Adoption of Quad Bike Crush Prevention Devices

A report prepared for WorkSafe Victoria

Prepared by:

Dr Tony Lower[1]

Dr Mark Trotter[2]

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[1] Australian Centre for Agricultural Health and Safety

[2] Precision Agriculture Research Group

Acronyms

ACAHS	Australian Centre for Agricultural Health and Safety
ACCC	Australian Competition and Consumer Commission
CPD	Crush Protection Device
CPSC	US Consumer Product Safety Commission
FCAI	Federal Chamber of Automotive Industries
GPS	Global Positioning System
HWSA	Heads of Workplace Health and Safety Authorities
ISCRR	Institute for Safety Compensation and Recovery Research
MIT	Multi-point Interval Tracking
PPE	Personal Protective Equipment
ROPS	Rollover Protection Structures
SIT	Single-point Interval Tracking
SPSS	Statistical Package for Social Sciences
TAC	Traffic Accident Commission
UDV	United Dairy Farmers of Victoria

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Executive Summary

Quad bikes are a leading cause of on-farm injury fatalities in Australia. Based on the 10-year average, 13 people are killed each year, with almost 50% of these resulting from rollovers of the vehicle and death frequently due to crush or asphyxiation. In 2011, there were at least 23 quad bike related fatalities in Australia. The Heads of Workplace Health Authorities (Australia & New Zealand) have supported fitting of Crush Protection Devices (CPDs) to reduce this burden. This small exploratory study sought to trial the use of CPDs and assessed factors that act as barriers and enablers to increase the adoption of these potentially lifesaving devices by farmers. The study also examined the feasibility of using GPS tracking devices to monitor the use of quad bikes

Methods

This study involved fitting a CPD (Quadbar) to the quad bikes of 11 dairy farmers. Ethics approval was gained through the University of Sydney Human Research Ethics Committee and participants were identified with the assistance of the United Dairy Farmers of Victoria (UDV). Participants completed a pre-intervention survey that described a range of factors including demographics, riding experience, number and condition of quad bikes on farm, estimated average / maximum speeds, duration of use, mechanical servicing and use of personal protective equipment.

The 11 quad bikes were fitted with two Global Positioning System (GPS) recorders. The first GPS unit was configured to record the location of the quad bike every 5 minutes using a Single-point Interval Tracking protocol for up to 14 days. The second collected high temporal resolution data consisting of a series of 4 location logs spaced 15 seconds apart every 5 minutes. This protocol is known as Multi-point Interval Tracking and monitored use for the first two days of the 14 day period. The first GPS unit provided data estimates of usage over the two week period whilst the second with the second enabling the calculation of speed variable estimates.

Following the 14 day intervention period the GPS units were removed from the quad bikes and the data downloaded. At the same time participants completed a post-intervention survey that covered many of the variables from the pre-intervention assessment plus additional items regarding the impact of the device on suspension, stability, rider movement, handling dynamics, obstacles (branches etc) and willingness-to-pay for purchasing a CPD.

Two separate focus groups were conducted with participants to obtain further feedback. Those unable to attend focus groups were interviewed by phone following the same interview protocol. This feedback was used to further explore those issues covered in the post-intervention survey.

Results

The fitting of the GPS devices stimulated further discussion and debate around safety for both farm owners and workers. Several employers also indicated that it added to their legal obligations in providing a safe workplace. The CPD’s had virtually no impact on the reported performance of the quad in terms of braking, steering, suspension or operators getting on/off. The most problematic issue was some contact with overhead objects, mainly electric fences (hot tape), though most

(n=7/10) reported no issues at all. There were also some limited issues with fitting trailers, carrying loads and noise from rattling. Despite these minor points it was strongly articulated that any issues with the CPD were clearly outweighed by the perceived potential benefits if the quad bike did roll. This was further illustrated by the fact that 10 of the 11 CPDs fitted remained in place some four to six months post the completion of the study.

The respondents reported a shift in their consideration of safety and that of their workers in relation to quad bikes. Some participants were moving towards side by side vehicles as they were perceived to be safer and a more practical option, while others were requiring helmets to be worn and limiting use of quad bikes by excluding visitor usage.

Farmers reported that the uptake of CPDs was being impacted by the quad bike manufacturers' negative public statements regarding the effectiveness of and purported risks associated with CPDs. Greater consistency of accurate evidence-based information to dispel these suggestions in the public domain was recommended by farmers to increase use of CPDs. Respondents were clear that there were lessons that could be learnt from the tractor ROPS debate, particularly in respect to countering the quad bike manufacturers' opposition to CPDs and provision of financial rebate incentives for fitting CPDs.

Promotion of CPDs was suggested as a useful approach in breaking down barriers to CPDs and raising awareness, especially via the United Dairy Farmers of Victoria and in the media. Farm women were also identified as key conduits for safety information. Other strategies included investigating reductions in insurance premiums as an incentive to fit CPDs and in instances where quads are conditionally registered, ensuring that CPDs are part of the requirements. To stimulate acceptance of the devices, the public visibility of CPDs was also deemed important by respondents. In respect to the cost of CPDs, respondents noted that if it was going to save a life any cost is a "bargain" and was money well spent.

Based on the GPS data, the average daily riding exposure for subjects was 1.5 hrs. The estimated average speed of quad bike operation was 8.4km/h, with the average maximum speed attained being 46.6km/h. The majority of usage events recorded (71%), were at speeds lower than 10km/h, with 95% of all events less than 30km/h.

Conclusions

Overall, the CPD was viewed positively by the majority of participants despite some issues of contact with hot tapes and towing. The major barrier to adoption is the disputed arguments regarding the effectiveness of CPDs that continue in the public domain. While preferring to adopt self-regulation in fitting CPDs, dairy farmers are unlikely to take such action while conflicting and polarised opinions exist. Clear guidance on CPDs is required from regulatory authorities and product safety agencies. Although respondents predominantly supported a carrot and stick approach, it was noted that if it came to a position where fitting CPDs was mandatory, such a position would be accepted though not preferred.

The results suggest that following the fitting and use of CPDs: (a) CPDs will generally be viewed positively by farmers; (b) CPDs do not interfere in any substantive way with current operation of quad bikes on dairy farms; and, (c) that there are specific steps that can be taken to increase the uptake of CPDs by dairy farmers. New programs taking into consideration the elements of diffusion of innovation are required.

There remain major deficiencies in the design of quad bikes and their capacity to protect riders in the event of an overturn as required by national Work Health & Safety Regulations. Any new vehicles sold into a workplace should comply with these Regulations. Additionally, there are issues of relevance in relation to product safety for both the work-related and non-work use of these vehicles. While farmers appear to be increasingly moving toward alternate and safer forms of farm transport, there remains a significant fleet of quad bikes in Australia that would benefit from retro-fitting of CPDs. Any further lag in the promotion of these potentially life-saving devices will only add to the death and injury burden caused by quad bikes.

Background

Burden of Death & Disability

Quad bikes have become a common feature in Australian agriculture however they are also frequently associated with death and serious injury. Using annual sales data from the Federal Chamber of Automotive Industries (FCAI), it is estimated that there is approximately 220,000 quad bikes in operation in Australia. Sales in 2011 exceeded 20,000 units[1] and while a proportion of these would be replacements for quad bikes that are non-operational, it is expected that sales will continue to grow in the immediate future. Hence, there is an urgent need to address this issue and reduce the trauma burden that quad bikes are imposing. This is evidenced by the establishment of the Heads of Workplace Health Authorities (HWSA) quad bike safety on farms strategy that has recently been developed.[2]

Data sourced from the National Coroners' Information System illustrate that there have been 127 quad bike related fatalities from 2001 to 2010.[3] As such, on average 13 people are killed each year with many more suffering serious injuries resulting in lifelong disabilities.

More recently, data sourced via the media in 2011 identified 23 fatal quad bike cases, with 18 of these occurring on-farms. For the first time ever, the annual number of on-farm quad bike fatalities exceeded that of tractors at a ratio of almost 2:1.[4] To date in 2012 (June 6), there have already been 9 fatal quad bike incidents, replicating the high numbers from the previous year.[5]

Of the fatal incidents between 2001 and 2010, 46% involved a rollover of the quad bike with death frequently resulting from crush injury or asphyxiation.[3] In the USA the Consumer Product Safety Commission (CPSC) data illustrates that where information is known, more than 70% of fatalities involved the vehicle overturning, tipping or rolling.[6] In an agricultural work context, these data are also reflected in information from the USA where approximately 50% of incidents involved rollovers.[7] In the Australian data set, it is noteworthy that almost 9 out of every 10 rollover deaths occur on a farm, with 69% of these occurring during work activities.[3] As such, while work-related rollover deaths predominate, there is remain a significant minority that are occurring in non-work activities. Irrespective of whether these incidents are work or non-work related, they have an immense negative impact on whole rural communities.

Due to variations in collection approaches across states, the level of detail regarding non-fatal quad bike injuries is less well known nationally. However, a review currently underway in Victoria comparing fatal incidents, hospital admissions and emergency presentations demonstrates that for each fatality there are approximately 40 admissions and a further 40 emergency presentations.[8] These data are strongly indicative of the severity of quad bike incidents, as a disproportionately large number result in admission. Similarly, recent data drawn from a small number of sites in Queensland covering the period 1999-2011, illustrates that there has been nearly 1,000 quad bike presentations to emergency departments in this period. Significantly, it is estimated that this represents only between 20-25% of all quad bike injuries.[9] Without question, quad bikes do have a significant injury burden, with the most serious injuries (head and spinal injuries), being both life-long and debilitating.

Prevention Options

There is evidence that the full spectrum of quad bike related deaths and injuries will only be comprehensively addressed through a range of strategies as articulated in the Trans-Tasman Quad Bike Strategy.[2] However, there is unequivocal evidence that such approaches must be based on the hierarchy of controls.

In accordance with the hierarchy of controls, when considering eliminating hazards and risk of rollover, farmers need to first select the most appropriate vehicle for the task(s) that they are undertaking. In most instances, due to the instability and propensity for rollover, this will not be a quad bike. However, if following this assessment a quad bike is deemed the most appropriate vehicle for the task(s) at hand, then steps must be taken to reduce the risk of a rollover. The first such step that must be considered at this point is fitment of a suitably tested Crush Protection Device (CPD).

At the present point in time the only commercially available CPD product in Australia is called the Quadbar.[10]

Data relied on by the manufacturers' and their representative organisation in Australia, the Federal Chamber of Automotive Industries (FCAI), has illustrated net injury benefits in fitting CPDs (including the model used in this study).[11] [12] Despite this, CPDs have been stridently resisted by the manufacturers. The most recent review of data undertaken by the Institute for Safety Compensation and Recovery Research (ISCRR) was definitive in its statements that given the limitations identified in the manufacturers' research:

> "The FCAI's strong opposition to the fitment of CPDs in general and the Quadbar in particular was found to be based on the research produced by Failure Analysis Associates and DRI. Their reasons for rejecting such devices cannot be supported given the major problems with the research methodologies identified by this review."

Furthermore,

> "This review identifies serious issues with the simulation methods used and the nature of incidents tested to predict the effect of crush protection devices on Quad bike roll over injuries and fatalities. Limited experimental and simulation results indicate that the Quadbar crush protection device demonstrates potential to reduce rider harm in such events."[13]

Currently, the Heads of Workplace Health Authorities (HWSA) which represents all state/territory Work Health and Safety agencies across Australia and New Zealand, have a quad bike safety strategy that they have endorsed. Within this strategy they have agreed that:

> "The retrospective fitting of devices designed to reduce the risk to riders from entrapment beneath an overturned vehicle will be supported (but not required) by WHS regulators providing the following criteria are met:
>
> 1. (Until a standardised test criteria is developed) that sufficient documented design and testing of the device has been carried out by competent persons overseen by a qualified engineer that demonstrates:
>
>   a) the structural adequacy of the device, and
>
>   b) that the device provides a net reduction in risk of injury across a range of potential quad bike rollover events (Note: Given the complexity it may not yet be practical to demonstrate this net reduction across the full range of potential rollover events);
>
> 2. The device does not adversely affect the normal operation of the quad bike - i.e. stability; rated load; rider control; mounting and dismounting; maintenance access; and terrain capability; and
>
> 3. Continued compliance with the quad bike manufacturer's instructions regarding helmet use, rider training, carriage of passengers and towing and loading limits." [2]

Despite this evidence and support from Work Health and Safety regulatory authorities, the views of farmers to adoption of CPD's remains divided. This may have been fuelled by public promotions supported by the FCAI, including an initial campaign targeting government representatives, quad bike retailers and the general public, that the Australian Competition and Consumer Commission (ACCC) determined may have breached the misleading and deceptive conduct provisions of the Consumers Competition Act (2010).[14] This divergence of opinion on the effectiveness of CPDs will likely pose a barrier to their adoption. As such, evidence-based and objective information on the potential impact of CPDs on injury is required.

