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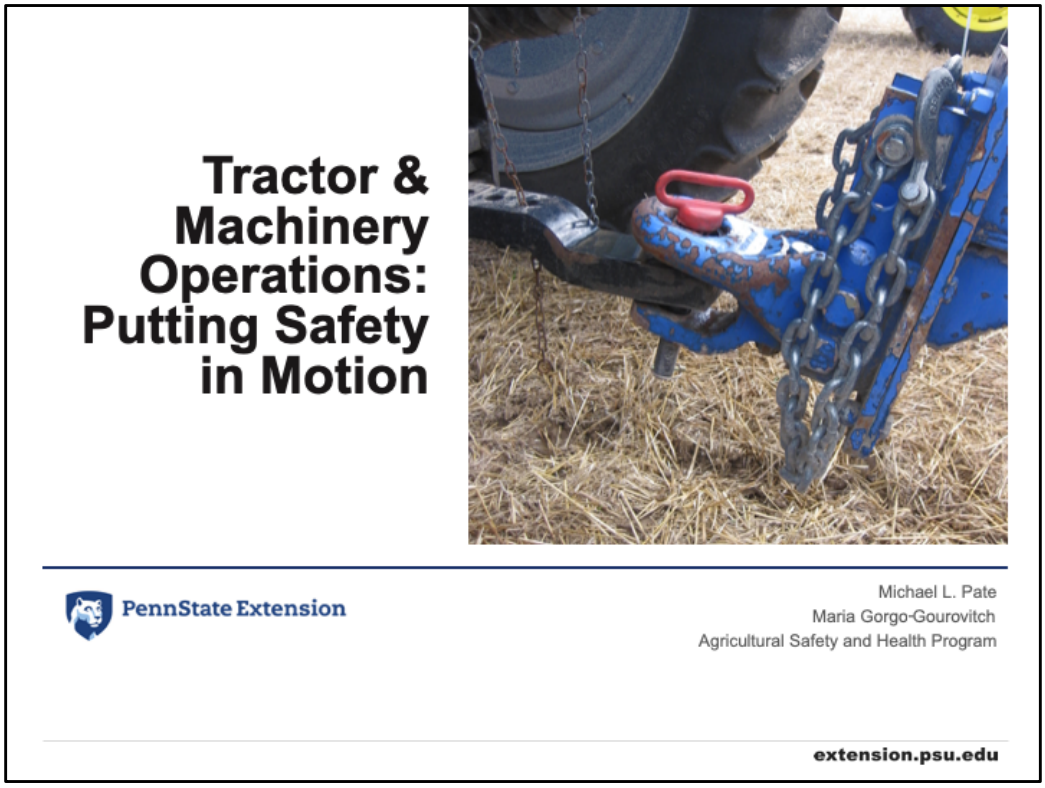

Welcome, my name is Michael Pate. I am with the agricultural safety and health program at Penn State. With me today is Maria Gorgo-Gourovitch and Montse who are assisting with this workshop. Today's workshop is entitled Tractor & Machinery Operations: Putting Safety in Motion. We chose this title because safety is an attitude in action. Let's get started.

Outline

- Hazards and Risk
- Pre-operation Checks
- Tractor Operations

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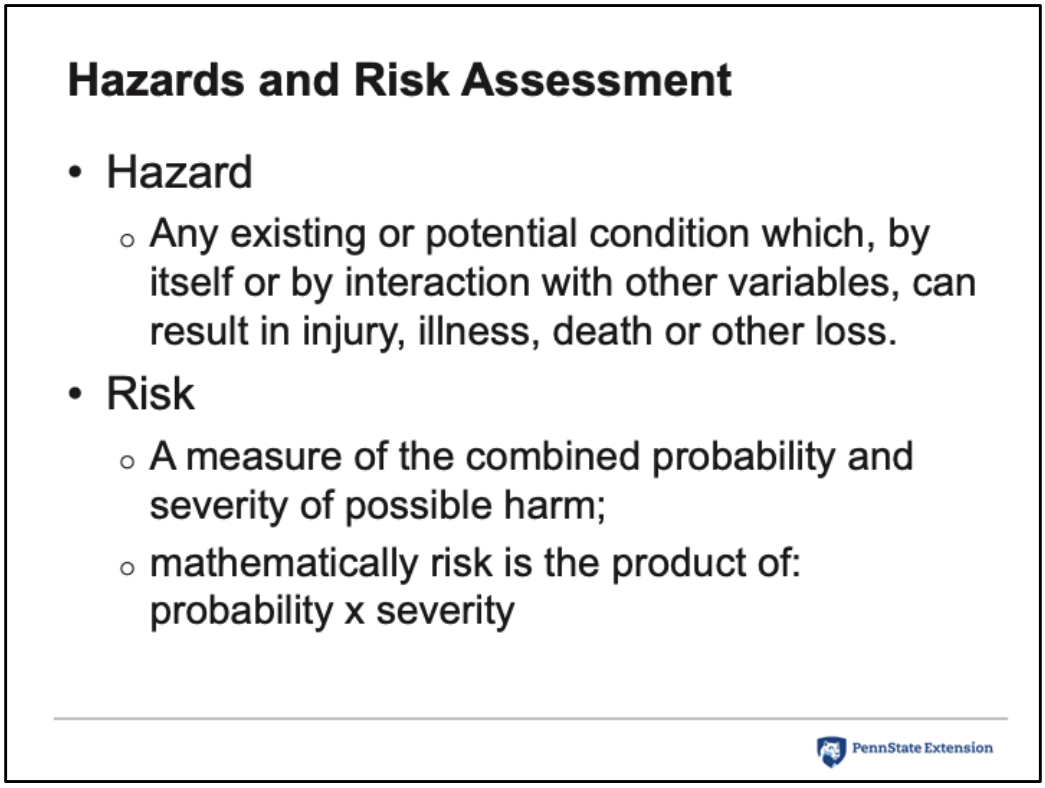
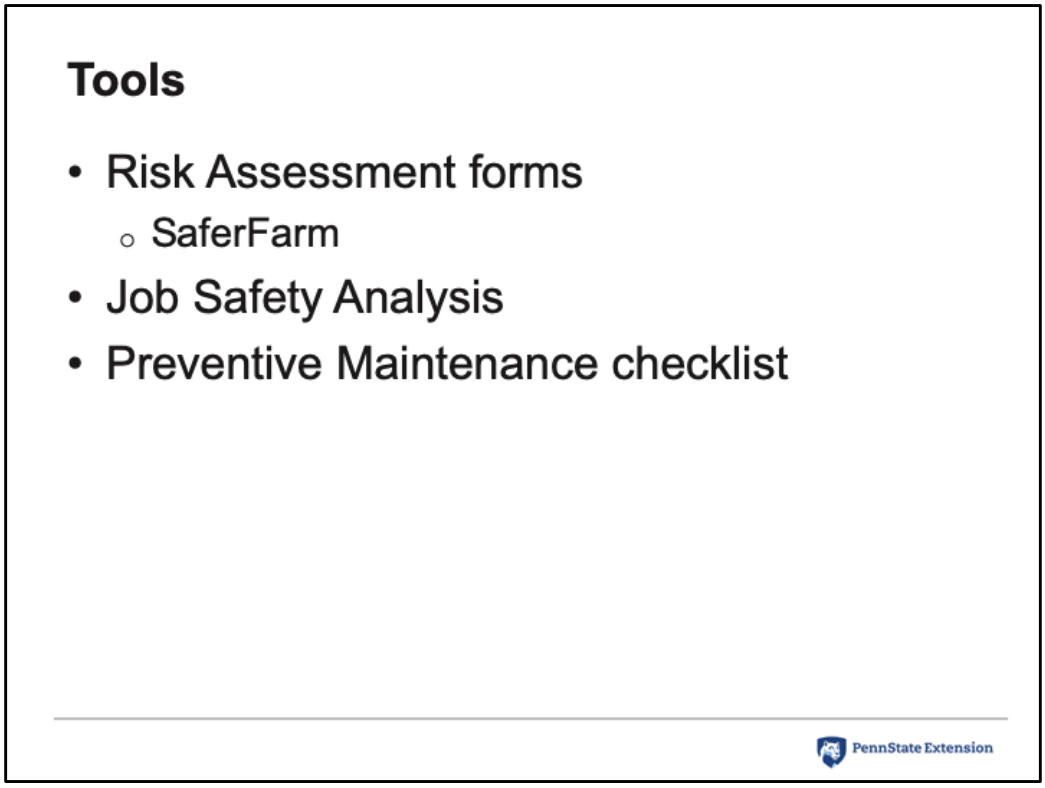
Today's presentation will follow this outline. We will begin with defining hazards and risks followed by pre-operation checks to start safety moving in the right direction. We will conclude today's presentation with fundamentals of safe tractor operations. The topics we will be discussing and practicing have several everyday applications. We all face hazards and judge the risk of exposing our self to those hazards everyday. Like when we drive a car or even prepare a meal. Let's first look at what we mean by hazards and risk. Understanding these terms is critical for our safety.



