Perspective: Emphasizing Safe Engineering Design Features of Quad Bikes in Agricultural Safety Programs

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HIGHLIGHTS
- Previous quad bike educational interventions focused solely on operator behavior, leading to positive shifts in 'safety knowledge' but very little change in actual rider behavior.
- Discussions in a recent virtual ATV Safety Symposium hosted by the University of California-Davis (2022) emphasized building agricultural community awareness of quad bike engineering controls—particularly in the U.S. and other nations.
- Outreach specialists in agriculture should begin to prioritize more discussion of quad bike engineering controls in training programs.

ABSTRACT. To date, most quad bike educational programs have featured an operator-focused approach, focusing on adherence to administrative controls, personal responsibility, and personal protective equipment. Though these programs lead to shifts in 'safety knowledge', they result in very little change in actual rider behavior. In this perspectives article, we highlight discussions from a recent ATV Safety Symposium and USDA-NIFA review of agricultural ATV safety in the U.S. that highlight the dire need for building agricultural community awareness of quad bike engineering controls such as CPDs, wider and more stable frame designs, and others. Although CPDs were introduced 15 years ago, we continue to observe low awareness of this and other important quad bike safety features among young adults in agriculture. We believe that it will be critical to apply some of the recommendations outlined in this article to improve future outreach programs focused on quad bike safety for agricultural occupational use. If rural, agricultural communities learn to accept and respect these life-saving technologies, future standards, policies, and legislative actions are more likely to be well-received.

Keywords. Agriculture, All-terrain vehicle (ATV), Crush-protection device (CPD), Engineering, Operator, Outreach, Quad bike, Safety.
In this article, we share perspectives on the future of outreach programs focused on quad bike safety for agricultural occupational use. The term ‘quad bike’ may be used as a more appropriate term for all terrain vehicles (ATVs) and does not include larger side-by-side vehicles (e.g., Utility Task Vehicles, or UTVs). The primary goals of this article are to a) highlight the dire need for the inclusion of more engineering controls in current quad bike safety outreach programs and b) share organizational strategies going forward with safety curriculum focused on young adults using quad bikes for agricultural work. Although this article will highlight discussions from the virtual ATV Safety Symposium (2022) and a current review of agricultural ATV safety in the United States (U.S.) (NCERA, 2020), the authors acknowledge that there are several other critical references from work done in this field. The ATV Safety Symposium, hosted by the University of California, Davis, was held virtually on June 28, 2022, and included eight presentations by nine presenters and a half hour of round table discussion. The symposium focused on the use of ATVs (quad bikes) for agricultural purposes.

In the past three decades, traditional quad bike safety outreach programs have primarily focused on youth and parents in rural, agricultural communities. In many of these programs, the recreational and occupational uses of quad bikes are not clearly delineated, although the nature of their use is drastically different. Most of these traditional programs have featured an operator-focused approach, focusing solely on adherence to administrative controls (e.g., eliminating extra riders, operating quad bikes on safe surfaces), personal responsibility (e.g., active riding techniques, refraining from alcohol use), and personal protective equipment (e.g., helmets, treded boots). It is interesting that these programs continue to focus primarily on administrative controls and personal protective equipment, even though they are less effective than other methods such as elimination/substitution and engineering controls (NIOSH, 2022). This approach seems to be in line with other studies conducted in Sweden examining the personal beliefs and social constructs of workers using quad bikes, who tend to shift the focus away from engineering controls and safety technology to leaning on blaming the operator for faulty behaviors (Edlund et al., 2019; Lundqvist et al., 2022). A thorough review of these safety outreach programs was performed in both the U.S. and Canada (NCERA, 2020; AHS, 2016). Until 2020, the Ag Health and Safety Alliance (AHSA) also utilized a similar approach to quad bike safety during the Gear Up for Ag Health and Safety (Gear Up for Ag) program with young adults (ages 18-25) working in agriculture. This program was developed to train young adults in collegiate agricultural programs on a range of agricultural health and safety topics using evidence-based information. However, as described in a previous study, we found that this outreach focus did not lead to a large shift in personal safety behaviors, such as wearing quad bike helmets more often and disallowing extra riders (Sheridan et al., 2020). In fact, we learned that many other quad bike educational intervention studies have demonstrated substantial ‘safety knowledge’ shifts but very little change in actual rider behavior—further demonstrating the disconnect between knowledge and action (Novak et al., 2013; Jennissen et al., 2015; AHS, 2016). In addition, education and behavior-related safety trainings have not lessened the number of injuries and fatalities associated with quad bike operations in the U.S. and Canada, and this continues to be problematic (Fawcett et al., 2016; Jepsen, 2018; Topping, 2021). It is time to consider how we can increase market demand for safer quad bike products instead of continuing to stress personal responsibility.
Shifting From Operator-Focus to Passive Controls

