Farm injury in Australia costs $200-$300 million a year.

On average there are 46 farm related fatalities in NSW each year.

Most fatalities involve farm vehicle, mobile farm machinery & farm structures but some are due to horse & livestock accidents.

Australian Wool Innovation
Mulesing:
“Shedding some wool on the matter”

What’s new in Education Resources at the CRC?
Weeds CRC Education Officers (VET sector):
- Annabel Bowcher
- Di Holding

ATVs…in the Spotlight
- John Temperley
  National Farm Injury Data Centre (NFID)

Biosolutions: Agricultural Technology
ACKNOWLEDGEMENT:
The NSWAAT would sincerely thank & acknowledge appreciation to:
Dr Scott Williams &
Dr Jim Rothwell
from the Animal Health and Welfare sector of the Australian Wool Innovation Limited;
for providing the following scientific material to produce & publish this article.

Dr. Scott Williams  Dr Jim Rothwell
Australian Wool Innovation Limited    PO Box 5071, Turramurra South,
Level 6, 369 Royal Parade     NSW, 2074, Australia
Parkville Vic 3052     Business/fax 02 9449 9437

History of Mulesing:
^ Mulesing involves the removal of the lateral skin folds on the breech and was invented by John Mules in 1929
^ In the 1940s, the operation was modified to also remove skin around the vulva and anus leading to a stretching of the perineal bare area.
^ To reduce tail strike, the modified mule was adapted to involve removal of skin from the dorsal surface of the tail.
^ In the late 1940s the radical mules was devised which linked the lateral cuts with the tail cuts.
^ It has been shown that a tail docked to the level of the base of the vulva and the retention of some wool bearing skin on the tail, minimises tail strike and cancer.
^ Farmers were reluctant to mules their own sheep partly due to aesthetic considerations. Mulesing did not gain widespread acceptance until contractors became involved. The welfare issues associated with mulesing have been recognized for as long as the operation has been in existence.
^ Search for less bloody and painful alternatives started in the 1930s.

Chemical Mulesing:
.....the alternatives

a. Manchester Operation - caustic

^ Mr L Manchester a Charlesville vet in 1938, patented a method to prevent blowfly strike in sheep.
^ The process was compared to the modified mules operation in 16 and 20 month old Merino ewes.
^ This involved an area 2-5cm wide adjoining the perineal bare area and on the dorsum of the tail.
^ These areas were swabbed with a caustic chemical until the wool began to disintegrate.
^ This method took two men about an hour to treat 50 sheep.
^ After treatment the sheep showed stiffness and this remained for about 5 days.
^ The treated area formed a hard scab which started to lift off in 2-4 weeks.
^ Once removed there remained a large granulating wound which healed by cicatricial contraction to form a linear scar.
^ Most animals had healed within 7-8 weeks. However many sheep took 11 weeks to heal fully.
^ Mulesed sheep were healed by 5 weeks
^ Bush flies were more attracted to the Manchester treated scabs than mulesed sheep.
^ Fly strike was more common on sheep treated by the Manchester method due to the time period taken to fully heal.
^ Greater vertical stretching of the bare area was apparent on Manchester operation sheep than mulesed sheep.
^ Both methods were effective at reducing breech strike.
b. Phenol & other chemicals

^ Scientists Pratt and Hopkins, investigated in 1976, methods which caused ‘permanent defleecing’. This involved a number of irritant and protein denaturing agents.
^ The following compounds caused death of the skin by scarring: zinc sulphate, chloral hydrate and potassium iodine. These were 5mL intradermal injections.
^ Investigations into using several acids, alkalis, ammonia, formaldehyde, Bouin’s fixative and cyclohexanone were shown to be ineffective.
^ The only chemical to exhibit death of the skin followed by crusting then healing with permanent wool loss were 40% phenol and 50% o-cresol.
^ These chemicals were applied topically.
^ Doses of phenol exceeding 1 g/kg body weight caused death.
^ Further research was conducted with a 40% aqueous formulation of phenol.
^ A roll-on applicator was developed by ICI. This applicator contained a formulation including a thickener, sticker, surfactant and dye.
^ In 2 weeks of application the treated skin become dark and hard; followed by a thick dry encrustation or scab developing after 3 weeks.
^ Within 5 to 8 weeks the underlying wound was healed. The healing process caused outward growth and stretching of the adjacent bare skin.
^ This method was directed at the pizzle ring area and jowling to control wool blindness.
^ This treatment was found to be slower and affected by breech wrinkles, as a result was considered to be less suitable than surgical mulesing.
^ The operation was considered to be painless but no assessment of animal stress or discomfort was reported.
^ Draw backs to this treatment were the safety to the operator and possible sheep toxicity. As a result this limited the use of this treatment.

