



# The Agricultural Health and Safety Network

## Safe Machinery Operations Module #1

**ROLLOVER PROTECTIVE STRUCTURES  
ROLLOVER PREVENTION STRATEGIES**



# Rollover fatalities are when

In this module please find information and case studies for training your family and workers.

A rollover incident is always devastating.

Whether it is a fatality or a debilitating injury the effects reach beyond the individual to the family and community. The good news is that rollover fatalities are 99% preventable when combined with ROPS and the use of a seatbelt.

## HAZARD CONTROL AND ROLLOVER PROTECTIVE STRUCTURES

Many farmers perform formal or informal safety audits\* on their farms. The physical state of the farm workplace is associated with injury. Therefore, the goal is to improve the physical state through risk assessment and taking action to correct hazards by using the most effective hazard control. The Hierarchy of Control is a standard industrial hygiene approach used in industry. A modified Hierarchy of Control has been shown to be effective in agricultural workplaces, and will identify a typical hazard found on Saskatchewan farms such as tractors without ROPS. In fact, 43% of tractors on Saskatchewan farms do not have ROPS. One in four tractor-related deaths on Saskatchewan farms is due to a rollover. Almost 80% of rollovers are sideways, and about 20% of rollovers are rearwards.

## DID YOU KNOW...

- Machinery is the leading cause of injury and fatality in summer and fall at 19%.
- Between 2003-2012, 70% of fatalities were machine-related (589 fatalities).
- Leading causes of fatality are rollovers run overs and entanglements. Almost half of all ag-related fatalities in Canada were due to these machine related causes.
- 56% of rollover fatalities occur when the tractor rolls sideways usually due to being too close to the edge of a ditch or slope.

The absence of ROPS on a tractor is a critical hazard because in the case of a rollover, not having a ROPS could cause a loss of life or permanent disability. A rollover incident is preventable. Because of the high risk associated with rollovers and the impact on farm fatality statistics, correction of this hazard should take high priority. However, if it is not possible to eliminate the unsafe tractor from use or substitute a safer one, it can be retrofitted with a ROPS.

Proper training of workers and the appropriate personal protective equipment should still be a priority. As the farm manager, you should set a good example and wear a seatbelt. On page 11 you will find more information on training young and new workers.

*\*For more information on the full Farm Safety Audit and the Hierarchy of Control go to the Agricultural Health and Safety Network's website: [agsafety.usask.ca](http://agsafety.usask.ca)*

# The Rollover Protective Structure (ROPS), Background and Research



preventable  
combined with ROPS and a seatbelt.

## BACKGROUND

Agriculture is known to be one of the most dangerous occupations. However, we can identify and correct hazards to make it safer. If your older tractor is not ready to retire, you may have the option to retrofit it with a ROPS safely and effectively at a minimal cost. This is the best way to protect yourself in the case of a rollover. In the event of a rollover, a ROPS paired with seatbelts will reduce the chance of fatality rollover by 99%.

## WHY DON'T FARMERS RETROFIT THEIR TRACTORS?

- Many farmers believe that their experience will prevent a tractor rollover injury
- They have no hills on their land so there is no rollover risk
- Their tractor won't fit into the barn or shed with ROPS
- Cost

## WHY RETROFIT OLDER TRACTORS WITH ROPS?

The previous generation of agricultural equipment was built to last, with the life span of older tractors having far surpassed current safety advancements.

This presents a challenge to ensure the safety of the user, especially when 25% of all work-related deaths are tractor rollover events. We are faced with a commercial gap for retrofitting ROPS that the equipment industry has been unable to successfully fill at a reasonable cost with minimal effort. The cost of retrofitting older tractors should not exceed the value of the tractor.

## THE LOW COST ROLLOVER PROTECTIVE STRUCTURES INTERVENTION PROJECT

In this project, researchers from across Canada are looking at the previous work and information regarding ROPS to move the development forward and fill that gap by developing economical, user friendly, engineered ROPS fabrication design drawings for the majority of older tractors and provide them to farmers. The reliability of building them with typical farm shop equipment is being tested.

The ROPS Pilot Project addresses regulations and liability, develops engineered drawings, conducts trial build and installations, and provides the testing of farmer built structures. Trials are taking place in Saskatchewan, Newfoundland, British Columbia, and Manitoba.

