



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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***Distributing Best Practices for Lighting and Marking:
Translating Research Regarding Farm Equipment Signage
into Practice***

***Jenna L. Gibbs¹, Kayla Faust¹, Marsha Cheyney¹, T. Renee Anthony¹, Marizen
Ramirez^{1,2}***

***¹Department of Occupational and Environmental Health, University of Iowa, Iowa
City, IA; ²Division of Environmental Health Sciences, University of Minnesota, Twin
Cities, MN***

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ABSTRACT. While transportation related incidents account for 42% of all occupational fatalities in the US, this burden especially affects agriculture, where it accounts for over 49% of all work-related deaths. ASABE provides recommended standards for best practices regarding the lighting and marking of farm equipment. Using these standards, we created an educational display and interviewed 313 farmers at farm shows across the Midwest. Survey questions included demographics, farm vehicle use, use of lighting/markings on farm vehicles, and personal accounts of near misses that occurred while operating farm equipment on roadways. Overall, 55% of farmers reported that they already used current retroreflective materials on their equipment, and 45% reported that they were missing/did not have the current materials. The differences among farm implement types and use of current materials was significant ($p = 0.02$). Compared to other implements, tractors, trailers, and sprayers were less likely to have current materials. Most farmers reported needing retroreflective materials for their tractors. Interestingly, more than half (57%) of established/experienced farmers reported having retroreflective materials, as compared to only 40% of new/beginning farmers ($p = 0.02$). Overall, approximately a quarter of surveyed farmers (26%) shared a personal account of an incident or near-miss that occurred while operating equipment on roadways. The most common cases involved being rear-ended (37%), passed in a 'no-pass' zone (20%), and hit from the side or front (13%). All farmers received a slow moving vehicle kit (including emblem and reflective strips) for participating in the short interview.

Keywords. *Agricultural equipment; crashes; lighting; marking; outreach; roadway safety; SMV*

Background

In 2015, the Great Plains Center for Agricultural Health (GPCAH) surveillance team found that transportation remained the leading cause of fatality in the agricultural industry. Crashes involving farm equipment on public roads accounted for about a fourth of transportation-related deaths. In a five year period (2005-2010), there were over 7000 roadway crashes involving farm vehicles in 9 Midwest states, resulting in more than 160 deaths (Harland et al, 2014). This means that on average, states in the Midwest region report > 1100 farm equipment-related crashes each year. These crashes can be costly due to the damage of crucial and expensive equipment and can result in severe and fatal injuries. A GPCAH study found that increased lighting and marking on farm equipment was associated with reduced roadway crash rates (Ramirez et al, 2016). The American Society of Agricultural and Biological Engineers (ASABE) has issued standards on lighting and marking farm vehicles to promote safety among all roadway users. The standard strongly emphasizes retroreflective materials, which include 8 strips (4 yellow, 2 orange, 2 red) and a slow moving vehicle emblem (SMV) on the back of the equipment for vehicles under 35 mph. GPCAH recommends increasing lighting and marking on farm vehicles to help prevent crashes.

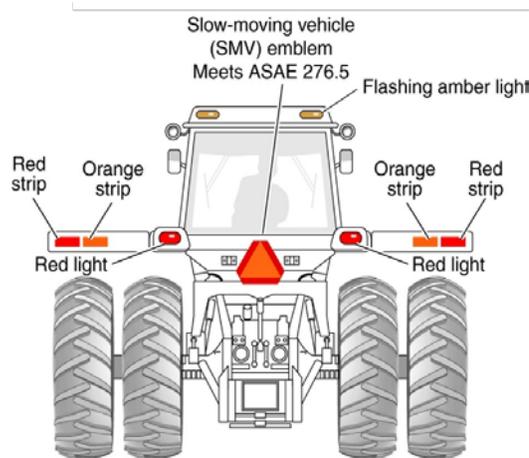


Figure 1. Proper lighting and marking of a tractor, according to ASABE standard 276.8, provided by IL Extension (2016)

Methods

In the summer of 2016, the GPCAH outreach team attended farm shows in South Dakota, Iowa, and Nebraska, and hosted a farmer-focused display with information on ASABE standard lighting and marking (Figure 1) and farm equipment roadway safety tips (Figure 2). These farm shows attracted both established, experienced farmers and new and beginning farmers. To increase awareness about lighting and marking, we worked with a local vendor to distribute “lighting and marking kits” (value: \$18-20), that included an emblem and 8 pre-cut retroreflective materials meeting current American Society of Agricultural and Biological Engineers (ASABE) standards (S.276.8). The current standard is recognized as the best practice for placing lighting and marking on farm equipment.