In addition to issues of injury benefits, manufacturers have also claimed that CPDs pose an increased hazard as they raise the Centre of Gravity, result in contact with overhead objects, impede mounting/dismounting, reduce the ability to use active riding techniques, reduce load carrying capacity and de-stabilise the bike.[15] Such practical issues are important in the broader consideration of fitting CPDs.

The aim of this exploratory program was to trial the use of CPDs with a small number of dairy farmers. Both quantitative and qualitative data were gathered to ascertain current usage patterns, report on any issues associated with fitting of a CPD and to assist in identifying ways in which future promotion and uptake of CPDs can be best achieved.

Aim & Objectives

Aim:

To determine the enablers and barriers to adoption of suitably tested CPDs for quad bikes by dairy farmers.

Objectives:

1. Define the reported attitudes, benefits and disadvantages of fitting a CPD by dairy farmers to quad bikes
2. Identify potential future promotion approaches to increase the adoption of CPDs by dairy farmers
3. Determine the willingness-to-pay by dairy farmers for CPDs
4. Calculate rider exposure (time) on quad bikes by dairy farmers
5. Assess the rider behaviours of dairy farmers in relation to speed of use

Research Methodology

Ethics approval for the study was attained through the University of Sydney Human Research Ethics Committee (Approval No. 13940).

Survey Design

The survey was based on earlier work undertaken by the Australian Centre for Agricultural Health and Safety (ACAHS)[16] and further developed to answer the specific research objectives specified for this study. Pilot survey instruments to account for both pre- and post-intervention assessments were developed and field tested with three dairy farmers from outside the study area to ascertain face validity. Based on feedback, some minor adjustments were made to the language and structure in the final surveys.

Study Sample

A purposive sample of individuals was recruited through the United Dairy Farmers of Victoria (UDV) which is the lead representative agency for the dairy industry in the state. In consultation with the UDV two study areas were selected to try and get a diverse picture of use in different dairy regions. The first represented irrigation based dairies (predominantly flat terrain) and an area that relied more strongly on natural rainfall rather than irrigation (hilly terrain). Dairy farmers were initially contacted by the UDV to ascertain preliminary interest. If interested in participating, letters of invitation to potential participants were forwarded, thereby ensuring that researchers were blind to the selection of participants. Each study participant was assigned a confidential and unique identifying code for completion of the pre- and post- surveys, plus collection of the Global Positioning System (GPS) data. Data were collected between November 2011 and March 2012. A master list matching the codes was maintained in a password-protected computer file accessible only to the principal researcher.

Pre-Intervention Survey

Upon receiving written consent to participate, subjects were contacted by mail to complete a pre-intervention survey. The survey addressed a range of issues centred on riding experience/ training, attitudes to quad bike safety, self-reported quad bike use and rider behaviour (Annex 1). The completed survey was provided to the Project Officer in a sealed envelope when the CPD and GPS units were fitted. Survey data were entered into Statistical Package for Social Sciences (SPSS) v19 and analysed with descriptive statistics being derived.[17] In instances of missing data, actual denominators are presented.

Fitting the CPD & GPS Units

The process of fitting the CPD's and GPS units commenced with a general safety inspection of the quad bike by the Project Officer based on WorkSafe Victoria's pre-operational checklist for quad bike use on farms.[18] Once the quad bike was deemed to be in suitable mechanical condition, the CPD was fitted by the Project Officer.

Two GPS units were then mounted at the base of the CPD. To ensure the integrity of the units in a dairy farm work environment where there may be considerable vibration from general use of the quad bike, the units were housed in a perspex casing and were mounted using cable ties (Figure 1).

Figure 1: GPS unit mounted at the base of the CPD

The first GPS unit was configured to record the location of the quad bike every 5 minutes. This commonly used Single-point Interval Tracking (SIT) protocol can be maintained for several weeks. However the data collected can only provide an estimate of the minimum distance travelled and speed calculations from each point logged 5 minutes apart. While it is a useful approach to determine overall riding exposure and use events, a more complex protocol was required to provide accurate estimates of distance travelled and speed.

The second was set to collect high temporal resolution data consisting of a series of 4 location logs spaced 15 seconds apart every 5 minutes. This protocol is known as Multi-point Interval Tracking (MIT) and consumes considerably more power than normal logging protocols. The MIT tracking protocol was expected to last for less time than the SIT units however several of the units only recorded tracking data for two to three days. This may have been due to high ambient temperatures reducing battery life or the rough environment of the quad bike (high vibration) causing the units to shut down. For the purposes of analysis, 2 days of MIT data and up to 14 days of SIT data were selected from each unit. If any of the units failed throughout the testing, attempts were to be made to re-fit the quad bikes with GPS units if feasible.

Throughout the 14 day period when data were collected, the participants were requested to use the vehicle normally. The GPS units were self-sufficient and required no maintenance or attention by the study subjects ensuring that a complete representation of rider activity was gained. The inability of the rider to turn the GPS off was considered important in gaining an accurate sample of true usage and speed events. Additionally, it was requested that wherever possible, the use of the quad bikes be limited to those subjects that had completed the pre-intervention surveys.

Validating GPS Data

To validate the models developed to process the GPS tracking data an accelerometer was fitted to one quad bike and the use of this bike monitored constantly for a 24 hour period. The GPS units fitted collected SIT and MIT data. The accelerometer collected movement data from the quad bike at a rate of 8 records per second (8 htz). This 8 htz data was re-sampled to 1 second data and usage events where identified and manually coded to produce a trace record that could compare information from the accelerometer, SIT and MIT data. Because the accelerometer collected data at such a high and constant rate it can be considered the “gold standard” against which usage events can be correlated.

Removal of GPS Units & Post-Intervention Survey

At the conclusion of the 14 day period, subjects were provided with the post-intervention survey for completion and the GPS units were removed from the quad bike by the Project Officer, with the CPD remaining fitted. The survey included many of the variables from the pre-intervention assessment plus additional items regarding the impact of the device on suspension, stability, rider movement, handling dynamics, obstacles (branches etc), willingness-to-pay for purchasing a CPD and a component for other free text comments (Annex 2). The completed survey was given to the Project Officer in a sealed envelope. In turn, the Project Officer forwarded the GPS units (plus accelerometer) and post-intervention surveys to the researchers. As per the pre-intervention survey, these data were entered into SPSS v19 and analysed with descriptive statistics tabulated.[17]

Focus Groups / Interviews

The final component of the intervention consisted of two small focus groups with the farmers represented in the study and individual phone interviews (for those unable to attend the focus groups). The focus group discussions were used to further explore those issues covered in the post-intervention survey. The groups were moderated by the principal researcher with the project officer also acting as an observer/recorder by documenting issues and direct quotes as they were raised by study participants. This was done to ensure all relevant data from participants were captured and to limit any potential bias in recording the information. If questions were raised in the focus group that may have biased the results in anyway (for/against CPDs), the questions were noted and held over for discussion after all of the focus group discussion had concluded. That is, none of those issues are recorded in this report.

Each of the focus groups consisted of several key discussion elements (Annex 3):

1. Participants were provided some limited data regarding average speed of use on their properties compared to the average for all farms involved in the study. Each of the subjects was also provided with a visual mapping of location points indicating where quad bikes were used on their properties over the 14 days of the study.
2. Perceived benefits / disadvantages of fitting a CPD -
    a. How may disadvantages be addressed?
    b. How may benefits be promoted?
3. Attitudes of the farming community to CPDs and how communication networks may be used to increase uptake
4. Cost of CPDs
5. Other issues of relevance

Focus group discussion points were recorded independently by both the principal researcher and the project officer. At the conclusion of each focus group the two researchers completed a comparative analysis of their meeting notes to establish key themes and any variations in the information gathered. All information recorded and transcripts of notes were then documented in a Microsoft Word file.

For the phone interviews, the same process was followed as that for the focus groups with the exception that the subjects did not receive their individualised results at the commencement of the discussion. Additionally, as interviews were only completed by the principal researcher, there was no capacity to cross-reference the information from these subjects with the project officer.

At the conclusion of the focus group discussion and phone interviews (and not included in this report), points raised that may have biased the contribution of study participants were covered. For example, several study participants wanted to know why the manufacturers were so opposed to CPDs and what the research actually meant.

Some four to six months following the completion of the 14 day trial period, each of the participants was also contacted by phone to determine if the CPD was still fitted and if there had been any further issues that may have arisen since the focus groups or earlier individual interviews.

Reliability of Self-Report Data

The study design allowed for what we understand to be the first comparison of estimated average and maximum speeds with objective data gathered by GPS. To assess the reliability of the self-report data on average and maximum speeds, measures of agreement were compiled using Pearson's correlation co-efficient.[17] Assessments included two separate analyses for both average and maximum speeds across three points: (a) data from the pre-intervention survey where participants estimated average and maximum speeds of use in the past 12 months; (b) data from the post-intervention survey for estimated average and maximum speed in the 14 days of the study; and (c) data from the GPS recordings for average and maximum speeds in the first two days of the study period. Cut off points to determine high levels of agreement were set at 0.80.

Similarly, to determine the reliability of pre- and post-intervention survey responses assessing use of personal protective equipment (PPE), prevalence and bias adjusted Kappa's were calculated.[19] Scores were assessed against specified criteria with results >0.81 illustrating almost perfect agreement and scores between 0.61-0.80 substantial agreement.[20]

GPS Data

Raw GPS data were extracted from the GPS tracking units. This data was processed in a Microsoft Excel "Converter File" which transforms the National Marine Electronics Association strings into useable data. This processed data was then analysed in ARC GIS to provide estimates of step length between points. These step lengths could then be converted to speeds (speed = step length/time between points). MIT data was further processed with the long interval (~5mins) removed leaving a data set with only the speed estimates for short intervals (~15seconds). These short intervals consist of the "burst" of 5 logged points approximately 15 seconds apart. Because the step lengths and speeds are calculated between subsequent points this leaves a burst of 4 step length and subsequent speed values. These bursts of the MIT data provide a much better estimate of the actual speed of the quad bike as opposed to the minimum speed provided in the SIT data.

The complete data file for any MIT GPS unit consisted of utilisation events (when the quad bike was being ridden) and non-events (when the quad bike was not being ridden). As GPS data contains inherent positional errors the non-events did not show up as speed = 0 and a model was needed to determine when the quad bike was truly being ridden (true event) and not being ridden (true non-event). Further difficulties were encountered when examining the data as it became obvious that GPS errors where being exaggerated when quad bikes were stored under cover reducing signal reception by the GPS and increasing multipath effects.

The model developed to determine when a quad bike was undertaking a true event for MIT data was if a burst of data (4 intervals) contained more than two records above 5km/hr then its was considered an event and continued to be considered an event until all records in a burst fell below 1km/hr. This model was applied to categorise each burst of data within a MIT protocol rather than the individual points.

The MIT data was processed to provide a distribution of all speeds and estimate of the average speed (km/hr) of events over the two day tracking period by averaging all bursts classified as events.

The maximum speed during the two day tracking period was extracted from all speed values classified as an event. It should be noted that the MIT protocol only provides a sample of quad bike activity (essentially every 5 minutes) and therefore only recorded the maximum speed captured during sampling event. It is entirely possible that the quad bike was driven at a faster maximum speed which was not recorded by the GPS.

The complete data file for any SIT GPS unit also required a model to determine true events. True events were defined as those intervals which had a speed above 2km/hr. The SIT was processed to provide the average quad bike usage per day.

Results

Study Participants

A total of 11 dairy farmers participated in this study, with the breakdown being farm owners (n=8), with one each reporting to be a farm manager, farm worker or family member. As can be seen from Table 1, study participants were younger 43.2 years (SD 13.1) than their Australian or Victorian counterparts, however it is important to consider that the comparative data relate to farm owners only. Additionally, the study subjects reported milking on average more cows (range 180-600) and also had larger property sizes (range 85-600ha).

Table 1: Summary of participants in relation to profile of Victorian and Australian Dairy farmers

Indicator	Current Study	Australia	Victoria
Average age of dairy farm owners	43	51	51
Average number cows milked	355	277	275
Average size of properties	347 ha	168 ha	154 ha

Source: National Dairy Farmer Survey 2011[21]

Key Pre-Intervention Survey Results

A summary of selected key results further describing the study participants is provided below in Table 2.

