



The Agricultural Health and Safety Network

Safe Machinery Operations Module #2

**FARM MACHINERY SAFETY STRATEGIES
PREVENTING ENTANGLEMENTS**



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In regards to fatal injury in Canada, agriculture is rated as the fourth most hazardous industry in Canada. Substantial economic costs are associated with these injuries as well as the pain and suffering to the families and communities where the loss occurs.

According to Canadian Agricultural Injury Reporting (CAIR*), fatalities due to entanglement were caused where the victim was:

- Wearing loose clothing or their hair was loose
- Performing another activity near the machine
- Cleaning or repairing the machine without shutting it off
- Trying to remove a blockage prior to shutting the machine off
- Checking the machine or its contents and falling into the machine

Tractors are related to 46% of machine-related agriculture fatalities. In this Module #2 we will look closely at the prevention of entanglements by looking at a series of examples. Entanglements also injure many more Canadians every year and require hospitalization.

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.

**Canadian Agricultural Injury Reporting (CAIR) www.casa-acsa.ca*

CAIR collects and analyzes information regarding agriculture-related injuries from the provinces across Canada. This analysis provides evidence that leads to the development of health and safety programming and focuses their strategies to meet the needs of rural stakeholders.

Preventing Entanglements

Background and Research



MACHINERY HAZARDS: RISK ASSESSMENT

A hazard is a condition or work practice that could result in a serious or fatal injury. The risk assessment approach provides a method by which farm operators or managers can identify hazards, assess risk, and correct hazards before injuries occur. The more frequently an individual is exposed to a risky situation, the greater is the chance that an injury will occur. The following table describes types of hazards that exist around farm machinery.

HAZARD	DESCRIPTION	EXAMPLE
HAZARD	TWO OR MORE PARTS MOVE TOGETHER WITH ONE MOVING IN A CIRCLE	PULLEYS AND BELTS
CRUSH POINT	TWO COMPONENTS MOVE TOWARD EACH OTHER	THREE-POINT HITCHES HYDRAULIC CYLINDERS
WRAP POINT	EXPOSED ROTATING COMPONENTS; NICKS, MUD OR RUST INCREASE WRAP POTENTIAL	PTO SHAFTS AUGERS
PULL-IN POINT	MECHANISMS DESIGNED TO PULL IN CROPS OR OTHER MATERIAL	PICK-UPS: COMBINES, BALERS, FEED GRINDERS, CONVEYORS
SHEARING, CUTTING POINTS	TWO PARTS MOVE ACROSS EACH OTHER OR A STATIONARY OBJECT	CUTTER BARS, AUGERS, FEED MIXERS
THROWN OBJECTS	OBJECTS PROPELLED BY MOVING MACHINERY PARTS	ROTARY MOWERS, STRAW CHOPPERS, MANURE SPREADERS
STORES ENERGY	ANY PRESSURIZED SYSTEM	HYDRAULIC FLUID, COMPRESSED AIR, SPRINGS, BELTS
BURN POINTS	POINTS THAT HEAT UPON USE	MUFFLER AND EXHAUST PIPES, ENGINE MANIFOLD AND BLOCK, HOT FLUIDS, STEAM

WHEN WE ARE FAMILIAR WITH OUR SURROUNDINGS, WE CAN FAIL TO SEE THE HAZARDS.

Equipment and moving parts produces the potential for serious or fatal injury to the operator and bystanders.

Service and maintain equipment daily before heading to the field. Refuel when the engine is off and cooled (about 10 minutes).

Equipment continues to increase in size making it more difficult to see all areas while in the cab. Before operating always walk around the equipment and check for bystanders.

A TYPICAL ENTANGLEMENT FATALITY

The victim, a 47-year old male, was grinding grain in a feed mixer mill driven by a power-take-off (PTO) device. Eyewitnesses stated that his clothing became entangled in the rotating PTO shaft as he attempted to step over it. There was no guard on the PTO shaft (the master shield was not in place). He suffered an amputation of the right leg, several broken ribs and a fractured spine. He died while emergency personnel were trying to extricate his body from the PTO mechanism.

POWER TAKE OFFS (PTO)

PTO entanglements usually occur when the shields are missing or damaged. Other factors that contribute to PTO entanglement include stepping over the rotating shaft, repairing the PTO while it is in operation, and wearing loose clothing around machinery.

PREVENTING A PTO ENTANGLEMENT

- All PTOs should have a master shield which covers the tractor stub shaft and the front universal joint of the attached drive line as well as the guard over the shaft.
- PTOs should be properly installed to reduce breaking or separating during operation. Separation of the tractor end of the shaft can cause extensive damage to both operator and machine.
- Use a PTO that is of the same brand as the machine being operated.
- Always shut off machinery and disengage the PTO before servicing, repairing, refueling, lubricating or adjusting equipment.
- Check frequently for cracked or broken shielding. Replace damaged PTO components before further use.