(Read the slides)
Hazards are things that isolated could potential harm us. A tractor tire is an excellent example as it is under pressure and could potentially explode. However, it requires a force or heat to be applied to the tire before it can cause harm.

Risks are subjective meaning a person can judge risk differently than another person. It is the estimation of the likelihood of harm occurring and the estimated severity of the harm. If we do not add air to a tractor tire or apply heat the risk is low for an explosion but the risk would increase if conditions change.

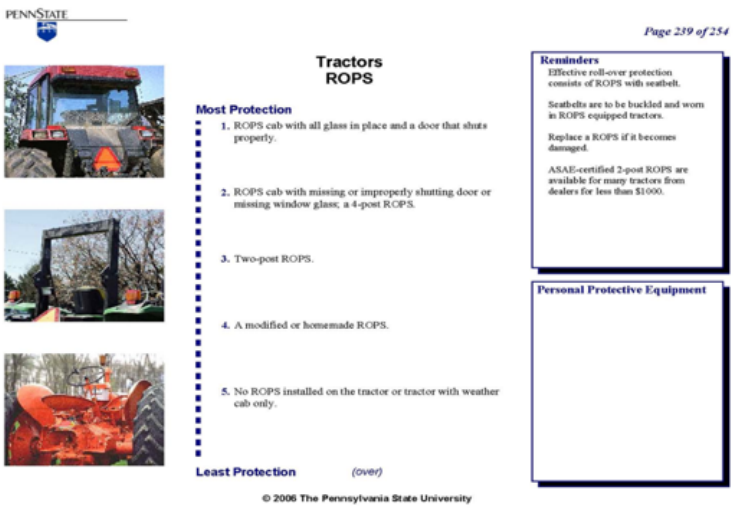
When we get ready to do a job we must identify hazards and evaluate the risk of injury. Once we have identified the risks for injury we can start to work safely using the appropriate measures.



You may be asking will how do I know what all the existing and potential hazards are? Don't worry there are a lot of tools available to help you assess your risk for injury and identify safety measures.

I will hand out some forms that have been developed to assist with hazard assessment. Each form have strengths that will help you identify the risks and implement safety measures or procedures to prevent an injury. Knowing the job and what tasks are to be performed is a great start. You can also use a equipment maintenance log or checklist to ensure you equipment is working safely and efficiently. Let's take a look at the SaferFarm tool in more detail.

saferfarm.org (A.K.A FARM-HAT)



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Tractors
ROPS

Most Protection

1. ROPS cab with all glass in place and a door that shuts properly.
2. ROPS cab with missing or improperly shutting door or missing window glass; a 4-post ROPS.
3. Two-post ROPS.
4. A modified or homemade ROPS.
5. No ROPS installed on the tractor or tractor with weather cab only.

Least Protection *(over)*

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Reminders

Effective roll-over protection consists of ROPS with seatbelt.

Seatbelts are to be buckled and worn in ROPS equipped tractors.

Replace a ROPS if it becomes damaged.

ASAE-certified 2-post ROPS are available for many tractors from dealers for less than $1000.

