

PLOWSHARES #8

Special *Breaking New Ground* Technical Report

New Concepts in Lift Attachments for Tractors and Combines*

Aaron Yoder
Graduate Assistant

Ned Stoller
Rural Assistive Technology Specialist
Breaking New Ground Resource Center
Purdue University

William E. Field
Professor

1146 Agricultural and Biological Engineering Building
West Lafayette, IN 47907-1146

INTRODUCTION

An estimated 250-300 farm and ranch operators in the U.S. experience a permanent spinal cord injury each year (Field, PVA 1992). Hundreds more suffer strokes, loss of limbs, and other conditions that severely limit their mobility. These farmers¹ are faced with the challenge of accessing the equipment they use regularly to till, plant, spray, harvest, and complete other essential tasks. If successful in addressing this challenge, they are usually able to continue to be a vital part of their farming operation. Understandably, therefore, among the most frequent requests received by the Breaking New Ground Resource Center (BNG) at Purdue University are ones that relate to accessing equipment by those with restricted mobility.

The purpose of this article is to provide those considering modification of a tractor, combine, or other piece of machinery with information adequate to make an informed decision concerning the lift concept best suited to their needs. The “homemade” and research-based solutions presented in this paper specifically apply to agricultural machinery, but the concepts can be transferred to other types of heavy equipment, such as logging and earth-moving equipment. Several factors, such as safety, cost, adaptability, and desired tasks should be carefully considered prior to a final decision on a lift design. Consultation with a rehabilitation engineer, an experienced assistive technology fabricator, and other farmers who have made similar modifications is strongly encouraged.

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¹As in all BNG publications, the term “farmer” is used to identify one who is directly involved in agricultural production (i.e., farmer, rancher, agricultural worker).

Nearly all of the designs documented and evaluated for possible inclusion in this report had two things in common—(1) they were relatively low cost, and (2) they successfully addressed the problem of accessing agricultural equipment. There were other lifts evaluated, however, that exposed the user to considerable



Figure 1. Valmet tractor with Life Essentials Pilot Lift.

risk of injury, required significant assistance from another person, or were not highly reliable and, therefore, were not included. From earlier BNG research came a set of design criteria aimed at guiding development of future lift concepts that proved useful in evaluating lifts for this report. Those criteria include the following desired characteristics:

1. A seat or platform to lift a person from ground level to the cab door in a position that would facilitate easy transfer into the operator's seat. (In some cases, this required a vertical lift of over 9 feet.)

2. Easy installation, with minimal alterations to the original equipment and minimal interference with the operator's vision. (Such attachments also should not hinder the equipment's efficiency during operation.)
3. A lift speed of approximately 10-15 feet per minute, and a load capacity of at least 300 pounds.
4. Fail-safe lift operation that would protect the person in the event of power or drive mechanism failure.
5. Safe exit alternatives in event of an emergency.
6. Flexibility so that other operators would not be hindered significantly when using the lift-equipped machinery.
7. A moderate cost that would encourage users to select a well-designed lift.

Not all the lift concepts presented here meet each of these criteria. Some "homemade" ones pose safety concerns but are nonetheless included to illustrate the diversity of designs that have been successfully used.

EARLIER TYPES AND CHARACTERISTICS OF LIFTS

During the early 1980s, with support from Deere & Company and the National Institute of Handicapped Research, BNG began to explore various solutions to getting farm equipment operators "back on their machines" following a spinal cord injury or other disabling conditions (Figure 2). The first step was to document and evaluate lift concepts that were homemade or fabricated locally by welding

or machine shops. These lifts generally fell into three categories:

1. **Winch-powered vertical sling lift** either (a) mounted on a mast on the exterior of the operator platform or (b) mounted on a telescoping beam on the interior of the platform or cab or (c) mounted completely separate from the machine, such as to an overhead beam, allowing one to be lowered into the operator's seat from above.
2. **Winch- or hydraulic-powered vertical platform lift** with the operator either (a) in a standing position (Figure 3) or (b) in a seated position or (c) in a wheel chair.
3. **Winch-powered lift seat** which rides on an inclined rail or rails (Figure 2).

Several less conventional concepts were also documented in the early BNG studies, such as the operator manually carried up to the machinery platform by a second person, the operator lifted up to the platform with a front-end tractor loader, and various ramp configurations that led up to the level of the operator platform. Each of these methods worked but presented safety concerns or relied heavily on a second person.

