2950 Niles Road, St. Joseph, MI 49085-9659, USA
269.429.0300 fax 269.429.3852 hq@asabe.org www.asabe.org

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Agricultural Machinery Safety Behavior Among Youth

Michael L. Pate[1], Rebecca G. Lawver[1], Dustin K. Perry[2], Scott W. Smalley[3], Celina Wille[1], Don Edgar[4], Jim Hafer[5], Marvin Young[6]

[1] Department of Applied Sciences, Technology, and Education, Utah State University, Logan, UT
[2] Montana State University, Bozeman, MT
[3] Department of Agricultural Education and Studies, Iowa State University, Ames, IA
[4] Department of Agricultural & Extension Education, New Mexico State University, Las Cruxes, NM
[5] Agricultural and Natural Resources Sciences Program, Chief Dull Knife College, Laem Deer, MT
[6] Prairie View Cooperative Extension, Prairie View A&M, Dallas, TX

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ABSTRACT. *The Supervised Agricultural Experience Safety Award program was launched with Montana, South Dakota, and Utah agriculture teachers. A combination of video conferencing and in-person training workshops were offered to school-based agriculture teachers in Montana, South Dakota, and Utah. Zoom webinar workshops were held with teachers during the COVID-19 Pandemic. The five annual training topics were Year 1) Tractor/Equipment Roll-over hazards, Year 2) ATV/UTV operation hazards, Year 3) Tractor/Equipment Operation Hazards, Year 4) PTO/Entanglement hazards, and Year 5) agricultural machinery transport hazards associated with use on public roadways. To assess the influence of agricultural machinery safety training on students' student work-based, journal reflections were collected through the Agricultural Experience Tracker to qualitatively describe students' production-based agricultural experiences as coded by NASS Commodity codes, describe students' safety reporting using Supervised Agricultural Experience (SAE) journal entries, and quantify teachers' workshop participation as related to student safety reporting. A total of 2215 journal entries were reviewed from Montana, Utah, and South Dakota. A total of 905 journal entries were associated with a teacher participating in the training program. Most student journal entries focused on machinery operations. A total of 80 journal entries specifically reported safety as the main topic. A total of 204 journal entries reported the use of tractors. A total of 82 entries (25.1%) noted Hay production as the agricultural production work experience. The results provide recommendations for developing an application model for translation using an FFA Award structure.*

Keywords. *Education, Machinery, Safety, Tractors, Training, Youth*

Introduction/Background

The agriculture industry continues to have the highest worker fatality rate (19.5 per 100,000 workers) than all other industries (U. S. Bureau of Labor Statistics [BLS], 2022). Even more concerning data predictions are noted in the National Children's Center (2022) fact sheet, which reported that between 2011 and 2020, agriculture had the highest number of

occupational fatalities for youth ages 17 and younger.

As a major branch within career and technical education, school-based agricultural education prepares students for employment related to the agricultural industry. Students within school based agricultural education (SBAE) programs may participate in supervised agricultural experiences (SAE) (National Council for Agricultural Education [NCAE], 2015) where they are provided work-based learning opportunities. Conceptually, SBAE curriculum standards focus on developing career skills, such as agricultural safety, as they prepare for future career opportunities (FFA, 2022). As part of a complete agricultural education program, numerous studies have documented SAE benefits (Camp et al., 2000; Lewis et al. 2012; Moules 2013; Rubenstein and Thoron, 2014), especially in the development of technical skills and workplace behaviors.

A unique data source to examine safety training and workplace exposures has been identified through students' SAE reflection journaling. Recent research has focused on "train the trainer" approaches to increase safety knowledge and awareness of secondary agriculture teachers and subsequent students (Perry et al., 2020). Resulting efforts of this research culminated in recommendations that additional research should focus on the effects of youth background and safety measures within SAEs (Pate et al., 2019; Perry et al., 2020).

There is a significant need for research examining safety training experiences and workplace behaviors among youth working in agriculture, as the availability of data directly from this group is limited. With only a handful of research studies prior to 2013 (Carraba et al., 2000; Jepsen, 2012; Wilkinson et al., 1993), a closer and more thorough examination of youth tractor and machinery safety training is needed. NIOSH (2002) noted that "[t]he effectiveness of tractor safety training programs has not been adequately evaluated nationwide" (p. 70). While students may exhibit greater confidence in operating procedures as a result of safety training, this does not always translate to a reduction of unsafe behaviors (Carraba et al., 2000) Despite demonstrated challenges associate with improving youth safety behavior, NIOSH (2002) recognized a Wisconsin study (Wilkinson et al., 1993) that found youth who had completed a training program reported an increase in usage of tractors equipped with roll-over protection structures (p. 71).