Table 2: Summary of self-reported results for study participants (pre-intervention)

1. Reported Farm topography - flat (n=6), undulating (n=2), mix hilly & flat (n=3)
2. Average age for commencing quad bike riding was 19.4 years (range 7-36), three participants had commenced riding before they were 16 years.
3. Years of quad bike riding experience - >10 years + (n=9), 6-10 years (n=1), 2-5 years (n=1)
4. Reported daily exposure (busy day) 1- 2 hrs (n=3), 2-5 hrs (n=5), > 5 hrs (n=2) with one no response. On a slow work day, four indicated they rode < 30 mins, 30-60 mins (n=2), 1-2 hrs (n=2), and 2-5 hrs (n=3)

5. Only one of the subjects had completed a formal rider training course.
6. Number of quads used on farm - one (n=3), two (n=6), three (n=2).
7. Of the 21 quad bikes reportedly owned by the subjects most had functioning brakes (n=17), hand levers in good condition (n=18), good tyre tread (n=18), correct tyre pressure (n=20) and seat in good condition (n=19).
8. Reported quad bike maintenance monthly or better - oil (n=10/10), brakes (n=7/8), suspension (n=5/9), tyres (n=8/9).
9. Estimated quad bike replacement time in the group was 4.2 years (range 2-15), however if the one outlier was withdrawn from this analysis the average drops to 2.7 years (range 2-5)
10. Estimated average speed was 19km/h (range 10-35), with the estimated maximum speed being 55km/h (range 40-75)
11. Main purpose(s) of daily quad bike use were - stock movement (n=11/11), transport (n=9/9), spraying (n=2/9), carrying (n=5/8), towing (n=6/9), recreation (n=1/8).
12. People reported riding on farm over past 12 months - farm owner (n=11), farm manager (n=2), family members (n=9), workers (n=7), visitors (n=5), that is just under half of farms had visitors that rode.
13. Helmet use was reported as always (n=1), usually (n=1), sometimes (n=1), never (n=8).
14. Four participants reported suffering a quad bike injury, two involved rollovers. None were carrying a passenger, load, spray tank or towing a trailer. Two reported terrain as flat & two as undulating.
15. Six of the 10 respondents reported near miss experiences - 2-3 (n=3) such scenarios, 4-5 (n=1) and 6-10 (n=2).
16. Three of the participants had rolled a quad, one occasion (n=1) and 2-3 occasions (n=2).

GPS Data

When the GPS units were removed following the 14 day intervention period, it was discovered that two had failed to initiate and collect any data. These units were subsequently sent back and redeployed to collect the required data. It was also discovered that the MIT tracking units had failed to collect the expected amount of data. The exact cause still remains unknown however high summer temperatures may have reduced battery life or the extreme environment (high vibration) may also have caused the units to shut down. As a consequence the shortest complete period of MIT tracking data, 2 days was selected for processing. In most cases 14 days of SIT data were collected for each quad monitored, however in some cases a shorter period was obtained. The minimum period processed for SIT data was 12 days.

Validation of GPS Data

The validation information demonstrates that the SIT data (Figure 2) closely resembles that recorded by the accelerometer which is the gold standard. The MIT data (Figure 3) also follows the accelerometer data (Figure 4) but failed to record one of the major events.

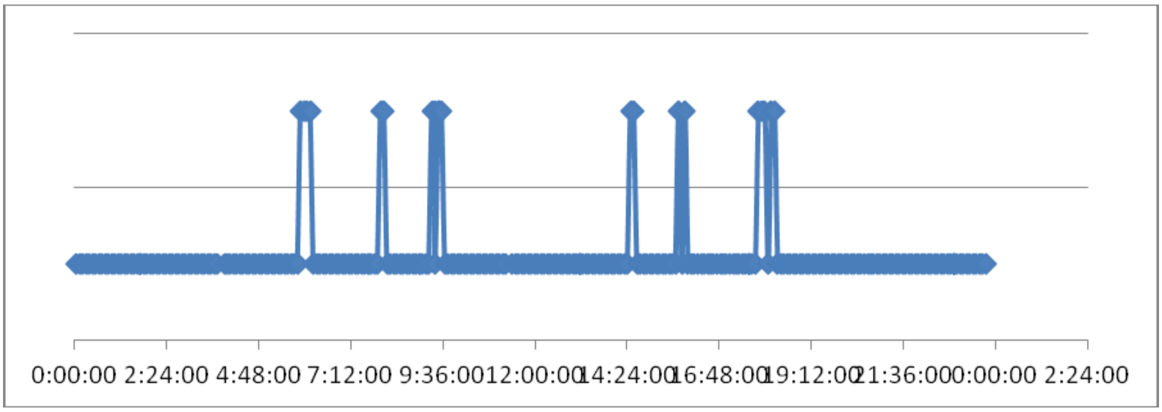


Figure 2: Trace of one day of SIT data from quad bike I9 (spikes show usage events)

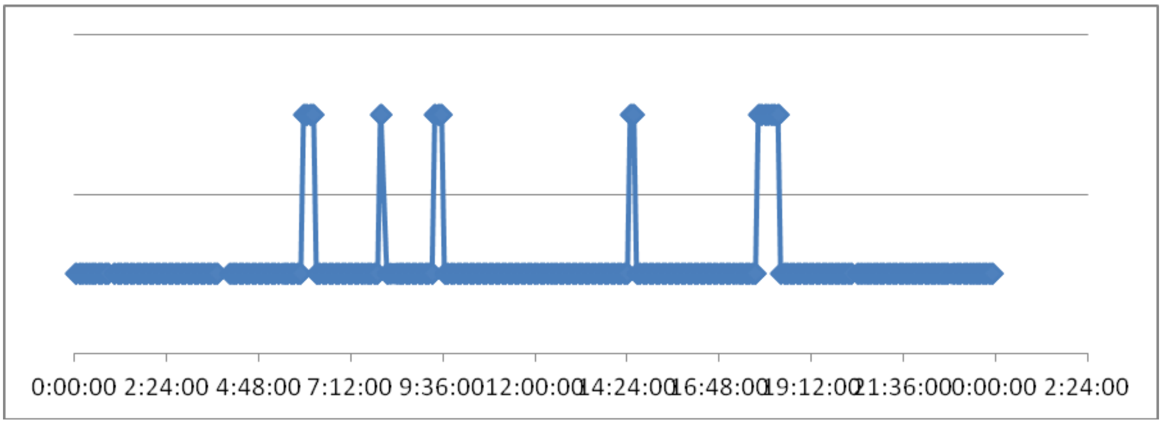


Figure 3: Trace of one day of MIT data from quad bike I9 (spikes show usage events)

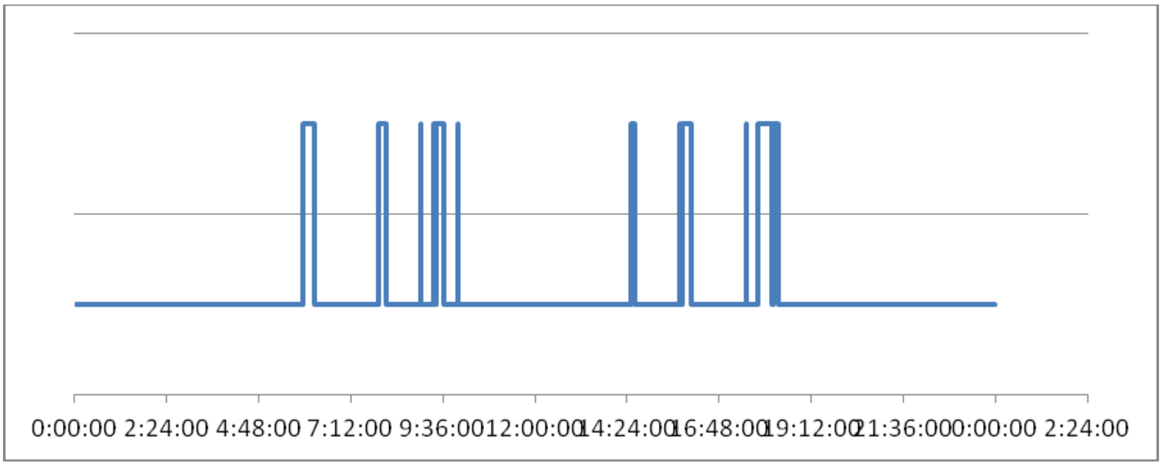


Figure 4: Trace of one day of accelerometer data from quad bike I9 (spikes show usage events)

When examining the SIT and MIT data in terms of the total usage time it is clear that the SIT provides the most accurate estimation of total daily usage compared to the MIT data (Table 3). The accelerometer recorded a total of 12 events, it should be noted that several of these events were small <60 seconds and may be due to the quad bike being bumped and not actual usage events (the accelerometer is an extremely sensitive sensor). The SIT GPS protocol successfully identified all of the major events recorded by the accelerometer and ultimately produced total daily usage times within 6 minutes of the accelerometer for this day suggesting that this is a suitable model for estimating quad bike usage time. The MIT GPS data showed a much reduced usage, this was expected as this protocol records only a sample of the speed of the quad bike and is prone to missing some events. The strength of the MIT protocol is that it can provide an accurate estimate of the speed of the quad bike.

Table 3: Comparison of GPS SIT, GPS MIT and accelerometer data for one quad bike over one day

Monitoring method	Events	Time in operation
GPS SIT	9	1:45
GPS MIT	5	1:24
Accelerometer	12	1:39

Pattern of Use

In relation to overall riding exposure, the SIT protocol determined that the average period of daily use was 1.5 hrs (Table 4).

Table 4: Basic exposure times based on SIT data

Quad Bike	Number of days used	Number of days tracked	Estimated daily average hours of use
A1	13	14	0:55
B2	14	14	1:56
C3	10	14	1:32
D4	14	14	1:21
E5	14	14	1:10
F6	12	12	1:57
G7	14	14	1:27
H8	12	12	1:55
I9	12	13	1:28
J10	12	12	1:48
K11	12	13	1:02
Average (range)			**1:30 (0.55-1.57)**

Data from the 11 subjects (Table 5) illustrates that the estimated average speed as determined by the GPS and drawing on the MIT protocol was 8.4km/h, with the average maximum speed attained being 46.5km/h. Annex 4 provides an overview of the relative proportion of event records at different speeds of use. The results indicate that overall 71% of usage events were recorded at speeds lower than 10km/h, with a further 17% between 11-20km/h and 7% at 21-30 km/h. As such, 95% of all usage events were at speeds lower than 30km/h. While there was variation between the use of each quad bike, this does demonstrate that the dominate pattern of use is at low to moderate speeds on these dairy farms.

Table 5: Basic movement descriptors from two days of intensive MIT tracking

Quad Bike	Estimated average Speed (km/hr)	Recorded maximum speed (km/hr)
A1	7.3	33.6
B2	6.7	27.1
C3	7.4	51.6
D4	2.4	11.5
E5	5.9	42.1
F6	8.5	54.6
G7	7.6	43.8
H8	9.5	77.3
I9	9.9	40.1
J10	10.2	61.7
K11	16.7	69.1
Average (range)	**8.4 (2.4-16.7)**	**46.6 (27.1-77.3)**

Key Post -Intervention Survey Results

The following Table provides a summary of the major points arising from the post-intervention survey which examined practices throughout the 14 day trial period.

Table 6: Summary of self-reported results for study participants (post-intervention)

1. Nine subjects rode daily with two others riding on 11-13 days.
2. Daily exposure was 30-60 mins (n=2), 1-2 hrs (n=7), 2-5 hrs (n=1) and over 5 hrs (n=1).
3. Estimated mean distance covered was 176km over the two week period (range 4-500).
4. Reported quad bike maintenance monthly or better - oil (n=4/10), brakes (n=3/11), suspension (n=1/11), tyres (n=7/11).
5. Estimated average speed was 19km/h (range 5-40), with the estimated maximum speed being 58km/h (range 40-80)

6. Main purpose(s) of daily quad bike use were - stock movement (n=11/11), transport (n=8/9), spraying (n=1/8), carrying (n=2/7), towing (n=2/8), recreation (n=0/8).
7. People reported riding on farm over the past 2 weeks - farm owners (n=7), farm manager (n=1), workers (n=5) and family members (n=2). No visitors had ridden the quads.
8. Helmet use was reported as always (n=2), sometimes (n=1), never (n=8).
9. Perceptions regarding ease of fitting the CPD - easy (n=8), not sure (n=2). Most estimated fitting would take less than 30 min (n=6) or 30-60 min (n=5).

Table 7 provides an outline of the survey responses regarding the perceived impacts the device may have had across a range of factors. As can be seen the vast majority (85%) of responses suggested little to no impact of the device being fitted. Contact with objects was identified as a somewhat or a significant issue by two respondents.

Table 7: Reported perceived impacts of CPD fitment on quad bike

Area Impacted	**Perceived Level of Impact of CPD**			
	Significant	**Some**	**Little**	**None**
Braking		1		10
Steering / handling		1		9
Suspension		1	1	9
Getting on/off			1	10
Contact with objects	1	1	1	7
Other		3		

Comments received on the "other" category included:

"Couldn't get through dairy"

"Bike felt heavy"

"Could not tow quad bike trailer as CPD unit got in the way"

In general, the fitting of the CPD made no difference to the way subjects reported that they rode the quad bike (n=10), the only exception to this related to the one subject that "Could not get under electric fences or gates". Having the CPD fitted did not alter the subject's perceptions of their personal safety when using the quad bike.

