



Tractor use and Operation



3 PDH or CE

**Professional Development Hours (PDH) or
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Learning Objectives

- ◆ Understand the purpose of a tractor.
- ◆ Understand the characteristics of a tractor.
- ◆ Recognize the hazard groups associated with tractors.
- ◆ Understand tractor stability.
- ◆ Identify the controls and instrumentation of a tractor.
- ◆ Understand preventive maintenance and pre-operation checks.
- ◆ Demonstrate safe use of a tractor.



Intro to Agricultural Tractors

The agricultural tractor has been around for more than a century. You will be operating a tractor designed to accomplish greater amounts of work than ever thought possible in the early 1900s. The speed, power, and handling ease of modern tractors is what makes them valuable and indispensable for modern agriculture.



Tractors are designed with both narrow and wide front ends.

- ◆ A narrow front end ("tricycle") will be an older tractor, as they have not been produced this way since the 1960s.

Tractors can use either wheels or tracks.

Can be two---wheel drive, four---wheel drive, or articulated.

- ◆ Articulated tractors are usually very large (at least 250 hp)

Tractors range from lawn and garden---size (~ 20 hp) to large four---wheeled drive, articulated tractors. (around 250 --- 500 hp)



Many older and smaller tractors will not have a rollover protective structure (ROPS), while all new tractors will have a ROPS and seat belt.

Tractor Purposes

Farm tractors were designed to complete four primary functions:

- ◆ Load Mover (High Lift)
- ◆ Remote Power Source (PTO)
- ◆ Implement Carrier (3 Pt. Hitch)
- ◆ Transport Unit (Drawbar Hitch)

Other uses can increase the chance of injury to you or others, or to the tractor implements, and other property.

Tractor Characteristics

Here are some design elements of a tractor:

- ◆ Rear wheels adjustable for width
- ◆ “Turn-on-a-dime” steering
- ◆ High-powered engine with many gear ranges for relatively low speeds
- ◆ Great clearance beneath the tractor
- ◆ More weight over traction wheels
- ◆ Individual brakes for each rear wheel
- ◆ Adjustable drawbar hitch

Design elements of a tractor (cont.)

- ◆ Power controls to increase pulling power
- ◆ Potential to add or subtract weights for ballast
- ◆ Hydraulic system for added power source
- ◆ PTO shaft to transfer power to towed a hitched machine
- ◆ Differential lock for added traction
- ◆ Adapted to carry or pull equipment



- ◆ Fitted with a Rollover Protective Structure (ROPS) or a Falling Object Protective Structure (FOPS)

Hazard Groups

There are several hazards associated with tractor operation. Tractor hazards are grouped into the following four categories:

- ◆ Overturns
- ◆ Runovers
- ◆ Power Take-Off Entanglements
- ◆ Older Tractors



Rollover

Tractor **rollover** is one major hazard group and accounts for the most farm-work fatalities.

- ◆ In Ohio, 65% of tractor fatalities come from tractors turning over either sideways or backward.

Some common examples of tractor overturns include:

- ◆ Turning or driving too close to the edge of a bank or ditch.
- ◆ Driving too fast on rough roads and lanes and running or bouncing off the road or lane.
- ◆ Hitching somewhere other than the drawbar when pulling or towing objects.
- ◆ Driving a tractor straight up a slope that is too steep.
- ◆ Turning a tractor sharply with a front-end loader raised high.

Overturns

The rollover protective structure (ROPS) and seat belt, when worn, are the **two most important** safety devices to protect operators from death during tractor overturns.

- ◆ Remember the ROPS does not prevent tractor overturns, but can prevent the operator from being crushed during an overturn.
- ◆ The operator must stay within the protective frame of the ROPS (Zone of Protection) in order for the ROPS to work as designed.
- ◆ This means the operator must wear the seat belt.
- ◆ Not wearing the seat belt may defeat the primary purpose of the ROPS.



