final report

Project code: **FLOT.302**

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Date published: **June 1999**

ISBN: **1740363272**

PUBLISHED BY
Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Assessment of cleaning systems for cattle

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

ACKNOWLEDGMENTS

The Project team would like to thank the following organisations for their assistance and co-operation in this project:

- **Meat and Livestock Australia** and the **Department of Natural Resources and Environment** for co-investing in the project.
- **Rockdale Beef** feedlot and abattoir for providing us with both animals and facilities so that the team could undertake Winter Trial 1.
- **Australian Meat Holdings** Beef City feedlot and abattoir for providing us with both animals and facilities so that the team could undertake Winter Trial 2.
- **O'Connors Abattoir** for providing us with facilities so that the team could undertake the Summer Trial.
- **VHSP, Laverton** for their assistance and use of facilities.
- **Rotary Shears P/L** for their input into this project.

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1.0 EXECUTIVE SUMMARY

This report presents the findings of the cattle cleaning trials undertaken as part of the Meat and Livestock Australia's project FLOT.302, "Assessment of Cattle Cleaning Techniques".

Introduction

When cattle are contaminated with faeces, the faecal material is not in itself attached to the hide. Dags, or dried faecal and dirt material are attached to, and formed around the hair (Auer *et al*, 1998). The adhesion of the faeces to the hair forms a very strong matrix. It is this matrix that needs to be broken, in order to remove dags from the animal. Many different methods of removal have been identified. These fall into two main categories, mechanical (RRDRS, shearing, hand raking) and chemical (washing, detergents).

This project consists of 3 trials (1 summer based and 2 winter based). All treatments used in the trials were identified as being the most widely used methods of cleaning cattle both in Australia and overseas (Rowland *et al*, 1997). AQIS regulations did not permit the use of untreated animals in Winter Trial 1. A second trial at Beef City was held to further evaluate the impact of treatments.

Objectives

The aim of this report is to:

- Identify strategies that favour delivery of clean livestock to abattoirs.
- Develop management systems to minimise the incidence of contamination of slaughter stock with food borne pathogens.
- Provide an independent audit of the Rockdale Robotic Dag Removal System (RRDRS).
- Evaluate the effectiveness of the range of pre- and post-slaughter treatment techniques currently being used by industry to address dag problems, by reducing the microbiological contamination of carcasses.
- Evaluate the effects of the treatments on the microbial status and potential meat quality attributes of treated carcasses.
- Evaluate the rate and cost per head of undertaking the selected treatment techniques.
- Evaluate and document any occupational health and safety issues associated with applying the treatments.

Methodology

Three trials were performed on cattle. One of these, a smaller trial of 20 cattle, was held in summer to assess the effects of cleaning treatments on dust load and subsequent final microbial load of carcasses from those cattle. Two further trials were undertaken in winter to assess the same cleaning treatments in high dag load season. Treatments were assessed by measuring:

- effects on microbial levels on carcasses in the chiller.
- costs of applying the treatment.
- effects on animal welfare.
- effects on occupational health and safety.
- effects on meat quality

Major Research Findings

The major findings are:

- there is no direct correlation between the dag loading of the live animal and the microbiological quality of the carcasses.
- the level of *E.coli* on the carcasses tested was very low, and well within the USDA Mega-Reg requirements.
- all treatments in the three trials were effective at reducing the dag loading of live animals, assessed using the UK Clean Livestock Grading System. Only shearing totally eliminated the loading.
- differences in other parameters assessed can be summarised as:
    - lowest stress was seen in animals in the spray wash and detergent, spray wash and pre-shear/shear groups.
    - meat quality would be expected to be highest in the wash and detergent treatment group for the pre slaughter treatments. However, overall, the post slaughter treatments (shearing and air knife) would have provided a result better than or at worst equal to the pre slaughter wash and detergent treatment as the treatment was performed on the dead animal.
    - O H & S risks are lowest in the spray wash, wash and detergent, RRDRS and the post slaughter air knife treatments
    - lowest costs were seen in the wash and detergent treatments and the two post slaughter treatments (air knife and Parke Rota Shear™).

Recommendations

➨To maintain adequate microbiological quality of carcasses, stock may be cleaned by washing alone.

➨ The value of the hide can be maximised at any point along the processing chain (ie between the feedlot/producer and the tannery).

➨when utilising mechanical methods of dag removal, animals should be cleaned at least seven days prior to slaughter and placed back onto feed and water in order to reduce the incidence of downgrading due to stress.

➨as new cleaning techniques become available, they should be evaluated through a similar process as indicated in this report. The treatment(s) should be benchmarked against the washing method and zero treatment (control) in order to provide a cross-reference to this report.

➨funding should be available to finish development and assessment of an enzyme treatment that is being developed (Auer *et al*, in press). This enzyme treatment is presently being used at the tannery in a pilot study, and is shown to be highly effective at eliminating dags from the hide. A proposal to develop the product has been submitted to MLA for funding.

➨In order to maximise profit, cleaning may still be necessary, and therefore a system should be developed to classify and describe livestock by hygienic status.

➨a system for the description of the cleanliness of livestock, to be introduced into the Aus-Meat Livestock language. This system would provide a common language for describing the dag loading of animals ready for slaughter. This scheme could also be used to implement a value based grading scheme for hides starting at the live animal. The processor will have some knowledge of the true value of the hides prior to slaughter.

➨from this information, there is scope for the EMO's to be redrafted so that the meat processing sector operates in terms of outcomes, rather than having to adhere to prescriptive, or subjective assessment criteria. In order to reduce the interpretation problems an assessment scheme can be incorporated into the EMO's as method for defining what constitutes "clean".

2.0 INTRODUCTION

This report presents the findings of the cattle cleaning trials undertaken as part of the Meat & Livestock Australia's project:

FLOT.302, "Assessment of Cattle Cleaning Techniques".

A team from the Department of Natural Resources and Environment - Agriculture Victoria, undertook the series of trials. There were three trials; one summer based trial, and two winter based trials. The aims of the project are to provide pertinent information that industry may use in deciding on the future use of a cleaning method in their own production system. Information such as the effectiveness of dag removal, microbiological effectiveness, occupational health and safety issues, animal welfare issues and the effects on meat and hide quality were assessed.

3.0 OBJECTIVES

This report is aimed at meeting the following objectives:

- To evaluate the effectiveness of pre- and post-slaughter treatment techniques currently used by industry to minimise dag problems, and reduce the microbiological contamination of carcasses.
- To evaluate the effects of the applied treatments on the microbial status and potential meat quality attributes of the treated carcasses.
- To evaluate the cost per head of undertaking the selected treatment techniques.
- To evaluate and document any occupational health and safety issues associated with applying the treatments.

4.0 PROJECT BACKGROUND

4.1 Clean Livestock and Food Safety

Consumers are becoming increasingly aware of the risk of food borne disease. The meat industry and its associated stakeholders are working to produce a safer product for its consumers. The industry is also working towards conforming to tighter regulation of standards both internationally and locally (USDA 1996). A proactive method of improving food safety is through the use of preventative systems such as the Hazard Analysis Critical Control Points (HACCP) system (USDA 1993). The aim of this process is to identify the potential source of a hazard in a production system, set critical limits to monitor it, and provide a documented method of corrective action.

Livestock are exposed to a variety of microorganisms and may be colonised by potentially pathogenic microorganisms prior to slaughter (Ayers, 1955; McGrath *et al* 1969). These pathogens are considered a hazard to the safety of meat products and therefore to the consumer of these products. Contamination of carcasses with pathogenic organisms generally occurs via ingesta, hair, hides and hooves and water (Ayers, 1955; Sparling 1996, USDA 1993). Prevention of contamination by these mechanisms is essential to produce a safe product with an adequate shelf life to maintain the industry's lucrative export markets.

It has been previously considered that it is an important factor in the supply of safe meat in the condition of cattle supplied for slaughter. In theory, the dirtier the condition of the stock when slaughtered, the greater the microbiological contamination of the carcass. Therefore, the supply of clean stock (free from dags and other physical contaminants) is seen by many as the critical control point in reducing or minimising the microbiological contamination of the carcass, thus increasing the safety of the subsequent meat product/s (USDA 1993). This research sets out to assess the extent to which these factors contribute to the microbial loading of the carcase.

4.2 Legislation / Standards

The Australian Quarantine and Inspection Service (AQIS) (1999) provides the following guidance to the interpretation of the Export Meat Orders (EMO's):

> *"To produce and process microbiologically safe meat, it is important for a slaughtering establishment to receive clean and healthy livestock for slaughter. AQIS, through the provisions of the legislation (EMOs), restricts slaughter of cattle that are soiled or unclean, as well as daggy animals from feedlots as these animals pose a risk of contamination of meat. In addition to the requirements of the EMOs, the Australian red meat industry, under its 'CATTLECARE' program, has undertaken the task of educating and increasing the awareness of livestock owners of the importance of clean livestock for slaughter in the delivery of safe products to meat consumers."*

In addition to AQIS, the Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ) have endorsed the following two documents:

1 Australian Standard for Hygienic Production of Meat for Human Consumption; AS4461:1997 (1997),

2 Australian Standard for the Construction of Premises Processing Animals for Humans; AS4462:1997 (1997).

These documents set mandatory standards applicable to all processors of stock used for human consumption. AS4462:1997 provides a set of objectives for the construction of processing facilities. Section 5.6 of this standard states that:

> *"facilities shall be provided to effectively wash or treat animals to remove contamination from the hide or skin where necessary."*

AS4461:1997 takes the processing of animals through to the chiller. The standard deals with the interaction of the supply of stock to the kill floor and their cleanliness (through *antemortem* inspection). It also deals with the interactions between the cleanliness of stock and processing rates. Statements from the standard to note are:

Section 6.1(c):

"The specific aims of *antemortem* inspection are to prevent animals that are grossly contaminated with extraneous matter from entering the slaughter floor."

Section 8.7 (a):

"Slaughter shall proceed at a rate which allows adequate time for bodies to be dressed in a hygienic and orderly manner."

Appendix C - *Antemortem* Procedures and Preventative Actions.

Observations	**Hazard**	**Disease**	**Preventative Action**
Faecal contamination	Light	Physical Contamination	Passed as fit for routine processing
	Moderate to Heavy	Physical Contamination	Withheld from processing pending treatment. OR Processed under restrictions that prevent unacceptable contamination of the processing floor.

4.3 Adhesion of Dags

An important issue in cattle cleanliness is the removal of dags. Dags are attached to, and formed around the hair (Auer *et al*, 1998), and do not form any attachment of faeces to the hide itself. The adhesion of the faeces to the hair forms a very strong matrix that needs to be broken in order to remove dags from the animal.

5.0 METHODOLOGY

This project consists of 3 trials (1 summer based and 2 winter based). All treatments used in the 3 trials were identified as being the most widely used methods of cleaning cattle both in Australia and overseas (Rowland *et al*, 1997). AQIS regulations did not permit the use of untreated animals in Winter Trial 1. Therefore, a second trial at Beef City was held to further evaluate the impact of treatments. All animals in the 3 trials received the standard aerosol/dust suppression water spray treatment prior to slaughter. This treatment consists of a potable water spray for between 3 and 5 minutes. This was not enough time to affect the cleanliness of the animal.

Summer Trial

The aim of this was to evaluate the effectiveness of treating cattle with dag removal techniques in reducing dust/aerosol levels at slaughter. Twenty Murray Grey steers of similar age selected from the same pen were randomly allocated into one of four treatment groups. All cattle were totally free of dirt (Category 1 on the UK Meat Hygiene Services grading scale), but had a very high level of dust. The cattle had been on feed for approximately 275 days and averaged 705 kg in weight prior to slaughter. The treatment groups include (refer Section 5.1):

Group One	Control	(n = 5)
Group Two	Spray wash	(n = 5)
Group Three	Spray wash plus detergent	(n = 5)
Group Four	Parke Rota Shear™	(n = 5)

All treatments were applied on Day 1, transported to the works, and slaughtered on Day 2. Stock were kept together over night ready for slaughter. Twelve hours post slaughter the carcasses were sampled and subsequently tested microbiologically (refer Section 5.2).