Of the nine subjects responding as to whether they would recommend it to other farmers, six indicated they would and four that they would not (one no response). Direct comments reflected the two lines of thinking on the issue:

"Height crossing fences"

"It is a safety precaution but it is very expensive"

"I don't think it makes it any safer. How you ride it depending on conditions, experience of rider is the main factor. Speed kills, Could give a false sense of security"

"Really no handling problems"

"If it helps to save a life its good but my dealer was very negative to the ROPS. But he also sold me the spray tank for the bike that was too big for the bike"

In relation to willingness to pay for a CPD, two subjects indicated they would not purchase one, with four indicating they would pay $200, three $400 and one each $600 and $1000. All but two of the respondents reported that they would be staying in the industry for six years or more and there was no observable relationship between likely longevity in industry and willingness to pay.

Accuracy of self report

The study design allowed for what we understand to be the first comparison of estimated average and maximum speeds with objective data gathered by GPS assessment. Data on the reliability of self-report comparing the pre- and post-interventions surveys and also the post-intervention survey with the objective data obtained from the MIT GPS tracking are provided in Table 8.

Table 8: Reliability of estimated average and maximum speeds of use

Speed Data	Pre & Post Intervention (r)	Post Intervention & GPS Data (r)
Average Speed	0.67 (p=0.124)	0.493 (p=0.024)
Maximum Speed	0.686 (p=0.20)	-0.217 (p=0.522)

Results from this analysis suggest that there is moderate correlation between both the average and maximum speeds provided by self-report from the respondents at pre- and post- intervention. However, the level of reliability between the post-intervention self report and the temporal data provided by the GPS recording over the first two days of operation in the study, are at best moderate for reports on average speed and low for reports on maximum speed. This suggests that for his sample, information provided by self-report tends to overestimate both average and maximum speeds of use.

Given the role that personal protective equipment can play in minimising injury, an analysis of responses comparing the pre- and post-intervention items was completed. Results indicate very strong agreement for statements relating to helmet use and substantial agreement for use of boots and goggles (Table 9).

Table 9: Reliability of reported PPE use between pre- and post-intervention surveys

PPE Item	Prevalence & Bias Adjusted Kappa
Helmets	0.88
Boots	0.76
Goggles	0.76

Focus Groups & Interviews

Six subjects in total participated in the two focus groups, with the remaining five subjects being interviewed by phone. Results are presented in accordance with the structure for the focus groups.

Benefits

The primary response regarding benefits was that it made the machine safer from both a personal view but also with specific reference to employees. Several farm owners highlighted just how important safety was in regards to their workers:

> "Personal safety for me as a rider - provides some protection"
>
> "Good that they can't keep rolling if they go over and give you a bit of space if that does happen. With employees it does give you a bit of peace of mind if something does happen. Having the bar on doesn't worry me - I got used to it"
>
> "It's only got to tip-over once and you'd have them on"
>
> "Can't see how it's (the bar) a negative"
>
> "Can't see any issues with them in general"
>
> "Don't even notice it"

It also stimulated further discussion and debate around safety:

> "Just opened our eyes to issue of safety"
>
> "Made us wear helmets"
>
> "Benefits workers (as they) look at it and discuss safety. Haven't had an accident to test it out but hopefully it will work when there is an event"
>
> "Obviously going to save some people - might encourage us to sell the bikes (for a side by side)"
>
> "XXXX dealer wants to stock them in his shop"

There was also the issue of responsibility for worker safety from a legal perspective:

> "I am going to fit all of my bikes with one - based on litigation"
>
> "Provides me as an employer some peace of mind, it's about protecting me from litigation. It's a line of defence in terms of safety"

Overall benefits of fitting were evident as was the fact that it had limited to no impact on the use of the quad bike:

> "Bar made no difference to stability or handling - don't know that it's there"
>
> "Three of us just didn't comment on it apart from niggling issues of towing"
>
> "In terms of them being a nuisance and in the way - that simply isn't the case"

Disadvantages

Without question the number one issue identified with the CPD was related to driving under hot tape fences and the tape being caught on the CPD:

> "When nip under hot tape - have to lift it up"
>
> "Going under fences is a problem - more of a dairy farm issue than other groups. My workers would take the quad without the bar for that reason"
>
> "Occasionally got in way going under electric fences but no major problem and we have left it on"
>
> "Once you get the hang of it just need to lift it up that much higher"

There were also two respondents that had contacted branches and one that could no longer drive the quad into the dairy (which was an infrequent event):

> "Did brush a tree branch but no issues"
>
> "Hit a few branches but that's really just about getting used to it. Forget that it's there but if it was like a ROPS with something in front wouldn't do it as you'd remember it was on. Branch I hit may be up to size of arm but didn't do anything when I hit the branch"
>
> "Don't know it's there and forget that it's there. Solution is just put a flexible mast at front of bike about same height as bar to remember it's there"

The second issue that was raised by several respondents involved issues around fitting trailers to the tow ball mounting point and limitations on the turning circle:

> "Hook-up of trailer, a bit of an obstacle"
>
> "Disadvantage restricted turning ability with trailer on"
>
> "Hooking up trailer & turning of trailer (bigger turning circle). Needs another extension plate to make this easier - but not a real big deal"
>
> "Have taken it off as when my wife reversed the trailer it got jammed and bent the tongue, otherwise I would have left it on"

Following this feedback (last point) a tow ball extension plate was provided to all participants and the participant has since re-fitted the CPD. Reports from several participants that have fitted the extension plate indicate that this has assisted with ease of hitching and moving trailers.

A further minor point was in relation to the noise that periodically came from the CPD:

> "Rattles a bit behind you"
>
> "Couldn't tell it was on other than a rattle every now and then"
>
> "Made the bike a bit noisier and did like the idea it was hooked to the tow ball and not the body as it didn't get in the way"

There were also some limited issues with carrying loads and fitting of registration plates reported:

> "Slight impact in carrying stuff but not a big deal"
>
> "Sometimes carrying stuff it gets in the way and especially under hot tapes. Bar had no impact on use other than that"
>
> "A bit tight behind the spray unit when reeling out hose"
>
> "Rego plates don't fit and fall off - could be easily solved by putting a space in to fit rego plates"

Both focus groups were asked to rate the significance of these disadvantages on a scale of 1 to 10, with 1 being none and 10 being major issues. One group categorised disadvantages as a 2 to 3, while the second group indicated it was 1 to 2 (at most). In the words of two participants:

> "We are nitpicking to give you some disadvantages"
>
> "Generally clutching at straws for disadvantages"

There was one subject that had reported the device had an impact on the suspension of the vehicle during the focus groups. However, following the focus group a secondary assessment of the quad bike during the re-fitting of one of the failed GPS units by the project officer, found that while the bike had quite stiff suspension, a minor adjustment to the set-up of the CPD rectified the issue.

Of the 11 subjects participating in the study 10 have kept the CPD fitted to their quad bike (4-6 months post intervention). As previously indicated another had removed the CPD due to issues with towing, however this has been resolved with provision of an extension plate for the tow ball and the CPD re-fitted. As such, only one subject has removed the CPD. This individual was most vocal in respect to the impact with hot tape contact but did indicate:

> "Don't think anything needs to be done in fitting them, as not sure they do anything. Inexperienced riders shouldn't be allowed near them. Even experienced people can get into strife. I took it off as bottom bolt came off - not going to re-fit it. Not an imposition having it fitted, pretty inert really other than inconvenience"

<u>Adoption by Farmers</u>

The adoption of CPDs by farmers is a complex issue to address and involves several inter-related factors.

Pre-existing attitudes can be difficult to overcome and there remains a tendency to focus on human error:

> "It's difficult as farmers are complacent and think they are bomb-proof"
>
> "Nothing can overcome safe use and riding a bike to it's and the riders limits. Bars might assist in certain circumstances but (they are) not the sole solution"

Consistency of information provided by quad bike manufacturers and other groups about the effectiveness of the devices also detracts from the potential uptake of CPDs:

> “Get a lot of mixed messages from manufacturers, this makes it hard to know what to believe”
>
> “Got to convince people it is not a hazard, especially if you employ people”
>
> “No real benefits as you need to put a roll bar on the front and have a belt”
>
> “More than happy to have it there but not well informed about its effectiveness”

Drawing on lessons from other areas such as that from the eventual mandatory requirement for Rollover Protection Structures (ROPS) on tractors:

> “While debate continues this makes people reluctant to spend money on it. It’s got to be a consistent message, making them mandatory would convince people. People were sceptical on tractor ROPS and (car) seat belts - but they work fine”
>
> “When frames were fitted to tractors (it) was based on bad accidents, this is the most effective way to show benefits”
>
> “Can do big brother carrot / stick that’s what’s needed”
>
> “Wouldn’t like to see it mandatory but it may come to that”

Public visibility of the devices has stimulated discussion with other workers, family members and even with quad bike retailers:

> “Benefits workers as they look at it and discuss safety. Haven’t had an accident to test it out but hopefully it will work when there is an event.”
>
> “Local AAAA dealer wants to stock them in his shop”
>
> “Local BBBB dealer is using (farmer - name withheld) as an example to other farmers about helmet use and could do the same about these”

Changes in patterns of use are observable, with greater recognition of safety issues per se and the use of more appropriate and stable vehicles:

> "We have banned visitors riding"
>
> "The next bike we get will probably be a two seater (side by side)"
>
> "I will be selling one of my quads and buying a Kubota (side by side) in part because I am getting a bit older - but also because I can carry more gear"

<u>Willingness to Pay</u>

Cost is always an issue:

> "Should be included into cost so it's a whole product - don't make it an option as farmers will not take that up (being cheap)"
>
> "What price do you put on a life, especially when you have teenage sons. Certainly not a big cost when compared to price of bikes - $200-300 easily "
>
> "Would pay $200 - but would pay $10,000 if it saved a life"
>
> "If it saves your life $500 is even a real bargain"
>
> "It comes down to $ or life"

Participants were also relatively consistent in indicating that they felt a cost of $200-$300 was reasonable, additionally issues of rebates and incentives were discussed:

> "$200 would make them compulsory and include in purchase price of bike"
>
> "Needs to also be reflected in a reduced insurance premium - that's an incentive"
>
> "50% rebates would be a big selling point"
>
> "Would pay about $250/300 - a subsidy like we had for the tractors would be good"

Potential Promotion Approaches

A range of methods to promote and increase the use of CPDs were outlined, however this is impacted by the previously mentioned uncertainty in relation to CPD's:

" Promotion and advertising through UDV"
"Needs to also be reflected in a reduced insurance premium - that's an incentive"
"If registration of bike required fitting of a bar at that point as a requirement, we would be getting bars on new bikes - no bar no insurance from the Traffic Accident Commission"
"The next bike we get will probably be a two seater (side by side)"
"Targeting through our wives really helps in focusing attention (on safety)"

Discussion

This study sought to determine the enablers and barriers to adoption of suitably tested crush protective devices (CPD) for quad bikes by dairy farmers. There were numerous perceived benefits associated with the fitting of these devices including increased personal safety and that of employees. However, there were also some issues identified, particularly in relation to contact with hot tapes that were seen as a negative. Further discussion of all relevant elements will be reported on in respect to each of the project objectives.

Benefits and Disadvantages of Fitting a CPD

The fitting of the devices clearly stimulated further discussion and debate around safety for both farm owners and workers. Responses indicated that this heightened the consideration of safety overall (not just in relation to quad bikes). Several respondents that employed staff also suggested that they felt it helped further contribute to their legal obligations in providing a safe workplace.

A consideration regarding fitting of CPDs are the purported influences that such devices have on useability and manoeuvrability of the quad bike. Drawing on the post-intervention survey and focus group/individual interviews, the CPD's had virtually no impact on the reported performance of the quad in terms of braking, steering, suspension and getting on/off. The most problematic issue was some contact with overhead objects, though most (n=7), reported no issues in this area.

A number of respondents indicated that they forgot that the CPD was attached and that when doing tasks that they have performed frequently, they have contacted objects. Most frequently this was electric fences (hot tapes) and periodically branches. The issue of hot tapes is predominantly commodity specific to dairy, however virtually all respondents thought that this could be overcome and was not really an impediment to improving the safety of the quads by having a CPD fitted. A relatively simple solution was proposed to fit a flexible mast to the front of the quad to remind them of the height of the CPD and many of these issues would be resolved.

A further issue raised by some respondents was fitting trailers to the tow ball once the CPD was in place and the manner in which this affected the turning circle. Subsequent to the focus groups / interviews, a small extension plate has been provided to all participants to enable easier fitting of towed equipment and to negate any impact on the turning circle.

There was some limited discussion in relation to small impacts in carrying loads, enabling the fitment of conditional registration plates and the rattling of the CPD being annoying. However, these were isolated issues raised from within the respondent group. In addition, the ranking of the significance of these disadvantages on a scale of 1 to 10, was very low (2/3) and (1/2) respectively, with 10 being a major issue.

Overall it was evident that the general feeling was that the CPDs enhanced safety and the disadvantages identified really required in the words of one participant some "nitpicking". This was further illustrated by the fact that 10 of the 11 CPDs fitted remained in place some four to six months post the completion of the study. For the one participant that removed the CPD he clearly stated that this was more to do with the inconvenience (particularly with hot tapes) and that the CPD itself was quite "inert".

