.79
TOTAL	555	100.00	99.99

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	260	46.85	
01...YES	2	.36	.68
02...NO	95	17.12	32.20
03...UNKNOWN	198	35.68	67.12
TOTAL	555	100.01	100.00

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	259	46.67	
01...YES	73	13.15	24.66
02...NO/OTHER	6	1.08	2.03
03...NO/UNABL	1	.18	.34
04...UNKNOWN	216	38.92	72.97
TOTAL	555	100.00	100.00

- -

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	127	22.88	
01...F3 YES	302	54.41	70.56
02...F3 NO	126	22.70	29.44
TOTAL	555	99.99	100.00

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

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...NS/NA	0	.00	
01...REG 1	47	8.47	8.47
02...REG 2	63	11.35	11.35
03...REG 3	42	7.57	7.57
04...REG 4	40	7.21	7.21
05...REG 5	142	25.59	25.59
06...REG 6	69	12.43	12.43
07...REG 7	35	6.31	6.31
08...REG 8	79	14.23	14.23
09...REG 9	38	6.85	6.85
TOTAL	555	100.01	100.01

VARIABLE: 44...MACH.TYPE FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	33	5.95	
01...CHM/FERT	21	3.78	4.02
02...GR/FD HN	82	14.77	15.71
03...HAY TOOL	67	12.07	12.84
04...HRVSTING	131	23.60	25.10
05...MNR HNDL	31	5.59	5.94
06...SEED	29	5.23	5.56
07...TILLAGE	53	9.55	10.15
08...MISC	106	19.10	20.31
09...UNKNOWN	2	.36	.38
TOTAL	555	100.00	100.01

VARIABLE: 45...CHEM.MACH. FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	511	92.07	
01...DUSTER	0	.00	.00
02...DSTRBTR	8	1.44	18.18
03...SPRAYER	9	1.62	20.45
04...AIRPLANE	0	.00	.00
05...OTHER	27	4.86	61.36
TOTAL	555	99.99	99.99

VARIABLE: 46...GRN.MACH. FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	443	79.82	
01...BLOWER	6	1.08	5.36
02...FEEDER	3	.54	2.68
03...CNV/AUG	7	1.26	6.25
04...CNV/BELT	3	.54	2.68
05...CNV/CHN	5	.90	4.46
06...SHELLER	3	.54	2.68
07...DRYER	1	.18	.89
08...ELV/AUG	20	3.60	17.86
09...ELV/CHN	9	1.62	8.04
10...GRINDER	7	1.26	6.25
11...GRN/MIX	13	2.34	11.61
12...MIX/BLND	2	.36	1.79
13...UNLOADER	13	2.34	11.61
14...OTHER	19	3.42	16.96
TOTAL	555	99.80	99.12

VARIABLE: 47...HAY TOOLS FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	465	83.78	
01...BALER	22	3.96	24.44
02...HRVSTER	17	3.06	18.89
03...CONDTNER	1	.18	1.11
04...MOWER/BA	5	.90	5.56
05...MOWER/CN	4	.72	4.44
06...MOWER/RT	9	1.62	10.00
07...RAKE	3	.54	3.33
08...CUBER	1	.18	1.11
09...WINDROWR	5	.90	5.56
10...OTHER	23	4.14	25.56
11...RND BLR.	0	.00	.00
TOTAL	555	99.98	100.00

VARIABLE: 48...HRVST.MCH. FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	443	79.82	
01...COMB/CRN	16	2.88	14.29
02...COMB/GRN	49	8.83	43.75
03...CRN PICK	13	2.34	11.61
04...CRN SHLR	1	.18	.89
05...COT PICK	2	.36	1.79
06...COT STRP	0	.00	.00
07...SGRBEET	0	.00	.00
08...FRUIT	3	.54	2.68
09...VEGTBL	4	.72	3.57
10...THRESHER	0	.00	.00
11...OTHER	16	2.88	14.29
TOTAL	555	98.55	92.87

VARIABLE: 49...MNR.HDLNG FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	523	94.23	
01...BARN	3	.54	9.38
02...GUTTER	4	.72	12.50
03...PUMP	0	.00	.00
04...LOADER	10	1.80	31.25
05...SPREADER	9	1.62	28.13
06...SPR/TANK	3	.54	9.38
07...OTHER	3	.54	9.38
TOTAL	555	99.99	100.02