Personal Protective Equipment

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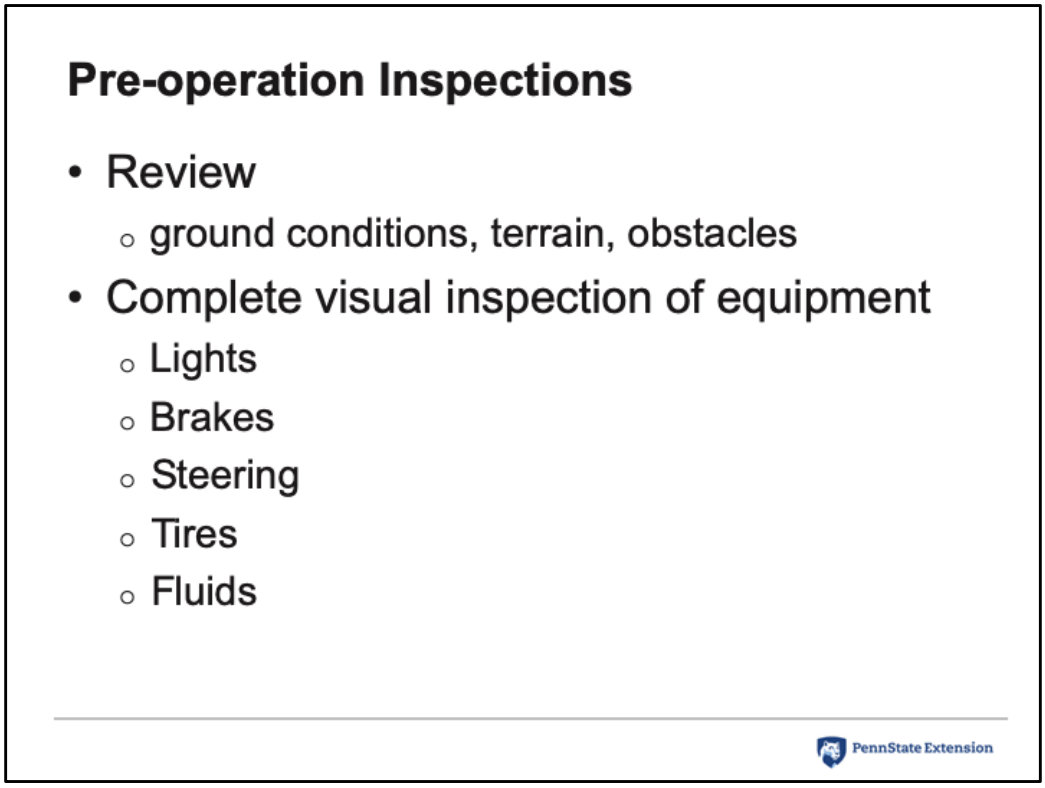
The first is the saferfarm.org website which was formally known as the Farm/Agriculture/Rural/Management – Hazard Analysis Tool (FARM-HAT) is a simple method that can be used by farm operators, the insurance industry, extension agents, and others to reduce farm hazards. This tool allows you to score the safety of equipment and objectively evaluate the hazards present. Users of this tool will: gain further understanding of agricultural safety and health hazards; learn what types of safety devices provide the most protection; learn what type(s) of personal protective equipment is appropriate for a given situation; find other sources of related information; and understand what behaviors can protect an individual from being harmed by a hazard.

A good practice to follow is to perform pre-operation checks prior to starting your work shift. Let's take a look at what that might include.



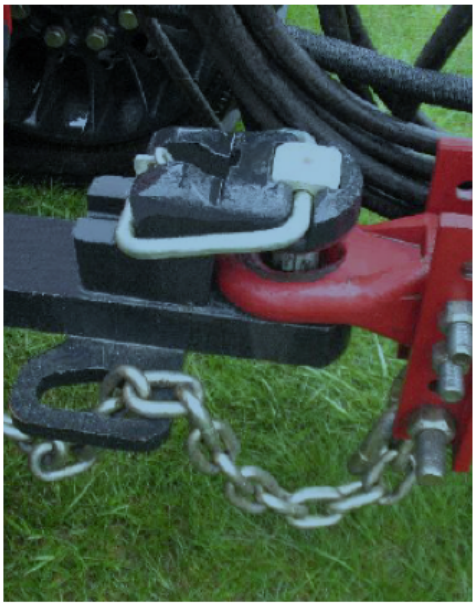
A variety of methods can be used to start a pre-operations review before work is to be started. This practice gets us in a “safety” mindset and moves us in the right direction. The most common items to review are the work conditions and/or the environment as well as any equipment to be used. Replace or adjust items to ensure equipment is operated safely. Lights help with visibility, brakes need to stop the machine, steering components should function properly to keep you going in the right direction, no one likes changing a tire so look for low tires and check air pressure, fluids keep the motor and other equipment running so if you are low on oil or fuel that could make for a frustrating work day.

Now you don’t just drive a tractor do you? Most of the time it is used to do some type of work. Tractors a hitched to implements or loaders to move, transport, or apply materials. Safe tractor operations takes into account the additional equipment that may be attached.

Let’s examine each of the methods to attach implements and other equipment.

Drawbar

- Categories
  - 0-5; increase in size
  - Increase in loads
- Adjustable or Fixed
- Single attachment point
  - Engineered and placed low to minimize rear rollover



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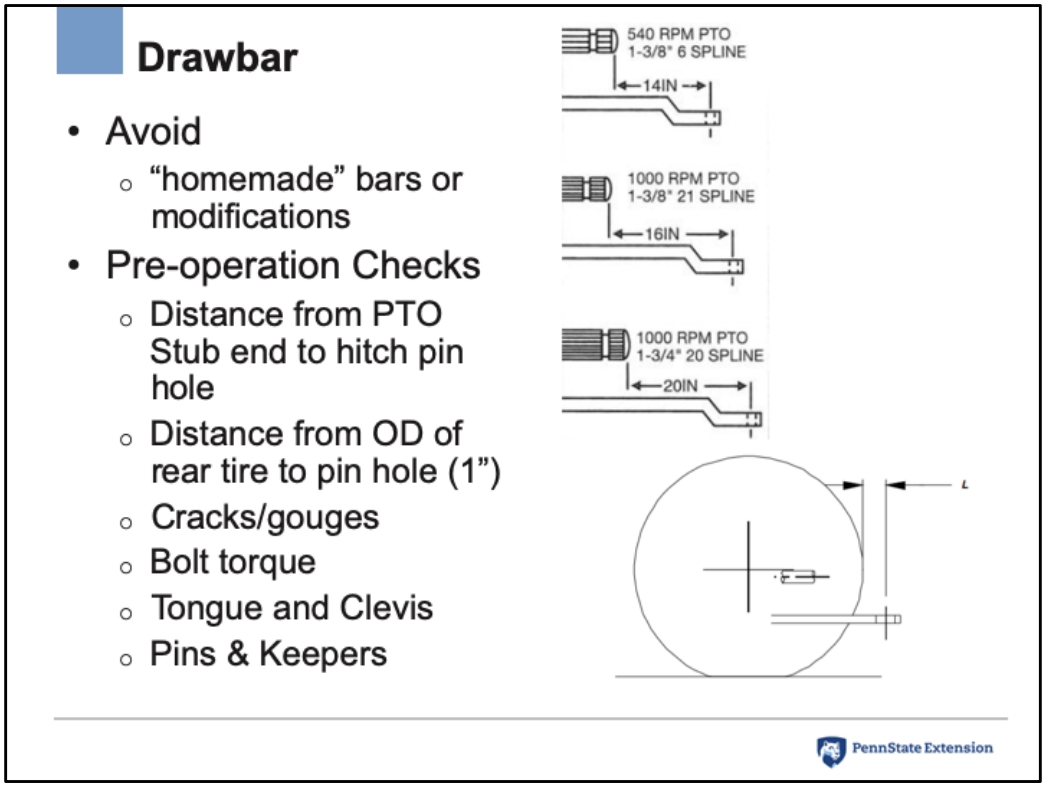
The drawbar is one of the most common ways to attach an implement or wagon.