Promotion Approaches to Increase Adoption of CPDs

Although there was a perception that CPDs would be beneficial in the event of an incident, there were a range of factors that needed consideration in increasing their adoption. A central point was the impact of the variation in arguments for and against the fitting of CPDs. Respondents indicated that they would be more comfortable fitting the devices if they were assured of their effectiveness, with the current impasse between health and safety organisations and the quad bike manufacturers, muddying the waters. As such, highlighting effectiveness appeared crucial to decisions by farmers regarding attitudes in fitting these devices. A consistent message was essential to move the issue forward.

There was a tendency by some respondents to emphasise human error as the core issue in relation to quad bike fatalities and injuries. This focus on "human error" in the quad bike debate has undoubtedly been propagated by quad bike manufacturers and as with virtually all injuries, human behaviour will play a part. As evidenced by some statements in this study, such "blame the user" approaches have certainly permeated the thinking of farmers. However, all participants acknowledged the importance of safe design as a first principle, with several relating safety back to design features in other areas of their work where they have seen safety benefits - tractors (ROPS), feed mixers / hammermills (guarding), electricity (Residual Current Devices) and silos (caged ladders). Such a first principles approach in tandem with clear evidence of effectiveness will be necessary to enhance adoption and start the safety process at the point of entry, that is, the design of the quad bikes. Notwithstanding this, an overarching safety approach for improved quad bike safety will also need to incorporate human factors.

Within the group there was a general belief in a carrot and stick approach being relevant to further promote uptake. Respondents raised and were highly attuned to the previous lessons drawn from tractors and the mandatory fitment of Rollover Protection Structures (ROPS). To them it was self-evident that this approach for tractors had provided innumerable benefits in saving many farmers lives. Significantly, many respondents also recalled the scaremongering undertaken by those against fitting of ROPS (and other issues like car seat belts) in raising issues such as contact with overhead obstacles and increasing the risk of injury, which have now been comprehensively de-bunked. As a general rule of thumb the agricultural sector is disinclined to support increased regulation, preferring instead to adopt self-regulated standards. Such a position was obvious in the feedback provided by these respondents in relation to CPDs. However, it was noted that if it came to a position where fitting CPDs was mandatory, such a position would be accepted though not preferred.

The fitting of the CPDs within this group of participants has stimulated considerable discussion around safety issues by other family members, staff and also quad bike retailers. This public visibility is a factor that can and should be built on to enhance further uptake of the CPDs. As with any new idea/concept, the more it can be showcased the greater are the chances of uptake as people recognise potential benefits. While respondents were aware there were some issues with quad bikes, most had no idea of the broader scope of the problem. All participants were aware of at least someone that had an incident and while they hear of these localised events, rarely are all of those incidents presented as an overall picture for the state or nationally. Ensuring such information is available to farmers will help to keep the issue on their radar.

Information from some respondents on the attitudes of local quad bike retailers was noteworthy. One reportedly expressed an interest in stocking the CPDs and another was critical of the devices. The basis of the rationale for each of these retailers is unknown as they were not interviewed as part of the study, however what is evident is that even within the industry the debate over CPDs appears polarised. A significant barrier for retailers as franchisees is that even if they wish to stock and/or fit CPDs, their capacity to do so under the terms of their distribution contracts with the quad bike manufacturers' is limited. For example, one study participant reported they are in the process of purchasing a new quad bike and has stipulated to the retailer that it must be fitted with a CPD, while another that has already purchased a new quad, is having difficulty in getting the retailer to fit a CPD. Just how retailers will respond in such circumstances, as it may be in breach of their franchise agreements with the manufacturers, is unknown. What is certain is that this provides a disincentive for retailers to promote CPDs. To add further complexity, there is irrefutable evidence that owners have been informed that their warranties may be voided if a quad bike is fitted with a rollover protection structure.

These factors highlight the necessity for independent evidence regarding the effectiveness (or otherwise) of CPDs for use by both consumers and quad bike retailers. Furthermore, there is a clear role for WorkSafe and product safety agencies in ensuring access to genuinely independent evidence-based information as the persistent pattern of behaviour by the manufacturers' and the FCAI, has been to bluntly reject all propositions regarding improving rider safety through fitment of a CPD in the event of a rollover. Just how this sits legally with consumer law (product safety) and the responsibilities of designers, manufacturers and distributors to manage the risks of overturn for "plant" under health and safety law, are worthy of further consideration.

At a practical level, respondents felt there were mechanisms to increase uptake of CPDs. This included promotion through the various forums of the United Dairy Farmers of Victoria and in the media, options that are likely to be highly feasible given the UDV support for this project. Additionally, a number of respondents suggested that targeting safety information to their wives would have the greatest impact in enhancing acceptance of CPDs. This has also been suggested in other studies with farmers more generally, as an important conduit to improving safety.[22]

The second mechanism was to examine incentives for reductions in insurance premiums when a CPD is fitted. This too may be feasible, but will require significant negotiation with the insurance industry and state governments who set workers compensation premium levels. However, the large and ongoing costs associated with severe trauma (particularly head and spinal injury), are likely to be strong triggers to prompt action.

In discussing the tractor ROPS success, respondents raised the issue of rebates and just how effective that has been in "prompting" them to fit the devices to older tractors. Although uptake remains less than 100%, this was seen as a suitable incentive for farmers to retro-fit the CPDs.

In Victoria, there is a requirement for conditional registration of quad bikes that are used in crossing public roads, most frequently between adjoining paddocks. Respondents suggested that a registration requirement could be that a CPD is fitted and without a CPD, users would be ineligible for insurance from the Traffic Accident Commission (TAC). The regularity of updating new quad bikes reported by study participants (average 4.2 years) also provides some limited scope to gradually update the national fleet with CPDs. While there may be some merit in such an approach, further investigation of the numbers of quad bikes conditionally registered in Victoria would be required and even if fitted to all vehicles at the point of registration, there would likely be a majority of quad bikes that are not registered. Consequently, for those quad bike owners that do not need to meet TAC registration requirements, there would be no "push-factor" for them to fit a CPD. For more widespread adoption nationally, registration requirements from each of the jurisdictions across Australia would need to be assessed before such an approach could recommended.

In considering the range of promotional points raised above it is relevant that consideration be given to how the Diffusion of Innovation theory[23] may be used to improve further adoption of CPDs. In summary, this theory proposes that innovators and early adopters who accept new ways of doing something (e.g. fitting a CPD), overtime influence others into accepting such approaches. The approach is widely known and utilised in existing agricultural extension programs and includes:

a) Attention to such details as the *compatibility* of the innovation with existing socioeconomic and cultural values. In this case CPDs will reduce injuries and the costs associated with those, while culturally it is no different in essence to protective devices on any other equipment, such as a ROPS on a tractor.

b) A clear view of the *relative advantage* of the innovation compared to current practices (including cost-effectiveness, usefulness and convenience). For CPDs, having one fitted increases the net protective effect (by up to 29% for the Quadbar) compared to non-fitted bikes.[11] As each quad bike fatality is estimated to cost in the vicinity of $1.6 million there is no question that they would be cost-effective.[24] Further the results from this study illustrate that they are convenient and have little to no negative impacts on usage patterns.

c) The *simplicity and flexibility* of the innovation. Fitting of CPDs to the tow ball of the vehicles is a straightforward process, which farmers in this study indicated posed no problems.

d) *Reversibility and perceived risk* of taking on board the innovation. In this instance it would be a simple matter of removing the CPD if so required from the tow ball.

e) *Observability* of the results, so that others who may be contemplating adoption of the innovation, can see it working. In this instance the public visibility of the product in newspapers, other media, training courses and being used on-farm will be important to uptake.

Any future promotional approaches should be built around these criteria and developed in close collaboration with the farming sector and its representative organisations.

Willingness-to-Pay for CPDs

Items relating to the willingness to pay for the CPD elicited some interesting responses. There was a wide range of opinions from $1000 in the post-survey to “would pay $10,000 if it saved a life” in the focus groups/interviews. Alternatively two of the respondents indicated they would not purchase one. However, the majority of respondents in the survey (n=7) indicated a cost between $200-400 was reasonable, while all of those that participated in the focus groups agreed on a $200-$300 cost.

When cross referenced with their likely longer term continuation in the industry, there was no obvious pattern arising in relation to what cost was seen as realistic. Importantly, there was a perception that it was better to have CPDs as a standard piece of equipment on a quad bike rather than an additional and/or optional extra. Some respondents reported that if it is an extra option, farmers are less likely to take it up as they are trying to save funds wherever possible. If it could be subsumed into the existing cost of the quad bikes at point-of sale that would be ideal and would not be questioned by farmers.

Based on these preliminary findings and the earlier discussions raised regarding potential rebate subsidies, there may be further scope for investigation of such an approach. Given that estimates are that each quad bike fatality costs the economy on average $1.6 million, such an investment may have a strong cost: benefit outcome.[24] Furthermore, these figures do not account for the significant morbidity (often lifelong) associated with quad bike use in Victoria.

Rider Exposure and Behaviour

Daily use of quad bikes during the study was determined to be an average of 1.5 hours, with all but one participant falling into the 1-2 hour range. Given the need to move milking cows on a daily basis this would translate to estimated annual exposure of almost 550 hours for each quad bike (noting it may not be the same individual that is always riding). This is a considerable period of risk-exposure within the business and only accounts for one quad bike per property (the 11 subjects reported a total of 21 quad bikes being owned on the property).

Not surprisingly the average speed of use was relatively low (8.4 km/h), with 71% of use under 10km/h (in keeping with movement of dairy stock) and 95% under 30km/h. While the average maximum speed was 46.6 km/h, there was notable variation between participants (range 11-70+ km/h). Although increasing speed will raise risk, even at low speeds, quad bikes pose a high risk from rollovers. As such, there remains a critical need to manage the risk of rollover events. Additionally, the use of suitable helmets, irrespective of speeds, remains valid in assisting to reduce head injuries.

Changes in Use

In broad terms of managing risk, there were two standout points raised by respondents. The first was a much higher recognition of the safety issues associated with quad bike use in general. A specific outcome reported by at least one respondent was that they had banned visitors from riding quad bikes (albeit after an incident involving a visitor). Similarly, several others indicated that they actively discouraged visitors from riding quads on their property, with this being supported by the finding that in the two weeks of the intervention, not one farm reported that a visitor had ridden the quad bike fitted with the CPD. This provides an opportunity for a targeted campaign to alert farmers to their legal requirements to manage risk for all people regardless of work status, that enter their workplace.

The second factor was the gradual move away from quad bikes to more stable and less injurious vehicles in the event of a rollover. Two of the respondents were very clear that they would be moving to side by side vehicles and for one of these this was specifically related to his age and the practical advantage of being able to carry goods. This could well be significant, as with the ageing farmer population (mean ~ 55 years),[25] issues with the stability of quad bikes will only continue to escalate due to physiological changes associated with the ageing process. This phenomenon is not just isolated to Australia, but has also been identified in the USA.[26] [27] In the context of assisting farmers to stay involved in agricultural production, increasing emphasis on the use of safer alternate vehicles to quad bikes cannot be underestimated and could well form part of a wider promotional effort to reduce mortality and morbidity associated with quad bikes. Indeed, in light of wide-scale negative publicity associated with the safety of quad bikes as they relate to rollover risks, there is strong anecdotal evidence that quad bike manufacturers' are directing increased advertising budgets to the promotion of side by side vehicles.

Study Strengths

A pivotal strength of this exploratory study is the mix of quantitative and qualitative methods utilised. Firstly, the quantitative data from the pre-intervention surveys provided a means to establish a baseline on a range of factors that may influence uptake of CPDs. Similarly, the post-intervention surveys provide direct self-report on issues associated with fitting / use of the CPD. The mixed methods approach has also assisted in validating information derived from self-report and to improve the depth of feedback attained. To our knowledge this is the first study looking at the use of crush protection devices and the opinions of those that use them in the international literature.

Included as part of these pre- and post-intervention assessments are items related to both estimated average and maximum speeds. When coupled with data from the GPS assessments, this provides an indicator by which the accuracy of self reported speeds can be objectively determined.

However, while speed is likely to be an important factor which increases injury risk overall, it must be noted that even at very low speeds, the risk of crush and asphyxiation from rollover events remains high.

Within the study design itself careful attention was paid to ensure that as little bias as possible was introduced. The participants' information sheet identified that the CPDs in use for this study had been illustrated by the manufacturers' own data to have a net protective benefit.[11] When fitting the CPDs the Project Officer was instructed not to discuss issues of effectiveness, the cost of the CPDs themselves, nor to comment on any media reports on CPDs that may be in the press. Similarly, during the focus groups / individual interviews, if any questions were raised by subjects to the researchers that may have biased the collection of information, such questions were held over to the conclusion of the data collection phase and then discussed, so that they were not incorporated into these results.