Runovers

There are three basic types of tractor *runover* incidents:

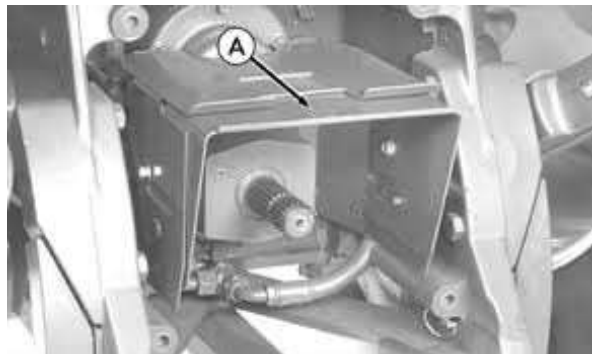
- ◆ A passenger (extra rider) on the tractor falls off and is run over.
- ◆ The tractor operator either falls off the tractor as it is operating or is knocked out of the seat and is run over.
- ◆ A person who is on the ground near a tractor is run over.

Power Take---Off Entanglement

The tractor power take---off (PTO) stub is another major hazard.

The PTO stub normally turns between 540 and 1,000 revolutions per minute (RPM).

- ◆ At this rate, the stub is turning from 9 to 17 times per second. A PTO mastershield (A) protects a person from the PTO stub.



Some tractors have PTO stub guards that fasten to the PTO stub.

All tractors should have a PTO master shield to protect the tractor operator and helpers.

Tractor Stability

Center of gravity (CG). A center of gravity is the point where all parts of a physical object balance one another.

On a two-wheel drive tractor, CG is generally about 10 inches above and 12 inches in front of the rear axle.

This figure shows the normal position of a tractor's CG.



The CG is inside a tractor's stability baseline.

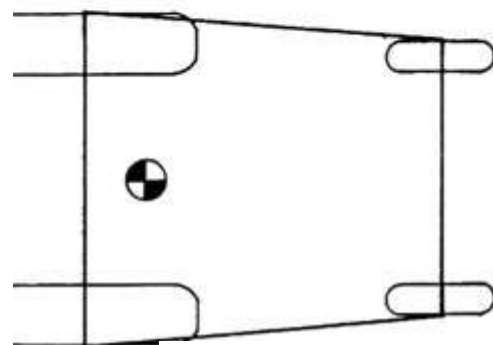
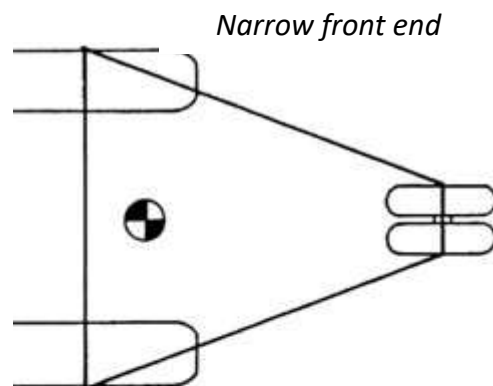
Drawing a line to connect all the wheels of the tractor as the wheels set on level ground forms a tractor stability baseline.

The line connecting the rear tire ground contact points is the rear stability baseline.

The lines connecting the rear and front tire on the same side are the right and left side stability baselines.

There are three very important points to remember about tractor CG and stability baselines:

- ◆ The tractor will not overturn if the CG stays inside the stability baseline.
- ◆ The CG moves around inside the baseline area as you operate the tractor.
- ◆ A wide front-end tractor provides more space for the CG to move around without going outside the stability baseline.



Wide front end

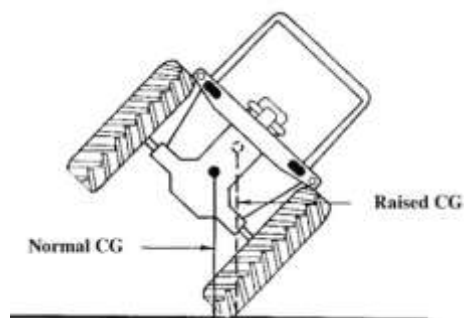
There are five main reasons why a tractor's CG moves outside the stability baseline.

- ◆ The tractor is operated on a steep slope.
- ◆ The tractor's CG is raised higher from its normal location.
- ◆ The tractor is going too fast for the sharpness of the turn.
- ◆ Power is applied to the tractor's rear wheels too quickly.
- ◆ The tractor is trying to pull a load that is not hitched to the drawbar.

When a tractor is on a slope, the distance between the tractor's CG and stability baseline is reduced.

On steep slopes, the tractor is already close to an overturn.