Winter Trial 1

200 Hereford and Hereford cross steers of similar liveweight and age were randomly taken from a pen of approximately 280 steers and used in this trial. All steers had been on the same ration for 156 days prior to slaughter and were of a similar dirt loading (Category 3 and 4 on the UK Meat Hygiene Services grading scale). All of the selected steers were randomly allocated to 1 of 11 treatment groups. The treatment groups are as follows (refer Section 5.1):

Group One	Control	(n = 20)
Group Two	Pre-shorn - Spray wash	(n = 20)
Group Three	Spray wash	(n = 18)
Group Four	Pre-shorn – shear	(n = 19)
Group Five	Shear	(n = 20)
Group Six	Pre-shorn – Spray wash and detergent	(n = 20)
Group Seven	Spray wash and detergent	(n = 20)
Group Eight	Pre-shorn – RRDRS (Welfare/Micro)	(n = 20)
Group Nine	RRDRS (Welfare/Micro)	(n = 20)
Group Ten	Pre-shorn – RRDRS (Meat quality/Micro)	(n = 20)
Group Eleven	RRDRS (Meat quality/Micro)	(n = 20)

Treatments 8 and 9 were used for welfare assessment, treatments 10 and 11 were used for testing meat quality attributes (microbiological loading was assessed across all treatments). All treatments (except for the pre-shearing, which was undertaken 8 weeks earlier) were undertaken on Day 1. Half an hour post treatment all cattle from groups 1, 3, 5 and 9 had blood samples removed from the tail vein for the measurement of the effects on animal welfare. On Day 2, all groups were re-exposed to the treatment area conditions without the treatment being applied. Blood was again collected for animal welfare assessment. Days 3 and 4 the cattle, in their treatment groups, were placed on clean rice hulls. On Day 5 the cattle were slaughtered and meat samples were

taken for glycogen and lactate analysis. Twelve hours post slaughter the carcasses were sampled and microbiologically evaluated (refer Section 5.2).

Winter Trial 2

One hundred Hereford and Hereford cross steers of similar liveweight and age were randomly taken from a pen of approximately 250 steers and used in this trial. All steers had been on the same ration for 180 days prior to slaughter and were assessed as Category 3 and 4 on the UK Meat Hygiene Services grading scale. All of the selected steers were randomly allocated to one of five treatment groups. The treatment groups are as follows (refer Section 5.1):

Group One	Control	(n = 20)
Group Two	Spray wash	(n = 20)
Group Three	Hand rake	(n = 20)
Group Four	Parke Rota Shear™, Post-slaughter	(n = 20)
Group Five	Air knife, Post-slaughter	(n = 20)

All treatments were applied on day one with slaughtering taking place on day two. Cattle were kept in their treatment groups over night ready for slaughter. Twelve hours post slaughter the carcasses were sampled and tested microbiologically.

Data Analysis

Data were analysed using Analysis of Variance (Genstat, 1997). Analysis of the treatment was undertaken for the effect on microbiological levels, meat quality characteristics, animal welfare impacts and the quality of the hides. Occupational Health & Safety assessments were ranked according to the raw results.

5.1 Cleaning Methods

5.1.1 Control Treatment

All cattle allocated to the control group were handled similarly to the other treatment groups except no cleaning regime was applied.

A. Summer Trial:

The cattle were placed in the yards for the same period (4 hours) as the other groups.

B. Winter Trial 1

Cattle were held in a crush for one minute in order to provide a base level to compare all subsequent measurements. This eliminated the effects of handling such as (drafting and moving).

C. Winter Trial 2

Cattle were drafted and placed in one pen at the abattoir receival yards and left until slaughter the following day.

5.1.2 Rockdale Robotic Dag Removal System

This system consists of a specially designed hydraulic crush that has robotically controlled arms with rotating drums on the ends of each arm. These drums are manipulated into position along side the animal whilst the animal is restrained in the crush. While the drum is rotating, the dags are pulled into the holes in the drum and thus parted from the hair.

5.1.3 Parke Rota Shear™

The Parke Rota Shear™ is an air driven handpiece that utilises the technology of a rotating cutting blade.

A. Pre-slaughter

The stock were shorn from midline to midline (including the legs). The animals were held in a crush and using the handpiece shorn to leave a stubble 2 to 4 mm in length. In winter trial 1, shearing was performed at 2 stages, one on entry to the feedlot and one just prior to slaughter.

B. Post-slaughter

Shearing occurred post-slaughter just after the animal had been exsanguinated and elevated to the rail. The operator used a rising platform to access the cattle in order to shear the cutting lines free of dags. The lines shorn consisted of the belly, and inside of the rear legs. Material that did not fall off the hide was removed manually by the operator after shearing.

5.1.4 Spray Wash

The animals were sprayed with non-potable water for a period of at least 40 minutes depending on water pressure and volume. Animals were placed in pen lots of between 10 and 20 head and sprayed with water in a similar manner to a sheep spray dip system. Following the spray soak, the animals were hosed to remove the loosened material.

5.1.5 Spray Wash with Detergent

The animals were sprayed with non-potable water for a period of at least 40 minutes depending on water pressure and volume. A non-foaming detergent (Kadet™) was included at a concentration consistent with manufacturer's instructions to act as a wetting agent to loosen the matrix bond between the hair and dag. Animals were placed in pen lots of between 10 and 20 head and sprayed with water in a manner similar to a sheep spray dip system. Following the spray soak, the animals were hosed to remove the loosened material.

5.1.6 Hand Rake

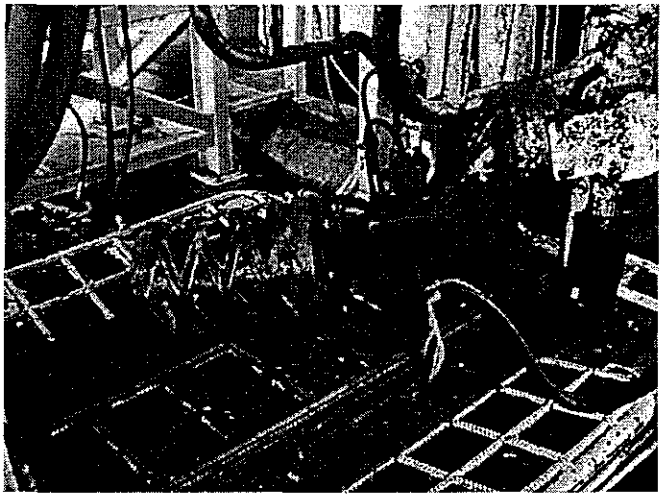
The animals were soaked for approximately 20 minutes using non-potable water. They were then placed into a handling race that provides access to the flanks of the stock. Specially designed rakes were used to then remove the dags. The rakes were scraped over the hide, dags collected in the tynes were ripped off as the rake moved along.

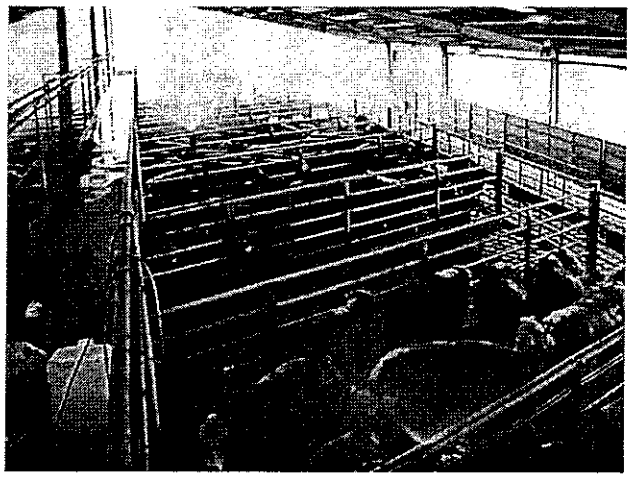
5.1.7 Air knife (Post-slaughter)

Shearing occurred post-slaughter just after the animal had been exsanguinated and elevated to the rail. The operator used a rising platform to access the cattle in order to shear the cutting lines free of dags. The lines shorn consisted of the belly, and inside of the rear legs. Material that did not fall off the hide was removed manually by the operator after shearing.

Parke Rota Shear in use

Rockdale Robotic Dag Removal System





Spray Washing Facilities

5.2 Microbiological Assessment

5.2.1 Sample Sites

One side from each carcass was sampled at each of three sites. The sites were selected to meet the US Department of Agriculture sampling regimes (USDA/FSIS, 1996). The sites used were a 100cm^2 site at the rump, flank and brisket.

5.2.2 Sample Collection

Samples were taken from the carcass according to the method stipulated by the US Department of Agriculture (USDA/FSIS, 1996). This method was utilised as it provides an adequate international benchmark for sampling procedures. Sampling staff worked in pairs, where the first member was responsible for swabbing the Carcass while the second member was responsible for the preparation of the Whirlpack® sponges and assistance to the first team member, to ensure the microbiological integrity of the samples.

Each sample was obtained at least 12 hours post-slaughter by swabbing a templated area of 10 by 10cm with a sterile Whirlpack® sponge wetted with approximately 10 ml of sterile 0.1 % peptone water. Each site was swabbed ten times in a horizontal direction and then ten times in a vertical direction. One sponge was used to sample the rump, reversed to sample the flank and then folded and rotated prior to sampling the brisket. The Whirlpack® sponge was then stored in a stomacher bag (Nasco™) with a total of 25 ml of 0.1% peptone

water. A new set of latex gloves (Ansell™ latex pre-powdered non-sterile) was used for each carcass to reduce cross contamination. The bags with sponges were then stored below 4^0C during the remainder of the sampling procedure and transport phase until processing was undertaken within 24 hrs post-sampling (AS 1766.1.2 – 1991).

5.2.3 Sample Processing

Sponge samples were stomached for 2 minutes prior to recovering diluent from the sponges. Serial ten fold dilutions of each sample were prepared (AS 1766.1.2 – 1991). Total plate counts were undertaken using the standard aerobic plate count at 25^0C, pour plate method (AS 1766.2.1 – 1991). Enumeration of *E. coli* and coliform counts was also undertaken using *E.coli* and coliform plate count Petrifilm™ according to the manufacturer's instructions.

5.3 Occupational Health and Safety Assessment

All cleaning techniques were assessed on the impact the application had on the worker's occupational health and safety whilst performing the cleaning technique. The "Victorian WorkCover Risk Assessment Model" was used to provide a format for measuring the level of risk associated with undertaking the treatments performed in the trial. This model provides a framework for assessing the probability of an incident occurring, how often the employee is exposed to the risk and an assessment of the end-point consequence/s.

5.4 Effects on Meat Quality

5.4.1 Summer Trial

All carcasses were assessed in the chiller, according to the Aus-Meat Chiller Assessment Grading System.

5.4.2 Winter Trial 1

All carcasses were sampled and assessed according to the Aus-Meat Chiller Assessment Grading System and assays completed to measure the final levels of glycogen and lactate in the muscle. Glycogen and lactate are indicators of meat quality.

Sample Collection

All samples were removed from the left –hand side of the carcass. Samples of approximately 10g were removed approximately 15 minutes after slaughter from the *Longisimus coli* muscle, placed in a plastic bag labelled with carcass number, sealed and frozen at –20°C in order to halt the biochemical reactions.

Sample Processing

Samples were processed utilising the same methodology used by Warner and Pethick (1998). This methodology has been modified from that presented by Dreiling *et al* (1987). Appendix 1 provides a description of the methodology for undertaking the glycogen and lactate assays.

5.4.3 Winter Trial 2

All carcasses were assessed in the chiller, according to the Aus-Meat chiller Assessment Grading System.

5.5 Animal Welfare Issues

Members of the NSW Agriculture Beef Industry Centre were employed to undertake an assessment of the welfare implications associated with the application of the treatments applied in this study.

In summary, timed observations of the animal behaviour were made in the race and in the crush prior to the application of the treatments as well as during the treatments. In addition, serological assays of evidence of stress were undertaken.

Within half an hour of applying the treatments, all animals were moved to a sampling race where a blood sample was collected from the tail vein in order to perform cortisol assays.