Drawbars come in different sizes to match the power and load requirements that the tractor can handle.

Drawbars can be adjustable or fixed in position.

They serve as a primary single attachment point and are located low on the tractor to prevent a rear rollover.

Next we will look at some pre-operations checks before using the drawbar.



It is critical that you use an OEM or engineered drawbar to reduce the chance of equipment failure which could cause a catastrophic injury. Grades of steel vary not knowing the type and the condition can create a failure
Cutting or welding creates heat, which weakens the materials strength

When getting ready to attach equipment using a drawbar be sure to check for the following as seen on the slide. O.D. is Outside Diameter.

Now let's look at some of the potential hazards working with the drawbar of the tractor.

Drawbar Hazard Identification

- Crush
- Run-over
- Stored energy
  - Hitch jack
- Load detachment

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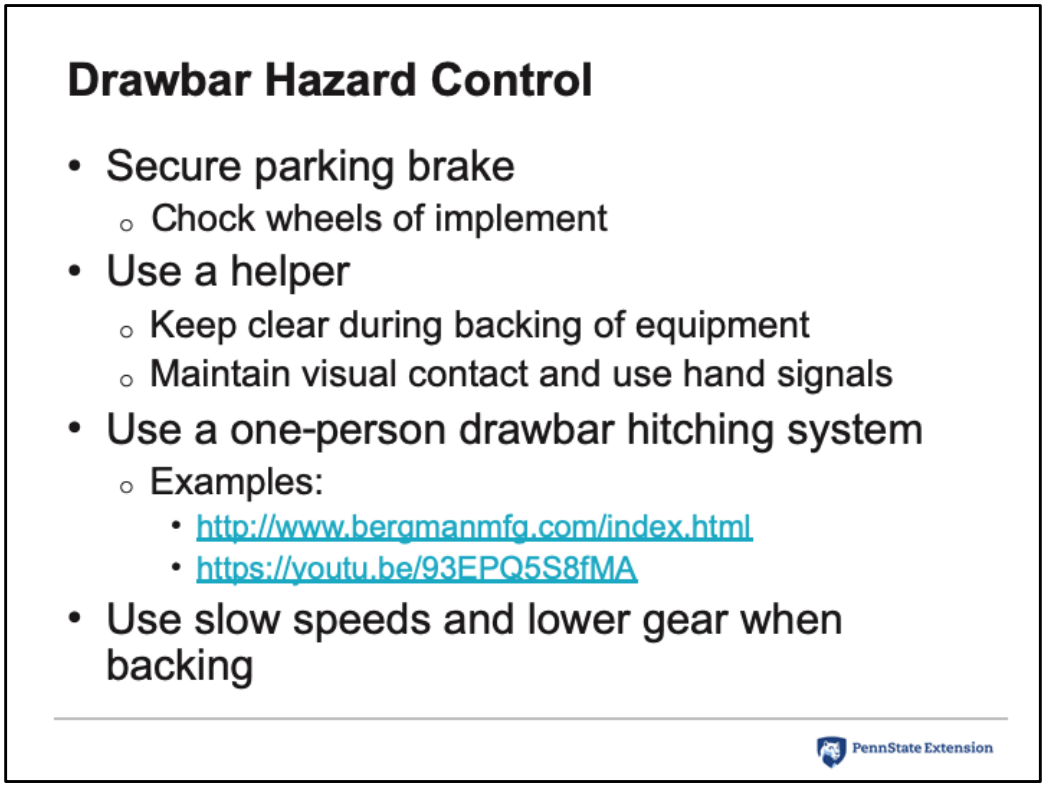
When you are backing any piece of machinery it is important to make sure there are no bystanders in the path of travel. Connecting implements should be done so that any stored energy such as a trailer load doesn't get released and hit a bystander. Loads must be securely attached.

Next we will look at making secure attachments.



Use the parking brake when the tractor has been placed in position to keep it from rolling. The equipment should be chock to prevent any movement.

If possible use a spotter or helper to guide the tractor during backing. Be sure to keep out of the path of travel.

If possible use new technology such as one-person drawbar hitching systems that allow a person to remain in the cab of the tractor.

Slow and steady wins the race. Avoid fast and jerky movements.

After the alignment of the drawbar and equipment hitch, we will look at using proper attachment pins.

Hitch Pins

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Hitch pins are vital to keeping the tractor connected to the equipment. Here is an example of a safe hitch pin with a safe retainer or keeper. The other example is a detachment waiting to happen.

We will look at some important points to remember about hitch pins.

Hitch pin selection

Diameter

Grade (shear strength)

Length

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Use the largest pin diameter that will fit through the tractor drawbar and implement hitch

Make sure the pin will not slip through the larger clevis holes.

Use pins that are long enough to allow a keeper to be inserted but do not drag the ground.

Use pins with a rated grade to insure proper loading strength.

Safety Chain

Length

Safety Chain Size

- Minimum strength equal to the gross weight of the implement being towed, for implements up to 80,000 lb (36,300 kg).
- Rated at 80,000 lb (356 kN) for implements weighing over 80,000 lb (36,300 kg).
- The rating of safety chains will be marked on a metal tag and should not be detached from the chain.

Grade

Intermediate support

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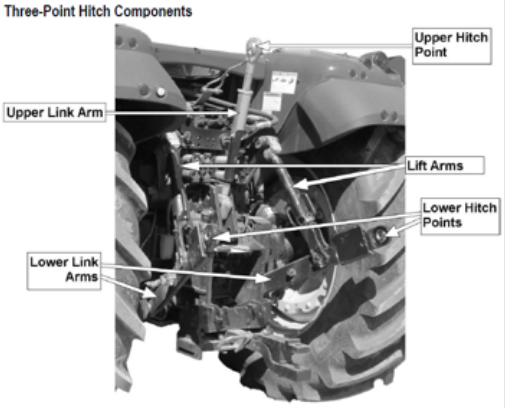
A safety chain(s) is a safety backup for tractor-to-implement connections. The safety chain maintains connection between the implement and tractor should the primary connection fail during transport. Be sure the chain is long enough to allow turning and is supported. Use the proper grade of chain to reduce the chance of failure.

Check chains for wear, stretching, or kinked.

Let's look at another connection type for your tractor and implement.