FOR MORE INFORMATION  
OR TO BECOME INVOLVED  
IN THE ROPS PROJECT:

[WWW.AGRIVITA.CA](http://WWW.AGRIVITA.CA)

*The Low Cost Rollover Protective Structures Intervention Project is one part of Agrivita Canada Inc.'s Canadian AgriSafety Applied Research Program funded by the Industry-led Research and Innovation Stream of the Agri-Innovation Program of Growing Forward II through Agriculture and Agri-Food Canada (AAFC). The project is lead by a national team of researchers from Prairie Agricultural Machinery Institute (PAMI) SafetyNet, the Canadian Centre for Health and Safety in Agriculture (CCHSA), the University of Alberta, the Injury Prevention Centre (IPC, formerly ACICR), and the Canadian Agricultural Safety Association (CASA). The project addresses the issue of rollovers by using engineering controls, one of the steps in the Hierarchy of Control which is commonly used in industry to reduce the risk of exposure to workplace hazards.*

## REMEMBER:

What is obvious to you may not be to an inexperienced operator. Not all workers understand why a seatbelt is necessary to benefit from a ROPS in the case of a rollover. Discussing this concept with your family and workers will contribute to adoption of seatbelt use.

# Lives are saved BY USING ROPS!

### DEFINITIONS AND INFORMATION TO WORK WITH WHEN YOU ARE EDUCATING YOUR WORKERS ABOUT USING ROPS.

- Tractors are more likely to rollover than a car or truck due to the higher centre of gravity.
- A ROPS is a cab or frame designed to withstand the forces of a tractor rolling over in order to protect the operator. It is designed to keep the tractor operator within a “zone of protection” in the event of a rollover.
- To be effective, ROPS must be paired with a seat belt to keep the operator within the protective zone of the ROPS.
- Without a seatbelt, the operator could be thrown from the protective area or crushed by the ROPS itself in a rollover.
- Do not wear a seatbelt on a tractor without a ROPS.
- Also remember that a tractor with a cab does not automatically mean that there is a ROPS. Certified ROPS will have a ROPS Label.
- Rollover injuries and deaths are preventable through the use of ROPS and seatbelts.

### HISTORY OF ROPS DEVELOPMENT AND HAZARD REDUCTION EVALUATION AND RESEARCH

- Manufacturers began including ROPS as standard equipment at varying times.
- Extensive impact testing of the ROPS ensures that the operator is protected during a rollover.
- Standards for ROPS are set by organizations such as the American Society of Agricultural and Biological Engineers (ASABE).
- Self-made ROPS may not conform to safety standards and may provide a false sense of security which is why there may be well tested options in the near future.
- In Canada the leading cause of farm work-related deaths is tractor rollover events, accounting for 25% of all farm work-related deaths. From 1998-2008, 330 Canadian farmers died in tractor rollovers. The fact is that the prevention of these fatalities and injuries could have been accomplished by installing a ROPS.
- *Evidence from Sweden, Norway, Finland and Germany demonstrates that mandatory ROPS retrofitting and mandatory ROPS on all new tractors virtually eliminated fatal tractor rollovers.*

# WHAT ARE Rollover Protective Structures?



## PREVENTABLE INCIDENTS vs ACCIDENTS

Are Accidents Accidental? Carelessness isn't a satisfactory explanation for why accidents occur. None of us go to work in the morning thinking, "Today I may get injured on the job; I really don't care."

When you tell someone to be more careful, it doesn't create a clear picture of what they need to do. And if you can't picture the safe behaviour, it likely won't happen. This is why new workers need to be taught the reasons behind your operation's safety rules.

Research shows that accidents have identifiable risk factors which are predictable. It is incorrect to view them as "freak events", but they should be viewed as preventable incidents. The terminology has changed from Accident to Incident.

Tractor rollovers are not common incidents, but they do have a high potential for causing death or disabling injury when they do occur. Prevention efforts have a high pay back value. Non-ROPS tractor rollovers are associated with an increased severity of injury when compared to ROPS equipped tractors. These deaths are preventable with Rollover Protective Structures and a seat belt. Retrofits are available for many older tractors. Check with a dealer whether a ROPS is available for your tractor.

**REMEMBER!!**  
**ONE SEAT!**  
**ONE RIDER!**

SEE  
[WWW.AGHEALTH.USASK.CA](http://WWW.AGHEALTH.USASK.CA)  
FOR THE FULL FARM SAFETY AUDIT  
FOR YOUR FARMING OPERATION

## ROLLOVER PREVENTION CHECKLIST

*Proper use and implementation of ROPS must be used along with safe work practices that can prevent rollovers.*

### PHYSICAL CONDITION:

- Does the tractor have a ROPS or ROPS-compliant cab?
- If tractor has a collapsible ROPS, can it be erected and latched in the erect position?
- If a tractor has a ROPS, is there a seat belt in working order, anchored to the seat?
- Does the tractor have a decal warning against high hitches?
- Are brakes able to hold the tractor's rated load?
- Can brakes be interlocked for road travel?
- Check steering components—no looseness when tie rod ends are pushed and pulled endways?
- Do brakes have non-slip pedals?
- Are tires properly inflated and free of defects?
- Does tractor have an emergency exit additional to doors? (pop-out window?)