The Agricultural Experience Tracker (AET) is an online data management system tool for managing time and financial resources associated with SAEs. Since July 2022, the AET has had over 600,000 students nationwide access the platform (AET, 2023). Within the AET, participants had the opportunity to complete an agricultural safety knowledge exam as well as document experiential learning (journaling) related to the Agriculture, Food, and Natural Resources (AFNR) Curriculum safety standards identified by the Safety in Agriculture for Youth Curriculum Clearinghouse (Fetzer, 2022).

Purpose and Objectives

Recognizing the lack of research to document agricultural youth application of safety training within work-based learning experiences, the purpose of this project was to assess high school agricultural education youth work-based learning experiences related to safety. Specific objectives included:

1. Qualitatively describe students' production-based agricultural experiences.
2. Describe students' safety reporting using SAE reflection journal entries.
3. Determine the relationship between teacher participation and student safety journaling.

Materials and Methods

Sample

The target population consisted of high school agricultural education youth from Montana, South Dakota, and Utah. Specific inclusion criteria were that students must have utilization of AET agricultural journal feature between the dates of 2018 and 2022 (N=2215).

Teacher Training

The Agricultural Safety Education Initiative was first conducted in the summer of 2017 and organized around the National Safe Tractor and Machinery Operations Program (NSTMOP) Curriculum (Pate et al., 2019). Training was offered each summer with the final offering ending in 2021. Each seminar focused training activities on a specific safety theme. The safety theme each year were:

- 2017 – tractor stability and roll-over protection
- 2018 – all-terrain/utility vehicle stability and operation for agricultural tasks
- 2019 – hitching/backing tractors and agricultural implement connections

- 2020 – power take-off guarding and safe operation
- 2021 – agricultural equipment transport on rural roadway and safe trailering practices

A combination of video conferencing and in-person training workshops were offered to school-based agriculture teachers in Montana, South Dakota, and Utah. Zoom webinar workshops were held with teachers during the COVID-19 Pandemic. A total of 11 in-person training workshops were offered to teachers. Four online Zoom webinar workshops were held with teachers during the COVID-19 Pandemic. A total of 28 teachers attended four or more workshop offerings. In-person workshops were offered to 176 unique teachers over the course of five years. The agricultural machinery safety curriculum continues to be provided via online training and video tutorials on The Agricultural Experience Tracker.

Student SAE Programming

A supervised agricultural experience safety award program was launched in 2018 with Montana, South Dakota, and Utah teachers. Each year, project leaders collected applications from students for the SAE safety awards. Awards were presented during each state FFA conferences as part of SAE recognition efforts. A total of 26 student submissions of the SAE risk assessment form were collected. A total of eight SAE Safety Awards were presented during state FFA conferences for Montana, South Dakota, and Utah.

AET Data Collection

Due to the use of pre-existing de-identified data, a certificate non-human subjects determination was submitted and approved under Utah State University Institutional Review protocol # 11426. An AET data request was submitted for de-identified student journal entries tagged under the AFNR standard Power, Structural and Technical Systems performance indicator 01.02. apply physical science and engineering principles to design, implement and improve safe and efficient mechanical systems in AFNR situations or the performance indicator 02.02 operate machinery and equipment while observing all safety precautions in AFNR settings. Journal entries were pulled by year (2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022). Student journal entries were written text-based entries. Written entries were qualitatively reviewed to identify production-based experiences. Each entry was coded by NASS commodity codes to describe type of production-based agricultural experiences.

Teachers and students were assigned a unique case identification number for data analysis. For students with multiple journal entries during the year, entries were aggregated. For example, a student who completed three journal entries in 2017-2018 was counted as one entry for analysis. The qualitative content of multiple entries was consolidated into one statement for analysis. Each entry was coded for the following variables:

- (yes/no) teacher participation in a safety training workshop;
- (yes/no) student mention safety in their journal entries;
- (yes/no) agricultural machinery (e.g. forklift, skid-steer, tractor, rake, baler);
- (yes/no) livestock (e.g. cattle/beef/calves, swine/pigs, horses, sheep/lambs; turkeys/poultry).

Journal entries coded as mentioning safety were coded with additional qualitative variables.

- (yes/no) safety basics;
- (yes/no) agricultural hazards;
- (yes/no) tractor;
- (yes/no) connecting implements;
- (yes/no) materials handling equipment

Results and Discussion

Table 1 provides a summary of the sample characteristic results from the qualitative analysis. A total of 2,215 unique student journal entries were reviewed between 2017 and 2022. The highest proportion of journal entries were represented by Utah. As a limitation, this could be a function of teacher adoption within each state. AET is not required to be used by states for student record keeping but provides a seamless integration with student's FFA degree and proficiency applications. Approximately 41% of students reporting journal entries were associated with a teacher who participated in the Agricultural Safety Education Initiative training workshops. Fewer than a quarter (20.6%) of the student entries were associated with agricultural production work experience. Agricultural machinery usage was noted in 74.3% of the journal entries. Few journal entries (3.6%, $f = 80$) directly noted safety as an aspect of their work-based experience. Of these journal entries, two-thirds (66.2%, $f = 49$) listed general agricultural safety as identified under the NSTMOP minimum core content areas (MCCA). Less than ten percent ($f = 7$) address safe tractor operation as identified under the NSTMOP MCCA.

