TO: Director, National Institute for Occupational Safety and Health

FROM: Iowa FACE Program

SUBJECT: Retired farmer dies in barnyard from tractor rollover -- Iowa.

SUMMARY: A 75 year old male farmer was killed while loading manure in his barnyard. He was using a tricycle type narrow-front tractor equipped with a front-end loader to scoop up manure from the cattle yard, then load it into a manure spreader which was located downhill from him. While making a turn in reverse, with the loaded bucket in the raised position, the tractor tilted to the side and tipped over on the sloped ground. Since the tractor had no ROPS, and was positioned perpendicular to the slope, the tractor rolled completely over, crushing the victim. He was found dead at the scene a few hours later by his wife.

RECOMMENDATIONS following our investigation were as follows:

- 1. *Tractors used with front end loaders should be equipped with ROPS.*
- 2. *Tricycle type narrow front tractors should not be equipped with front end loaders.*
- 3. *Loading areas should be designed to minimize the risk of tractor and loader overturns.*
- 4. *Tractor front end loader operators should be made aware of overturn hazard and methods to reduce this hazard, including safe driving on sloping grounds, the changing center of gravity caused by a loader bucket, keeping the bucket low while driving, and using counterweights on the tractor.*

INTRODUCTION

On April 16, 1995 a 75 year old male farmer was killed from a tractor rollover while cleaning his barnyard of manure. The Iowa FACE Program became aware of the incident by radio news and began an immediate investigation. Information was obtained from a local newspaper, the county Sheriff's office who took detailed photographs, the Iowa Medical Examiner's report, and an interview with the victim's wife who first found him. A site investigation was performed on May 12, 1995, and additional photographs were taken.

The victim had been living at this farm location for the past 38 years and was very familiar with his equipment and routine farming chores. He had been retired from a professional position in town since 1979, and the farm had been reduced to 55 acres. The victim had been farming full-time for the past 16 years, assisted by his wife. She states he had driven tractors all his life, and had used this particular tractor since it was acquired in 1974. The tractor was manufactured approximately 1960 and had a tricycle type front end where the front wheels are close together. The tractor had a same-brand factory supplied front end loader. The victim had been loading manure with this same tractor in the same cattle yard for many years without apparent problems. He had no obvious medical problems that contributed to this accident.

INVESTIGATION

At approximately 10:00 A.M. the victim was cleaning his cattle yard of manure using a small tractor equipped with a front-end loader. This involves scooping up a load from the level ground south of the barn (see diagram 1), then backing up, turning and driving ahead downhill to where the manure spreader was located. Each time this required the tractor to be perpendicular to the hill at some point in its travel. We determined that the tractor was straddling the right edge of the driveway when it tipped over, being tilted to the right and to the front, transferring much of its weight to the narrow front end. A heavy load in the raised bucket shifted the center of gravity higher making the tractor more unstable.

Another contributing factor was centrifugal force created by making or finishing a turn at this hazardous point in the barnyard. Lateral torque from the raised and loaded bucket was sufficient to cause the tractor to overturn at this point. From the position of the steering wheel, gearshift, and skid marks on the rear tires, we assume the tractor was backing up and turning around. The tractor tipped at the point when it was perpendicular to the hill. The driveway into this barnyard was fairly level from the gate to the barn, sloping on the eastern side of the driveway, which is where the rollover occurred (see diagram 2). The victim may have also applied the brakes at the end of his reverse curve which would have further increased the lateral momentum.

This chore of loading manure was performed many times in the past with the same equipment, however the manure pile and manure spreader may have been in different locations than we observed. At the time of the incident the victim may have had a heavier load of manure, or it may have been lop-sided, or perhaps the loader was in a higher position, or he was backing up at a higher speed, or driving over a more sloping spot in the barnyard, or a combination of these factors. The farmer had worked several times under these same hazardous conditions, however this time the tractor rolled over.

The tractor was over 30 years old and had liquid-filled rear tires, although we could not determine the degree of filling. It was equipped with a factory made front-end loader which was in reasonably good condition, although there was some play in the linkage to the tractor. There were no apparent environmental factors contributing to this accident and the barnyard surface was not muddy or wet. The victim had no reason to be in a hurry, nor were there any contributing medical conditions.