Farmer recipients of the kit received information on optimal lightning and marking of their implements, and in return they provided information on what implement needed the reflective materials the most, and why they used it on the roads. Farmers completed a short survey, which included questions on: a) demographics, b) occupational use of farm equipment on roadways, including the type of farm equipment frequently driven and reasons for operating equipment on roads, c) use of current retroreflective materials [yes = currently uses all retroreflective materials (including SMV and multicolored strips); no = does not use current retroreflective materials or is currently missing the emblem or strips]. All responses were self-report. We calculated summary statistics and examined factors associated with having current retroreflective materials. During these activities, we also collected real-life stories from farmers about crashes or near-miss incidents that they experienced. These stories were organized into several categories, including: rear-ended, passed in a no passing zone, hit from the side or backed into, drove under or near equipment, passed on the left while making a left turn, veered too far to the right to make room for traffic, and rolled or lost control of the implement. The number of crashes or near-miss incidents were reported by type of incident.



Figure 2. Roadway safety tips for farm equipment operators

Results

Lighting and Marking Kit Survey

We distributed retroreflective kits and surveyed 313 farmers (75% male and 25% female). Most farmers were grain and livestock producers (80 and 51%, respectively). However, production type was not mutually exclusive-- several farmers reported more than one type of production. Over half of the farmers (54%) who received kits intended to use them to update or replace damaged or faded markings currently installed on their equipment although many (46%) were missing proper marking altogether (Table 1). Most farmers stated that they were in most need of reflective kits for their tractors and grain carts (39% and 27%, respectively), although some needed them for trailers (11%) and hay-transport equipment (9%) (Figure 3; in this figure 'Other' includes ammonia tanks, mowers, skid loaders, and UTVs). Most farmers who drove farm equipment for the purposes of transporting livestock, grain, or hay reported needing the kits to update current worn materials already in their possession (51-90%). The most common self-reported reasons for driving farm implements on roadways was to transport equipment from field to field on a single farm property (31%), general equipment transport to multiple farm properties, transporting hay (11%), and transporting grain (14%). However, approximately 72% of farmers who use farm equipment as a means of farm-to-farm transport reported they were currently missing reflective materials. (Figure 4). "I live on a busy highway. At first, I didn't think these reflective materials were necessary on my tractor, because my fields are only a couple miles away," said a male grain farmer from Iowa. "However, I have had a few close calls, so now I am careful, even when traveling short distances." Another grain farmer in Iowa commented, "I have plenty of lighting and marking on my tractor, but not much on my tractor trailers. I guess I never realized that that is the first thing drivers see."

Table 1. Who received the reflective kits? (N = 313 kits disseminated)

Gender	N (%)
Male	236 (75%)
Female	77 (25%)
Reason for Kit	N (%)
Needs Replacing	166 (54%)
Never Owned/Lost	142 (46%)

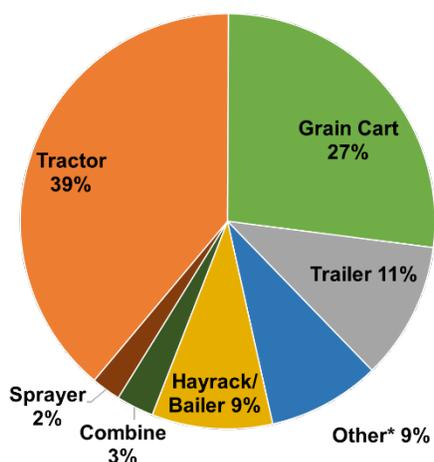


Figure 3. Where farmers plan to install new equipment marking kits to reduce crash risk.