This procedure was then re-applied the following day (without drafting) in order to assess the residual psychological effects of the treatments.

5.6 Effects on Hide Quality

All hides were collected post removal, tagged for identification and packaged in such a way that enabled quick assessment at a later date. Hides were assessed for overall quality, in particular fleshing score, hair balling, dung contamination, and uneven combing. All assessments were based on visual inspection and a subjective rating system.

The scoring systems used for the assessment of the hides are detailed in Tables 1 and 2.

TABLE 1: Hair ball, Dung contamination and Uneven combing Score System

Score	Description
1	No area of the hide affected
2	Up to 3% of the hide affected
3	Up to 10% of the hide affected
4	Up to 20% of the hide affected
5	Up to 30% of the hide affected
6	Up to 40% of the hide affected
7	Up to 50% of the hide affected
8	Up to 60% of the hide affected
9	Up to 75% of the hide affected
10	Over 75% of the hide affected

TABLE 2: Fleshing Score System

Score	Description	Hide Value
1	Over 30% of the hide is damaged.	$28.00
2	Up to 30% of the hide is damaged.	$40.00
3	Up to 15% of the hide is damaged.	$60.00
4	Up to 3% of the hide is damaged.	$70.00
5	Nil damage.	$76.00

The monetary value of the hides was calculated. All calculations were undertaken on "Value Based Marketing" principles.

5.7 Visual Assessment of Cleanliness

All stock were individually assessed for the level of dirt/manure loading on the hide. There are only two recognised schemes in use internationally. Both schemes provide maximum objectivity to a subjective assessment. The grading scheme used for this series of trials is that of the UK's Meat Hygiene Service. The scheme is known as the Clean Livestock Policy (1997).

Assessment is made on a sliding scale from 1 to 5, with 1 being clean and 5 being the heaviest laden. The following provides a brief description of the scheme used:

Category 1	Clean, free of manure/dirt.
Category 2	Light contamination.
Category 3	Significant contamination.
Category 4	Heavily contaminated.
Category 5	Very heavily contaminated.

5.8 Cost of Treatments

The costs attributed to treating stock as described in Section 5.1 were calculated. The costs identified included capital outlay to purchase or build the necessary infrastructure and running costs (consumables, interest, depreciation and costs associated with labour). A "best-bet" value for maintenance of equipment was used. This amount would vary considerably from one works to another.

Premiums for WorkCover insurance can rise substantially depending on the number of incidents requiring claims due to the treatment being utilised, this is a hidden cost that requires acknowledgment. These premiums vary greatly from state to state, for instance in Queensland the feedlot industry experiences premiums of 6.364% and in New South Wales 10.36% (Morris Risk Services,

pers com 1999). These costs need to be considered separately on a case by case basis. Therefore, selecting a treatment that increases the risk placed on staff could lead to an increase in accidents and therefore premiums. Section 6.3 provides an insight into the work risks associated with each of the treatment groups.

An additional hidden cost is the potential slowing of work rates. In both winter trials, the rate of flow of the slaughter chain was measured during the treatment groups as well as before and after the trial animals.

6.0 RESULTS

6.1 Visual Effectiveness of Cleaning Method

The visual assessment was performed prior to treating the animals in the holding yards, assessment was performed again post-slaughter but pre-hide removal.

A. Summer Trial:

As the cattle used in this trial were classified as category 1 on the UK Clean Livestock Grading Scheme (1995) prior to the treatments being applied, the effectiveness of the treatments in improving the grade cannot be assessed in this trial. All cattle prior to slaughter were graded as category 1, the cleanest grade.

B. Winter Trial 1:

Cattle averaged category 3.5 for cleanliness on selection for the trial. All treatments applied reduced the levels of dag loading on the live animal. Groups 7 (spray wash with detergent), 9 (RRDRS welfare/micro) and 11 (RRDRS meat quality/micro) had the highest levels of loading on the live animal post treatment.

TABLE 3: Visual Assessment of Dag Loading – Winter trial 1

Treatment Group	Pre-treatment Visual Assessment	Post-treatment Visual Assessment
Control (Group 1)	3.5	3.5
Preshorn/spray wash (Group 2)	3.5	1.25
Spray wash (Group 3)	3.5	1.25
Pre-shorn/shear (Group 4)	3.5	1.0
Shear (Group 5)	3.5	1.0
Pre-shorn/spray wash and detergent (Group 6)	3.5	1.25
Spray wash and detergent (Group 7)	3.5	2.00
Pre-shorn- RRDRS (Group 8)	3.5	1.25
RRDRS (Group 9)	3.5	2.25
Pre-shorn – RRDRS (Group 10)	3.5	1.25
RRDRS (Group 11)	3.5	2.25

C. Winter Trial 2

Cattle averaged category 3.5 for cleanliness on selection for the trial. Group 2 (spray wash) was significantly cleaner than the control group 1. Group 3 (hand rake), 4 (Parke Rotor Shear™ post slaughter) and 5 (air knife post slaughter) were not significantly cleaner. Overall assessment for groups 4 and 5 would not be expected to be affected as only small areas of the animal were cleaned along the cutting lines.

TABLE 4: Visual Assessment of Dag Loading – Winter Trial 2

Treatment Group	Pre-treatment Visual Assessment	Post-treatment Visual Assessment
Control (Group 1)	3.5	3.5
Spray Wash (Group 2)	3.5	1.25
Hand rake (Group 3)	3.5	2.0
Parke Rota Shear (Group 4)	3.5	3.5
Air knife post slaughter (Group 5)	3.5	3.5

6.2 Microbiological Assessment

A. Summer Trial

Total Viable Counts (Log TVC/cm^2) were estimated and as they were not normally distributed were analysed by "ANOVA by Ranks". There were no statistical differences between any of the treatment groups (Figure 1). Coliform and *E. coli* counts were performed. No coliforms or *E. coli* were found on the carcasses.

B. Winter Trial 1

Log TVC/cm^2 are presented in Figure 2. The data are not normally distributed and were analysed by "ANOVA by Ranks". There are some statistically significant differences between the groups, however, the box plot shows that these differences are small and that, overall, the counts on carcasses were so low (less than log 2.5/cm^2) that any differences are almost negligible. Coliform counts are displayed as a box plot of an "ANOVAR on Ranks" (Figure 3) and a frequency distribution (Figure 4). The counts are all low and there are no

significant differences between treatment groups. Some of the groups do have coliform counts greater than detectable limits, but are still extremely low. There are only a small number of carcasses in this trial with detectable *E. coli* levels. None of these carcasses are above the lower limit for the USDA/FSIS 3 class-sampling plan.

Figure 1. Log total viable counts/cm^2 – Summer Trial

Key:	c	control group
	d	spray wash with detergent group
	s	shear group (live)
	w	spray wash group

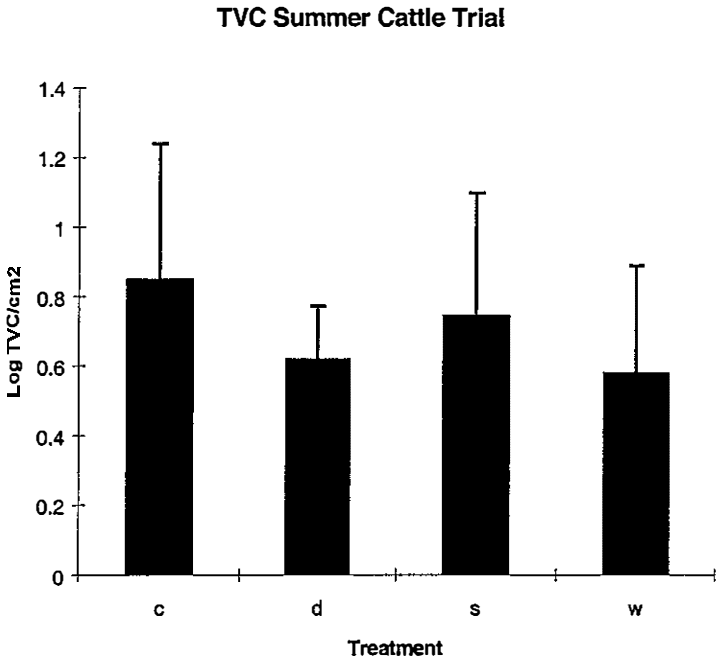
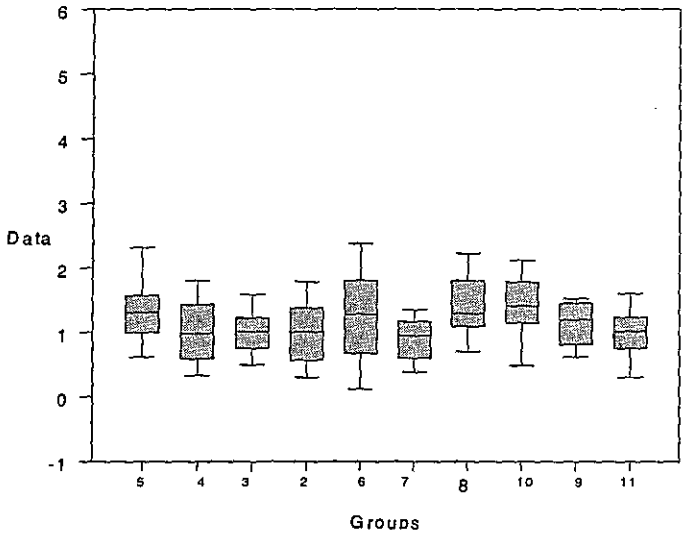
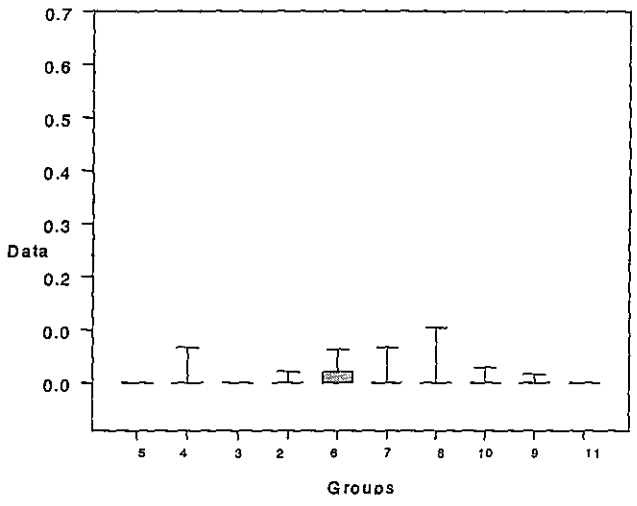


Figure 2. Log total viable counts/cm^2 - Winter Trial 1



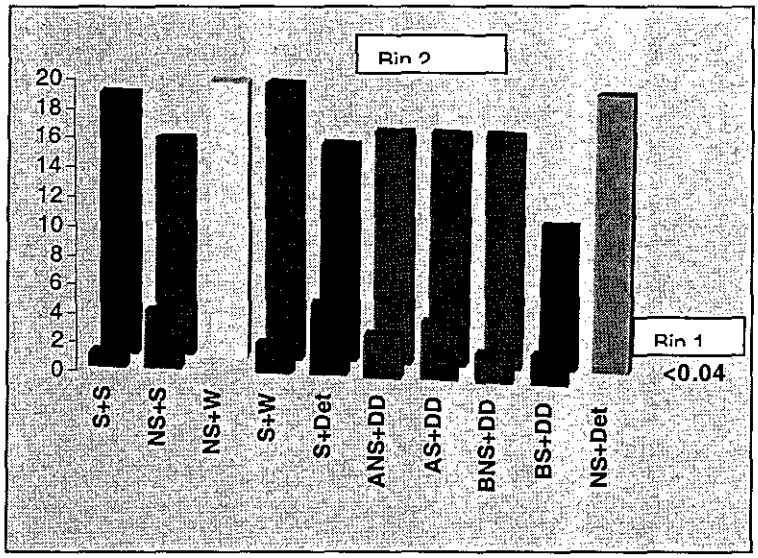
Key:
2 Pre-shorn – spray wash
3 Spray wash
4 Pre-shorn - shear
5 Shear
6 Pre-shorn – Spray wash & detergent
7 Spray wash & detergent
8 Pre-shorn – RRDRS (welfare/micro)
9 RRDRS (welfare/micro)
10 Pre-shorn – RRDRS (meat quality/micro)
11 RRDRS (meat quality/micro)

