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BRIEF REPORT

Tractors, Trees, and Rollover Protective Structures: A Cause for Concern

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ABSTRACT

Injury and fatality events that are caused by tree work and tractor-related activities contribute to the already elevated rates of work-related injuries in the agriculture and logging sectors. This brief report highlights the circumstances surrounding these events, as well as a number of surveillance sources that identify the extent to which they contribute to the injury burden in these hazardous industries. These data sources include fatality investigations, agricultural injury news reports, consumer product injury data captured from emergency rooms and near-miss reporting data captured from individuals participating in the National Rollover Protective Structure Rebate Program (NRRP). Several recommendations for further research and interventional efforts are outlined, with particular consideration of the manner in which rollbars have been involved in falling object incidents.

KEYWORDS

Falling objects; injury; tractors; logging; tree work; agriculture; rollover protective structures;; surveillance

Introduction

Agriculture and logging industry worksites have been widely recognized for their potentially hazardous work conditions[1–5] and many of the factors contributing to occupational injury and illness have been documented and assessed.[6–8] However, one particular issue that would benefit considerably from additional research and interventional efforts is the issue of agricultural tractors and tree work. Surveillance data from a number of sources document these events, which can lead to severe injuries and death.[9,10]

While rollover protective structures (ROPS) have been highlighted in the literature as potentially reducing the extent of injuries or even preventing them,[11,12] these safety devices are not designed to protect tractor operators from falling objects. Searching the literature, we identified several research reports providing information regarding the extent or circumstances of falling object injuries and deaths in the agricultural sector.[13–17] Research conducted on similar events in the logging industry also reveals falling objects as a source of concern.[18,19] While these articles provide an indication of the extent to which falling objects are a concern in the agriculture and logging industries, none focused specifically on the intersection of tractors and falling objects/trees. This brief report highlights data sources that document injuries and fatalities related to these factors.

Tractors and tree work

In agriculture and logging operations, tractors and bucket loaders are frequently used to carry heavy loads such as round bales, logs, or other large/heavy objects. Additionally, tractors are often employed to pull tree stumps from the ground, bring down trees that have been felled but are caught on neighboring trees, or assist with structure demolitions. These activities can be hazardous, especially when a confluence of factors cause these objects to be dislodged in a way that crushes or injures the tractor operator.

Methods

Given the severity of these events, examining the frequency and circumstances of tractors and tree

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work/falling objects is imperative. Currently, no single US data source provides an all-inclusive surveillance of these types of injuries.[20,21] Fortunately, a number of available sources do provide the opportunity to gather an initial look at the conditions and factors that contribute to injury and death. The resources featured in this brief report include the NIOSH Fatality Assessment and Control Evaluation (FACE) program, the National Electronic Injury Surveillance System (NEISS) Database, the AgInjuryNews (AIN) Database, and National ROPS Rebate Program (NRRP) participant near-miss reporting survey data.

FACE Data

The National Institute for Occupational Safety and Health (NIOSH) conducts detailed examinations of the circumstances surrounding worksite fatalities in collaboration with state-based FACE programs, state labor and health departments.[22] These investigations are conducted by engineers, industrial hygienists, or safety specialists and involve a worksite inspection, interviews with individuals familiar with the event and a review and summary of the evidence gathered. Investigation summaries outline the events and factors that led to the fatality and also provide recommendations for employers and workers to address the primary hazards outlined in the investigation. This information is publicly accessible and can be found on the FACE website at https://www.cdc.gov/niosh/face/inhouse.html. FACE cases reviewed are from 1983 to the present.

