AGRABILITY PLOWSHARES TECHNICAL REPORT

AgrAbility
Cultivating Accessible Agriculture

Agricultural Machinery Access Lifts: Design, Utilization, and Safety Issues

THIS PUBLICATION WAS MADE POSSIBLE BY USDA/NIFA SPECIAL PROJECT 2016-41590-25880

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Original Publication 2000: (Plowshares 8)
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INTRODUCTION

Each year, an estimated 250-300 farmers and ranchers in the U.S. experience permanent spinal cord injury (Field, 1992) and hundreds more suffer strokes, loss of limbs, and other conditions that severely limit their mobility. Many of these agricultural producers are faced with the challenge of accessing the operator stations of the machinery that they use regularly to till, plant, spray, harvest, or complete many other farming/ranching tasks.

This paper discusses accessibility-related issues, including potential assistive technology options, selection criteria and safety related to mechanical lift technologies for accessing tractors, combines, or other pieces of equipment utilizing mechanical-lift technology. Having the appropriate information, the right mindset, encouragement from others, and professional advice/assistance, many producers with mobility impairments regain access to equipment that is so essential to their livelihood. Although the homemade and commercially produced access solutions discussed here apply specifically to agricultural machinery, the concepts demonstrated are relevant to various pieces of off-highway heavy equipment used in many industries.

Early Equipment-Accessibility Research

Over the years, some of the most frequent requests received by the Breaking New Ground (BNG) Resource Center at Purdue University have been related to accessing agricultural tractors and machinery by farmers/ranchers with restricted mobility. During the early 1980s, with support from Deere & Company and the National Institute of Handicapped Research (now the National Institute on Disability, Independent Living, and Rehabilitation Research) BNG began to explore various solutions that could assist these individuals in accessing their equipment following a spinal cord or other disabling injury or condition. From this early research came a set of design criteria to guide development of "person-access lifts", criteria that subsequent experience has proven useful.

BNG's first priority was to document and evaluate the designs of those access lifts that had been homemade or fabricated locally by welding or machine shops, often with the input of professional engineers. These early access lifts generally fell into three categories: sling lift, platform lift, and chair lift.

Several less conventional concepts were also studied, among them: (1) operator carried up to the machine's operator station by a second person, (2) operator elevated to the operator station via front-end loader bucket or forklift, and (3) various ramp configurations whereby operator could be wheeled, walked, or otherwise helped up to the level of the operator station. While each of these methods "worked", they presented safety concerns and/or relied heavily on a second person, thus were, not endorsed or encouraged by BNG.

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On early access lifts, the user-lift interface was designed to meet the needs of the specific operator with a disability (Figure 1). Therefore, little or no effort was made to standardize either the lift components or the methods of transfer. For example, while a wheelchair-accommodating platform lift would elevate one in their chair to the level of the operator station, it did not move him/her within easy reach of the operator seat. This created a lengthy and awkward transfer, which increased the likelihood of a fall or overexertion. However, despite the negatives of this design, it did allow for the chair to be transported and be available wherever the machine went.

Figure 1. 1980's access lift concept, BNG Mark II man-lift.

ACCESS LIFT DESIGN/SELECTION

Such factors as safety, cost, adaptability, and desired tasks should be carefully considered prior to choosing an access lift type. Consulting with a rehabilitation engineer, assistive technology professional (ATP), experienced assistive technology fabricator, and/or other farmers who have made similar accommodations is strongly encouraged before making a decision. As with any piece of technology, an access lift is an investment. It is not uncommon for the usable life of an access lift to exceed 25-30 years, as modern designs encompass fewer wearing parts, most of which can be easily repaired or replaced. Choosing a proven access lift design is essential to the safety of the operator, longevity of the product, and level of independence attained.

Nearly all the access lift designs documented and evaluated for inclusion in this report had four things in common— (1) provided a safe method of 'handling' the operator, (2) successfully addressed the problem of accessing the machine, (3) were reliable and robust in design, and (4) allowed for independent operation by the user. Other access lift designs were also evaluated; however, they either exposed the user to considerable risk of injury, required significant assistance by another person, or were not highly reliable and, therefore, are not discussed.