Three-point Hitch

- Raise and lower implement
  - Hydraulic cylinder
- Top link to adjust set of the implement level
- Pre-op checks
  - Ensure controls are in depth position
  - Restrict side movement of draft links
  - Check drawbar position
  - Check ballast requirements
  - Check hitch pins and alignment



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The three point hitch serves as a connection to link the implement to the tractor and keeps the implement supported and in line with the tractor at all times.

This system allows the operator to raise and lower impements using hydraulic controls.

The two lower links serve as attachment points and transfer tractor pull to the implement.

When connecting or preparing to use the three point hitch, conduct the following pre-op checks.

Three-point Hitch Hazard Identification

- Pinch point
- Run-over
- Crush
- Roll-over or tipping
- Load detachment

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Similar hazards as the drawbar connection with the addition of pinch points. Be sure to keep bystanders out of the path of travel and ensure proper connections.

Three-point Hazard Control

- Proper ballasting of tires
- Use helper
  - Hand signals and visual contact
- Support stands to align implement
- Use one-person in-cab three point hitching system
- Slow speeds and lower gear during backing.

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Since the tractor may carry the entire weight of the implement, tractor ballast is extremely important for maintaining control of the machine.

To prevent injuries associated with the three point hitch hazards remember the following seen on the slide.

Power Take Off Shaft

- Power transmission to implement
- 540 rpm or 1000 rpm
  - Size of shaft diameter changes
- Pre-op checks
  - Guards
  - Alignment of drawbar and three-point

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We will now look at the next connection point between the tractor and the implement. This connection is primarly for the transfor of power between the tractor engine to the implement. The PTO shaft comes in different sizes and operate at different speeds based on manufatuer specifications. The most common speeds are 540 and 1000 rpm. Each has a unique spline to identify them.

Be sure to inspect the PTO for proper guarding and alignment with the drawbar and/or three point hitch.

PTO Hazard Identification

- Entanglement
- Pinch point
- Run-over

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PTO's present a very unique hazard of entanglement. Make sure warning labels and guards are present and in good order.

PTO Connections

Types of PTO Retainers

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The pto will connect to the tractor using one of three common connections.

Slide collar lock is the most common on newer PTOs.

PTO Hazard Control

- Replace worn or damaged driveline components
- Use guarding in good condition

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If guards or components are missing or damaged be sure to replace them.

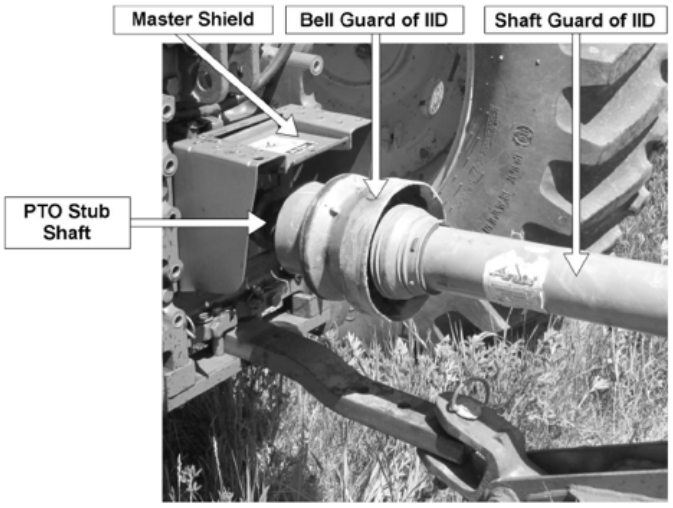
PTO Guarding

Stub cover

Master Shield

Bell Guard

Shaft Guard



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Let’s look at some critical safety components of the PTO system. Each provides protection from operator entanglement at various locations.

Hydraulic Connections

- Operate a high pressure
  - 2,100-3,000 psi
- Allows raising or lowering of implement
- Rotational power
- Engaging mechanisms

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Hydraulic connections are also used to transmit power from the tractor to the implement. Hydraulics serve many purposes. This system operates at very high pressure and components can become hot.

Hydraulic Remote Operation

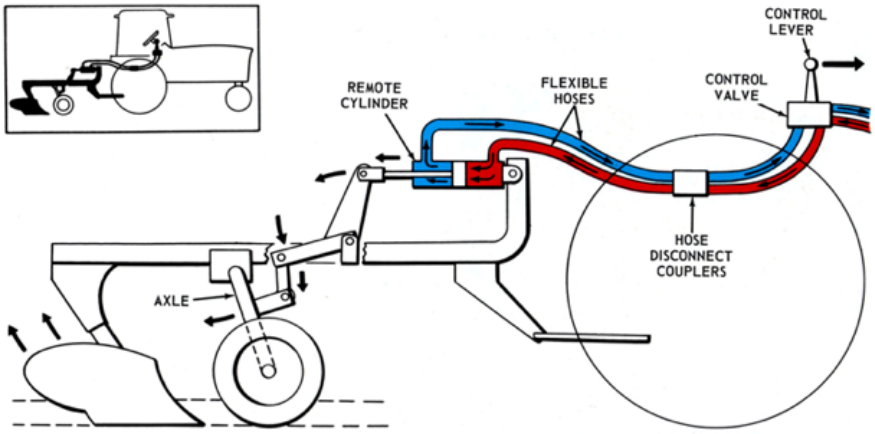

Fig. 7—Raising A Pull-Type Plow Using Remote Cylinder Hydraulics

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This is a common use of hydraulic remotes used to control the depth of an implement. Sometimes the hydraulics turn motors or actuate other moving components of the implement.

Hydraulic Hazard

- Fluid injection
- Run-over
- Crushing
- Pinch
- Burn

Fig. 16 — Be Careful with Hydraulics

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The common hazards include equipment falling and crushing operators who perform maintenance.

Fluid injection is a very serious injury and requires specialized medical care not commonly found in rural health care providers. Often times it can result in an amputation of a limb to save the individuals life.

Hydraulic Hazard Control

- PPE
- Use cardboard
- Relieve pressure in circuit
- Repair damaged equipment
- Maintain connections
- Use cylinder locks

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To help reduce the risk of injury make sure to wear personal protective equipment such as gloves, safety glasses, and appropriate clothing.

Recognize that when an implement is disconnected, the hydraulic lines may still be under high pressure. The pressure should not be relieved by impacting the tip of male coupler. Escaping oil is a safety hazard and may cause injury.

Leaving an implement with pressure in the hoses is a hazardous practice as temperature changes can expand oil and increase system pressure leading to failure of hoses, fitting, valves or cylinders. It is best to lower the equipment to the ground before disconnecting the hydraulics.

Hydraulics

- Pre-op checks
  - Leaks
  - Remove dirt and debris before connections
  - Check hoses for wear
  - Ensure pressure has been released from the system
  - Ensure hoses are protected
  - Check fluid level
  - Transport locks

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This system requires great care when completing the pre-op checks.
Keep the system clean by wiping dirt and debris before making connections.

