LARGE AGRICULTURAL VEHICLES ON ROADS IN AUSTRALIA

A REPORT COMPILED BY:

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Summary of Project Findings

Agriculture is one of Australia's largest and most productive industries in Australia operating on just over half (51%) of Australia's land area [1], contributing 3% of Australia's total gross domestic product[2]. Most agricultural activities are undertaken in rural Australia, and are therefore not highly visible to the average urban dwelling Australian. One exception where the public meet agricultural activities is on public roads where agricultural production and the supply chain of agricultural produce is visible, in the form of trucks transporting animals, crops, fodder, etc as-well-as coming across agricultural vehicles such as tractors, header, cotton modules, spray rigs etc.

Agricultural vehicles are used in a wide variety of agricultural activity such as planting, seeding, cultivating, harvesting, spraying and are often moved between properties either by being driven, loaded onto other vehicles, or towed. The use of agricultural vehicles on roads is controlled by a class notice or permit system depending on jurisdiction, yet little work has assessed the actual safety risks of these vehicles on roads and appropriateness of the restrictions placed on the movement of agricultural vehicles in terms of delivering higher safety outcomes. Depending on the size of the agricultural vehicles, there are differing requirements that are mandatory in order to drive on public roads. For large agricultural vehicles (LAV) due to their size, oversized in terms of width, length, height and/or weight, and the fact they can be slow moving (self-powered LAV in particular), the road traffic authorities have created a range of strategies with the stated aim of keeping all road users safe. However, these measures impose restrictions and costs for farmers to undertake their work, particularly as equipment size and dimensions increase. It is also unclear, due to limited evidence, as to the effectiveness and need for the measures placed on the movement of agricultural vehicles in terms of delivering road safety outcomes as there is limited evidence or monitoring of road incidents involving agricultural equipment (as opposed to all heavy vehicles such as long haul trucks).

There is a need for a comprehensive program of work to ensure the safety of all road users, balanced with the needs of agriculture around the use of agricultural vehicles on public roads. This project explored the nature of interactions between agricultural vehicles and the public to understand public road incidents, the risk factors involved in public road incidents, operational experience and possible strategies to prevent incidents and promote safety.

The main findings from this research include:

- LAVs are on roads all year round, mainly during daylight hours, although different types of equipment will be present on roads depending on the agricultural activity required such as planting or harvesting.
- LAV trips are usually a short distance (Mean = 35.2km), although some are travelling over 1500km which are often agricultural contractors

- The trips of individual farmers are normally on the same route, however they occur on all types of public roads from local single lane dirt roads, to national multi-lane divided highways. This includes most operators trying to avoid busy roads by either traveling at non-busy times or using routes which minimise contact.
- There are small number of LAV related incidents nationally – approximately 56 crashes and 2 deaths per annum. In 2016 there were 1,295 road deaths, thus based on the average figures 0.15% of these deaths would have been LAV related.
- Two thirds (66.8%) of people thought there was either 'no' or 'low to moderate' risk of an increase in risk of an accident on road. A third (32.3%) of the public thought that LAVs increase the risk 'moderately' to 'highly' of there being an accident with only 2.5% thinking that it was high.
- Near misses are a powerful illustration of how to prevent future incidents, identify that driving skills, visibility and vigilance are important.

While the overall level of incidents and near misses is very low compared to cars and trucks, the industry is keen to understand what additional steps can be taken to encourage safer driving from all vehicles and ensure the message is clear about the need for "sharing the roads". As such a number of recommendations emerged from this project and include:

- From the research the participants identified that the focus for an immediate safety campaigns could be about:
    - The public understanding the characteristics of LAVs, i.e. oversized nature, slower operational speed and the safety mechanisms in place such as escort or piloting vehicles, flags and lights.
    - The public understanding what to do when you encounter a LAV, i.e. pull over to the side and allow the LAV to pass, or how to pass one safely such as allowing for adequate space.
    - The need for LAV's to be on roads and where they fit in the production of agricultural commodities.
    - Benefits of adaptive driving, i.e. driving which is responsive to the road conditions and other vehicles.
    - A general campaign to respect all road users with a focus on agricultural vehicles
    - Helping the public to understand the needs of these vehicles when on roads i.e. turning ability, visibility of other vehicles, speed and room on road.
    - We would recommend based on research that the initial campaign should:
        - Have an overall message that focuses on – "respect of all road users on roads" and "the need for LAVs to be on public roads". The target of this campaign would be all road users although it would benefit by focusing on engaging and informing motorists who are unfamiliar with agricultural machinery movements.

    - Messages should also include information about the safe interaction with LAVs ie when approaching a LAV "slow down, pull over, adapt your driving'". The target of this campaign would be rural road users.

- Adding a section in the driver licence process (i.e. in the information sent out and the written test) around LAVs would provide an ongoing mechanism for training all new drivers about what to do around LAVs. This would ensure that both general motorists as well as those who drive in the agricultural community are equally educated.
- Respect for road users of all types was identified, this included the idea for the development of a non-compulsory code of a conduct about how LAV operators should behave when on public roads and what is expected of the community. This document would be developed by the agricultural industry as a guide to safe driving on public roads and be able to educate the public about how LAV's operate on public roads.
- Further work is required in improving the underlying data and understanding of incidents involving LAVs. While this project has made steps to determine how much of an impact LAVs are having on road incidents, it is suggested the evidence could be strengthened further by exploring fatal events and having better and detailed incident data which clearly separates out agricultural vehicles (including the regular reporting of this information). We recommend the following to achieve this:
    - A study of road fatalities with a focus on rural areas and LAVs using the National Coroners Information System to explore all risk factors, quantify the number of deaths due to LAV interaction, trends over time and risk factors. This information could also be linked to other road trauma data to provide a comprehensive picture around LAV incidents and prevention options.
    - Development of clear terminology and definitions around LAVs, separate from other large / heave vehicles on roads, to then be implemented by each jurisdiction to help provide clear ongoing data around LAV incidents on public roads. This would allow for appropriate comparison with other road fatality statistics.
- Further work exploring road designs, which facilitate easy movement of LAV and also designs of LAVs which allow them to be moved (ie ease of changing height and width) easily on roads could also increase safety.
- There could be value in the industry advocating for future design of LAV to be able to be packed down to appropriate road widths to allow for movement on road, as this was articulated as the one dimension of LAV that most impinges on the safety of other road users.
- Technological advances should be further considered as an active and real-time means of communicating with the driving public about LAV presence on rural roads. These could incorporate driver awareness signs, such as those present on major highways or scanning technology similar to toll technology, or satellite navigation notification used to transmit data to real-time signs or apps.

- Encouraging transport agencies and police to report statistics specifically for agricultural vehicles to enable monitoring of statistics.

It is acknowledged that the project findings will be used to inform a communication strategy to improve road safety interactions with LAV's.

Conclusion: This study is the first in Australia to explore the safety of LAVs on public roads. LAVs are a requirement of farming and need to be on public roads as part of the business of agriculture and to ensure food and fibre productions. From the research, it is clear that different types of LAV are on roads all year round, however are predominately moving small distances during the day. While there are incidents on public roads, the numbers are small, but more work could be undertaken immediately in educating the public about how to interact with LAV on public roads. These community education campaigns could highlight the need for LAVs to be on roads and what to do when you encounter them, as-well-as a wider campaign around respecting all people on roads. Incorporating information in the written test to achieve your driver's license was identified as a cost effective ongoing way to educate new drivers.

