Virginia Cooperative Extension

PUBLICATION 442-084

Assistive Technologies in Agriculture

Robert "Bobby" Grisso, Professor and Extension Specialist, Biological Systems Engineering, Virginia Tech
John Perumpral, Professor Emeritus, Biological Systems Engineering, Virginia Tech
Kristen Pevarski, former student, Biological Systems Engineering, Virginia Tech
Kirk Ballin, Director, Virginia AgrAbility Project, Virginia Easter Seals

Introduction

In terms of work-related injuries, farming remains one of the most dangerous occupations in the United States. In 2007, national statistics showed 411 fatalities – 23.5 deaths per 100,000 farm workers – from accidents resulting from agriculture-related activities (NIOSH 2009). Statistics also reveal that agriculture-related activities result in nonfatal injuries. For example, in 2006, crop and animal-production activities resulted in 22,400 and 13,100 injuries, respectively (U.S. Department of Labor 2006). These nonfatal injuries may include primary as well as secondary injuries.

The average age of farmers and ranchers in the United States 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. As the average age of farmers continues to increase, with almost 44 percent of the farming workforce over the age of 65 (USDA 2007), there is potential for the number of fatalities and nonfatal injuries from agricultural operations to rise. Chronic illnesses, automobile crashes, recreational activities, and falls also 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. Many have used AT systems in the past to continue with their agriculture-related activities (National AgrAbility Project: *www.agrability.org*). 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, and it provides lists of agencies and resources that can help farmers and ranchers with the implementation of ATs.

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.

www.ext.vt.edu

Produced by Communications and Marketing, College of Agriculture and Life Sciences, Virginia Polytechnic Institute and State University, 2010

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.

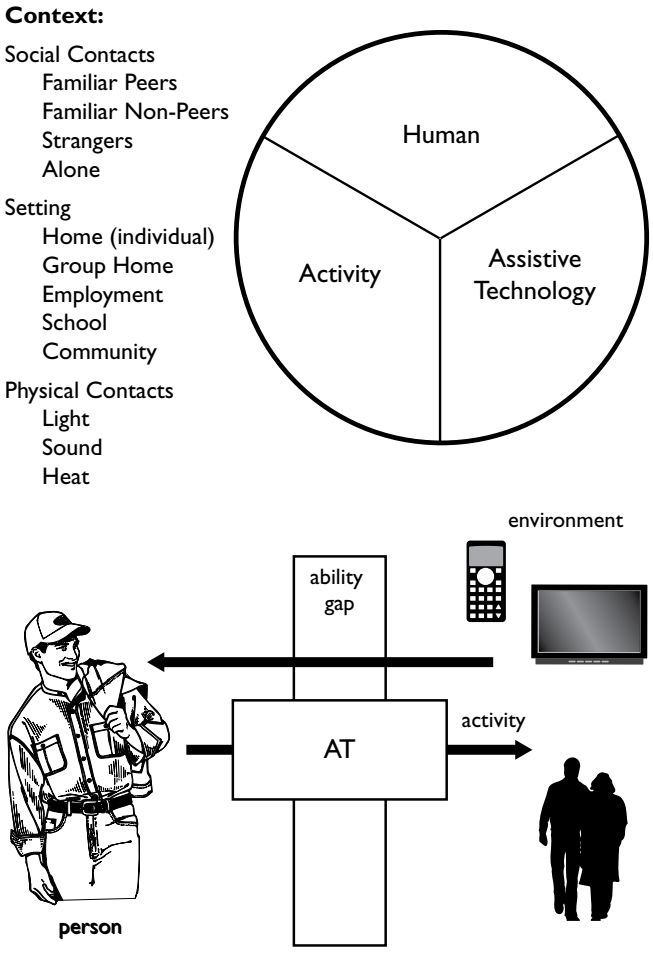

Figure 1. Human Activity Assistive Technology Model (HAAT). *(Adapted from Cook and Hussey, 2002)*

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 at the University of Wisconsin maintains a comprehensive database of ATs used in agriculture (AgrAbility Project 2009). 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 technologies 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 preexisting 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.

For more information on reducing secondary injuries and the proper use of AT systems, review:

Allen, P. B., W. E. Field, and M. J. Frick. 1995. Assessment of work-related injury risk for farmers and ranchers with physical disabilities. *Journal of Agricultural Safety and Health* 1(2): 71-81.

Field, W. E., A. M. Yoder, and D. Kingman. 2001. Influences of disabling conditions on the nature and frequency of farm/ranch-related injuries. National Ag Safety Database. *http://nasdonline.org/static_content/documents/1833/d001768.pdf* (accessed Jan. 20, 2010).