The opportunity provided by the structured focus group/ individual interview also enabled further data to be obtained that reinforced issues pertaining to the useability, benefits, disadvantages and willingness to pay for a CPD. The promotion approaches identified by participants to increase further uptake were also well defined in this process.

Study Limitations

A limitation of this study was the small number of participants and the fact that compared to their Victorian and national counterparts, the sample was younger, had larger property sizes and milked more cows.[21] In part, this may be an artefact that not all participants involved in this study were farm owners. Moreover, the voluntary nature of subject recruitment via the UDV was not random and may have provided some bias as larger size business operations may be more likely to volunteer for such a study and be industry innovators / early adopters. Further, the patterns of usage can vary depending on the season and activities being undertaken at the time of assessment, and could result in either an over or underestimate of use. Notwithstanding these issues, the study was exploratory in nature and does provide a reflection of some of the prevailing thoughts, attitudes and actions of dairy farmers in respect to quad bikes.

A further limitation is the potential contagion that may result from specific media stories and/or interventions by those either supporting or opposed to CPDs. Additionally, it was impossible to control for other external factors such as the opinions of other farmers and/or quad bike retailers with whom subjects may have discussed the CPDs.

While it was the same individuals that completed both the pre- and post-intervention surveys, it is possible that in some instances other workers/family members may have used the quad bike during the initial two day period in which speed data were collected. Additionally, for simplicity, study participants were requested to report on average and maximum speeds over the 14 day period. However, the GPS data relevant to speed was only able to be tracked for the first two days using MIT data. While it is assumed that daily usage patterns (including speeds of operation) only vary marginally, these issues may result in some variations between the stated maximum speeds in the post-intervention survey and the objective GPS data.

The application of GPS tracking to monitor quad bike movement has proven challenging and has included considerations regarding the robustness of the sensing data in normal farm usage situations. The use of GPS units which automatically collected data at set intervals was deemed necessary to reliably record quad bike use. This was in comparison to the use of a GPS unit that is manually switched on and would have been subject to the judgement of farmer to activate the device. The GPS units set to record positions automatically provided an ideal platform when the bike was actually in use but experienced several challenges, particularly increased error of position recording when parked in a shed. This increased error of position is due to poor signal strength and multi-path GPS signals being recorded whilst the bike is out of the direct sight of GPS satellites. These errors resulted in movements well above the normally stationary error of GPS being reported and models had to be developed to determine when the bikes were truly being used and when the GPS error was erroneously suggesting that they were moving. This problem was compounded by the fact that these quad bikes were being used on dairy farms where it appears a large proportion of usage was at low speeds, for example following along behind a herd of cows. Despite these challenges a reasonably sound estimate of the use and movement parameters of these bikes has been developed. Further research and analysis would be worthwhile to validate the data and models used to predict usage events.

It is clear from the challenges identified in this research that future monitoring of quad bikes should include systems that integrate both accelerometer and GPS, this would clarify when bikes were being used and when the GPS error was erroneously suggesting that they were being used. Another research technique which may be of value is video recording of the activity of the bike via a camera mounted on the bike and facing forward. This would enable better classification of the use of the bike e.g. moving cows, riding along a road, which would bring a further degree of clarity to the results.

Future Research

Clearly, as this assessment only related to dairy farms its applicability to other commodity sectors requires further assessment. However, in relation to the major issue assessing attitudes, benefits and disadvantages of fitting a CPD and the impact on useability of the quad bike, there is no reason to suggest that findings would be significantly different. In this study the most obvious of the disincentives to fitting a CPD were issues involving movement under hot tapes. This is almost exclusively a dairy farm specific issue.

The one area where there is likely to be some variation is in respect to average and potentially maximum speeds. Given the nature of dairy farming it would be expected that speed of use in moving milking cows will be slow. In contrast, commodity groups such as grains, cotton, sugar and horticulture are not constrained by stock movement. Similarly, in areas where beef and sheep/wool production predominate, the use of quad bikes for mustering is common, which generally requires higher speeds. Further assessment in these commodity groups is necessary to examine the issues and specifically to highlight commodity-relevant approaches to promoting CPDs.

While not the focus of this study, it is agreed that a broad and evidence-based approach to reducing deaths and injuries from quad bike use drawing on the hierarchy of controls is required. Included in this must be attention to improving selection of the most appropriate vehicle for the task to be undertaken, enhancing bike maintenance and condition, ensuring passengers are not carried, enforcing a no-child policy on quad bikes of all sizes, placing restrictions on the use of quad bikes by visitors, ensuring all people that ride quads are competent and suitably trained, plus use of a helmet. Any future studies should incorporate these issues to help build the evidence-base for successful interventions.

Conclusion

This exploratory study sought to determine the enablers and barriers to adoption of suitably tested CPDs for quad bikes by dairy farmers. Overall, the CPD was viewed positively by the majority of participants despite some issues of contact with hot tapes and towing. The major barrier to adoption was the disputed arguments regarding the effectiveness of CPDs that continue in the public domain. As illustrated in this study, once farmers have been provided an opportunity to use a CPD, virtually all of the purported reasons proposed by the quad bike manufacturers' to not fit such devices, have been debunked.

The results suggest there are steps that can be taken to increase the uptake of CPDs by dairy farmers. The cost of the CPDs is not a major barrier, with linkage to existing conditional registration requirements and/or financial incentives likely to lead to increased adoption. Furthermore, with increased usage of CPDs and therefore greater public visibility, it is likely that higher levels of uptake will follow. New programs taking into consideration the elements of diffusion of innovation are required.

There remain significant deficiencies in the design of quad bikes and their capacity to protect riders in the event of a rollover as required by National Work Health & Safety Regulations for "plant".[28] Any new vehicles sold into a workplace should comply with these Regulations. Furthermore, there are issues that relate to product safety in respect to quad bikes, whether that is for work or non-work purposes. While farmers appear to be increasingly moving toward alternate and safer forms of farm transport, there remains a significant fleet of quad bikes in Australia that would benefit from retro-fitting of CPDs. Based on existing information on their effectiveness, any further lag in the promotion of these potentially life-saving devices will only add to the death and injury burden caused by quad bikes.

Annex 1

THE UNIVERSITY OF SYDNEY

School of Public Health
Faculty of Medicine

ADOPTION OF QUAD BIKE CRUSH PROTECTION DEVICES PROJECT

Pre Intervention Survey

Thank you for taking the time to complete this survey.

If you have any questions regarding the survey please contact the Principal Researcher:

Dr Tony Lower
Director
Australian Centre for Agricultural Health & Safety
Ph: (02) 6752 8210
Email: tony.lower@sydney.edu.au

Date:........../.............../.................

INSTRUCTIONS
PLEASE PLACE A TICK OR CROSS IN THE APPROPRIATE BOX(ES)

A. PERSONAL DETAILS
All information recorded will remain confidential.

1. What is your unique code? ....

2. Year of Birth: 19.........

3. Sex: ☐ Male ☐ Female

4. Height....................cm

5. Weight...................kg

6. Do you hold a motorcycle licence (2 wheel)? ☐ Yes ☐ No

7. If yes to Q6, how long have you held a motorcycle licence for?................years

8. If yes to Q6, how often have you ridden on the road in the past year?

- ☐ Never
- ☐ Just Once
- ☐ 2 - 3 times
- ☐ 4 - 10 times
- ☐ 11 - 20 times
- ☐ More than 20 times
- ☐ Don't know

9. What is your employment status? (select most relevant answer)

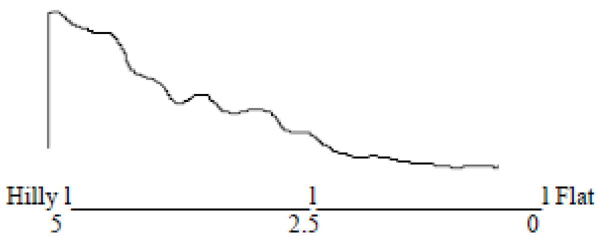
- ☐ Farm Owner
- ☐ Farm Manager
- ☐ Farm Worker
- ☐ Farm Family Member
- ☐ Other (specify)..............................

B. FARM DETAILS

10. Farm Size...ha

11. Current number of cattle milked? ……………………………….........

12. On the scale below rank the topography of your property (if your property is a mixture of hills and flat place a mark at 2.5, if it is more hilly then flat place a mark between 2.5 and 5).



13. Over the last 12 months, how many farm workers did you have on your farm, including employed persons and those not paid wages such as family, that were working:

a) Full-time ____ number workers

If > 0: what was the approximate total number of weeks worked on the farm by full-time workers? ____ number weeks

b) Part-time (including contract milkers) ____ number workers

If > 0: what was the approximate total number of weeks worked on the farm by part-time workers? ____ number weeks

14. In the past 12 months, who has ridden quad bikes on your property?

- ☐ Farm Owner
- ☐ Farm Manager
- ☐ Farm Family Member (specify # that have ridden) ___
- ☐ Farm Worker (specify # that have ridden) ___
- ☐ Farm Visitors (specify # that have ridden) ___
- ☐ Other (specify # that have ridden) ___

C. EXPERIENCE

15. How frequently would you ride a quad bike?

- ☐ Daily
- ☐ 3-4 days a week or more
- ☐ 1 - 2 days a week
- ☐ 1 - 3 days a month
- ☐ A few days a year

16. How long have you been riding quad bikes?

- ☐ < 1 year
- ☐ 1 - 2 years
- ☐ 2 - 5 years
- ☐ 6-10 years
- ☐ > 10 years

17. At what age did you start riding a quad bike?..............................years

18. On a busy day how long would you spend riding a quad bike?

- ☐ < half hour
- ☐ 30 min-< 1 hour
- ☐ 1 - 2 hours
- ☐ 2 - 5 hours
- ☐ > 5 hours

19. On a slow day how long would you spend riding a quad bike?

- ☐ < half hour
- ☐ 30 min < 1 hour
- ☐ 1 - 2 hours
- ☐ 2 - 5 hours
- ☐ > 5 hours

20. Who taught you how to ride a quad bike? *(tick more than one if necessary)*

- ☐ Self
- ☐ Friend
- ☐ Dad
- ☐ Mum
- ☐ Brother / Sister
- ☐ Instructor
- ☐ Other Adult, please specify.........

21. Have you completed a quad bike rider training course? (If no, skip to Q23)

☐ Yes ☐ No

22. If you have completed a rider training course, when (year) and where (town/farm location) was it run and who ran it (e.g. TAFE teacher, quad company riding instructor)?

(a) When (year):,,,?

(a) Where:..

(b) Who:..

D. QUAD BIKE DETAILS

23. How many quad bikes are on the farm?......... (number)

24. Can you give the following technical details about the quad bikes on your farm?

	Quad Bike 1	Quad Bike 2	Quad Bike 3	Quad Bike 4
Make				
Size (cc)				
Year of manufacture (approx)				
3 or 4 wheel	☐ 3 ☐ 4	☐ 3 ☐ 4	☐ 3 ☐ 4	☐ 3 ☐ 4
Brakes functioning well	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
Hand control levers in good condition	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
Tyre tread good	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
Tyre pressure correct	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
Seat in good condition	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

25. Which of these quad bikes (1, 2, 3 or 4) is to be fitted with the crush protection device (CPD) for this trial? .... (quad number – as per Q 24)

26. For the quad bike that will be fitted with the CPD, how often is routine maintenance performed on the quad bike?

(a) Oil: ☐ Daily ☐ Weekly ☐ Monthly ☐ Never ☐ Breakdown
(b) Brakes: ☐ Daily ☐ Weekly ☐ Monthly ☐ Never ☐ Breakdown
(c) Suspension: ☐ Daily ☐ Weekly ☐ Monthly ☐ Never ☐ Breakdown
(d) Chain: ☐ Daily ☐ Weekly ☐ Monthly ☐ Never ☐ Breakdown
(e) Tyres: ☐ Daily ☐ Weekly ☐ Monthly ☐ Never ☐ Breakdown
(f) Exhaust: ☐ Daily ☐ Weekly ☐ Monthly ☐ Never ☐ Breakdown

27. What are the main use(s) for your quad bike /s?

(a) Mustering/ moving stock: ☐ Daily ☐ Weekly ☐ Sometimes ☐ Never
(b) Transport: ☐ Daily ☐ Weekly ☐ Sometimes ☐ Never
(c) Spraying: ☐ Daily ☐ Weekly ☐ Sometimes ☐ Never
(d) Carrying: ☐ Daily ☐ Weekly ☐ Sometimes ☐ Never
(e) Towing: ☐ Daily ☐ Weekly ☐ Sometimes ☐ Never
(f) Recreation: ☐ Daily ☐ Weekly ☐ Sometimes ☐ Never
(g) Other:...