Introduction

Agricultural is a major industry in rural Australia employing 481,000 people and producing $95 billion sales and service incomes[3]. Agricultural production requires a variety of machinery and vehicles to be used both on and off farm. Agricultural vehicles are used on public roads to support the production, collection and movement of agricultural produce. The presence of agricultural vehicles on public road, including road use to move between properties, results in interactions with the general driving public[4]. There are numerous vehicles involved in the agricultural supply chain including prime movers, rigid trucks, road trains and b-doubles and are often grouped for reporting purposes those vehicles used on farms such as tractors and spray rigs[5]. For the purposes of this paper we are interested in vehicles that are designed for agricultural work and are also moved on roads[5]. Data on these vehicles fatal work-related incidents is collated as is information about their road usage patterns allowing exposure and risk to be calculated[5,6]. However there is a lack of information about incidents involving agricultural vehicles on public raods[4].

Large agricultural vehicles (LAV) are different from other large vehicles used on public roads. LAV are used to assist in the production of agriculture goods incorporating activities such as planting, cultivating/harvesting or for application of fertilisers. These vehicles are typically fit-to-purpose and are either driven, if self-powered, loaded onto another vehicle or towed to their destination [7]. The size of these vehicles is another differentiator, as these vehicles due to their fit-to-purpose nature are often oversized in terms of width, length, height and/or weight. While it is not uncommon for other supply chain vehicles to be long they do not typically exceed the other dimensional qualities, which LAV do. Another differentiator is that LAV can be slow moving (self-powered LAV in particular) which when combined with being oversized has created a potential hazard on roads in Australia[4]. This hazard is mitigated by the low speed of travel, low frequency of use on roads, roads accessed are largely restricted to local locations, extensive signage and lighting located on the vehicles, and often pilot vehicles, to increase their visibility and communicating with approaching motorists.

There is limited evidence to suggest that the presence of these vehicles on public roads results in an increase in risk (Table 1). However, it is noted that there are challenges in determining the relative risk, particularly relating to calculations around exposure and what makes an appropriate denominator for calculating rates. Further work is required to establish a denominator that can be used to compare on-road use of LAVs with heavy vehicles and other road users.

This project aimed to explore the nature of interactions between agricultural vehicles and the public to understand public road incidents, the risk factors involved in public road incidents, operational experience and possible strategies to prevent incidents and promote safety. This information will be used to promote awareness raising efforts including educational campaigns to support the sharing of rural roads.

There is evidence that the rate of road traffic fatalities increases with rurality [8,9] and is an issue for agriculture road transport and rural work health and safety generally[10,11] (Table 1). With more people travelling in rural Australia[12], there is a need for rural road users to recognize hazards and adapt driving styles to avoid road traffic incidents. Currently there is a lack of information about LAV operator experiences driving these vehicles on the roads, including the challenges in movement and in interacting with the general driving public. Correspondingly, there is also an absence of information from the community perspective about their awareness of LAVs being present on roads, rates of exposure, and interaction experiences. This project aims to remedy this dearth of information, to update our current knowledge about LAV interaction experiences, and to use this to improve rural road safety.

Table 1. Road Transport Fatalities and Injuries by Vehicle Type and Rurality of Occurrence

Vehicle Type	**Overall Road Crashes** [13]				**Heavy Vehicles** * [6]		**LAV on road** [4,14]		
Crash Incident by Rurality for Fatalities and Injuries	Urban Fatalities	Rural and Remote Fatalities #	Urban Hospitalised Injuries	Rural and Remote Hospitalised Injuries #	Urban Fatalities	Rural and Remote Fatalities #	Crash Incident Number	Fatalities	Hospitalised Injuries
Time Frame	2008-2015		2008-2014		2008-2015		Data varies by State or Territory – Range: 2005-2016		2010-2015
N (%)	6502 (68.6)	2968 (31.3)	200,746 (85.4)	34,218 (14.6)	965 (64.9)	522 (35.1)	677	24	48
Number per annum	813	371	28,678	4,888	121	65	56	2	8
Crude Rate per 100,000 Australian population per annum [a]	3.46 road crash fatalities	1.58 road crash fatalities	122.16 hospitalised crash injuries	20.82 hospitalised crash injuries	0.52 crash fatalities	0.28 crash fatalities	0.24 crash numbers	0.009 crash fatalities	0.034 hospitalised crash injuries

* There were 3,255,534 heavy rigid and articulated truck registrations between 2008-2015. # Rural and remote includes: Outer Regional, Remote and Very Remote Categories. [a] The crude rate was calculated bases on the estimated resident population of Australia as at June 2014 which was 23,475,686 and the average number of deaths/hospitalisations per annum.[15] 2014 was selected as the denominator for the crude calculations as all data incorporates the time frame of 2014.

Methodology

A triangulation methodology was used to obtain data, to explore convergence and validation of issues pertaining to LAV interaction experiences on rural public roads. Three methodical approaches were used to gather information for this project. These include a literature review, a survey of LAV operators, and community members about interaction experiences and focus groups with operators. A brief overview of the approaches on data collection for each methodological phase, are briefly outlined. For more in depth discussion on methodology readers are referred to the journal article manuscripts.

A few definitions of the terms that will appear throughout:

> ***Large agricultural vehicle:*** *vehicles used directly in agricultural activities, which are oversized in terms of their height, width, length and/or weight. While the actual size may differ depending on the commodity group and production activity in question, generally they are larger than a typical car. The large agricultural vehicle can be driven or towed in combination on public roads. Some examples include sprayers, harvesters, tractors, seeders, chaser bins and tillers. Notable exceptions include utility vehicles, quad or ATV bikes and road trains.*
>
> ***Near miss:*** *refers to events were the potential for a crash to occur was present but due to mitigating factors (human or otherwise), the potential crash was avoided. Note this information is self-reported.*
>
> ***Crash:*** *refers to events where there has been property, vehicle or personal damage due to an interaction involving a large agricultural vehicle on a public road, including where the agricultural vehicle was not at fault. The resulting property damage or physical injuries may be minor or substantial but need not have been reported to police or insurance companies. Note that the word accident is not used, and this is in alignment with the stance taken amongst the wider injury prevention and safety community, that the term 'accident' implies a lack of control over the situation. As such crash will be the term used throughout.*
>
> ***Public road****: any road that is located outside of properties and is maintained by council or government.*

Literature Review

The purpose of the literature review was to explore any existing evidence relating to the use of LAV on public roads including exposure rates, motor vehicle incidents involving LAV, risk factors and proposed or evidence-based risk minimization and prevention strategies.

Literature review methods:

The databases searched included: Agricola, Scopus, Web of Science, Medline, PsycINFO, ScienceDirect, Web of Science, and Google Scholar searches. Keywords included within search: machinery, agriculture, road accident, road incident, crash, road safety, collision, injury, farm equipment, roadways, drivers, risk, and prevention.

To be included in the review, the articles had to focus on LAV use on public roads and there was data pertaining to road crash incidents. A PRISMA approach to article screening was used[16]. A critical appraisal of each article was undertaken using McMasters guidelines for quantitative studies[17]. A thematic analysis of the article was undertaken to provide information on the size of the problem, risk factors and prevention strategies.

Online survey

The online surveys were conducted using SurveyGizmo ™, an electronic on-line survey tool. The LAV operator survey was targeted towards farmers, farm managers and agricultural contractors. Questions focused broadly on type, frequency and duration of agricultural vehicle movements on public roads, exploration of attitudes and issues relating to vehicle movement, including the risks and possible prevention strategies. The community member survey asked questions pertaining to their experiences of traveling on rural roads and interactions with LAVs. The project reference group provided feedback on the questions, with their suggested modifications being incorporated prior to the surveys being released. The surveys were both open for one month for the period – 22nd March to 23rd April 2018.

Recruitment

Advertising of the operator survey occurred via industry mechanisms including newsletters, media and websites. A media release was generated to foster community participation with some media outlets including newspapers, and newsletter picking up the story via this mechanism. Additionally assistance was sought from various Australian automobile associations and caravanning clubs, for them to communicate about the community survey to their members. The links to both surveys were also widely communicated using social media platforms.