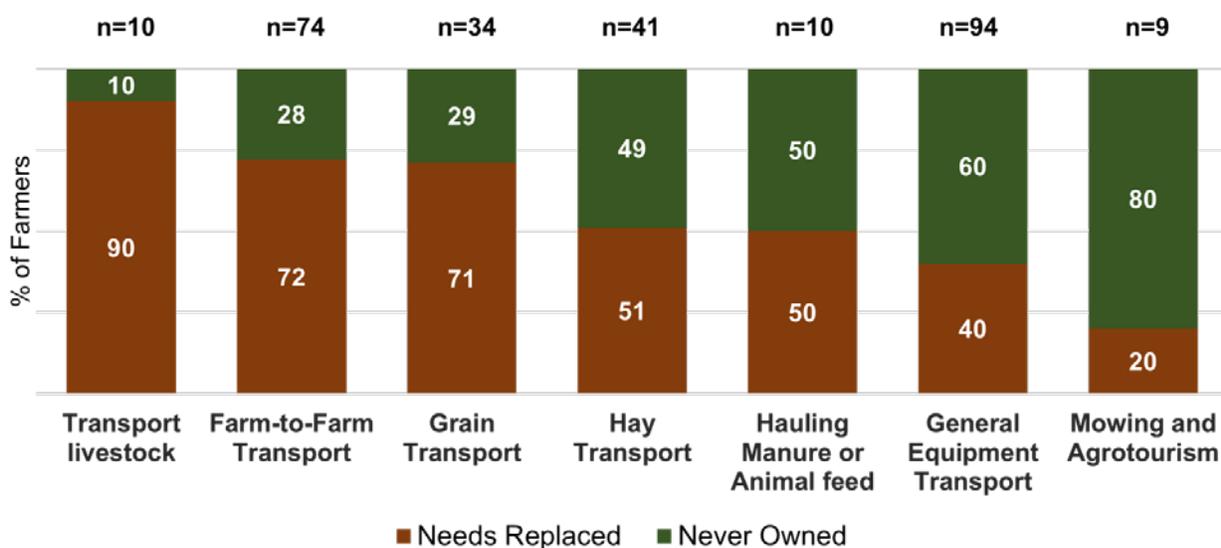
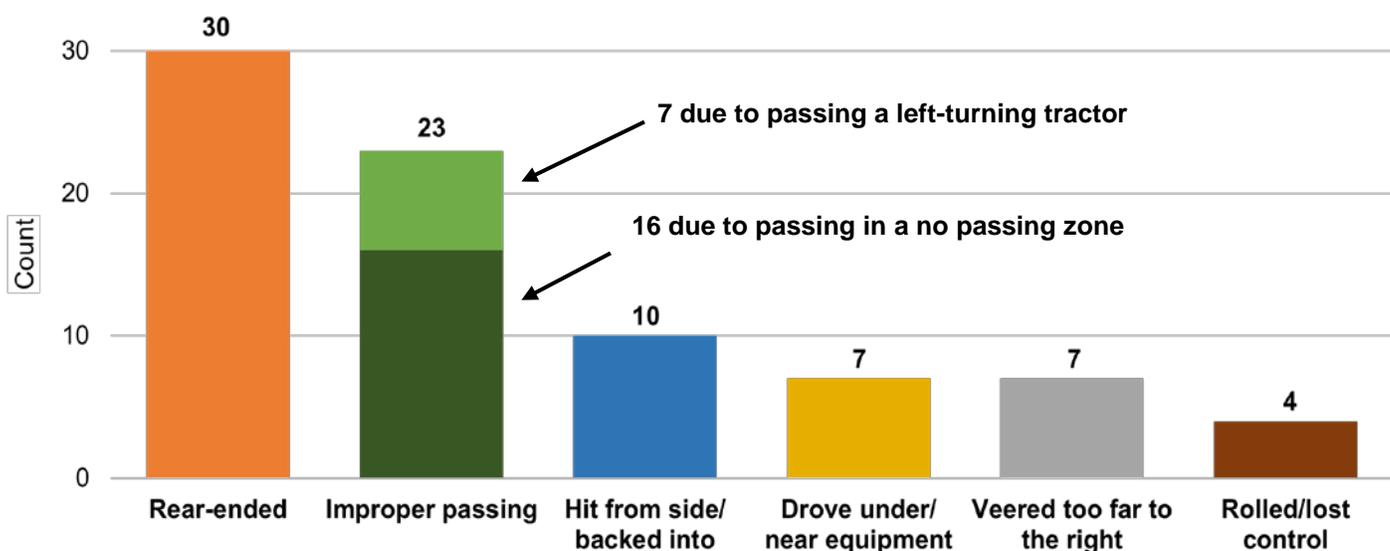


Figure 4. Reason for operating farm equipment on public roads by reason kit is needed

Near-misses and crashes

The team collected stories describing roadway incidents from 81 farmers. The majority of accounts (37%) focused on being rear-ended by motor vehicle drivers (Figure 5). Improper passing procedures such as passing in a no passing zone and attempting to pass a tractor while it makes a left-hand turn were also commonly reported causes of crashes and near misses (28%). Fifty-two (62%) of the accounts involved other motor vehicles, which were more likely to be involved in rear ended and improper passing. One farmer, from Iowa, described getting rear ended by a drowsy driver who fell asleep at the wheel. “Sometimes during harvest, we have to work late and that is one of the risks,” the farmer described. Nineteen (24%) of cases involved a semi-truck, which were more likely to be involved in 'hit from side or front' and 'veering too far right to make room for traffic'. Two of the farmers described how semi-truck drivers seemed intimidating on the roads, especially at high speeds. For example, a grain farmer from Nebraska described a near-miss with a semi-truck, stating “One time, I was turning into our driveway with a load of rye. A semi-truck came over the hill behind me, going rather fast. I turned my tractor into the ditch to get out of his way.” Only four cases involved another farm implement (5%), and these either involved 'rear-ended' or 'hit from side or front'.

Figure 5. Reported crashes and near-misses



Conclusions

This research translation project has been both effective in disseminating kits directly to farmers, and in gathering information from farmers on current lighting and marking practices, why implements are driving on roadways, and personal experiences of near-misses or crashes. Following this study, GPCAH has made the following recommendations:

1. Reflective marking education and dissemination efforts should be targeted to specific types of farmers (e.g., new/beginning farmers) and roadway activities (e.g., during spray season, when using trailers, updating older tractors).
2. Guidelines should be developed for when and how to replace worn or faded reflective materials, particularly if the equipment is more than 10 years old.
3. Continue to research factors influencing crashes and near-misses with agricultural equipment on roadways to learn more about how they can be prevented.
4. Increase safety awareness among motor vehicle and semi-truck drivers who share the roads with farmers.

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