TRACTOR SAFETY—PREVENTION AND PROTECTION

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INTRODUCTION

Tractor overturns are a major cause of agricultural-worker deaths each year. In 1993, over 31 percent of U.S. agriculture worker deaths were tractor related. Of the tractor-related fatalities, 55 percent or nearly 200 total were caused by tractor overturns (National Safety Council, 1994). In addition, other serious non-fatal injuries also result from overturns of tractors without roll-over protective structures (ROPS). One out of every six agricultural worker deaths in 1993 was due to a tractor overturn (National Safety Council, 1994). These deaths and serious injuries may have been prevented if the tractors had been equipped with ROPS and the operator was wearing a seat belt.

ROLL-OVER PROTECTIVE STRUCTURES

A roll-over protective structure (ROPS) is a structural frame designed for protection of the operator in the event of a vehicle overturn. ROPS are designed to absorb energy resulting from the impact of the vehicle with the ground surface during an overturn and protect the operator from serious injury. ROPS utilization is shown to have a dramatic impact in reducing fatalities during vehicle overturns (Woodward and Swan, 1980).

Required installation of ROPS has significantly reduced the tractor rollover fatalities in Sweden. In the early 1950's, Sweden began the initial ROPS design work (Bucher, 1966; Sullivan, 1975; Watson, 1967). The first ROPS were made available for tractors in the 1960's and have since been included in the entire design of many tractors.

An agreement between North American tractor manufacturers resulted in all new tractors sold after 1984 be manufactured with ROPS. Also, retrofit ROPS are currently available for tractors manufactured with ROPS as an option. Although some tractor manufacturers had ROPS-equipped tractors earlier, many tractors manufactured prior to 1970 did not have ROPS as an option, and thus, the axle mounts were not designed to structurally support a ROPS during an overturn. Such tractors are referred to as pre-ROPS tractors.

NIOSH (1993) estimates that of the 4.61 million tractors utilized in the U.S., 61 percent were manufactured before 1971. Many of these, but not all, are considered pre-ROPS tractors. Of 898 Colorado tractors surveyed in 1991, 37 percent are more than 20 years old. Of these older tractors, only 11.5 percent were equipped with ROPS. Of all the tractors surveyed without ROPS, only 46 percent had ROPS available from the tractor manufacturer. A 1988 study of West Virginia tractors revealed an average tractor age of 19.3 years (Etherton and Myers, 1990). Only 7.2 percent of the tractors between the ages of 15 and 34 years are equipped with ROPS. By retrofitting farm tractors with ROPS, an estimated 2800 rollover-related fatalities could be prevented in the U.S. (NIOSH, 1993).

The Wisconsin Rural Health Research Center has compiled a Rollover Protection Directory entitled "A Guide to Tractor Roll Bars and Other Rollover Protective Structures." The guide lists ROPS distributors for almost every tractor. ROPS range in price from $500-$1500. ROPS cabs are more expensive, but also are available for older tractors.

The safest place for any tractor operator (either child or adult) during a rollover is on the tractor seat, held by a seat belt and under a ROPS. Seat belts keep the operator in a protected area during a rollover.

The Occupational Safety and Health Administration (OSHA) requires that employers provide employees with:

- A standard roll-over protection structure,
- A standard seat belt,
- Protection from tractor fluid spillage, and
- Protection from sharp surfaces.

ROPS Regulations

The Occupational Safety and Health Administration (OSHA) has issued regulations for ROPS utilization.

"Agricultural tractors manufactured after October 26, 1976, shall meet the following requirements:

1. A roll-over protective structure (ROPS) shall be provided by the employer for each tractor operated by an employee.

2. Where ROPS are required by this section, the employers shall:

   a. Provide each tractor with a seat belt that meets the requirements of SAE Standard J4C;

b. Ensure that each employee uses the seat belt and tightens the belt sufficiently to confine the employee.

Exempted Uses

- 'Low profile' tractors while they are used in orchards, vineyards, or hop yards where the vertical clearance requirements would substantially interfere with normal operations and while their use is incidental to the work performed therein.