The criteria for an effective access lift for agricultural machinery were generated through consumer reviews and an expert panel consisting of safety professionals, fabricators, lift users, and researchers (Yoder, 2000). From this research, the following ideal characteristics were derived:

- Seat or platform to lift a person from ground level to cab in such a position as to facilitate transfer onto the operator seat. *(While not specifically noted in Yoder's research, the tractor seat could be replaced by the access lift in some cases, thus eliminating the need for a second transfer (Figure 2).)*
- Relatively easy to install, with minimal alterations to the original equipment and minimal interference with the operator's vision. *(Also, access lift attachments should not hinder the equipment's efficiency during operation.)*
- Lift speed of approximately 10-15 feet per minute and load capacity of at least 300 pounds. *(In some cases, the weight capacity will need to be greater to accommodate heavier individuals.)*
- Fail-safe features/devices that would protect the user in event of power failure or mechanical malfunction.
- Unobstructed path to the machine's operating station. *(This includes guarding against pinch points, sharp edges or protruding objects that can cause injury or difficulty during use.)*
- Power-limiting clutch or switch to avoid operator injury or machine damage during operation.
- Safe exit alternatives in event of an emergency.
- Flexibility so that able-bodied persons would not be hindered significantly when using the access lift-equipped machine.
- Moderate cost to encourage users to select a well-designed access lift.

Figure 2. Lift seat doubles as operator seat of tractor, eliminating the need for a second transfer. *(Source: Life Essentials)*

ACCESS LIFT STYLES AND MOUNTING TYPES

There are basically three different access lift styles (i.e., ways of transporting one up to the operator station) and two different access lift mounting types (i.e., lifting system structures and components). The three styles are: *sling lift*, *platform lift*, and *chair lift* — all of which over the years, have changed little from the early models. However, the mounting types of lifts (and their associated technologies) have changed considerably, with the two distinctly different ones being: *dedicated-machine lift*, which is mounted directly to a particular piece of equipment, and *independent* or *mobile lift*, which is mounted to a pickup truck or trailer that pulls alongside the machine to be accessed. Following is a discussion of, first, the three styles and then the two types.

Styles of Access lifts

Sling Lift (Figure 3)

The sling access lift transports the operator to the desired location using a mesh, fabric, or woven strapping sling suspended from a specialized overhead hanger. This style of lift has been used for situations where space is limited (e.g., skid-steer loader cab, horse mounting, zero-turn mower) or when transfer from one seat to another is physically difficult. In some situations, if the operator is not capable of transferring, the sling can be detached from the support structure and left on the seat during operation of the machine. With a sling lift, caution must be exercised and consideration given to avoid contusions, pressure sores, or other secondary injuries, thus users should look for access lift components that include added padding and weight-disbursement characteristics. Emphasis should also be given to the users' stability when selecting this style, as some models may not provide sufficient support during use, depending on the level of paralysis.

An electric powered vertical sling lift could be mounted (a) on a mast on the exterior of the operator platform; (b) on a telescoping beam on the interior of the platform or cab; (c) on a roller track on an overhead beam in the machinery shed, which would allow the user to be lowered into the operator seat from above; (d) to a parallel linkage fixture mounted to the floor of a building; or (e) to a mobile unit, such as trailer, RV, horse trailer, or truck.

Figure 3. Sling lift used to assist user for horseback riding. *(Source: Life Essentials)*

Platform Lift (Figure 4)

Designed to accommodate the operator in a standing position, flip-down seat, or wheelchair, the platform access lift allows one to be positioned on a platform then lifted to the level of the operator station. It is best used in situations where the user can walk on level surfaces but has difficulty in climbing the machinery steps.

Figure 4. Platform lift with fold-away platform allows easy entry for both users in need of assistance and able-bodied users.

Another form of this access lift style can be found on a vehicle (truck, bus, semi-tractor, RV, etc., with a powered running-board that can be lowered to ground level. This and allows the user to stand on the running-board platform and be raised to the appropriate entry height (Figure 5).

Figure 5. Running board lift to assist driver (and/or passenger) into vehicle.

Chair Lift (Figure 6)

The chair access lift is perhaps the most popular style of lift for individuals with significant mobility impairments. To use it effectively, the operator must be able to transfer him/herself (or receive help in transferring) from one seated position to another—i.e., first at ground level from wheelchair or vehicle to lift chair and then at the operator station level from lift chair to operator seat. One exception occurs with some models of machinery where the access lift seat of a dedicated lift also serves as the driver's seat, thus eliminating the need for the second transfer (Figure 2).