Figure 3. Coliform counts/cm^2 - Winter Trial 1



Key:
2 Pre-shorn – spray wash
3 Spray wash
4 Pre-shorn - shear
5 Shear
6 Pre-shorn – Spray wash & detergent
7 Spray wash & detergent
8 Pre-shorn – RRDRS (welfare/micro)
9 RRDRS (welfare/micro)
10 Pre-shorn – RRDRS (meat quality/micro)
11 RRDRS (meat quality/micro)

Figure 4. Coliform counts/cm^2 - Winter Trial 1 (Bin 1< 0.04, Bin 2 > 0.04)
Where level of detection is 0.04 coliforms/cm^2

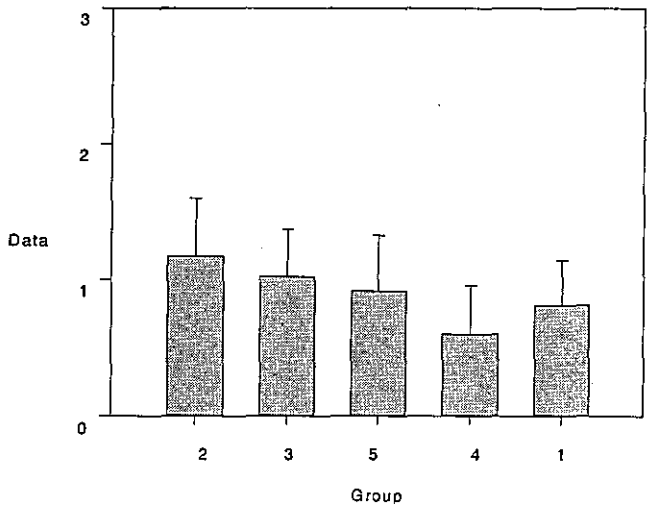


S+S: pre-shear, shear
S+NS: pre-shear, no shear
NS+W: no shear, wash
S+W: shear, wash
S+Det: shear, wash and detergent
ANS+DD: no shear, de-dagger group A
AS+DD: shear, de-dagger group A
BNS+DD: no shear, de-dagger group B
BS+DD: shear, de-dagger group B
NS+Det: no shear, wash and detergent

C. Winter Trial 2

Only Log TVC's are provided (Figure 4) as the coliform and *E coli* counts are extremely low for all groups. Figure 5 shows that treatment groups 2 & 3 (Spray wash and raking respectively) resulted in significantly higher TVC's than the control group.

Figure 5. Log TVC/cm^2 - Winter Trial 2



Key:
1 Control
2 Spray wash
3 Hand rake
4 Shear post slaughter
5 Air knife post slaughter

6.3 Occupational Health and Safety Assessment

Appendix 2 provides copies of the "Risk Assessment Calculator" that was used to calculate the risk associated with undertaking the treatments. Table 5 provides a summary of these results.

A. Summer Trial

All treatments were assessed using the Risk Assessment Calculator. These assessments are attached in Appendix 2. A summary of the results is provided in Tables 5A and 5B. From the assessment of the treatment groups, it can be seen that treatment group 4 (pre-slaughter shearing) is of much greater risk to the operator than the other three treatments applied.

TABLE 5A: OH&S Summary of Risk Assessment Ratings

Treatments	Probability	Exposure	Consequences
Control (group 1)	Practically Impossible	Continuous	Acceptable
Spray wash (group 3)	Conceivable but unlikely	Frequent	Acceptable
Spray wash & detergent (group 7)	Conceivable but unlikely	Frequent	Acceptable
Shear (group 5)	Very likely	Continuous	Substantial
Pre-shear/spray wash (group 2)	Very likely	Continuous	Substantial
Pre-shear/shear (group 4)	Very likely	Continuous	Substantial
Pre-shear/spray wash & detergent (group 6)	Very likely	Continuous	Substantial
Pre-shear/RRDRS (group 8 and 10)	Very likely	Continuous	Substantial
RRDRS (group 9 and 11)	Practically Impossible	Continuous	Acceptable
Hand rake (group 3)	Very likely	Frequent	Substantial
Parke Rota Shear (post slaughter) (group 4)	Conceivable but unlikely	Continuous	Moderate to Acceptable
Air knife (post slaughter) (group 5)	Remotely possible	Continuous	Moderate

B. Winter Trial 1

All treatments were assessed using the Risk Assessment Calculator. These assessments are attached in Appendix 2. A summary of the results is provided in Tables 5A and 5B.

From the analysis of the treatments performed it can be seen that any treatment that includes pre-slaughter shearing places the operator in a much higher risk category than those treatments without shearing. Both washing treatments and the RRDRS treatment group had a final assessment of a low or acceptable risk level.

C. Winter Trial 2

All treatments were assessed using the Risk Assessment Calculator. These assessments are attached in Appendix 2. A summary of the results is provided in Tables 5A and 5B.

From the analyses it can be stated that the hand rake treatment provides similar operator risk as the shearing treatment. The two post slaughter treatment groups showed a slightly increased level of risk to the operator. This level of risk places the operator in the moderate level risk band that requires monitoring.

TABLE 5B: OH & S Summary of Risk Assessment Ratings

Treatments	Risk of Injury	Comments
Control (group 1)	Acceptable	Dealing with cattle – always a little risk of injury.
Spray wash (group 3)	Acceptable	Dealing with cattle – always a little risk of injury.
Spray wash & detergent (group 7)	Acceptable	Dealing with cattle – always a little risk of injury.
Shear (group 5)	Substantial	Continuous bending at waist and unprotected legs of cattle, high risk of being kicked
Pre-shear/spray wash (group 2)	Substantial	Continuous bending at waist and unprotected legs of cattle, high risk of being kicked
Pre-shear/shear (group 4)	Substantial	Continuous bending at waist and unprotected legs of cattle, high risk of being kicked
Pre-shear/spray wash & detergent (group 6)	Substantial	Continuous bending at waist and unprotected legs of cattle, high risk of being kicked
Pre-shear/RRDRS (groups 8 and 10)	Substantial	Continuous bending at waist and unprotected legs of cattle, high risk of being kicked
RRDRS (groups 9 and 11)	Acceptable	Dealing with cattle – always a little risk of injury.
Hand rake (group 3)	Substantial	Using rigid equipment in between unprotected legs of cattle, high risk of being kicked or equipment being ripped out of hands and causing injury.
Parke Rota Shear (post slaughter) (group 4)	Moderate to Acceptable	Using sharp/cutting devises on moving platforms provides some need for increasing the risk to the operator.
Air knife (post slaughter) (group 5)	Moderate	Using sharp/cutting devises on moving platforms provides some need for increasing the risk to the operator.

6.4 Effects on Meat Quality

6.4.1 Summer Trial

A. Chiller Assessment

There were no statistical differences (p= 0.46) obtained for any of the attributes measured in the chiller.

6.4.2 Winter Trial 1

A. Chiller Assessment

There were no statistical differences (p=0.25) obtained for any of the attributes measured in the chiller. It must be noted that there was some level of bruising observed in this group of animals. The bruising was not correlated to any one treatment. Without analysing the abattoir/feedlots records, it cannot be determined whether the level of bruising was abnormally high for these premises.

B. Assays for Glycogen and Lactate Levels in Meat

Glycogen and lactate assays were performed as indicators of the level of stress of the animals, and as indicators of subsequent meat quality. A high level of glycogen correlates with a less stressed animal, and higher lactate levels indicate a greater likelihood of achieving a suitable endpoint pH. Table 6 provides a summary of the treatment group results. It was found that Group 7 (Spray wash and detergent) had significantly higher levels of glycogen and lactate than Groups 2, 5, 6, 10, and 11, while Groups 3 and 4 (Spray washing and Pre-shear/shear respectively) had significantly higher levels of glycogen. Group 7 (Spray wash and detergent) had significantly higher levels of lactate in the muscles, which should provide meat of better quality.

Animals from groups 2, 5, 6, 10, 11 would be expected to have lower final meat quality.

TABLE 6: Glycogen and lactate levels: Winter Trial 1

Treatment	Glycogen	Lactate
Pre-shorn/spray wash(Group 2)	0.33	0.43
Spray wash (Group 3)	0.48[b]	0.46
Pre-shorn/shear (Group 4)	0.41[b]	0.47
Shear (Group 5)	0.31	0.42
Preshorn/spray wash and detergent (Group 6)	0.31	0.47
Spray wash and detergent (Group 7)	0.39[a]	0.59[a]
Preshorn/RRDRS (Group 10)	0.32	0.41
RRDRS (Group 11)	0.33	0.40
	p = 0.026	P = 0.014

6.4.3 Winter Trial 2

A. Chiller Assessment

There were no statistical differences (p= 0.448) obtained for any of the attributes measured in the chiller.

6.5 Animal Welfare Issues

A. Summer Trial

There were no measurements for animal welfare performed on this set of treatments. The treatments were repeated in Winter Trial 1 and assessment made there.

B. Winter Trial 1

The RRDRS treatment did not elevate plasma cortisol or result in residual psychological stress beyond levels associated with other procedures involving similar handling of animals. However, plasma cortisol levels associated with RRDRS, shearing and control groups were high compared to other cattle handling studies, indicative that the general handling procedure employed for

these groups was stressful and, in all likelihood, handling practices stressed the animals more than the cleaning procedures *per se*. Cortisol levels were far lower after the more chronic washing procedure than after the more acute RRDRS, shearing, and control procedures. Pre-shearing resulted in lower cortisol levels compared to animals which were not pre-shorn, although this result appears to have been confounded by residual effects of drafting just prior to the welfare assessment.

C. Winter Trial 2

There were no measurements for animal welfare performed in this trial.

6.6 Effects on Hide Quality

A. Summer Trial

Sampling and assessment of the hides for this set of treatments were not undertaken for this trial. There were no dags on hides pre-cleaning and therefore would be no damage as a result of poor dag removal.

B. Winter Trial 1

The values of the hides altered as a result of the treatment being applied. Table 2 shows the value placed on the hide in relation to the fleshing score. Table 7, shows the results obtained from the assessment of all hides collected from this trial.

From Table 7 it can be seen that the average fleshing score of each treatment group was greater than 4, where a score of 5 indicates no damage has been caused during the fleshing process. Cattle in Group 7 (Wash and detergent) and Groups 9/11 (RRDRS) had significantly lower ($p<0.001$) fleshing scores than the other treatment groups.

Cattle in treatment groups 3, and 9/11 (Washed, and RRDRS respectively) had significantly higher ($p<0.05$) hair ball score than all other treatment groups. Cattle from treatment groups 2, 4, and 5 (pre-shear washed, pre-shear shear, and shear treatment groups respectively) had significantly lower ($p<0.05$) hair ball scores than the other treatment groups.

The cattle in treatment group 5 (shear) had a significantly higher ($p<0.05$) level of uneven clipping than any other treatment group. This was due to operator error during clipping. Uneven clipping impacts on the final value of the hide, limiting the hide to lower value markets.

The hides were assessed using the pricing schedule set out in Table 5, and presented in Table 8. It was found that treatment groups 7 and 9 were valued lower for hides than any other treatment groups. Treatment group 7 (wash and detergent) did not achieve the same hide value as that of treatment group 3. The reasons for this difference are unclear.

