

AGRICULTURAL HAZARDS

TRAUMA AND AGRICULTURAL MACHINES

William H. McConnell

Agricultural machines have revolutionized farming. In colonial days, almost 90% of the country's population was needed to produce enough food for everyone. Today, our present population is very well fed by a total agricultural population of 9,425,000 people and according to the U.S. Department of Agricultural Statistics of 1972, less than half of this number, or 4,446,000, make up the actual labor force (this includes 3,281,000 family workers and an additional 1,165,000 hired employees). The application of machines to agricultural production has been one of the major factors in the development of agriculture as we know it today.

This mechanization of farms according to latest information is represented by 4,562,000 farm tractors (wheel and crawler), another 820,000 garden tractors, 760,000 combines, 613,000 corn pickers and picker-shellers, just to mention a few of the more common powered propelled machines. The longevity of farm machines is another factor which must be reckoned with as in the words of General MacArthur, "Old soldiers don't die, they just fade away". The average life of farm tractors is 11 years and the same is generally true of other larger equipment. Only the operators on large acreages tend to replace their equipment with up-to-date models.

Agricultural machine manufacturers have made available to the farmer today an array of mechanical devices to assist him in his chosen occupation and he can, through the use of electronics, mechanics and hydraulics perform work tasks that were not even dreamed of a few years ago. Along with the development of these machines to extend the worker's limited time and multiply his efforts, we have seen the disappearance of such accidents as getting kicked by a draft horse, lacerated by a chip from an ax, cutting a finger while sharpening scythes, and having a foot stepped on while milking a cow. In its place, we have an ever changing scene of accident possibilities with powered machines and tools so diverse as to make demands on the safety expertise of the agricultural worker greater than that of the industrial worker. The problem presented today is how can better injury control be attained for today's agricultural workers and employees.

HAZARD ASSESSMENT

If we wish to examine the injury data for agriculture, we have only a round number estimate of about 200,000 disabling injuries annually according to the 1974 edition of Accident Facts put out by the National Safety Council. They also point out that in 1973 their figures indicate a death rate of 61 per 100,000 workers. This calculation can be used when making comparisons with other industrial rates in a manner similar to procedures followed by the Bureau of Labor Statistics in preparing their estimates. However, for our purposes today, we are interested only in information related to injuries with farm machines. NSC data from farm accident studies over the past several years indicate that work injuries are related to major farm machines in the following percentages: Tractor, 40%; wagon, 20%; elevator and conveyor, 16%; combine, 12%; mower, 4%; corn pickers and shellers, 4%; and balers, 4%.

It is obvious that good data is one of our problem areas. Dr. Keith T. Maddy, California Department of Agriculture, spoke to this issue at a USDA Research Leaders Conference early in 1975 in California. I quote, "A major need in the field of farm safety is for high quality data to identify what the actual problems are. Research is needed to develop improved systems for obtaining and interpreting such data. A number of surveys have produced incomplete and noncomparable data".

A significant step forward in data regarding accidental injuries was contained in some recent work done in Michigan Accident Survey by Howard J. Doss and Richard G. Pfister which is reported in the January-February, 1974, issue of the Farm Safety Review. This study produced some accident rate information on major farm machines from which it is possible to determine accident frequency rates for a number of specific types of farm machinery and are as follows per million hours of use: tractors, 8.4; corn pickers, 48.6; combines, 112.0; wagons, 71.9; elevators 573.6; balers, 106.4. All machines other than tractors have a combined rate of 40.9.

There is also a need to devote more attention to factors related to accident causes. One of the more recent studies done by Phillips, Stuckey and Pugh which specifically sought information on such variables as farm size, sex, family size, educational attainment of the head of the household and number of accidents per family, was exceedingly enlightening.

First, accident rates were significantly higher on farms of 200 acres or more. Secondly, the better educated farmers tended to

operate bigger farms resulting in greater work exposure with an apparent greater number of accidents ensuing. In fact, the higher the level of education the head of the household attained, the greater the number of accidents registered by the family. Thus, the authors summed up these findings succinctly by indicating that apparently the more educated farmer operates more acres, utilizes more machinery, works longer hours and in general, is exposed to a greater number of accident potential situations.

The National Safety Council's Farm Department has been active in instigating a number of state wide studies which have become a useful information source for determining the size of the accident problem in agriculture. The present standardized accident studies tell us who, to what extent and how many are involved in farm accidents. However, the second level and more in-depth inquiry of particular accident problems (epidemiology) will be necessary if we are to develop sufficient specificity in designing successful counter-measure programs regarding safety problems.

MACHINERY TRAUMA

The most visible symptoms of machinery trauma are those which are of an obvious nature, thus this paper will dwell primarily upon the acute injury problems that are demanding immediate attention.