VARIABLE: 50...SEED MACH. FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	528	95.14	
01...BRDCSTR	2	.36	7.41
02...DRILL	11	1.98	40.74
03...PLANTER	14	2.52	51.85
04...OTHER	0	.00	.00
TOTAL	555	100.00	100.00

VARIABLE: 51...TILL.TOOL FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	497	89.55	
01...CLTVTR	15	2.70	25.86
02...HARROW	16	2.88	27.59
03...PLOW/DSC	4	.72	6.90
04...PLOW/MBD	6	1.08	10.34
05...TILLER	1	.18	1.72
06...OTHER	11	1.98	18.97
07...PLOW/CHL	3	.54	5.17
08...S.T.HROW	2	.36	3.45
TOTAL	555	99.99	100.00

- -

VARIABLE: 52...MISC.EQ. FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	442	79.64	
01...ENGINE	6	1.08	5.31
02...CARRIER	2	.36	1.77
03...IRRGTN	13	2.34	11.50
04...LADDERS	4	.72	3.54
05...SKPLDRS	7	1.26	6.19
06...FRKLFTS	5	.90	4.42
07...TRUCK	9	1.62	7.96
08...PRUNING	1	.18	.88
09...JACK	2	.36	1.77
10...SHREDDER	4	.72	3.54
11...WAGN/GRN	9	1.62	7.96
12...WAGN/FLT	13	2.34	11.50
13...WAGN/SLF	11	1.98	9.73
14...OTHER	27	4.86	23.89
TOTAL	555	99.98	99.96

- -

VARIABLE: 53...ANIMAL EQ. FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	549	98.92	
01...CHUTES	4	.72	66.67
02...BRANDING	0	.00	.00
03...SHEARS	0	.00	.00
04...UTHER	2	.36	33.33
TOTAL	555	100.00	100.00

VARIABLE: 54...MACH.AGE FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	43	7.75	
01...1 OR <	45	8.11	8.79
02...2 - 5	197	35.50	38.48
03...6 - 10	126	22.70	24.61
04...> 10	76	13.69	14.84
05...UNKNOWN	67	12.07	13.09
TOTAL	555	99.82	99.81

VARIABLE: 55...MOUNTING FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	71	12.79	
01...NOT APP.	135	24.32	27.89
02...INTEGRAL	3	.54	.62
03...MNTD/FRT	25	4.50	5.17
04...MNTD/RR	61	10.99	12.60
05...SELF-PRO	78	14.05	16.12
06...SEMI-MNT	9	1.62	1.86
07...TOWED	162	29.19	33.47
08...OTHER	11	1.98	2.27
TOTAL	555	99.98	100.00

VARIABLE: 56...USE FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	28	5.05	
01...HRVSTING	82	14.77	15.56
02...IN-TRANS	15	2.70	2.85
03...LOADING	43	7.75	8.16
04...PLANTING	14	2.52	2.66
05...SPRDING	5	.90	.95
06...STOP/NR.	173	31.17	32.83
07...STOP/RN.	95	17.12	18.03
08...TILLAGE	14	2.52	2.66
09...OTHER	86	15.50	16.32
TOTAL	555	100.00	100.02

VARIABLE: 57...POWERSORCE FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	41	7.39	
01...NOT APP.	104	18.74	20.23
02...ELEC.	49	8.83	9.53
03...ENGINE	154	27.75	29.96
04...GR.DRIVE	11	1.98	2.14
05...HAND	10	1.80	1.95
06...HYDRLIC	33	5.95	6.42
07...PTO	143	25.77	27.82
08...OTHER	10	1.80	1.95
TOTAL	555	100.01	100.00

- -

VARIABLE: 58...PORTION FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	43	7.75	
01...AUGER	32	5.77	6.25
02...EJECTOR	8	1.44	1.56
03...CBL/LINK	7	1.26	1.37
04...CHN-SPRK	35	6.31	6.84
05...CONTROL	10	1.80	1.95
06...CTRHEAD	10	1.80	1.95
07...FEEDING	17	3.06	3.32
08...GEARS	9	1.62	1.76
09...HAMMERS	1	.18	.20
10...HITCH	49	8.83	9.57
11...HYD FLD.	2	.36	.39
12...HYD HOSE	1	.18	.20
13...BLADE	16	2.88	3.13
14...KNOTTER	3	.54	.59
15...LIFTING	19	3.42	3.71
16...PTO	18	3.24	3.52
17...PLNGRHD	1	.18	.20
18...ROLLS	10	1.80	1.95
19...SHAFT	1	.18	.20
20...SPINDLS	2	.36	.39
21...TIRE	19	3.42	3.71
22...V-BELT	22	3.96	4.30
23...OTHER	172	30.99	33.59
24...NONE	48	8.65	9.38
TOTAL	555	99.98	100.03