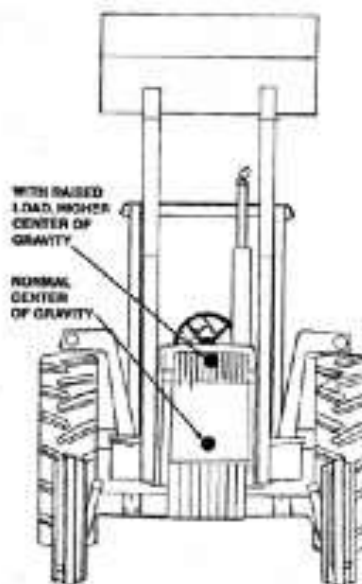
A small bump on the high side, or a groundhog hole on the low side, may be all that is needed for the tractor to overturn.



A front-end loader or other attachment mounted on a tractor can raise the tractor's CG

When the bucket is raised high, the balance point for the whole tractor is also raised.

This figure shows how a raised CG makes it easier for a tractor to turn over sideways.

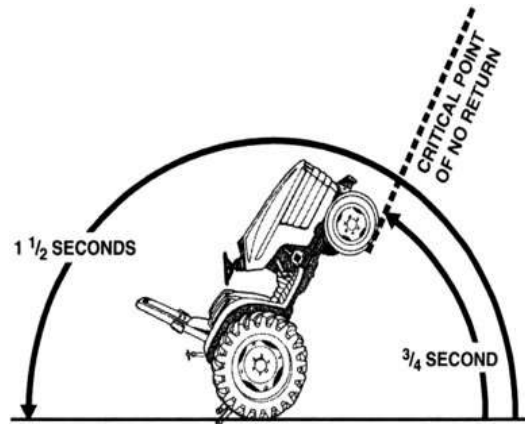


The CG of a tractor is found closer to the rear axle than the front axle on two wheel drive tractors.

A tractor may only have to rear to about 75 degrees from a level surface before its CG passes the rear stability baseline and the tractor continues flipping over.

This position is commonly called the “point of no return.”

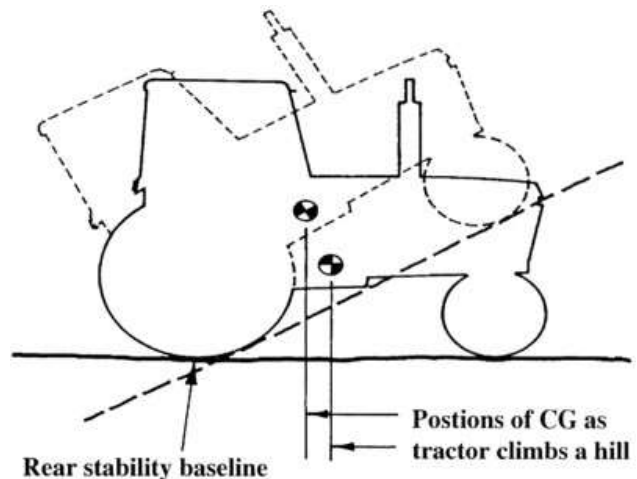
This point can be reached more quickly than an operator can recognize the problem.



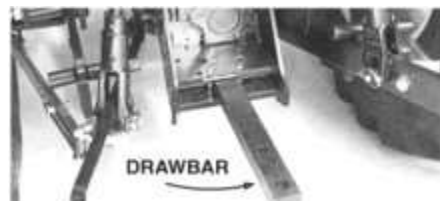
Common examples of this type of tractor overturn are: the rear tires are frozen to the ground; tires stuck in a mud hole; or tires blocked from rotating by the operator.

Rear overturns can also happen on a slope if an operator applies too much power too quickly to the rear axle.

When a tractor is pointed up a slope, there is less rise needed to reach the point of no return because the CG has already moved closer to the stability baseline.

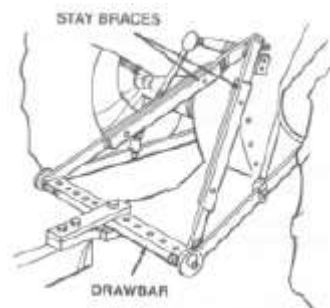
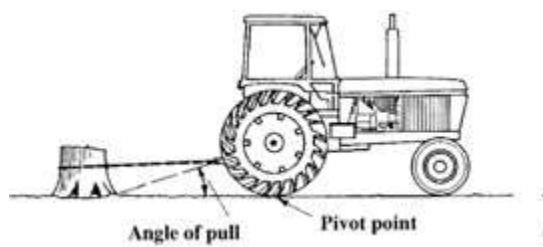


A tractor, including the drawbar, is designed to safely counteract the rearward tipping action of pulled loads.