c. Cationic, quaternary ammonium compounds

^ In 1993 R. Chapman; investigated the use of cationic quaternary ammonium compounds. These compounds caused necrosis by precipitating polyanionic glycosaminoglycans in the skin.
^ Full thickness necrosis of the skin occurred when injected intradermally by many of these chemical compounds.
^ 6-7 days after topical application full thickness necrosis was noted from the application of three compounds.
^ As a result the dead skin formed eschars that sloughed 3 to 4 weeks after treatment to form linear scars.
^ If the treated skin was 5 cm or more wide the linear scar caused the adjacent bare area to stretch. This effect was equivalent to surgical removal.
^ However it was demonstrated that rises in blood cortisol levels and behavioural evidence of stress and discomfort were similar, after surgical and non-surgical mulesing, but simply delayed after non-surgical treatment.
^ This treatment had an unpleasant smell and on windy days caused irritation to the operator. Fly strike occurred under the eschars and lambs suffered damage to the nose and face from grooming the treated areas. As a result commercialisation was abandoned.
In Summary:

**Chemical Mulesing**

<table>
<thead>
<tr>
<th>Methods</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Caustic</td>
<td>* All kill the skin</td>
</tr>
<tr>
<td></td>
<td>* Linear scarring</td>
</tr>
<tr>
<td>B. Protein Denaturing Compounds</td>
<td>* Stretching of skin</td>
</tr>
<tr>
<td></td>
<td>* Hazardous to operator</td>
</tr>
<tr>
<td>C. Quaternary Ammonium Compounds</td>
<td>* Predisposed site to fly strike</td>
</tr>
<tr>
<td></td>
<td>* Discomfort/stress (A&amp;C)</td>
</tr>
<tr>
<td></td>
<td>* Delayed discomfort (B)</td>
</tr>
</tbody>
</table>

---

**ALTERNATIVES TO CHEMICAL MULESING**

**A. FREEZING**

^ In 1976 scientists investigated freezing the surface of the skin. ^

^ Methods used were:  
- a branding iron chilled with dry ice and methanol,  
- saturating the skin with liquid nitrogen, or  
- spraying on refrigerant gas or propane.  

^ All caused a wool break but no treatment caused permanent depilation.  

^ 1990 scientists applied copper plates to the skin chilling the plates and saturating the skin with methanol. This resulted in improving the thermal conductivity and was more effective than spraying on cryogenic gases.  

^ Full thickness necrosis, sloughing of the skin and linear scar formation occurred when freezing of the skin to below -20°C.  

^ Freezing methods of greater than -8°C, resulted in the wool breaking and recovery of the skin and the re-growth of the wool.

**Results of Freezing:**

- No suitable temperature that could kill dermal papillae.  
- Causes permanent depilation without skin necrosis.
C. HIGH ENERGY ELECTRONS
^ In 1990 scientific work investigated the use of a linear accelerator.
^ This device produced ionizing radiation which damaged the mitotically active cells.
^ This treatment indicated that permanent depilation was possible.

Results of Ionizing Radiation:
* Discomfort by sheep around the breech region 48 hours after treatment.

D. Prevent Wool Growth by the use of:
  - follicle ablating agents
  - light
^ CSIRO developed a method involving:
  - shearing the breech,
  - possibly washing the area,
  - applying a solution of 5-ALA in carriers, (5-amino levulinic acid)
  - irradiate the treated region with a high intensity visible light wavelength for 3-5 minutes
    - wavelength is 600 – 700 nm (red-yellow).

Results:
- Practical difficulties
- Depilation

E. Intradermal Collagenase
^ At the University of Adelaide, Phil Hynd and colleagues have made promising research on the use of collagenase.
^ Naturally occurring protein, collagenase is injected into the dermis of the breech.
^ The protein disrupts the normal structure of the skin and depilation occurs.
^ As the area heals, the skin tightens and shrinks removing skin folds.

Results:
✓ local bruising
✓ formation of a dry hard scab
✓ linear scar left after healing
✓ depilation in the region treated
✓ several weeks there is some wool re-growth.
✓ similar to that produced by mulesing.
✓ painless
✓ without adverse effects.

Future Research:
✓ develop a practical means of application
✓ optimise the formulation;
✓ determine the optimum application shape
✓ establish efficacy against flystrike
✓ confirm that this treatment causes minimal stress to lambs.

- - CONCLUSION - -
^ Chemical and physical treatments can cause temporary disruption to wool growth.
^ Skin necrosis can be induced.
^ 5-ALA appears to give true depilation but this method has practical difficulties.
^ All techniques cause some discomfort and susceptibility to fly strike.
^ Intradermal collagenase treatment appears to be the best prospect for gaining the benefits of mulesing without its undesirable features.
Keep up-to-date with weed resources and information

- The Weeds CRC’s latest newsletter has a vast array of weed information in this edition.
- The newsletter can be mailed or emailed to you or downloaded from: [www.weeds.crc.org.au/main/weed.watch.html](http://www.weeds.crc.org.au/main/weed.watch.html).
- One of the highlights is a new technical series publication from the Weeds CRC which provides the latest information on using integrated weed management in winter pulse crops across Australia.

