final report

Project code: W.LIV.0159

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Date published: October 2016

PUBLISHED BY
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Preparation of rangeland goats for live export

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

Abstract

This project defines a domesticated goat for the purposes of long haul live export and proposes preparation management protocols for the long-haul shipment of domesticated goats.

Since 2007, there have been no long haul shipments of goats, due in part to an unacceptable degree of variation in performance between shipments, explained mostly by the type and source of the goat being shipped. If this variation can be overcome there are significant economic benefits to be gained.

The protocols developed may assist in minimising the risk of realising a negative animal welfare outcome from the point of selection for live export to disembarkation in the destination market. Adoption of this definition and management protocols may allow for a limited resumption of the long-haul transportation of domesticated goats and provide additional business opportunities for producers and live exporters.

The domestication management process and benchmarking procedure for wild captured goats and draft Best Practice Guidelines developed through this project are not just relevant for the long haul live export trade, but the wider industry as well, particularly feedlots and depots. While there were demonstrable benefits in terms of animal performance and increased domestication, the level of mortality (mainly due to coccidiosis) indicated serious concern with pursuing strategies to enable Rangeland goats to undertake long-haul voyages.

Executive Summary

Management of goats through the long haul live export chain had been identified as a problem for the live export industry. One particular issue identified through prior research is the definition and different management requirements of different kinds of goats.

There is general agreement between industry and government that there are two distinct supply chains for live export goats and therefore two distinct management protocols are required. The two distinct supply chains are based on the two potential sources of goats for live export which are:

1. Captured wild goats; and

2. Domesticated goats.

Given the economic benefits of resuming long haul shipment of goats (see Appendix 1: Economic Benefits of Long Haul Sea Transport of Live Goats, a net benefit analysis), this report defines a domesticated goat for the purposes of live export and proposes and tests various management protocols and benchmarking procedure for wild captured goats for long-haul shipment. The definition and protocols were developed in consultation with Meat & Livestock Australia (MLA), LiveCorp, Department of Agriculture and Food WA (DAFWA), live export industry representatives, ruminant nutritionists and Murdoch University Veterinary School staff.

Experimental trials using entire male rangeland goats of about 12 – 18 months of age were conducted over four goat catching seasons (November – March) at the property of Keros Keynes located near Geraldton in WA. Although various strategies, particularly increasing human interaction with the goats, demonstrated benefits in terms of animal performance and increased domestication (preparedness for live export), the level of mortality, and the lack of effect of domestication on the rate of mortalities (mainly due to coccidiosis), indicated serious concern with pursuing strategies to enable rangeland goats to undertake long-haul voyages.

If animals arrive at a depot with large parasitic burdens then the strategies to prepare them for live export may not reduce mortalities unless effective parasite control or screening is undertaken, particularly to prevent coccidiosis. A draft amendment to the Best Practice Guidelines has been prepared that takes into consideration some of the findings from this study.

Recommendations:

1. For the domestic or international (chilled/frozen meat) market, results from this project provide beneficial management strategies to increase production from captured Rangeland goats. A practical investment in terms of increased human interaction with the goats produced increases in pellet acceptance, increased weight gain and decreased aggression amongst goats.
2. Mortality is still a major problem and an effective low-cost strategy to reduce parasite burdens in captured wild goats would benefit producers.
3. The guidelines developed through this project will require commercial trialling before there was confidence that both the expected improvements to animal welfare and the economic benefits meet industry expectations.

Glossary of Terms

The following are definitions relevant to this program of work.

Rangeland goat
'Rangeland' is used by industry to describe the environment from which *feral* goats have originated. Normally, goats are called 'rangeland' if it has been captured from a wild state, has not been born as a result of a managed breeding program, and has not been subjected to any animal husbandry procedure or treatment.

Feral goat
The feral goat is the domestic goat (*Capra aegagrus hircus*) when it has become established in the wild.

Domesticated goat
A *domesticated goat for the purposes of long-haul live export* is one which complies with each and all of the following:

a) Displays the distinct characteristics of a recognised breed and whose pedigree can be demonstrated to be at least a first cross (F1) of that breed.
b) Has been born and raised on the property of origin and subject to *animal husbandry* since birth;
c) Has been ear tagged for the purposes of whole-of-life traceability on the property of birth;

Long haul
A voyage greater or equal to 10 days. Day one of the voyage means the first day at sea after leaving the first port of loading.

Pre-export goat depot
This is where captured goats undergo pre-export conditioning before transfer to a Registered Premise. This is to include regular handling and involve the provision of feed and water from troughs. Pre-export conditioning may take place on the individual supplier's property provided they have adequate facilities in place.

Registered premises
Where premises are used for holding and assembling livestock for export, such premises must be registered in accordance with the legislation. Registered premises operators are responsible for the design, maintenance, security and operation of the premises, including the provision of appropriate shelter, feed and water supply systems, animal husbandry and care by competent animal handlers.

Mortality (removed from study)
For experimental purposes this study was conducted under animal ethics regulations (Murdoch University AEC) which required an animal to be 'removed from the study' and treated or euthanased if the goat has:

- A decrease in body weight by 10%; or
- Displays a drop in body condition score of 0.5 or more between two weekly live weight measurements; or
- A body condition score which falls below 1.5

Table of Contents

1. Background

Since 2007, there have been no long haul shipments of goats, due in part to an unacceptable degree of variation in performance between shipments. Much of this variation in performance can be explained by the type and source of the goat being shipped. If this variation, along with other serious impediments identified within this report (such as management of parasitic burdens), can be overcome there are significant economic benefits to be gained (see Appendix 1: Economic Benefits of Long Haul Sea Transport of Live Goats, a net benefit analysis).

W.LIV.0130 Preparation of goats for export (2009) identified a number of management knowledge gaps in the goat live export supply chain, particularly in the pre-export preparation phase.

The W.LIV.0130 report and the identified knowledge gaps were considered by an industry review panel on 28 September 2010. This panel identified a number of risks associated with these knowledge gaps and the live export of goats in general, but also made the distinction that the majority of these risks were associated with undomesticated or captured wild goats rather than domesticated goats. The panel concluded, on this basis, that from an industry perspective, domesticated and undomesticated goats should be treated differently in preparation for live export.

There is now general agreement between industry and government that there are two distinct supply chains for live export goats based on the source of the goats and thus level of domestication. The two potential sources of goats for live export are:

1. Captured wild goats; and
2. Domesticated goats.

The risks associated with the export of goats identified during the 28 September 2010 meeting are almost exclusively associated with captured wild goats. While the majority of captured goats are sourced from the pastoral zone, some goats are captured in higher rainfall, agricultural areas. Consequently the process of "capture" was considered to be a better indicator of risk rather than provenance as is the case with sheep (pastoral zone sheep are considered to present a greater risk than non-pastoral zone sheep: *B.LIV.0123 Investigating Mortality in Sheep and Lambs Exported through Adelaide and Portland (2010)*).

Limiting long-haul live export of goats to domesticated goats by excluding captured wild goats was, therefore, seen as a way to effectively manage the risks identified during the 28 September 2010 meeting. For this to be achieved, a sound definition of what constituted a domesticated goat was required.

2. Project objectives

The project objectives are displayed below.

Table 1: Project objectives

Objective	Detail	Completed
1	a) Develop industry guidelines for pre export and on board management of domesticated goats for long haul voyages. Guidelines should consider: • Validation of breed • On farm background, husbandry and preparation • Mechanisms for verification and enforcement • Potential use of KIDPLAN • Nutrition requirements – for preparation and on board • On board management if outside of ASEL – i.e. fodder, bedding, stocking density* • A review past successful long haul goat consignments*. b) Economic benefit cost analysis completed based on the re-establishment of the long haul live export trade.	95%* (*a review of past successful goat consignments did not reveal any useful information as to the reason of success and therefore was not included – DAFWA. On board management if outside ASEL was also not detailed) 100%
2	a) Define a domestication management process for wild undomesticated goats so as to achieve successful long haul shipment by sea. Domestication process should determine optimum level of management, and husbandry practices for goats prior to entering pre export feedlot facilities. Recommendations on management procedures will include but not be limited to: • Optimum domestication period • Optimum nutritional and dietary fibre requirements • Options for minimising dominance behaviour in bucks • Nutritional state of the animals in relation to their ability to respond to pellets and their quality, domestication and susceptibility to disease	100%
3	Based on outcomes of objectives one and relevant scientific literature develop and validate a quality assurance program for long haul goat shipments. The quality assurance program will include protocols, guidelines and Standard Operating Procedures (SOP's) throughout the supply chain from on farm through to receiving markets in the Middle East and South East Asia. It will involve three components: 1. Preparation of a draft framework for the publication of 'Best Practice Guidelines for preparation of non-domesticated goats for long haul voyages by sea'. The draft will: • Define the process of domestication for captured unmanaged wild goats. • Present recommendations for optimal nutritional management, pellet quality and susceptibility to disease.	 90%* (*after milestone 5b [Objective 2] the 'NO GO' decision was agreed upon in terms of further experiments. However it was

	• Define procedures that negate dominance behaviour in unmanaged rangeland goats. • Present guidelines for on-farm handling of live export goats. • Present an economic evaluation (including benefit cost analysis) for implementation of guidelines. • Present guidelines of ideal health regimes 2. Validate Quality Assurance program developed in stage one by testing best practice guidelines in pre export facility. Testing will involve following a minimum of three sources of captured wild goats from on farm through to domestication at depot facility (as per draft best practice guidelines developed in stage one). • Stage 2 will be complete following successful validation of three different sources of goats. Sources of goats may come from one or more consignments. • Following validation provide draft quality assurance program including protocols, best practice guidelines and Standard Operating Procedures (SOP's) throughout the supply chain from on farm through to receiving markets in the Middle East and South East Asia. • Provide 3 x full day workshops for industry briefing and consultation prior to finalisation of best practice guidelines. • Provide full day workshop / briefing session for AQIS. Intention of workshop will be to demonstrate validation of Quality Assurance program achieved in stage one and present industry case for implementation of trial long haul voyages of successfully domesticated wild goats. 3. Subject to MLA, industry and AQIS approval validate stage one outcomes by implementing QA program on a long haul trial shipment of goats. Testing will involve following and reporting on outcomes of at least one consignment of captured wild goats from on farm through to receival in market.	agreed to complete a Final Report, including revised Best Practice Guidelines [Objective 3a]) 0%* (*The 'NO GO' decision supported by the Livestock Export R&D Committee in June 2014 and further supported by the full research committee on 15 July 2014) 0%* (*see above)

3. Method, results and summary for Objective 1

Objective 1 of the project was as follows:

a) Develop and industry agreed definition of a domesticated goat
b) Develop industry guidelines for pre export and on board management of domesticated goats for long haul voyages. Guidelines should consider the below and be developed in consultation with industry:

- Validation of breed
- On farm background, husbandry and preparation
- Mechanisms for verification and enforcement
- Potential use of KIDPLAN*
- Nutrition requirements – for preparation and on board
- On board management if outside of ASEL – i.e. fodder, bedding, stocking density
- A review past successful long haul goat consignments.

** KIDPLAN has not been integrated into the definition or guidelines due to the low levels of adoption of KIDPLAN and the fact that KIDPLAN was being reviewed at the time of undertaking this work.*

c) Economic benefit cost analysis completed based on the re-establishment of the long haul live export trade.

The economic benefit cost analysis can be found in Appendix 1 of this report.

This report and the protocols have been developed in consideration of the regulatory requirements and practicalities relating to the live export of goats at the time of writing.

3.1 Methodology

Schuster Consulting Group Pty Limited, sub-contracted by DAFWA, sought guidance from the DAFWA, MLA and LiveCorp in undertaking this report. Two major long haul exporters, four predominantly air freight exporters and two ruminant nutritionists were also consulted.

Australian Standards for the Export of Livestock (Version 2.3) 2011[1] (ASEL), *W.LIV.0130 Preparation of goats for export (2009)* and *B.LIV.0123 Investigating Mortality in Sheep and Lambs Exported through Adelaide and Portland (2010)* were referred to throughout the development of this report and referenced accordingly.

A definition of a domesticated goat for the purposes of live export and management protocols for the long haul live export of domesticated goats was established (see Glossary of Terms).

3.2 Results

3.2.1 Risk assessment

The risks identified during the industry review panel meeting on 28 September 2010 are predominately unique to wild captured goats. Limiting long-haul live export to domesticated goats removes these risks.

Table 2 below presents the risks identified at the 28 September 2010 meeting, qualifies the risks as being associated with wild captured goats or all goats and references the relevant record keeping (refer to Appendix 2) and management protocols (refer to Appendix 3) proposed to manage the risk.

[1] Australian Government Department of Agriculture, Fisheries and Forestry (2011), *Australian Standards for the Export of Livestock* (Version 2.3), published April 2011.

Table 2: Risks, at risk elements and management solutions

Risk	At risk element	Management solution
Dominance behaviour	Predominately a risk of wild captured goats.	• Protocol 3 a) Selecting goats – Domesticated goat • Protocol 3 i) Selecting goats – Horned goats • Protocol 4 g) Selecting goats - Mandatory drafting of goats based on gender, weight and age. • Protocol 4 g) Selecting goats - Monitoring and removal of dominant animals. • Protocol 5 a) Registered Premise - Mandatory drafting of goats based on gender, weight and age. • Protocol 5 a) Registered Premise - Monitoring and removal of dominant animals. • Protocol 5 b) Registered Premise – Maintenance of social groups. • Protocol 6 b) Transport – Maintenance of social groups. • Protocol 7 c) On-board – Maintenance of social groups.

Risk	At risk element	Management solution
Disease - Enterotoxemia (pulpy kidney) - Internal parasites - Coccidiosis - Salmonella	Diseases are significantly more pronounced in wild captured goats due to a naive immune system as well as a tendency to stress, allowing diseases, especially Salmonella and coccidiosis, to manifest.	• Protocol 3 a) Selecting goats – Domesticated goat • Protocol 2 iii) Animal Husbandry - Vaccination • Protocol 2 v) Animal Husbandry – Internal parasite control • Protocol 4 a) On-farm - Animal husbandry • Protocol 4 f) On-farm – Disease • Protocol 5 c) Registered Premise – Time spent in Registered Premise • Protocol 9 c) Documentation – Veterinary treatments
Water (volume, quality)	Predominately a risk of wild captured goats due to their lack of familiarity in watering from troughs and issues associated with confinement.	• Protocol 3 a) Selecting goats – Domesticated goat • Protocol 4 i) On-farm – Pre-export conditioning • Protocol 8 c) Nutrition - Provision of water • Protocol 8 c) Nutrition – Trough cleaning
Exposure - En route - In situ	All goats; however, wild capture goats are higher risk due to typically lower levels of fat cover and a predisposition to stress.	• Protocol 3 a) Selecting goats – Domesticated goat • Protocol 3 h) Selecting goats – Northern ports • Protocol 4 b) On-farm – Exposure • Protocol 7 a) On-board – Location on vessel
Shipping during winter	All goats; however, wild capture goats are higher risk due to typically lower levels of fat cover and a predisposition to stress.	• Protocol 3 a) Selecting goats – Domesticated goat • Protocol 4 b) On-farm – Exposure • Protocol 6 c) Transport – Exposure • Protocol 7 a) On-board – Location on vessel

Risk	At risk element	Management solution
Stress - Capture - Crowding - Nutrition	Predominantly wild capture goats in response to capture, confinement and trough feeding.	• Protocol 3 a) Selecting goats – Domesticated goat • Protocol 3 e) Selecting goats – Age of goats • Protocol 4 e) On-farm – Pre export conditioning • Protocol 4 h) On-farm - Nutrition • Protocol 4 h) On-farm - Intake • Protocol 8 - Nutrition • Density guidelines in ASEL and land transport regulations.
Unnecessary extension of ASEL	N/A	• Introduction of Management Protocol rather than changes to ASEL
Handling between capture and the export depot	Exclusively wild captured goats.	• Protocol 3 a) Selecting goats – Domesticated goat

A ruminant nutritionist was consulted regarding the appropriateness of the pellet recommendation for goats published in ASEL and the subsequent recommendation for the addition of 200g/head/day of chaff or roughage made through *W.LIV.0130 Preparation of goats for export (2009)*. The recommended pellet specification has been modified based on this consultation and is presented in the management protocol.

3.2.2 Definition

A *domesticated goat for the purposes of long-haul live export* is one which complies with each and all of the following:

d) Displays the distinct characteristics of a recognised breed and whose pedigree can be demonstrated to be at least a first cross (F1) of that breed.
e) Has been born and raised on the property of origin and subject to *animal husbandry* since birth;
f) Has been ear tagged for the purposes of whole-of-life traceability on the property of birth;

Animal husbandry

Animal husbandry in the context of defining the domestication of goats must include but is not limited to:

a) Containment for the purposes of management
b) Ear tagging
c) Vaccination:
    a. This must involve as a minimum the administration of a clostridial (5 in 1) vaccination in the first 12 months of the animals life followed by a

second vaccination or “booster dose” four to six weeks later. Annual vaccinations are then required. This provides protection against enterotoxaemia (pulpy kidney), tetanus, blackleg, black disease, malignant oedema and swelled head in bucks.