### SAFE WORK PRACTICE:

- If tractor has a ROPS, do you always wear the seat belt while operating?
- Do you always steer clear of hazards such as ditches and soft areas?
- Do you slow down for turns?
- Do you back up steep slopes and back out of ditches?
- Do you use engine braking when going downhill with a heavy load?
- If you must turn on a slope, do you turn downhill?
- Do you approach and pick up round bales from the downhill side?
- Do you estimate the weight of a load and check the operator's manual to be sure it is within tractor's rated weight?

# CASE STUDIES

## WHY USE THE CASE STUDY METHOD FOR LEARNING?

Rather than simply listing a series of rules, we suggest that using case studies can be a very effective tool for learning. Case studies have an important role in developing skills and knowledge for the learner. They are stories which provide situations that characters must negotiate. They are realistic and complex providing material for relevant discussion. It also:

- Bridges the gap from theory to best practices
- Encourages active learning
- Develops key skills such as problem solving and communication
- Provides an enjoyable and engaging way to learn

## INCIDENT ANALYSIS

For each of the following case studies, we will perform an accident/incident analysis, in order to identify the following:

### 1. THE IMMEDIATE CAUSE OF THE INCIDENT:

- The events that immediately precipitate or lead up to the incident

### 2. POSSIBLE CONTRIBUTING FACTORS:

- Human?
- Mechanical?
- Environmental?

### 3. THE BASIC, OR SYSTEMIC, CAUSE OF THE INCIDENT:

- This means the basic or underlying cause of an incident is often related to an unsafe operating procedure. Remove this, and you prevent a similar incident from happening in future.

### 4. WHAT ONE THING COULD PREVENT A SIMILAR INCIDENT?

- Implementing a standard, safe operating procedure gives you a safety net when things go wrong. They will go wrong.

The following case studies are based on actual incidents modeled on tractor fatalities that have occurred on Canadian farms. The names of victim, date, and location, etc. are fictitious. Following each case study you will find the answers to the above questions. You may discuss additional answers or elements of the case study to discuss that apply to your farming operation.

# CASE STUDY

# 1

In June 1995, Marc, aged 18, had finished high school and been accepted as a student by the College of Engineering at the University of Québec. He was elated when he was hired as a summer labourer near his home in the Saguenay Lac. St. Jean district of Québec by a hog operation undergoing an expansion. The wages would help fund the expenses of his coming year at university.



Raised on a farm, Marc brought a wide range of skills to the job. Jacques, the crew boss to whom Marc reported, wished he had another five summer workers just like him.

On July 10, Marc was operating a John Deere 2040 tractor which was towing a flat-bed trailer loaded with lumber for the new hog barn. Going downhill on a gravel side road, he lost control of

the tractor. The tractor went over the edge of the road and overturned, pinning him under the rear tire. The tractor did not have a rollover protective structure or seatbelt and the trailer had no brakes

When emergency personnel freed him from the wreckage, Marc was breathing but unconscious. He died of head injuries six weeks later in hospital. The accident investigation revealed that the load being towed exceeded the tractor's rated safe weight.

## Incident Analysis Questions and Answers:

### 1 WHAT WAS THE IMMEDIATE CAUSE OF THE INCIDENT?

Going downhill on a gravel road towing a heavy load, the tractor operator lost control of the tractor, resulting in a side overturn.

### 2 WHAT WERE POSSIBLE CONTRIBUTING FACTORS?

#### HUMAN

- Limited experience towing heavy loads
- Lack of awareness of similar incidents

#### MECHANICAL

- Heavy load
- No independent trailer brakes
- No rollover protective structure or seatbelt

#### ENVIRONMENTAL FACTORS

- Hill
- Gravel road

### 3 CAUSE OF THE INCIDENT:

The tractor couldn't handle the load it was expected to pull

### 4 WHAT "ONE THING" COULD PREVENT A SIMILAR INCIDENT?

- Never use a tractor that is too small to handle the load being pulled.
- If the load exceeds the tractor's rated safe weight, the trailer should have independent brakes.

#### Documentation for you Farm Safety Plan

DATE DISCUSSED WITH FAMILY OR WORKERS:

SIGNATURES:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

# CASE STUDY | 2

Hank and his son, Jake run a market garden operation in Ontario's Niagara Peninsula. They hire seasonal labour to help pick, wash and pack the produce. Their workers come mainly from Mexico and the West Indies.