When loads are attached to a tractor at any point other than the drawbar, the safety design of the tractor for pulling loads is defeated.

The heavier the load and the higher the “angle of pull,” the more leverage the load has to tip the tractor rearward.

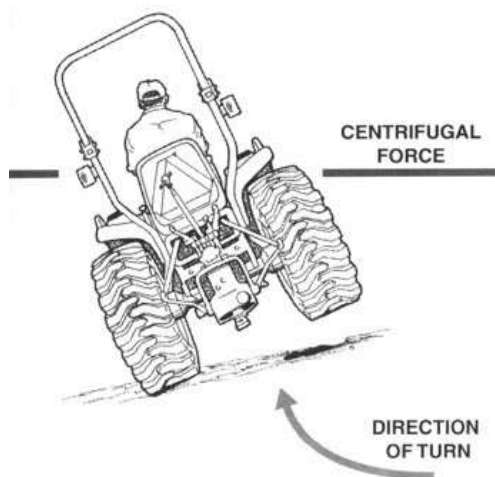


Centrifugal force (CF) is the outward force nature exerts on objects moving in a circular fashion.

During tractor overturns, CF is that force trying to roll the tractor over whenever the tractor is turning.

Centrifugal force increases both as the turning angle of the tractor becomes sharper (decreases), and as the speed of the tractor increases during a turn.

Centrifugal force is what usually pushes a tractor over when the tractor is driven too fast during a turn or during road travel.



Instrument Panel

The tractor control panel tells the driver about the operating conditions within and around the tractor.

All tractor drivers should know what instruments are available to indicate that the tractor is operating properly.

Using tractor Owners' Manuals is the best source to help you to learn this information. As different manufacturers design different dashboards and gear setups. The following is a mere example

Instruments and Gauges

Instruments can be warning lights, analog gauges, computer digital displays, buzzers, or standard gauges.



It is important for the beginning operator to develop the habit of regularly checking the instrument panel. Check the gauges:

- ◆ At start up
- ◆ At regular intervals during operation
- ◆ When changes occur in the normal sounds of operation

Abnormal gauge readings, plus changes in operating sounds, indicate that there is a problem.

You should immediately **stop the engine in a safe place**, and seek help from the owner or an experienced operator.

Instruments you will use may include the following (there may be many more):

- ◆ Engine speed indicator (Tachometer)
- ◆ Oil pressure indicator
- ◆ Engine temperature indicator
- ◆ Fuel gauge
- ◆ Air filter condition indicator
- ◆ Transmission temperature indicator
- ◆ Hydraulic system oil level indicator
- ◆ Hour meter

- ◆ Charge indicator

Tractor Controls

Operators must know:

- ◆ Color coding of controls
- ◆ Controls for stopping the engine
- ◆ Controls for moving the machine
- ◆ Power engagement controls
- ◆ Positioning and adjusting controls
- ◆ Movement of controls



Controls and Colors

Based on published standards of ASABE

Red = engine control

- ◆ Start up, shut off

Orange = directional controls

- ◆ Ground motion (i.e. forward/reverse)

Yellow = power engagement

- ◆ Power Take---Off (PTO) control

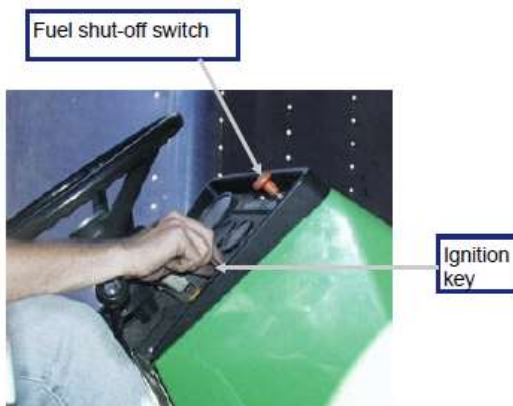
Black = positioning and adjustment

- ◆ Hydraulics: Raise and lower implements

Engine Stop Controls

The Color **Red**

- ◆ Stop Engine Control
 - Gasoline Engine
 - **Red** letters on key switch
 - Diesel Engine
 - **Red** fuel shut-off switch
 - Most older diesel tractors are shut off with a fuel shut-off switch not by the ignition key.