Participants

A total of 312 and 239 participants completed the operator and community surveys respectively. The project was aiming for a minimum of 200 participants to give it enough power to undertake analysis, this number was reach, however future studies should consider reaching a statistically significant number at a commodity and state level for the operator survey and at a state level for the community survey.

Analysis

The survey data was analysed in Statistical Package for the Social Sciences (SPSS ™, Version 22) using a range of statistics techniques including Chi Squared for categorical data and ANOVA for continuous variables[18]. Statistical precision was set at $p < 0.05$ for all statistical analysis.

Focus Groups

A total of six focus groups were run between February and April 2018. The sessions were held in the following locations and in the following order: Canberra, Dubbo, Mackay, Adelaide, Goondiwindi and Melbourne.

Associate Professor Richard Franklin facilitated the focus groups, with these sessions being recorded and transcribed. The transcribed documents were then thematically analyzed using NVivo ™[19].

Recruitment

Focus group recruitment was undertaken by the National Farmers Federation (NFF) with help of their members and by the project reference group for key agricultural industry areas. Normally for focus groups you would continue until saturation (ie no new concepts come out of the new focus group), for this study however we tried to ensure a mix of agricultural commodity groups and also geographical locations. Saturation was reached with the last focus group not raising any new concepts.

Participants

A total of 101 participants attended a focus group sessions, with a minimum attendance of six and maximum of 37 attending the sessions. The focus group sessions typically went for an hour to ninety minutes.

Ethics

Ethics approval to undertake the focus groups and online surveys was obtained from the James Cook University Human Research Ethics Committee (Approval Number H7284).

Results and Discussion

In total 654 people participated in this study, although it is acknowledged that potentially there could be some overlap between the focus group participants also completing the operator survey (Table 2).

Table 2. Methodology Overview for Project

Methodology Overview			
		Survey	
Literature Review	**Focus Groups**	**Operator**	**Community**
Number of Reviewed Papers: 138	Number of Sessions: 6	Number of Participants: 312	Number of Participants: 241
Number of Papers Included in Final Review: 30	Total Participants Numbers: 101	Full Completions: 302	Full Completions: 239
Number of Australian Studies: 0	Average Duration of Session: 94 minutes	Male: 284	Male: 203
Number of American studies: 24	Average Number of Participants: 16	Female: 18	Female: 30

Survey Participant Overview

There were a total of 541 participants who fully completed the online surveys, 302 for the operator survey and 239 for the community survey. The demographic description of each is outlined (Table 2), with that majority of the participants being male and aged 45 years and older (Table 3). For the operator survey 78.2% were farm owners, in the 'other' category regarding their role in agricultural community included a business owner, agricultural machinery dealer, share farmer (not owner) and business manager. Grain was the most common commodity (88.1%), 'other' commodity groups represented included grapes (n=2), wool (n=2), peanuts (n=2), poppy/hemp, seed and fodder, agricultural contractors, contract sowing (all others n=1 unless noted).

Exposure

A number of questions were asked to determine how often LAV are driven on public roads. Table 4 provides a summary of the results. LAVs vehicles are commonly used during day light hours, at all times of the year (Figure 1). It is noted that there is some differentiation between the types of vehicles commonly present on roads and the time of year, noting this figure does not include the respondents who indicated they drive all year round (84.1%, 4% and 85% of those who operate tractors, grain harvesters and air seeders respectively) (Figure 2). The operators have on average 28 years of driving experience and the vehicles are typically been driven only short distances (Mean = 35.2km) (Table 4). The most common LAV driven on roads was tractors (n=295, 94.6%) followed by grain harvester vehicles (n=253, 81.1%) and air seeders (n=246, 78.8%). Majority of the roads used by LAVs are located in rural locations (Table 4).

Community members articulated that they had an interaction with a LAV during daylight hours (71.2% occurring between 6am and 3pm) and they expected to encounter them during daylight (Figure 3). The time of season that they would expect and actually had encountered a LAV, was also insightful in that they

were expected all year round (Figure 4). Community members were then asked to articulate how often they had encountered LAV whilst driving in the last 12 months. From this question it was determined that LAV interactions for an individual were moderately infrequent. These encounters are categorized based on the participant estimates as being: quite rare (less than four encounters) 20%, infrequent (between four to twenty encounters) 56.4% and only a smaller proportion had frequent encounters (greater than 20 encounters in the past year) 23.6%. The location of their most recent encounter were predominately on two lane bitumen roads with (34.5%) and without markings (24.1%).

Likewise during the focus group sessions when asked to indicate their use of LAV on roads, there was great variability in their on-road usage, particularly amongst contractors who often travelled large distances.

"…we recently move 5 headers 800 km…"[Goondiwindi Focus Group].

Interestingly the contractors who are travelling these vast distances often put them onto truck or opt to tow the other bits such as combs rather than drive them. They also noted the focus groups that the route was often the same each time.

"…We've never changed the route, we've always gone the same way…" [Mackay Focus Group]

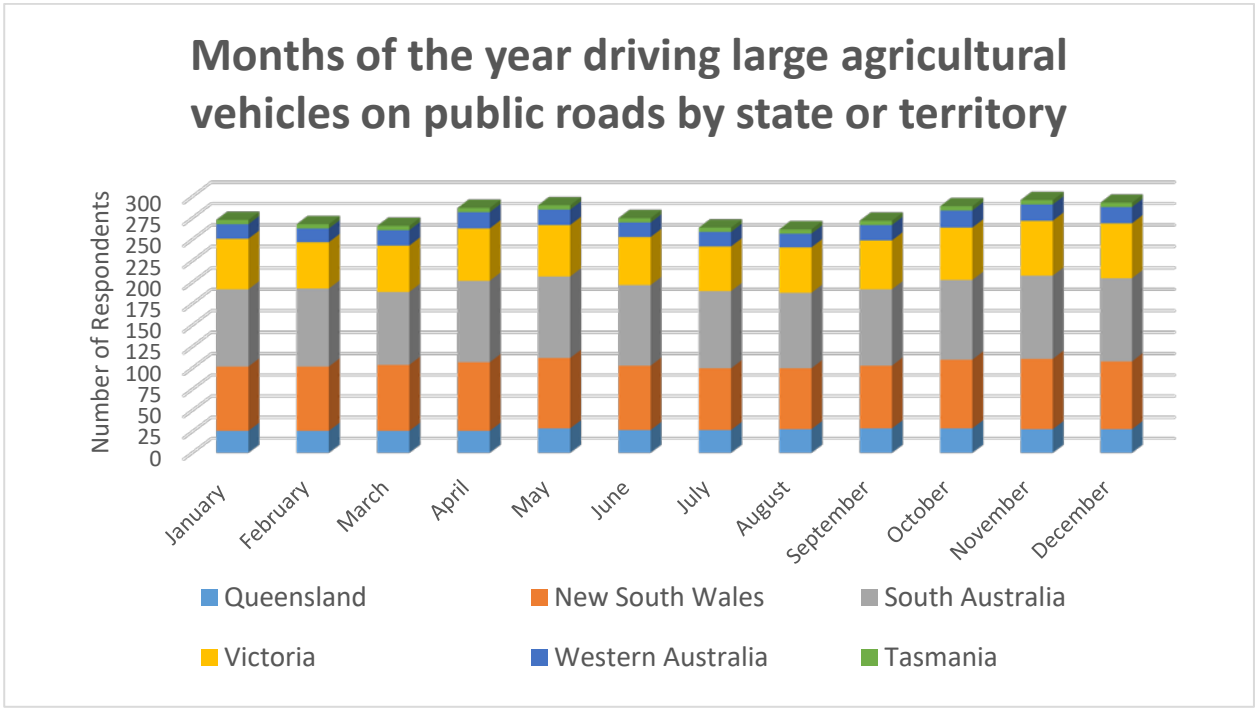

Figure 1. Time of the year LAV driven on public roads by State or Territory of Residence