On April 30, 1994, Luis, a new employee aged 25, was helping Jake unload an International Harvester TD9 caterpillar tractor from the flat deck of a truck. As the employee started the tractor and put it in gear, the tractor lurched forward and began to slide sideways off the ramp. The tractor had a ROPS, but he was not wearing a seatbelt. He jumped off to the right, but

the tractor simultaneously rolled to the right and pinned him underneath its gas tank.

Luis was pronounced dead on arrival at hospital. The coroner's report listed a crushing injury of the chest as the cause of death. Hank and Jake were questioned by Ontario Provincial Police officers and by an inspector from the Department of Labour. They stated it had been difficult to communicate with Luis who spoke little English. When hired, Luis had claimed through a translator that he had experience as a tractor operator. Hank and Jake could produce no documentation that the employee had received instruction or supervision in tractor operation.

## Incident Analysis Questions and Answers:

### 1 WHAT WAS THE IMMEDIATE CAUSE OF THE INCIDENT?

A caterpillar tractor, being unloaded from a flat deck truck by ramp, lurched forward as it was started and slid off the ramp, crushing the operator as he tried to jump clear.

### 2 WHAT WERE POSSIBLE CONTRIBUTING FACTORS?

#### HUMAN FACTORS

##### Owners

- Failure to verify new employee's skills before assigning him to operate hazardous equipment
- Failure to provide training
- Failure to provide supervision

##### Victim

- Lack of knowledge and experience
- Limited English language skills
- Misrepresentation of his previous experience
- Failure to wear seat belt

#### MECHANICAL FACTORS

- None

#### ENVIRONMENTAL FACTORS

- None

### 3 CAUSE OF THE INCIDENT:

The new employee did not have appropriate training and supervision

### 4 WHAT "ONE THING" COULD PREVENT A SIMILAR INCIDENT?

- Ensure that powered mobile equipment is operated only by a competent person.

#### Documentation for your Farm Safety Plan

DATE DISCUSSED WITH FAMILY OR WORKERS:

SIGNATURES:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

# CASE STUDY | 3

Donna, aged 38, operated a ranch with her husband, Darrell, in the foothills of west central Alberta. In early 1994, a loan approval allowed the couple to purchase more land and expand their

operation to 150 head of Simmental cattle. Donna continued work as a teaching assistant at the local K - 6 school, but cut back to half time in order to help Darrell with the increased workload on the ranch.

On March 28, 1994, a Chinook followed by freezing temperatures had covered the ground with a thin crust of ice.

Donna was helping feed cattle and was driving a John Deere 2950 tractor equipped with a front-end loader with a bale. As she drove up a steep embankment, the tractor overturned backwards, landing in a creek and trapping her beneath it. The tractor was fitted with a rollover protective structure and seatbelt, but Donna was not wearing the seatbelt at the time of the accident.

By the time paramedics were able to free her body at the scene, Donna showed no signs of breathing or pulse. Despite resuscitation attempts, the rescue team was unable to revive her. The autopsy report listed drowning as the cause of death.



## Incident Analysis Questions and Answers:

### 1 WHAT WAS THE IMMEDIATE CAUSE OF THE INCIDENT?

As the operator drove the tractor forward up a steep slope, the tractor overturned backwards into a creek, trapping her underwater.

### 2 WHAT WERE POSSIBLE CONTRIBUTING FACTORS?

#### HUMAN FACTORS

- Lack of knowledge about safe tractor operation
- Lack of experience as a tractor operator
- Failure to wear seatbelt

#### MECHANICAL FACTORS

- Driving uphill shifts tractor's centre of balance backward.
- A bale raises the centre of gravity.

#### ENVIRONMENTAL FACTORS

- Steep slope
- Icy surface

### 3 CAUSE OF THE INCIDENT:

The victim did not back up the steep embankment.

### 4 WHAT "ONE THING" COULD PREVENT A SIMILAR INCIDENT ON YOUR FARM?

- Avoid driving forward up a steep slope - back tractor up the slope instead.

#### Documentation for you Farm Safety Plan

DATE DISCUSSED WITH FAMILY OR WORKERS:

SIGNATURES:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

# CASE STUDY | 4

Luc and his sons operate a mixed sheep, grain and vegetable farm in northwest New Brunswick. Luc is proud that his boys, Robert and Claude, both want to farm, and takes some credit for that. "I always encouraged them to be a part of it, and that way, they grew up knowing what to do." After a moment, he adds ruefully, "Maybe I gave them too much responsibility."