NEISS data

The NEISS dataset is managed by the United States Consumer Product Safety Division and offers data on the events and factors involved in consumer-related product injuries.[23] The data featured in the dataset are pulled from a "nationally, representative probability sample of hospitals".[23] Participating hospitals submit information on the circumstances surrounding the event that led to emergency care and hospitalization. NEISS has also established an interagency agreement with the Centers for Disease Control and Prevention (CDC) to collaborate in the collection and dissemination of injury data. NEISS data can be accessed through an online "data and query builder" at https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx. For this study, the outcome variable used to search the dataset was injuries to tractor operators related to trees resulting in emergency department visits. Case narratives from 13 years of data (2010–2022) were reviewed for "tractor" and "trees" to identify whether the injury was related. Inclusion criteria were as follows: "Tractor operated with operator in the cab" and "Struck by a falling tree" or "Struck by swinging tree branch" or "Hit by a tree limb/branch". National estimates were created using weights provided by the NEISS. The complex sample function of SPSS was used to obtain estimated number of injuries with confidence intervals (95% CI). A limitation of the NEISS dataset, is that unweighted values < 20, weighted values smaller than 1,200, or a coefficient of variance bigger than 33% provide unstable results.[24]

AIN data

The AIN system offers summary data captured through the identification and documentation of publicly available traumatic injury reports, primarily derived from news media, obituaries, and the like.[25] Events are identified through news clipping services, Google alerts and from publicly sourced offerings (AIN registered users, safety specialists, advocates, and other stakeholders). Data is coded and entered in the AIN system, which is then made available to the public via the AIN website https://aginjurynews.org/. AIN database searches can be filtered by a number of criteria, including location, date, time, PPE used, victim demographics, role in the event and injury agents. A subset of the dataset was exported for this project and by filtering tractor operator incidents involving falling trees from Jan 2016 to July 2023.

NRRP hotline data

The NRRP provides United States farmers with assistance locating ROPS for tractors that lack these essential safety devices. In several states, farmers also benefit from rebate funding that

allows them to offset the expense of installing ROPS on tractors. On an annual basis, participants in the program are surveyed to identify events that could have led to injury or death if the tractor had not been equipped with ROPS through the program. Participant responses are stored in a database at the Northeast Center for Occupational Health and Safety, which contains responses from 2008 to present (July 2023). Reporting near miss events is not a requirement of the program and it is likely that some events were never reported.

Results

Each of these data sources pointed to examples where tractor use in agricultural production or logging operations led to falling trees or falling objects, that either struck the tractor's ROPS or the tractor operator. Given the information provided in the NEISS dataset the authors were unable to assess overlap between these data sources. There were no known duplicates between the AIN and FACE datasets.

FACE data

A search of NIOSH face reports offered three examples of tractors and falling objects that led to the death of the tractor operator. An example from one FACE report is featured below:

> NIOSH Fatality Assessment and Control Evaluations (FACE) Detailed Report: "At approximately 9:48 a.m. on September 26, 2017 Employee was driving on a public road with his work vehicle, a John Deere 5015 mower. He needed to get the mower to another site for mowing an area. As he drove on the public road, a tree on private property was uprooted and fell. The tree struck the canopy of his tractor and seriously fractured his right leg. Employee also suffered leg contusions. Employee was transported to a medical center where he later died due to the severity of the leg fracture and contusions."

NEISS data

An estimated 3,851 (95% CI 3,704–3,997) tractor-tree-related injuries were treated in US emergency departments, 2010 to 2022 (Figure 1). Patient age ranged from 18 to 86 years. The mean age of the patients was 56.73 (95% CI 52.10–61.36) and 37.5% (estimated 1,446) of them were in the 65 and older age group. The most common diagnosis was laceration reported in 27.6% ($n = 1061$), followed by fractures (24.6%, $n = 948$), contusions and abrasions (14.1%, $n = 544$), and traumatic brain injury (13.9%, $n = 514$). Among the body parts affected, the head, face, and neck were injured in 51.8% of the patients ($n = 1,995$). Trunk injuries were reported in 18.6% ($n = 717$) of patients and upper extremity injuries were reported in 16% ($n = 604$) of patients. About 77% of the patients ($n = 2,959$) were treated and discharged from the emergency department while 17% of the patients were admitted to the hospital for further treatment.