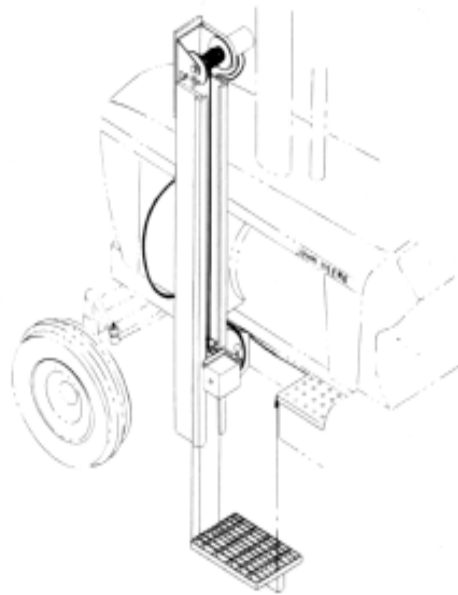


Figure 3. Original drawing of a platform lift.

The common modes of operating these early lifts were with a linear actuator (electric or hydraulic), a cable and winch, a ball screw device, or a roller chain. The *linear actuator type* was generally used in conjunction with a parallel linkage to raise and lower the lift with a shorter stroke. The *cable-and-winch type* was found to be typically less expensive and simpler to construct than the others. The *ball-screw type* could be powered by just one small electric



Figure 2. Prototype winch-powered access lift from the early 1980s.

motor because of the mechanical advantage gained by the screw itself. (Ball-screw lifts could also prevent the operator from falling in event of a mechanical failure.) The *roller-chain type* used common materials readily found on most farms and had parts that farmers were accustomed to working with, but they required more power than the screw type. (In some cases, roller chain assemblies were used in conjunction with a hydraulic actuator to raise and lower lift platforms in a manner similar to that found on fork lifts.)

Although some of the linear actuator lifts identified were powered by the tractor's (or combine's) hydraulic system, most operated off of its 12-volt electrical system. Using the hydraulic system was found to be less desirable because the tractor engine had to be started to operate the lift. (Some farmers had placed a starter switch at the ground level to start the tractor then operated the hydraulics from remote control levers. This scheme, however, was viewed as dangerous because it placed the operator in the path of the tractor if it were to move during starting or lift operation.)

The electrical system, on the other hand, could be tapped into without the engine running and could even be used to run an auxiliary hydraulic pump that powered a hydraulic actuator. Using such an actuator in this arrangement was desirable in some situations because of the emergency exit options it provided.



Figure 4. A wheelchair platform lift.

The lift/user interface was designed on these earlier lifts to meet the specific needs of each operator with a disability. There was no effort being made to standardize either the lift components or the methods of transfer. For example, wheelchair platform lifts were not able to move as close to the tractor operator's seat, so a longer, more awkward transfer

was necessary. However, the wheelchairs were usually transported and available wherever the tractor moved (*Figure 4*). In some cases, considerable effort was required to transfer from the lift seat to the operator's seat, or assistance from another person was necessary.

While many lifts were mounted directly onto the tractor or combine, some were independent of the machinery.

An obvious advantage of an independent lift was that it could be used to access more than one piece of equipment. Stationary lifts could be mounted to a building or post to eliminate the bulkiness added to the tractor by a lift device. More versatile than a stationary lift were those mounted in the bed of a pickup truck or lift cart so the farmer could both drive to and access his machinery directly from the vehicle (*Figure 5*).



Figure 5. An independent lift mounted on a pickup truck.

Lifts mounted directly to the tractor or combine were seen as providing added security in event of an emergency. Such lifts, if still operational, could be used to exit a damaged piece of machinery, whereas independent lifts did not offer this option. Also, machinery-mounted lifts could be accessed at any location without the pickup truck or lift cart having to be there and usually permitted closer positioning to the tractor operator's seat than an independent lift.

MORE RECENT DEVELOPMENTS IN MACHINERY-MOUNTED LIFTS

This section briefly summarizes some of the newer or refined concepts of lifts now being used to gain access to agricultural equipment. Most are based on the work done by Life Essentials, a division of Round Grove Manufacturing (West Lafayette, IN), currently the only commercial source of machine-mounted lifts (*see Resources section*).

Parallel Linkage Lifts

This type of lift (*Figure 6*), which was developed at Purdue, utilizes an electric linear actuator. A parallel linkage keeps the lift chair level at all points throughout its motion. The electric linear actuator is fastened at diagonal corners of a flexible, four-sided frame made of square steel tubing. One end of the frame is attached to existing bolt holes on the tractor; the other end supports a seat. The actuator can raise the lift seat from 18 inches above the ground to approximately 6 feet high, depending on frame length. It contains an internal slip-clutch to prevent injury to the user or damage to the lift in the event of linkage binding.



Figure 6. A parallel linkage lift mounted on a Ford 4610 tractor.