TABLE 7: Hide Assessment Scores – Winter Trial 1

Treatment	Fleshing Score (1 = very bad, 5 = very good)	Hair Ball (0 = none, 10 = > 75% of hides affected)	Dung Contamination (0 = none, 10 = >75% of hides affected)	Uneven Combing (0 = none, 10 = > 75% of hides affected)
Pre-shear / Shear (group 4)	5.000[a]	0.00[c]	0.000[b]	0.263[b]
Shear (group 5)	5.000[a]	0.00[c]	0.000[b]	2.600[a]
Pre-shear / Wash (group 2)	4.895[a]	0.00[c]	0.000[b]	0.000[b]
Spray Wash (group 3)	4.944[a]	2.89[a]	0.111[b]	0.000[b]
Pre-shear / wash & detergent (group 6)	4.900[a]	1.45[b]	0.050[b]	0.000[b]
Wash & detergent (group 7)	4.450[b]	1.30[b]	2.600[a]	0.000[b]
Pre-shear / RRDRS (groups 8 and 10)	4.900[a]	1.30[b]	0.600[b]	0.000[b]
RRDRS (groups 9 and 11)	4.300[b]	3.45[a]	2.600[a]	0.000[b]
s.e.m.	0.1117	0.410	0.3011	0.2210

N.B: Within column values followed by different letters are significantly different $P<0.05$.

TABLE 8: Hide Value Analysis

Treatment	Fleshing Score	Hide Value ($)
Pre-shear / Shear (group 4)	5.000[a]	76.00
Shear (group 5)	5.000[a]	76.00
Pre-shear / Wash (group 2)	4.895[a]	76.00
Spray Wash (group 3)	4.944[a]	76.00
Pre-shear / wash & detergent (group 6)	4.900[a]	76.00
Wash & detergent (group 7)	4.450[b]	70.00
Pre-shear / RRDRS (groups 8 and 10)	4.900[a]	76.00
RRDRS (groups 9 and 11)	4.300[b]	70.00

C. Winter Trial 2

Sampling and assessment of the hides for this set of treatments were not undertaken for this trial, as most treatments had already been evaluated in trial 1.

From the data supplied in Tables 3, 7 and 8, it can be seen that there is a direct correlation between the visual assessment of the hides, the fleshing scores given to the hides and the payment received for the hides.

6.7 Cost of Applying the Treatment/s

Please note that these values are based on best estimates. These costings provide indicative calculations for each treatment group. Each system needs to be costed to fit individual enterprises.

In both winter trials, the rate of flow of the slaughter chain was measured during the treatment groups as well as before and after the trial animals (baseline measurements). It was found that the rate of work did not differ from the baseline. Therefore, additional costs were not incurred.

All costings have been calculated based on 20000 head over the 5 year period, an FTE worth $38000 (includes on costs), interest valued at 7%pa with the capital outlay spread over a 5 year period.

Table 9: COMPARISON OF COSTS FOR TREATMENTS

Treatment Groups	Capital Outlay	Operating Costs	$/head	Comments
Control Group (group 1)	0	0	5 to 50	Knifing or Cleaning fee charged by some processors
Spray Wash Group (group 3)	7500 (6500 to 8000)	Maintenance $300 Electricity $150 Labour 0.2 FTE	0.51	
Spray Wash and Detergent Group (group 7)	7900 (6900 to 8400)	Maintenance $500 Electricity $200 Labour 0.2 FTE Consumables $175/20L	0.55	
Shearing Group (group 5)	4300	Maintenance $200 Electricity $75 Labour 0.8 FTE	1.69	
RRDRS Group (groups 9 and 11)	550000	Maintenance $3000 Labour 0.8 FTE	7.67	
Pre-shorn - Spray wash (group 2)	11800	Maintenance $500 Electricity $225 Labour 1 FTE	2.20	
Pre-shorn – Spray wash and detergent (group 6)	12200	Maintenance $700 Electricity $275 Labour 1 FTE Consumables $175/20L	2.24	
Pre-shorn – Shear (group 4)	8600	Maintenance $400 Electricity $125 Labour 0.4 FTE	0.93	
Pre-shorn – RRDRS (groups 8 and 10)	554300	Maintenance $300 Electricity $150 Labour 1 FTE	7.99	
Hand rake (group 3)	500	Maintenance $200 Labour 0.75 FTE	1.44	
Parke Rota Shear™, Post-slaughter (group 4)	4300	Maintenance $200 Electricity $75 Labour 0.3 FTE	0.67	
Air knife, Post-slaughter (group 5)	2000	Maintenance $200 Power $75 Labour 0.3 FTE	0.65	

7.0 DISCUSSION

This project is of a complex and integrated nature. For the data presented in this report to be utilised by the Beef Industry in a beneficial way, it needs to be looked at in its entirety. Strong ties exist between the visual effectiveness of the cleaning methods, the fleshing scores of the hides and the value received for the hides. Previous research undertaken by Grau, Brownlie and Roberts (1967); Grau and Smith (1973); Ridell and Korkeala (1993); Biss and Hathaway (1995); Bell *et al* (1996); Hadley, Holder and Hinton (1997); Delazari *et al* (1998) show that livestock with high dag loads have higher concentrations of bacteria on the Carcass. However, this has been disputed by Schnell et al (1995); Van Donkersgoed *et al* (1997) and Roberts (1979) where they found that dag loading and microbiological assessment of the carcasses showed no correlation. The microbiological assessment undertaken in these trials also showed that there was no direct correlation between the dag loading of the live animal and the microbiological quality of the carcass.

The data show that all treatments assessed in the three trials reduced the dag loading on the live animal, some to a greater extent than others. Shearing of animals was by far the most effective treatment for the removal of dags as it increased the fleshing scores of the hides and nullified the effect of hairballing. The only negative effect observed with the shearing treatments was uneven combing, but this did not effect the value of these hides. The other treatments used were not able to eliminate dags although they reduced the dag loading of the animal. These treatments did have a detrimental effect on fleshing scores, and subsequently reduced the value of the hides. This impacts markedly on the returns from the hides. From the data supplied in Tables 3, 7 and 8, it can be seen that there is a direct correlation between the visual assessment of the hides, the fleshing scores given to the hides and the payment received for the hides.

There are some statistically significant differences in the microbiological assessment between the groups, however the differences are small and overall the counts on carcasses so low (less than log 2.5/cm^2) that any differences are almost negligible. Some of the groups had coliform counts greater than detectable limits, but these were still extremely low. There were only a small number of carcasses in the trials with detectable *E. coli* counts. All of these carcasses were below the lower limit for the USDA FSIS 3 class-sampling plan.

When assessing the Occupational Health and Safety aspects of treatments, it must be noted that regardless of the type of task, there will always be some level of risk associated. The same is true in any dealing with livestock. For these reasons the associated risk can be only be "acceptable" at best when undertaking the treatments. From the analysis of the treatments performed it can be seen that any treatment that includes a pre-slaughter shearing step places the operator in a much higher risk category than those treatments without shearing pre-slaughter. The hand rake treatment group was assessed at a similar risk level as that of the pre-slaughter shearing groups. The two post slaughter treatment groups provided a slightly increased level of risk to the operator, placing the operator in the moderate level risk band. Both washing treatments and the RRDRS treatment group had a final assessment of either low or acceptable risk levels. The risk levels can however, be lowered with some engineering and design modifications of the operation. For instance, the highest risk procedure of shearing can be reduced with the redesigning of the crush that is used for restraining the animal whilst shearing is performed. The two post-slaughter treatments can also be made more risk evasive through the provision of safety harnesses on the rising floor and the inclusion of guards on the hand pieces to prevent accidental self-inflected wounds to the operator. Higher risk activities will end up attracting penalties in the form of increased premiums due to the increased number of accidents that could occur.

There were no statistical differences (p=0.25) obtained for any of the meat quality attributes measured in the chiller. The level of bruising observed cannot be assessed with the current data for these premises. However, the bruising did not appear to be correlated to any one treatment.

Analysis of the glycogen and lactate levels of animals in different groups showed that animals in group 7 (spray wash and detergent), and group 3 (spray wash) and group 4 (pre-shear/shear) had significantly higher glycogen levels than all other treatments. This suggests that meat from these animals will be more likely to achieve a suitable pH level and thus better meat quality. Lactate levels for animals in group 7 were significantly higher than all other treatments, also suggesting that meat from these animals would be most likely to reach a suitable pH end point, and thus better meat quality. In general treatments including mechanical intervention resulted in meat of potentially lower quality.

Cortisol levels were also used to assess the stress of treatment groups. Higher cortisol levels were seen in the RRDRS, and pre-slaughter shearing groups than in the wash treatments. The control groups, being held in the crush for a minute, had higher handling rates than the wash groups. The handling of the stock will have contributed to the higher cortisol levels seen in the control group.

The Rockdale Robotic Dag Removal System (RRDRS) had some effect on the visual assessment of cleanliness, but proved not to be completely effective at dag removal, particularly from the legs and flanks of animals. Animals treated with RRDRS were more stressed (determined by cortisol, glycogen and lactate levels) than animals in the washing treatment groups, but were as stressed as the control group animals. There was also no difference between microbiological quality of carcasses processed using the RRDRS and other treatments. The use of the RRDRS provided the user with an acceptable level of operator risk. The capital cost of incurred for the system is prohibitive for all but the largest of feedlots. The average cost incurred for treating stock is comparable with the

knifing fee associated with slaughtering non-treated stock. Thus the RRDRS has little advantage over other treatments assessed in this project.

When considering microbiological quality of carcasses from animals treated by any of the cleaning methods assessed in this project, there were no differences in either pathogen or hygiene indicators. It would appear that, with the correct dressing and chilling procedures, combined with quality assurances systems already in place, the level of contamination of cattle normally accepted for slaughter (less than 5 using the UK Meat Hygiene Service Clean Livestock Policy system) will have little effect on carcass contamination.

8.0 RECOMMENDATIONS

➨To maintain adequate microbiological quality of carcasses, stock may be cleaned by washing alone.

➨ The value of the hide can be maximised at any point along the processing chain (ie between the feedlot/producer and the tannery).

➨when utilising mechanical methods of dag removal, animals should be cleaned at least seven days prior to slaughter and placed back onto feed and water in order to reduce the incidence of downgrading due to stress.

➨as new cleaning techniques become available, they should be evaluated through a similar process as indicated in this report. The treatment(s) should be benchmarked against the washing method and zero treatment (control) in order to provide a cross-reference to this report.

➨funding should be available to finish development and assessment of an enzyme treatment that is being developed (Auer *et al*, in press). This enzyme treatment is presently being used at the tannery in a pilot study, and is shown to be highly effective at eliminating dags from the hide. A proposal to develop the product has been submitted to MLA for funding.

➨a system for the description of the cleanliness of livestock, to be introduced into the Aus-Meat Livestock language. This system would provide a common language for describing the dag loading of animals ready for slaughter. This scheme could also be used to implement a value based grading scheme for hides starting at the live animal. The processor will have some knowledge of the true value of the hides prior to slaughter.

➨In order to maximise profit, cleaning may still be necessary, and therefore a system should be developed to classify and describe livestock by hygienic status.

➨from this information, there is scope for the EMO's to be redrafted so that the meat processing sector operates in terms of outcomes, rather than having to adhere to prescriptive, or subjective assessment criteria. In order to reduce the interpretation problems an assessment scheme can be incorporated into the EMO's as method for defining what constitutes "clean".

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APPENDIX ONE

DARK CUTTING GLYCOGEN ASSAY

First Stage - Sample Preparation.

1. Weigh about 250 mg and record meat sample sizes in the assay data sheet. Take sample tubes out of freezer individually when preparing to weigh them out. Cut into four or five smaller pieces.

Use 50ml centrifuge tubes. Place sample in tube.
Add 2.5ml of chilled 30mM HCl. to meat sample. Keep sample on ice.
Homogenize for about 30 seconds or less in short bursts with Polytron.
Wash and dry homogeniser after each sample. Keep homogenate on ice.
Spin samples for 10 minutes at 3500 rpm and transfer supernatent into 2.5ml Eppindorf tubes.
Freeze samples until ready for use. Thaw only on day of assay and minimise time out of fridge.
Spin down for 2 min. at 10,000rpm after thawing.

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Glycogen Assay

2. Take 25µl of supernatant, put into 3ml tube and add 1ml of amyloglucosidase solution.
Run assay in duplicate. Incubate in shaking water bath for 90 min at 37°C.
Whilst incubating, set up blanks for assay, add 25ul of supernatant to 1ml of chilled distilled water.

