



AgrAbility Tip Sheet # 3 on Reducing Potential for Secondary Injuries

Using a Tractor with Hand Controls

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Introduction

Due to the variation in makes and models of tractors, no commercial manufacturers produce off the shelf, ready-made hand controls for tractors. At the present time, the only commercial manufacturer that AgrAbility staff has identified that will fabricate custom-made hand controls for tractors is Round Grove Machine in West Lafayette, Indiana. However, farmers themselves or employees at local machine shops are most often the designers and fabricators of needed hand controls.

When designing custom hand controls, the fabricator needs to consider (a) the physical abilities and limitations of the operator; (b) the location of the controls, ensuring that the placement does not block access to the operator's seat or limit the operator's ability to access other controls in the tractor; and (c) the impact the control placement may have on co-workers who use the same equipment. In an effort to reduce the potential of secondary injuries to the operator and others using the equipment, the following suggestions are offered to assist those who design, fabricate, and install hand controls on a tractor.

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Preventing Loss of Control of the Tractor

1. An operator should be able to lock the clutch control into a disengaged position quickly. Clutch and brake controls that must be pulled toward the operator can place him or her at risk while he or she maneuvers the tractor. For example, stopping quickly in an emergency requires the operator to pull back on both the clutch and brake controls at the same time. Because the operator with a spinal cord injury may lack upper body stability, this movement results in his or her chest being pushed into the steering wheel. A chest strap and a disengaging locking mechanism for the clutch can make this task safer.
2. Hand controls that are optimally positioned to the anthropometric need (body measurements) of the operator will improve function and safe operations. Controls that require the operator to reach too far to use them can result in loss of control of the tractor.

3. Whenever possible the operator with a disability should have co-workers hitch the equipment to the tractor. Using hand controls restricts the operator's range of motion and thus his or her field of vision when backing up the tractor. In addition, "feathering" or "inching" is often required when hitching equipment. This feathering task requires the operator to have one hand on the clutch while ever so slightly while backing up the tractor to be within inches of the implement to be hitched to it. Once the tractor is in place, the operator must engage the brakes immediately to stop the tractor from moving any further. An operator can add extra mirrors and an automatic hitching system to the tractor to make hitching equipment an easier and safer task.
4. Modify end row maneuvers or use headland traffic patterns to reduce the number of tasks the operator must do at the same time. For example, wide turns can be performed without having to apply one of the brakes but sharp turns require braking. Some fields have grass headlands so tillage implements are raised before turning on the headlands, which requires less brake use.
5. Front-wheel-assist and four-wheel-drive tractors also require less breaking on turns. Tractors equipped with an electrically controlled power shift or hydrostatic transmission allows the operator to slow down the tractor without using the clutch or brakes.
6. Hand controls should be designed and positioned so that the operator's elbow is slightly bent, not hyper-extended, when the hand control is in the position farthest from the operator.
7. Hand controls should be securely fastened to the tractor pedals or pedal arms. Secured hand controls are critical to the operator's ability to maintain control of the tractor.
8. Hand controls should be mounted on the tractor so that they do not interfere with foot placement or cause involuntary contact with the legs, hands, or arms of co-workers who may also operate the tractor.
9. Hand controls for the brakes should not interfere with the operator's ability to lock the brakes together.
10. If an over-center locking mechanism is used to lock the clutch in a disengaged position, the mechanism must be secured to keep it from becoming accidentally engaged. Loose linkage, improper design, or vibration could cause the clutch to slip from the disengaged position and the tractor could move unexpectedly.
11. The maximum force required to activate a hand control should not exceed one third of the operator's maximum push/pull force. It is important to note that although the maximum force required for operators with full upper-body strength should not exceed 35 pounds, the maximum force for operators affected by spinal cord injuries may be significantly less depending upon the level of the spinal cord injury.