DID YOU KNOW . . .

- The average person's reaction time is between .75 to 1 second?
- PTO shafts rotate between 9 and 16 times per second? At this speed, approximately 7 feet can be pulled in per second.
- A six inch auger entangles at a rate of 10 feet per second.
- The common speed for pulleys is 66 feet per second (nine times faster than a PTO shaft).
- In the average time it takes a person to react (3/4 of a second) a lawnmower blade will have gone around 39 times.

When repairing, lubricating or troubleshooting, SAFETY first!

- Turn engine off • Disengage PTO
- Remove key • Apply parking brake
- Lock and securely block raised equipment before working underneath.

POWER TAKE OFF DRIVEN EQUIPMENT CHECKLIST

RATIONALE:

- Our reaction time is slower than the speed of a rotating shaft.
- Most PTO entanglements take place at the connecting points between the PTO and the tractor or between the PTO and the attached implement when protective shields have been removed or damaged.
- Entanglements also occur at the point where the intermediate shaft of the PTO telescopes.
- PTO entanglements usually cause severe, disabling injuries or death.

PHYSICAL CONDITIONS

- Do all PTOs have shields and guards in place?
- Is there a master shield in place where your PTO meets the tractor?
- Are shields on PTOs checked periodically to ensure that they rotate freely? **CHECK WITH POWER OFF.**

WORK PRACTICES

- Before leaving the tractor seat, is the PTO always disengaged, engine shut off and keys removed?
- When working with PTO driven equipment, is clothing close fitting, long hair covered, and no laces, etc. exposed?
- Do you ALWAYS avoid stepping over the PTO shaft?
- Are worn or defective parts replaced as soon as possible?

Preventing Entanglements



REMEMBER!! ONE SEAT! ONE RIDER!

FARM MACHINERY SAFETY CHECKLIST

RATIONALE:

- Balers are the cause of serious injuries when the operator attempts to adjust or unplug the machine while the power is engaged. This is because the pick up and belts cannot be shielded making them very hazardous and, as a result, operator's limbs may become entangled in the mechanism causing severe lacerations, amputations, even death.
- When handling bales with machinery, the large round bales which weigh between 800 and 1500 pounds, may fall from improperly designed or applied handling devices and crush the machinery operator or bystander causing serious spinal injuries or death.
- Most incidents with portable augers involve entanglements of the hands or feet, and occur when a piece of loose clothing, glove, tie string or shoelace is caught in the flighting, or when an operator attempts to unplug the auger while it is running resulting in severe lacerations or amputations. Drive belts and winch handles are also common sources of injury.

PHYSICAL CONDITIONS

- Are key warning decals on machinery readable?
- Are all shields and guards in place?
- Are all machines free of jagged metal or protrusions?
- Are hydraulic lines free of excessive wear or leaks?
AVOID HYDRAULIC FLUID INJECTION INJURIES BY USING PAPER OR CARDBOARD TO DETECT LEAKS.
- Is any equipment that is likely to be towed on roadways equipped with safety chains and safety hitch pin?
- Are SMV signs in good condition (clean and not faded)?

WORK PRACTICES

- Are defective and worn parts replaced as soon as possible?
- Are tires inspected regularly and properly inflated?
- Are children and bystanders kept away from operating equipment?
- Is the power turned off before adjusting or servicing machinery?
- Are moveable components properly blocked before repair or adjustment?
- Do you ALWAYS observe the "NO RIDERS" rule on machines or draw bars?
- When implements are parked, are they always stored in a safe position with loads fully lowered?
- Are farm implement manuals readily available to the operator?

SEE

WWW.AGHEALTH.USASK.CA

FOR THE RECENTLY REVISED FARM SAFETY AUDIT. PRINT IT, OR USE IT AS AN ELECTRONIC CHECKLIST ON YOUR LAPTOP OR TABLET.

In the next four pages you will find detailed information on how to prevent an entanglement injury. Each concept is detailed with an example and an explanation. When one identifies the hazard they can assess the risk and correct the hazard. The following are incidents that involved real people. They have shared their experiences so that it won't happen to someone else who chooses to learn from their stories.

Len P. lost his left leg in a post-hole auger when he slipped on frost – it was November – and the self screw on the PTO shaft hooked onto his nylon bootlace. He points out,

“The digger wasn't shielded. There had been a shield at one time, but it interfered with the operation of the machine, I guess. I borrowed the thing from my neighbor and there was no shield with it. I thought about putting a shield on it, but each, I'll be careful! So anyway, I remember the thought going through my mind, 'I should get out of here,' and the next thing I knew I was in it.”

1. GUARD OR SHIELD ALL MOVING PARTS ON MACHINERY

Reinstall guards or shields that have been removed. Contact the manufacturer to order retrofit guards or shields when necessary. Frequently inspect and immediately repair damaged shields, belts, pulleys and bearings.

