



Assistive Technologies in Agriculture

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Introduction

In terms of work-related injuries, farming remains one of the most dangerous occupations in the United States. Recently, 374 farmers and farm workers died from a work-related injury, resulting in a fatality rate of 20.2 deaths per 100,000 farm workers – from accidents resulting from agriculture-related activities. Statistics also reveal that agriculture-related activities result in nonfatal injuries. For example, crop and animal-production activities resulted in 22,400 and 13,100 injuries, respectively. These nonfatal injuries may include primary as well as secondary injuries.

The average age of farmers and ranchers is steadily increasing. As they age, many continue farming with age-related disabilities and/or primary injuries sustained previously. Age and existing disabilities may negatively impact motor skills, reaction time, and hearing. The average age of farmers continues to increase, with almost 33 percent of the farming workforce over the age of 65, there is potential for the number of fatalities and nonfatal injuries from agricultural operations to rise. Chronic illnesses, automobile crashes, recreational activities, and falls have been found to cause disabilities among farmers. Recent demographic data from the AgrAbility Project show that only about 22 percent of the AgrAbility customers sustained disabilities from agriculture-related activities.

Assistive technology (AT) is the bridge that can help those farmers and ranchers who have disabilities or primary injuries to continue to be productive while reducing opportunities for secondary injuries (see *Preventing Secondary Injuries in Agricultural Workplaces*). Many have used AT systems in the past to continue with their agriculture-related activities. While

some of these ATs are independent of the type of operation, many are operation-specific. The goal of this publication is to introduce readers to the ATs used in agriculture and to the steps involved in the design of a successful AT system. This publication also discusses both common and operation-specific AT systems used in agriculture and how they influence secondary injuries.

What is Assistive Technology?

In simple terms, any technology that helps an individual with a disability to carry out a functional activity is defined as assistive technology. Assistive technologies are primarily used to improve functional outcomes for persons with disabilities. A broad range of devices, services, strategies, and practices are designed to accomplish this overall goal. An AT system may involve the use of commercially available or custom-made, low- or high-tech devices.

Central to any AT system is the individual with a disability who is trying to perform an activity in a specific location. The selection or design of an AT system will involve selecting or designing a device or strategy that will enable the individual to safely and effectively carry out the desired task. Therefore, the selection or design of an AT focuses on the individual’s disability. Because the needs and skills of individuals being served differ, each case is unique, and the AT system design or selection must be handled individually. The purpose of AT intervention is neither remediation nor rehabilitation, but to enable the individual with a disability to carry out a certain activity in a safe and effective manner.

Assistive Technology System

The most critical component of a given AT system is the individual with a disability. This individual is trying to carry out an activity in a given environment. The responsibility of the AT practitioner (the person trained in designing AT systems) is to recommend an assistive device that will enable the individual to carry out the desired activity safely and effectively by taking into consideration the person's special needs and skills. The system's focus is on the performance of this individual with a disability, and the overall goal is to maximize productivity. A close examination of an AT system will show that it is a four-component system, as shown in figure 1.

Context:

- Social Contacts
 - Familiar Peers
 - Familiar Non-Peers
 - Strangers
 - Alone
- Setting
 - Home (individual)
 - Group Home
 - Employment
 - School
 - Community
- Physical Contacts
 - Light
 - Sound
 - Heat

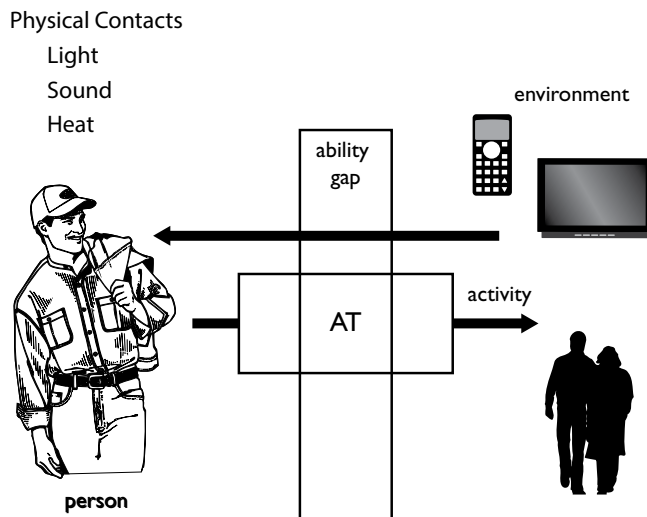
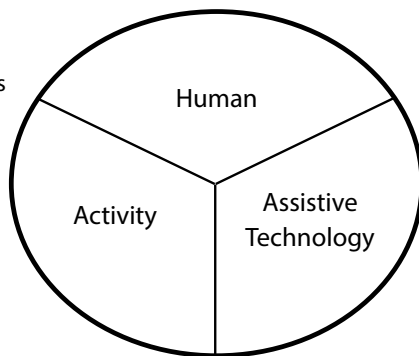