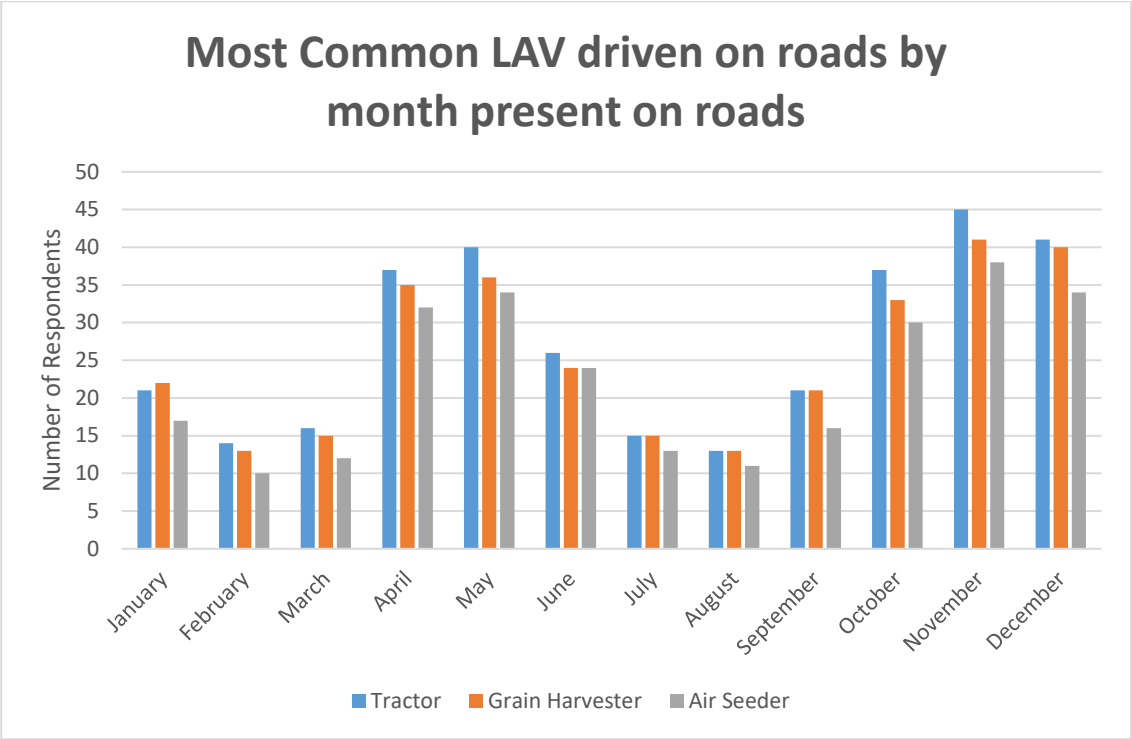

Figure 2. Time of the year LAV driven on public roads for the top three most commonly driven LAV

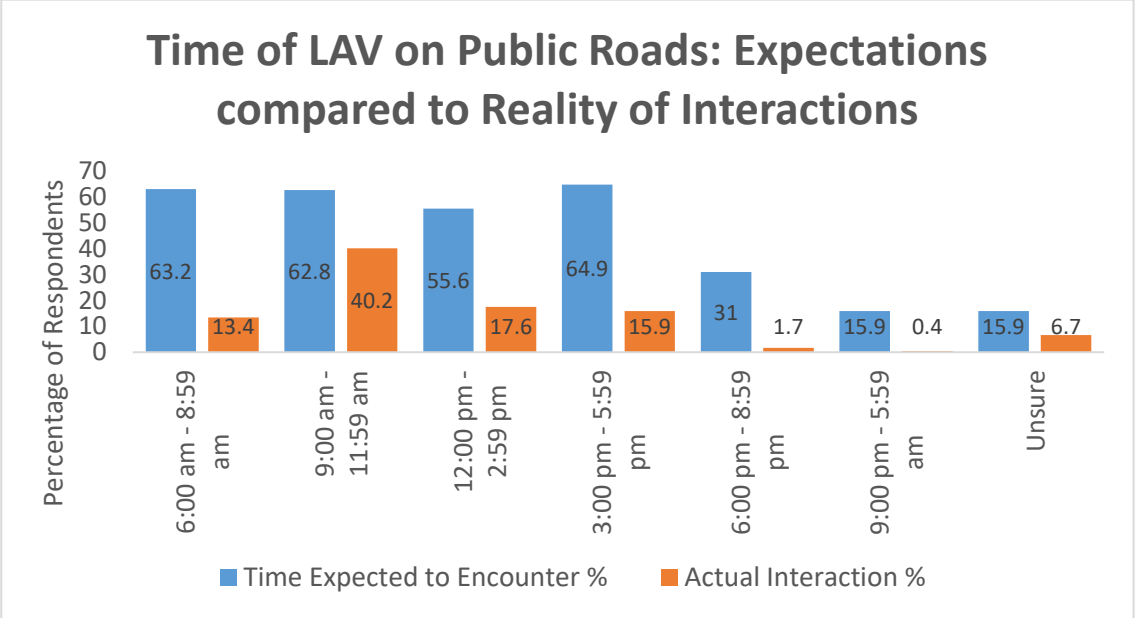

Figure 3. Time of Day LAV expected on roads and community experienced interaction with LAV

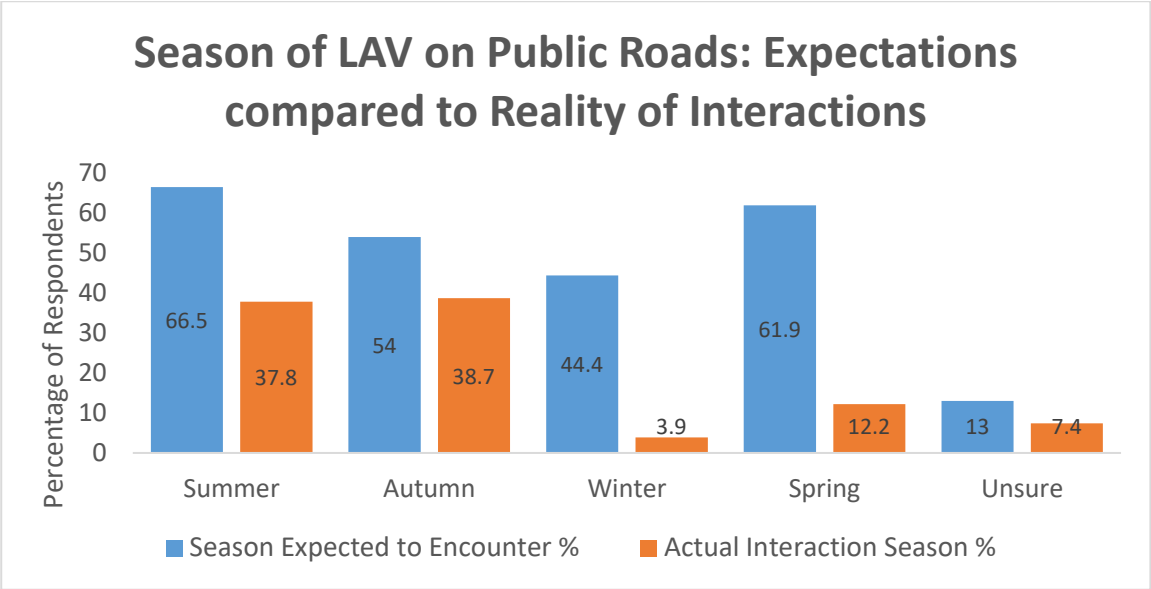

Figure 4. Season of year LAV expected on roads and experienced

Interactions

In the academic literature, human factors were identified to influence the potential for negative road interactions between LAV and the general driving public, these included failure to reduce speed, lack of attention on roads and level of driving experience.