Grisso, R. D., J. Perumpral, and K. Ballin. 2009. *Preventing Secondary Injuries in Agricultural Workplaces*. Virginia Cooperative Extension publication 442-085. *www.pubs.ext.vt.edu/442-085* (accessed Jan. 20, 2010).

Willkomm, T. 1997. *Risks in Using Modified Tractors by Operators With Spinal Cord Injuries and Their Co-Workers*. Ph.D. dissertation, University of Pittsburgh.

Yoder, A. M. 2002. *Ergonomic Evaluation of Commercially Available Operator Lifts for Farmers With Disabilities*. Ph.D. dissertation, Purdue University. *http://docs.lib.purdue.edu/dissertations/AAI3105054/* (accessed Jan. 20, 2010).

The National AgrAbility Project is currently completing an assessment tool that can be used to identify 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 will soon be available at *www.agrability.org*.

Mathew, S. N. 2009. *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. A listing of these agencies follows.

Woodrow Wilson Rehabilitation Center (WWRC): *www.wwrc.net/*; (540) 332-7065

National AgrAbility Project: *www.agrability.org*; (800) 825-4264

AgrAbility Project (University of Wisconsin): *www.agrabilityproject.org*

Amputee Coalition of America: *www.amputee-coalition.org/Fact_Sheets/Assist_Orgs.html*; (888) 267-5669

Easter Seals, Virginia: *http://va.easterseals.org*; (866) 874-4153

U.S. Department of Veterans Affairs: *www1.va.gov/health*; (877) 222-8387

Rehabilitation Engineering and Assistive Technology Society of North America: *www.resna.org*; (703) 524-6686

Additional Resources

For a more complete list of the assistive technologies available, visit the AgrAbility Assistive Technology Database; *http://fyi.uwex.edu/assistivetech.org*.

Purdue University. 2009. *The Toolbox CD: Agricultural Tools, Equipment, Machinery, and Buildings for Farmers and Ranchers with Physical Disabilities*. 6th ed. Breaking New Ground Resource Center. West Lafayette, Ind.: Purdue University. *http://cobweb.ecn.purdue.edu/~bng/BNG/Resource%20Center/Toolbox/index.html* (accessed Jan. 20, 2010).

Acknowledgments

The authors would like to express their appreciation to David Holshouser, associate professor and Extension agronomist, Tidewater Agricultural Research and Extension Center; Paul Jones, National AgrAbility Project, Breaking New Ground Resource Center, Purdue University; and Wythe C. Morris, Extension agent, agricultural and natural resources, Virginia Cooperative Extension Carroll County Office, for their review and comments.

This factsheet resulted from an Extension project (project No. 2006-41590-03436) supported by the Cooperative State, Research, Education, and Extension Service (CSREES) of the U.S. Department of Agriculture.

References

Allen, P. B., M. J. Frick, and W. E. Field. 1995. The safety education training needs of farmers and ranchers with physical disabilities. *Journal of Agricultural Education.* 36(3): 50-56.

AgrAbility Project. 2009. Assistive Technology Database. *http://fyi.uwex.edu/assistivetech.org* (accessed July 8, 2009).

Cook, A. M., and S. M. Hussey. 2002. *Assistive Technologies: Principle and Practice*, 521. 2nd ed. St. Louis: Mosby.

Mariger, S. C., R. D. Grisso, J. V. Perumpral, A. W. Sorenson, N. K. Christensen, and R. L. Miller. 2009. Virginia agricultural health and safety survey. *Journal of Agricultural Safety and Health* 15(1): 37-47. *http://asae.frymulti.com/azdez.asp?search=1&JID=3&AID=25414&CID=j2009&v=15&i=1&T=2* (accessed June 15, 2009).

NIOSH (National Institute for Occupational Safety and Health). 2009. *Agricultural Safety*. Washington, D.C.: Centers for Disease Control. *www.cdc.gov/niosh/topics/aginjury/* (accessed Aug. 15, 2009).

USDA (U.S. Department of Agriculture). The Census of Agriculture. National Agricultural Statistics Service. 2007. Summary by Age and Primary Occupation of Principal Operator: 2007. *www.agcensus.usda.gov/* (accessed Aug. 15, 2009).

U.S. Department of Labor. Bureau of Labor Statistics. Office of Safety and Health Statistics. 2009. Numbers of nonfatal occupational injuries and illnesses by industry and case type, 2006. In *Occupational Injuries and Illnesses: Counts, Rates, and Characteristics, 2006*. Report 1014. *www.bls.gov* (accessed July 8, 2009).