**Technical Series No. 9: Weed management in winter pulses: integrated solutions**

- **Weeds in winter pulses - integrated solutions** is a new FULL COLOUR publication providing integrated pulse-based solutions to weed management in annual cropping systems, highlighting recent research and 'on-farm solution' case studies.
- It is available **free of charge** from the Weeds CRC.
- This publication provides excellent information on general crop management and decisions about crop rotations for those teaching Primary Industries and Agriculture in secondary schools.
- It includes excellent pictures of pulse seedlings in the appendix section with the appropriate plant parts marked.
- These pictures can also be obtained from the Education Officers at the Weeds CRC for use in class teaching. They will also be used in a soon to be published Factsheet on crop seedling growth stages.

The book covers all aspects of managing weeds in the pulse phase of a rotation including:

- Factors to consider when choosing a pulse species (eg soil type, weed spectrum, residual herbicides).
- The impact of weeds on pulse production and the cropping rotation.
- Problem weed species in each state.
• How to ‘tip the balance’ toward the pulses instead of the weeds (including information on optimising competitive ability eg canopy development, seeding rate, row spacing, sowing time, seeding depth, soil properties, fertiliser use and placement, disease, mite and insect management, planning rotations).
• Weed management using herbicides (including pre- and post-emergent information, options at harvest, application technology and alternate application methods).
• Cultural management (eg rotations with pulses and forage legumes, stubble management).

• Hygiene on farm.
• A comprehensive appendix section includes information and diagrams on crop growth stages, glossary of terms, further information (eg publications and websites) and cited references.
  ➢ It is hoped that the diverse range of weed management techniques discussed will provide ideas and inspiration to those wanting to learn more about winter cropping across Australia. Many of the principles outlined can be applied to other crop types.
  ➢ To order a copy of the Weeds in winter pulses – integrated solutions, fax this order to the Weeds CRC.

Order Form
Please send me ____________ copies of **TS #9: Weeds in winter pulses - integrated solutions**
Name: 
Position & Organisation: 
Postal Address: 
Please add me on your Weed Watch Newsletter mailing list YES / NO 
FAX this whole page to (08) 8303 7311. If you have any problems phone (08) 8303 6590

SEND ORDER FORM.......... 
WEEDS CRC RESOURCE IS FREE!!
Some new factsheets have also been published on the website which are ideal for education and training purposes and may also give you some ideas for practical exercises.

Where possible, the appropriate units of competency that the factsheet information is most suited to are also included on these resources.

The latest factsheet topics include:

- Fs28 Herbicides: knowing when and how to use them.
- Fs29 Frequently asked questions about herbicide tolerant crops.
- Fs30 On farm solutions: sowing weed free seed.
  (including research conducted in Victoria and NSW looking at what weed seeds are present in seed boxes at sowing).
- Fs31 A community approach: Ag’n’Chat
  - specialised and innovative training for farm women.
    (including how to conduct a short workshop on describing plants for identification purposes).

The following factsheets will be appearing on the website soon:

- Fs32 Weed management: describing plants for identification.
- Fs33 Weed management: collecting and preserving plants for identification.
- Fs34 Planning weed management: a protocol for a regional approach.
- Fs35 Integrated weed management: chincherinchee.
- Fs36 Herbicides: use in and around water.
- Fs37 Integrated weed management: developing a plan using tactic groups.

Can’t find the appropriate weed management resource?

If there are any other weed management topics that you feel you would like resources for, please contact:

the Weeds CRC VET Education Officers:
  Annabel Bowcher (annabel.bowcher@agric.nsw.gov.au) or
  Di Holding (di.holding@agric.nsw.gov.au).

The Weeds CRC can assist in finding existing resources or develop new or more appropriate weed management training materials if they are required.

What resources and information do you need for your students?

The suggestions and input that you provide to the Weeds CRC are essential as they enable the Education Officers to produce education and training materials that are tailored to your needs.

Weeds CRC resources are produced in a ‘no cost’ (electronic versions) or ‘low cost’ format (printed). Weeds CRC education resources are produced to assist educators and trainers across Australia to provide the best possible weed management information to their target audience.

Let us know what you need!!

Contact the Weeds CRC Education Officers (VET sector):

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  ph 02 69 381 941
  email annabel.bowcher@agric.nsw.gov.au

Di Holding
  ph 02 69 381 671
  email di.holding@agric.nsw.gov.au
Acknowledgement:

➢ To Mr John Temperley from the National Farm Injury Data Centre (NFID) at Moree; for providing the following article on the current statistics with ATVs in Australia

➢ The information contained in this article would be useful for all Ag teachers who deliver the elective unit in Primary Industries “Operate Ride-On Vehicles” to our senior students.