Both legs of the victim were on one side of the tractor indicating he made an attempt to escape while it was turning over. The victim was crushed underneath the seat and 3-point hitch of the tractor. There was no rollover protective structure (ROPS) installed. The victim was found approximately 2 hours after the occurrence, and he was obviously dead when his wife found him at 12:30 P.M. Photographs were taken of the accident scene when rescue workers arrived, before the tractor was pulled off the victim. There was no eye witness to this fatal incident.

Based on the photographs and observations on site, we determined the following to be

contributing factors:

--The tractor was backing up and turning. The gear was in reverse, the steering wheel being slightly turned to the left, and skid marks were visible on the left tire.

--The operator was coming close to the position where he would stop, switch gears and drive forward, turning downhill towards the manure spreader.

--At this turning point the ground was sloping, and the tractor was perpendicular to the hill.

--The tractor was tilted to the right and to the front, much of the weight being on the narrow front wheels.

--There was a slight depression in the ground under the front wheels, and rocks 2 to 3 inches above the ground approximately in the position where the left rear wheel was when the rollover began.

--The bucket had been filled with a heavy load of manure.

--The loader was raised to 2/3 UP position.

--The loader had some play in the linkages to the tractor, allowing the loader to tilt slightly more than the tractor in certain conditions.

-- A centrifugal force was present when coming to a stop while turning and having a heavy load of manure in the bucket in the raised position.

-- Applying the brakes at the end of a reverse could have increased the centrifugal force on the tractor.

CAUSE OF DEATH

The County Medical Examiner determined that death was due to *"Severe crushing chest injury due to a tractor rollover"* with no contributing factors.

RECOMMENDATIONS / DISCUSSION

Recommendation #1 ***Tractors used with front end loaders should be equipped with ROPS.***

Discussion: Front end loaders raise the center of gravity and make all tractors less stable. Rollovers to the side are therefore more likely and the need for ROPS is evident. When considering all contributing factors in this case, tractor overturn was a very potential hazard in this regularly performed task on this farm. Installation of a ROPS on this older tractor would have saved the operator's life by preventing a complete rollover.

Recommendation #2 ***Tricycle type narrow front tractors should not be equipped with front end loaders.***

Discussion: Older tricycle type tractors are common on row crop production farms. Putting front-end loaders on these tractors was common in the past, and many of these tractors are still in daily use. On level ground few farmers have experienced problems, but operating the loader on hilly terrain is very dangerous due to the unstable front end. Rear counterweights or liquid-filled tires would improve stability, but the operator must still be constantly aware of changing slopes, holes, bumps, and ruts which can dangerously shift the center of gravity with the bucket raised. Tricycle type tractors are significantly more prone to rollovers than wide front tractors, and should therefore not be used with front end loaders. On this farm there was a wide front tractor of the same brand and model and approximately same year and condition.

This tractor would have been a safer choice to be used with the front end loader. Using the wide front tractor would likely have prevented this accident.

Recommendation #3 ***Loading areas should be designed to minimize the risk of tractor and loader overturns.***

Discussion: The loading area was mostly on sloping ground. The driving paths were limited by fences and buildings providing no adequate level area to safely turn the tractor around. The entrance to this barnyard was narrow, limited by fences on the west side and sloping to the east. The driveway was fairly level, however the ground was sloping on the eastern side. This area was used for turning the tractor around during loading of the manure spreader.

Movement of machines around livestock buildings requires proper work areas. This should be a consideration when designing buildings, roads, and fences. In this case the farmyard did not have adequate room for turning around. It is impractical to repair a slope such as this, however barriers may be installed to prevent machines entering dangerous areas.

Recommendation #4 ***Tractor front end loader operators should be made aware of overturn hazard and methods to reduce this hazard, including: safe driving on sloping grounds, the changing center of gravity caused by a loader bucket, keeping the bucket low while driving, and using counterweights on the tractor.***

Discussion: Front end loaders are typically capable of lifting a heavy load, thus greatly raising the center of gravity of the machine and shifting the weight off the rear wheels to the front wheels. This can greatly reduce the stability of the tractor and increase the risk of overturn. Operators must be aware of the overturn hazard and drive with the loader bucket down, avoiding unstable ground, driving straight up and down hills with the loader on the uphill side, turning around on level ground, using counterweights on their tractors whenever appropriate, and avoiding the use of tricycle type tractors with loaders

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