Behaviours observed of non-agricultural vehicle drivers not conducive to safe driving / road interactions, as identified by LAV operators as increasing the risk of an accident or near-miss included: not concentrating (n=221, 70.8%), overtaking (n=202, 64.7), not being sure on how to interact with a LAV (n=197, 63.1%), and speeding (n=147, 47.1%). 'Other' responses included not being courteous or respectful (n=5) or that they are not local drivers (n=1). The behaviours that LAV operators commonly perceive that other drivers should do when they encounter a LAV are to: slow down (n=271, 86.9%), only over take when safe to do so (n=253, 81.1%), give the LAV space when following behind (n=162, 51.9%) and give adequate space when overtaking (n=160, 51.3%). These responses, although pre-defined, illustrate that LAV operators do perceive that other road users do take appropriate actions to make the encounter safe.

The most common actions that drivers noted they undertake when they encounter a LAV on roads is to slow down (n=191, 79.9%), only overtake when safe to do so (n=176, 73.6%) and ensuring there is adequate provision of space when overtaking (n=145, 60.7) (Figure 5). There was also one 'other' option, the use of UHF radio, that was identified as an action taken to ensure the safety of all on roads, this was also identified in the focus groups with discussion that using IHF radios allowed for both parties to be aware of their presence and adjust their driving appropriately. It is noted that the listed actions represent the common principles of safe and courtesy driving behaviour and are not specific to LAV with the exception of the hand signals option.

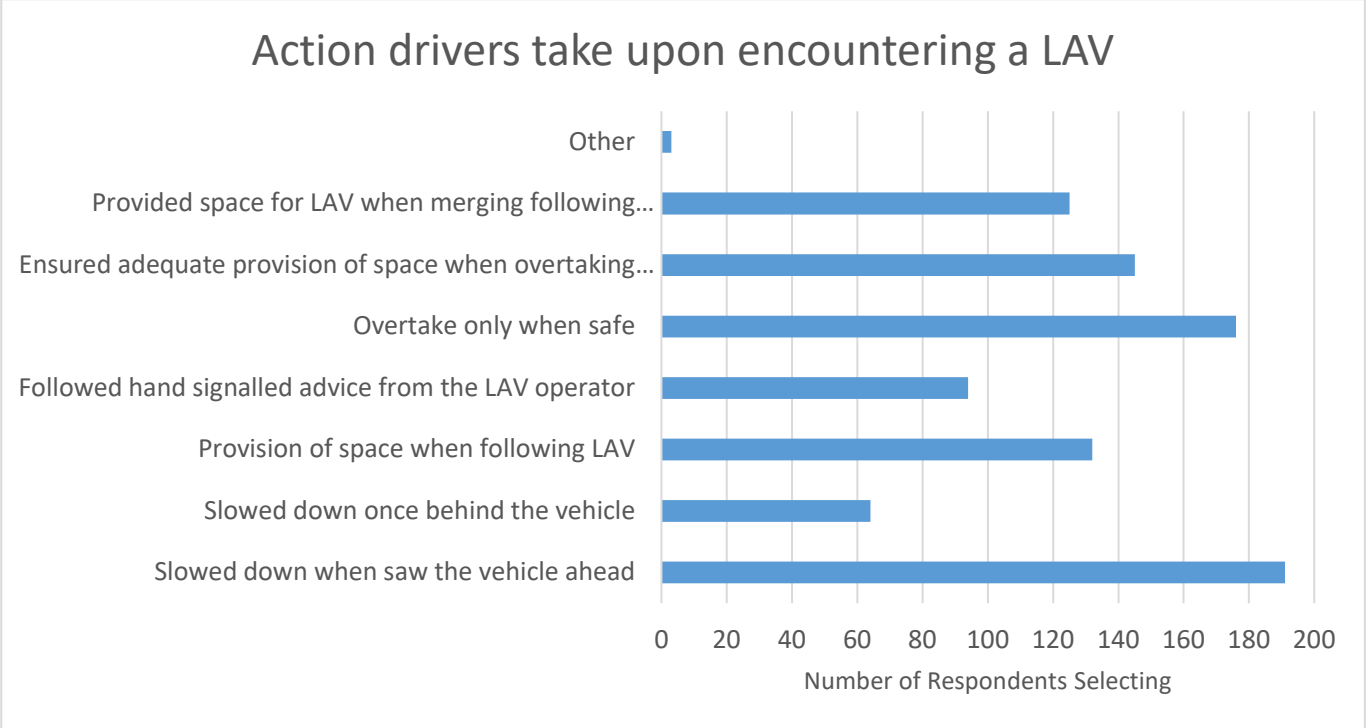

Figure 5. Actions non-agricultural vehicle drivers taken when encounter a LAV on a public road

Participants were also asked to articulate what actions or communication tools the LAV operator used during their most recent interaction, with 13 options and one 'other'. The most common actions stated of the pre formulated options were: flashing lights were in use on the vehicle (n=179, 74.9%), signs located on the vehicle indicating it was oversized (n=159, 66.5%), guidance vehicles situated in front of the vehicle (n=107, 44.8%), pulled over (n=101, 42.3%) and waved people around (n=96, 40.2%). The 'other' category included use of UHF radio (n=8), made room for person when safe to do so (n=2), the operator was aware of other road users (n=2), and operator couldn't pull over due to impinging road conditions (n=1). The requirements to have these communication tools such as light, signs, guidance vehicles vary depending on size and location where the vehicle are being moved.

The topic of 'respect' was brought up a number of times during the focus group sessions and relates clearly to interaction experiences. Two good illustrations of the context of these comments can be found in the following quotes from two focus group attendees:

> *"The other thing I think is - you know, it's been raised elsewhere, is this issue just about having some patience. That if you are sitting behind a vehicle, they're going to try and pull over where they can. We're not going to sit there for hours with you sitting behind them type of thing. So a little bit of respect seems to be an important aspect of thinking about other people on the road. It's not just about you and what you need to do. Certainly the issue has been raised about it just needs to be done. We produce food; if you want food, if you want to eat, it's got to be done. So there seems to be some issues around that." [Goondiwindi Focus Group]*

> *"One of the things that we have talked about previously is not a regulatory process, but a code of conduct, which I think most people are following, that we are respectful of other people on the road. Where possible, we'll pull over, but you've got to be aware that that can be sometimes difficult….So we're very generally saying, well, this is what we're doing, and we're asking you just to respect that we're there as part of it." [Melbourne Focus Group]*

Another issue that emerged as a point of discussion regarding the capacity to manoeuvre out of the way is road design and the changing dimensions of the LAV, which are clearly articulated to be outside of the scope of the farmers' control. In terms of road design one quote that emerged is the following:

> *"One of the issues, talking about getting off the roads, that is a huge issue because of the way all the roads have all been designed now that a lot that you use to take off the sides of the roads and the first things you do is tip it over. I think we need to be increasing the road construction." [Canberra Focus Group]*