Table 1. Characteristics of AET Student Journal Entries

	f	%
Distribution of Students by State		
Montana	742	33.5
Utah	983	44.4
South Dakota	490	22.1
Agricultural Production Work Experience		
Yes	457	20.6
No	1758	79.4
Teacher Training Participation		
Yes	905	40.9
No	1310	59.1

This translational pilot project demonstrated the value of training teachers and the capacity to transfer agriculture safety knowledge and skills to their students work-based learning reflections. More is needed to positively direct work-place safety skill development. We recognized that the use of virtual classrooms and other technology to share training materials and content could enable the project's impact to reach students across the United States. As part of the SAE safety award program, the supervised agricultural experience risk assessment tool has been shared with Iowa Department of Education: Agricultural Education Division within Career and Technical Education. Project activities have been shared with State FFA associations for Utah, Montana, and South Dakota. Currently, the National SAE for All initiative hosted by The Council for Agricultural Education has incorporated the risk assessment documents within student record keeping. These documents have been shared through teacher in-services at local, regional, and national conferences. The SAE safety curriculum materials are hosted on the USDA-NIFA funded Safety in Agriculture for Youth Clearinghouse which is publicly available through eXtension.org

As part of the High Plains Intermountain Center for Agricultural Health and Safety (HICAHS) Center, members of the project team have developed an innovative professional development program to help SBAE teachers improve youth safety knowledge and increase the safety of work environments that employ young agricultural workers. This model, shown in Figure 1., utilized social spheres of influence to promote safety improvement through individualized supervised agricultural experiences. A key component of this model is the implementation of evidence-based safety curriculum in each sphere of influence considering local needs.

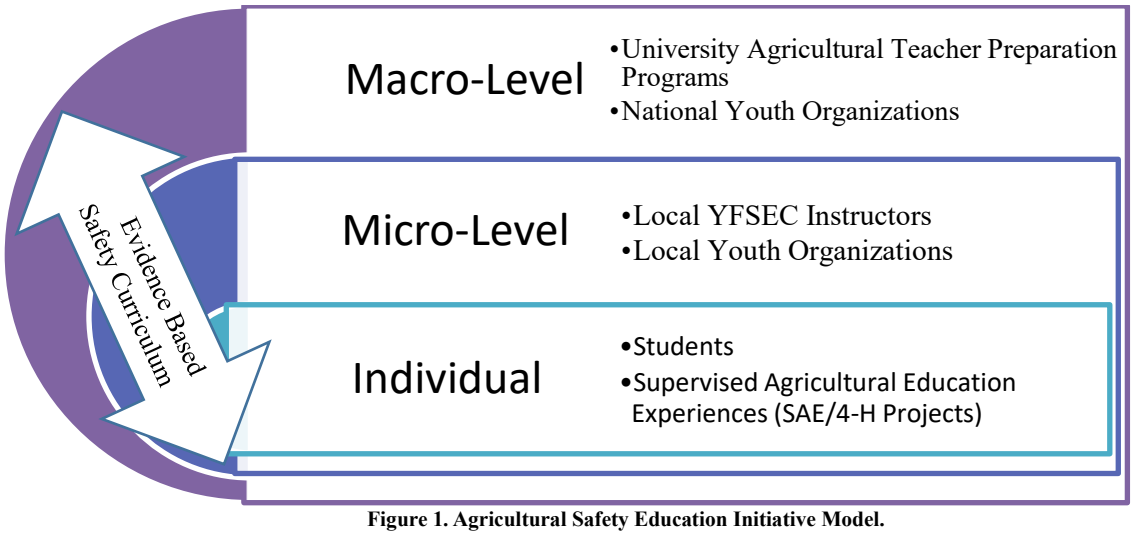

Figure 1. Agricultural Safety Education Initiative Model.

The project was delivered through the Agricultural Experience Tracker (AET) online tool to accommodate teachers' needs to deliver student training at a distance. The Agricultural Safety Education Initiative was introduced in the summer of 2017 and organized around the National Safe Tractor and Machinery Operations Program (NSTMOP) Curriculum (Pate et al., 2019). Pate et al. (2019) initially found teachers' (N = 116) average NSTMOP scores increased significantly after participation in the program ($t(109) = 11.9$, $p < 0.001$). Through preliminary data, this ongoing project has documented that instructors who continue participation in the training program over multiple years showed improvement in their tractor and machinery safety knowledge. Over 15,000 students from across the U.S. have participated in the AET online tool.

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