- 'Low profile' tractors while used inside a farm building or greenhouse in which the vertical clearance is sufficient to allow a ROPS equipped tractor to operate and while their use is incidental to the work performed therein.

- Tractors while used with mounted equipment which is incompatible with ROPS (e.g., cornpickers, cotton strippers, vegetable pickers, and fruit harvesters).

Definitions

'Agricultural tractor' means a two- or four-wheel drive vehicle, or track vehicle of more than 20 engine horsepower, designed to furnish the power to pull, carry, propel, or drive implements that are designed for agriculture. All self-propelled implements are excluded.

'Low profile tractor' means a wheeled tractor possessing the following characteristics:

- The front wheel spacing is equal to the rear wheel spacing, as measured from the centerline of each right wheel to the centerline of the corresponding left wheel.

- The clearance from the bottom of the tractor chassis to the ground does not exceed 18 inches.

- The highest point of the hood does not exceed 60 inches.

- The tractor is designed so that the operator straddles the transmission when seated.

Remounting

Where ROPS are removed for any reason, they shall be remounted so as to meet the performance requirements specified in the standard.

Labeling

Each ROPS shall have a label, permanently affixed to the structure, stating: manufacturer's or fabricator's name and address; ROPS model number (if any); tractor makes, models or series numbers that the structure is designed to fit; and whether or not the ROPS model was tested in accordance with the requirements of the standard.

Operating Instructions

Effective June 1, 1975, every employee who operates an agricultural tractor shall be informed of the operating practices contained below and of any other practices dictated by the work environment. Such information shall be provided at the time of initial assignment and at least annually thereafter.

- Securely fasten seat belt if the tractor has a ROPS.
- Where possible, avoid operating the tractor near ditches, embankments, and holes.
- Reduce speed when turning, crossing slopes, and on rough, slick, or muddy surfaces.
- Stay off slopes too steep for safe operation.
- Watch where you are going, especially at row ends, on roads, and around trees.
- Do not permit others to ride.
- Hitch only to the drawbar and hitch points recommended by tractor manufacturers.
- Operate the tractor smoothly—no jerky turns, starts, or stops.
- When tractor is stopped, set brakes securely and use park lock if available.

GUIDELINES FOR SAFE TRACTOR OPERATION

1. Be sure tractor is properly serviced. Check lubrication, fuel, and water. It is best to check the radiator level when the tractor is cold. If you must check it when hot, use extreme care.

2. Never refuel your tractor while the engine is running. Static electricity, a spark from the ignition system, or a hot exhaust could cause the fuel to ignite. Grounding out the tractor by use of a ground wire or by dropping mounted equipment so it contacts the ground can reduce the static electricity problem.

3. Always fuel your tractor outside and store your fuel outside. It's best to have fuel storage at least 40 feet from any building. Keep the area free of weeds or any other burnable material.

4. Carry a first aid kit and approved dry chemical extinguisher. Tractors should have at least a five-pound extinguisher.

5. Be sure of good ventilation before starting the tractor engine. Exhaust gases contain carbon monoxide which is odorless, colorless, and deadly.

6. Keep small children away from the tractors. Tractors are designed to carry only one person—the driver. Each year small children are killed as a result of falling from the tractor. The chances of children being killed are just as great when they are allowed to ride on trailing equipment.

7. Keep wheels spread wide whenever possible. A tractor will overturn sideways much easier if the wheels are close together. When wheels must be moved in for narrow row farming, operators should use extra precautions, especially when traveling at higher speeds on roads.

8. Reduce speed before turning. Doubling the speed of a farm tractor increases the danger of upsetting sideways four times. Centrifugal force tries to keep the tractor in a straight line. If you try to turn at a high rate of speed, the tractor will attempt to go straight rather than turn.

9. Reduce speed when using a loader. A loader in the raised position can increase the possibility of overturns. Keep the loader as close to the ground as possible. Be alert for ditches, rocks, or holes that might cause the tractor to overturn. The center of gravity can be affected if the load is kept too high in the air.

10. Stop the engine before getting off the tractor. Operators can be killed by a tractor when the tractor has been left running with the operator off the seat, leaving when it has been put in gear, parked, or had the brakes locked.