Additional vaccinations may be required by the importer as indicated in the importing country protocol.

d) Internal parasite control
    a. This must involve as a minimum the drenching of all goats with a registered broad-spectrum anti-helminth drench upon introduction to the 21 day on-farm pre-dispatch conditioning yard.

    Additional anthelmintic controls may be required by the importer as indicated in the importing country protocol.

e) Drafting for the purposes of management

Detailed records must be maintained for goats destined for live export and only goats for which detailed records have been maintained can be considered for long haul live export.

Validation of breed

According to the definition of a *domesticated goat for the purposes of long-haul live export*, the goat must display the distinct characteristics of a recognised breed and be of a pedigree that can be demonstrated to be at least an F1 of that breed.

A recognised breed is a breed for which standards have been developed, usually by a breed society as outlined in *Table 3*.

Table 3: Recognised goat breeds in Australia, for the purposes of long-haul live export

Dairy	**Meat**	**Fibre**
Saanen	Boer	Angora
Toggenburg	Kalahari Red	Cashmere
British Alpine	Savannah	
Anglo Nubian	Rangeland	
Australian Melaan		
Australian Brown		

In seeking to export goats, a producer must be able to demonstrate the mob-based pedigree of all goats within a consignment and declare this pedigree in writing. This must be in the form of an exporter statutory declaration or the Livestock Production Assurance National Vendor Declaration and Waybill (Goats) (LPA NVD/Waybill (Goats)).

3.2.3 Location

Domesticated goats for the purpose of long-haul live export may be sourced from agricultural areas or from the pastoral zone provided they comply with the definition of a *domesticated goat for the purposes of live export*. There is no definition of the pastoral zone in ASEL.

Figure 1 is from the Australian Wool Innovation Limited (AWI) website and originally from the Land and Water Resources Audit 1999 (http://www.wool.com/Grow_Pastures-and-Nutrition.htm) and has been used in this project to determine location of goats from the "pastoral zone".

The pastoral zone covers the majority of Australia's landmass and is characterised by annual rainfall below 300mm. This map is also used by ABARE and was used in a recent MLA/LiveCorp publication *B.LIV.0123 Investigating Mortality in Sheep and Lambs Exported through Adelaide and Portland*.

Figure 1: Agricultural production zones in Australia

3.2.4 Registered Premise

Premises used for the holding and assembling of livestock for export by sea or the pre-export quarantine or isolation of livestock for export by sea.

3.2.5 Supply chain process

The supply chain is described in Figure 2.

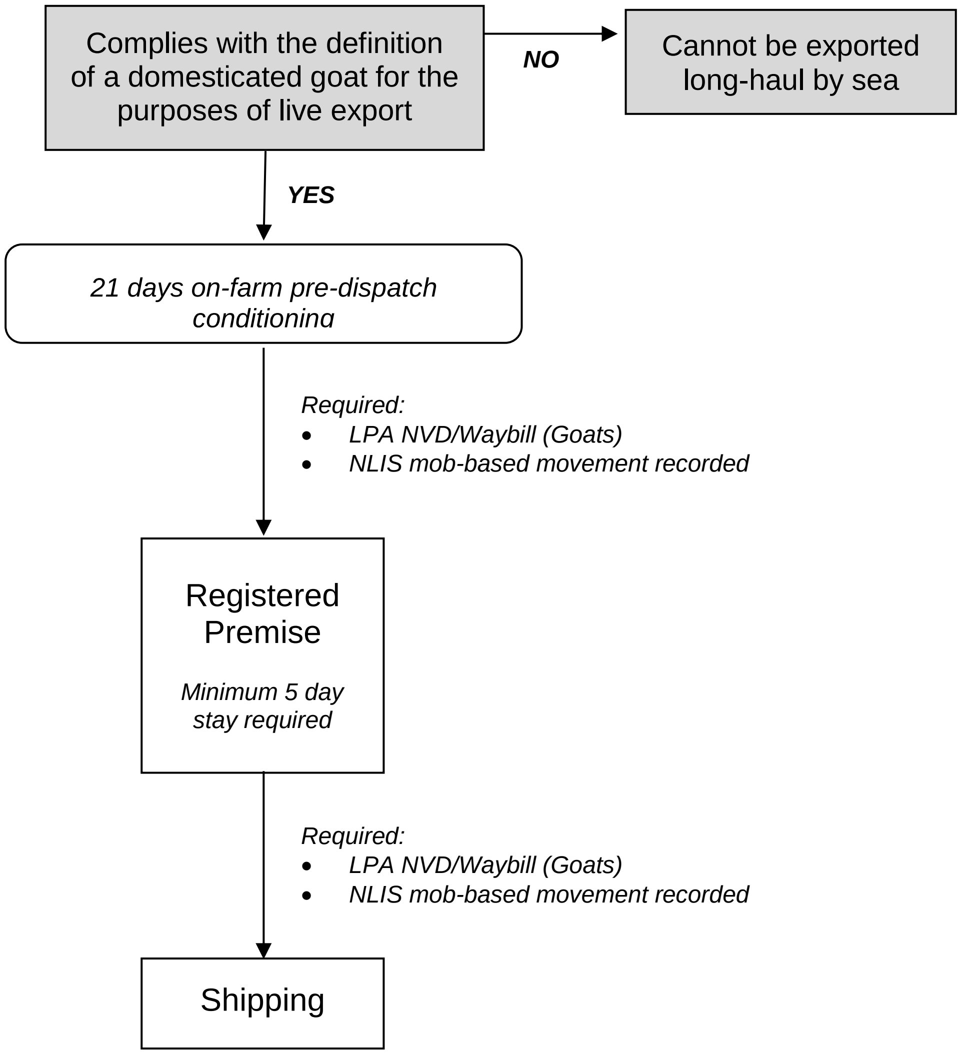

Figure 2: Supply chain process

Registered Premises are used for the holding and assembling of livestock for export by sea or the pre-export quarantine or isolation of livestock for export by sea.

3.2.6 Management protocols

A series of record keeping (Appendix 2) and management protocols (Appendix 3) have been developed to assist supply chain participants in the management and preparation of domesticated goats for the purposes of long-haul live export and are intended to complement rather than replace:

- State and territory requirements for land transport;
- ASEL;
- The *Australian Animal Welfare Standards and Guidelines for the Land Transport of Livestock;* and

- Any requirements of the importing country.

3.3 Summary

The definition of a domesticated goat for the purposes of long-haul live export along with the protocols proposed through this report have been constructed to complement ASEL and, in doing so, minimise the risk of realising a negative animal welfare outcome from the point of selection for live export to the point of loading.

A consultative approach was used throughout the development process to ensure the delivery of a workable solution which safeguards the welfare of the animal as well as the interests of the broader industry, the exporter and the producer.

Adoption of these definitions and management protocols may allow for a limited resumption of the long-haul transportation of domesticated goats and provide additional business opportunities for producers and live exporters.

4 Method, results and summary for Objective 2

Objective 2 involved:

a) Define a domestication management process for wild undomesticated goats so as to achieve successful long haul shipment by sea. Domestication process should determine optimum level of management, and husbandry practices for goats prior to entering pre export feedlot facilities. Recommendations on management procedures will include but not be limited to:

- Optimum domestication period
- Optimum nutritional and dietary fibre requirements
- Options for minimising dominance behaviour in bucks
- Nutritional state of the animals in relation to their ability to respond to pellets and their quality, domestication and susceptibility to disease

Multiple experiments were undertaken as a part of Objective 2 and these are detailed below.

4.1 Experiment 1: Validating industry applicable indicators that could be used to assess readiness of rangeland goats to be live exported by ship

4.1.1 Experimental Aims

The aim of Experiment 1 was to validate industry applicable indicators that could be used to assess readiness of rangeland goats to be live exported by ship (domestication). Indicators of domestication investigated were:

a. flight response
b. approach to feed
c. aggression
d. weight and BCS loss/gain
e. qualitative behavioural analysis (QBA)
f. dye based assessment of feeders

4.1.2 Methodology

All sample collection methods used were approved by the Murdoch University Animal Ethics Committee (approval number R2411/11 and 2541/12).

120 rangeland entire bucks (live weight 33 ± 0.5 kg, approximately 12-18 months of age) were selected from about 400 goats trapped at a water source over a period of two days, using a swinging one-way gate trap, on Wooramel station near Carnarvon in Western Australia. They were immediately transported to the study location situated 20km east of Geraldton, at the goat depot run by Keros Keynes. In order to validate indicators of readiness for export, animals were randomly assigned to two treatments involving variable degrees of human interaction:

- Low Interaction: a human only entered the group pen to remove dead or sick animals, or to top up feed bins and clean water troughs (two pens; n = 30 per pen).
- High Interaction: a human entered the group twice daily and calmly walked amongst the goats for 40 minutes (two pens; n = 30 per pen).

Assessments were made on each pen weekly, for three weeks. The pen group was initially drafted into the three groups of 10 animals distinguished by their differing ear tag colours. Each group was then moved into the holding pen at the end of a lane way (Fig. 3) for an aggression and flight response test. The goats were allowed two minutes to settle during which time video footage was taken and later analysed for number of agonistic contacts. A human then stood at the opposite end of the laneway and the gate was opened. After 30 seconds the human approached the goats at a walking speed of approximately one metre per second. The behaviour of the goats was recorded on video. The flight distance was recorded at the point at which the first goats began to run towards and past the human. Flight speed was also calculated from the video footage.

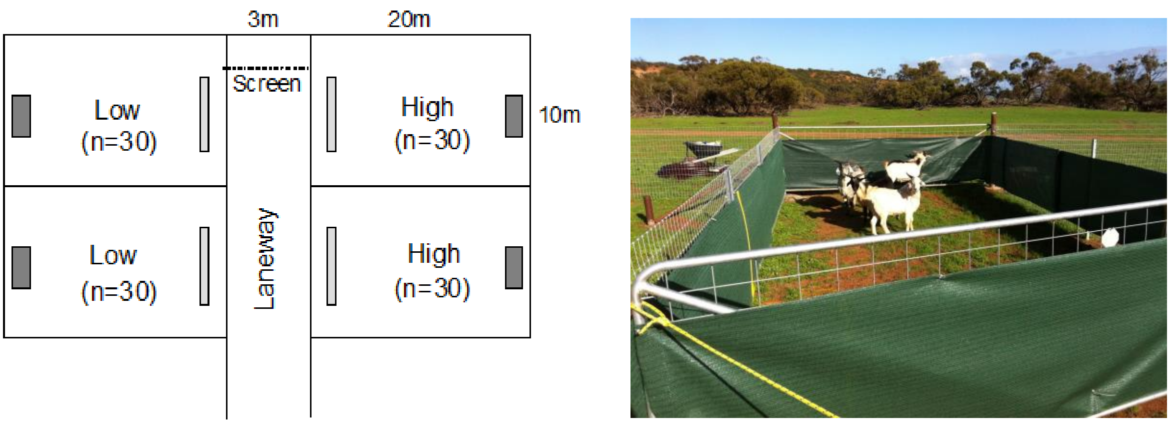

Figure 3: Layout of the pens testing the two levels of human interaction, low and high, and the associated laneway where the flight distance and feed approach tests were conducted in the holding pen / test arena (picture right).

For the approach to feed test, a bucket with branches of leaves was placed in the laneway 2.5m in front of the screen (12.5m in front of the back of the holding pen. A human then stood 5m away from the bucket on the other side to the goats. The screen gate was then opened and the approach distance to the feed, the time taken to approach, and the number of goats that ate was recorded. The goats were given a maximum time of three minutes to approach the feed. Following this test the goats were placed back in their home pen. Once all three sub-groups were back in their pen, boards which had been covering the pellets in the trough overnight were removed and the goats were observed. The number observed eating pellets at the feeder was recorded.

Statistical analysis
A Linear mixed effect model (SAS Version 9.2, SAS Institute, Cary, NC, USA) was used to analyse live weights, BCS, and behaviour domestication indicators with fixed effects of nutrition treatment, domestication treatment and time with animal ID as the random term.

4.1.3 Results and discussion

General Health
There were no recorded mortalities during the experiment. This may be partially attributable to a combination of the environmental conditions, the condition of the goats on entry into the depot (average BCS = 2.2), the time-frame of the experiment (three weeks), and the background enteric pathogen load of the goats.

Live Weight
There were significant differences between the high and low group live weights on Day Seven (Week one (W1)) and Day 21 (Week three (W3)) (Fig. 4). Both groups significantly gained weight (P<0.05) over the three weeks of the experiment. The high contact group gained weight during the entire trial time period. The low contact group gained weight in the first week, but their weight gain stopped thereafter. Body condition score of the goats did not vary significantly over the duration of the experiment in either group (data not shown).

Pellet Feeding
Very few goats were seen eating pellets offered *ad-lib* at Day Seven during the one-hour observation period, in either group (Fig. 5). On Day 14 over 20% of the high contact group were observed eating pellets, while still very few (>2%) low contact goats were observed eating pellets. During W3, the amount of hay provided to both groups was reduced to encourage pellet feeding. On day 21, over 55% of the high contact goats were observed eating pellets, while just over 5% of the low contact group were observed eating pellets.

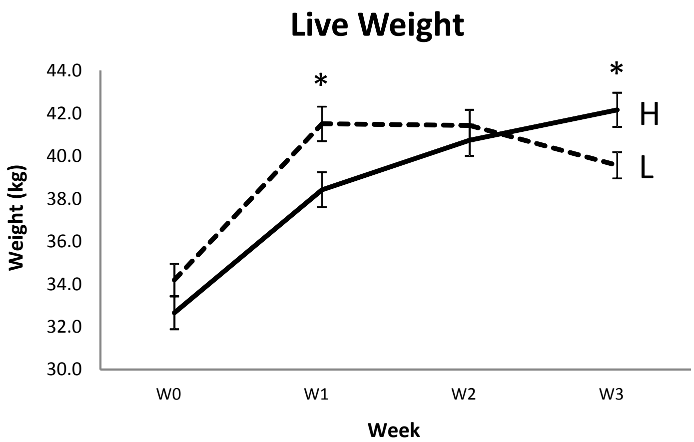

Figure 4: Average goat live weight over the three week trial period. High contact group H – solid line, Low contact group L – dashed line. Values are means ± SE. Asterisk indicates significant difference between groups (P<0.05).

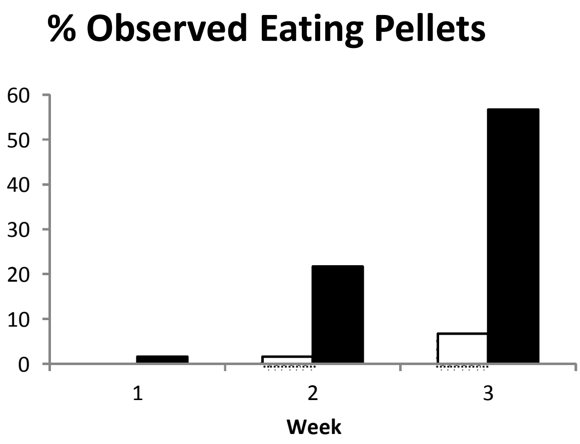

Figure 5: Percentage of goats observed eating pellets during a one-hour observation period over the three week trial period. High contact group – black bars, Low contact group – white bars.

This data indicates that the goats that had the high level of contact with humans gained weight to a similar degree as the low contact group during the early phase of the process when both groups were mainly consuming hay. The slightly lower weights in the high contact group at Day seven might be explained by the twice-daily entrance of a human into their pen upsetting their eating behaviour. However, the high contact group continued to gain weight during the rest of the trial, while the weight of the low contact group plateaued and then declined by the end of the trial. This difference corresponded with the high contact group becoming more accustomed to the pellet diet than the low contact group.

4.1.4 Behaviour

Flight response

There was no significant difference between the two groups, or over time, during the three weeks in terms of the distance they approached the stationary person when the screen gate was opened (Fig. 6).

There was no significant difference between the two groups during the first two weeks in terms of the distance they retreated when the stationary person started moving, however by Day 21 the distance retreated in the high contact group was significantly less ($P<0.05$) than the low contact group (Fig. 7). In both groups, the distance retreated did not change significantly over time, though there was a trend ($P=0.08$) for the distance of retreat of the high contact group decreasing over time.

There was a significant difference between the high and low contact groups in terms of the distance when they “flew” past a moving person, but only in W3 (Fig. 8). In W3 the high contact group ran past as the person approached to 4.3m (from the back of the arena), while the low contact group ran past when the person made it to 2.6m from the back of the arena. However, there was no difference over time in the high contact group, the difference arose because the flight distance in the low contact group was significantly lower in Week three compared to both W1 and Week 2 (W2) ($P<0.05$).