Over 40 years ago, Haddon (1980) stated that the best method of occupational control were passive controls, in which protection does not depend upon the worker’s actions, and this framework was discussed in both the ATV Safety Symposium (2022) and the Agricultural ATV Safety Report (NCERA, 2020). Unfortunately, not much outreach in the U.S. or Canada has focused on quad bike engineering controls until the mid-2000s; perhaps this is due to the introduction of some of the first crush protection devices (CPDs), such as ‘safety arcs’ in Israel and the T-Bar in the 1990s, followed by the Quadbar in 2007 (D. Robertson, Quadbar, personal communication, 23 Aug 2022; Meyers, 2017; Jepsen, 2018; Khorsandi et al., 2019, 2021). A CPD is defined as a structure designed to form a protective space between the bike and the ground in the event of a roll-over. It is not the same as a Roll Over Protective Structure/System (ROPS), which is an external frame or structure that forms a compartment to protect the rider of heavy machinery (Wordley, 2012). It is not surprising that in recent years, a tremendous focus has been on the use of CPDs for operator protection. This is particularly important for agricultural applications since a recent study found that most farm work-related incidents involved a rollover, where the use of CPDs may have been particularly effective (Lower et al., 2022). Although CPDs are important, we note that several other quad bike safety features may be considered as well. Adjustable seats, electric power steering, wider frame designs, and stability ratings may be considered at the point of purchase and modified by the manufacturer. Others, such as CPDs, accessories, and implements fit for the model, dual wheels, and alarm systems, may be added on after the initial purchase. These after-purchase features may be designed by the original equipment manufacturer (ideally) or retrofitted by an aftermarket manufacturer. More research is needed on some of these technologies, such as dual wheel systems, to learn if they provide more stability and roll protection. It is likely that increasing overall track width will increase the stability angle of the device (Grzebieta et al., 2015; Ayers et al., 2018). It should be noted that the use of any quad bike accessory, even if made by the original equipment manufacturer, shifts the quad bike’s center of gravity, affecting performance and safety. However, the use of accessories made by the OEM is still preferred over homemade or altered versions.

Current Issues and Recommendations

One of the main and perhaps most important themes of the 2022 ATV Safety Symposium was the emphasis on building agricultural community awareness of quad bike engineering controls. Researchers at the Symposium discussed the benefits of promoting engineering controls and safer design so that agricultural workers, general operators, and farm families know what to look for when purchasing a quad bike for occupational use. Several researchers also discussed some challenges in working with quad bike manufacturers to identify, implement, and promote more solutions for safe design. Attendees representing the powersports industry stated that to increase acceptance of these technologies, they would need to have a flashier appeal or design for end users. Researchers also mentioned that government incentives and rebate programs to support installation of engineering controls on quad bikes would be more successful if supported by consumer awareness.

However, research conducted in 2020 and 2021 revealed that less than one-fifth of young adults involved in Canadian and American agriculture were aware of important quad bike safety features meant to prevent roll-over events—even when actual photos of the
safety devices were provided in a survey (Gibbs et al., 2022a, b). This included a low awareness of CPDs, wider frames, stability ratings, dual wheels, and alarm systems. Very few young adults in agriculture were aware of CPDs in particular—only 17%. It was interesting that more young adults in agriculture were aware of performance-inspired features such as windshields and rollbars/roll cages, which are more common on recreational off-highway vehicles (ROVs) (71 and 59%, respectively). It is unknown how these results compare to countries, like Australia and Israel, where CPDs (also called ‘Operator Protection Devices’, OPDs) are mandated (Khorsandi et al., 2021). In 2019, the Australian government passed new standards to improve ATV safety (Sukkar, 2019). Based on this standard, all new general use (utility) ATV models are required to be fitted with a CPD or have one integrated into the design and meet minimum stability requirements. In the U.S., Canada, and other countries where CPDs are not required by law, it is important to raise awareness within the community to influence social acceptance and respect for the life-saving technologies that these devices have to offer. We believe this is very important to do before or alongside standards, policy, and legislative development. Insurance companies, local or regional agricultural associations and nonprofits, consumer product safety groups, governments, and learning institutions in rural areas (e.g., high schools, colleges) are all key partners. Increased awareness will also ensure that if a CPD rebate program is launched in the U.S., it is more likely to be successful. Customer demand for safer quad bike products will also drive markets and retailers to innovate new technologies to improve quad bike stability and create quad bikes more specifically for occupational use.