The parallel linkage lift is adaptable to smaller tractors having no cab or having cabs with front-opening doors. (*Note:* It has not been used on combines due to limited vertical motion.) The lift is mounted toward the front end of the tractor. A special linkage located on the tractor's mounting bracket causes the chair to automatically swing toward the cab doorway as the lift is raised and away from the doorway as the lift is lowered.

The seat can be rotated about a support hinge, enabling the rider to obtain the most convenient approach to the cab doorway. It can also be transported away from the doorway during field operations for increased visibility and so that other persons can access the operator station without using the lift. Additionally, the seat can be positioned so as to allow the operator to reach the fuel tank for refueling.

A controller, which connects to the lift actuator by a stretch-type umbilical cord, can be operated from a wheelchair in the general area of the lift or from the lift seat. A

second controller is mounted in a convenient place near the operator's seat on the tractor. The 12-volt actuator is wired into the tractor's electrical system with a fused link.

Because it must be custom-fabricated to mount on each tractor design and be modified for each operator seat configuration, the parallel linkage lift is no longer popular. However, it can be fabricated locally and is both safe and relatively inexpensive.

Hybrid Lifts

An adaptation of the parallel linkage lift is the "hybrid lift" (*Figure 7*). It utilizes a parallel linkage for vertical motion and a swing arm (similar to that on the vertical screw lift

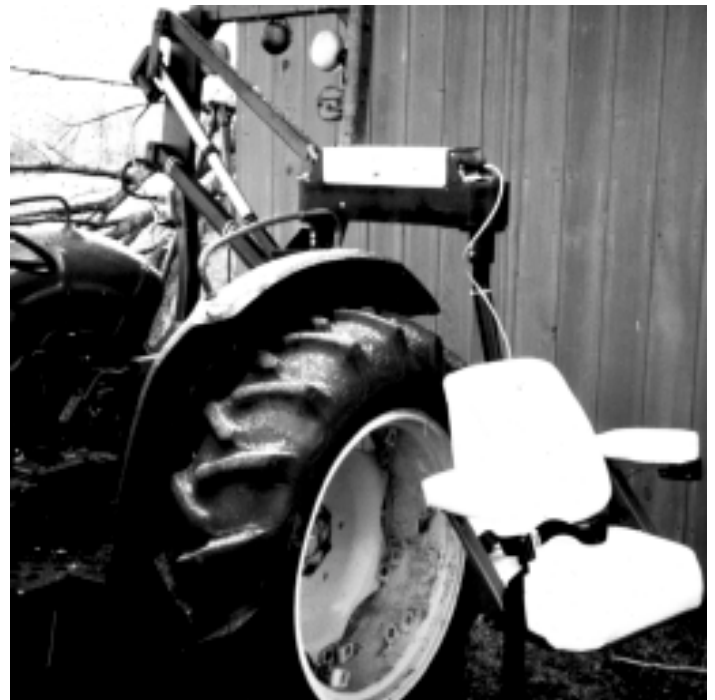


Figure 7. A hybrid lift where the lift chair also serves as the tractor seat.

described later) for a greater range of horizontal motion. A unique feature of the hybrid is that both lift and tractor make use of the same seat, eliminating the need for the operator to transfer except from a wheelchair at ground level. The parallel linkage raises the seat up from ground level; the swing arm assembly positions the seat over the operator's station in the tractor; then the seat is lowered into a cradle provided on the operator's platform.

The hybrid lift is best suited for relatively small tractors that do not have cabs, since the lift chair is also the tractor seat. It is generally mounted on the tractor's rollover protection structure, or ROPS. (*Note:* Any modifications to the existing ROPS may void the warranty or be inconsistent with the applicable standards for these devices.)

Vertical Mast Lifts

There are two styles of the vertical mast lift—platform and chair. Both can be used on either tractors or combines, with or without cabs (*Figure 8*). Also, the lift assembly of either can be transported high enough above ground level to



Figure 8. A vertical mast platform lift on a combine.

avoid field crop residue during equipment operation yet can be lowered to a position that allows easy transfer to or from a wheel chair.

The core of the lift is the mast itself, a square steel tube with a slot cut out of one side, which in cross-sections gives it a “C” shape. The purpose of the mast is to support the ball-screw assembly and protect it from the twisting and lifting forces exerted on it as a farmer is raised to the operator’s platform. The screw is mounted into bearings at either end of the mast. Within the mast is a slide equipped with roller bearings that roll along the mast’s four inner sides, keeping the screw centered.

When the vertical screw is actuated by the reversible, 12-volt motor, a low-friction nut travels up and down the screw, transporting the internal slide assembly. An extension of the slide protrudes out through the mast slot, providing the base for the lift seat or platform.

A new version of the vertical mast lift, developed by Life Essentials, uses a roller chain and sprocket drive instead of a ball-screw assembly. While this reduces cost and improves reliability, it does call for a fail-safe mechanism to keep the lift from falling in event of chain failure.