Mounting Types of Access Lifts

Dedicated-Machine Lift

A dedicated-machine access lift is mounted directly on and used to access just one piece of equipment (Figures 1, 2, 4, 5, 6). It's commonly found in either a chair or a platform configuration attached to a vertical mast and powered by the machine's electrical system. Main benefits of the dedicated access lift are: (1) the operator being able to enter/exit the machine at any time, and (2) a design (often a universal design) that's relatively simple and has few limitations as to movement. This allows it to be mounted to several different machinery types and often to pre-existing mounting points on their frames just by selecting the appropriate specialized mounting brackets.

Both the dedicated-machine chair lift and the platform lift can be used on tractors, combines, and other machinery with or without cabs. Also, the access lift assemblies can be attached high enough above ground level so as to

Figure 6. Chair lift mounted to vertical mast. *(Source: Life Essentials)*

avoid uneven ground or field crop residue during equipment operation yet can allow the seat to be lowered to a position that allows easy transfer to or from a wheelchair.

DEDICATED MACHINE ACCESS LIFT KEY COMPONENTS

Vertical mast. (Figure 6) The mast is a square or circular steel tube, often with slot cut out of one side. Its purpose is to support and guide the movement of the chair or platform and to protect the drive assembly. Height of the vertical mast can be fabricated to fit the application, with some tractors and combines requiring as much as 10 feet of lift. It should be located so as to minimize interference with operator vision. For tractors, that's usually to the front of the cab door and away from the rear drive wheels (space permitting); for combines, it can be installed either to the front or to the rear of the cab door, depending on the machine's design. It can also be fastened to the existing equipment steps, as shown in Figure 4.

A vertical mast assembly configured for a chair-style access lift offers additional articulations, oftentimes via a secondary electric motor, so that the operator can position him/herself appropriately. These articulations allow the user to swing the chair away from the machine for easier mounting/dismounting then into the cab (or over the wheel fender if an open operator station) for a near proximity transfer to the machine's operator seat.

Electrical system. The access lift's electrical system is wired into the machine's existing system, fused to prevent electrical overload, activated by a key-operated switch to prevent misuse (on some models), and usable without the engine running. This greatly improves the safety of access lift-equipped machines. Some lifts contain their own power supply that must be charged from an external electrical source when the machinery is parked. Movement of the lift components is achieved via electric winch, electric linear actuator, or electric motor (direct drive or powering hydraulic pump). (Note: Be aware that many winch models are not approved for the lifting of humans.)

On platform-type lifts, user input controls are hard-wired with up/down buttons; on chair-type lifts, the user controls are commonly controlled by a wearable wireless fob (on newer models) or a hard-wired remote. On both, hard-wired and wireless, the operator is able to remotely position the access lift chair for use or storage without incurring additional reaching or awkward positioning. Designs that incorporate electrically powered winches require special consideration to prevent the risk of failure and "freefall." Only winches that have been specifically designed for overhead or human lifting should be used and careful attention should be given to preventing cable wear or damage due to interferences with other lift or machine components.

Hydraulic powered system. Some early designs of access lifts operated off the hydraulic system of the machine. Such systems required hydraulic control valves to be located within reach of the operator in order to control access lift functions and, in the case of relying on the hydraulic systems of the machine, the capacity for remote starting. Though proven to be functional, those systems are rarely used in current designs.

Hydraulic systems are expensive, and in some cases, expose the operator to run-over situations (from a remotely placed ignition switch at ground level), similar to jump-starting a tractor from the ground by by-passing interlocks that prevent the machine from starting in gear. Cases have been documented in which operators with disabilities were injured while attempting to start a machine while located on the ground in front of the rear tire. It is recommended that if selecting an access lift that is hydraulically driven, the hydraulic system be electrically powered (such as current production models), this, allows for use while the machine is not running.

DEDICATED MACHINE LIFT MOUNTING CONSIDERATIONS

There are various considerations that play into the feasibility of mounting a dedicated vertical-mast access lift onto a piece of equipment. Table 1 identifies some ideal scenarios and also potential difficulties that may be encountered in the access lift-machine retrofitting process.

Independent Access lift

Being mounted to the bed of a pickup truck or a trailer (vs. onto one specific machine), the independent- or mobile-type access lift offers the advantage of allowing the user to access multiple pieces of equipment not only for entry, but also for fueling and other maintenance activities—and without having to make any alterations to the machine. Its lift arm often features a telescoping section that extends into the operator station, which makes for easier transition and allows the lift to be positioned at a greater distance from the machinery.

Pickup truck-mounted version. (Figure 7) Of the two types of independent access lifts, the pickup-mounted has been the most popular in recent years. Installation involves replacement of the truck's factory-installed bed and use of the truck's electrical system to power a hydraulic pump that controls the movement of the lift. Operating range of this version is about 12 feet vertically and 14 feet horizontally.