Why should you do this when it means more time and expense to operate and maintain the equipment?

- Entanglement injuries are among the most traumatic events seen in hospital emergency departments. They include amputations, crushing or fractures of the limbs, major lacerations, head and spinal cord trauma, and frequently result in permanent disability.
- Reacting quickly won't protect you from a machinery entanglement. The outside of a PTO shaft rotating at 540 rpm travels more than two metres in less than a second.
- There will be times when you are tired, frustrated, or in a rush. You may trip momentarily and reach out, grabbing whatever is nearest. A machine guard provides you with a safety net when operating, or operator conditions are not ideal.

2. DO A PRE-OPERATIONAL SAFETY CHECK ON THE OPERATOR. (THAT MEANS YOU!)

Any of the following human factors increases the likelihood of accidents including machinery entanglements:

- Rushing
- Fatigue
- Frustration
- Hunger or thirst – low blood sugar and dehydration affect the brain first
- Becoming chilled or overheated – too high or too low a body temperature affects muscle coordination, reaction time and thinking.
- Using alcohol or medications that impair judgement, balance and coordination, while at work
- Temporary physical illness or chronic disease which may affect perception, balance and coordination.
- Complacency – “I've done it that way for years.”

When Doug T.'s feet became entangled in a hard core baler on September 5, 1990, he was pulled in up to thigh level. Miraculously, he survived with functioning legs and feet thanks to reconstructive surgery. Doug can identify two human factors – fatigue and frustration – in that incident.

“We had combined the night before until about 3:00 a.m. and then I got up at 6:00 a.m. to start doing some baling before the day's combining began. I had trouble getting the bale started and, finally, I must have got frustrated enough that I kicked some straw into the pick-up. It happens quick and you think it would never happen to you. It's not the baler's fault, you know, it's the person on the baler.”

Preventing an Entanglement Injury



Bob G., now in his 60s lost his right arm at age four when he became entangled in a tractor PTO. He used to visit other farmers who have recently been injured on behalf of the provincial Farmers with Disabilities group. He says,

"With any of the people I talk to when I do a visitation, it's always, 'They were going to save a little time.'"

3. ALWAYS DISENGAGE THE PTO, TURN OFF THE ENGINE AND REMOVE THE KEYS BEFORE LEAVING THE TRACTOR SEAT. IF YOU'RE A BYSTANDER, WALK AROUND, DON'T CLIMB OVER A ROTATING PTO.

The seconds it takes to do the following tasks are insignificant when compared to the time it will take to perform even the simplest tasks with a missing arm or leg for the rest of your life.

- disengage the PTO
- turn off the engine
- remove the keys
- walk around a rotating PTO



4. TURN OFF THE POWER BEFORE ATTEMPTING TO REPAIR, ADJUST OR UNPLUG MACHINERY.

Do you leave the tractor and PTO running while you attempt to repair, adjust or unplug machinery? You probably know this is unwise, but may have done it without a problem many times.

- Stop unsafe work practices now before you lose a limb or your life.
- Don't assume if you are using a stick or other object to unplug a machine, that you will react and let go if there is a problem. You can't react fast enough. It is important to view the object as an extension of your arm, not as protection.

Joe S. lost his left lower arm and hand on January 15, 1985 while trying to unplug a PTO driven feed mill, clogged by a frozen bale. He had unplugged the mill while it was running dozens of times before. Joe recalls,

"That time, the grate between my hand and the hammers slipped. The hammers took the big mitt I had on and rolled it under, catching the index finger of my left hand. It was all over in the twinkling of an eye, or a blink."

Hindsight tells Joe he could have prevented the incident by leaving the frozen bales to thaw.

There were other bales, and I knew the frozen ones plugged the mill. Sometimes you just have to 'work smarter' not harder."

Neil E. lost his right lower arm and hand on October 23, 1996 while cleaning out the auger of a combine that he was helping a neighbour put away for the winter. He recalls how easily it happened.

"My neighbour said, 'I'm going to start the auger up' but I didn't hear him."

Neil emphasizes,

"When you're working with another person, you need to take three steps to

- verify,
- clarify, and
- confirm communication.

How does that work? First you say, 'I'm going to start up now.' Next you say, 'Did you hear me?' And then you ask, 'What did I say?' It doesn't take many seconds to prevent a tragedy."

5. COMMUNICATE EFFECTIVELY WHEN YOU WORK WITH ANOTHER PERSON.

Machinery noise can make it difficult to communicate verbally. Add to that the fact that older farmers with poor hearing due to years of noise exposure may not hear a shout of warning, and you have an accident in the making.