Figure 1. Human Activity Assistive Technology Model (HAAT). (Adapted from Cook and Hussey, 2002)

Assistive Technology System Design Process

There are a number of steps an AT practitioner has to follow during the selection or design of an AT system. Detailed information on the skills, abilities, and special needs of the individual involved should be collected and evaluated. Secondly, details of the activity and the surroundings in which the activity is to be performed must be evaluated. This evaluation may involve identifying different tasks associated with the activity. The activity together with the associated tasks define the goal for which the AT system is to be developed.

Once the goal is established, the practitioner will be in a position to select an appropriate AT device or develop a plan for intervention. The next step will include implementation of the intervention plan or installation of the selected AT system. The individual with a disability must be trained in the use of the particular AT system. The practitioner should evaluate the effectiveness of the system or intervention plan developed. Based on the results of this evaluation, system changes should be made to improve its effectiveness if necessary.

Assistive Technologies Used in Agriculture

Farmers and ranchers with disabilities have been using ATs to enable them to carry out different farming-related activities for many years. These technologies can be grouped into two categories: some are common to all operations, whereas others are specific to the type of operation. For example, a wheelchair used by a disabled farmer for mobility is a common AT, used irrespective of the type of operation. An AT used on a tractor to meet the special needs of a disabled operator will also fall in the first category. On the other hand, a remotely operated gate for guiding animals is a good example of an AT in the second category because it is specific to animal production.

The AgrAbility Project maintains a comprehensive database of ATs used in agriculture. This publication covers only selected ATs in the two categories. More specifically, in addition to selected operation-independent ATs, it cites selected examples of ATs specific to crop, animal, dairy, and poultry production.

Operation-Independent ATs

Tractor Alterations

Tractors are the workhorses on farms, and they are widely used for a variety of applications in the vast majority of farming operations. Numerous examples of AT applications and associated tractor alterations exist to accommodate the needs of disabled farmers. One such straightforward example is retrofitting tractors with additional steps (figure 2) and handholds for individuals with difficulty in balancing, an irregular gait, a weak lower body, and/or arthritis.

One of the most-used tractor controls during farming operations is the clutch. In order to assist amputees and others who have restricted use of their legs, tractors are often retrofitted with hand-operated clutches. A hand-operated mechanical linkage system for controlling the clutch is shown in figure 3.

A simple spinner knob on a steering wheel (figure

4) can be very effective in providing better steering control for individuals with low grip strength or prosthetic devices. Even though modern tractors require only minimum steering effort, a variety of disabilities make it difficult to grip the typical steering wheel. The addition of a spinner knob can enable individuals with a disability to control the tractor effectively.

Custom-made seats have also been in use to assist individuals with spinal cord injuries, especially those who are quadriplegic. These seats, as shown in figure 5, are designed to deal with issues such as pressure relief for ulcers. Lumbar support, seat angle, footrests, and knee and ankle positioning isolate operators from low-frequency vibration and other possible sources of discomfort.

Docking stations (figure 6) for attaching machines are for those who deal with mobility problems. These devices enable operators to attach or detach machines without leaving their seats.



Figure 2. Left, tractor retrofitted with additional steps; right, tractor equipped with mechanical lift.

Figure 3. Hand-control linkage for operating the clutch.



Figure 4. Steering wheel with a spinner knob for ease of moving the steering wheel.

Figure 5. Retrofitted tractor seat for protecting operators with certain disabilities.

Figure 6. Quick connect adaptor for attaching and detaching implements to the drawbar.

Living Space Alterations

Living space is often modified using appropriate ATs to protect farmers with disabilities from secondary injuries. These modifications may include adding ramps (figure 7) for wheelchair access, improving lighting in areas frequented by individuals with disabilities, and replacing doorknobs with lever handles for a better grip.



Figure 7. Ramp for improving wheelchair access.

Other ATs in this category may include the following:

- Manual or powered wheelchairs for mobility.
- Rubberized, nonslip surfaces for heavily used concrete floor areas.
- Corrective or improved footwear for back and arch support.
- Large zippers or snaps on clothing to help get clothing on and off.

Operation-Specific Assistive Technologies

Livestock

Livestock handling is recognized as one of the most dangerous farming activities. The risk of secondary injuries as a result of existing injuries or disabilities is extremely high when handling livestock. Many ATs have been in use to assist and protect operators with disabilities from sustaining additional injuries. These technologies help avoid or minimize direct contact with the animals. Most of these categories and assistive technologies are used for both livestock and dairy operations, though the latter also has certain specific assistive technologies.