Ground Motion Controls

The Color **Orange**

- ◆ Engine speed (throttle)
- ◆ Transmission controls
- ◆ Parking break or park-lock
- ◆ Independent emergency brakes
- ◆ Differential lock



Power Engagement Controls

The Color **Yellow**

- ◆ PTO
- ◆ Cutter heads / Mower deck
- ◆ Feed Rolls
- ◆ Elevators
- ◆ Winches
- ◆ Unloading Augers



Positioning and Adjusting Controls

The Color **Black**

- ◆ Remote hydraulics
- ◆ Implement hitches
- ◆ Unloading components
- ◆ Engine chokes
- ◆ Steering column position
- ◆ Lights, flashers, signals
- ◆ Cab comforts



Control Devices and Functions

Three common types of control devices:

- ◆ Foot Controls
 - Pedals
 - Hand controls
- ◆ Levers
 - Knobs
 - Switches
 - Buttons
- ◆ Combination Hand and Foot
 - Engine throttles



Lighting and Marking

Highway transport of farm equipment at night requires lighting and marking. Older equipment must meet these requirements as well. The requirements are:

- ◆ Slow-moving Vehicle (SMV) emblem (Mounted 2-10 feet above the ground)
- ◆ Extremities of width defined by side marker lights or decals
- ◆ Ability to warn of turns by recognizable signals



If the towed equipment prohibits the view of lighting and marking of the tractor, lighting and marking must be present on the towed equipment.

The SMV emblem is designated for agricultural equipment traveling less than 25 mph on Ohio roadways.

Preventive Maintenance

Performing basic maintenance is a critical task for every machine

The first step to a preventive maintenance program is pre--- operational checks

Checking fluid levels, lines and hoses, batteries, cleaning windows and adjusting mirrors should all been done each time BEFORE driving (pre-operation)

Pre-Operational Checks

Items to check:

- ◆ Fuel level
- ◆ Coolant level
- ◆ Engine oil level
- ◆ Hydraulic oil level
- ◆ Battery condition
- ◆ Lug nuts and wheels
- ◆ Tire condition
- ◆ Loose or defective parts
- ◆ SMV emblem
- ◆ Fluid leaks
- ◆ Operators platform/ steps
- ◆ Seat adjustment
- ◆ Seat belt
- ◆ Fire extinguisher
- ◆ Lights
- ◆ Visibility from operator's seat

Preventative Maintenance

Remember

- ◆ Be sure to follow the pre-operation check list
- ◆ Check ALL fluid levels
- ◆ Batteries require special care when charging and jump starting
- ◆ Tires and wheels must also be inspected
- ◆ The operator's platform must be free of obstructions (i.e. tools and debris)



Safe Tractor Mounting

Establish yourself as a good tractor operator by using these procedures each time you climb onto and sit down on a tractor seat:

- ◆ Keep the operator platform free of tools, equipment, mud or other debris.
- ◆ Use handholds and steps as you mount the tractor. Try to keep three points (two hands and one foot or two feet and one hand) on the tractor at all times.
- ◆ Adjust the seat and steering wheel (if necessary).
- ◆ Adjust and buckle the seat belt (if the tractor has ROPS).
- ◆ Check the major controls (PTO, hydraulics, gearshift stick) for the neutral (or PARK) position.

Before You Start the Engine

The safe operator will then think about and check many things before turning the key.

- Is the area immediately around the tractor clear of persons and animals?
- Is the tractor inside a building? If yes, is the building as open as possible to avoid a carbon monoxide fume buildup?
- Do you understand the tractor's instrument panel?
- Have pre-operation checks been made?

If you answered "Yes" to all of the above, now you are ready to start the tractor.

Shutting Down

At the end of a day, there are many things to think about as you prepare to park and shut the tractor off for a period of time or for the night.

Stop and park on the most level ground possible. Set the brakes (both brakes should be locked together) or place the gearshift in park.

- ◆ Lower all attached equipment to the ground.
- ◆ Place all controls and switches in an off, neutral, or locked position.
- ◆ Engine cool down—Manufacturers suggest cooling the engine for several minutes at a fast idle (800-1200 RPM) to prevent internal damage to hot engine parts. While letting the engine idle to cool, check all systems on

the tractor. Then stop the engine.