28. What would be the average speed of quad bike operation on your farm?...............km/h

29. What would be the maximum speed of quad bike operation be on your farm?...............km/h

30. During what periods of the day would you normally ride your quad bike? (you can tick more than one)

□ 5.00am - 10.00am	□ 3.00pm - 8.00pm
□ 10.00am - 3.00pm	□ After 8.00pm

31. Approximately how often would you consider replacing quad bikes on your farm? ...... (years)

E. PROTECTIVE CLOTHING AND EQUIPMENT

32. When you ride a quad bike how often do you wear?

Helmet:	□ Always	□ Usually	□ Sometimes	□ Never
Work Boots:	□ Always	□ Usually	□ Sometimes	□ Never
Goggles:	□ Always	□ Usually	□ Sometimes	□ Never

F. INJURY DETAILS

33. Have you had a quad bike injury?

□ Yes **Go to Q34**

□ No **Go to Q45**

G. ACCIDENT

34. If yes, please specify the type of injury you sustained in your **most recent accident** *(please tick **only one**).*

□ Cuts / Lacerations	□ Puncture / Penetrating
□ Abrasions	□ Bruising
□ Swelling / Pain	□ Burns
□ Foreign Body in eye	□ Crush Injury
□ Fracture	□ Dislocation
□ Sprain / Strain	

□ Other, please specify...

35. If yes, please specify the body part injured *(choose the body part that was* ***most seriously*** *injured).*

Head:
- ☐ Eye
- ☐ Nose
- ☐ Ear
- ☐ Face/cheek/forehead
- ☐ Skull

Upper Body:
- ☐ Shoulder
- ☐ Upper arm
- ☐ Elbow
- ☐ Forearm
- ☐ Wrist
- ☐ Finger
- ☐ Hand

Trunk:
- ☐ Ribs
- ☐ Spine
- ☐ Pelvis
- ☐ Chest
- ☐ Abdomen
- ☐ Back
- ☐ Genitalia

Lower Body:
- ☐ Hip
- ☐ Upper leg
- ☐ Knee
- ☐ Lower leg
- ☐ Ankle
- ☐ Toes
- ☐ Foot

36. Did the incident involve a rollover of the quad bike?

☐ Yes ☐ No

37. Please specify the way the accident occurred (e.g. collision with stump, swerved to miss a rock, lost balance etc)

....
....
....
....

38. What type of quad bike were you riding?

(a) Make:..

(b) Engine Size:................................cc

(c) Age of Motorcycle:.......................yrs

(d) Number of Wheels: ☐ 3 wheels ☐ 4 wheels

39. Approximately how long had you been riding the quad bike before the accident occurred?

- ☐ < half hour
- ☐ 30 min-60min
- ☐ 1 - <2 hours
- ☐ 2 - <4 hours
- ☐ > 4 hours

40. Approximately how fast were you going when the accident occurred?.................km/h

41. Where you carrying

(a) Passenger	☐ Yes	☐ No
(b) Spray tank	☐ Yes	☐ No
(c) Heavy load (> 10kg)	☐ Yes	☐ No
(d) Towing trailer etc	☐ Yes	☐ No

42. What was the best description of the topography where the incident occurred?

- steep
- flat
- hilly
- Not Applicable(e.g. happened loading/unloading from ute)
- undulating

43. Did you seek medical treatment? (e.g. GP, hospital, physiotherapist)

- Yes
- No

44. In hindsight, what do you think could have prevented the accident or reduced your injury? e.g. better brakes, riding slower, wearing a helmet, more experience etc

....
....
....

H. NEAR MISS INCIDENTS

45. Have you ever had a crash on a quad bike that has not resulted in injury? e.g. hit a rock and thrown over the handlebars landing on your back.

- Yes
- No

46. Approximately, how many such incidents have you had?

- 1
- 6-10
- 2-3
- >10
- 4-5

47. Have you ever had an incident where the quad bike has rolled and/or tipped over?

- Yes
- No

48. Approximately, how many rollover incidents have you had?

- None
- 4-5
- 1
- 6-10
- 2-3
- >10

Please place the completed survey in the envelope supplied and give the sealed envelope directly to the Project Officer after he has fitted the Crush Protection Device.

THANK YOU VERY MUCH FOR YOUR TIME

Annex 2

THE UNIVERSITY OF SYDNEY

School of Public Health
Faculty of Medicine

ADOPTION OF QUAD BIKE CRUSH PROTECTION DEVICES PROJECT

Post Intervention Survey

Thank you for taking the time to complete this survey.

If you have any questions regarding the survey please contact the Principal Researcher:

Dr Tony Lower
Director
Australian Centre for Agricultural Health & Safety
Ph: (02) 6752 8210
Email: tony.lower@sydney.edu.au

Date:........../.............../.................

INSTRUCTIONS **PLEASE PLACE A TICK OR CROSS IN THE APPROPRIATE BOX(ES)**

1. I.D. NUMBER:..................................

Please answer all of the following questions in relation to the 14 day period when the quad bike was fitted with the crush protection device (CPD). All questions relate solely to the quad fitted with the CPD.

2. During the 14 day period, who has ridden the quad bike fitted with the CPD on your property?
   - ☐ Farm Owner
   - ☐ Farm Manager
   - ☐ Farm Worker (specify # that have ridden) ___
   - ☐ Farm Family Member (specify # that have ridden) ___
   - ☐ Farm Visitors (specify # that have ridden) ___
   - ☐ Other (specify # that have ridden) ___

3. Over the 14 day period on how many days did you ride the quad bike?

☐ Daily	☐ 2-4 days
☐ 11-13 days	☐ 1 day
☐ 8-10 days	☐ 0 days
☐ 5-7 days	

4. Over the 14 day period on average how long did you spend riding the quad bike?

☐ < half hour	☐ 2 - 5 hours
☐ 30 min-< 1 hour	☐ > 5 hours
☐ 1 - 2 hours	

5. Over the 14 day period, approximately how many kilometres would you have covered on you quad bike?...km

6. For the quad bike fitted with the CPD, how often did you perform routine maintenance over the 14 day period?

(a) Oil:	☐ Daily	☐ Weekly	☐ Monthly	☐ Never	☐ Breakdown
(b) Brakes:	☐ Daily	☐ Weekly	☐ Monthly	☐ Never	☐ Breakdown
(d) Suspension:	☐ Daily	☐ Weekly	☐ Monthly	☐ Never	☐ Breakdown
(e) Chain:	☐ Daily	☐ Weekly	☐ Monthly	☐ Never	☐ Breakdown
(f) Tyres:	☐ Daily	☐ Weekly	☐ Monthly	☐ Never	☐ Breakdown
(g) Exhaust:	☐ Daily	☐ Weekly	☐ Monthly	☐ Never	☐ Breakdown

7. For the quad bike fitted with the CPD, what were the main uses over the 14 day period?

(a) Mustering/ moving stock:	☐ Daily	☐ Weekly	☐ Sometimes	☐ Never
(b) Transport:	☐ Daily	☐ Weekly	☐ Sometimes	☐ Never
(c) Spraying:	☐ Daily	☐ Weekly	☐ Sometimes	☐ Never
(d) Carrying:	☐ Daily	☐ Weekly	☐ Sometimes	☐ Never
(e) Towing:	☐ Daily	☐ Weekly	☐ Sometimes	☐ Never
(f) Recreation:	☐ Daily	☐ Weekly	☐ Sometimes	☐ Never

(g) Other:...

8. What was the average speed of quad bike operation be on your farm over this 14 days?
...............km/h

9. What was the maximum speed of quad bike operation be on your farm over this 14 days?
...............km/h

10. During what periods of the day did you normally ride your quad bike? (you can tick more than one)

☐ 5.00am - 10.00am	☐ 3.00pm - 8.00pm
☐ 10.00am - 3.00pm	☐ After 8.00pm

11. When you rode the quad bike during the 14 day period how often did you wear?

Helmet:	□ Always	□ Usually	□ Sometimes	□ Never
Work Boots:	□ Always	□ Usually	□ Sometimes	□ Never
Goggles:	□ Always	□ Usually	□ Sometimes	□ Never

12. When you rode the quad bike fitted with the CPD during the 14 day period, did you notice any impact on:

(a) Braking	□ Significant	□ Some	□ Little	□ None
(b) Steering / handling	□ Significant	□ Some	□ Little	□ None
(c) Suspension	□ Significant	□ Some	□ Little	□ None
(d) Getting On/off quad	□ Significant	□ Some	□ Little	□ None
(e) Contact with objects (branches etc)	□ Significant	□ Some	□ Little	□ None
(f) Other (please specify)				

....

....

....

13. From seeing the crush protection device (CPD) fitted to your quad bike by the Project Officer - How long do you estimate that it would take you to fit a CPD to another bike?

□ < 30 minutes □ 30-60 minutes □ > 60 minutes □ Unsure

14. From seeing the crush protection device (CPD) fitted to your quad bike by the Project Officer - How easy / difficult to follow were the instructions for fitting the CPD?

□ Very difficult □ Difficult □ Easy □ Unsure

15. Did fitting the crush protection device (CPD) make you change the way you rode the quad bike in any way (if yes, please specify)

□ Yes □ No

....

....

....

16. Did having the crush protection device fitted make you feel safer on the quad bike?

□ Yes □ No □ No different

17. Based on your experience of having the crush protection device fitted to your quad bike, would you recommend fitting of this CPD to other farmers? (please briefly explain your answer)

 Yes No No different

....

....

....

18. If you have more than one quad bike on your farm will you be purchasing crush protection device to fit to each of these?

 Yes No Unsure Not applicable (only one quad on farm)

19. Based on your current circumstances in dairy farming, how many more years do you think that you will remain working in the dairy sector?

 < 1 1-5 years 6-10 years > 10 years

20. On average it is estimated that quad bikes are responsible for several hundred Hospital Emergency visits each year, not to mention the many minor incidents that do not require medical intervention. How high do you consider the risk to yourself, family, employees or visitors of a non fatal quad bike injury on your farm?

 Non-existent Probable
 Unlikely, but possible Inevitable
 Possible

21. What would you be willing to pay for an effective crush protection device to avoid an employee / family member suffering a non-fatal injury that does not require hospital or GP attention (e.g. major bruising, small laceration)?

 $1000 $400
 $800 $200
 $600 Would not purchase one

22. On average there have been 14 quad bike fatalities per year for the last 10 years, with half of these involving rollovers of the quad bike. How high do you consider the risk to yourself, family, employees or visitors of a fatal quad bike injury on your farm?

 Non-existent Probable
 Unlikely Inevitable
 Possible

23. Are there any other comments you would like to make regarding the benefits or disadvantages of fitting a crush protection device to your quad bike?

....

....

....

....

....

....

Please place the completed survey in the supplied and give the sealed envelope directly to the Project Officer after he has removed the GPS.

THANK YOU VERY MUCH FOR YOUR TIME

Annex 3

School of Public Health
Faculty of Medicine

FOCUS GROUP GUIDE

1. To start, please introduce yourself and tell us about your farm business?

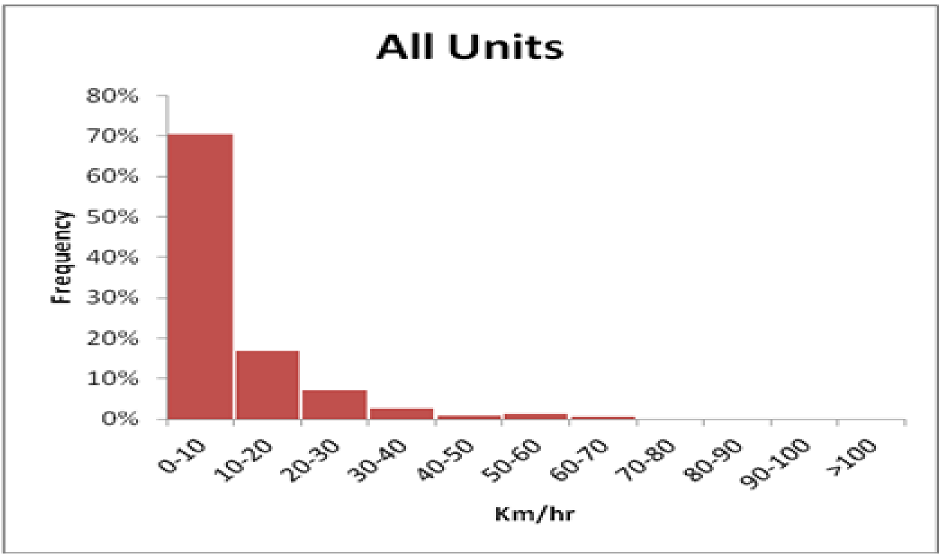
Please take into account the overall survey results we have presented.

2. What do you see as the disadvantages and benefits of fitting a crush protection device to your quad bike?
    a. Benefits
    b. Disadvantages
3. For the disadvantages, are there ways they could be overcome?
    a. Work through each disadvantage listed
    b. On a scale of 1 to 10, how significant are these disadvantages, with 1 being no issue and 10 being a major issue
4. For the advantages, how could /should these be promoted to other farmers?
    a. Work through each benefit listed
5. What do you think the attitudes are of most other farmers to fitting crush protection devices to their quad bikes?
    a. How can these attitudes be used and/or changed to encourage fitting of crush protection devices?
    b. What are the networks of people, organisations, media that we could tap into to promote uptake of crush protection devices by farmers?
6. How much of a barrier is the cost of fitting a crush protection device?
    a. How could this be addressed?
7. Do you have any other comments or suggestions about the crush protection devices?
8. Are there any questions I should have asked about the crush protection devices but did not?