3. Make up standards in duplicate using 1mg/ml glucose solution (Sigma standard).

ml. of standard.	0	0.025	0.050	0.075	0.100
ml.of water	2.05	2.025	2.000	1.975	1.950

Second Stage

4. Take 0.08 ml from samples and standards,add to new vials. **To these tubes add 2ml. of GOD**

INCUBATE FOR **45 Min.**

5. Read OD at 420nm. BLANK the Spectophotometer with GOD.

Amylglucosidase solution = 1ml of Amylglucosidase concentrate to 100ml of Acetate Buffer

SPECTROPHOTOMETER

1 Turn on Machine at least 20 minutes prior to use. This allows the analyser to warm up.

2 The main screen will appear which shows the MAIN MENU, to select a pre-programed assay select TEST MENU (# 6) and then press ENTER

3 To selct an assay LOAD TEST (# 1) and ENTER. Now select the assay you want.
(**Glycenz # 19**) ENTER

AUTO SIPPER

1 Open lid and pull plate back untill it clicks into place then close cover

2 Release the clamp on the waste hose.
The waste hose must be open when the machine is sampling and clamped off so no air can enter the machine when you have finished you work.

3 Flush the system with distilled water by pressing and holding the wash button. Do not allow air to enter.

RUNNING THE SAMPLES

1 Take 3ml of GOD and add 0.120 ml of water, wash the machine, Press the Auto Zero button

2 Take your concentrate standards and read them into the machine. (2 readings / standard)

3 Print graph.

4 Take 50ul check samples and read first, ensuring absorbant values are between 0.375-0.390 before running blanks through

5 Now run duplicate samples

6 With the left over Standard read them at the end of the assay, plus run the 50ul check samples again.

LACTATE ASSAY

For a Total of 50 Samples you must make up a STOCK SOLUTION.

To 396 mg of SODIUM GLUTAMATE Add :-

90 mg of NAD,

44.4 ml of 0.1 M Aminopropanol Buffer, (bring to room temp or assay wont work)

Now add 0.200 ml of GPT (Glutamate Pyruvate Transaminase)

THE ASSAY

Try to put all solutions to the bottom of vial by a violent express of the pipette

1. Using Duplicates add **0.015 ml of sample** to tubes
   Put **0.0850 mls of Distilled Water** into all tubes

2. Make up Standards

3. a) Standard 0, 0.010 ml, 0.020 ml

   Add to these tubes

   b) Water 0.100 ml 0.090 ml 0.080 ml Do duplicates.

4. Put **0.890 ml of Stock Solution** to all tubes including Standards and Vortex.

5. Now add **.009 mls of Lactate Dehydrogenase** to all tubes including Standards and Vortex

   Incubate for 1 Hours.

LACTATE ANALYSIS

1 Turn on Machine at least 30 minutes prior to use. This allows the UV lamp to warm up.
2 The main screen will appear which shows the MAIN MENU, to select a pre-programed assay select TEST MENU (# 6) and then press ENTER
3 To select an assay LOAD TEST (# 1) and ENTER. Now select the assay you want.
(Lactate # 15) ENTER

RUNNING THE SAMPLES

1 Wash zero standard through machine and auto zero
2 Read one set of standards
3. Read samples

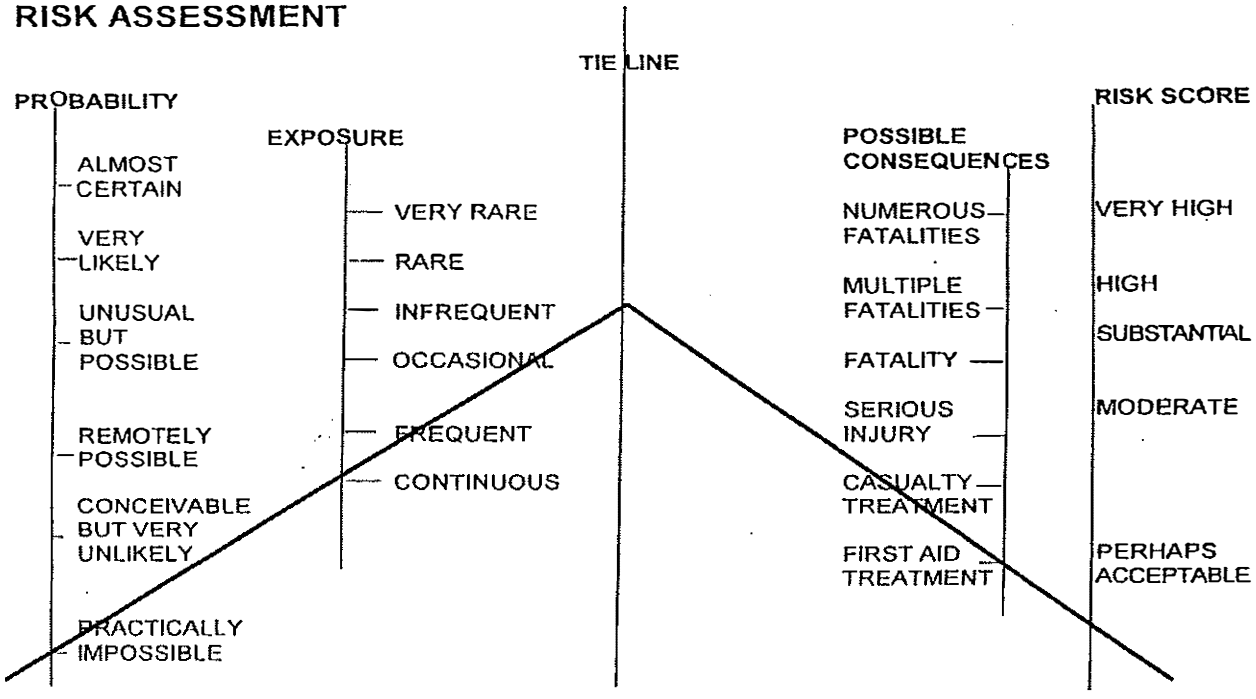
3. Read other set of standards to ensure OD has not drifted.

APPENDIX TWO

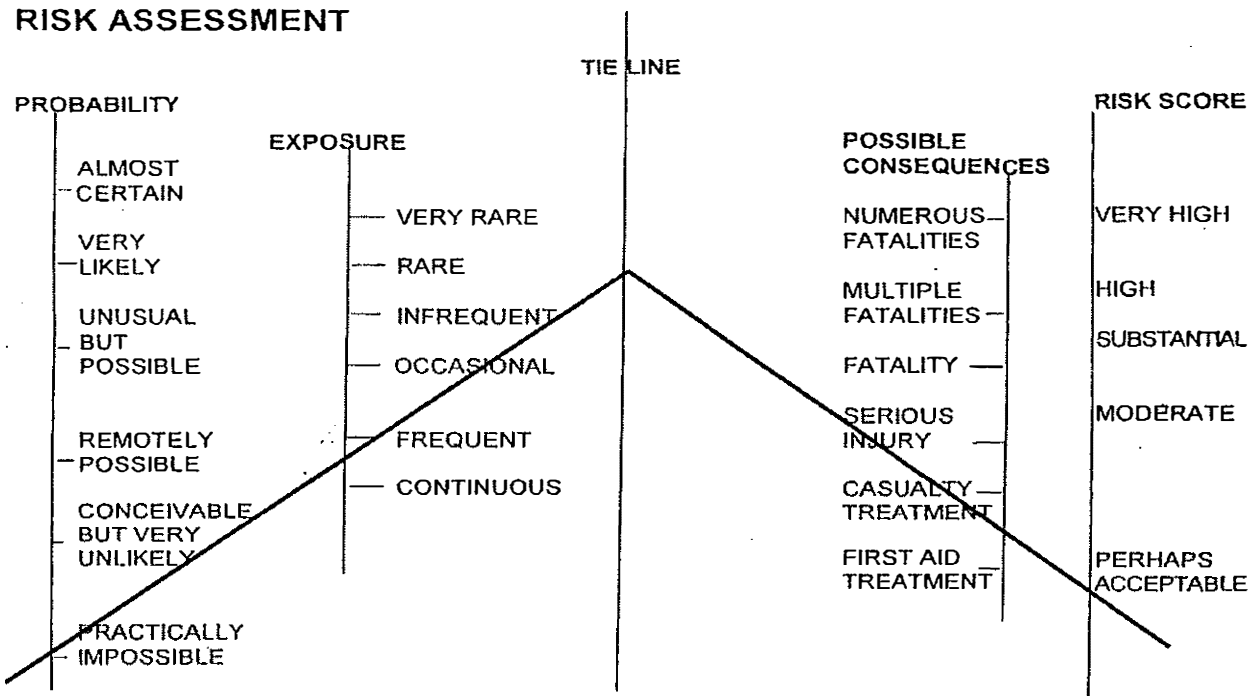
Methodology of Risk Assessment

Risk assessment is a measure of the probability, exposure and possible consequences of undertaking an action. The Victorian WorkCover utilises the Risk Assessment Calculator (below). The process starts on the left of the page and works across the page. The assessment is done in teams of 3 or 4 people that need to agree on the various classifications of each area. By linking the ratings with a line ruled through the agreed ranks, a risk score is obtained. This risk score provides the committee with a level of risk of the job and can be used to rank operational procedures in the work place.