Never use your hand to check for leaks. A piece of cardboard or mirror should be used.

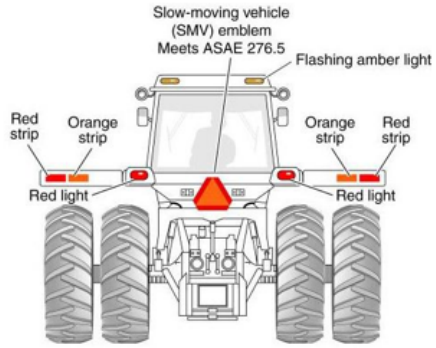
Check to make sure hoses are protected from heat sources, binding, or excessive rubbing against sharp edges.

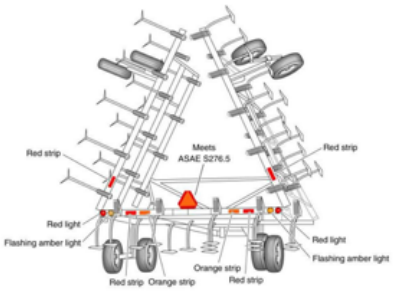
When transporting use approved locking mechanisms to prevent damage to equipment.

Be sure the fluid level is at the recommended level.

Electrical

- Operation of safety lighting
- Wiring and terminals
  - Clean and Inspect
    - Check for:
      - Corrosion
      - Wear
  - Maintain support(s) for wiring
  - Ensure functions with controls in the cab.





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Clean and highly visible lighting and marking are critical for transport of equipment on road ways. Check electrical equipment to ensure it is functioning and keep lights clean. Be sure electrical connections are free from corrosion and wiring is free of wear.

Maintenance

- Brakes
  - Stopping
  - Hard turning
- Types
  - Band brakes (external contacting)
  - Shoe brakes (internal contacting)
  - Disk brakes
- Actuators
  - Mechanical
  - Hydraulic

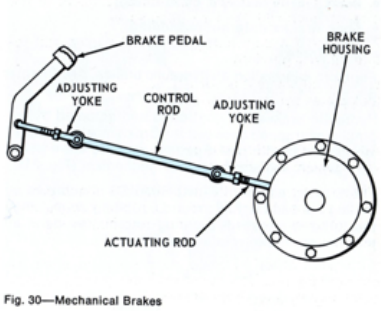
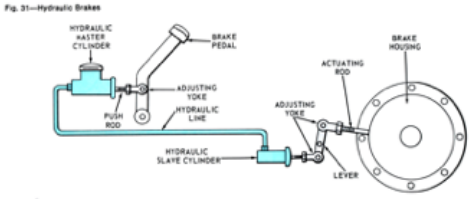


Fig. 30—Mechanical Brakes



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If your tractor is in motion you will eventually need to stop it's travel. Brakes are very critical. Make sure brakes are in good condtion and adjusted properly.

Servicing Brakes

- Check for too much pedal free travel
- Poor or uneven braking action
- Look for leaks and loose fittings
- Check fluid reservoir

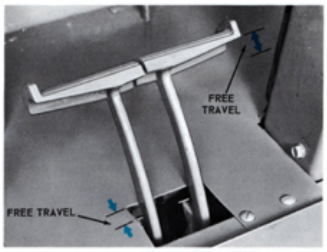
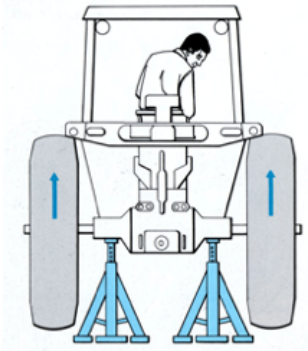


Fig. 36—Two Methods Of Measuring Pedal Free Travel

Fig. 38—Checking For Equal Braking Action



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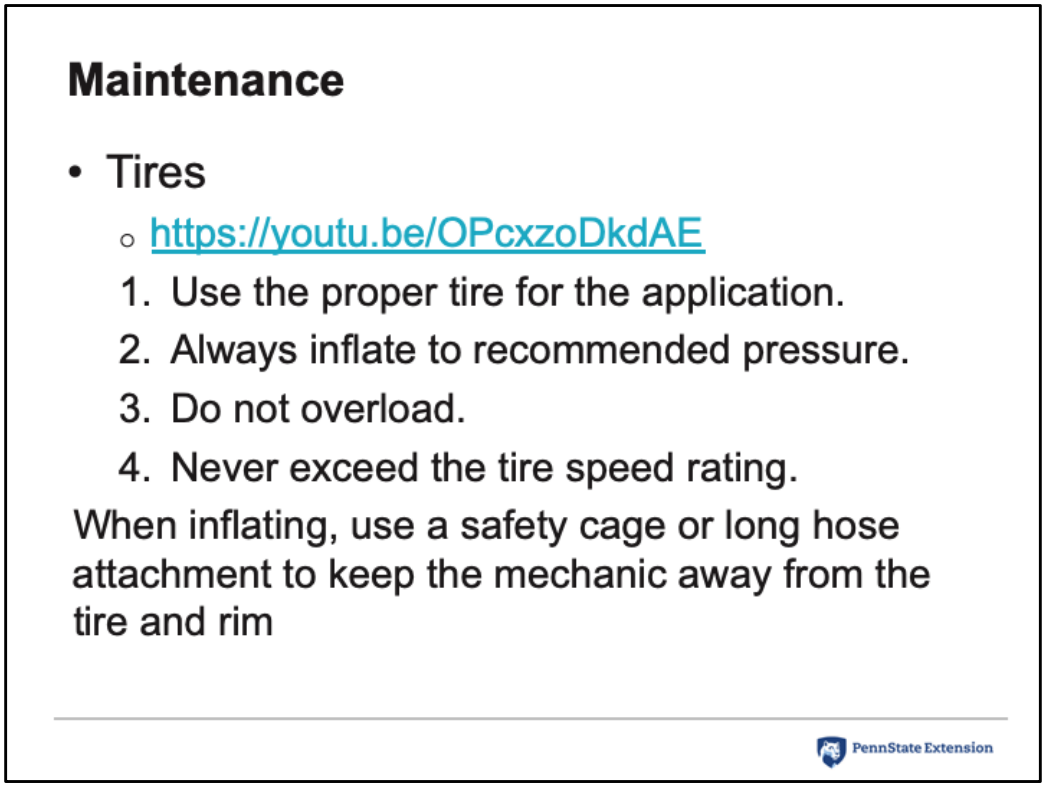
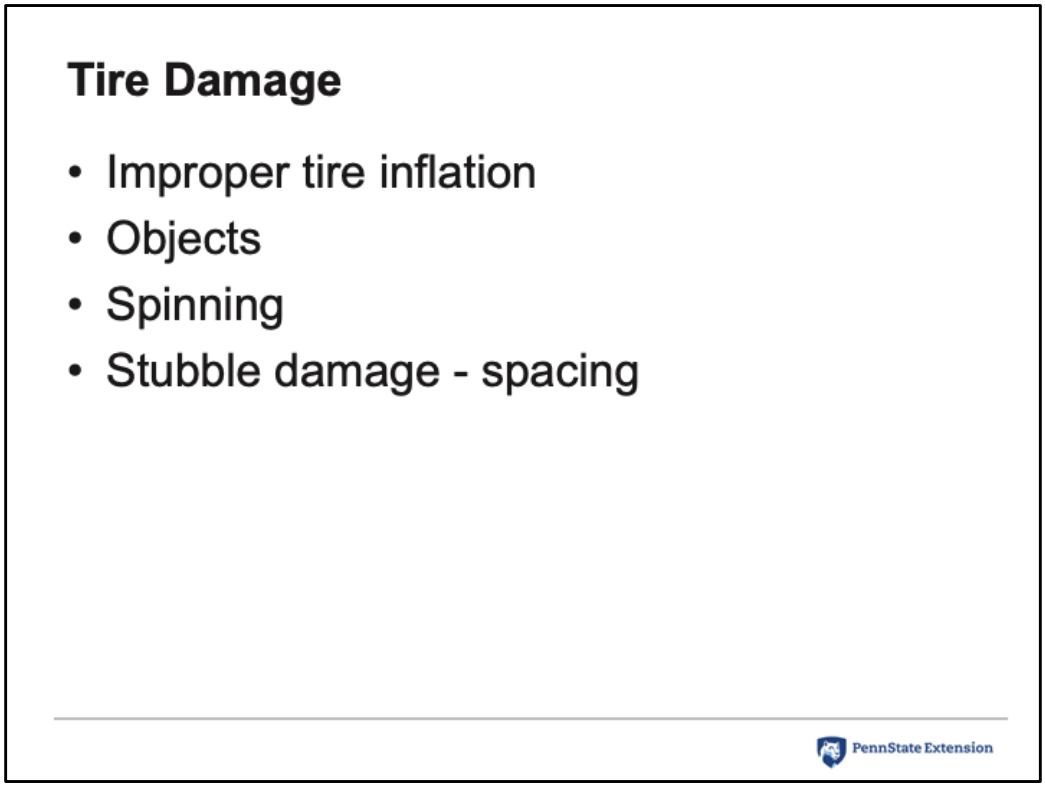