Trauma, in this instance, will be regarded as mechanical, electrical, and/or thermal insult to the body. In discussing it, we will be most concerned with the abnormal energy exchange relative to the mechanical type and to a lesser extent those abnormal exchanges of electrical and/or thermal energy. These energy sources will be examined specifically in relationship to the major powered propelled agricultural machines.

An example of such mechanical energy might be the unexpected event that takes place when a worker suspects a v-belt drive is slipping and places his hand on the v-belt to increase the tension in order to cause the driven part to start to rotate. In this process, the fingers of his hand do not clear the pinch point of the v-belt drive and he suffers a traumatic amputation of two fingers.

Large agricultural machines are not mechanically unique in that many of them, more likely than not, have a variety of power transmitting components such as chain and sprocket drives, v-belt drives, rotating shafts, gear sets, knives and so forth, which have common operational characteristics. Further, if properly guarded where and however the operator may be exposed to them, these components do not present a hazard in normal operation.

Then there are the functional components which L. W. Knapp has very appropriately described several times:

"The mechanical injury problem is related to the inherent characteristics of machines which, by design, are expected to grasp, pound, shake, sort, pull, cut, vibrate, etc., agricultural products in a manner to make them usable for the farmer or the consumer. Major groupings of such machines by category would include soil tillage machines; planting machines; cultivating machines; forage harvesting machines; grain, fiber and vegetable harvesting machines; transport and elevating machines; agricultural chemical applying machines; and sorting and packaging machines.

"Mechanically, these machines are an amalgamation of gears, chains, belts, hydraulic cylinders, motors, electronic devices, etc., that must be controlled by an operator. To err in the judgements necessary to optimize their potential, not only brings about an economic loss, but can result in a serious accident, for they may be powered by motors of considerable horsepower and exert forces of hundreds of pounds of energy. They are not sensitive to the differences between plant protoplasm, which they are to reduce to a desired form, and human protoplasm, should it be encountered inadvertently (that is, a corn picker will not reject a human hand if it is encountered among ears of corn on the husking bed)."

From a major grouping of agricultural machines, one could describe them to be associated in general with four basic operations, that of tillage, planting, harvesting and transport. At the present state of our knowledge with regard to trauma, and from information compiled by the Michigan Study, it appears that harvesting should be our number one problem area. High accident rates are noted in all of the six machines previously mentioned in the Michigan Study, with tractor injuries most likely related to transport on the highways.

The seriousness and the severity of farm machinery accidents, which in many instances can result in amputations and permanent disabilities, places them high on the priority list for counter-measure action. Now, let's look at the specific agricultural machines and discuss some of the typical types of injury associated with their use.

We know there is an agricultural accidental injury problem today, and as described in Accident Facts, 1974 edition, it ranks number 3 amongst all industries in the number of fatal accidents annually. The real question is why can't we solve this problem. I believe it is because we have treated it as a single problem. It is time we quit looking for all inclusive injury prevention techniques and give attention to the need for improved design as well as more actively attempting to determine the ultimate causes of various kinds of agricultural accidents. The basic methodology in determining which factors of man, machine or environment, were responsible for injuries has been overlooked too long. We have been consistently leading ourselves into blind alleys by looking for all encompassing solutions to accidents and have placed too much emphasis upon "operator error". What is implied by this course of action is if we can get the man straightened out, then we will eliminate the injury. This is a fallacy for surely we know that all people will not read and follow safe practices nor will they heed all visible warning signs. (Even after having an accident, they often duplicate the same unsafe practice.)

IN-DEPTH INVESTIGATION OF TRAUMA

Historically, agricultural accident statistics have been based upon analysis of information gathered from the various states records of death certificates, newspaper clipping services and occasional accident surveys; however, the 1960's brought about a rapid change in the overall methodology of securing data. The advent of the application of epidemiological techniques by the Institute of Agricultural Medicine and Environmental Health to the study of specific accident problems has caused the entire picture to be refocused. A new emphasis as to that which can be accomplished through in-depth study was revealed.

Farm family accident studies in Ohio and Michigan based on a statistically sound sampling technique have indicated specific areas where additional research was needed. These studies are most useful in pointing out problem areas for injury control needs but, even more importantly, pointed out the need for more comprehensive information on farm machinery accidents themselves. These two preceding statements further affirm the fact that expanding the data base is not sufficient when dealing with farm machinery safety. There is already a reservoir of data on agricultural injuries just waiting to be applied.

Assuming then that we need more comprehensive information on farm machinery accidents, let's explore the methodology and philosophy of the in-depth investigation, a research tool of considerable import.