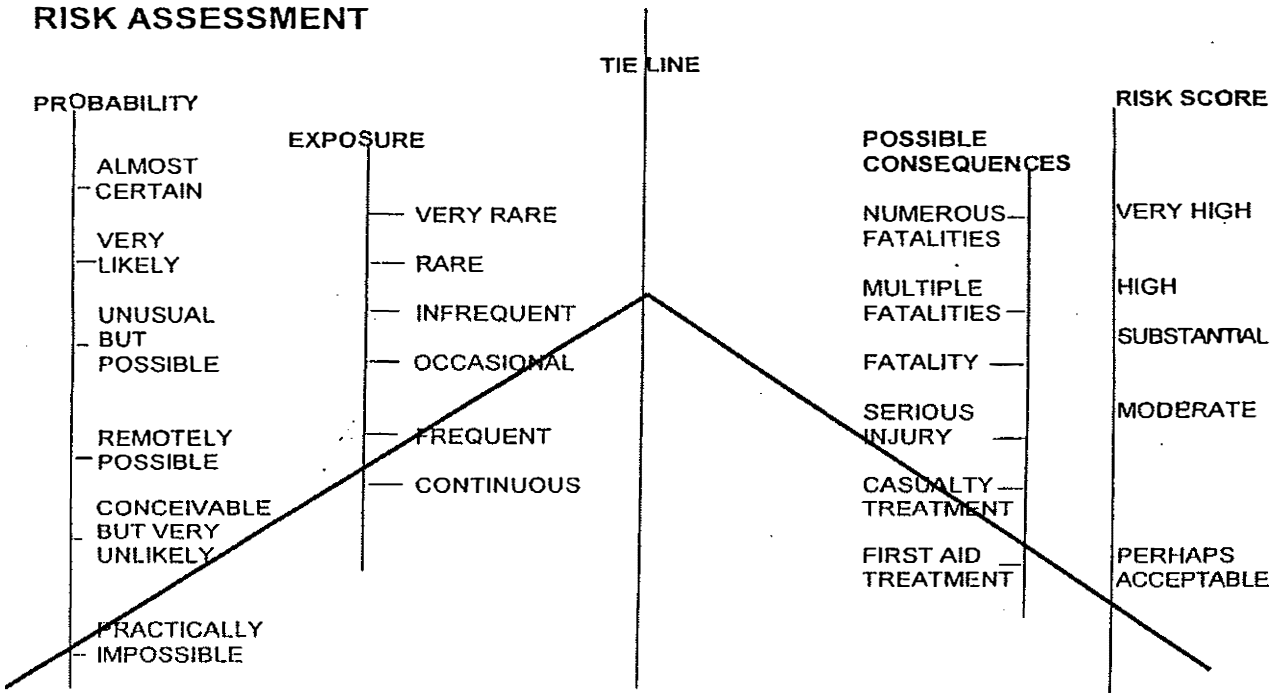
Control Treatment Groups



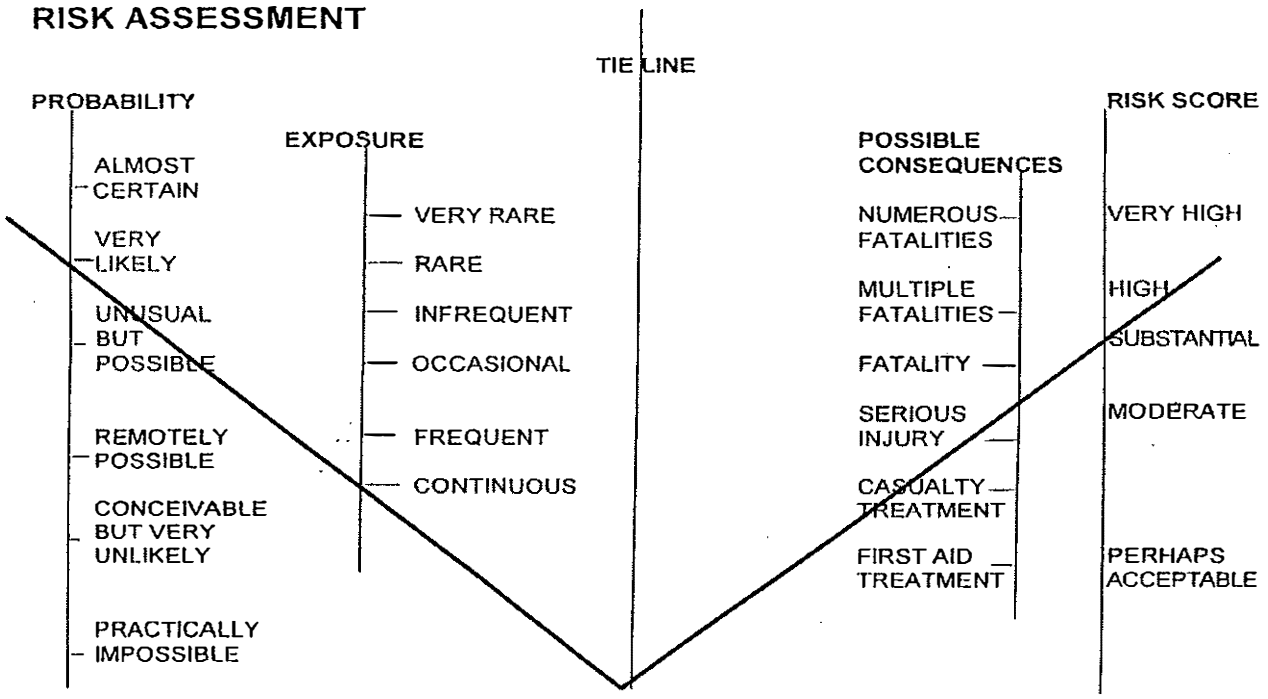
Spray Wash Treatment Groups



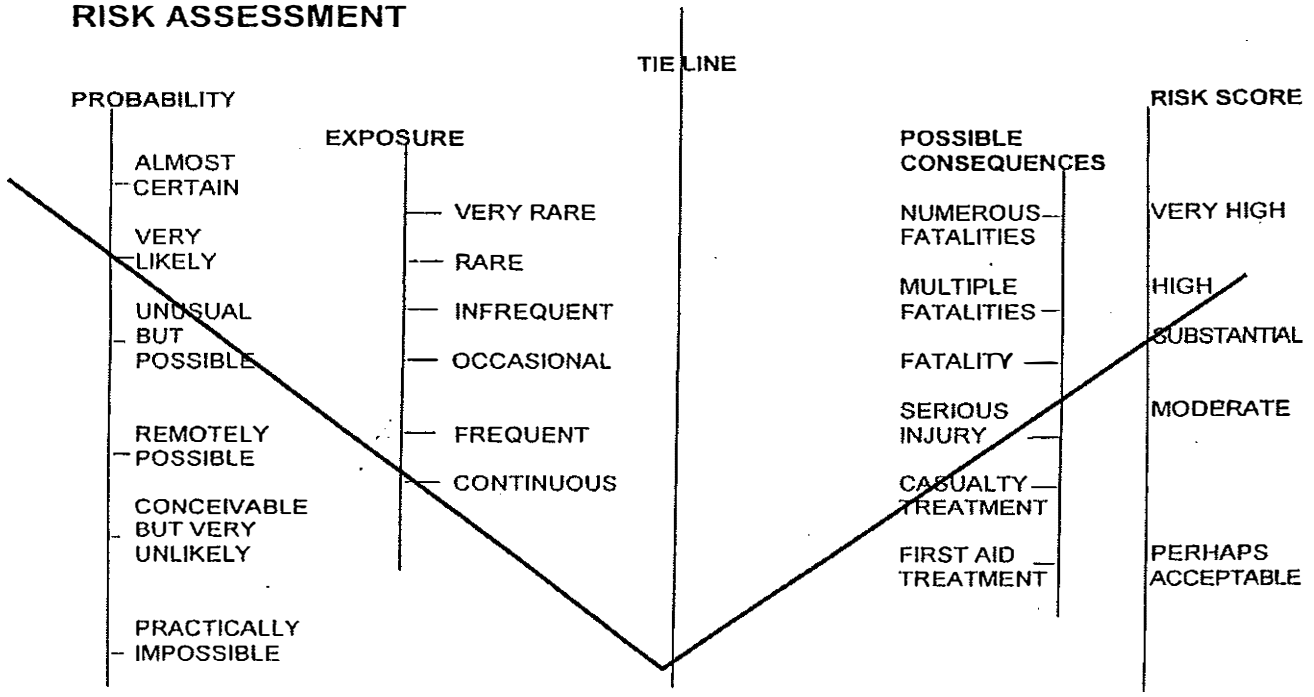
Spray Wash and Detergent Treatment Groups



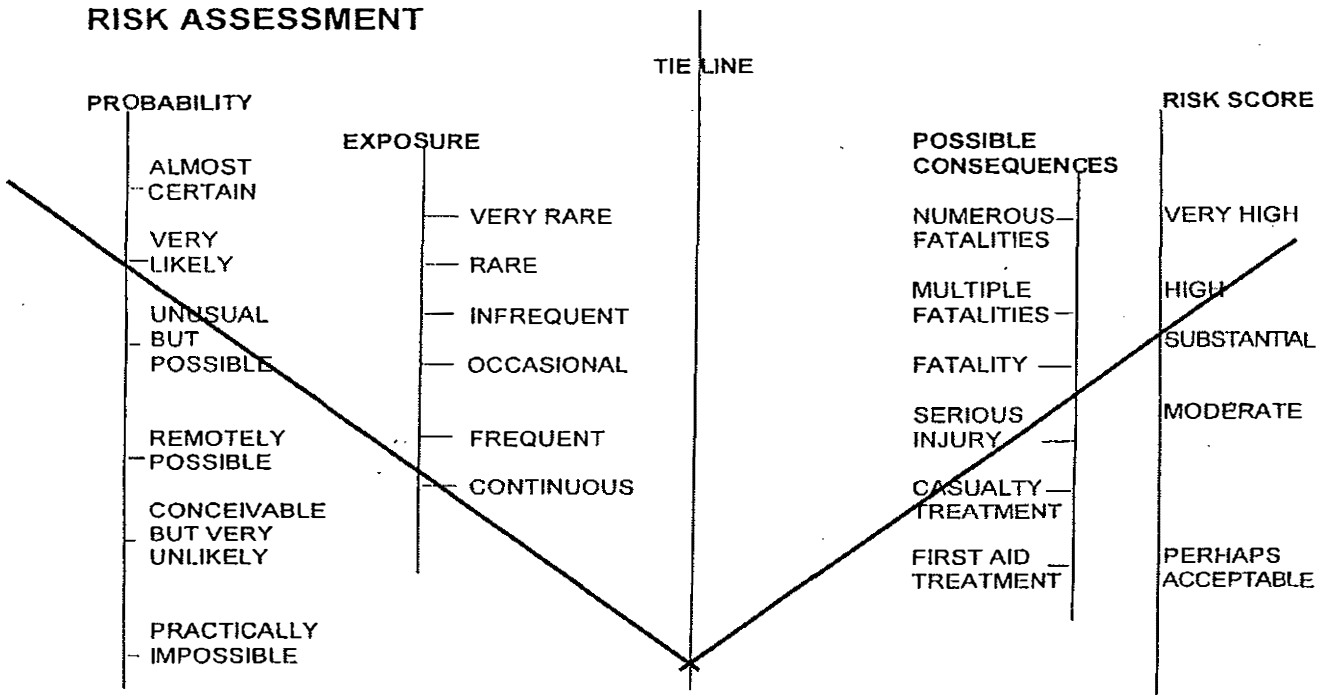
Shearing Treatment Groups (Midline to Midline)