The vertical mast lift is relatively easy to mount on different types of equipment by modifying the mounting brackets. These custom-made brackets typically allow mounting to the preexisting holes on a tractor or combine frame.

Length of the mast can be varied to fit the application, with the average for tractors and combines being about 10 feet. The mast is purposely located in an existing blind spot to minimize interference with operator vision. On combines, the lift mast can be located either to the front or rear of the cab door, depending on design of the machine (*Figure 9*). On tractors, the mast is installed to the front of the cab door, away from the rear drive wheels.



Figure 9. A vertical mast chair lift mounted on a large combine

The lift’s electrical system is wired into the existing 12-volt system of the tractor or combine, is fused, and is activated by a key-operated switch to prevent misuse.

Platform lift. The vertical mast platform lift has a simple design consisting only of a mast, a handrail-equipped lift platform, an electric motor to turn the vertical screw, and two push-button switches mounted on the lift frame for raising and lowering the platform. This type of lift is typically installed for persons with mobility impairments but who are otherwise able to stand or transfer onto the platform independently.

Chair lift. The vertical mast chair lift consists of the mast assembly described above, with a chair connected to a swing arm assembly (*Figure 10*). Each swivel joint of the swing arm contains double roller bearings on a heavy steel shaft. Inside the swing arm assembly are two electric mo-



Figure 10. A vertical mast chair lift mounted on an International 5288 tractor.

tors and two pairs of electric relays which energize the motors. A mast motor, mounted at the top of the mast and controlled by a pair of relays at that same location, turns the vertical screw for raising or lowering the seat. The swing arm motors drive worm gears to move the swing arm and prevent free swinging of the arm. One swing arm motor moves the chair toward the cab doorway; the other rotates the chair, allowing the user to obtain the most convenient position for entering the cab. All motors contain internal slip clutches to prevent injury to the user or damage to the lift.



Figure 11. A vertical mast chair lift used with a front-mounted cab door.

With a vertical mast chair lift, the equipment's cab door can be either front- or rear-opening (Figure 11). The swing arm mechanism rises above the cab's open door then swings the user around the outside of the door and into the cab. The chair has a seat belt and arm rests for safety and added support. The lift is usually equipped with a hand-held remote control connected to the swing arm assembly by a heavy-duty stretch cord. (Work is currently underway to develop a reliable wireless controller for the lift to eliminate this umbilical cord.) The remote has six push buttons, enabling the operator to move the chair in six different directions, often simultaneously.

Vertical mast platform and chair lifts have a variety of alternative applications besides tractors and combines. Adaptations have been successfully used with vans, pickup trucks, semi-trucks, specialty-crop harvesting equipment, heavy construction equipment, boats, boat docks, and even in assisting horseback riders mount their steeds.

TYPES OF INDEPENDENT LIFTS

An alternative to the machinery-mounted lift is the free-standing or "independent" lift. This type seems to be favored where there are several pieces of equipment to be accessed or where there is only one site used for transfer to a machine. This section briefly describes lifts that are independent of the equipment to which they help provide access.

Man Lift

One type of independent lift designed and used by Don Skinner (See Resources), utilizes a boom arm and base similar to those found on a manual engine hoist (Figure 12). The lift has a seat mounted on the end of the boom, with a parallel linkage to keep it level at all times. The seat is raised and

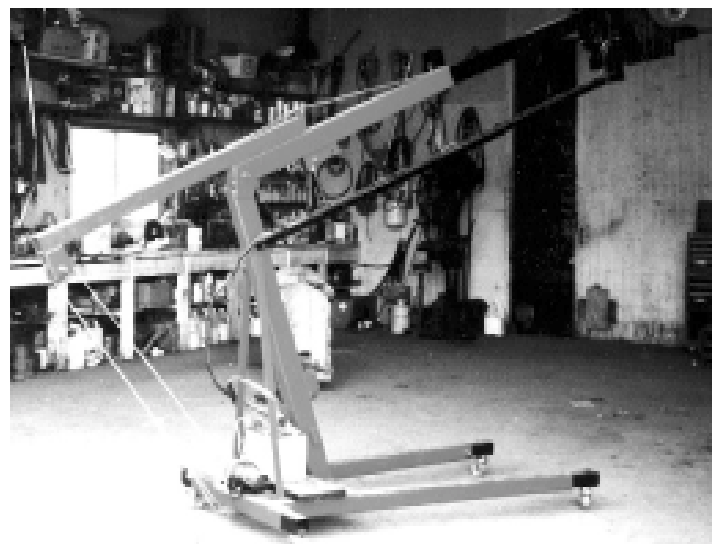


Figure 12. The Man Lift uses a boom arm and base similar to those found on a manual engine hoist.

lowered by a 12-volt battery-powered cable winch. The winch is mounted at the base of the lift, with a cable running from the winch to a pulley mounted on an extension at the rear of the boom arm then back to the base. The controls for raising and lowering the boom are on the lift seat. Only winch motor assemblies designed specifically for carrying humans should be used for this type of lift. (See Safety Section for additional information regarding winch lifts).