On April 5, 1991, Luc and Claude had taken a sick ewe to the veterinary clinic in Campbellton. Robert, aged 20, and his brother, Gilles, aged 12, were attempting to free the farm's second truck from a mud hole in front of the sheep enclosure. Gilles

was operating the Ford Jubilee tractor while Robert shouted instructions from the driver's seat of the truck.

Gilles accelerated suddenly and the tractor reared up and rolled backwards. There was no rollover protective structure or seatbelt on the tractor. Gilles fell and was crushed by the tractor's right rear fender. The autopsy report listed a internal injuries including a ruptured liver and spleen as the cause of the boy's death.

## Incident Analysis Questions and Answers:

### 1 WHAT WAS THE IMMEDIATE CAUSE OF THE INCIDENT?

The tractor operator suddenly accelerated while attempting to tow out a truck mired in mud, causing the tractor to overturn backwards and crush the operator as he fell.

### 2 WHAT WERE POSSIBLE CONTRIBUTING FACTORS?

HUMAN FACTORS:

- Lack of knowledge about safe tractor operation
- Lack of experience as a tractor operator
- Mechanical Factors
- Sudden acceleration
- Stationary load
- Tractor noise (makes communication difficult)
- No rollover protective structure or seatbelt
- Environmental Factors
- Mud hole

### 3 CAUSE OF THE INCIDENT:

Children should not operate large equipment.

### 4 WHAT "ONE THING" COULD PREVENT A SIMILAR INCIDENT?

Limit children aged 12 to 13 to the supervised use of lawn and garden tractors or small tractors (up to 70 hp) for simple jobs only\*.

- For example, jobs should not involve PTO-powered implements, front-end loaders, distant hydraulics, pulling heavy loads, working inside buildings or in an orchard, travel on public roads, simultaneous use of multiple vehicles, hitching a tractor to move a stationary or stuck object.

\*The North American Guidelines for Children's Agricultural Tasks (NAGCAT) is a good reference tool to help decide what chores children are ready to start. It can be found here: <http://casa-acsa.ca/content/north-american-guidelines-childrens-agricultural-tasks-nagcat>

#### Documentation for you Farm Safety Plan

DATE DISCUSSED WITH FAMILY OR WORKERS:

SIGNATURES:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

## TRAINING NEW OPERATORS: OPERATOR SAFETY

A valid driver's license is an accepted indication of an individual's maturity and capability for operating a motorized vehicle.

- Training for new operators begins before they are ready to operate machinery.
- Discuss the safety equipment needed for each task.
- New operators should read and understand the operator's manual before operation.
- Learning to service a machine helps the new operator gain understanding of operating systems.
- Demonstrate blind spots before the equipment is operated. Remember rear visibility is limited.
- Point out hazards to the new operator during training.
- Plan work where the new operator can be well supervised.
- Give the new operator easy tasks under supervision and gradually increase task difficulty.
- Schedule frequent breaks when a job is repetitive or requires intense concentration.
- Use a system of mutually understood hand signals to decrease the risk of accidents. They can be found at the following link:

**Set a good example  
FOR THE NEW  
OPERATOR!**

## TRAINING FOR A TASK

Don't forget to document the training that you have done with a new worker in your Farm Safety Plan. Even more experienced workers may need an update on your current safety procedures. Remember to use positive feedback to encourage continued safe work practices. Here are the basics:

- Explain how the task is to be performed
- Demonstrate the correct procedure
- Point out the hazards
- Make sure the new worker can perform the task correctly and safely prior to allowing them to work alone
- Frequently check in on the new worker

### References

Canadian Agricultural Injury Reporting. Agriculture-Related Fatalities in Canada 2003-2012, [www.cair-sbac.ca](http://www.cair-sbac.ca)

Farm Safety Audit: A Management Tool for Farmers, [aghealth.usask.ca](http://aghealth.usask.ca)

### Reviewed by:

Dr. Niels Koekncke, MD, MSc, FRCPC  
Canadian Centre for Health and Safety in Agriculture

Jim Wasserman,  
Prairie Agricultural Machinery Institute

Justin Gerspacher,  
Project Engineer, Prairie Agricultural Machinery Institute

**CONTACT US:**

Agricultural Health  
and Safety Network

Canadian Centre for Health  
and Safety in Agriculture

University of Saskatchewan  
104 Clinic Place PO Box 23,  
Saskatoon, SK S7N 2Z4  
Phone: 306-966-6644  
Email: [agsafety@usask.ca](mailto:agsafety@usask.ca)