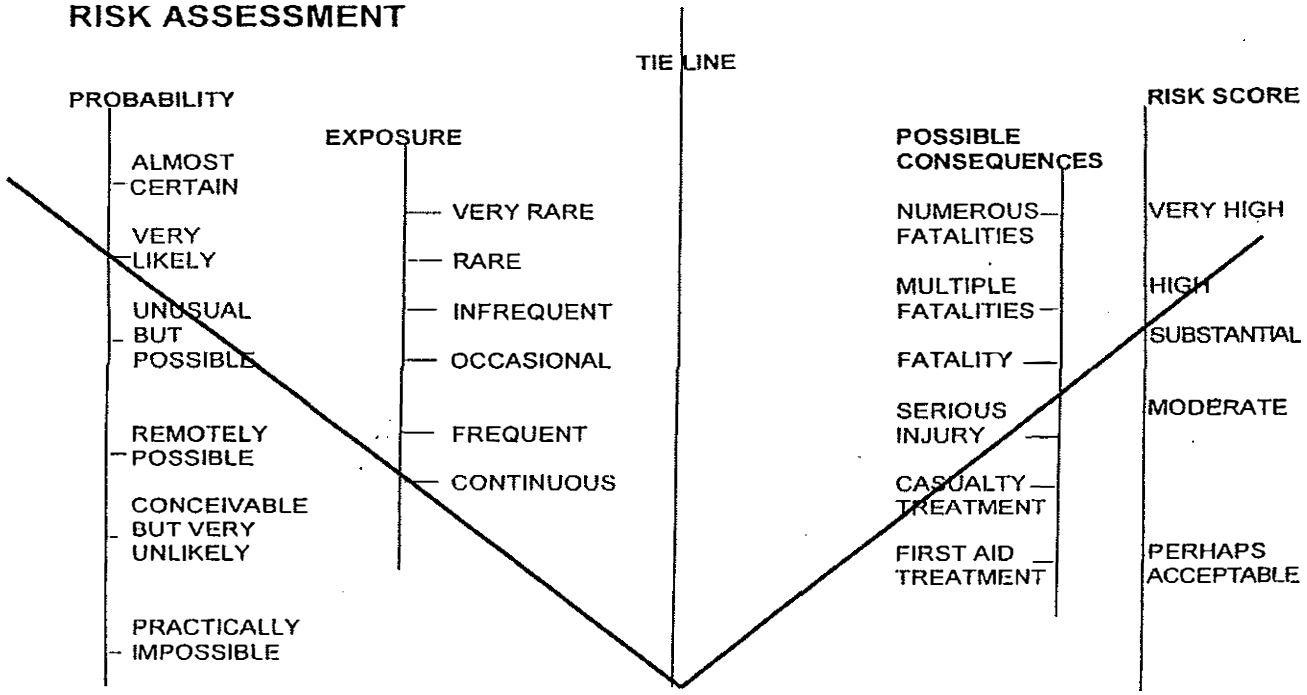
Pre Shear – Spray Wash Treatment Groups



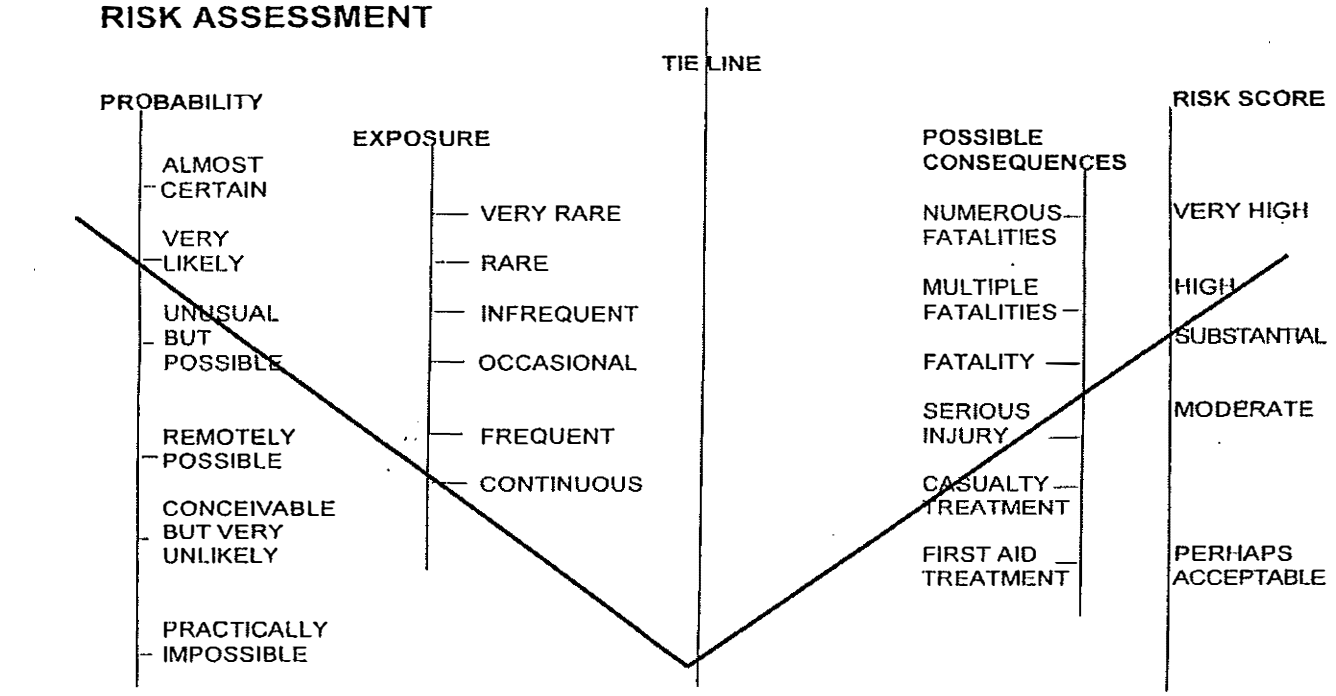
Pre Shear – Shear Treatment Groups



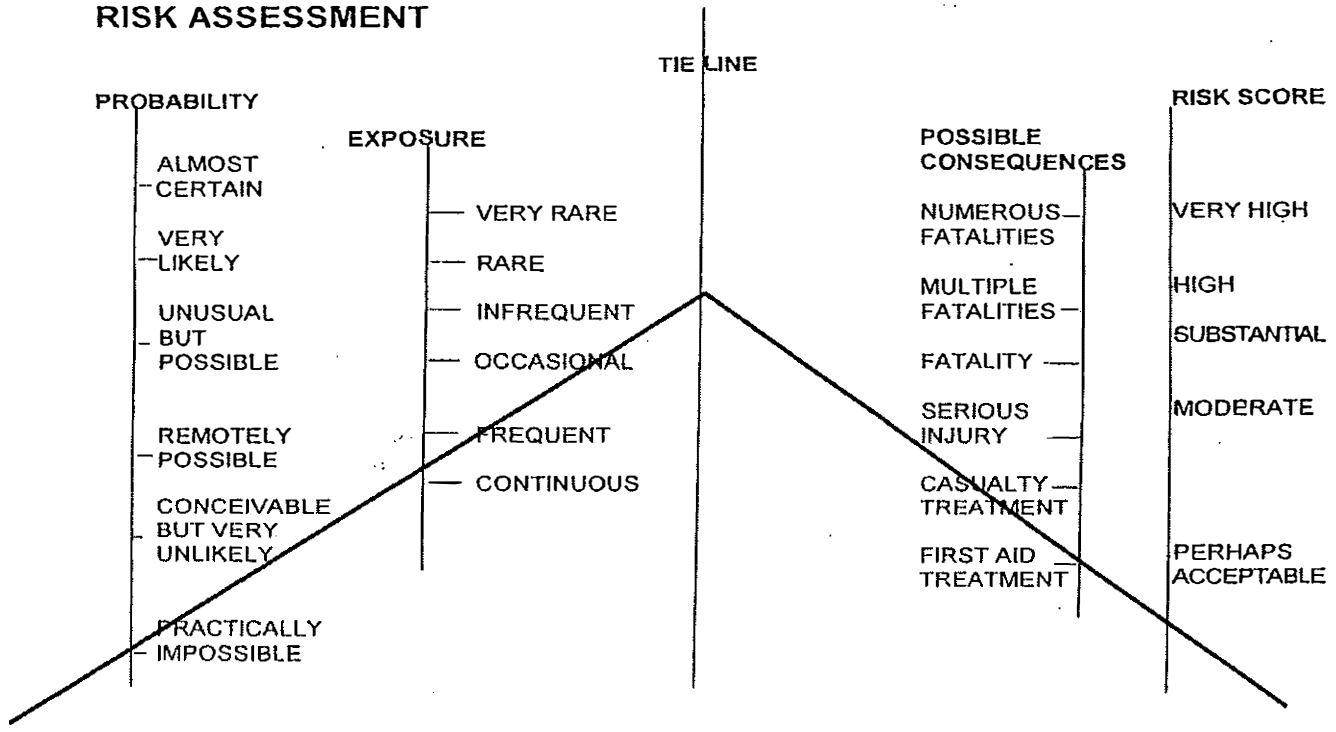
Pre Shear – Spray Wash with Detergent Treatment Group



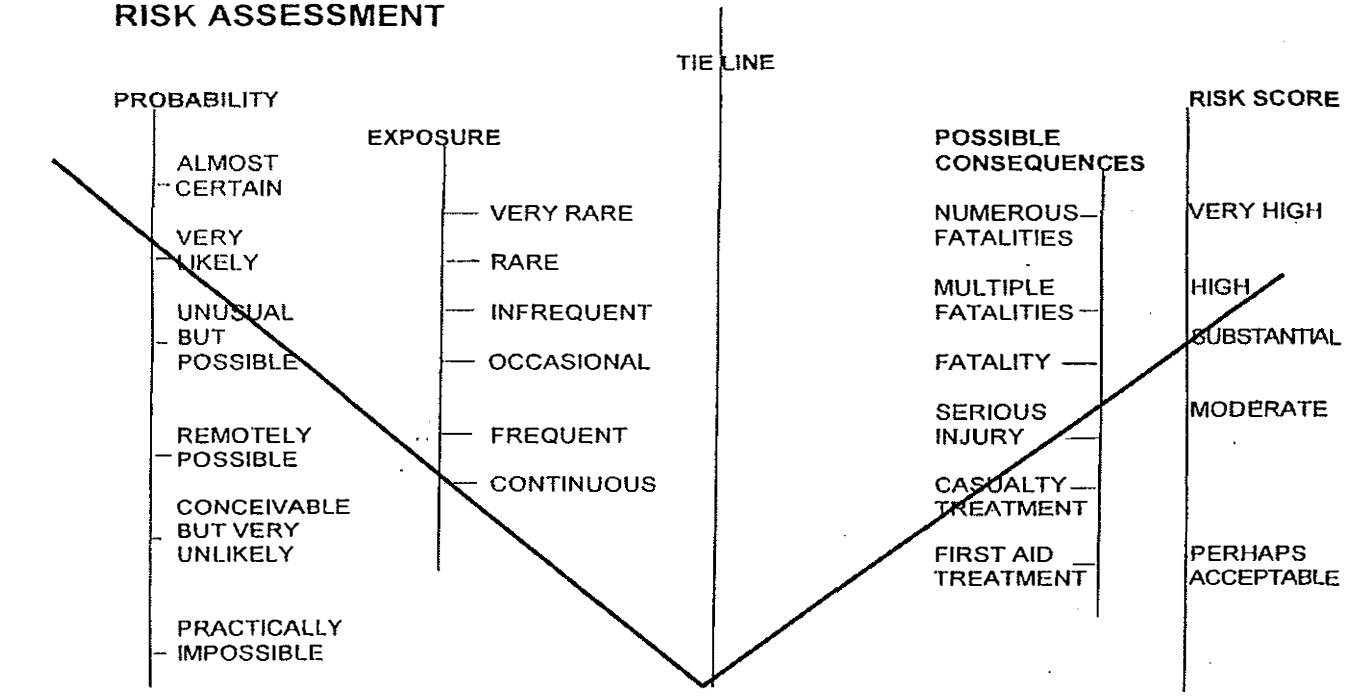
Pre Shear – RRDRS Treatment Group



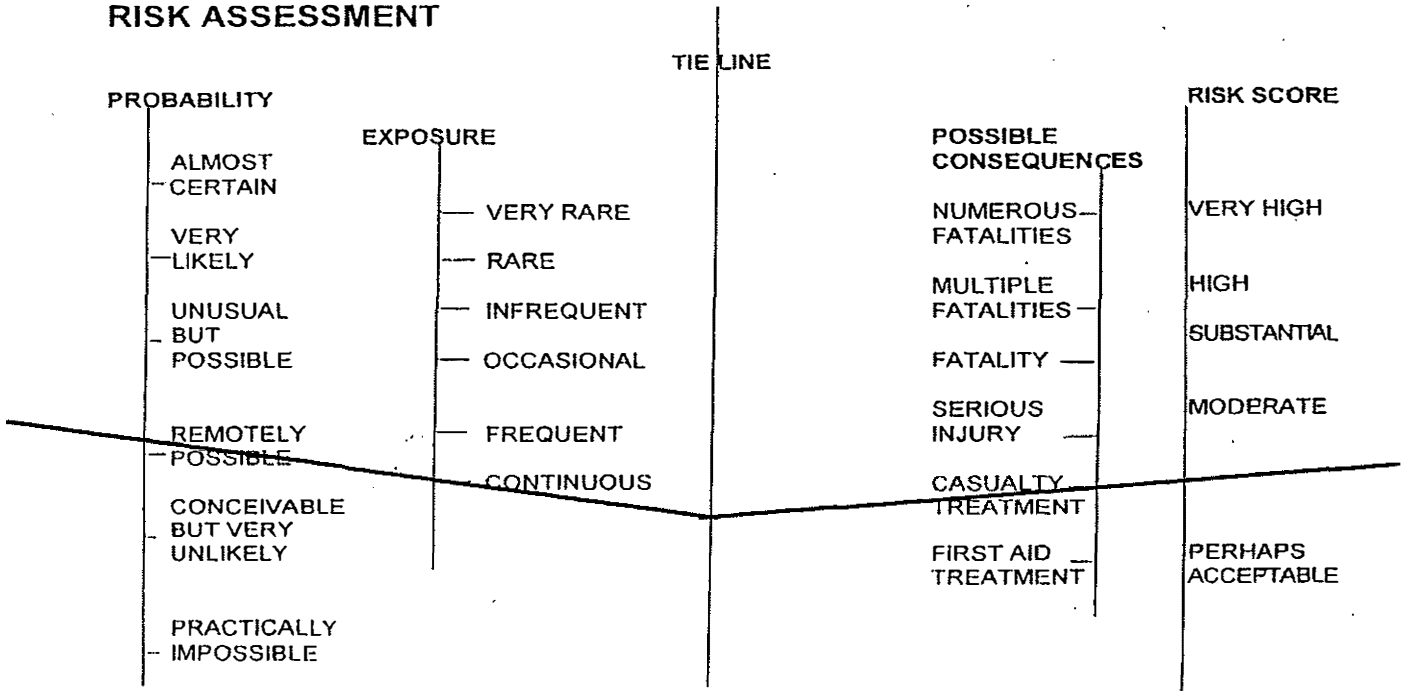
RRDRS Treatment Group



Spray and Hand Rake Treatment Group



Post Slaughter Use of the Parke Rota Shear (Cutting Lines Only)



Post Slaughter Use of the Air Knife (Cutting Lines Only)