Independent Pilot Lift

Life Essentials, maker of the Pilot Lift, has also constructed an independent lift utilizing the Pilot Lift and associated technology. The independent Pilot Lift is the same as, essentially as the ones mounted to tractors, but it is attached to

a self-propelled base. The base consists of a U-shaped frame constructed of square tubular steel with wheels mounted on the four corners. The unit is propelled by a motorized drive wheel mounted under the lift assembly. The drive wheel is rotated by a 12-volt electric motor, and an automotive-type steering wheel is used to steer the drive wheel (Figure 13).



Figure 13. Independent Pilot Lift

Trailer-Mounted Lift

The trailer-mounted independent lift, which in essence is a vertical mast lift mounted on a small utility trailer, can be towed with a pickup truck or other vehicle to the desired transfer site (Figure 14). This same type of lift could be modified to mount in the bed of a pickup.

Freedom Lift

The Freedom Lift (Figure 15) is one that's mounted in the bed of a pickup (see Resource section). For farmers who use wheelchairs, it can provide access to all of the farm's self-propelled equipment, eliminating the need to alter each piece of machinery. At the same time, it allows for access to the equipment for fueling and other maintenance activities.



Figure 14. An independent lift mounted to a trailer that can be towed anywhere for access to machinery.

The lift unit mounts in the back of a standard 1/2- or 3/4-ton pickup truck without modifications. It operates by hydraulics, using its own self-contained electric hydraulic pump that runs off the truck's 12-volt battery. A hydraulic outrigger automatically extends down at the rear of the truck to provide stability when the lift is activated.

The lift platform is designed for wheelchair use, or a flip-down seat can accommodate a person who does not need a wheelchair during transfer. The lift can be operated by a hand-held radio remote control or by the switches mounted on the operator platform. The remote control allows the operator to position the lift next to the open door of the tractor, combine, or pickup cab while seated in the cab of either vehicle.



Figure 15. The Freedom Lift from Freedom Technologies, Inc.

	Advantages	Disadvantages
Mounting		
Individual Machine	Access to and from machine location	Access to only one machine
Independent	Access to an unlimited number machines	Machinery can only be accessed from the location of the lift
Type		
Standing Platform	Least expensive option	Operator must be able to stand
Wheelchair Platform	Access to wheel chair at all times	Large and bulky Long transfer distances
Parallel Linkage	Simple to design and construct	Minimal reach and lifting distances
Chair Lift		
<i>rail/slide</i>	Inexpensive to design and construct	Relies on winch for power
<i>swing arm</i>	Greater reach (horizontal and vertical) Greater range of motion in all directions	Cost
Power		
Hydraulic	Escape capability More durable in harsh environments	Requires additional modifications More expensive components
Electric		
<i>winch</i>	Least expensive option	Safety (see safety section)
<i>linear actuator</i>	Made to order	Limited range of motion
<i>chain</i>	Easy to repair	Larger power requirement
<i>screw</i>	Generates large amount of force Prevents freewheeling or falls	Cost

Table 1. Comparisons of lift design characteristics

CASE STUDIES OF FARMER-DEVELOPED LIFTS

A number of farmers with disabilities have constructed or modified lifts to access their agricultural equipment. Although each lift was built specifically for the individual farmer, the concepts developed and implemented could be used by others considering the construction of a lift.

Following are case studies involving three farmers—Bob Yeagle (Farmer City, Illinois), Dick Welty (Boggs town, Indiana), and Kenneth Stennett (Waynesboro, Mississippi). Yeagle has made extensive modifications to the lift he acquired from Life Essentials and mounted it on a van for increased flexibility; Welty constructed his own platform lift to hoist himself to the cab of his combine; and Stennett built a sling lift, mounting it permanently inside his barn to access a small tractor.

Yeagle's Modified Pilot Lift

Bob Yeagle was an electrician when he sustained a C-5,7 spinal cord injury in 1991. In 1993, with the help of neighbor Kyle Kopp and the local office of Vocational Rehabilitation Services, Bob was able to obtain a Pilot Lift from Life Essentials and have it mounted on one of Kyle's tractors.

Kyle farms several thousand acres around Farmer City, in addition to custom-harvesting thousands of acres of seed corn for two local seed companies. With an accessible tractor, Bob could operate the auger wagon during harvest and help with fall and spring tillage operations.