AIN data

According to AIN, 25 people were injured due to incidents involving tractor operators and trees (17 fatal and 8 nonfatal; examples in Table 1). Victim

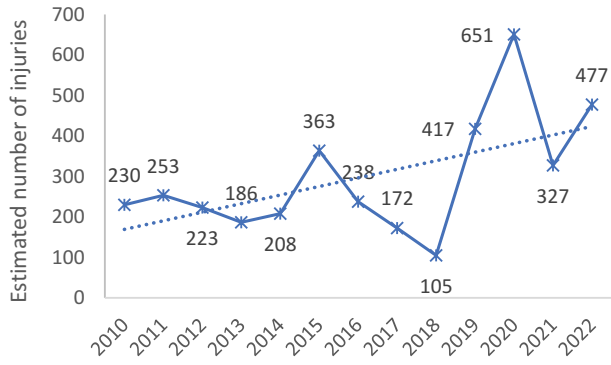

Figure 1. Yearly distribution of injuries treated in U.S. emergency departments.

Table 1. Examples of incidents described in AgInjuryNews data.

Example #1	A 58-year-old male nonfatally injured when working with a tractor in a field near the woods. The operator was killed when a tree fell on him.
Example #2	A 67-year-old who was fatally injured when he was struck by a large branch, pinning him to the seat of his tractor.
Example #3	A tractor operator (age unknown) was fatally injured when using a tractor to move downed trees. One of the trees ended up falling onto and pinning the man into the seat of his tractor.
Example #4	An 87-year-old male fatally injured when his tractor ran into tree limb, pinning him.
Example #5	A male (unknown age) fatally injured when pinned to his tractor's seat as he was removing a tree from a hay field.

age ranged from 28 to 89 years (7 victims had no age information); 12 victims (48%) were in the 65 and older age group.

NRRP hotline data

Data collected from NRRP participants reporting close-calls revealed 22 events involving trees or falling objects and tractors. This database includes surveys from 8,418 individuals reporting on events from 2008 to 2023. Tasks involved at the times of these events included brush hogging, pulling trees, logging, spreading fertilizer, or mowing. Events largely involved falling objects such as tree, branches, or poles. Although information relating to treatment of injuries was often not included in the reports, participants indicated that severe injuries were averted as a result of the ROPS that had been installed through the program. An example from one NRRP participant is featured below:

> National ROPS Rebate Program (NRRP) Participant: "Pulling out firewood, when tree being dragged out hit an old, smaller, dead, cedar tree causing it to fall onto the ROPS of the tractor. The ROPS kept the old cedar tree from hitting me. I thought the tree I was dragging was going to slip past the tree. Could not believe when the old tree broke off and fell onto the ROPS."

Conclusions/Recommendations

Falling objects, tractors and tree-related injuries and fatalities represent an area of agricultural and logging injury prevention that requires further research and interventional engagement. As documented in the surveillance and survey data featured in this brief report, falling objects, and the use of tractors in agricultural and logging work can be considerably dangerous. While data from the NRRP indicate that ROPS have been helpful in averting injury or death for some operators, they are not designed or tested to perform this function. Falling Object Protective Systems (FOPS) have been designed by engineers[26] and are provided on some tractors, although the extent to which these are utilized to conduct tasks that could involve falling objects is unknown. The authors of this brief report call for further research into the circumstances of these events, as well as the utility of FOPS for protecting tractor operators as well as interventions to mitigate these risks. While behavior-changing interventions to prevent workers from using agricultural tractors for tree work would be ideal, it is unlikely such an intervention would be successful on a large scale. These types of interventions would place responsibility on tractor operators for purchasing and maintaining additional equipment – costs that many in the agriculture sector would find difficulty justifying. Thus, the coauthors also recommend consideration of an amendment to the ROPS testing standard,[27–29] which would involve adding a test or evaluation criteria to the current standards method for resolving this issue. Additionally, promoting the importance of Four Post ROPS and/or cabs instead of two post ROPS for activities that involve a higher chance of falling objects should also be a target for future interventions.

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