Introduction:

• Over recent years, Australian agriculture has become increasingly reliant on All Terrain Vehicles (ATVs) as a result of their ability to perform a wide range of tasks under varying environmental conditions. Activities such as mustering, towing and carrying of goods, spraying, shifting irrigation pipes, transportation and inspection of crops, pastures, fences, water and livestock, which were once performed by more traditional means (tractor, utility, horse or 2 wheel motor bikes) are now more likely to be done by an ATV.

• A 1994 NSW Health Report indicated that 20% of participants from a farm or rural property had at least one ATV in use on their farm, with the number of ATVs ranging from 1 to 10 per farm

--- Injury associated with ATV use in Australia ---

• There is a growing concern world-wide over the number of deaths and serious injury occurring in association with agricultural and leisure use of ATVs.

• The actual number of deaths associated with ATV operation in Australia is not immediately available to the Australian Centre for Agricultural Health and Safety. A Register of ATV Deaths has been established that has identified 59 cases from July 2000 (as at March 2005). The level of detail pertaining to these cases is variable. Cases have been derived from:
  ➢ The National Coronial Information System
  ➢ Four cases reported in the press as a farm death, not yet in the NCIS.

• Of these 59 deaths, only 8 are classed as non-agricultural, with another 9 unable to be determined at this stage.

• During the period 1989-1992, there were four deaths attributed to agricultural ATV use. The increase is assumed to be related to the increase in numbers of ATVs in use on Australian farms.

• Of ATV riders surveyed by Schalk and Clarke, 8.2 percent had suffered injury associated with riding the ATV in the previous 2 years. Of 612 motorcycle riders reported by the women on 182 farms, 8.4 percent were injured while riding an ATV in the previous 2 years.

---


Injury events occur through a complex interaction between the person, the agent of injury and the operating environment. We have attempted to identify risk factors for ATV associated death and serious injury from the information that is available. The following information has been distilled from analysis of the information relating to all ATV related deaths and from the study of motorcycle riders and injury associated with motorcycles undertaken by Schalk and Fragar reported in 2000¹.

**Human and behavioural risk factors**

### i. Age and use

Riders of all ages are at risk of death, and risk most likely reflects exposure – in that the age range of those who have died broadly reflects the age distribution of farmers. The majority of those who have died were ATV operators, however passengers (and bystanders) are also at risk. Table 1 indicates the age of those who died as a result of ATV-related activity.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Operator</th>
<th>Passenger</th>
<th>Bystander</th>
<th>Unknown</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>6-15</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>16-25</td>
<td>7</td>
<td>1</td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>26-45</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>46-65</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>+ 66</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Unknown</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>6</td>
<td>1</td>
<td>4</td>
<td>59</td>
</tr>
</tbody>
</table>

Source: NFIDC ATV Deaths Register (ACAHS)

The rate of injury associated with ATV riding was shown to decline with rider age in the Schalk and Fragar study.

### ii. Gender

Of the 59 deaths reported in the Register, 51 were male and 8 were female.

### iii. Competency and training

Information regarding training and rider skills of riders associated with ATV-related deaths is only available for 8 deaths before the Victorian Coroner, where no rider had undertaken formal training.

There is limited information relating to rider training or skills deaths database, although several narratives indicated that farmers had purchased their ATV in the last 12-24 months.

Over 97% of motorcycle riders (2 and 4 wheeled cycles) reported in the rider survey (Schalk and Fragar) that they had never participated in a formal motorcycle rider training course.

**iv. Activity being undertaken**

ATV-related deaths are associated with a wide range of work activities in agriculture and horticulture, including mustering, spraying pesticides, transporting and travelling on the property.

### Table 2: Industry of victim

<table>
<thead>
<tr>
<th>Industry</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural -- Unknown</td>
<td>24</td>
</tr>
<tr>
<td>Dairy Cattle</td>
<td>3</td>
</tr>
<tr>
<td>Grain, Sheep, or Beef</td>
<td>12</td>
</tr>
<tr>
<td>Horticulture</td>
<td>1</td>
</tr>
<tr>
<td>Other livestock Farming</td>
<td>1</td>
</tr>
<tr>
<td>Non Agricultural</td>
<td>8</td>
</tr>
<tr>
<td>Unable to be Determined</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>59</strong></td>
</tr>
</tbody>
</table>

Source: ACAHS ATV Deaths Register

There are significant numbers of deaths associated with leisure operation of ATVs.

Agricultural and other activity being undertaken by the deceased is indicated in the following table.