The Pilot Lift was a vertical mast lift with electric ball-screw lift actuation. It was mounted on a Case Magnum tractor equipped with hand controls. Initially, the buttons on the lift controller were difficult for Bob to operate, because he had quadriplegia. To solve this problem, he replaced several of the buttons with toggle switches, which were easier to activate.

The seat of the Pilot Lift was modified to provide Bob greater stability and safety when accessing the tractor (Figure 16). A frame was constructed from round steel tubing to create arm rests and a crossbar barrier in front of the seat. Because the seat was plastic, Bob welded the steel frame to the mounting plate under the seat. The controls for the lift were welded to the crossbar so there would be no danger of dropping the controller. Two other seat modifications included (1) making the back higher (by riveting a curved



Figure 16. Bob Yeagle's modified lift seat.

piece of hard plastic onto the existing back) and (2) making it swivel (which gives Bob the best possible position to transfer from lift to tractor seat).

Further modifications to the Pilot Lift came in 1997, when Bob had a local welding shop transfer the lift from the tractor to his van (*Figure 17*). He had it mounted on the driver's side, directly behind the driver's door. This allows him to travel between field and tractor more freely, since Kyle's custom-harvesting operation includes fields up to 20 miles apart, and using the tractor between fields was too time-consuming.

A bracket was welded to the frame of the van, then the lift bolted to the bracket to allow easy removal, if necessary. The lift had to be bolted sideways to the van frame to remain within the required vehicle width for road travel. This decreased the reach of the lift arm by about 6 inches. Also, the van frame was approximately 18 inches lower than the tractor frame that the lift was originally mounted on.



Figure 17. Bob Yeagle's vertical mast chair lift mounted to his van.

To accommodate the decreased horizontal reach of the lift arm, Bob added a linear actuator and a telescoping pipe to the arm section that supported the lift seat. With these modifications, he can trip a switch and have the lift seat extend 2 feet directly away from the van, allowing him to access the tractors with the van parked a greater distance away.

The telescoping seat extension control switch is located on the end of the left armrest and can slide in and out of the armrest tubing. After Bob transfers to the tractor, he can reach the extension controls to retract the seat away from the tractor, but the sliding controller remains close enough to operate the switch. When the seat is retracted, he shoves the controller back into the armrest and out of the way of the tractor door.

The lower mounting position, which reduced vertical lift, was remedied by bolting a heavy pipe extension between the lift mast and the pivot arm. The pipe raises the entire lift arm more than 2 feet without extending the mast, providing Bob with the height needed to access three of Kyle's tractors. The transport height of the lift is far above the van roof, so he must be careful when driving under trees or other low objects. In transport on the roads, the lift seat rests on the van roof to prevent excessive vibration. However, this has caused some denting of the van roof, which could be minimized by fastening a mounting structure, such as a luggage rack, to the roof for added support.

Welty's Platform Lift

Dick Welty and his family constructed a simple platform lift for his John Deere 9500 combine so the cab could be accessed without climbing the ladder (*Figure 18*). A very simple concept was used, and minimal modifications were made to the combine so its resale value would not be decreased. A steel C-channel, a 12-volt electric cable winch, and a platform are the three components of the lift.

The C-channel extends from the bottom step of the ladder to 4 feet above the operator's platform and is bolted to the right side of the ladder, with the slot facing away from the combine. Angle iron flanges welded onto the back of the C-channel are bolted to existing holes on the ladder. A steel plate welded to the top of the channel supports the cable winch so that the cable hangs directly down the inside of the channel from the winch spool. The winch motor is wired into the combine's electrical system.

The platform has three parts - the slide, the arm, and the standing surface. The slide is rectangular steel tubing about 4 feet long that can slide within the vertical C-channel. The cable from the winch hooks onto the slide to pull it up and lower it down the channel. A 6-inch by 10-inch steel plate is



Figure 18. Dick Welty's winch-operated platform lift on his John Deere 9500 combine.

welded to the slide such that it can ride in the slot of the C-channel as the slide is pulled up and down. This plate is braced by another plate welded to the slide to create the platform arm. A 6-inch section of square tubing is welded vertically to the end of the arm to act as the receiver for the lift's standing surface.

The standing surface was created with expanded steel and angle iron to allow snow and rain to flow through. It is about 15 inches by 20 inches, with a 6-inch piece of square tubing welded vertically downward from one end. The tubing is slightly smaller than the tubing on the arm, allowing the standing surface to interface with the arm by sliding the smaller tubing into the larger. This flexible interface lets the lift rotate 180 degrees to provide unobstructed access to the combine ladder for operators not needing the lift. The lift does not restrict the pivoting motion of the ladder featured on the John Deere 9500 combine.