To address low awareness of engineering controls, AHSA has completely reorganized the quad bike safety educational program for young adults in agriculture. The quad bike safety portion typically lasts 20 minutes and is an important component of the overall Gear Up for Ag program, which ranges from 2 to 4 hours in length. This included the development of a completely new curriculum with a strong emphasis on engineering controls and the development of a 2-minute motion graphic showing the controls and highlighting their effectiveness in an animated form. Following the motion graphic, educational staff accommodated additional time for discussing the motion graphic and sharing stories about quad bike incidents on the farm. Following the delivery of the revised curriculum, 30% of young adult participants in both the U.S. and Canada reported one of their ‘biggest takeaways’ from the entire program was related to the topic of quad bike safety, and responses focused on engineering controls rather than the administrative and personal protective equipment (PPE) controls presented (Gibbs et al., 2022a, b).

It also seemed like the revisions to the safety curriculum impacted the potential future decisions of young adults, since 35% of the young adults in both countries stated they were “likely or somewhat likely” to consider purchasing a CPD for their quad bikes. Like other outreach programs, follow up is needed with these individuals to see if the new curriculum changed actual safety behaviors or influenced a purchasing decision.

Similarly, the University of Nebraska Extension and the Central States Center for Agricultural Safety and Health have been promoting engineering design controls in their outreach efforts. Crush Protection Devices (CPDs) have been installed and used as talking points on both the full-size ATV simulator and quad bike tilt-tabletop demonstrations. In fact, the tabletop demonstrations are useful tools to visually “experience” the roll-over prevention of multiple features. One limitation of these activities is that they are focused on youth. For example, the Gear Up for Ag program mainly focused on young adults working in agriculture. Although some of these young adults may have the ability to purchase a
quad bike or CPD on their own, they do not have the same decision-making power as their parents or farm supervisors, who may be able to finance safer changes immediately. Although most of the outreach efforts at the University of Nebraska have focused on youth and young adults, the demonstrations are designed with parent audiences in mind.

**Recommendations**

Based on these perspectives, we recommend the following for other outreach programs focused on quad bike safety:

1. Present quad bike safety topics in line with the National Institute for Occupational Safety and Health hierarchy of controls (NIOSH, 2022), clearly presenting engineering controls chronologically in front of other controls focused on administrative rules, rider behavior, and PPE use. Include group-focused discussions to strategize ways to make these engineering controls more appealing.

2. Use interactive demonstrations and graphics (such as animated motion graphics) to show the effectiveness of engineering controls, such as tabletop tilt tables for scaled quad bikes, remote control quad bikes with CPDs with hitching demonstrations, and simulated terrain to show the protection provided by CPDs in the event of a rollover. This may include having CPDs or quad bikes with engineering controls present at the outreach program so that trainees can touch, feel, and ask questions about the controls. Demonstrations may emphasize the impact of accessories or towed implements on quad bike stability. We provided information on several of these examples during the ATV Safety Symposium (2022).

3. Provide outreach participants with three to five engineering controls that they can consider in the near future and how to inquire about these when visiting an implement or powersport dealer to purchase a quad bike or quad bike accessories.

4. Inform quad bike users of how they can advocate for safer products by contacting consumer product safety representatives and working with non-profit organizations focused on safety or local/regional agricultural associations. Create and provide several resources on product stability ratings so that users can learn to identify safer models, such as those highlighted by Heydinger et al. (2016) and Ayers et al. (2018).

5. Modify the quad bike safety program for the end user. Different advice and recommendations will need to be emphasized for occupational and recreational use of quad bikes. Although youth audiences benefit from learning about rules, safe riding, and PPE—parents, employers/managers, young adults pursuing collegiate-level education for agricultural production management will require a strong focus on engineering controls since these individuals are likely to make farm purchasing decisions. One example is the ATV Safety Institute, which has developed different quad bike safety courses based on age level, occupation, and experience (Khorsandi et al., 2019). Studies in the vehicular transport industry found that ‘management commitment to safety’ was the single strongest aspect of safety culture, demonstrating the important role of farm managers and parental involvement in the demand for safer vehicular products (Mooren et al., 2014).

**Conclusion**

Perspectives shared at an ATV Safety Symposium and a review of agricultural ATV safety in the U.S. have highlighted the need for building agricultural community awareness of quad bike engineering controls such as CPDs, wider and more stable frame designs, and
others. Although the CPD was introduced 15 years ago, we continue to observe low awareness of this and other important quad bike safety features among young adults in agriculture. We believe that it will be critical to apply some of the recommendations outlined in this article to improve future outreach programs focused on quad bike safety for agricultural occupational use. Following the revised Gear Up for Ag program, we found that about one third (35%) of young adults working in agriculture stated they were at least somewhat likely to consider purchasing a CPD for their quad bikes—but this proportion was still lower than intended. More research should be conducted to examine agricultural consumer perspectives on the hesitancy to further equip quad bikes with safety features like CPD. This may include asking about barriers to use, such as hindrance with regards to clearances (tree limbs, etc.), potential interference with agricultural accessories, cost, and design likes/dislikes. If rural, agricultural communities learn to accept and respect these life-saving technologies, future standards, policies, and legislative actions are more likely to be well-received.

References