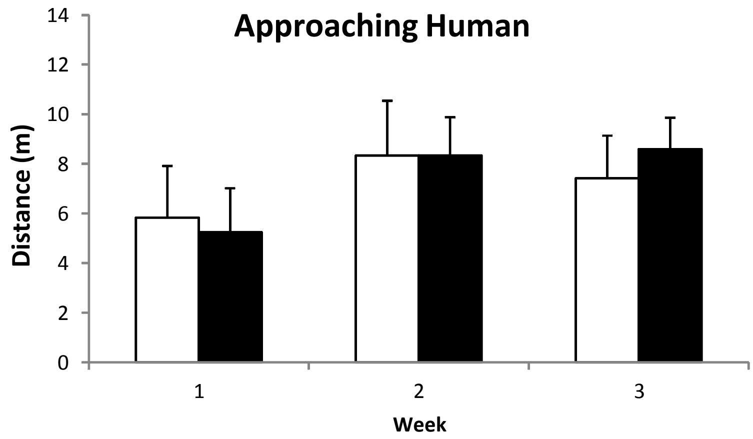

Figure 6: Distance (m) of voluntary approach to a stationary person, measured from back of the test arena over the three week trial period. High contact group – black bars, Low contact group – white bars.

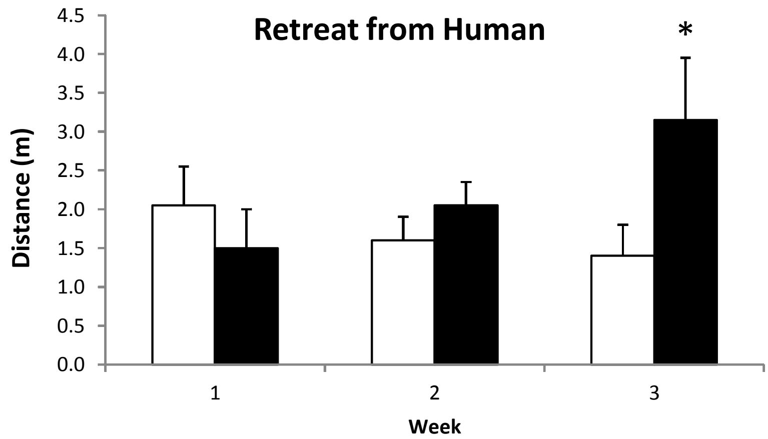

Figure 7: Distance (m) of retreat when a stationary person moved towards the goats, measured from back of the test arena. High contact group – black bars, Low contact group – white bars. Asterisk indicates significant difference between groups (P<0.05).

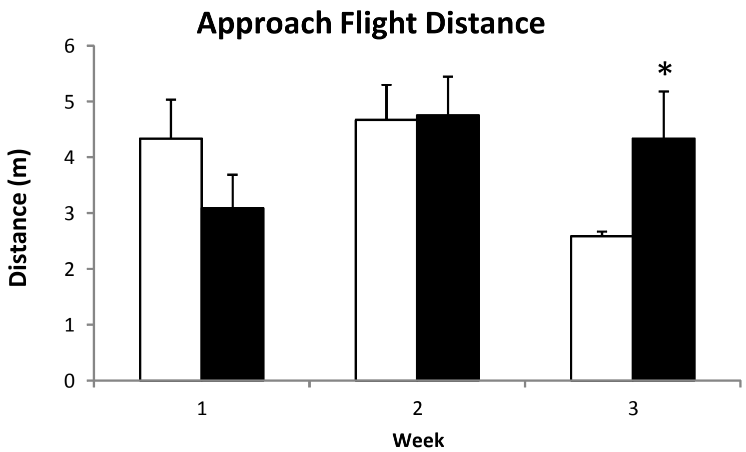

Figure 8: Distance (m) that a moving person got towards the group of goats, measured from back of the test arena, before the goats “flew” past the person. High contact group – black bars, Low contact group – white bars. Asterisk indicates significant difference between groups (P<0.05).

Together, this data suggests that these three measures, on their own, are not robust enough as tests to detect domestication in goats, but perhaps when used in combination they could provide some information. Research in sheep and cattle has shown that tame animals have lower flight distances compared to nervous animals (Grandin 1978, Hutson 1982, Kilgour & de Langen 1970). The results from this study indicate that goats, although showing some similar trends, are not totally the same as sheep and cattle when it comes to flight responses.

With subsequent analysis of the video footage after the flight distance tests, flight speed was calculated. That is, once the goats had "flown" past the human, the speed they were going down the laneway (as a group) where a second camera was positioned could be calculated. Analysis of this data indicated that, in both groups, speed of flight decreased over time ($P<0.05$), but decreased faster over time in the high contact group, with the speed of flight for the high contact group being significantly lower than the low contact group in both W2 and W3 (Fig. 9).

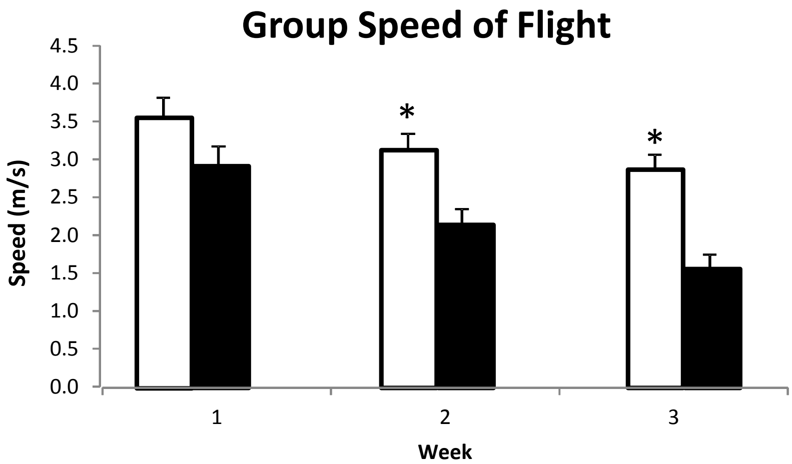

Figure 9: Speed (m/s) that the group of goats achieved over a 25m distance after they "flew" past a human. High contact group – black bars, Low contact group – white bars. Asterisk indicates significant difference between groups ($P<0.05$).

In summary, speed of flight (in this particular flight response test) appears to be a good measure to detect domestication in goats, whilst flight distances are less reliable.

Approach to feed (with human present)

There was no significant difference between the two groups during the three weeks in terms of the distance they approached a bucket of feed with a stationary person standing 5m on the other side (Fig. 10). There was a lot of variation in the groups in terms of how close individuals got to the bucket, with the usual scenario being that a few goats approached all the way to the bucket in the two minute time-frame, some made it some distance to the bucket, and a few didn't move from the back of the test arena. Hence this measure used the total distance travelled by all individuals in the group. There was a trend for the total group distance of approach of the high contact group to increase over the three weeks ($P<0.06$), but at no time-point was this different to the low contact group.

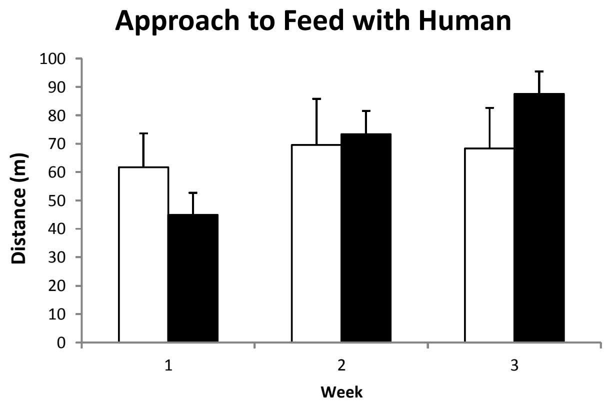

Figure 10: Total distance (m) of all individual group members, measured from the back of the test arena, travelled towards a bucket of feed with a human placed 5m on the other side. The test was concluded after two minutes. High contact group – black bars, Low contact group – white bars.

There was no significant difference between the two groups during the three weeks in terms of the number of goats within a group that made it to bucket of feed and started feeding, with a stationary person standing 5m on the other side (Fig. 11). There was a trend for the number of feeding goats in the high contact group to increase over the three weeks (P=0.09), but at no time-point was this different to the low contact group.

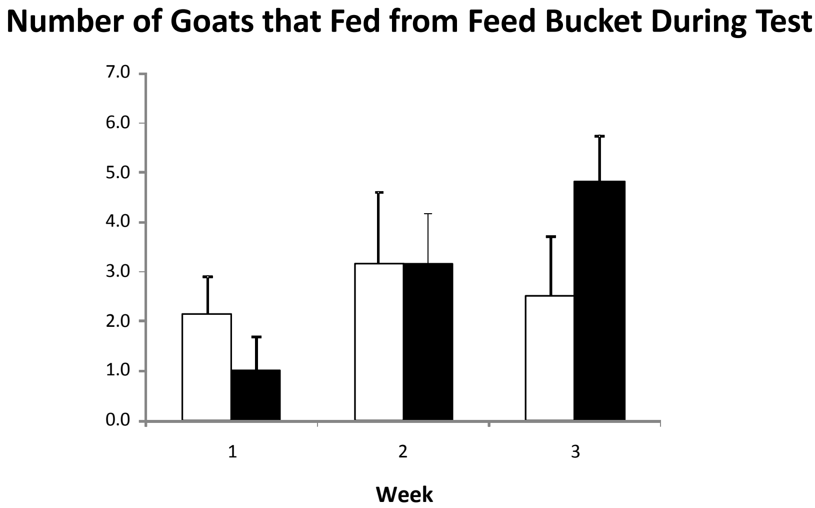

Figure 11: Total number of goats that fed from a bucket placed 12.5m from the back of the test arena, with a human placed 5m on the other side. High contact group – black bars, Low contact group – white bars.

In summary, measures of approach of goats to a feed whilst a human is present does not appear to be a good measure to detect domestication in goats.

Aggression

The two one-minute aggression tests ("flight response" and "feed approach") were combined for the data analysis (i.e. number of aggressive contacts over two minutes). The number of aggressive contacts between the groups was similar in W1, but significantly different (P<0.05) between the groups in W2 and W3 (Fig. 12). The high contact group was less aggressive than the low contact group in W2 and W3.

The number of aggressive contacts increased in W2 for the low contact group compared to W1 and W3 (P<0.05), while the number of aggressive contacts in the high contact group significantly decreased over time (P<0.05). This data indicates that, in the holding pen prior to the behaviour tests, the high contact goats became less aggressive over time. This may indicate that the high contact group were becoming more accustomed to being moved around by humans, and that the desire to compete for resources (feed or personal space) was declining.

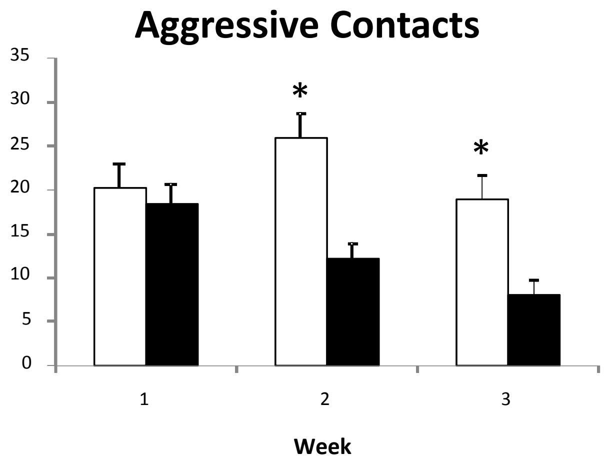

Figure 12: Aggression during flight distance test during the three weeks. High contact group – black bars, Low contact group – white bars. Asterisk indicates significant difference between groups (P<0.05).

An additional aim was to investigate the use of qualitative behavioural analysis (QBA) as a tool to indicate readiness to export (domestication). QBA has emerged as a scientifically validated method for quantifying the behavioural expression of an animal which reflects its psychological as well as physical state. Previous QBA studies have shown that observers can reliably and repeatedly assess the behavioural expression of pigs, cattle, horses, poultry and dogs. In these studies, observers were given the freedom to generate their own terminology to describe the behaviour of an animal (free choice profiling) and there was significant agreement between observers in the use of their terminology to quantitatively score the animals' behavioural expression. The use of QBA as a method for assessing the response to exposure to a novel environment has not previously been used in goats

Video footage was taken from each treatment group in the flight response test (described above). Sixteen observers were initially shown 10 video clips of groups of goats during the flight response test. Clips were chosen that demonstrated a wide range of behaviour to allow observers to describe as many aspects of their expressive repertoire as possible. After watching each clip, observers were given two minutes to write down any words that they thought described that animal's behavioural expression. Observers then viewed and scored (Likert scale) 24 video clips of all the treatment groups (and two camera angles) using their own unique list of descriptive terms. These data were submitted to statistical analysis with Generalised Procrustes Analysis (GPA). GPA calculates a consensus or 'best fit' profile between observer assessments through complex pattern matching. GPA provides a statistic (the Procrustes Statistic) which indicates the level of consensus (i.e. the percentage of variation explained between observers) that was achieved. Then through Principle Components Analysis (PCA), the number of dimensions of the consensus profile is reduced to several main dimensions (usually two or three) explaining the variation between videos. Each video receives a quantitative score on each of these dimensions, so that the video's position in the consensus profile can be graphically represented in two or three-dimensional plots. To investigate the treatment effects, the GPA scores for each dimension were analysed using repeated measures ANOVA.

Overall, observers were able to distinguish goats exposed to both high human interaction and low human interaction management techniques based on their behavioural expression (Fig. 13). In addition, the study demonstrated the ability of observers to recognise change in behavioural expression of goats in response to time of exposure to human interaction management techniques. The principal of QBA draws upon good stock-person skills of observation, hence reinforcing the value of checking goats regularly, i.e. if something "*doesn't look right*" trust your instincts.

4.1.5 Summary

Overall, the hypothesis was supported that goats exposed to a high level of human interaction would become more accustomed to their environment in the depot. This presented itself in the high contact group as higher weight gain, greater acceptance of the pellet diet, lower flight speed, and lower aggression than goats exposed to a low level of human interaction. Some of the other measures, e.g. flight distance and approach to feed, were less reliable in indicating that the high contact goats were becoming more accustomed to their environment in the goat depot than the low contact goats. Therefore, the trial highlighted certain behavioural and performance measures that could be used as industry applicable indicators to assess readiness to export (domestication). These indicators can now be used to test other management and husbandry practices for domestication of wild Rangeland goats. A variety of methods were also trialled and identified as unsuitable indicators.

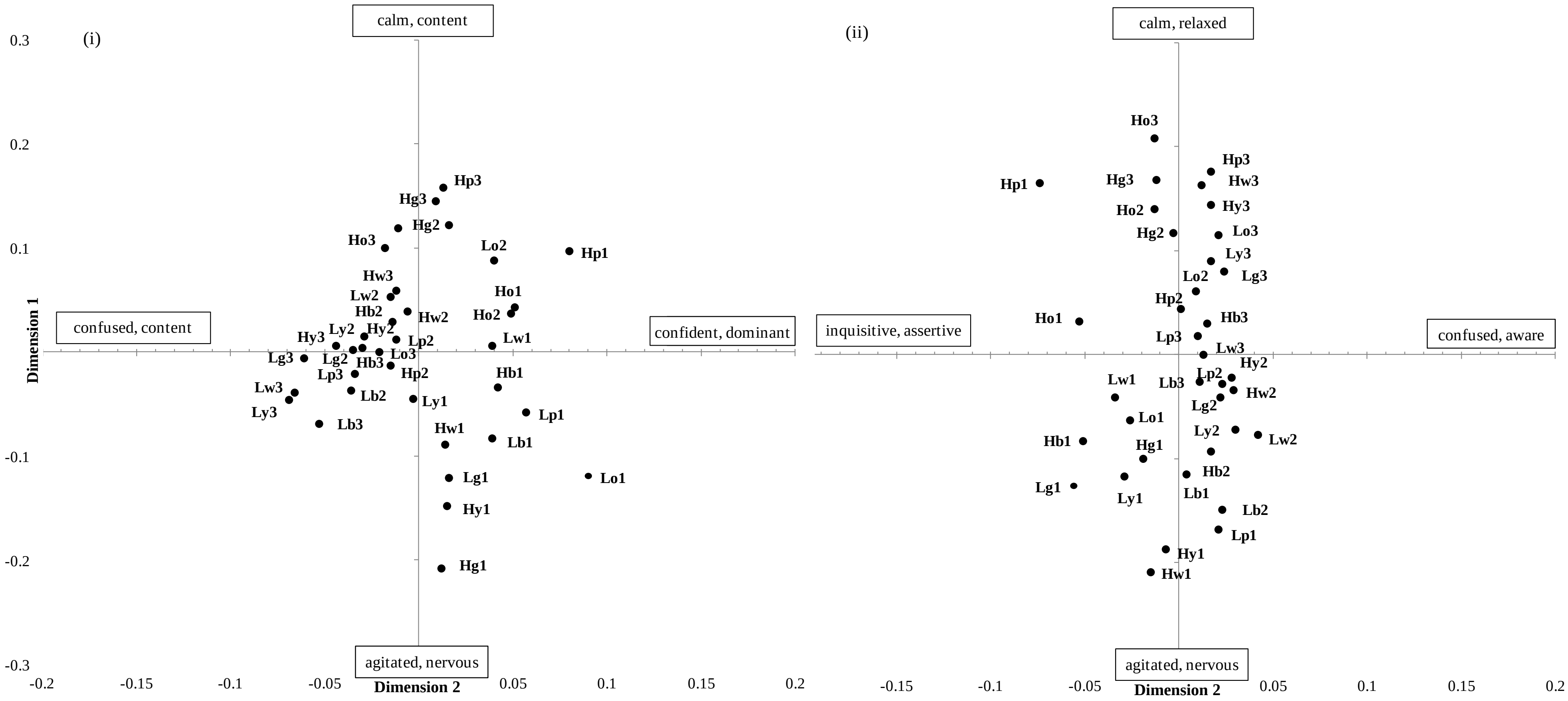

Figure 13: For (i) camera 1 (close up view) and (ii) camera two (long distance view), positions of the groups of goats are shown (represented by lower case letters; p: pink, o: orange, g: green, b: blue, w: white, y: yellow) in high interaction (H) and low interaction (L) groups, assessed in W1(1), W1 (2) and W3 (3) on Generalised Procrustes Analysis dimensions one and two obtained from Qualitative Behavioural Assessment.