Trailer-mounted version. (Figure 8) This access lift is mounted to a trailer, which can be towed to just about any worksite. It's the likely choice of those who either do not have or may not want to modify a pickup truck. Also, this type offers benefits in the following situations: (1) if a dedicated access lift or the machinery it's mounted on breaks down, (2) if

*Table 1. Ideal Scenarios and Potential Difficulties in Mounting a **Dedicated Access** Lift.*

Ideal scenarios	*Potential problems*
Newer machinery: Pair service life of access lift to host machinery; additional benefits realized in the use of hand controls.	**Short wheelbase tractors and compact tractors used in orchards: Difficult to fit components.**
Large operator station: Allows more room to maneuver operator for easy transfer.	**4WD tractors: Creates pinch points from articulated steering.**
Existing bracketry/mounting locations: Often on tractors made for front loaders or saddle tanks; combine ladders may also be conducive to lift mounting.	**Dual front wheels: Limited space when turning limits mast location.**
Tilting steering column: Increases area for easy transfer.	**Tractors equipped with loader: Loader structure and mounting locations can interfere with access lift mounting and/or range of motion.**
Observer (buddy) seat: Provides additional space for easy transfer.	**Open-station tractors with large fenders: Difficult for user to manuever for easy transfer.**
Wide door opening: Allows for easier maneuverability.	**Cab tractors with doors hinged at the front of the cab and swing forward: Creates akward angle to properly position lift.**
	Mechanical failure of host machine: Operator limited to the dedicated lift equipped machine.

Figure 7: Pickup truck-mounted independent access lift.

Figure 8. Trailer mounted independent lift.

custom farming and helping neighbors while using their equipment, (3) if they operator has a short-term disability, such as a broken leg, and (4) in cases where a dedicated access lift would interfere with a particular operation or be highly susceptible to damage (e.g., logging). The operating range of the trailer-mounted access lift is approximately 9½ feet vertically and 8 feet horizontally. One concern raised with these lifts is the height that they can operate in order to access taller equipment that is now in use. Seat belts are installed on these access lifts to reduce the risk of falls, as are stabilizer outriggers to mitigate any chassis yaw.

While independent/mobile access lifts offer various benefits to the user (in addition to those noted above), there are also limitations to be aware of. Table 2 lists some further pros and cons the potential user should consider in his/her decision-making process.

*Table 2. Benefits and Potential Limitations of an **Independent Access** Lift.*

Benefits	*Limitations*
Allows access to all machines with the investment of a single lift. One trailer lift costs less than purchasing two dedicated lifts.	More expensive than single dedicated-machine vertical-mast units.
Provides a great range of motion (up to 12 feet up and 14 feet out).	Equipment must be located next to the access lift for entry/exit.
Allows access to other locations in addition to ground the operator station.	Difficult/dangerous emergency exit when the machine is out of range of the access lift.
No modification of machinery necessary.	Requires 'host' pickup truck to be customized (if a trailer model isn't used.)
No obstructed visibility from mounted fixtures.	Trailer lift must be mounted to a hitch for stability. (In some instances, a hitch ball can be mounted to a permanent structure instead of to a vehicle.)
Reduces number of transfers: User can transfer from vehicle directly to the lift.	
Operator not limited to accessing only lift-equipped machines.	

Figure 9. Independent access lift allows user to access locations up to 12 ft. up and 14 ft. away from the host vehicle.

Figure 10. Wireless controller fob used to position independent and dependent access lifts from lift seat or from another location.

INDEPENDENT ACCESS LIFT KEY COMPONENTS

Lift arm. The lift arm structure of an independent access lift combines parallel linkage (for maintaining level lifting of the user seat throughout the range of vertical motion), linear actuators (for extension of seat into the cab/seating area for close transfer), gearbox with slip clutches for linear articulation (for swing of the arm and reducing force if contacted with another object), and a hydraulic cylinder (for smooth control of lifting height). (Figure 9)

Power source. Over the years, the two main power sources of access lift technology have been electric and hydraulic. However, today nearly all the newer access lifts are electrically powered; and even where hydraulics are utilized, they are usually powered by an electric pump.