Also important to note is the fact that substantial strength is required to operate a tractor that does not have a power shift or hydrostatic transmission. Therefore, if it an operator with limited strength should be driving such a tractor up or down a hill and it stalls the operator would be put in a potentially dangerous position. Several controls may need to be operated at the same time in order to move the tractor from the stalled position, which may be difficult for an operator with limited strength to do.

Preventing Cuts, Scrapes, Burns and Bruises

1. Hand controls should be easily removable in order to keep the pathway to the tractor seat clear while the operator with a disability transfers in or out of the seat or while co-workers use the machinery. Hand controls that are located in the path of tractor seat have caused scrapes and bruises. If the hand controls cannot be easily removed, either the hand controls or the operator should be properly padded to minimize potential bumps, bruises, or scrapes.
2. Hand controls should not interfere with a co-worker's ability to operate the equipment safely. ASAE (American Society of Agricultural Engineers) Standards state that hand controls should be created in such a way to maintain the same logical function and direction as the original controls. However, these standards do not take into account the unique ergonomic needs of the operator with a disability. For example, although ASAE states that hand controls should be pulled in a rearward (toward the operator) direction, an operator with a spinal cord injury may prefer controls that push forward (away from the operator) so that he or she can use the back of the seat for additional leverage and support. As noted previously, clutch and brake controls that require the operator with a spinal cord injury, to pull rearward, result in the operator's chest coming in contact with the steering wheel.
3. Metal hand controls for the tractor should be padded or coated with a slip-resistant material to prevent the operator's hands from sustaining cuts, scrapes, or burns. These materials include "Magic Wrap", Plastic-dip, bicycle grips, pipe insulation, and 3M self adhesive rubber grips. To increase optimum grip on the controls, the operator should consider wearing gloves.
4. Hand controls constructed of flat bar stock should be avoided. Control handles should be round and 1.5" to 2" in diameter. Handles should be covered with slip resistant material. This material might include a bicycle grip, spray on rubberized material, or rubberized "Magic Wrap" tape.
5. Sharp edges should be removed from the hand controls installed in the tractor.
6. Tractor operators with spinal cord injuries frequently report that due to leg spasticity or general bouncing that occurs when operating the tractor on rough terrain, their legs inadvertently come into contact with the controls. Besides operating the tractor in a lower gear and padding the hand control lever extensions with pipe insulation may help to prevent the operator from sustaining bruises to their knees or legs. If the hand controls cannot be adequately padded, operators can wear kneepads to minimize potential bruising. A tie down strap for operators' legs can also be used to help prevent their legs from coming in contact with the hand controls during a leg spasm.
7. Leg clearance should be sufficient between the operator and the controls to keep his or her knees, feet, and ankles from coming into contact with the controls when they are activated.

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Preventing Repetitive Stress Injuries (RSI)

1. Use ergonomic guidelines (see references below) when designing hand controls for the tractor. These guidelines suggest that controls should be no more than 1.75" in diameter; that the forces required to operate the controls should be between 18 lbs. and 37 lbs., with a force of 18 lbs. being optimal; and that the handgrip is at least 3" long. Although these guidelines are a start, it is important to consider each person's unique needs, because most ergonomic guidelines were developed for the average operator who has no impairment. For example, the reaching distance a person who does not use a wheelchair is 20% greater than that of a person who does use a wheelchair.
2. Hand controls should be custom designed and constructed to meet the individual operator's needs. These designs must take into consideration the position of the tractor seat in relation to the controls, the operator's maximum and minimum reach zone, and the operator's maximum push/pull ability.
3. Vibration is a leading cause of RSIs. Wrap controls in a visco-elastic material to absorb vibration.
4. When using hand controls, the tractor operator should wear gloves that are padded with visco-elastic or other vibration-absorbing materials.
5. Hand controls should be operated without excessive deviation (extension or flexion) of the wrist. The tractor operator should keep his or her wrist as straight as possible when engaging the hand controls.

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