Dick's platform lift was built for about \$250, using farm shop equipment and readily available components. It is an excellent example of farm shop ingenuity and practicality. For instance, the same hand rails used on the steps were used with the lift.

The primary problem with this design is the lack of a fail safe device or brake to prevent the lift from free falling in the event of cable failure. To make such a brake, one might (1) cut notches into the back of the C-channel every 6 inches; (2) mount a spring-loaded latch on the slide with a pin protruding through a notch in the channel to prevent the platform from sliding; and (3) fasten the winch cable to the latch so the weight of the platform pulling the latch against the cable would compress the spring and pull the pin out of the notch, thus allowing the lift to raise and lower free from interference. If the cable or winch failed, the weight would be off the latch, so the spring would rebound and push the pin into a notch, stopping the platform from falling.

Stennett's Sling Lift

Kenneth Stennett has 30 brood cows to produce calves, plus two poultry houses that hold up to 43,000 birds. He uses a Kubota 4030 tractor to haul manure, now ditches, and feed cattle large round hay bales. He also mows his yard with a riding mower and checks his cattle year-round on an ATV. With a T-4 spinal aneurism, he was paralyzed and could not access his equipment.

Not deeming his operation worth the expense of a commercially built tractor lift, Kenneth and his friends rigged a pivoting pipe arrangement and boat winch to lift him onto the tractor. Kenneth was free hanging in a sling attached to the cable, so any equipment failure could have possibly resulted in secondary injury. Although the initial cable-winch lift was simple and easy to build, it was also hazardous.

Herb Willcutt of the Mississippi AgrAbility Project worked with Kenneth to develop a safer alternative to his lift, with funding support from the Vocational Rehabilitation Service office. Kenneth's preference was a stationary lift that would not require modifying the tractor in any way. His broiler houses were too small to maneuver a tractor in, and a lift would have been too bulky if mounted on the tractor. So he and Herb decided to use a sling lift and mount it on a roller track in his machinery shed (*Figure 19*). This would allow him to be raised, rolled above the tractor seat, then lowered into position.

The options considered for a lift were a cable boat winch, a machine shop hoist, and a lift certified for lifting people. The boat winch cost approximately \$100 and had a 4,800-pound rolling load capacity; the inherent danger, however, was cable or winch failure during operation. The



Figure 19. Kenneth Stennett's stationary sling lift mounted in his machinery barn.

shop hoist cost about \$500 but could hoist 1,000 pounds straight up; however, it was labeled “not for human lifting.” The option chosen, therefore, was the certified person-lifting hoist, which included a sling with 500- pound rated capacity. At \$1,800, it cost nearly four times the shop hoist but, for safety reasons, was justified.

A 6-inch I-beam was mounted across the barn where the tractor was stored, and the hoist mounted to rollers riding on the bottom flange of the beam. (A 4-inch beam would have been adequate, but the 6-inch beam cost only \$20 more and provided significantly more strength). The lift was designed with safety in mind, so all components were sized accordingly. The hoist has a 16-feet-per-minute lifting speed and is powered by 115-volt AC. The flexibility of the sling lift allows Kenneth to access three pieces of equipment with one lift.

LIFT SAFETY CONSIDERATIONS

A discussion of modifying agricultural equipment to provide a means of access for persons with severe disabilities is not complete without addressing injury potential. In fact, an engineer or rehabilitation professional must hold client well-being paramount in developing access solutions. In some cases, the professional will not be able to recommend or assist with a particular solution due to unacceptable levels of risk. Solutions not consistent with local or published professional standards or with manufacturers' recommendations can present serious liability problems for a professional if an

injury were to occur. Cost of the “best” solution or design should not be the decisive factor in the final decision; however, experience has shown that safe solutions don't always have to be the most expensive.

The following sections touch on areas that should be given special attention in selecting, installing, and using access lifts on agricultural equipment. The information is presented under the categories Man-, Machine-, and Environment-Related Hazards (*also see Resources section*).

Man-Related Hazards

When making modifications, one should consider the limitations and characteristics of the potential user. If there is a loss of sensitivity in the extremities, special attention needs to be given to preventing contact with hot components, such as those found on engines, electric motors, and exhaust systems. Also, all sharp edges should be removed and potential pinch points removed or protected. In some designs, slip clutches should be used to protect the operator in the event that an extremity becomes wedged between moving and stationary components.

Where an individual has limited stability, grab-bars and hand-holds at transfer points plus seat belts on both the lift chair and operator's seat can prevent falls. In some cases, such as involving higher level spinal cord injuries, an assistant should be available during the transfer process to act as an observer to prevent falls or harmful contact with machine parts.