VARIABLE: 59...CONDITION FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	55	9.91	
01...DMG GRD	4	.72	.80
02...EQ.FLURE	49	8.83	9.80
03...GOOD	344	61.98	68.80
04...GREASE	3	.54	.60
05...GRD N.P.	17	3.06	3.40
06...GRD REM	12	2.16	2.40
07...IMP.HTCH	2	.36	.40
08...LEAKING	1	.18	.20
09...NO BRKS	4	.72	.80
10...POOR BRK	1	.18	.20
11...OTHER	62	11.17	12.40
TOTAL	555	99.81	99.80

- -

VARIABLE: 60...FLAG FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	196	35.32	
01...ON	9	1.62	2.51
02...NOT ON	350	63.06	97.49
TOTAL	555	100.00	100.00

- -

VARIABLE: 61...LIGHTS FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	195	35.14	
01...ON	21	3.78	5.83
02...NOT ON	339	61.08	94.17
TOTAL	555	100.00	100.00

VARIABLE: 62...SMV FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	185	33.33	
01...ON	50	9.01	13.51
02...NOT ON	318	57.30	85.95
TOTAL	555	99.64	99.46

VARIABLE: 63...RFLCTRS FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	197	35.50	
01...ON	30	5.41	8.38
02...NOT ON	327	58.92	91.34
TOTAL	555	99.83	99.72

VARIABLE: 64...OTHER FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	170	30.63	
01...ON	60	10.81	15.58
02...NOT ON	324	58.38	84.16
TOTAL	555	99.82	99.74

VARIABLE: 65...ACTIVITY FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	59	10.63	
01...ADJSTING	63	11.35	12.70
02...BYSTNDR	15	2.70	3.02
03...CLEANING	43	7.75	8.67
04...FEEDING	31	5.59	6.25
05...FILLING	7	1.26	1.41
06...LBRCTING	9	1.62	1.81
07...OPRTING	95	17.12	19.15
08...REFUELNG	1	.18	.20
09...R'PARING	86	15.50	17.34
10...RIDING	27	4.86	5.44
11...OTHER	78	14.05	15.73
12...HITCHING	32	5.77	6.45
13...UNKNOWN	9	1.62	1.81
TOTAL	555	100.00	99.98

- -

VARIABLE: 66...ACT FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	51	9.19	
01...DSTRCTED	14	2.52	2.78
02...PROT.EQ.	32	5.77	6.35
03...HRSPLAY	0	.00	.00
04...IMPR.USE	30	5.41	5.95
05...INATTENT	64	11.53	12.70
06...JUMPED	12	2.16	2.38
07...LOST BAL	63	11.35	12.50
08...XTRA RID	2	.36	.40
09...REACHING	89	16.04	17.66
10...TOO FAST	5	.90	.99
11...POSTN	64	11.53	12.70
12...OTHER	83	14.95	16.47
13...UNKNOWN	46	8.29	9.13
TOTAL	555	100.00	100.01

VARIABLE: 67...LOCATION FILE: GTFFWI DATE: 04/12/88

VALUE	FREQUENCY	PER CENT DISTRIBUTION INCL ZERO	EXCL ZERO
00...UNK/UNC	22	3.96	
01...BARN	34	6.13	6.38
02...BRIDGE	4	.72	.75
03...CAT SHED	6	1.08	1.13
04...CRN FLD	43	7.75	8.07
05...DRVWAY	66	11.89	12.38
06...FEEDLOT	25	4.50	4.69
07...GRN FLD	83	14.95	15.57
08...GRANARY	32	5.77	6.00
09...GRNHOUSE	8	1.44	1.50
10...HAY FLD	40	7.21	7.50
11...HOG HSE	5	.90	.94
12...HIGHWAY	5	.90	.94
13...MAC SHED	41	7.39	7.69
14...ORCHARD	6	1.08	1.13
15...PASTURE	13	2.34	2.44
16...POLT HSE	1	.18	.19
17...SHOP	15	2.70	2.81
18...SILO	16	2.88	3.00
19...WOODS	7	1.26	1.31
20...OTHER	68	12.25	12.76
21...UNKNOWN	4	.72	.75
TOTAL	555	98.00	97.93