4.2 Experiment 2a, Benchmarking indicators of 'readiness to export'

4.2.1 Experimental aims

The aim of this study was to benchmark indicators of 'readiness to export' against standard or augmented management practices to investigate their validity, timing of attainment, and additional management strategies needed for attainment. The benchmarks were to indicate minimum standards for:

- Live weight / body condition score – e.g. all animals in a test group, excluding those removed from the trial because of ill health or misadventure, must not lose weight and/or condition in two consecutive weeks prior to (potential) transport.
- Mortality – e.g. the rate of deaths in a test group must not exceed 1% per week.
- Feed (pellet) intake – e.g. at least 50% of animals must be observed eating from the trough containing the pelleted diet in a one hour period after an overnight fast.
- Agonistic behaviour – e.g. using a sub-sample of animals from a test group placed in a confined pen, the number of agonistic contacts must not exceed 15 in a two minute period immediately after confinement

The benchmarks were subjectively determined from the results of Experiment 1 (Fig. 14), and consultation with researchers (Murdoch, DAFWA), MLA/LiveCorp and industry representatives.

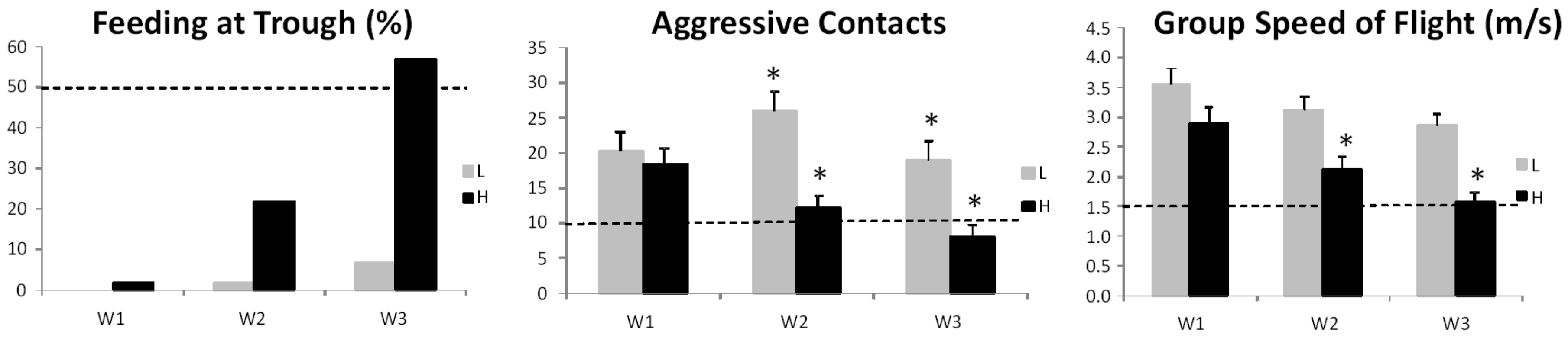

Figure 14: Benchmarks (dashed lines) ascertained from Experiment 1 with feeding at trough, agonistic contacts and speed of flight data for the high interaction (HI) group (n = 60) and the low interaction (LI) group (n = 60) over three weeks.

4.2.2 Methodology

All sample collection methods used were approved by the Murdoch University Animal Ethics Committee (approval number R2541/12).

Starting in February 2013 and extending for six weeks, 260 intact Rangeland bucks (32±0.4 kg, approximately 12-18 months of age) were separated into two treatment groups (high interaction and low interaction). The high interaction group was exposed to humans for a period of about one hour per day when they were the human would walk calmly around their pen for about 30 minutes and then, using low-stress handling techniques, they were run through the race. Two "mentor" goats were placed in each high interaction pen. These mentor goats were of similar age and size, but had been acclimatized to the depot set-up for at least three months prior, and as such provided source of information (learning) for the other goats on location of feed, water and general acclimatisation to management (Provenza *et al*. 1994). The low interaction group was only exposed to humans during measuring periods and to remove sick or injured animals, and had no mentor goats. Measurement of domestication was carried out weekly.

The benchmarks indicated minimum standards to be achieved for:

1. Live weight / body condition score (BCS) – all animals in a test group, excluding those removed from the trial because of ill health or misadventure, must not lose weight and/or condition in two consecutive weeks prior to (potential) transport.
2. Mortality – the rate of deaths in a test group must not exceed 1% per week.
3. Feed (pellet) intake – at least 50% of animals must be observed eating from the trough containing the pelleted diet in a one hour period after an overnight (14 hours) fast (NB: animals still had access to water).
4. Agonistic behaviour – using sub-samples of animals from a test group placed in a confined pen, the number of agonistic contacts must not exceed 10 in a two minute period immediately after confinement.
5. Flight speed - using a sub-samples of at least six animals from a test group, the group flight speed must not exceed 1.5m/s over the first 25 metres.

Statistical analysis
A Linear mixed effect model (SAS Version 9.2, SAS Institute, Cary, NC, USA) was used to analyse live weights, BCS, flight speed, aggression and feeding behaviour with fixed effects of nutrition treatment, domestication treatment and time with animal ID as the random term.

4.2.3 Results and discussion

Animal health
Overall, 11 animals died during the experiment, seven in the high interaction group and four in the low interaction group (Fig. 15). Only one animal died in the first three weeks, which was a low interaction animal. This represents mortality percentage in the first three weeks of 0% and 0.8% for the high and low interaction groups, respectively. The overall mortality rate over the six weeks of the experiment was 5.4% and 3.1% for the high and low interaction groups, respectively. Many of the deaths in the high interaction group occurred between the Week four (W4) and Week five (W5) measurement days. This coincided with a higher incidence of scouring at this time (Fig. 17), and an unseasonally large storm front that passed through putting some of the weaker animals under environmental challenge. Three animals that were found not too long after death were sent for post-mortem. The results indicated that two goats had significant numbers of coccidia and strongyloid, and the third goat had

evidence of pulpy kidney. In terms of the benchmark, if only the first three weeks of data were used, then the mortality rate in both groups achieved the benchmark of less than 1% mortality. In the past, the Australian Livestock Export Standards (ALES) stated that 'goats must not be sourced for export unless they have become conditioned to being handled and to eating and drinking from troughs for a minimum of 21 days before transfer to a registered premise, S1.20 (LiveCorp, 2008). However, this step in the export process should be dictated by the required outcome rather than a specific time period. Indeed, when the goats in the current experiment were followed for a further three weeks, the weekly mortality rate increased to 3.9% in the high interaction group at W5, and 1.6% in the low interaction groups at Week six (W6). In the old ALES system, these goats would have been allowed on the ship after three weeks "conditioning", even with the mortality benchmark.

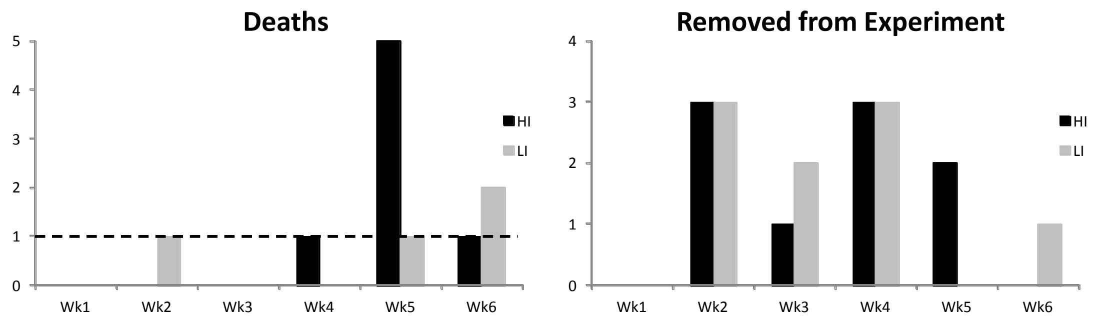

Figure 15: Number of bucks deaths and number removed from the experiment in the high interaction (HI) group (n = 130) and the low interaction (LI) group (n = 130) at each weekly measurement day. The dashed line represents the benchmark level of 1% mortality. The two data sets are mutually exclusive, i.e. animals that died are not included in the 'removed from experiment data'.

When animals lost weight at two consecutive measurement days they were removed from the experiment. Overall, 18 animals were removed over the six weeks, nine in the high interaction group and nine in the low interaction group (Fig. 15). Four high interaction bucks were removed in the first three weeks, and five low interaction bucks were removed in the first three weeks. This represents a percentage removal in the first three weeks of 2.3% and 3.8% for the high and low interaction groups, respectively. The overall removal rate over the six weeks of the experiment was 6.9% for both the high and low interaction groups. A follow up of the animals that were removed from the experiment indicated that 74% died or were euthanased due to ill health within four weeks of the experiment finishing. This percentage probably would have been higher if the animals were not treated. The effect of mortalities (or removed from study) needs to be taken into consideration when looking at the data presented for animal performance and behaviour.

Live weight and body condition score

Live weights were similar between treatment groups at the start of the experiment (Fig. 16). There was an overall significant effect of treatment and time on live weight ($P<0.05$). Live weight increased in both treatment groups over the six weeks of the experiment, and overall the high interaction group had higher live weights than the low interaction group. In the first week after introduction to the pellets, neither group gained weight, and in the second week only the low interaction group failed to gain weight. It is likely that the influence of the novel environment and feed resulted in a lack of liveweight gain until goats became habituated. Post-hoc analysis revealed that the high interaction group had heavier live weights than the low interaction group at W2 and W3 (P<0.05).

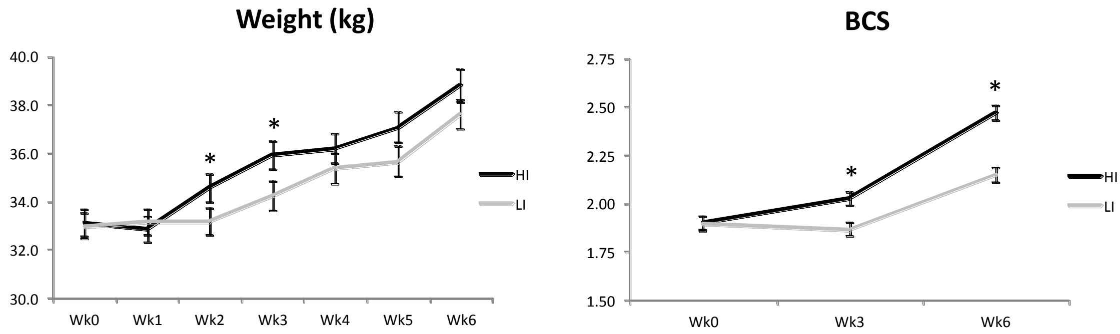

Figure 16: Mean (± SE) fasted live weight and body condition score (BCS) of bucks in the high interaction (HI) group (n = 130) and the low interaction (LI) group (n = 130). An asterisk indicates significance at P<0.05.

A plateauing of live weight in the high interaction group occurred at W4, which coincided with an increase in pellet consumption and a number of animals scouring (Fig. 17), probably due gut function in relation to the pellet diet, and five deaths. The number of animals scouring subsided after W4, with a subsequent increase in liveweight gains. Therefore, in the first three weeks of the experiment, live weight could be a useful measure of habituation/domestication. However, monitoring after this time point seem to be essential as evidenced by the increase in scouring occurring around W3 and W4 as the goats consume more pellets, which their gut may not be fully adapted to yet. Bannink (2008) stated that functional adaptation of the rumen to a new diet occurred within a week, whereas the structural adaptations (rumen papillae) take six weeks to reach peak levels in goats.

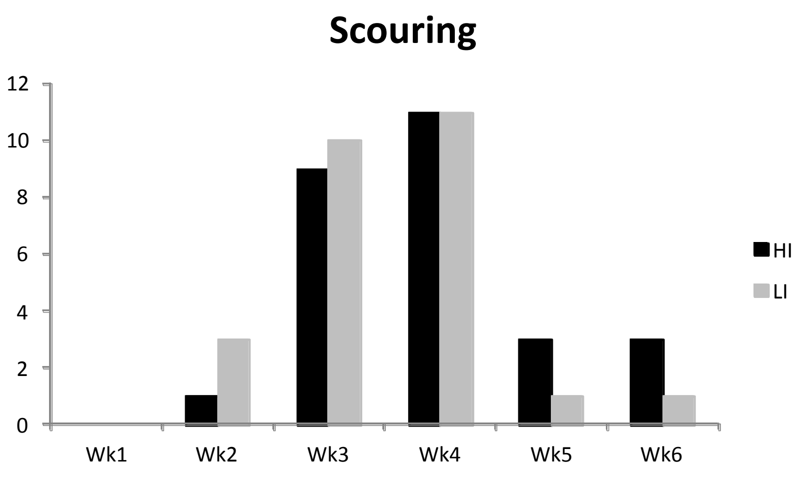

Figure 17: Number of bucks scouring in the high interaction (HI) group (n = 130) and the low interaction (LI) group (n = 130) at each weekly measurement day.

Body condition scores (BCS) were similar between treatment groups at the start of the experiment (Fig. 16). There was an overall significant effect of treatment, time and the interaction on BCS (P<0.01). BCS increased in both treatment groups over the six weeks of the experiment, and overall the high interaction group had higher BCS than the low interaction group. In the first three weeks after introduction to the pellets, only the high interaction group had increased BCS, but BCS in both groups had increased by W6. Post-hoc analysis revealed that the high interaction group had higher BCS than the low interaction group at W3 (P<0.05) and W6 (P<0.01). This indicates that even though the live weights of the two groups weren't significantly different by the end of the trial at six weeks, overall the goats in the high interaction group had put on more condition relative to weight.

Pellet feeding

The pellet used in this study was designed by Dr John Milton (UWA) to specifically resemble a shipper pellet used for sheep, as discussions with Gary Robinson at Wellards suggested that Wellards would be unlikely to use different pellets for goats to those they use for sheep on board. Subsequently, the pellets had a different nutritional content to what the depot owner, Keros Keynes, traditionally used. Therefore, different pellets were used in Experiment 1 than Experiment 2a. The main difference being that the pellets used in the current experiment had almost a third less grain and more fibre (Table 4). Comparing liveweight gains between Experiments 1 and 2a, that were conducted at a similar time of year and with similar animals (Fig. 18), it is evident that the goats had slower growth rates on the shipper pellets. However, there were no mortalities in Experiment 1, but this experiment only lasted 3 weeks and perhaps mortalities may have occurred later if the experiment were longer.

Table 4. Nutritional component content of the standard pellets used on the Keynes' property, used in Experiment 1, and the shipper pellets designed for Experiment 2a.