11. Never hitch to the axle or other high point. Always hitch to the drawbar, slowly take up slack, and never jerk on chains or cables. Broken parts of a chain can act like shrapnel, and a cable can cut the legs from under a person. Nylon ropes have killed tractor operators and bystanders when

the rope broke away from an implement. The stored energy in the rope catapults the rope end into the victim. Tractors also can upset backwards when pushing, using a front end loader, or when hitched to the front end by chains or cables that pass under the back axle. Keep the hitch as low as possible, preferably 17 inches. Never get above 21 inches.

12. Be extremely careful when driving up an incline. A tractor can upset if the center of gravity moves behind where the rear wheels are in contact with the ground. Try and back up if it's necessary to get up an incline. If you get caught on a steep incline, back down very slowly and apply the brakes lightly. Weight on the front of the tractor will help.

13. Disengage the power take-off when it's not in use. Use the power shield whenever equipment is in use. If you do not have a PTO shield, make one—it may save your life.

14. Do not wear loose clothing while operating a tractor. Loose clothing can catch on moving parts causing an accident.

15. Keep the tractor in gear when going down hill. This allows the tractor engine to serve as a brake. In Nebraska it's unlawful to coast down a hill with the vehicle out of gear. Some tractors may have "free wheeling" in their transmission drive. Make sure this type of transmission is put in direct drive before attempting to use the engine as a brake.

16. Engage the clutch gently, especially when going uphill. 'Jackrabbit' starts are dangerous to both the operator and the tractor.

17. Never attach a post or log to the rear wheels when the tractor is stuck in the mud. If the wheels are not free to turn, the tractor can pivot around the axle and upset. Try to back out. If this does not work, get another tractor to pull you out.

18. The tractor operator must follow all traffic rules on open roads. This includes proper lighting, hand signals, right-of-way, etc. Tractors are restricted from using interstate highways.

19. Do not use a tractor for a job it wasn't designed to do. The tractor was designed as a source of power to do field work. It was not designed for chasing cattle, drag racing, or transportation to and from town.

TRACTOR INSTABILITY

Factors that contribute to tractor instability include:

Higher Center of Gravity—As a loader is raised, the center of gravity is higher on the tractor. This makes the tractor easier to roll over on steep slopes and while turning at high speeds. To avoid overturns, keep the center of gravity as low as possible.

Speed—Many tractor rollovers occur at high speeds on country roads. Higher speeds produce higher side (lateral) forces on the tractor during a turn; these forces can cause the tractor to roll on its side. To avoid overturns, slow down, especially when turning, and lock brakes at transport speeds.

Turning Radius—Sharper turns put more side forces on the tractor making it more likely to roll to the side. Turns should be made gradually to avoid tipping to the side (see Figure 1). Sharp turns along with high speeds, steep slopes, and high centers of gravity can lead to tractor rollovers.

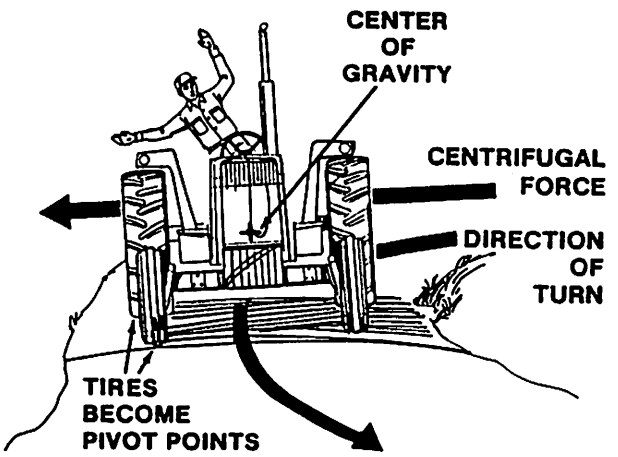

FIGURE 1. Sharp turns produce higher centrifugal forces, causing an overturn.

High Hitch—When pulling agricultural implements or other items such as tree stumps and stuck vehicles, you should always attach these items to the drawbar. The only exception is implements that are designed to mount to the three-point hitch. Hitching high, such as at the axle or on the three-point hitch, increases the possibility of a rear rollover.