The following are selected examples of assistive tech-

nologies used in livestock operations:

- Livestock guards that eliminate the need for opening or closing gates.
- Easy-to-open spring-loaded latches.
- Quick gate latch for one-handed use.
- Small animal tip chute.
- Large animal tip chute.
- Cattle chutes.
- Calf table.
- Crutching frame with chest belt for sheep shearing.
- Deck chair to hold sheep while being trimmed, examined, or medicated.
- Pig holders able to hold pigs on their backs.
- Automatic horse feeders.
- Slicers (for slicing wet or frozen bales).
- Motorized feed carts.
- Trailer-mounted livestock feeder.
- Bale feeder for dispensing hay.
- Horse and cattle drinker that dispenses water each time an animal nears bowl.
- Base-heated water trough to reduce freezing.

Dairy

In addition to some of the ATs listed in the previous section, the following are specific to dairy operations:

- Automatic milker takeoff for easy milker detachment.
- Airlift milking stool.
- Portable stool attached to the hip to free both hands.
- Carrier rail for easily moving from one milking station to the other.
- Supermixer for specialized dairy cattle diet.

Crop Production

- Automatic grain-level indicator for grain bins.

Poultry

- Feather picker.
- Laying nest.

Horticulture and Gardening

Many assistive technologies are employed in general gardening. Selected examples are:

- Elevated garden for wheelchair users or those with other mobility impairments.

- Extended-reach shears.
- Garden bench for users.
- Long-handled bulb planters.
- Vertical gardening for individuals in wheelchairs.

Assistive Technologies and Secondary Injuries

Farmers returning to farm work after being involved in an accident risk the occurrence of a secondary injury. Primary injuries can cause weaknesses that can lead to further injury. For example, a farmer with arthritis could lose his grip and fall; the fall causes the secondary injury. Assistive technologies are designed with these risks in mind to compensate for weaknesses and reduce the potential for further injury.

Existing disabilities and injuries may adversely affect both reaction time and motor skills. Therefore, individuals with sustained injuries and/or disabilities engaged in physically demanding and otherwise dangerous agricultural operations significantly increase their chance of secondary injuries. The impact of secondary injuries on individuals already trying to manage the primary injury can be devastating. In many situations, the secondary injuries may cause permanent damage because pre-existing conditions are worsened by additional injuries. In other situations, they may require additional recovery time. The impact of a secondary injury on a farmer/rancher and on the farmer's family can be profound.

Most agricultural operations are high-risk operations. For this reason, the straightforward approach for individuals with disabilities and primary injuries to avoid secondary injuries is to not take an active role in farming. Often this is not an acceptable option, in which case the farmer should make every effort to avoid high-risk activities. For example, activities such as handling livestock, working on elevated locations, and machine maintenance have all been identified as high-risk operations (Mariger et al. 2008; Allen, Frick, and Field 1995). If this is also not an option, the operator must make every effort to adopt assistive technologies that can reduce the risk of secondary injuries.

In general, ATs help farmers with disabilities to continue farming with reduced opportunities for secondary injuries. However, it must be noted that AT use periodically results in secondary injuries. Often such

situations arise when homemade ATs that do not meet design standards are used, or when commercially available ATs are used without properly matching them to the user's abilities. Secondary injuries may also occur when ATs are used without proper training.

The National AgrAbility Project has identified common safety issues with an AT used in the agricultural workplace. It is part of the research project developed in the dissertation below. The assessment tool is available at www.agrability.org.

Mathew, S. N. *An Assessment Process to Estimate the Secondary Injury Potential of Assistive Technology Adopted by Farmers With Disabilities*. Ph.D. dissertation, Purdue University.

Agencies for Assisting With the Adaptation of ATs

Disabilities and the needs they create vary from individual to individual, so adaptation of any assistive technology must be done on an individual basis. Persons with disabilities seeking adaptation must work with an AT practitioner. These individuals are trained to select or design an AT system while taking into consideration the disability of the individual, their needs, and the functioning environment. Specialists associated with the assistive technology program will generally be involved in the training and the evaluation of the AT selected. Most states have an assistive technology program. In Virginia, this service is provided by Woodrow Wilson Rehabilitation Center. Farmers in Virginia may also contact other organizations for assistance.

Additional Resources

For a more complete list of the assistive technologies available, visit the AgrAbility Assistive Technology Database; <http://www.agrability.org/Toolbox/>.

Purdue University. *The Toolbox CD: Agricultural Tools, Equipment, Machinery, and Buildings for Farmers and Ranchers with Physical Disabilities*. Breaking New Ground Resource Center. West Lafayette, Ind.: Purdue University.

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