Effectiveness of roll-over protective structures in reducing farm tractor fatalities

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Authors' objectives
To evaluate the effectiveness of roll-over protective structures (ROPS) as an engineering control for the prevention of fatalities from farm tractor roll-overs.

The systematic review was one of many undertaken as part of an occupational injury project coordinated by the Harborview Injury Prevention Research Centre in the US. It included participants from the Injury Control Research Centres, and the Division of Safety Research, Agricultural Safety and Health Centres. Some methodological details of the review have been published elsewhere (see Other Publications of Related Interest).

Searching
The following databases were searched: MEDLINE, EMBASE, NIOSHTIC, Expanded Academic ASAP and PsycINFO. Other relevant information sources were identified by checking references and consulting with experts in the field.

Study selection
Study designs of evaluations included in the review
There was no apparent restriction on study design, other than the need for comparative data. Relevant studies from peer-reviewed journals, technical and government reports, and unpublished reports were included, as were studies from the US or other countries. Most of the studies included in the review were surveys.

Specific interventions included in the review
The use of ROPS on agricultural tractors. Interventions that influenced the implementation of ROPS, such as legislation and education, were also included.

Participants included in the review
Operators of agricultural tractors, regardless of age, gender or race/ethnicity, were included.

Outcomes assessed in the review
There were two primary categories of outcome, namely implementation of ROPS and fatalities. Nonfatal injury and occurrence of a roll-over incident were also included for some studies. Studies were excluded if they did not objectively measure outcomes, or if they did not contain interpretable data.

How were decisions on the relevance of primary studies made?
The studies were selected for inclusion as described previously (see Other Publications of Related Interest). The abstracts or titles were screened by two independent experts using standardised criteria to identify potentially eligible articles. If an abstract or title met the screening criteria, a full copy of the study was retrieved. A standardised checklist was then used by two independent raters to determine whether the retrieved articles should be included. The authors of the review then abstracted each study, judged methodological quality, and made the final decisions on which articles to include.

Assessment of study quality
Although it was reported that the studies were assessed for validity, there was no information on how the validity assessment was performed or on the quality of the included studies.

Data extraction
The authors do not state how the data were extracted for the review, or how many of the reviewers performed the data
The data that were extracted were the reference details of the study, the location, the intervention, the outcome measure used, and a summary of the results and comments.

Methods of synthesis
How were the studies combined?
The studies were combined in a narrative summary.

How were differences between studies investigated?
The differences between the studies were not evaluated. However, the findings of U.S. studies were reported separately from those based in Northern Europe.

Results of the review
Twenty-one studies were included in the review (the number of participants was not reported): 7 studies looked at the implementation of ROPS and 14 evaluated the effectiveness of ROPS.

Implementation of ROPS (7 US studies).
Farm tractor roll-overs result in approximately 200 fatalities per year in the US. ROPS or crush-proof cabs, which are designed to protect the farmer during roll-over incidents, are currently used on only about 50% of the estimated 4.8 million tractors in the US. A significant proportion of tractors built after 1985, when manufacturers began implementing a voluntary ROPS standard, have had their ROPS removed. The effectiveness of ROPS is limited if the farmer does not use a seatbelt to prevent ejection from the protective environment of the ROPS during a roll-over. In New York, 68% of tractors with ROPS also had seatbelts. It was estimated that 54% of all tractor use time in the US is not protected by ROPS and seatbelts.

Prevention of fatalities or injuries (9 US studies, 4 Northern European studies, and 1 international comparison).
Studies for the US were either specific case investigations of fatalities, or were ecological studies relating patterns of ROPS use to patterns of fatalities. The overwhelming majority of fatalities occurred from roll-overs of tractors without ROPS. In the very few studies where fatalities did occur when using a tractor with ROPS, the farmer did not use a seatbelt and was thrown from the tractor. The best evidence concerning the effectiveness of ROPS came from Sweden and other Northern European countries, which clearly demonstrated that ROPS can essentially eliminate roll-over fatalities.

Cost information
It was estimated that the cost of retrofitting older US tractors with ROPS ranged from approximately US$500,000 to US$900,000 per life saved, which is comparable to other life-saving interventions.

Authors' conclusions
Future research efforts should include the development of collapsible and telescoping ROPS that can be used in low clearance areas such as dairy barns and fruit orchards. ROPS retrofits also need to be developed for many older tractor models. Effective educational and incentive programmes need to be developed to increase the acceptance and use of ROPS among US farmers. A national policy should be implemented to ensure that all tractors operated in the US are equipped with ROPS or crush-proof cabs.

CRD commentary
This appeared to be a review of moderate quality. The inclusion and exclusion criteria were clearly defined. The search strategy appeared to be fairly comprehensive and included a search of unpublished data. However, the years searched and the specific search terms used were not reported. Some information about the review process was presented.
although it was not reported how the data were extracted or how many of the reviewers were involved in the process. A systematic appraisal of the validity of the included studies does not appear to have been undertaken. In addition, any differences between the included studies were not discussed, although the findings of the US studies were reported separately to those from Northern Europe. Relevant details of the primary studies were presented in tabular format, and the narrative summary of the results was appropriate.

The authors’ conclusions appear to follow from the results.

**Implications of the review for practice and research**

Practice: The authors stated the following three implications for practice.

1. ROPS retrofits need to be developed for many older tractor models.

2. Effective educational and incentive programmes need to be developed to increase the acceptance and use of ROPS among U.S. farmers.

3. A national policy should be implemented to ensure that all tractors operated in the US are equipped with ROPS or crush-proof cabs.

Research: The authors stated that future research efforts should include the development of collapsible and telescoping ROPS that can be used in low clearance areas such as dairy barns and fruit orchards. They also stated that the relative effectiveness of ROPS frames, compared with crush-proof cabs, needs further evaluation.

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**Other publications of related interest**


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