Small Treadwidth—Tractors with tires close in and tricycle-type tractors are more likely to roll over because the center of gravity is closer to the tipping axis. To make a tractor more stable, spread out the tires or put on duals.

Slope—Rear Roll: Many rear wheel drive tractors have most of their weight on the rear wheels. This is necessary to produce the required traction. However, insufficient weight is on the front tires so that they may come off the ground, and the tractor may roll over backwards when driving straight up a steep include (see Figure 2).

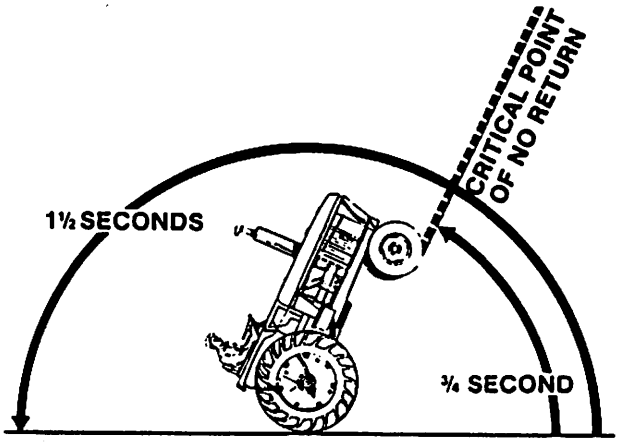

FIGURE 2. Rear rolls occur quickly on steep slopes.

When a tractor travels up a steep hill pulling a heavy load on tilled soil, these heavily weighted rear tires tend to dig into the soil. If these back tires become stuck, the front wheels may raise off the ground. With about one-fourth of an axle turn, the tractor could overturn backwards as Figure 2 shows. To avoid rear rolls, put extra weight on the front of the tractor and back up steep inclines.

Slope—Side Roll: Tractors roll easier on steep side slopes because the center of gravity of the tractor is closer to the tipping axis of the tractor. Once the center of gravity is directly above the tipping axis, the tractor is on the verge of rolling over. To avoid a side roll, avoid crossing steep slopes.

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Nitrogen Management Under Irrigated Conditions

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Introduction

Nitrogen (N) is the essential plant element which most frequently limits irrigated crop production in Colorado. Commercial N fertilizers are a cost effective means of supplementing soil supplied N for plant growth and are necessary for sustaining high crop yields. However, it has been documented that improper or excessive use of N fertilizer can lead to nitrate pollution of surface or ground water. Both urban and rural fertilizer applicators can minimize this problem by implementing Best Management Practices (BMPs) for fertilizer use.

Nitrate is a naturally occurring form of N that is highly soluble in water and may cause health problems if ingested in large amounts. A number of sources of NO_3 exist, including manure, septic and municipal effluent, decomposing organic matter, soil organic matter, and N fertilizer. High NO_3 levels in drinking water can cause methemoglobinemia or "blue baby syndrome"; a condition primarily seen in very young infants and farm animals. Although reports of methemoglobinemia are extremely rare, the U.S. EPA has established a safe drinking water standard of 10 ppm NO_3-N for community drinking water supplies.

To fully understand the transformation and movement of N in the environment, some knowledge of the N cycle is needed. Nitrogen in the soil is commonly found in the form of organic N in the soil humus, ammonium (NH_4), nitrate (NO_3), or in a gaseous form (NH_3, N_2O, N_2). Nitrogen in soil organic matter may be converted to the NH_4 form by a biological process called mineralization. The NH_4 form is converted to NO_3 by another biological process called nitrification. Fertilizer N, whether organic or inorganic, is biologically transformed to NO_3, which is highly leachable. The speed of this transformation is determined by soil temperature and moisture, but will eventually occur in any well-drained agricultural soil. Plants will absorb and utilize both NH_4 and NO_3. Therefore, producers need to match N applications to crop uptake patterns to minimize NO_3 leaching and maximize efficiency.

Nitrogen Fertilizer Best Management Practices

BMP 1. Base N fertilizer rates on results from soil analysis, as well as irrigation water and plant analysis when appropriate, using environmentally and economically sound guidelines.