Access lift controls. (Figure 10) Current independent access lift designs are controlled by some form of wireless electrical fob. The wireless type can operate the lift for some 30-35 hours on a single charge and run it for 5 minutes on as little as a 1-minute charge. Today, wireless controllers are industrial grade (thus able withstand a punishing agricultural environment) and use a micro USB port to recharge (readily available as the charger for many cell phones). If control buttons are difficult to press due to hand impairments, an alternative is a toggle switch control box.

The range of the wireless controller is considerable, which offers the user the ability to position independent access lift seat from either the piece of machinery or the lift-carrying vehicle. Being able to wirelessly control the access lift benefits vertical-mast as well as independent lift users, since the operator can move the seat to a more appropriate storage position, to maximize visibility, and to close the cab door.

INDEPENDENT ACCESS LIFT MOUNTING CONSIDERATIONS

Mounting an independent access lift to a pickup truck typically requires a 3/4- ton or larger truck in order to support the weight of the typical lift assembly as well as the increased torque/strain added to the truck's frame. The factory pickup bed is removed, additional bracing/structural components are welded to the trucks' frame, and a flatbed body (commonly made of aluminum) replaces the factory bed. Access lift components are then secured through the bed, directly to the added bracketry welded to the truck frame. The

vehicle manufacturer should be consulted before structural modifications are made, as this could void the warranty.

For increased stability during access lift operation consider an electric-powered stabilizing outrigger secured to the side of the pickup on which the lift is mounted to eliminate compression of the truck's factory suspension, as dynamic forces are changed with the position of the lift (Figure 11). In association with the outrigger, an audible alert is installed in the truck cab to notify the driver in event the outrigger is not retracted before transport.

Figure 11. Stabilizing outrigger on a truck-mounted independent access lift.

ACCESS LIFT SAFETY ISSUES

System-Related Issues

Should a malfunction occur, a well-designed access lift would have fail-safe devices to prevent freefall and limit switches or slip clutches to de-energize movement if the operator or lift contacts another object. An operator with no or little feeling in his/her extremities may not be aware of pinch or crush injuries caused by being caught between moving components.

Operators should be aware that in the event of power failure or fire, the lift may not operate. If the lift is the operators only way of exiting the machine, an action plan should be developed that includes an alternative escape method. Additional research and development are needed to identify an emergency exit system broadly suitable for agricultural equipment and workers with mobility impairments. Regardless, every piece of equipment that has been modified with an access lift should be equipped with a two-way radio or cell phone and a fire extinguisher.

A dedicated-machine access lift offers a method of exit if the electrical system is still functional. An independent access lift does not offer such an option, so should a life-threatening situation require immediate evacuation of the machine, the operator would be required to take extreme measures, (such as throwing themself from the operator station), possibly resulting in secondary injuries.

Although many of the newer dedicated machine lift designs incorporate a backup method of lowering the lift in the event of component failure, use of a second person is often required unless a secondary battery system is available. The most common vertical-mast dedicated access lift can be manually lowered with a ratchet and a swivel feature 'unlocked' to allow for articulation of the seat carrier. On one independent access lift design, a hydraulic hand pump and release are triggered, along with a manual release of pivot points, to move the lift back to a transport position.

Safety-Protecting Components

Slip clutches should be located in the gearbox of the access lift to reduce the force of movement, preventing machine damage or injury to the operator. In the downward direction, some lift models will de-energize with approximately 15 pounds of down pressure. Access lifts operated in cold climates may require that the slip clutch be adjusted to overcome increased resistance, especially with lateral articulation on uneven terrain and if swinging uphill.

As discussed previously, the vertical-mast access lift is often powered by an electric motor-driven roller chain. While the components are durable, fail-safe measures incorporated into many designs cause a safety catch mechanism to activate if the chain becomes slack, thus preventing freefall. When it comes to construction of a homemade access lift, it's extremely important that all components selected be approved for the lifting of humans (especially the cable or strap winch) and that some sort of 'stop' is included to prevent a freefall in event of failure.

Safety-Enhancing Preventative Maintenance

Preventative maintenance is the best way to guard against mechanical malfunctions. Modern access lift designs are simple and robust, thus requiring but a few key components to be maintained, the crucial one being the battery. Periodically checking its water level and keeping it clear of collected dirt, residue, and corrosion can prevent many possible issues. For a vertical-mast access lift, the drive chain should be lubricated and proper tension maintained. Although many components are sealed and permanently lubricated, the operator should still be vigilant in identifying and replacing damaged or worn parts.