Component (kg/tonne)	***Std Keynes pellet (Exp. 1)***	***Shipper pellet (Exp. 2)***
Wheat seconds	360	270
Lupins	225	160
Canola seconds	55	32
Oat husks	90	155
Lupin straw	115	170
Barley straw	115	170
Rumensin	0.2	0.2
Other (minerals, etc)	40	43

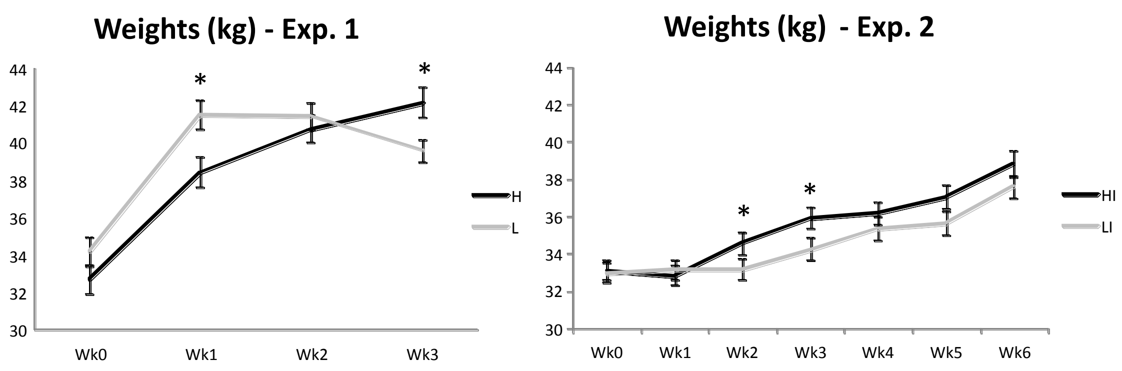

Figure 18: Comparison of the mean (± SE) fasted live weights of bucks in Experiment 1 with the high interaction (HI) group (n = 60) and the low interaction (LI) group (n = 60); against the fasted live weight of bucks in Experiment 2a with the high interaction (HI) group (n = 130) and the low interaction (LI) group (n = 130). An asterisk indicates significance at P<0.05.

The percentages of bucks feeding at the pellet trough in one hour immediately following an overnight fast were similar between treatment groups at the first measurement at W1 (Fig. 19). There was an overall significant effect of treatment and time on the percentage of bucks feeding at the pellet trough (P<0.05). Percentage feeding increased in both treatment groups over the six weeks of the experiment, and overall the high interaction group had higher percentage feeders than the low interaction group. Following post-hoc analysis, in the second, third and fourth weeks after introduction to the pellets, the high interaction group had higher percentage of feeders than the low interaction group (P<0.05). In terms of surpassing the benchmark of 50%, the high interaction group achieved this by W3, whereas the low interaction group only achieved this benchmark by W5. On closer inspection of the videos, the two “mentor” goats in each high interaction pen where in the first five goats that approached the trough in the first three weeks. It was also noticed that there was a hierarchy of feeding. During the one hour video footage, a cohort of presumably more dominant bucks ate at the trough initially, and when they had finished, less dominant bucks approached.

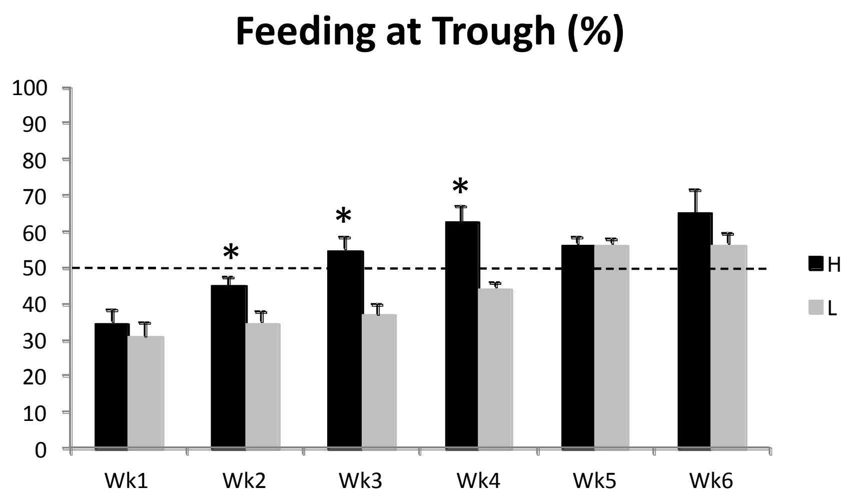

Figure 19: Mean (± SE) percentage of bucks that fed at the pellet trough within one hour following an overnight fast. Each of the two pens of high interaction (HI) and low interaction (LI) goats contained 65 animals. An asterisk indicates significance at P<0.05. The dashed line represents the benchmark level of 50%.

Agonistic contacts

There was an overall significant effect of treatment and time (P<0.05) on the number of agonistic contacts between bucks in the confinement pen over a two minute duration (Fig. 20). The number of agonistic contacts in both the high and low interaction groups decreased over time, but following post-hoc analysis, the number of agonistic contacts in the low interaction group was higher than the high interaction group at W3, W4 and W6 (P<0.05). In terms of surpassing the benchmark, i.e. the number of agonistic contacts in two minutes, the high interaction group achieved this by W4, whereas the low interaction never achieved this benchmark.

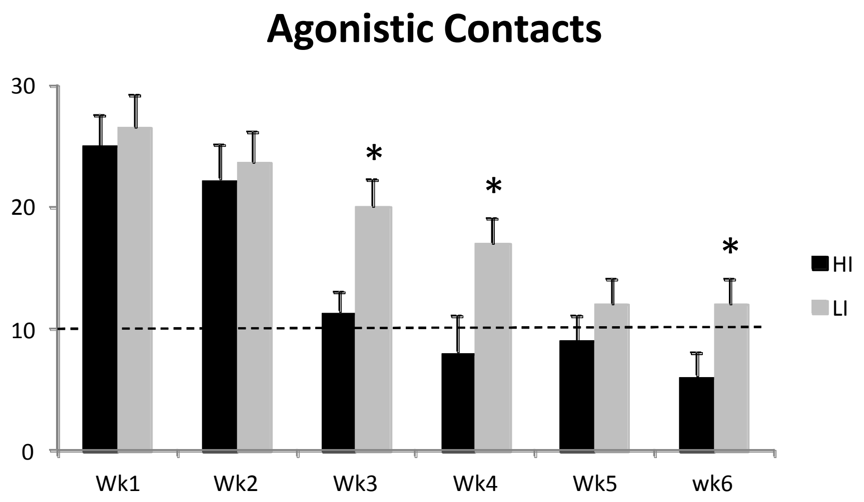

Figure 20: Mean (± SE) number of agonistic contacts between sub-groups (n ≈ 20) of bucks in the confinement pen over a two minute duration for the high interaction (HI) group (n = 6) and the low interaction (LI) group (n = 6) at each weekly measurement day. An asterisk indicates significance at P<0.05. The dashed line represents the benchmark level of 10 contacts per two minutes.

Flight speed

There was an overall significant effect of treatment and time (P<0.05) on the time taken for the goats to run past a human to a distance of 25 metres (Fig. 21). The flight speed of both the high and low interaction groups decreased over time, but following post-hoc analysis, the flight speed of the low interaction group was faster than the high interaction group at W1, W3 and W4 (P<0.05). Previous studies have also found good correlations with tests that measure goats' response to human approach, such as flight speed (Lyons and Price 1987; Mattiello *et al.* 2009). In terms of surpassing the benchmark, i.e. a flight speed lower than 1.5m/s, the high interaction group achieved this by W3, whereas the low interaction group only achieved this benchmark by W5.

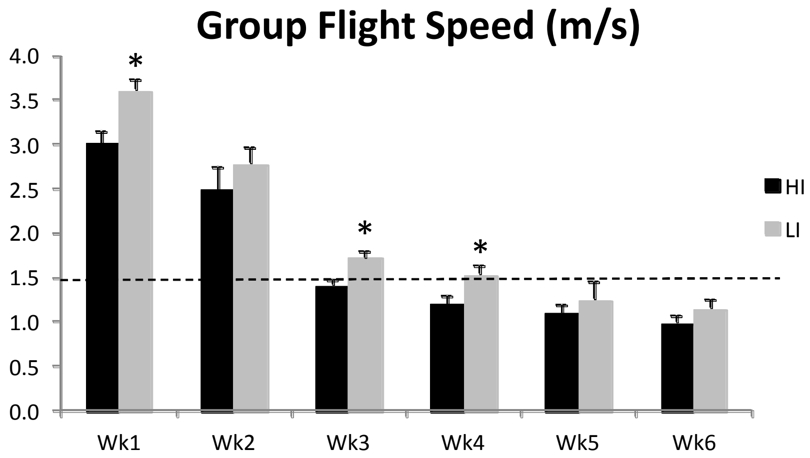

Figure 21: Mean (± SE) flight speed (m/s) in sub-groups (n ≈ 20) of bucks over a 25 metre distance after moving past an approaching human in the high interaction (HI) group (n = 6) and the low interaction (LI) group (n = 6) at each weekly measurement day. An asterisk indicates significance at $P<0.05$. The dashed line represents the benchmark level of 1.5m/s.

Success in achieving benchmarks

When comparing the weekly achievement of benchmarks (Table 3) it is apparent that the low interaction treatment was unable to attain all benchmarks over the six week duration of the experiment. Whereas, the high interaction treatment attained the benchmark in all five categories assessed by Week four. However, in W5, the high interaction group failed to reach the benchmark for mortality, but attained it again in W6. Overall, this suggests that, given an implementation of these benchmarks into an ALES system, having minimal interaction with the bucks would mean that it would be unlikely that those animals would be selected for export after 21 days. Indeed, even if the ALES timeframe was extended to 42 days, these animals could still not be selected for export. On the other hand, implementing a fairly practical protocol of human interaction, and using strategies such as mixing some experienced goats with newly arrived goats at the depot, could result in animals attaining the benchmarks at 21 days. However, as seen from this current experiment, this timeframe in the export process may need to be dictated by the required outcome rather than a specific time period. Indeed, when the goats in the current experiment were followed for a further three weeks, the weekly mortality benchmark for the high interaction group was not attained in W5. However it is acknowledged that a set time period, albeit a ‘blunt instrument’, does allow auditing/monitoring systems to have a checkpoint.

Table 5: Summary of the weekly attainment of the five benchmarks for 1) weight, 2) mortality, 3) pellet feeding, 4) agonistic behaviour and 5) flight speed (fear) for the high interaction (HI) and low interaction (LI) bucks.

Benchmark		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
1. Weight	HI	NA	✓	✓	✓	✓	✓
	LI	NA	✓	✓	✓	✓	✓
2. Mortality	HI	✓	✓	✓	✓	✗	✓
	LI	✓	✓	✓	✓	✓	✗
3. Pellets	HI	✗	✗	✓	✓	✓	✓
	LI	✗	✗	✗	✗	✓	✓
4. Fighting	HI	✗	✗	✗	✓	✓	✓
	LI	✗	✗	✗	✗	✗	✗
5. Fear	HI	✗	✗	✓	✓	✓	✓
	LI	✗	✗	✗	✗	✓	✓

In terms of difficulty in attaining each of the individual benchmarks with the higher level of interaction, it appears that weight gain was easily achieved. However, it is likely that this benchmark was only easily achieved because of the weekly monitoring and removal of goats that were losing weight, which was an ethical requirement. Reduction of fighting to lower than 10 agonistic contacts per two minutes was the hardest benchmark to attain. Keeping mortality below 1% per week period was unable to be obtained, and again this was probably also influenced favourably by removing goats from the experiment that were losing weight.

4.2.4 Summary

Although the benchmarks used in this experiment were derived from findings of Experiment 1 and discussions with experts, they are still at a subjective level. Decisions would need to be made, based on the findings of the current experiment, about whether more or less stringency needs to be enforced by raising or lowering the benchmarks, or indeed by increasing or decreasing the number of benchmarks. As particularly seen from the mortality benchmark, consideration of timing of measurements needs to be also carefully considered. Recommendations are given below for each of the benchmarks:

Weight/BCS benchmark
Live weight and BCS were useful measures of whether goats were eating and their general health, however, this benchmark needs to be considered in relation to the probable need for weekly monitoring and removal of goats that were losing weight to attain it.

Mortality benchmark
This is probably the most crucial benchmark in relation to any resumption of long-haul live export of rangeland goats. Also, consideration of timing of measurement

needs to be also carefully considered as an ALES-related 21 day timeframe may lead to false predictions from this benchmark.

Pellet feeding benchmark
Indications from the present study are that observation of animals eating pellets is a useful benchmark, as it clearly is correlated to the domestication process and the level of interaction. It also a crucial benchmark in relation to any resumption of long-haul live export of rangeland goats to avoid problems of inanition. However, on its own, this benchmark may give false predictions of outcomes as, as implied from the findings of the current experiment, over-consumption of pellets may lead to gut problems which could be detrimental to the health of the animals.

Agonistic behaviour benchmark
Fighting between individuals in the depot and on-board ship obviously has the potential to lead to serious injury, and/or death. It also seems to form the basis of a social hierarchy where activities like access to pellets in a feed trough can be affected. Therefore, it is an important benchmark to consider. Also, it was reasonably quickly reduced with an increased (but practical) level of human interaction, but not below the benchmark threshold within a 21-day timeframe.

Flight speed benchmark
Temperament is defined as an animal's behavioural response (e.g. fear) to handling by humans (Burrow 1997). The use of temperament measures on cattle has long been accepted by industry as a valid measure of animal's reactivity to humans and has been correlated with many different production indices. Temperament is predominantly measured using flight speed in many species (Burrow et al. 1988). In the current study, the fear of humans, as tested by flight speed, was quickly diminished with an increased (but practical) level of human interaction. It is a fairly quick and simple test to conduct, but on its own is probably not robust enough.

4.3 Experiment 2b, Use of an anti-GnRH vaccine to minimise dominance behaviour in bucks

4.3.1 Experimental aims

The aim of this study was investigate the use of an anti-GnRH vaccine to minimise dominance behaviour in bucks. The anti-GnRH vaccine, Improvac® (Pfizer Animal Health), registered for use in pigs, has proven efficacy on decreasing aggressive behaviours and reducing odour in boars, with the additional benefit of no withholding period. Improvac® is currently registered for use with a protocol of an initial vaccination followed by a booster after a 28 day interval. However, this experiment examined its efficacy with a booster at a 14 day interval concurrently with a 28 day interval, as minimising preparation times for export will make export more feasible and cost effective. Within this experiment the following was examined:

1. The efficacy of an anti GnRH immunological product (Improvac®) to negate dominance behaviour in bucks. Treatments will assess impact on scrotal circumference, plasma testosterone, behaviour (including QBA).
2. Impact on dominance behaviour, feeding behaviour and stress responses when goats are segregated e.g. in property of origin lines, according to weight / age or with sheep.

Treatments assessed the impact on time taken to start feeding, body weight and agnostic behaviour. Any incidence of disease or ill thrift was investigated and reported including veterinary treatments, pathology reports, and post mortem results.

4.3.2 Methodology

All sample collection methods used were approved by the Murdoch University Animal Ethics Committee (approval number R2459/12).

Forty six Rangeland goats of varying age (between 12 and 18 months), and weighing on average 30kg, were trapped at Wooramel station. On arrival at the test site at the Murdoch University Veterinary Farm in Perth, WA, goats were given three days to recover from travel and acclimatise to new conditions. The experiment contained two treatment groups (I14 and I28) and one control (C) and ran for eight weeks. The treatments for groups during the trial were as follows:

- Experimental group one (I14) received vaccine at day 0 and day 14
- Experimental group two (I28) received vaccine at day 0 and day 28
- Control group (C) received sterile saline.

Statistical analyses
Repeated measures analysis of variance (ANOVA) was performed on all data except the agonistic behaviour data which was analysed by factorial ANOVA. Fisher's PLSD was used for post-hoc analysis.

4.3.3 Results and discussion

Testicular size
There was no difference in testis size, as measured by scrotal circumference (SC), in the three treatment groups at the start of the experiment (Fig. 3), at W3 or W5 when the 14 day and 28 day booster injections were given to the I14 and I28 groups, respectively. However, by Week seven (W7) there was a significant ($P<0.05$) difference between the three groups, with the SC of the I14 group decreasing in size by approximately 7% and the I28 group decreasing by approximately 13% compared to Week one. By Week nine (W9) the SC of the I14 group had decreased by approximately 13% and the I28 group decreasing by approximately 17% compared to W1 (Fig. 22).

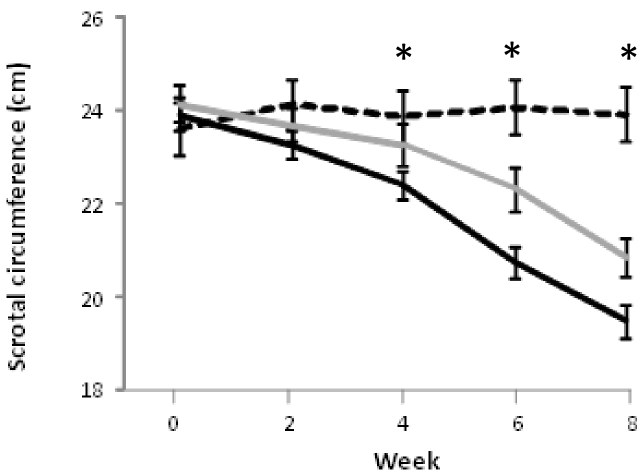

Figure 22: Change in scrotal circumference in the three treatment groups of goats, control (dashed line), I14 (grey line) and I28 (black line). An asterisk indicates significance at $P<0.05$.