Tires keep you rolling so maintain them. Here are some tips for maintaining your farm tires and keeping you safe. Tires that show signs of damage, have excessive tread wear or are under inflated will not perform safely. Checking the tires on your equipment should always be part of your daily inspection before operating any type of machinery. While the most obvious safety risk is from tire blow out or failure during operation, there are many other factors that could cause harm to both the operator and the equipment. Tractor or other types of equipment rollovers pose the most risk to operators and while there are many reasons that a rollover can occur, having the right tires, tire pressure and proper traction for the application and environment can help prevent these incidents.



Take the time to properly inspect your tires for signs of wear, cracking, rim damage and inflation.

Tire Visual Inspection

#1

no gouging or other tread or sidewall damage and is probably rated with at least 90% tread wear.

#3

some damage between the lugs and is at or below 50% remaining tread wear.

#5

The cracking in the tread area has damaged the tire and the tread wear remaining is in the 10-20% range

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Looking at theses pictures gives us a gauge to evaluate our tire health.

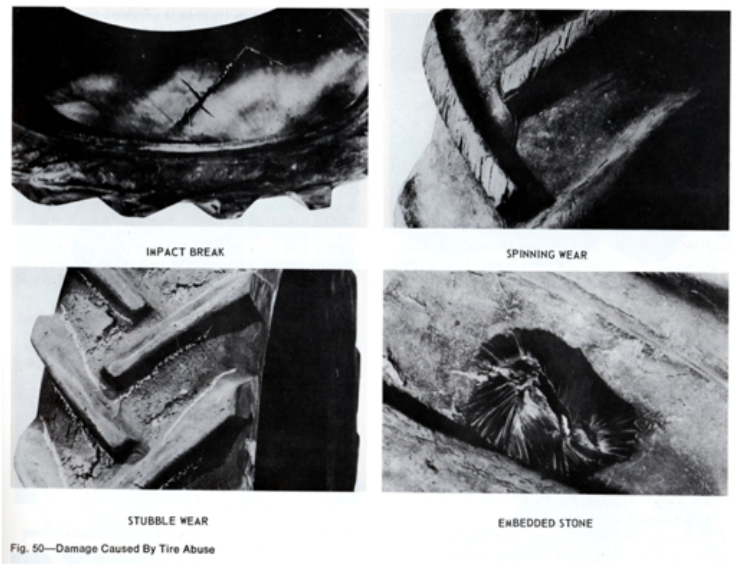

Fig. 50—Damage Caused By Tire Abuse

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Other evidence of damage to tires.

Tire Inflation

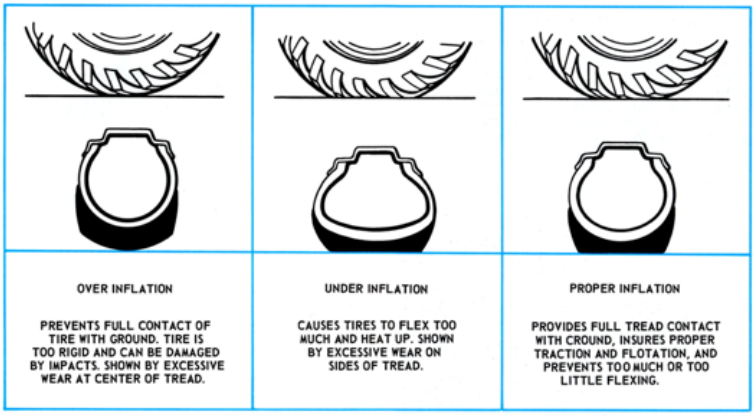

Fig. 45—Tire Inflation

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These pictures show the effect of proper inflation has on tread contact.

Operating the Tractor

- Roll-overs hazard
  - Side
  - Rear
- Run-overs hazard
  - Bystanders
- Falls
- Noise
- Eye Injury
- Entanglement

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After you have performed pre-operation checks, you can get started operating the tractor safely. Remember the operating a tractor presents additional hazards to the operator.

Falling from the operator station as well as noise exposure can result in significant injuries.