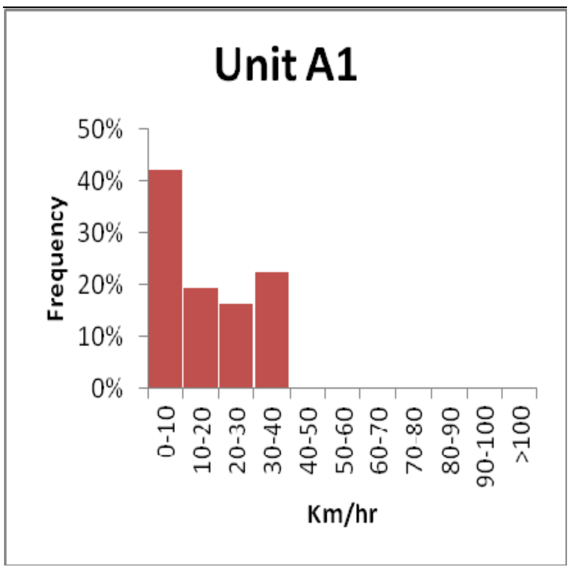
Thank you for your time.

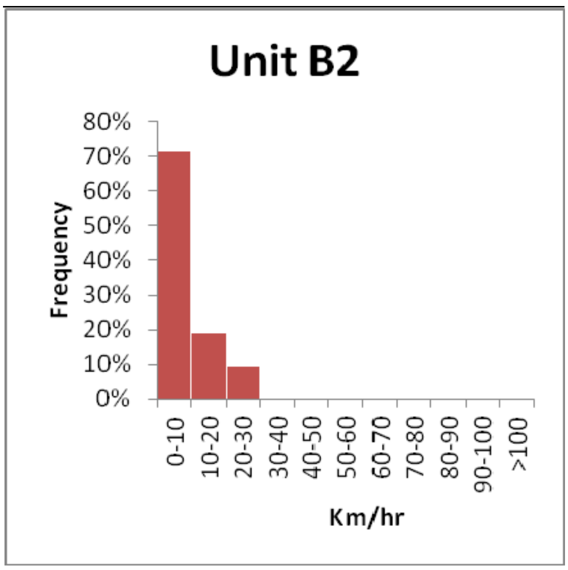
Annex 4

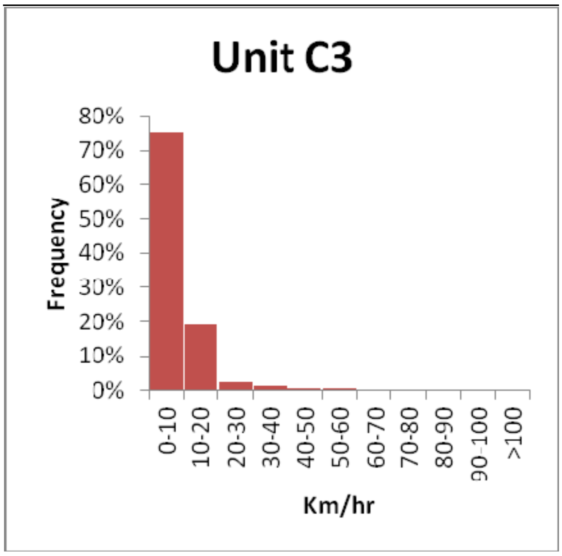
Speed Distributions (All Units)

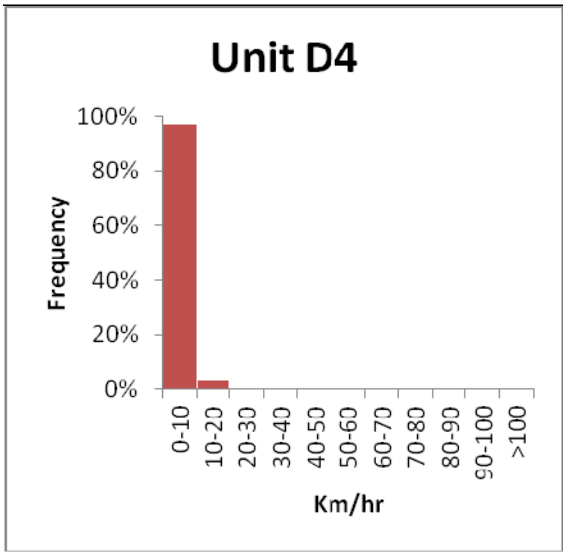


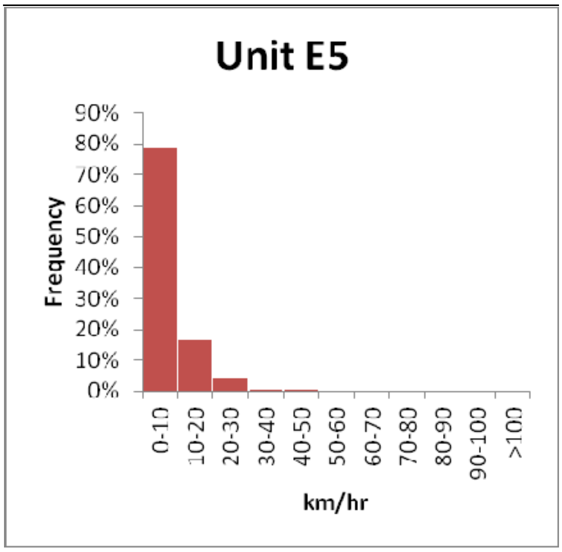
Speed Distributions (Individual Units)






Unit C3
Frequency
80%
70%
60%
50%
40%
30%
20%
10%
0%
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
>100
Km/hr


Unit D4
Frequency
100%
80%
60%
40%
20%
0%
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
>100
Km/hr


Unit E5
Frequency
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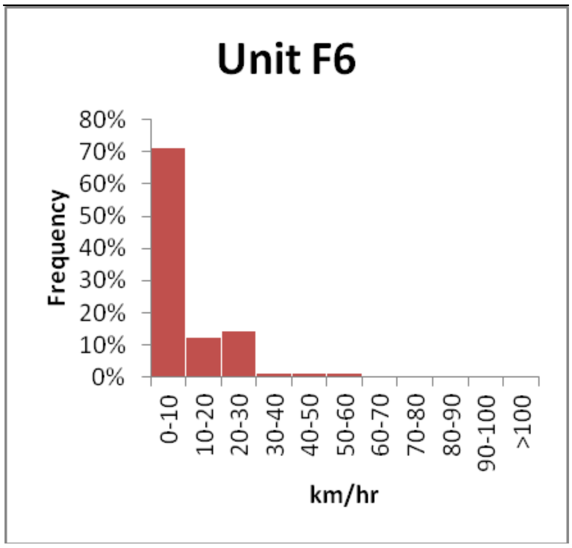
80%
70%
60%
50%
40%
30%
20%
10%
0%
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
>100
km/hr


Unit F6
Frequency
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60%
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40%
30%
20%
10%
0%
0-10
10-20
20-30
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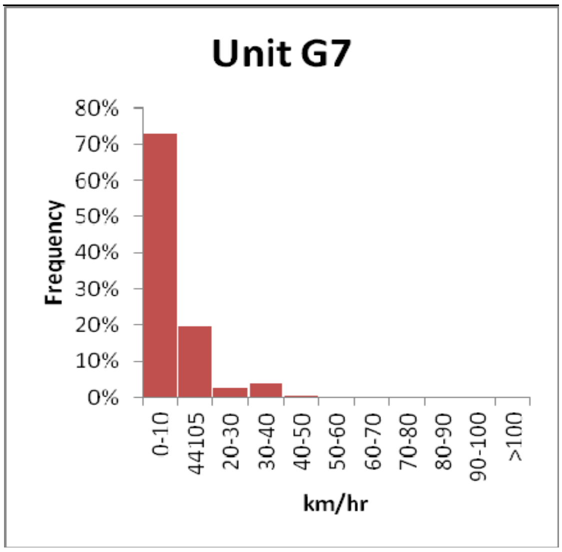
70-80
80-90
90-100
>100
km/hr


Unit G7
Frequency
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70%
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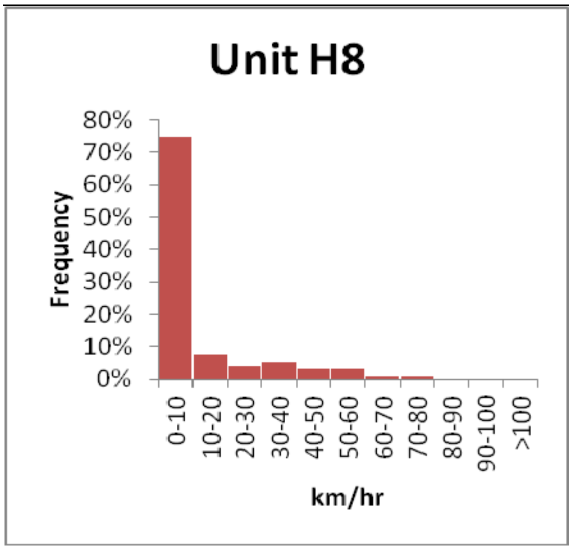
50%
40%
30%
20%
10%
0%
0-10
44105
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
>100
km/hr


Unit H8
Frequency
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60%
50%
40%
30%
20%
10%
0%
0-10
10-20
20-30
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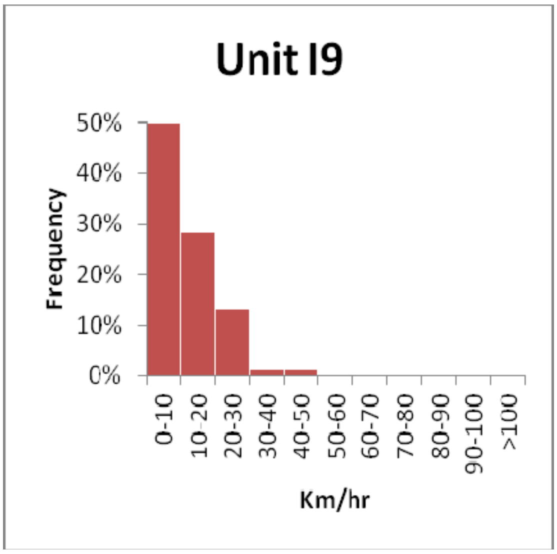
80-90
90-100
>100
km/hr


Unit I9
Frequency
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0%
0-10
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30-40
40-50
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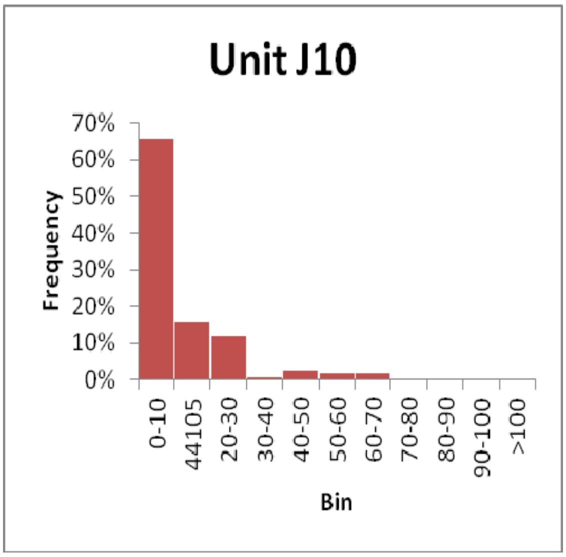
80-90
90-100
>100
Km/hr


Unit J10
Frequency
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60%
50%
40%
30%
20%
10%
0%
0-10
44105
20-30
30-40
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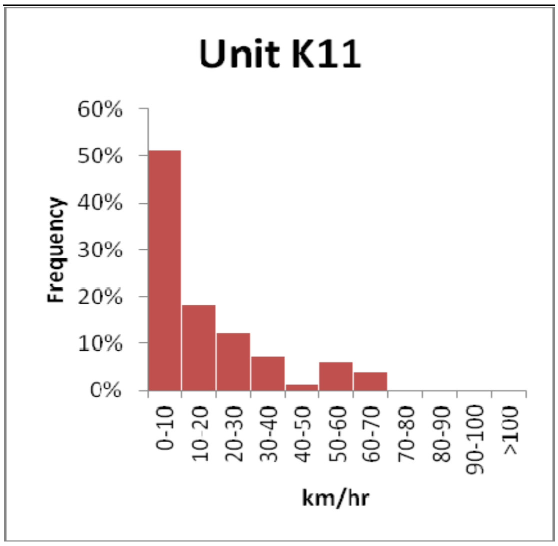
60-70
70-80
80-90
90-100
>100
Bin


Unit K11
Frequency
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50%
40%
30%
20%
10%
0%
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
>100
km/hr

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