Circulating testosterone concentrations
The circulating concentration of testosterone in the three treatment groups of goats was not different at the start of the experiment (Fig. 23). By W5 the average testosterone concentration of the I28 group was significantly (P<0.05) less than the Control and I14 groups. By W7 the average testosterone concentration of both the I14 and I28 groups was significantly (P<0.01) less than the Control. The average testosterone concentration of the Control group increased over the nine weeks of the experiment, coinciding with the seasonal increase in sexual behaviour at that time of year. This seasonal increase makes the decrease in Experiment groups one and two more significant as Improvac® suppression was successful even in the face of normal seasonal increase.

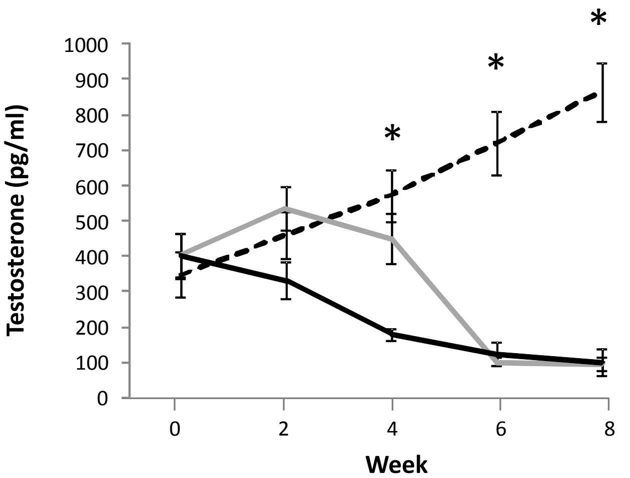

Figure 23: Circulating testosterone concentrations (pg/ml) in the three treatment groups of goats, control (dashed line), I14 (grey line) and I28 (black line). An asterisk indicates significance at P<0.05.

Agonistic behaviours
On the first day of the trial when agonistic behaviours were tested there were no differences between the Control, I14 and I28 groups with an average number of contacts per animal in the two minute period being less than one in all three groups (Fig. 24). This low number of agonistic behaviours on Day 0 may have been a result of the novelty of the confinement pen where the behavioural tests were undertaken, along with handling and data collection. By Day 15 the agonistic behaviours had increased significantly (P<0.01) in all three groups, averaging about five aggressive contacts per animal in two minutes. There was no difference between the three treatment groups on Day 15. On Day 30 there was a non-significant trend for the number of aggressive contacts to be declining, but again no significant difference between the three treatment groups. On Day 60, the number of aggressive contacts in both of the Improvac® treated groups had significantly declined (P<0.05) from Day 15 values, with the I14 group averaging 1.13±0.40 contacts in two minutes and the I28 group averaging 0.38±0.18 contacts in two minutes, and both Improvac® groups had fewer (P<0.05) aggressive contacts compared to the Control group, averaging 2.88±0.79 contacts in two minutes, on Day 60.

These results indicate that the Improvac® treatment decreased agonistic behaviours in intact male rangeland goats, with the standard 28-day booster treatment regimen producing the greatest effect. There was a non-significant trend for aggressive behaviours decreasing from Day 15 to Day 60 in the Control group, probably indicating a small amount of behavioural change associated with acclimatisation to confinement and human interaction.

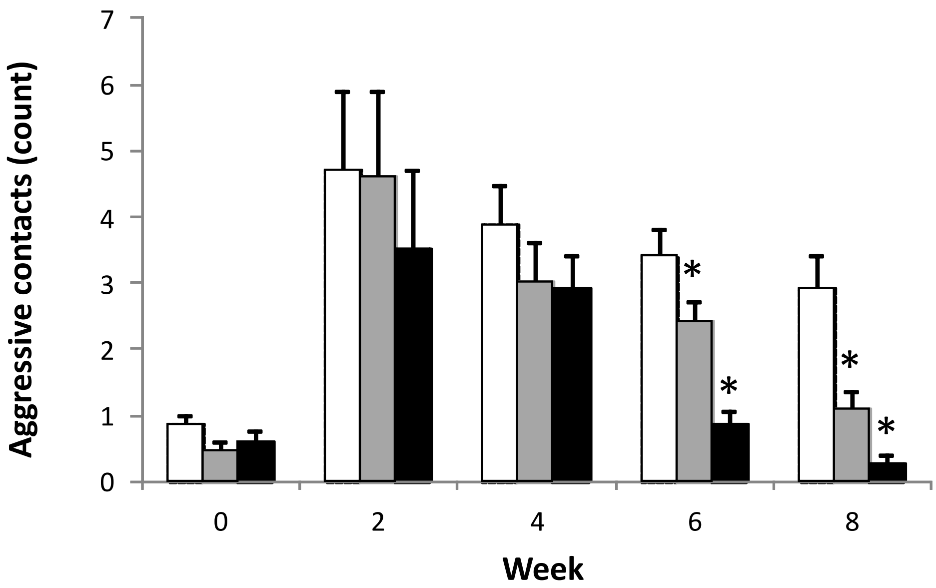

Figure 24: Average number of aggressive physical contacts per animal in two minutes in the three treatment groups of goats, control (white columns), I14 (grey columns) and I28 (black columns). An aggressive contact was registered when an animal head butted, head to body or mounting of another animal. An asterisk indicates significance at $P<0.05$.

4.3.4 Summary

In conclusion, Improvac® decreases agonistic behaviour in male rangeland goats, reduces testicular size and decreases circulating testosterone concentration. This confirms the efficacy of this commercially available anti-GnRH vaccine developed for pigs to be used on rangeland goats.

It was hypothesised that decreasing the time between primary immunisation and booster might provide faster significant results and therefore decrease time in preparation facilities prior to export. The trial results confirm this, but indicate that a 28 day booster is more effective. The immune system requires time to produce an adaptive response and if subsequently challenged before this is complete, will not respond as well to the second challenge. However, the 14-day booster was still effective at providing immunocastration effects in rangeland goats. Therefore, this trial proves efficacy of both 14 and 28 day booster vaccination protocols for use of Improvac® in rangeland goats, but given the more favourable results with reduced aggression it's recommended using the manufacturer's recommendation of a 28 day booster. It should be noted that using Improvac on goats would be off-label and will therefore require a vet prescription.

In pigs, Improvac® has a 'zero day' withholding period. The effects of Improvac® are only temporary and are thought to last for a minimum of 8 weeks. However, several studies have shown that the effects of immunocastration last longer, even up to 22 weeks after completion of the vaccination course (Zamaratskaia *et al*., 2008 and Brunius *et al*., 2011). The findings of this study indicates that the use of Improvac® as part of a domestication protocol to reduce agonistic behaviour in rangeland goats is warranted.

4.4 Experiment 3: The impact of nutritional status (pellet nutritional quality) on the ability and time taken to achieve the benchmarks for 'readiness to export'

4.4.1 Experimental aims

The aims of this study were:

1. To determine the impact of nutritional status (pellet nutritional quality) on the ability and time taken to achieve the benchmarks for 'readiness to export' as tested in Experiment 2a.

Parameters measured for treatments included body weight and BCS, time taken to start feeding, feed dye assessment and bloods. All feed types and rations were analysed for nutritional content.

2. To determine if protozoan, bacterial or helminth burden is affected by particular management systems and/or nutritional status.
3. Use quantitative PCR (qPCR) to monitor goats to determine if there is an association between the prevalence and type of bacteria, protozoans and worms with scouring, faecal consistency, body condition score and time of year

4.4.2 Methodology

Two of the major pathogens affecting scouring and ill-thrift in goats are Salmonella and Eimeria sp which are responsible for the enteric diseases Salmonellosis and Coccidiosis respectively. Yet little is known about their prevalence and contribution to scouring in rangeland goats in Australia. Moreover, the overall efficacy of "off label" treatments for coccidiosis in goats, e.g. Baycox, is unknown, or if its efficacy is affected by particular management systems and/or nutritional status. As part of Professor Una Ryan's (Murdoch University) MLA-funded project entitled "Impact of bacteria and coccidia on scouring & productivity in sheep" (Project no: AHE.0027), quantitative PCR assays for detecting and enumeration of Eimeria, Cryptosporidium, Giardia, Salmonella, Campylobacter and Haemonchus have been developed and validated. These quantitative PCR's were applied for the detection and characterisation of these parasites in rangeland goats.

All sample collection methods used were approved by the Murdoch University Animal Ethics Committee (approval number R2541/12 and R2617/13).

This study started on the 10th February 2014, and extending for eight weeks. 280 intact bucks (about 30kg, approximately 12-18 months of age) were separated into four treatment groups. Two groups received the high interaction and two groups received the low interaction treatments as per Experiment 2a. In addition, one of the high interaction groups and one of the low interaction groups received a 'high quality' pellet (12 MJ/kg ME, 20.8% CP) while the other two groups received the standard 'shipper' pellet (9.9 MJ/kg ME, 12.1% CP) (Table 6). Apart from the differences in energy and protein content, the Low quality shipper pellet contained 26.8% acid detergent fibre (ADF) and 49.0% neutral detergent fibre (NDF), while the High quality pellet contained only 25.5% ADF and 40.4% NDF. Both pellets contained Rumensin (monensin) to help control coccidiosis. Initially the goats had *ad libitum* access to hay in all pens, but this was gradually cut back as they started eating pellets.

Table 6: Nutritive chemical analysis of the high and low quality pellets.

Analysis	High quality pellet	Low quality pellet
Crude protein (% of DM)	20.8	12.1
Metabolisable energy (MJ/kg DM)	12.0	9.9
Fat (% of DM)		
Digestibility DOMD (% of DM)	3.7	3.4
ADF (% of DM)	73.7	58.9
NDF (% of DM)	25.5	26.8
	40.4	49.0

The goats were randomly divided into 12 groups and a coloured ear-tag colour was applied to differentiate groups (23-24 goats in each group), and the 12 groups were randomly allocated between four pens (three groups in each pen). Each pen was then assigned a different human interaction and nutritional treatment (Fig. 25). Each pen shared one fenced side with another pen while the remaining three sides had no contact with any other pen containing goats. A laneway ran between the pens and a small pen was created at the end of the laneway for use in the behavioural tests (see below).

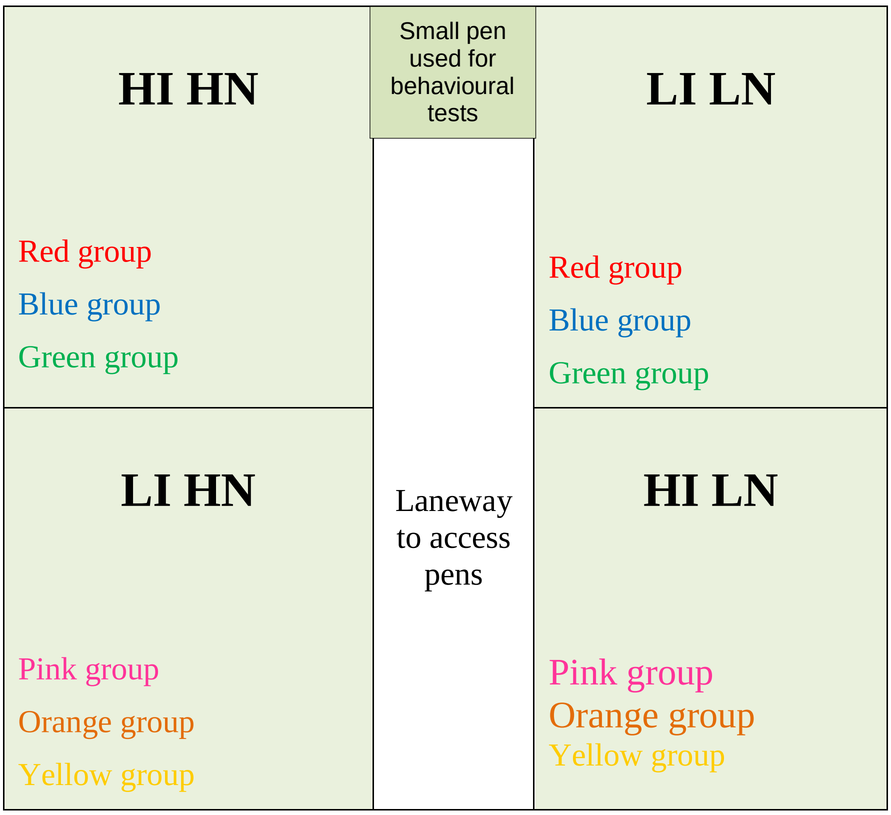

Figure 25: A representation of the 2x2 factorial treatment layout, for the high interaction high nutrition (HI HN), low interaction low nutrition (LI LN), low interaction high nutrition (LI HN), and the high interaction low nutrition (HI LN) groups.

Human interaction was given in the form of a familiar human (one of only a handful of stock-people working at the feedlot) walking calmly around inside the pen of the goats for 30-60 minutes per day. This person would deliberately enter the flight zone of the goats without touching them, and remain in silence for the entire interaction time. The high interaction (HI) and low interaction (LI) groups used the same level of human interaction as described for Experiment 2a, and like in that experiment, two “mentor” goats were placed in each HI pen. These mentor goats were of similar age and size, but had been acclimatized to the depot set-up for at least three months prior. The low interaction group was only exposed to humans during measuring periods and to remove sick or injured animals, and had no mentor goats.

Weight and body condition score (BCS) of the goats was measured weekly for eight weeks, with the first measurements taken on the day the goats were divided amongst the pens (Week zero (W0)). Weights and BCS were taken in the morning following an overnight fast.

All behavioural tests were conducted after each pen of goats was weighed, condition scored and drafted into their sub-groups. The aggression test and flight speed test were then carried out as described for Experiment 2a. After all sub-groups had been returned to their home pen the goats were given access to their pellet troughs and video cameras installed on the trough recorded which goats were ate at the troughs in one hour.

Faecal samples were collected by rectal palpation from 125 randomly selected goats beginning immediately after arrival at the commercial goat depot, and again at four, eight and 12 weeks after arrival (four weeks after nutritional experiment ended). After the first sampling, the goats selected for enteric pathogen monitoring were equally distributed between the treatment groups (described above). Breech faecal staining score (dag score), faecal consistency score (FCS), live weight and body condition score (BCS) and other related clinical signs of each animal were also recorded. Faecal consistency score was measured using a scale of one (hard, dry pellet) to five (liquid/fluid diarrhoea) previously described (Greeff and Karlsson, 1997). Breech faecal soiling score was measured using a scale of one (no evidence of breech fleece faecal soiling) to five (very severe breech faecal soiling extending down the hind legs to, or below the hocks) used for sheep (Australian Wool Innovation, 2007). After the first sampling, all animals were treated with an anthelmintic (Cydectin®) and an anti-coccidial (Baycox®). At four weeks into the trial, nearly 16% of the goats were observed to be scouring. A faecal egg and oocyst count taken at this time indicated an average of 2,880 (predominantly eimeria oocysts). A second drench of Cydectin® and Baycox® was given two days after the W4 sampling.

Faecal samples were immediately placed on ice until transported to the lab and then stored in the refrigerator (4°C). Eimeria oocysts per gram (OPG) and worm egg counts (WEC) were also performed on 2g faeces from each sample, by microscopy using a modified McMaster method (Lyndal-Murphy, 1993) and each oocyst/egg counted represented 50 OPG/WEC. Once microscopic OPG and WEC were conducted, all faecal samples were stored at -20°C until DNA extraction was performed.

DNA isolation

Genomic DNA was extracted from 200mg of each faecal sample using a Power Soil DNA Kit (MolBio, Carlsbad, California) as described in Yang et al (2014c). A negative control (no faecal sample) was used in each extraction group.

PCR amplification, quantitation and sequencing

Primers and probes for Eimeria, Cryptosporidium, Giardia, Salmonella, Campylobacter, Haemonchus, Teladorsagia and Trichostrongylus were used as previously described (Yang et al 2014a; 2014b; 2014c; 2014d). Primers and probes to an internal amplification control (IAC) which consisted of a fragment of a coding region from Jembrana Disease Virus (JDV) cloned into a pGEM-T vector (Promega, USA) was also used as previously described (Yang et al 2013). The specificity and sensitivity of the primers and probes used has been previously described (Yang et al 2014a; 2014b; 2014c; 2014d).

Statistical analysis
A Linear mixed effect model (SAS Version 9.2, SAS Institute, Cary, NC, USA) was used to analyse live weights, BCS, flight speed, aggression and feeding behaviour with fixed effects of nutrition treatment, domestication treatment and time with animal ID as the random term.