### Table 3: Activity of victim

<table>
<thead>
<tr>
<th>Industry</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checking Water</td>
<td>2</td>
</tr>
<tr>
<td>Drafting/Mustering/Herding</td>
<td>7</td>
</tr>
<tr>
<td>Inspecting Property</td>
<td>1</td>
</tr>
<tr>
<td>Hunting</td>
<td>3</td>
</tr>
<tr>
<td>Leisure/Sport/Recreation</td>
<td>6</td>
</tr>
<tr>
<td>Structure Maintenance</td>
<td>1</td>
</tr>
<tr>
<td>Weed Control</td>
<td>8</td>
</tr>
<tr>
<td>Transporting Materials</td>
<td>1</td>
</tr>
<tr>
<td>Travel</td>
<td>2</td>
</tr>
<tr>
<td>Unable to be Determined</td>
<td>28</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>59</strong></td>
</tr>
</tbody>
</table>

Source: ACAHS ATV Deaths Register
v. Speed
• More information relating to speed of ATV at time of injury event is needed. There are seven cases with information regarding the speed of the ATV;
  ❖ Three cases quoted to be travelling ‘at speed’
  ❖ One case travelling at 15km/hr
  ❖ One case travelling at 40km/hr
  ❖ One case travelling at 40-50km/hr
  ❖ One case travelling at 70km/hr.

• Schalk and Fragar surveyed riders regarding the average and maximum speeds in relation to their agricultural industry. There was wide variation, with 80% of riders operating their cycles at average speeds of less than 50 kph, except in cane and cotton where speeds are reportedly higher. Animal handling industries tended to use lower speeds compared to cropping industries, with dairy industry reports the lowest. The majority of motorcycle accidents reported by riders occurred at speeds of less than 30kph.

vi. Alcohol and other drugs
• More information is needed relating to the role that alcohol and other drugs may play in ATV-related deaths and serious injury. There were seven cases of alcohol and/or other drugs in the register;
  ❖ Two cases involved alcohol
  ❖ One case involved alcohol and amphetamines
  ❖ One case involved alcohol and cannabis
  ❖ One case involved alcohol and ecstasy
  ❖ One case involved alcohol, cannabis and amphetamines
  ❖ One case involved cannabis.

--- Machine risk factors ---

i. Size and make/model of machine
• More information is needed relating to injury risk associated with size and design features of ATV. Information relating to the engine capacity of only 13 ATVs associated with death was available:
  ❖ Suzuki 500 – Two rollover deaths
  ❖ Polaris Sportsman 500 (6x6) – One rollover death
  ❖ Honda 450 – One rollover death
  ❖ Yamaha Kodiak 400 – One rollover death
  ❖ Yamaha 400 – One collision with vehicle death
  ❖ Honda TRX 350 – One death thrown from ATV
  ❖ Yamaha YFZ 350 – One death thrown from vehicle after collision
- Polaris Magnum 330 – One rollover death after collision with fence
- Suzuki 330 – One death from collision with fence
- Suzuki 250 – One rollover death
- Yamaha 250 – One death thrown from ATV.
- Suzuki 160 – One rollover death

**ii. Rollover and rollover protection of operator**
- There is a propensity for ATVs to rollover and cause serious injury to riders. At least 30 of the deaths in the Register were associated with the ATV rolling over and pinning the victim underneath the machine. No information was available relating to whether there was fitment of any form of roll-over protective structure, which are not commonly used in Australia.

<table>
<thead>
<tr>
<th>Table 4: Cause of Accident</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrown from ATV</td>
<td>12</td>
</tr>
<tr>
<td>Side Rollover</td>
<td>5</td>
</tr>
<tr>
<td>Rear Rollover</td>
<td>6</td>
</tr>
<tr>
<td>Front Rollover</td>
<td>2</td>
</tr>
<tr>
<td>Unknown Rollover</td>
<td>17</td>
</tr>
<tr>
<td>Pinned between ATV and Object</td>
<td>4</td>
</tr>
<tr>
<td>Over handlebars</td>
<td>2</td>
</tr>
<tr>
<td>Knocked off ATV by Object</td>
<td>1</td>
</tr>
<tr>
<td>Fallen from ATV</td>
<td>2</td>
</tr>
<tr>
<td>Collision with Vehicle</td>
<td>2</td>
</tr>
<tr>
<td>Contact with Wire Fence</td>
<td>1</td>
</tr>
<tr>
<td>Contact with Handlebar</td>
<td>1</td>
</tr>
<tr>
<td>Unknown</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>59</strong></td>
</tr>
</tbody>
</table>

Source: ACAHS ATV Deaths Register

**iii. Loading of machines**
- Loading of the ATV has been associated with rollover deaths. More information is needed to understand the role that loading plays in ATV rollover. One of the deaths associated with ATV rollover had used the machine for carrying or towing loads (lengths of steel tube). Six deaths were spraying and may have had significant load of herbicides, but limited details are available. There were eight deaths involving a passenger being carried on the ATV and one involving two passengers being carried on the ATV.