Operator-Related Issues

When making modifications, the operator should consider his/her own characteristics and limitations. If the individual has lost sensitivity in their extremities, special attention needs to be given to preventing contact with hot engine components, electric motors, and exhaust systems. Also, all sharp edges should be smoothed or padded and potential pinch points removed or covered. Slip clutches should be used to protect an extremity from becoming crushed between moving and stationary components. Those who have little or no feeling or control of their lower limbs should use a strap around their legs to abate movement when on the lift.

If limited stability is an issue, grab-bars and hand-holds at transfer points plus seat belts on both the access lift chair and operator seat can help prevent falls (Figure 12). With certain disabilities (e.g., higher-level spinal cord injury), an assistant should be available during the transfer process to act as an observer to prevent falls or harmful contact with machine parts.

Environment-Related Issues

All operators of agricultural equipment are exposed to certain potentially harmful environmental conditions, including rough terrain vibrations, dust, noise, fumes, temperature extremes, and excessive sunlight. When transferring to or from machinery on uneven terrain, make sure the access lift is in a level position. This ensures stable footing for platform-type lift users and smooth horizontal motion for chair type users. Those with a spinal cord injury or other physical impairment may be especially sensitive

Figure 12. Additional hand-hold to assist operator in transition to and from access lift seat.

to at least some of these exposures and should be protected from them. Therefore, it is highly recommended that machinery considered for modification be equipped with environment-controlled cabs. (Newer tractor and combine cabs provide substantial protection from nearly all the above-mentioned hazards.)

RECENT ACCESS LIFT TECHNOLOGY UPGRADES

Important strides continue to be made in the arena of access lift technology, including drive mechanisms, powering systems, lighting options, universal design, control-user interface, mechanical reliability, and precision placement of the user. Following is an overview of the developments that have occurred (or are occurring) in the first three.

Drive Mechanisms

Earlier drive mechanisms utilized parallel linkages, incline rails, and ball screws. Parallel linkages and incline rails were bulky, did not allow the range of vertical motion necessary, and had horizontal travel limitations to position the user in near proximity for easy transfer. The ball-screw drive, on the other hand, delivered high torque with relatively low power

Figure 13. Ball-screw drive sideboard access lift mounted on a grain truck.

demands and offered the fail-safe benefit of preventing freefall if a malfunction occurred (Figure 13). However, with the ball-screw, issues developed relative to collected residue on the drive components, and the speed of operation was slower than users desired. Thus, ball-screw access lifts were (and still are) typically limited to light-duty designs.

Drive mechanisms for most modern vertical-mast access lifts utilize a roller-chain coupled with a slip clutch in the gearbox and powered by an electric motor. This allows for a greater range of heights to match the machine onto which the access lift is mounted. Roller-chain drive mechanisms are also less expensive, lower maintenance, and more durable.

Powering Systems

Today, movement of the independent access lift is typically controlled by an electric-powered hydraulic system via use of electronic valves and features a telescopic extension for closer transfers. Soon, the ability to automate functions should be made possible by use of electronic controlled hydraulic valves, which will allow the user to pre-program the lift's destinations. According to a design engineer with Life Essentials LLC, the exact movement-tracking capability of new-model independent access lifts will allow for pre-programmed buttons to automatically position the access lift chair in a 'door-ready position' (i.e., a location outside the driver's door of a pickup for easy transfer on to the access lift) and then return the lift to storage position (Begley and Begley, 2017).

Lighting

Typically, available as an optional accessory, lift lighting is often an afterthought. However, as the demands of agriculture increasingly require operators to work into the evening or night, proper positioning of access lift components can prove to be difficult (or impossible) in low-light situations. Modern lighting technology allows for access lifts to be equipped with low-power LED lights, which help ensure an adequately lit work zone while adding little burden to the machine's electrical system (Ehlers, 2018).

SUMMARY

The need exists for safe and ready access to agricultural equipment by those with restricted mobility. Studies by the BNG Resource Center regarding this need have identified numerous issues that should be considered when access lifts are designed, built, or bought. Several of the access lift designs that have proven successful were discussed in this paper. The main criterion used when designing, building, or acquiring an access lift must be safety! There are cases in which it is not recommended that an individual access and operate agricultural machinery, such as when they have seizures, cannot obtain a standard drivers license, or prohibited by a medical professional. However, in most cases, a person (even one with severely restricted mobility) can be provided the means by which he/she is enabled to both access and operate agricultural machinery. For more information on assistive technology solutions for farmers, ranchers or other agricultural workers, please refer to: AgrAbility.org/Toolbox.

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This research was made possible by USDA/NIFA Special Project 2016-41590-25880.

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