Hand signals are another way to communicate when you can't hear clearly. Standard signals ensure everyone gets the same message from the same signal. Alberta Agriculture and Forestry has a poster of the Universal Hand Signals:

[http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/aet11594](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/aet11594)

6. CONSIDER YOURSELF AN ELITE ATHLETE – AND DRESS FOR THE EVENT.

PTO entanglements occur in all months of the year but are most common during cold weather when there is an increase in the amount and type of clothing worn. Be especially careful when conditions are windy. A gust can blow an otherwise stationary piece of clothing into the path of moving machinery parts.

- Wear close fitting clothes.
- Make sure bootlaces are tucked away.
- Cover long hair.
- Avoid loose cuffs, belts, ties or protruding buckles that are easily caught on equipment. Coveralls conceal such hazards.
- Leave jewelry and accessories such as chains or scarves with loose ends at home. Even rings can increase the damage to a finger or result in amputation when a hand is crushed.
- Close fitting leather or insulated work gloves are less apt to become caught than loose fitting hand wear.

Basil B. became entangled in a tractor PTO on November 4, 1996. He recalls,

"I had on insulated winter coveralls over blue jeans and long johns, and pull on leather work boots. The legs on the coveralls were wide to fit over winter boots. I remember jumping off the tractor and seeing the wind blow the pant leg of my coveralls toward the PTO. As my pant leg caught in the PTO, it flipped me to the ground. I have since learned it takes less than one-third of a second to wrap a 36 inch pant leg up a PTO."

Preventing an Entanglement Injury



7. KEEP BYSTANDERS AND CHILDREN AWAY FROM ALL MOVING MACHINERY.

Tractors and other machinery account for 70% of all farm fatalities and over 80% of fatalities occurring in children aged 14 years and younger.

- Farm kids will always want to help with farm work, and learning “on the job” is part of growing up on a farm. It is the responsibility of the parent or other supervising adult to decide what jobs a child can handle safely, and to provide the appropriate training and supervision. The North American Guidelines for Children’s Agricultural Tasks can help parents make those decisions. To view the illustrated Guidelines on line, visit: www.nagcat.com.
- Every farm with young children, or children who visit regularly, needs a designated safe area for unsupervised play, away from machinery. If they are around operating machinery, young children need the full attention of an adult.
- Also at risk are adult family members from off the farm and temporary help who may not be fully aware of the danger of drive shafts, belts and pulleys. A reminder to stay a good distance from moving machinery parts will alert them to the hazard.

Andrew W., age 8, was helping his dad unload a grain truck during harvest of 1997. Trying to close the end gate, he slipped and fell into the auger. His right arm was amputated at the shoulder.

Andrew’s mother speaks of the toll the accident has taken on the family:

“We take full responsibility and have experienced guilt and grief. Although time is healing, we still cry and feel numb when we remember that day.”

8. INVEST IN A REMOTE CONTROL ENGINE SHUT-OFF.

By installing receivers on all potentially hazardous equipment, you can shut down an engine immediately with a credit card sized transmitter in a pocket or attached to your belt. With the addition of a solenoid, the device works on manual shut-offs. A fail safe feature prevents the engine from starting again without turning the key in the ignition.

Tony P. became entangled in a baler on August 6, 1993. He used his left hand and a utility knife to gradually sever the rotating 8 inch belt that had taken most of the flesh from his elbow and arm. Tony tells other farmers,

“When you’re alone in that situation, and there’s no way to shut the equipment down, it’s a real hell hole.”



KEY POINTS

Too many men, women and children suffer the devastating effects of a farm machinery entanglement. Multiple tragedies occur every year, especially during peak seasons.

On September 24, 1982, Clara C. and her husband were combining. As she reached through the moving pulley of a variable speed drive to reset a slipped belt, her right hand became entangled and was amputated at the wrist.

Although Clara was admitted to hospital at 1:55 p.m., her surgery did not take place until midnight. Surgical staff were busy with another farmer who had lost a hand in an unrelated combine incident and a farmer who lost a finger the same day.

SAFEGUARD YOURSELF FROM ENTANGLEMENTS:

1. Guard or shield all moving parts on machinery.
2. Do a pre-operational safety check on yourself.
3. Always disengage the PTO, turn off the engine and remove the keys before leaving the tractor seat. If you're a bystander, walk around – don't climb over – a rotating PTO.
4. Turn off power before attempting to repair, adjust or unplug machinery.
5. Communicate effectively when you work with another person.
6. Dress for the event with close fitting clothing.
7. Keep bystanders and children away from all moving machinery.
8. Invest in a remote control engine shut-off.

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.
- Develop a system of mutually understood hand signals to decrease the risk of accidents.

Set a good example FOR THE NEW OPERATOR!

Disclaimer

Although every care has been taken in providing this information, the authors accept no responsibility or liability for any consequences arising from the use of such information.

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.
- Check in on the new worker frequently.

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