**iv. Maintenance of machine**
- In one death, where the victim was flung over the ATV and crushed between the machine and a wall, it was noted that the brakes had needed attention, and that the throttle was jammed on full, and two cases involved comments on the unsafe condition of the ATV.
• The Schalk and Fragar study reported that poorer ATV maintenance regimes were associated with higher injury rates than those whose maintenance were more timely.

v. Other
• In one death, it was noted that a tree branch had pierced the rear tyre causing the ATV to veer and crash.

--- Environmental risk factors ---
• Slope and surface appear to play a key role in ATV-related deaths, and it appears that there are terrain limits for operation of so-called “all-terrain vehicles”.

i. Slope
• Of the 24 cases mentioning the slope of the terrain;
  ❖ One case was on undulating ground
  ❖ 17 cases were noted to be on steep ground, embankments or a hill
  ❖ One case was on a slight downhill slope
  ❖ Four cases were on level ground
  ❖ One case was on an incline of 20-30 degrees.

ii. Surface
• Table 5 outlines the surface conditions of the specified accident sites.

<table>
<thead>
<tr>
<th>Table 5: Surface of Accident Site</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsealed Road or Lane</td>
<td>8</td>
</tr>
<tr>
<td>Paddock</td>
<td>8</td>
</tr>
<tr>
<td>Beach/Sandy Track</td>
<td>2</td>
</tr>
<tr>
<td>Airstrip</td>
<td>1</td>
</tr>
<tr>
<td>Embankment</td>
<td>7</td>
</tr>
<tr>
<td>Shed/Garage</td>
<td>3</td>
</tr>
<tr>
<td>House Yard</td>
<td>1</td>
</tr>
<tr>
<td>Cattle Yards</td>
<td>1</td>
</tr>
<tr>
<td>Driveway</td>
<td>1</td>
</tr>
<tr>
<td>Unable to be determined</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
</tr>
</tbody>
</table>

Source: ACAHS ATV Deaths Register

--- Mechanisms of injury and body part injured ---
• The mechanism of injury in the majority of cases was noted to be blunt force with the body part crushed between ATV and the ground or other surface, or contact of the body with a rock or tree or other surface, having been flung from the ATV.
The body part injured and associated with death was mostly the head and cervical spine, crush injuries and asphyxia.

Table 6: Cause of Death (1a) --

<table>
<thead>
<tr>
<th>Category</th>
<th>Injury</th>
<th>ICD 10 Code</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circulatory System</td>
<td>Acute myocardial infarction</td>
<td>I21</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Chronic ischaemic heart disease</td>
<td>I25</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Cardiac Arrest</td>
<td>I46</td>
<td>1</td>
</tr>
<tr>
<td>Head Injury</td>
<td>Fracture of skull and facial bones</td>
<td>S02</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Intracranial injury</td>
<td>S06</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Other and unspecified injuries of the head</td>
<td>S09</td>
<td>6</td>
</tr>
<tr>
<td>Neck Injury</td>
<td>Fracture of Neck</td>
<td>S12</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Injury of nerves and spinal cord at neck level</td>
<td>S14</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Injury of blood vessels at neck level</td>
<td>S15</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Crushing injury of neck</td>
<td>S17</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Other and unspecified injuries of neck</td>
<td>S19</td>
<td>1</td>
</tr>
<tr>
<td>Thorax Injury</td>
<td>Injury of other and unspecified intrathoracic organs</td>
<td>S27</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Crushing injury of thorax</td>
<td>S28</td>
<td>7</td>
</tr>
<tr>
<td>Hip/thigh Injury</td>
<td>Injury of blood vessels at hip and thigh level</td>
<td>S75</td>
<td>1</td>
</tr>
<tr>
<td>Multiple Injuries</td>
<td>Unspecified multiple injuries</td>
<td>T07</td>
<td>8</td>
</tr>
<tr>
<td>Other</td>
<td>Asphyxiation</td>
<td>T71</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>59</strong></td>
</tr>
</tbody>
</table>

Source: ACAHS ATV Deaths Register

In the Schalk and Fragar study of injury, riders injured on ATVs reported sprains (25.6%) and fractures (23.4%), whereas riders injured on 2-wheel motorcycles commonly sustained cuts/lacerations (23.5%). Bruising was an injury common to both machines with 23.4% and 22.3% of injured riders sustaining bruising on ATVs and 2-wheel motorcycles respectively. Lower leg injuries appear to be common for both ATV and 2-wheel motorcycle riders, although the percentage of injuries received varies considerably, 14.9% for ATVs and 21.6% for 2-wheel motorcycles. It was also observed that ATV riders commonly sustained injuries to the upper body, shoulder (12.8%) and wrist (8.5%), and trunk, ribs (10.6%), whereas 2-wheel motorcycle riders sustained injuries to the lower body, upper leg (11.0%) and ankle (10.0%).