- ◆ Hydraulic system—Even if you did not use the hydraulic system recently, static pressure keeps hydraulic lines pressurized. With the engine off, work the hydraulic controls to relieve that pressure. It will be easier to attach the hydraulic lines later.
- ◆ Chock wheels if a heavy load is attached to the tractor to prevent runaways.

Using the Tractor Safely

Remember tractors can serve many purposes:

- ◆ Remote power source for implements.
- ◆ Carry/pull machines.
- ◆ Move loads.
- ◆ Transport materials.

If you are not sure of a specific use for your tractor, consult the Owner's Manual and your supervisor.



Tractors can be operated safely if they are used as designed and operated following recommended practices.

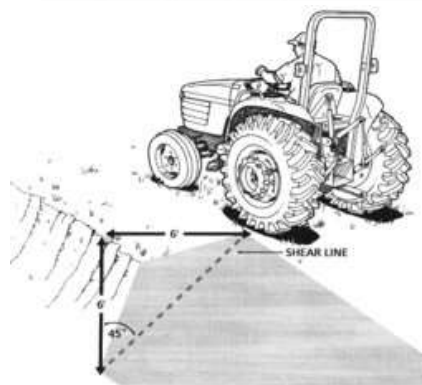
Slow down on steep slopes, rough ground and sharp turns.

Stay clear of ditches, embankments and large obstacles such as stumps or groundhog holes.

Ensure that all shielding remains in place.

Ensure area is all-clear before moving the tractor.

Controlling speed, and watch for pedestrians, especially in high traffic areas around farm buildings.



Recommended practices (Cont.)

Only start from the operator's seat.

- ◆ No by-pass starting of the engine.

Do not allow extra riders.

Always hitch the load to the tractor draw bar or 3-point hitch.

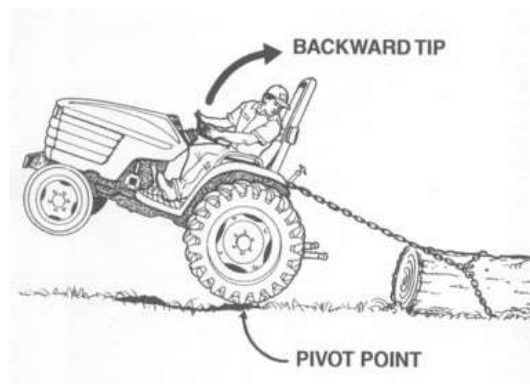
When hitching to the drawbar use a large enough hitch pin and a locking pin.

Ensure that all shields remains in place.

Do not wear loose clothing, jewelry or hooded sweatshirts with loose strings, when operating or repairing a tractor.

Stop the PTO before dismounting the tractor.

No horseplay or use of distractive devices, such a cell phones, while operating equipment.



Front End Loader Safety

Never walk or work under a raised loader.

Raise and lower loader arms slowly and steadily.

Allow for the extra length of the loader when making turns.

Be careful when handling loose or shift-able loads.

Operate the loader from the operator's seat.



Front End Loader Safety

Travel with the bucket in the lowered position

Watch for overhead wires and obstacles when you raise the loader.

Never lift or carry anyone on the loader, bucket or attachments.

Lower the loader when parking or servicing.

Visually check for hydraulic leaks and broken, missing or malfunctioning parts, then make necessary repairs.



Reducing risks during road travel.

Move equipment at off-peak hours when possible.

Use escort vehicle when possible.

Use warning and signal lights to increase visibility.

Make sure a clean, non-faded SMV emblem is displayed on vehicles and implements traveling slower than 25 mph.



Reducing risks during road travel.

Use Roll Over Protective Structure (ROPS) in the upright position and the seat belt at all times

Lock brake pedals together (A) during road travel. (Pushing one brake pedal at high speed could cause the tractor to swerve in one direction and potentially rollover sideways.)



Keep loads and loader bucket low

Stay alert for traffic and roadside obstacles

Agricultural Tractor Operator Training

For additional information regarding tractor safety

Reference

National Safe Tractor and Machinery Operation Program, Hazardous Occupations Safety Training in Agriculture. Penn State University, Ohio State University, and National Safety Council

OSHA 29CFR1910 and 29CFR1928