Table 3. Demographic Description of Operator and Community Survey Participants

Demographic Descriptors	Operator Survey		Community Survey	
	N	%	N	%
Gender				
Male	284	91.0	203	84.9
Female	18	5.8	30	12.6
State or Territory				
Queensland	30	9.6	83	34.7
NSW + ACT	85	27.2	42	17.6
South Australia	98	31.4	46	19.2
Victoria & Tasmania	70	22.4	47	19.7
Western Australia + NT	19	6.1	9	3.7
Age				
18-24	12	3.8	5	2.1
25-34	41	13.1	18	7.5
35-44	78	25	25	10.5
45-54	65	20.8	29	12.1
55-64	76	24.4	50	20.9
65-74	27	8.7	88	36.8
75+	3	1	16	6.7
Enterprise				
Small	64	20.5	N/A	
Medium	231	74		
Large	9	2.9		
Role in Ag. Community				
Farm owner	244	78.2		
Farm manager	83	26.6		
Contractor	70	22.4	N/A	
Farm employee	21	6.7		
Family member of farmer	53	17		
Other	4	1.3		
Commodity				
Cotton	33	10.6		
Sugar	8	2.6		
Dairy	9	2.9		
Grain	275	88.1	N/A	
Livestock	176	56.4		
Horticulture	13	4.2		
Fruit trees	2	0.6		
Hay & Fodder	12	3.8		
Other	10	3.2		
License types				
Car	171	54.8	164	68.6
Light rigid vehicle	67	21.5	43	18.0
Medium rigid vehicle	72	23.1	44	18.4
Heavy rigid vehicle	103	33	60	25.1
Heavy combo.	127	40.7	51	21.3
Multi. Combo	103	33	22	9.2
Motorcycle	115	36.9	74	31
Marine	116	37.2	68	28.5
Do not currently hold a license	9	2.9	5	2.1
Other*	12	3.8	10	4.2

* The 'other' category were defined for licenses held included aircrafts (n=2), permit for heavy weight vehicles (n=2), forklift (n=2) and tractors (n=1).

Table 4. LAV Driving Characteristics

LAV Driving Characteristics	Mean (SD)	Median
Number of licenses held	3.0 (2.0)	3
Average distance travelled (km)	35.2 (80.0)	15
Maximum distance travelled (km)	1733 (362.8)	50
Number of years driving	28.0 (13.2)	27
How many trips on busy days	3.2 (4.6)	2
Number of days during busy periods, where need to move LAV on roads	73.9 (139.1)	45
	N	%
Time of day preferred driving:		
6:00am – 8:59am	54	17.3
9:00am – 11:59am	66	21.2
12:00pm – 2:59pm	57	18.3
3:00pm – 5:59pm	58	18.6
6:00pm – 8:59pm	21	6.7
9:00pm – 5:59am	1	0.3
Road types driven on with large agricultural vehicles	N	%
Highway	149	47.8
Two lane bitumen with markings	188	60.3
Two lane bitumen without markings	173	55.4
Single lane bitumen road	199	63.8
Dirt road	289	92.6
Private property road	243	77.9
Unsure	-	-
Other:	4	1.3

Incidents

The literature retrieved suggests that crash incidents are uncommon although this does not include deaths data from Australia. The grey literature suggests that there are on average 83 crashes and 3.5 deaths per annum (677 crashes and 24 fatalities covering data between 2005-2016)[4] (Table 1), however better analysis and root cause analysis of these incidents is recommended. As reflected in the table, there is limited detail, which enables a more considered review of LAV on-road fatalities and injuries sustained, in comparison to the existing data which separates out heavy trucks (which often incorporates LAVs) and motorbikes. There is also the potential that these figures are not reflecting all LAV on-road incidents as it might not include cases were the LAV is being towed or where the LAV was the cause but not involved in the incident (e.g. a car swerves and crashes due to the presence of the LAV). Road agencies have the capacity to pull LAV cases out and this might be something that the NHVR might recommend, allowing confidentiality of data in the event of small numbers. However we would recommend a further study to validate these numbers using the National Coroners Information System, this would allow for route cause analysis of the incidents, detailed information about vehicle type and location, recommendation for data improvement via the coronial system and further analysis based on risk factors. We would also recommend an ongoing program of work exploring LAV incidents on roads.

A total of seven LAV operators outlined in the operator survey they had been in an LAV crash incident in the last three years. Of note is that four of these involved cars and the remainder included an incident involving a truck, caravan, cyclist and another agricultural vehicle. The medical outcomes from these incidents are reported to be minimal and included no medical treatment being required (n=4), one ambulance attendance, another requiring hospitalization and one who preferred not to state. The main attributions for the incident were noted to be human factors including the behaviour of other road users (n=5, 1.6%) and road design (n=4, 1.3%).

For the community members the number of incidents involving LAV was also reported to be low (n=4), the need for medical treatment mirrors the operators with no medical attention required (n=2), one ambulance attendance and one hospitalization. Human factors was found to be an issue (n=1), road design (n=1) and one respondent used the 'other' option to indicate that fatigue was an issue resulting in the incident. In terms of avoiding the incident, the following were noted to be potential avoidance mechanisms (from the listed) – LAV operator could have been more aware of the presence of other road users (n=1), utilized vehicle lights and signals to better communication with other vehicles (n=1), and been more careful driving around a blind corner (n=1).

The focus group participants also articulated that their involvement in road incidents whilst operating LAV was low. An example of those that had sustained a crash

> "…*I had an incident years ago when I was just driving a tractor with … around, next thing I hear this commotion behind me, look back and it's … the car was virtually sideways, just about to be up against the slasher*…" *[Mackay Focus Group]*

Near Misses

The literature obtained from the review process did not discuss near miss experiences which is not unexpected given this is a novel way of exploring incidents given their non-existence. Exploring perceptions of perceived factors or actual actions undertaken that stopped an incident from occurring might provide insight into how to prevent future incidents. By asking them to reflect on their experiences, but disrupting this process by taking an unexpected perspective, can yield non-standard responses. Given the number of responses obtained when the surveys asked about near miss events, it would appear the general public know what is meant by this term (with a little bit of prompting in the form of a definition) and are able to identify the factors taken by themselves or others to prevent an incident.

About a third of the LAV operator survey participants (n= 117, 37.5%) indicated they had experienced a near miss event whilst driving a LAV in the last three years. With an average number of near miss experiences being listed as 4.1 (SD=7.3). Similar to the incidents, the most common other type of vehicle involved in a near miss were cars or other light vehicle (n = 94, 30.1%), caravan (n=15, 4.8%) or truck (n=15,

4.8%). The salience of caravans and trucks as a risk factor relative to the more common car highlights that while it was perceived that caravans were commonly involved in near misses this is not the case. The three most common articulated factors that influenced the near miss event not becoming an incident were the driving skills of road users (n=46, 24.4%), visibility of LAV (n=49, 15.7%) and vigilance in LAV operators (n=38, 12.2%). When members of the general driving public were asked the same question about their near miss experiences with LAV only 13.4% (n=32) indicated they had almost experienced an incident personally. This again highlight the due diligence by operators to ensure all people on roads are safe when they are moving LAVs.

> *"P35:Just getting back to the frustration side of things. I have always said you can't go in a caravan or a tractor or something that is going slow and they can't get off [road] … You should where practical pull off and let those people go around. It would avoid a lot of frustration …P36 It would certainly go well in the code of conduct." [Canberra Focus Group]*

Of the 32 community survey participants (13.4%) who indicated they had experienced a near miss with a LAV. The factors that influenced it being a near miss event and not a crash were: vigilance in road users such that they were aware and monitoring the behaviour of other road users (n=145, 60.7%), driving skills of road users (n=139, 58.2%) and presence of road shoulders enabling the LAV to be maneuvered off the road (n=98, 41%).

The focus group discussion regarding near misses was illustrative of the value of attention amongst the driving public, LAV and other. It was clear that near misses are something that are encountered amongst LAV users although the frequency of these cannot accurately be attested to, see the following quote:

> *"I think we're talking about deaths and stuff, what we'll never be able to capture is the near misses. I've got guys who come home every night and say oh I nearly had an accident, so it's all these nearly had an accidents where either the driver of the harvester or the truck has been able to pull up or swerve or the car serve, something's had to give that's the issue. So a death hasn't occurred, it's not going to be reported but there's still an issue and I think that's probably one of the bigger challenges that we'll never be able to capture." [Adelaide Focus Group]*

Challenges

The LAV operators indicate that width is the dimensional characteristic, which is perceived to contribute to accident occurrence (n=118, 37.8%). Some challenges noted that are specific to driving LAV were the absence of road shoulders (N=196, 62.8%), width of vehicles (n=191, 61.2%) and interacting with other road users (n=173, 55.4%).