Machine-Related Hazards

When designing a platform or chair lift, attention should be given to eliminate pinch points any place where the platform or seat moves past a stationary step or obstacle. Guards to keep toes on the platform and fingers out of pinch points should be installed where necessary, and decals warning of specific hazards should be affixed on the lift.

As previously discussed, cable-winch lifts present a special problem. Since the potential for injury is high if a winch or cable fails, this type of lift should be avoided unless the hoist is specifically designed to lift people and is adequately secured and is properly maintained.

Also, consideration should be given to emergency use of the lift in event of power failure or fire. If the lift is the only safe method of getting off the machine, an action plan needs to be developed and possibly an alternative escape method worked out. Regardless, every piece of machinery that has been modified with a lift should be equipped with a two-way radio or cell phone and a fire extinguisher (*Figure 20*).

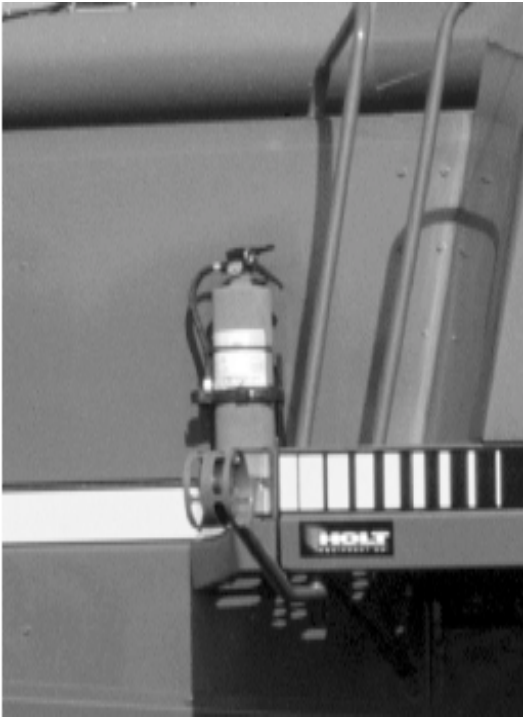


Figure 20. Providing adequate fire protection on equipment is important.

Environment-Related Hazards

An operator of agricultural equipment is exposed to certain potentially harmful environmental conditions, including vibrations, dust, noise, fumes, temperature extremes, and excessive sunlight. A person with a spinal cord injury or other physical condition may be highly sensitive to some of these exposures and thus should be protected from them. Therefore, it is highly recommended that tractors used regularly and being considered for modification be equipped with an environment-controlled cab. (The newer tractor or combine cabs provide substantial protection from nearly all the above-mentioned hazards.)

SUMMARY

The need exists for access to agricultural equipment by those with restricted mobility. Initial studies by the BNG Resource Center of this type of equipment have identified specific issues that should be considered when lifts are designed, built, or bought. Several lift designs that have proven successful have been discussed in this paper.

The main criterion used when designing, building, or acquiring a lift must be safety. There is no good reason, however, why a person (even one with severely restricted mobility) cannot be provided the means such as to enable him/her to operate agricultural machinery.

RESOURCES

The following are sources of products, services, and/or information related to lift attachments for agricultural equipment. Although far from exhaustive, this list is intended as a starting point for those interested in this topic.

Life Essentials (manufacturer of custom manlifts)
345 Burnett Road
West Lafayette, IN 47906
Phone—(800) 543-3740
FAX—(765) 423-1017
E-mail—info@roundgrove.com
Internet—www.roundgrove.com

Freedom Technologies Incorporated (manufacturer of the Freedom Lift)
P.O. Box 258, R.R. 4
Saskatoon, Saskatchewan S7K 3J7
Phone—(306) 244-1508

Don Skinner (designer of Man Lift)
RR #2, Box 196
Pawnee, IL 62558
Phone—(217) 526-3358

National AgrAbility Project
Breaking New Ground Resource Center
Purdue University
1146 ABE Building
West Lafayette, IN 47907-1146
Phone—(765) 494-5088 or (800) 825-4264
FAX—(765) 496-1356
E-mail—bng@ecn.purdue.edu
Internet—www.agrability.org

“Purdue-Designed Chairlift Attachments for Farmers with Restricted Mobility,” by C.B. Richey and W.E. Field (1986). Request from BNG Resource Center.

“Potential Health and Safety Risks of Farming/Ranching with a Disability” (Plowshares #27), by M.L. Gruver, P.B. Allen, J. Schweitzer and W.E. Field (1997). Request from BNG Resource Center.

Plowshares #2, “Hand Controls for Agricultural Equipment.” Request from BNG Resource Center.

Plowshares #6, “Farming Following a spinal cord injury.” Request from BNG Resource Center.

“Modified Agricultural Equipment: Manlifts for Farmers and Ranchers with Physical Disabilities.” Request from BNG Resource Center.