The prevalence of each pathogen at different sampling times was expressed as the percentage of samples positive by PCR for at least one sampling time, with 95% confidence intervals calculated assuming a binomial distribution, using the software Quantitative Parasitology 3.0 (Rózsa et al 2000). The Eimeria OPG and WEC data were categorised as positive (OPG/WEC ≥50 per gram) or negative (no oocysts/eggs detected). Nutritional treatment, domestication treatment and time effects were analysed using general linear models (SAS Version 9.2, SAS Institute, Cary, NC, USA) with pathogen (Cryptosporidium, Giardia, Eimeria, Campylobacter, Salmonella, Haemonchus and Trichostrongylus) presence or absence at the first sampling as a fixed effect. Odds ratios (ORs) analysis were also conducted using Pearson's chi squared test to assess the association between the presence of pathogens and faecal consistency score (FCS ≥3.0).

4.4.3 Results and discussion

For all treatments (Fig. 26), weight increased over the eight weeks (P<0.01). The greatest increase in weight was seen in the HI HN group (16% P<0.001), followed by the HI LN group (12% P<0.01), then the LI HN group (7% P<0.05), then the LI LN group (6% P<0.05).

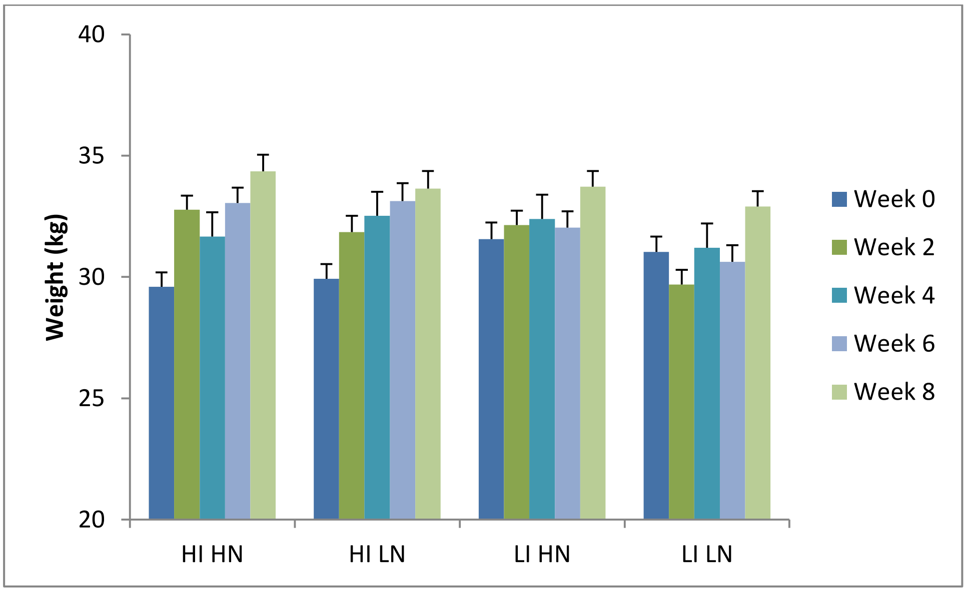

Figure 26: Live weights for the high interaction high nutrition (HI HN), low interaction low nutrition (LI LN), low interaction high nutrition (LI HN), and the high interaction low nutrition (HI LN) groups. Values are means ± SEM.

For all treatments (Fig. 27), BCS increased over the eight weeks (P<0.001). The greatest increase in BCS was seen in the HI HN group (34% P<0.001) and the HI LN group (34% P<0.001), then the LI HN group (21% P<0.001), then the LI LN group (18% P<0.01).

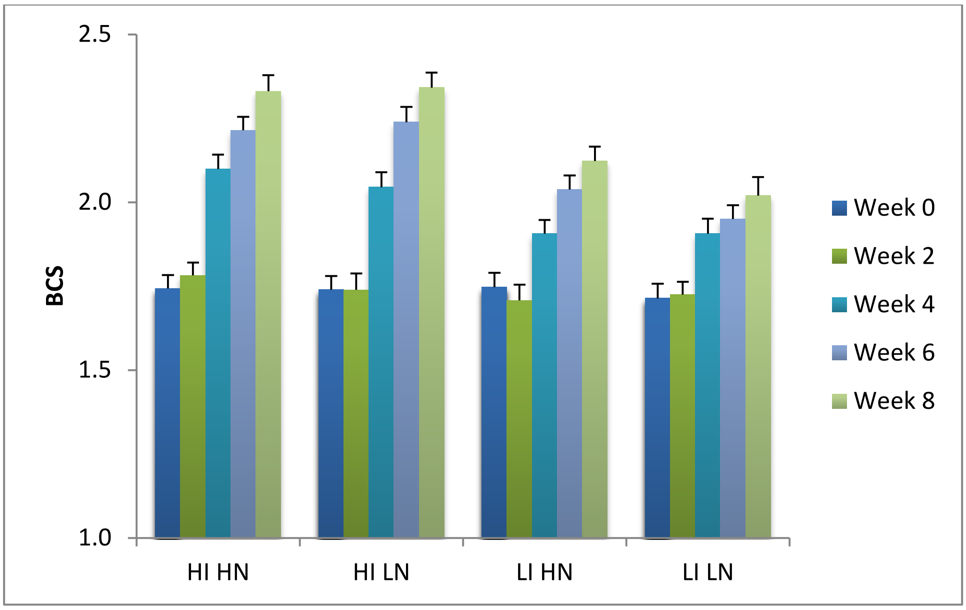

Figure 27: Body condition score (BCS) for the high interaction high nutrition (HI HN), low interaction low nutrition (LI LN), low interaction high nutrition (LI HN), and the high interaction low nutrition (HI LN) groups. Values are means ± SEM.

For all treatments (Fig. 28), the number of aggressive contacts increased from week to W1. The likely explanation for this is that in W1 they may have been diverted from fighting by being placed in the novel confinement pen. However, from W2 to Week eight (W8) the number of aggressive contacts for all treatments decreased (P<0.001). The greatest decrease in aggressive contacts between W2 and W8 was seen in the HI LN group (39% P<0.01), then the HI HN group (37% P<0.05), then the LI HN group (30% P<0.01) and the LI LN group (30% P<0.05).

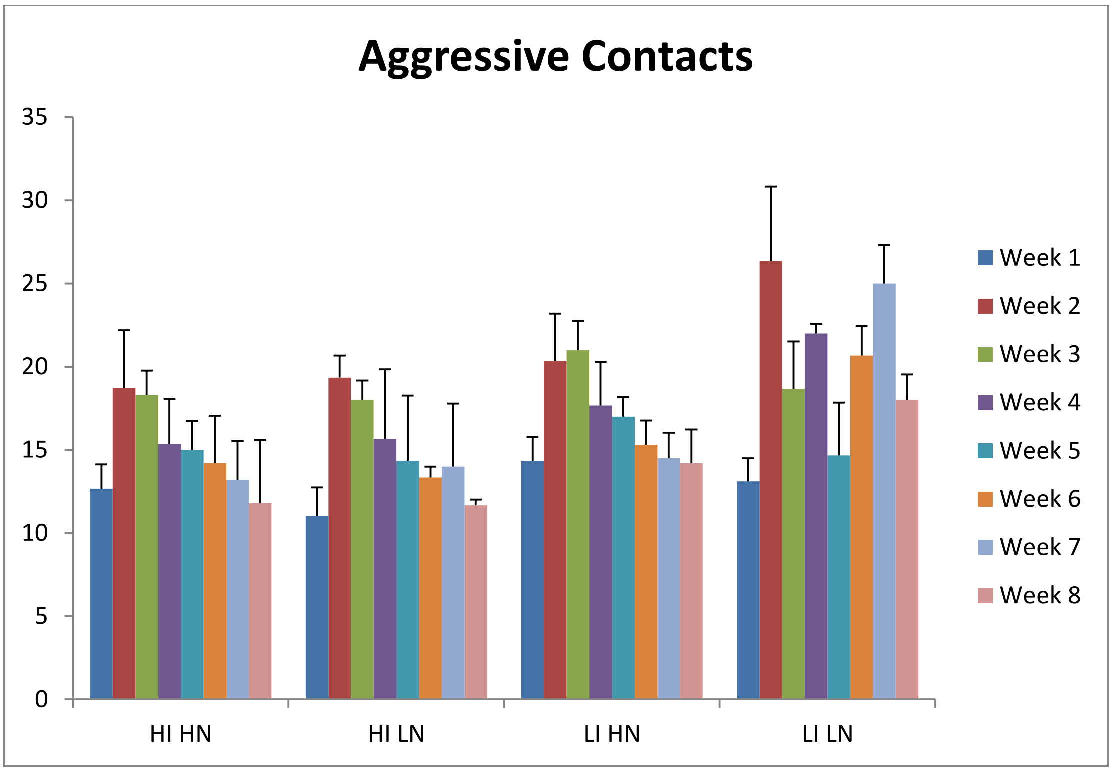

Figure 28: Number of aggressive contacts in two minutes for the high interaction high nutrition (HI HN), low interaction low nutrition (LI LN), low interaction high nutrition (LI HN), and the high interaction low nutrition (HI LN) groups. Values are means ± SEM.

For flight speed (Fig. 29), the results were much more variable, and although they appeared to decrease over the eight weeks in three of the four treatment groups, except HI LN, the only group that had a somewhat consistent decline in flight speed was the LI LN group. Similarly, the benchmark of under 1.5m/sec was not obtained by the HI LN group at eight weeks.

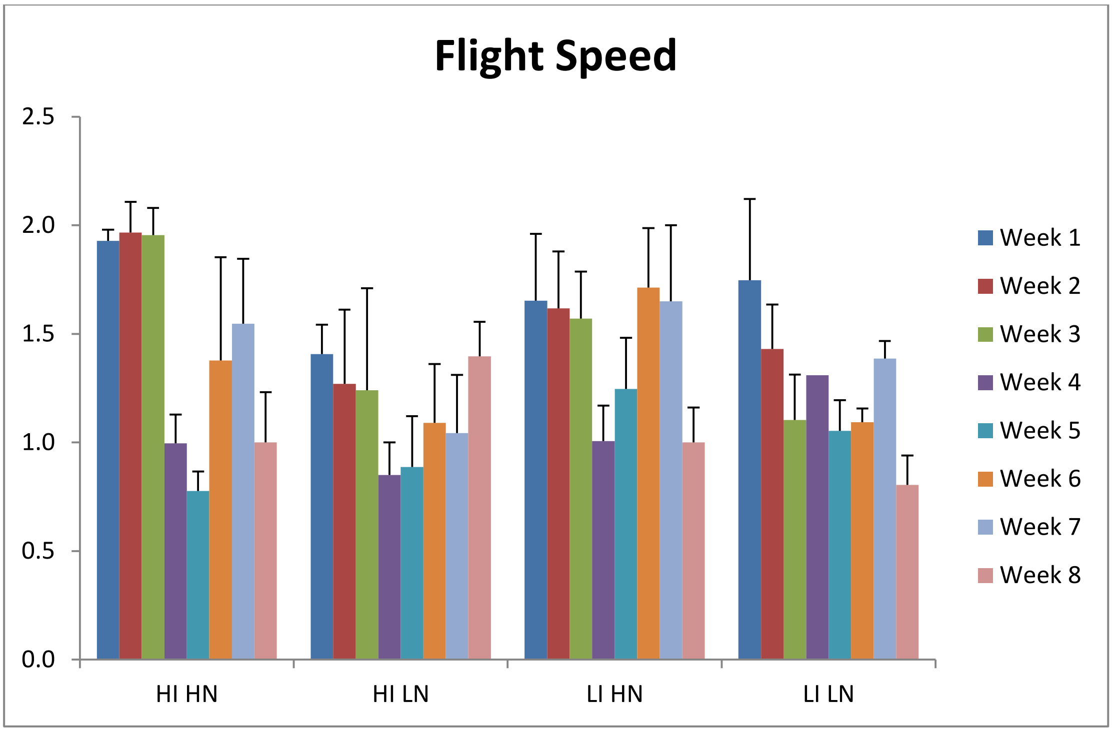

Figure 29: Flight speed (metres/sec) over 25 metres for the high interaction high nutrition (HI HN), low interaction low nutrition (LI LN), low interaction high nutrition (LI HN), and the high interaction low nutrition (HI LN) groups. Values are means ± SEM.

With the addition of video cameras on the feed troughs monitoring and identification of individual animals that were consuming pellets was enabled. This increased the power of this measure, and defined a three minute window after allowing goats access as the optimum for analysing pellet acceptance over the eight week period. None of the goats were observed eating during this time window in W1, and less than five animals were observed eating in this time window in the HI HN and LI LN groups. For the two low nutrition groups, HI LN and LI LN, and the HI HN group, the number of goats feeding at the trough within three minutes of allowing them access increased from W1 to W8 (Fig. 30). Again, like the flight speed results, there was a lot of variation over time, with only the LI LN group showing a consistent increase over time.

Although not corroborated with actual consumption data as this was not measured, the higher rate which the low nutrition pellet troughs had to be re-filled compared to the high nutrition pellet troughs, along with the apparent better acceptance of these pellets, indicates that maybe the goats preferred the higher fibre content in these pellets even though they contained lower levels of energy and protein.

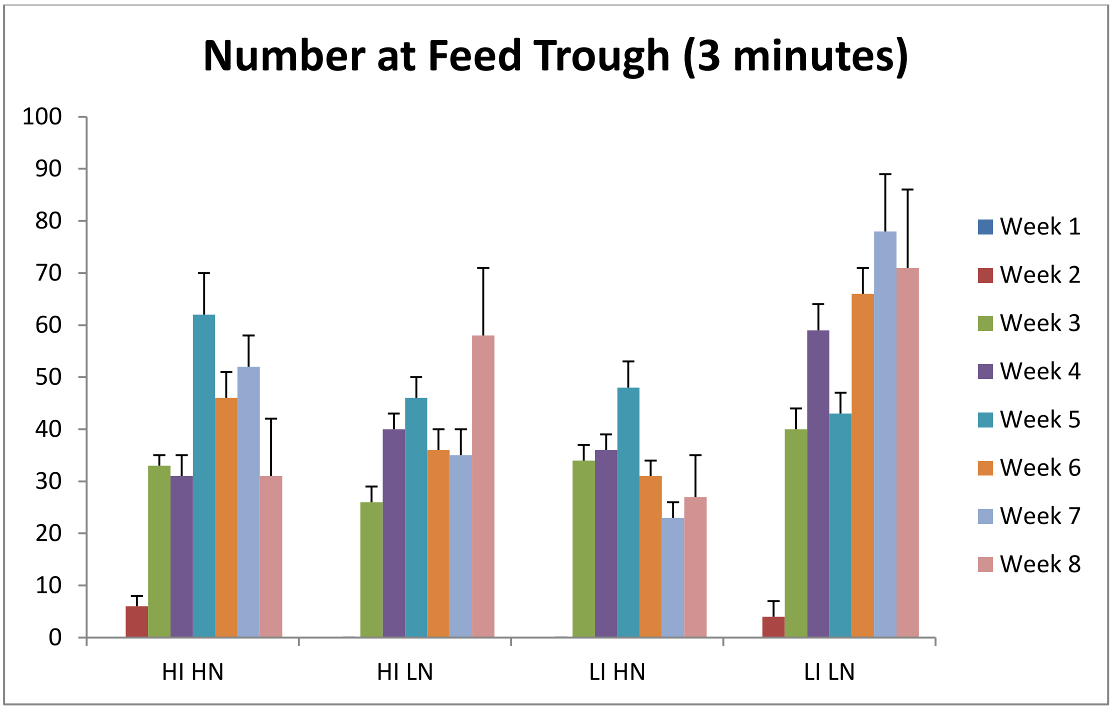

Figure 30: Number of goats feeding at the trough within three minutes of allowing them access for the high interaction high nutrition (HI HN), low interaction low nutrition (LI LN), low interaction high nutrition (LI HN), and the high interaction low nutrition (HI LN) groups. Values are means ± SEM.

Mortality was calculated based on actual deaths (71%) plus animals that were removed because they had lost weight or were scouring severely (29%). Although 60% of the animals that were removed were successfully treated and survived, in a normal production scenario or on board ship these animals may have also died if not treated. The effect of mortalities (or removed from study) needs to be taken into consideration when looking at the data presented for animal performance, behaviour, and prevalence of enteric pathogen data over time. For example, the goats that died, or were removed from the study, were obviously not measured or faecal sampled at subsequent time-points.

There were mortalities in all treatment groups that exceeded the weekly benchmark of 1% (Fig. 31). In the HI HN group there was a 2.9% mortality rate in W5, 1.5% in W6 and 1.5% in W7. In the HI LN group there was a 1.4% mortality rate in W1, 2.9% in W6 and 1.5% in W8. In the LI HN group there was a 1.4% mortality rate in W1, 1.4% in W4 and 2.9% in W6. In the LI LN group there was a 1.4% mortality rate in W1 and 7.2% in W6. In total 17 goats died during the eight week experiment, with nearly 50% of deaths occurring in W6. There were no deaths in W2 and W3.