Community members indicated that the main factors they perceive increase the risk from LAV travelling on roads, were due to road and lane widths, not providing adequate provisions for these vehicles (n=131, 54.8%), size of the LAV (n=113, 47.3), and maximum speed is slower than other road users (n=102, 52.7%). Community respondents didn't perceive that LAV presence on roads leads to increased risk for other road users (Figure 6).

Challenges that emerged from the focus group sessions included width, speed, road design, and height of vehicles.

> *"…We're hearing a lot about the challenges with the roads, the design of the roads, and the change of the roads. So this banking of roads is not unique again to hear, all the way from Victoria up through here, they've banked all of the roads because of flooding-related issues. …" [Mackay Focus Group]*

Prevention Approaches

The academic literature had a few suggestions for ways to prevent road incidents and these included educating members of the public, raising awareness and the need for specific licensing and training requirements for LAV operators.

The main ways that LAV operators indicated that safe interactions between LAV and other vehicles could occur is via mixed methods (i.e. selected all of the above) (n=142, 45.5%), which included items such as community service announcements on radios, car navigation alert systems, escort/pilot vehicle requirements, and adaptive driving practices. For those that selected responses, the two most common responses were including information on how to safely interact on driver's license tests (n=213, 68.3%), and using roads signs to communicate about the presence of LAV (n=126, 40.4%).

Similarly, the community members indicated the top three ways to enhance the safety of all road users when LAVs are present on roads. These include information on how to safely interact with LAV on driver's license tests (n=148, 61.9%), capacity of drivers to use adaptive driving practices (n=140, 58.6%) and communicating about the potential presence of LAV on roads (n=133, 55.6%). The ways to communicate about their presence are noted to include: road signs (n=180, 75.3%), local radio broadcasts (n=65, 27.2%) and television advertisements (n=55, 23%).

Educating members of the public, raising awareness and the need for specific licensing and training requirements for LAV operators was also reflected in the focus groups.

> *"There is - if you look in the Queensland - I've bought the book last year. If you go to get your license there's only a short little paragraph in there that says what to do when you approach an oversize sign. It doesn't say how wide, it just says slow down and obey the*

escorts - whatever they're doing, hand rules or whatever. There's nothing in there to say what to do when you approach two or what to do when you approach police. There's simply only one. It's just shows a sign, oversize load ahead, and what to do when approach, it says slow down. So we need to have a lot more in there." [Goondiwindi Focus Group]

"Yeah, well we need to - perhaps the people getting their driver's license, young people need to be addressed to what do they do when they come to a wide load. I don't think there's anything there when they go for their written test or whatever it is to get their driver's license. I don't think there's anything there about wide loads. Male: think there is something about wide loads. Male: don't know, I haven't been for my license for a long time. Male: there's six lines in the paragraph. Male: there. Male: Page 72… " [Goondiwindi Focus Group]

Targeting of Communication Campaign

The LAV operators indicated that a campaign, which aims to target all road users, would have value (n=81, 26%) but of those who specified the two key audiences would by young drivers (n=71, 22.8%) and visitors (n=86, 27.6%). They also believed that the messages should incorporate a discussion regarding adaptive driving approaches that should be used by road users and ways to safely overtake the vehicle.

There were a lot of good ideas on how to communicate with people ranging from using location services to target via social media, i.e. you have entered an agricultural zone where slow large moving vehicles are present on roads, or incorporating in GPS systems in cars. It has been suggested there is no point in doing anything generic as indicated by this quote:

"Probably the key is work out when and where the incidents occur…[sic] target your campaigns and see if they cut through. There's no point doing something generic, you know, probably going to be - be aware over the next 30 days this is happening in your local area. There's local papers, TV whatever, Facebook.'" [Adelaide Focus Group]

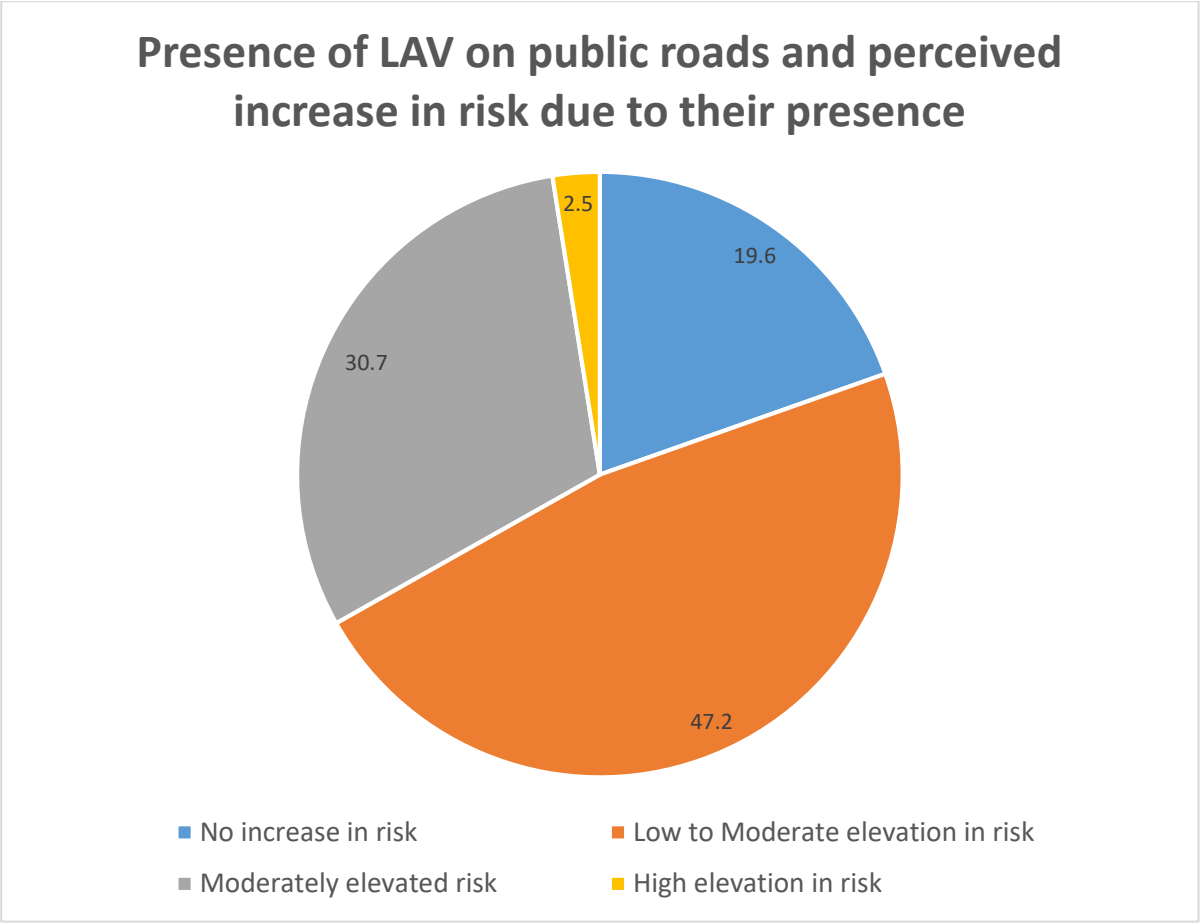

Figure 6. Perceptions of Risk inherent from having LAV present on roads

Future Directions

The research will be used by the National Farmers' Federation and its members to develop a targeted road safety education campaign. The key findings will be summarized and specific recommendations made about what types of messages will be most effective at improving road safety outcomes.