Tree limbs can hit operators who are not enclosed in a cab making safety glasses important to protect your eyes from being hit.

Safe Operations

Always face the tractor for mounting and dismounting. Use three points of contact. Never jump from the tractor.

Fasten Seat Belt
(ROPS equipped tractor)

Avoid ditches, embankments, and holes

Reduce speed when turning, crossing slopes, and on rough, slick, or muddy ground

Stay off slopes too steep for safe operation

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When you begin your operation remember to perform the following.

Safe Operation

Watch where you are going

No riders

Avoid jerky turns, starts, and stops

Hitch properly (Drawbar and three-point)

Set brakes securely when stopped (parking brake)

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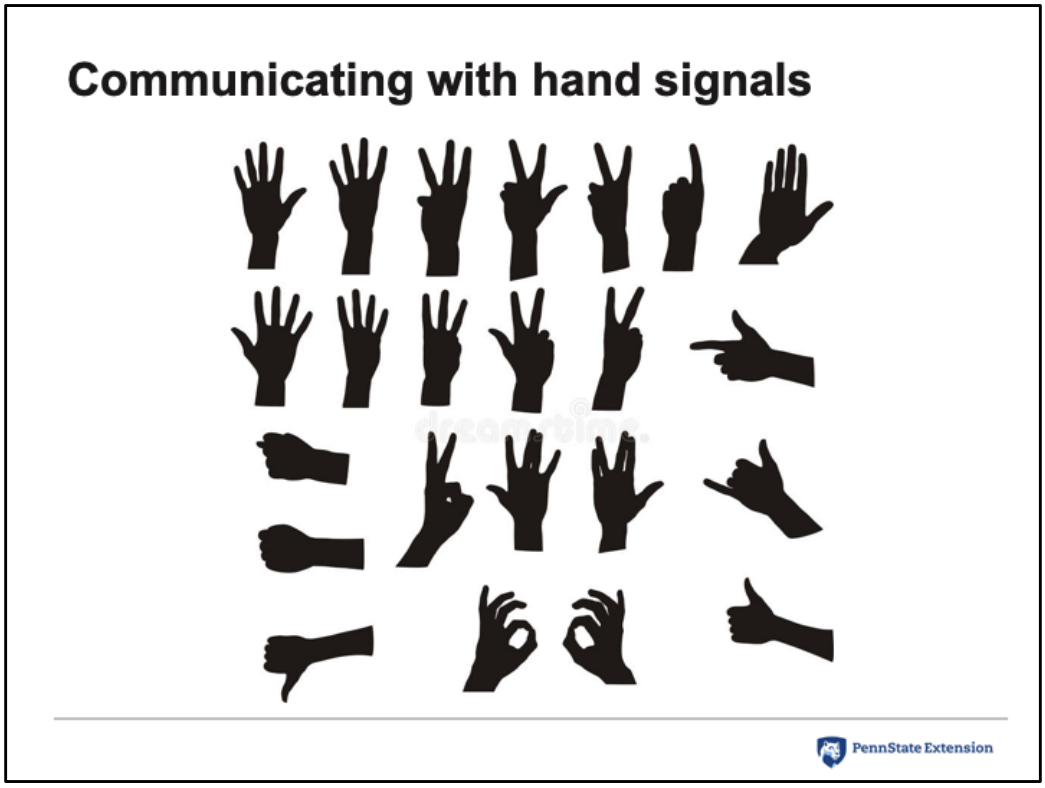
As you go about your work remember to maintain your safety by ensuring the following.



Sometimes tractor engine noise and distance can limit our ability to communicate with each other.

We are going to show you common hand signals to communicate machine operation. We will practice each before we going to the hands-on portion of the workshop.

Figure 8 – START THE ENGINE — Simulate cranking of vehicles by moving arm in a circular motion at waist level.

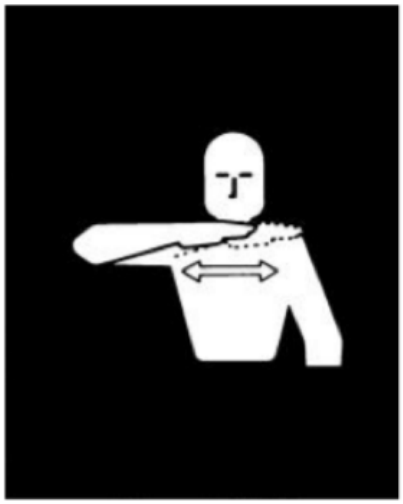


Figure 9 – STOP THE ENGINE — Draw right hand, palm down, across the neck in a "throat cutting" motion from left to right.

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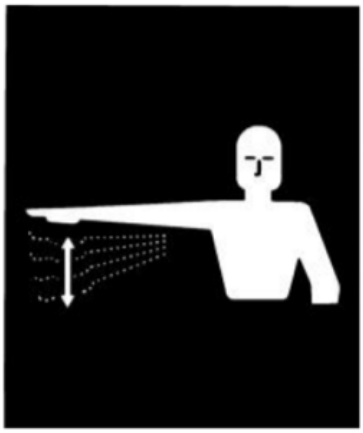

Figure 7 – SLOW IT DOWN — DECREASE SPEED — Extend the arm horizontally sideward, palm down, and wave arm downward 45 degree minimum several times, keeping the arm straight. Do not move arm above horizontal.

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Figure 1 – THIS FAR TO GO — Place palms at ear level facing head and move laterally inward to indicate remaining distance to go.

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Figure 5 – STOP — Raise hand upward to the full extent of the arm, palm to the front. Hold that position until the signal is understood.

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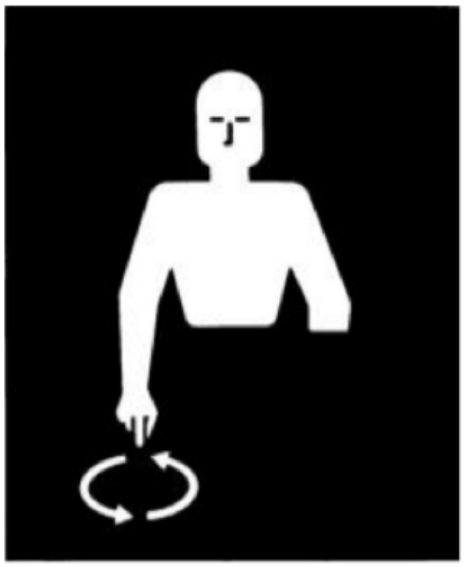

Figure 10 – LOWER EQUIPMENT — Make circular motion with either hand pointing to the ground.

Figure 11 – RAISE EQUIPMENT — Make circular motion with either hand at head level.

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