First of all, we are describing a methodology which delves into three distinct areas contributing to the accident sequence which are the man, the machine or agent and the environment.

Obtaining this information requires someone who has had training, has experience with the activity being investigated or developed an expertise in this area and uses a professionally skillful approach to the information gathering sequence.

The basic job of the investigator is to get all of the factual information that is available such as the physical, mental and health characteristics of the individual involved, a specific determination of the terrain at the accident site, the climatic conditions at the time of the accident and the detailed description of the machine that was involved. While securing this information the investigator must be continually on the alert to determine the sequence of the events that led up to the actual accidental injury. In addition, he must also seek to determine why the victim was doing what he was doing just prior to the occurrence of the accident. This in itself is very useful in evaluating some of the natural behavioral patterns exhibited by victims.

Finally then, a report is prepared which will include basic information of the victim, the produce and the accident site along with pictures of the machine involved as well as the simulated re-enactment of the scene whenever this is possible.

Preparation of an accidental injury report requires a professionally trained investigator who not only has the technical skill to ask intelligent questions about a machine, but also possesses a great deal of expertise in interviewing and communicating with the people from whom he is seeking information. This latter skill is most important in securing the voluntary cooperation of an accident victim.

It has been our experience that when case reports are prepared by trained investigators the analysis of such cases for a specific machinery category can be very productive for the development of specific counter-measures. The abundance of factual information and particularly the natural behavior patterns of the victim uncovered during the interview not only make it possible to

develop hazard patterns, but also makes it easier to establish priorities for counter-measures which could reduce the injuries associated with a particular type of accident.

Some might ask where is the reservoir of data on occupational injuries in agriculture? My answer is that we have a real world of agricultural accidents to sample, those of yesterday and today. There is no reason to speculate on how something may go wrong and cause an injury to an agricultural worker if we send skilled investigators out to the site of the accident and visit with the accident victim and witnesses.

Some will say that we need to expand the data base. However, I feel that the lack of the firm data base is no longer an excuse for continuing to proliferate agricultural occupational trauma exposures in the farm environment.

SUMMARY

Agricultural mechanisation has revolutionized farming but presents a problem in attainment of better injury control for agricultural workers and employees. A major need in agricultural safety is high quality data to identify actual injury problems. Acute injury associated with farm machines needs the application of epidemiological techniques. In-depth investigation of farm machinery accidents by specific categories is indicated. Trained professionals, in-depth investigators, can provide the factual background for implementation of appropriate counter-measures and more effective educational programs.

REFERENCES

1. Accident Facts, 1974 Edition. National Safety Council, Chicago, Illinois.
2. Knapp, L.W. "Agricultural Injury Prevention." JOM, Vol. 7, No. 11, November 1965.
3. Agricultural Statistics for 1972. U.S. Department of Agriculture, Washington, D.C.
4. Knapp, L.W. and L.R. Piercy. "An Epidemiological study of Power Take-Off Accidents." Institute of Agricultural Medicine, University of Iowa, Bulletin #10, 1966.

5. Phillips, G.H., W. E. Stuckey and A.R. Pugh. "Farm Family Accidents: 1967 and 1972." J Safety Research, Vol. 7, No. 2, pp 85-89, June 1975.
6. Knapp, L.W., L.R. Piercy and W.H. McConnell. "Looking at Human Behavior for Clues to Man-Machine Problems." Presented at Winter Meeting, ASAE, 1969.
7. Maddy, K. "Farm Safety Research Needs." Presented at U.S. D.A. Research Leaders Conference, Pacific Grove, California January 1975.
8. Doss, H.J. and R.G. Pfister. "Michigan Accident Survey." Farm Safety Review, Vol. 32 pp. 10-13, January-February 1974.

OCCUPATIONAL HEALTH AND SAFETY SYMPOSIA

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Division of Technical Services
Cincinnati, Ohio 45202

February 1976

This publication contains major papers presented at the 35th AMA Congress on Occupational Health, held September 29 to 30, 1975 in Cincinnati, Ohio. The Congress was supported by NIOSH/CDC Cost-Sharing Contract No. 210-75-0033. Dr. Henry Howe was AMA Project Director and compiled the initial proceedings from submitted papers and verbatim transcripts.

Marilyn K. Hutchison, M.D. NIOSH Project Officer

The assistance of the following individuals is gratefully acknowledged:

AMA

James H. Sammons, M.D.
William R. Barclay, M.D.
Asher J. Finkel, M.D.
Henry F. Howe, M.D.
Barbara Jansson

CDC-NIOSH

David J. Sencer, M.D.
John F. Finklea, M.D.
Marilyn K. Hutchison, M.D.
Leo Sanders
Marilyn Hodge

HEW Publication No. (NIOSH) 76-136