Recommendations

There are key recommendations that emerge from this project.

- The focus for an immediate safety campaigns could be about:
    - The public understanding the characteristics of LAVs, i.e. oversized nature, slower operational speed and the safety mechanisms in place such as escort or piloting vehicles, flags and lights.
    - The public understanding what to do when you encounter a LAV, i.e. pull over to the side and allow the LAV to pass, or how to pass one safely such as allowing for adequate space
    - The need for LAV's to be on roads and where they fit in the production of agricultural commodities

  - Benefits of adaptive driving, i.e. driving which is responsive to the road conditions and other vehicles
  - A general campaign to respect all road users with a focus on agricultural vehicles
  - Helping the public to understand the needs of these vehicles when on roads i.e. turning ability, visibility of other vehicles, speed and room on road.
  - We would recommend based on research that the initial campaign should:
    - Have an overall message that focuses on – "respect of all road users on roads" and "the need for LAVs to be on public roads". The target of this campaign would be all road users although it would benefit by focusing on engaging and informing motorists who are unfamiliar with agricultural machinery movements.
    - Messages should also include information about the safe interaction with LAVs ie when approaching a LAV "slow down, pull over, adapt your driving'".
- Adding a section in the driver licence process (i.e. in the information sent out and the written test) around LAVs would provide an ongoing mechanism for training all new drivers about what to do around LAVs. This would ensure that both general motorists as well as those who drive in the agricultural community are equally educated.
- Respect for road users of all types was identified, this included the idea for the development of a non-compulsory code of a conduct about how LAV operators should behave when on public roads and what is expected of the community. This document would be developed by the agricultural industry as a guide to safe driving on public roads and be able to educate the public about how LAV's operate on public roads.
- Further work is required in improving the underlying data and understanding of incidents involving LAVs. While this project has made steps to determine how much of an impact LAVs are having on road incidents, it is suggested the evidence could be strengthened further by exploring fatal events and having better and detailed incident data which clearly separates out agricultural vehicles (including the regular reporting of this information). We recommend the following to achieve this:
  - A study of road fatalities with a focus on rural areas and LAVs using the National Coroners Information System to explore all risk factors, quantify the number of deaths due to LAV interaction, trends over time and risk factors. This information could also be linked to other road trauma data to provide a comprehensive picture around LAV incidents and prevention options.
  - Development of clear terminology and definitions around LAVs, separate from other large / heave vehicles on roads, to then be implemented by each jurisdiction to help provide clear ongoing data around LAV incidents on public roads. This would allow for appropriate comparison with other road fatality statistics.

- Further work exploring road designs, which facilitate easy movement of LAV and also designs of LAVs which allow them to be moved (ie ease of changing height and width) easily on roads could also increase safety.
- There could be value in the industry advocating for future design of LAV to be able to be packed down to appropriate road widths to allow for movement on road, as this was articulated as the one dimension of LAV that most impinges on the safety of other road users.
- Technological advances should be further considered as an active and real-time means of communicating with the driving public about LAV presence on rural roads. These could incorporate driver awareness signs, such as those present on major highways or scanning technology similar to toll technology, or satellite navigation notification used to transmit data to real-time signs or apps.

In Table 5 we provide some consideration of the feasibility and costs for achieving the future directions for use by the LAV reference group in considering next steps for making Australian roads safer.

Table 5. Future Directions and Perceived Feasibility Consideration

Recommendations	**Feasibility**	**Cost**	**Safety Improvements**
Awareness Raising Campaign	High	Med/High	Medium – Depends on content and reach
Driver's License Inclusion of Question on Written Learners Test	Medium	Medium	Low/Medium
Training/Communication with Existing Drivers – Leaflet with registration letter (example of a cost effective mechanism)	Med/High	Medium	Low
Code of Conduct with Agriculture and Community Groups	High	Low	Low/Medium
Data Collection and Publication on LAV on-road incidents	High	Low	Medium – Details of circumstances still missing
Road design features	Low	High	High – Benefits beyond LAV encounters
Industry Advocacy for Design and Safe Features in LAV	High	Negligible to Low	Medium
Community Advocacy for Communication for Rural Drivers – UHF installed	Low/Med	Negligible to Low	High – Benefits beyond LAV encounters
Technological advance to announce presence of LAV on rural roads.	High	High	Medium - Clutter

Conclusion

This study is the first in Australia to explore the safety of LAVs on public roads. From the research, it is clear that LAV are on roads all year round, however are predominately moving small distances during the day.

Where there are incidents on public roads, the numbers appear to be small especially in comparison to other vehicles. Community education campaigns which highlight the needs for LAVs to be on roads and what to do when you encounter them would be of value, as would a wider campaign around respecting all people on roads. Further work is required to comprehensively understand the issues and the effectiveness of prevention (current and future). Incorporating information in the written test to achieve your driver's license was identified as a cost effective ongoing way to educate new drivers.

References

1. Australian Bureau of Statistics. 4627.0 - Land Management and Farming in Australia, 2016-17. 2018. http://www.abs.gov.au/ausstats/abs@.nsf/mf/4627.0 (accessed 20-06-2018 2018).
2. Australian Bureau of Statistics. 7503.0 - Value of Agricultural Commodities Produced, Australia, 2016-17. 2018. http://www.abs.gov.au/ausstats/abs@.nsf/mf/7503.0 (accessed 20-07-2018 2018).
3. Australian Bureau of Statistics. 8155.0 - Australian Industry, 2015-16. Canberra: ABS, 2017.
4. Ritzinger A, Di Cristofor R, Nolan D, Kenwright J. Future challenges of changing agricultural equipment. Sydney, Australia: Austroads Incorporated, 2016.
5. Mitchell R, Driscoll T, Healey S. Work-related road fatalities in Australia. *Accid Anal Prev* 2004; **36**(5): 851-60.
6. Bureau of Infrastructure Transport and Regional Economics. Road trauma involving heavy vehicles - Annual summaries. Canberra, ACT: BITRE, 2017.
7. Gorucu S, Murphy DJ, Kassab C. Injury risks for on-road farm equipment and horse and buggy crashes in Pennsylvania: 2010–2013. *Traffic Inj Prev* 2017; **18**(3): 286-92.
8. Mitchell RJ, Chong S. Comparison of injury-related hospitalised morbidity and mortality in urban and rural areas in Australia. *Rural Remote Health* 2010; **10**(1): 1326.
9. Fatovich DM, Jacobs IG. The relationship between remoteness and trauma deaths in Western Australia. *Journal of Trauma and Acute Care Surgery* 2009; **67**(5): 910-4.
10. Safe Work Australia. Work health and safety in the agricultural industry. Canberra: Safe Work Australia, 2016.
11. Marsden Jacob Associates. Road transport trends in Australian agriculture. Canberra, Australia: Rural Industries Research and Development Corporation, 2013.
12. Australian Bureau of Statistics. 4102.0 - Australian Social Trends, 2008. Canberra: ABS, 2008.
13. Bureau of Infrastructure Transport and Regional Economics. Road trauma Australia 2016 statistical summary. Canberra, ACT: BITRE, 2017.
14. Henley G, Harrison J. Hospitalised farm injury, Australia, 2010–11 to 2014–15. Canberra: Australian Institute of Health and Welfare, 2018.
15. Australian Bureau of Statistics. Estimated Resident Population. Persons, Australia. Canberra: Australian Bureau of Statistics, 2018.
16. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS medicine* 2009; **6**(7): e1000097.
17. Law M, Stewart D, Pollock N, et al. Quantitative Review Form and Guidelines. 2014 1998. https://srs-mcmaster.ca/research/evidence-based-practice-research-group/#YoBigPEd (accessed January 30 2018).
18. IBM Corporation. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corporation; 2013.
19. QRS International Pty Ltd. Nvivo 10 for Windows. 2014.