Injury from ATVs occurred mainly due to rolling the machine (22.8%), hitting a stationary object (18.2%) or human error (11.4%). Human error has been defined for the survey as an incorrect action performed by the rider which has resulted in a detrimental effect, for example jamming the brakes on resulting in a skid.

--- General ---

These findings relating to Australian agriculture are consistent with the findings of a report by Rechnitzer et al.s that described findings for 24 ATV deaths in the NCIS system as well as data from the United States and New Zealand.

--- Rechnitzer G, Day L, Grzebieta R, Zou R and Richardson S. All terrain vehicle injuries and deaths
Monash University Accident Research Centre March 2003. ---
The following articles were presented at the recent Biosolutions Festival on Agricultural Biotechnology that took place at Wagga Wagga Civic Centre on 14th May 2004 as part of the Australian Innovation Festival. Students from a number of schools across the Riverina attended.

These articles have been reproduced with permission of Dr John Harper one of the key organizers of the Biosolutions Festival. The Association acknowledges John and Traceys efforts in the Biotechnology Festival for the permission granted to publish these articles.

A table has been included where the Ag. Biotech Festival talks may be incorporated into the syllabus. Summaries of each talk are provided to assist in the analysis of the topic.

Dr. John Harper (Charles Sturt University) & Ms Tracey Lonergan (Wagga Wagga City Council) jharper@csu.edu.au (02) 6933 2837 or (02) 69 33 2812

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**Board of Studies NSW, Syllabus outcomes**

The series of talks relate to the Stage 6 Agriculture Syllabus Outcomes

5.12c Students learn about technology and describe some of the problems of using biotechnology

5.12d Students learn about technology and describe ways in which technology has increased the variety of made resources.

**Stage 6 Syllabus Outcomes**

^ Biotechnology is an Optional subject.

^ The series of talks dealt specifically with one particular outcome.

9.6 Option-Biotechnology

2. Biotechnology has come to be recognised as the use of living organisms to make or modify a product, to improve plants or animals or to utilise microorganisms for specific use

5. Modern Biotechnology includes recombinant DNA technology

6. There are many applications and areas of research in biotechnology

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<table>
<thead>
<tr>
<th>Speakers</th>
<th>Stage 5</th>
<th>Stage 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.12c</td>
<td>5.12d</td>
</tr>
<tr>
<td>4 &amp; 11. Drs D. Luckett &amp; J. Oliver</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>5. Assoc. Prof. Gavin Ash</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>8. Mr Rex Stanton</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>
Dr David Luckett and John Oliver NSW Agriculture:

**“DNA Markers in Plant Breeding.”**

Agricultural Biotechnology that Delivers non-GMO Crop Varieties without Controversy

DNA markers are a bit like signposts which enable a plant breeder to quickly identify useful traits such as disease resistance, tastiness etc when breeding new lines of crops for delivery to farmers.

Before molecular markers plants had to be grown up and tested for the desirable traits. With molecular markers signposting that a desired trait is present only requires a small amount of DNA which is analysed and a useful plant is identified quickly.

Why Do Plant Breeding?

- Need genetic improvement of plant species
  - Food, fibre, horticulture, grazing
  - Fuel, construction
  - Higher yield per unit area
  - Better stress tolerance
    - Disease, insects, weeds
    - Drought, salinity, acidity, frost
  - Improved quality, nutritional value
- Selective breeding occurs in all plant species utilized by man

What Are DNA markers?

- Signposts for significant genes
- Naturally-occurring variability in DNA
- Genome full of this variation
- Need a variable sequence close by gene of interest = linked
- When signpost is seen the gene is most likely to be there too
- Too far apart and signpost is unreliable
Why Use DNA Markers?

- When testing for the gene is
  - Expensive
  - Time-consuming
  - Not possible
    - Disease
    - Insect pest
  - Alternative is unreliable or seasonally-dependent

Not Controversial?

- Is it biotechnology?
  - work with DNA
- No foreign genes inserted
- Only using natural variation in the breeding population of the species
- Needs preliminary research
  - To find suitable variation as basis for markers
  - Make them easy to use

Want Proof It Works?

- Narrow-leaf lupins
  - Very vulnerable to anthracnose fungal disease
  - Disease is not in NSW (yet!)
  - Field testing is expensive and can be unreliable
  - One strong gene for resistance
    - Italian wild plant
  - Use a closely-linked marker to track gene
  - Easy to discard genotypes without signpost and, therefore, without the gene

Example

- "Wonga" Resistant
  - RR MM
- "Jindalee" Susceptible
  - rr mm

Cross

- F1: Rr Mm

F2

- RR MM
- Rr Mm
- rr mm

25%  50%  25%

Keep  Discard  Discard

DNA markers in plant breeding

- Produce conventional varieties
  - Quicker
  - Cheaper
  - More efficient
- Non-GMO
- Acceptable to
  - Consumers (end-user)
  - Farmer (producer)
  - Society in general

Questions?
The use of transgenic technologies in plant improvement is an emotive issue in Australia. These technologies include modification of plants, animals, bacteria and viruses by the addition, deletion or silencing of genes. The most commonly manipulated traits include insect and herbicide resistance and improved nutrition. The industry within Australia is highly regulated in an effort to reduce the risks to humans and the environment.

The Gene Technology Act 2000 provides for a national scheme for the regulation of genetically modified organisms in Australia, in order to protect the health and safety of Australians and the Australian environment by identifying risks posed by or as a result of gene technology, and to manage those risks by regulating certain dealings with genetically modified organisms.

This is achieved by the Office of the Gene Technology Regulator (OGTR) and the head of the Office Dr Sue Meek (the Regulator). The OGTR receives advice from a range of committees and bodies including local councils, AQIS, AFFA (see slides!) and its own committees.

The OGTR then regulates transgenics through Institutional Biosafety Committees in each location that this type of research is undertaken.

The OGTR also maintains a web site where it disseminates information to the public about its activities (http://www.ogtr.gov.au/).

Contact Details: Associate Professor Gavin Ash
School of Agriculture Charles Sturt University
PO Box 588 Wagga Wagga NSW 2650
Ph. 02 69332765   Email: gash@csu.edu.au
Regulating Gene Technology in Australia

- The Gene Technology Act 2000 (came into force on 21 June 2001)
- "... a national scheme for the regulation of genetically modified organisms in Australia, in order to protect the health and safety of Australians and the Australian environment by identifying risks posed by or as a result of gene technology, and to manage those risks by regulating certain dealings with genetically modified organisms."

What does the Act do?
- Regulation of all GM work in Australia
- Establish the office of the Gene Technology Regulator
- Establish advisory committees
- Provides the process for risk assessment to human health and the environment
- Provides powers for monitoring and enforcement of the legislation
- Provision of a database of GM in Australia
\[ \text{Mr Rex Stanton} \]
\[ \text{School of Agriculture CSU:} \]

\[ \text{“Why Grow Canola?”} \]

\[ ^\wedge \text{Canola is a type of rapeseed (Brassica napus) that has been selectively bred to produce oil suitable for human consumption, with canola based products available since the mid 1970s.} \]
\[ ^\wedge \text{Limited herbicide options has made weed control problematic in conventional canola varieties. Herbicide tolerant varieties have been developed using classical breeding techniques (i.e., Triazine tolerant canola) and mutagenesis (i.e., Imidazolinone tolerant canola).} \]
\[ ^\wedge \text{Biotechnology has been used to produce varieties that are tolerant to glyphosate and glufosinate-ammonium.} \]
\[ ^\wedge \text{These herbicides are not currently used as selective herbicides and therefore afford farmers broader selective herbicide rotations, decreasing the risk of herbicide resistance development.} \]

1. 

\[ \text{Why grow canola?} \]

Wagga Wagga Biotech Innovation Festival 14 May, 2004

3. 

\[ \text{History of canola} \]

- rapeseed (Brassica napus)
- used as industrial oil/lubricant
- Australian introduction 1960’s
- 1979 - ‘Canola’ introduced
  - low erucic acid
  - low glucosinolates

5. 

\[ \text{Canola in a rotation} \]

- introduced as a ‘break crop’
- reduces disease carryover
  - take-all
  - cereal cyst nematode
- biofumigation
- increased wheat yields

8. 

\[ \text{Threats to canola} \]

- limited broadleaf weed control options
- herbicide resistance
- disease carryover
  - sclerotina
  - blackleg
- insect pests
  - diamond back moth
Varieties of canola

- Conventional ~ 30%
- Triazine tolerant (TT) ~ 60%
- Imidazolinone (IMI) tolerant ~ 10%
- glyphosate tolerant
- glufosinate-ammonium tolerant
- bromoxynil tolerant

The future for canola

- loss of TT varieties?
  - herbicide resistance
  - loss of herbicides
- speciality crops?
  - low linolenic acid varieties
  - bio-diesel

Technology Developments include:

- marker-assisted breeding of plants & animals
- DNA fingerprinting of plant varieties
- functional genomics to understand gene function & regulation in plants & animals
- Bioprospecting & access to biological resources to develop new drugs & industrial biotechnology, including novel traits in industrial crops
- use of bioinformatics to generate & mine new information from large data sets including information on genomic structure & its diversity
- use of biotechnology to control weeds & pests & restore landscapes
- RNA interference technology in plants & animals
- development of agronomic strategies to manage persistence of Bt genes used in cotton, including the size & maintenance of insect refugia
- development of livestock cloning