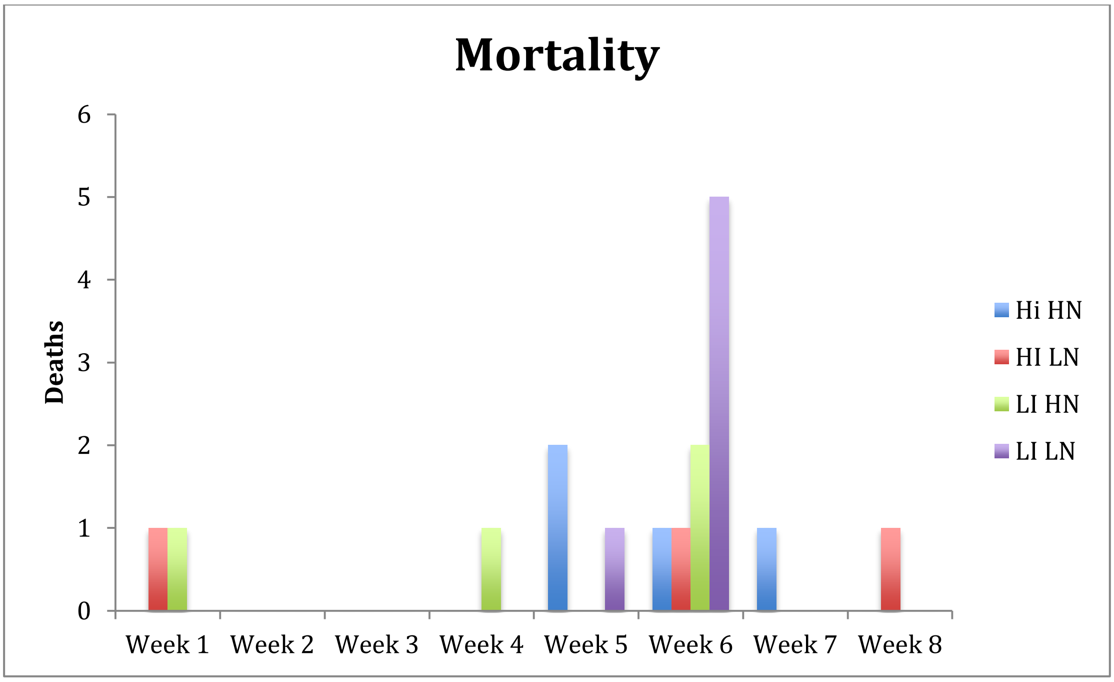

Figure 31: The mortality rate in deaths per week for the high interaction high nutrition (HI HN), low interaction low nutrition (LI LN), low interaction high nutrition (LI HN), and the high interaction low nutrition (HI LN) groups.

All mortalities were confirmed as due to coccidiosis, as determined by autopsy and enteric pathogen analysis. There was no effect of treatments (human interaction or diet) on mortality (Fig. 31) or enteric pathogen identity or prevalence. The effect of mortalities on prevalence of enteric pathogens over time needs to be taken into consideration. For example, the goats removed from the study at W6 (Fig. 31) would not have been represented in the W8 or Week 12 (W12) data for enteric pathogen prevalence (Fig. 33).

The goats arrived at the depot having been mustered from Wooramel station near Carnarvon. The season had been very dry, but as Wooramel station has a natural water system, large numbers of goats congregated in small areas near the remaining water sources. Faecal egg counts were taken from the goats on arrival from the station (W0), just prior to treating animals with an anthelmintic (Cydectin®) and Baycox® (an anti-coccidial), and these averaged 2,500 per gram, mainly consisting of eimeria oocysts (coccidia), as determined by microscopy (Fig. 32). NB: general advice is that treatment should be given when the egg count is greater than 500 per gram. At W4 , nearly 16% of the goats were observed to be scouring. A faecal egg and oocyst count taken at this time indicated an average of 3,350 (predominantly eimeria oocysts). A second drench of Cydectin® and Baycox® was given after the W4 sampling. At W8, about 3% of the goats were observed to be scouring. An egg count taken at this time indicated an average of 1,500 (predominantly eimeria oocysts). At a follow-up in W12 (four weeks after the experiment finished), less than 0.5% of the goats were scouring. An egg count taken at this time indicated an average of 950 per gram of faecal sample.

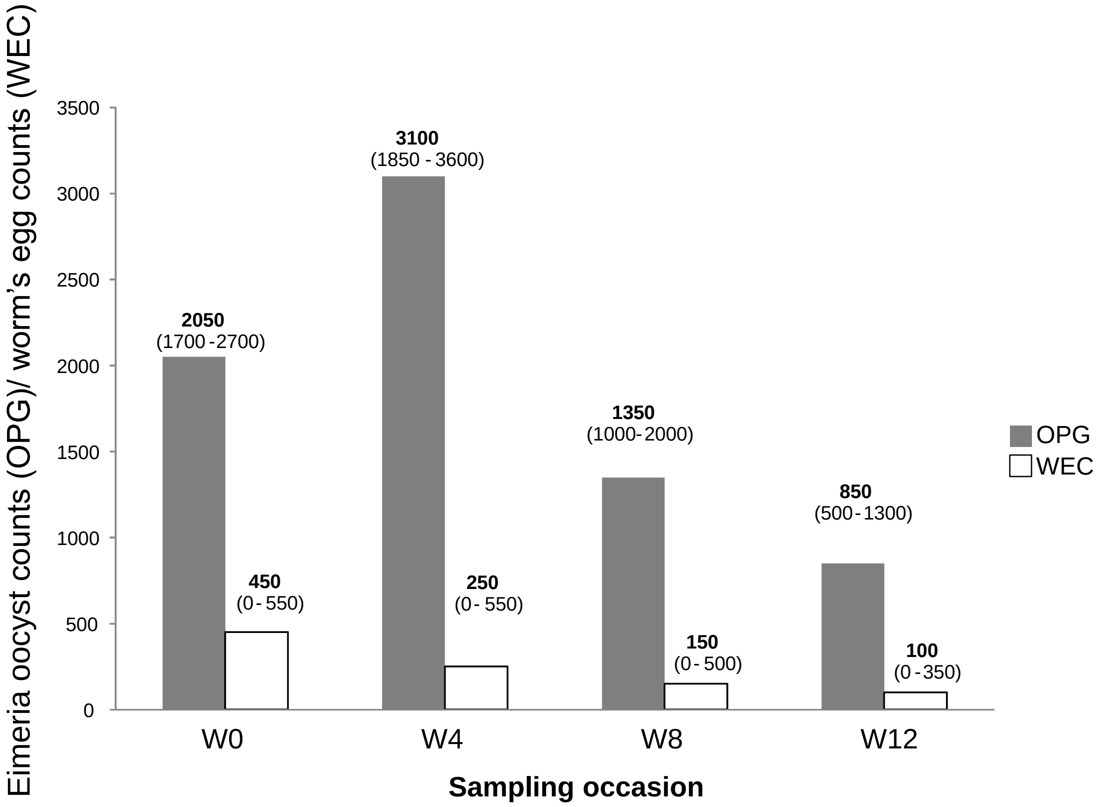

Figure 32: Eimeria oocyst counts per gram of faeces (OPG) and worm egg counts (WEC), as determined by microscopy, over the collection period, W0 to W12. Ranges are listed in parentheses

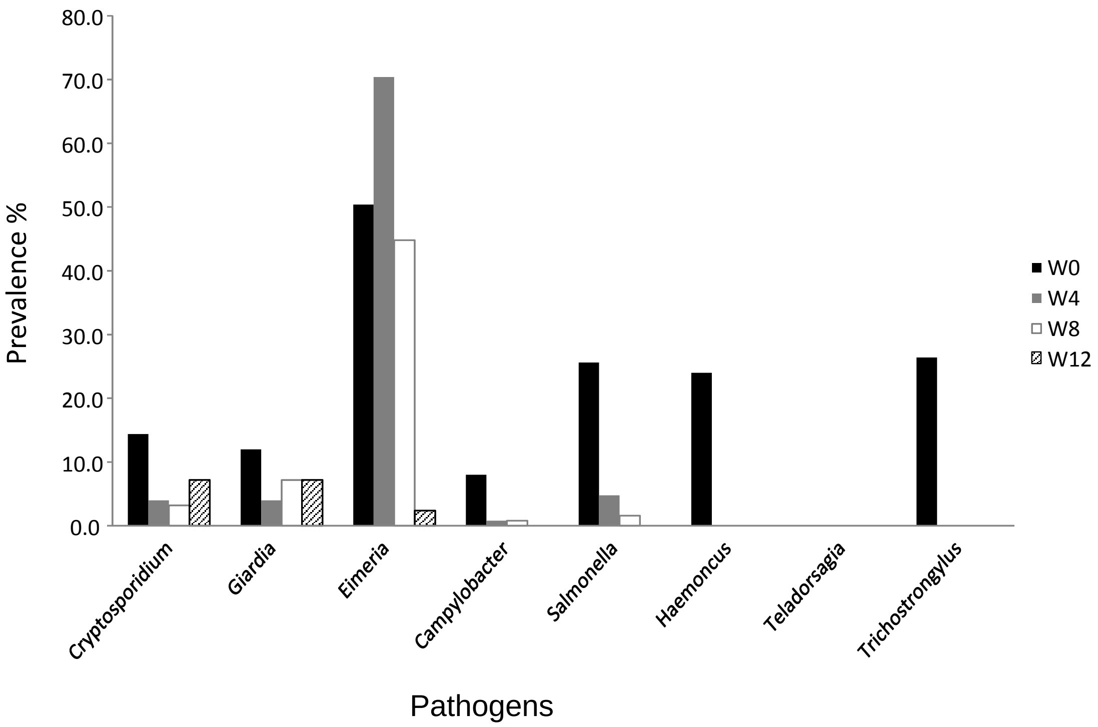

Figure 33: Prevalence (%) of enteric pathogens (trichostrongylus, teladorsagia, haemoncus, salmonella, campylobacter, eimeria, giardia, cryptosporidium) in Rangeland goats as determined by qPCR.

Prevalence of different enteric pathogens as determined by qPCR
Seven of the eight pathogens analysed were detected in the faeces, with only Teladorsagia not detected in the faeces at any of the sampling times (Fig. 33). Eimeria was by far the most prevalent pathogen detected in rangeland goats with an overall prevalence of 42.0% and a peak prevalence of 70.4% at W4 of faecal collection. The prevalence of Eimeria dropped to 44.8% during the third collection (W8) and 2.4% for the final collection (W12). The prevalence of Trichostrongylous and Haemonchus were 26.4% and 24.0%, respectively at W0, but were not detected for the subsequent sampling times. Salmonella and Campylobacter prevalence peaked at 25.6% and 8% respectively at W0, but the prevalence decreased in subsequent samplings. Cryptosporidium and Giardia prevalence was 14.4 and 12% respectively, at W0, and was 7.2% for both pathogens at W12. Co-infections with one or more pathogens were common (Table 7). The most common co-infections were with Eimeria and Trichostrongylus at W0, Eimeria and Salmonella at W4, Eimeria and Giardia at W8, and Cryptosporidium and Giardia at W12. The prevalence of multiple infections (protozoa, bacteria and worms) started at 52.8% at W0 and dropped to 12.0%, 7.2% and 4.0% for the subsequent samplings.

Table 7: Prevalence (%) of multiple infection, as determined by qPCR, and contribution of each enteric pathogen in rangeland goats over four sampling periods, W0 to W12. 95% confidence intervals are listed in parentheses

	Multiple infections	Two pathogens	Three pathogens	Four pathogens
W0	52.8 (47.8-58.5)	29.6 (23.1-32.9)	17.6 (15.8-21.4)	5.6 (3.4-7.9)
W4	12.0 (8.8-14.5)	10.4 (3.8-12.9)	1.6 (0.3-3.7)	0
W8	7.6 (4.9-9.4)	6.4 (4.5-11.2)	0.8 (0.4-1.6)	0
W12	4.0 (3.2-5.8)	4.0 (3.2-5.8)	0	0

4.4.4 Summary

Although the strategy of increased human interaction again demonstrated benefits in terms of animal performance and increased domestication (preparedness for live export), the level of mortality, and the lack of effect of domestication or diet on the rate of mortalities or enteric pathogen load indicates serious concern with pursuing strategies to enable rangeland goats to undertake long-haul voyages. The variation in mortalities seen in this project over the years that the trials have been conducted, along with the recent evidence of the enteric pathogen burden animals are carrying, suggests that if animals arrive at a depot with large burdens then the strategies to prepare them for live export may not reduce mortalities unless effective parasite control is undertaken, particularly to prevent coccidiosis.

The main control for coccidiosis is the Baycox® drench, which is not registered for goats in Australia. It appears from the trial data that Baycox® is not a suitable treatment to prevent mortality from coccidiosis in Rangeland goats in a feedlot scenario. Also, the cost of treatment with Baycox® (about $20 per animal in this trial), and the long withholding period (56 days) would preclude this as a viable option for most depot owners.

For the domestic market or chilled/frozen meat international market, results from this project provide beneficial management measures to increase production from rangeland goats. A practical investment in terms of increased human interaction with the goats produced increases in pellet acceptance, increased weight gain and decreased aggression amongst goats. Although death rates are still a major problem in this respect, with no effect of human interaction or pellet quality on mortality, the end result is a loss of income to the depot owner and reduced on farm animal welfare. However, a future effective low cost strategy to reduce parasite burdens would also benefit local production.

Unless there were alternative effective measures developed to combat coccidiosis and salmonella in rangeland goats, or perhaps a parasite screening step in the protocol, then our opinion is that ‘uneventful’ long-haul voyages for rangeland goats could not be guaranteed. Therefore, termination of investigations into preparation of rangeland goats for live export is suggested, and perhaps in the future consider investigating comparisons of alternative parasite controls.

4.5 Objective 2 summary

Experimental trials using entire male rangeland goats of about 12–18 months of age were conducted over four years at the property of Keros Keynes located near Geraldton in WA. Although various strategies, along with the management protocols highlighted in Objective 1, particularly increasing human interaction with the goats, demonstrated benefits in terms of animal performance and increased domestication (preparedness for live export), the level of mortality, and the lack of effect of domestication on the rate of mortalities (mainly due to coccidiosis), indicated serious concern with pursuing strategies to enable rangeland goats to undertake long-haul voyages.

If animals arrive at a depot with large parasitic burdens then the strategies to prepare them for live export may not reduce mortalities unless effective parasite control or screening is undertaken, particularly to prevent coccidiosis.

For the domestic or international (chilled/frozen meat) market, results from this project provide beneficial management strategies to increase production from captured Rangeland goats. A practical investment in terms of increased human interaction with the goats produced increases in pellet acceptance, increased weight gain and decreased aggression amongst goats. Mortality is still a major problem in these markets due to a loss of income to the depot owner and reduced on-farm animal welfare. However, a future effective low-cost strategy to reduce parasite burdens in captured wild goats would benefit producers.

5 Objective 3: Best practice guidelines

Based on outcomes of objectives one and relevant scientific literature develop and validate a quality assurance program for long haul goat shipments. The quality assurance program will include protocols, guidelines and Standard Operating Procedures (SOP's) throughout the supply chain from on farm through to receiving markets in the Middle East and South East Asia. It will involve three components:

a. Preparation of a draft framework for the publication of 'Best Practice Guidelines for preparation of non-domesticated goats for long haul voyages by sea'. The draft will:
    - Define the process of domestication for captured unmanaged wild goats.
    - Present recommendations for optimal nutritional management, pellet quality and susceptibility to disease.
    - Define procedures that negate dominance behaviour in unmanaged rangeland goats.
    - Present guidelines for on-farm handling of live export goats.
    - Present an economic evaluation (including benefit cost analysis) for implementation of guidelines (not completed).
    - Present guidelines of ideal health regimes (in conjunction with Murdoch Veterinarians) —vaccinations, parasite management, nutrition, electrolyte supplementation.

b. Validate Quality Assurance program developed in stage one by testing best practice guidelines in pre export facility. Testing will involve following a minimum of three sources of captured wild goats from on farm through to domestication at depot facility (as per draft best practice guidelines developed in stage one).
    - Stage 2 will be complete following successful validation of three different sources of goats. Sources of goats may come from one or more consignments.
    - Following validation provide draft quality assurance program including protocols, best practice guidelines and Standard Operating Procedures (SOP's) throughout the supply chain from on farm through to receiving markets in the Middle East and South East Asia.
    - Provide 3 x full day workshops for industry briefing and consultation prior to finalisation of best practice guidelines.
    - Provide full day workshop / briefing session for AQIS. Intention of workshop will be to demonstrate validation of Quality Assurance program achieved in stage one and present industry case for implementation of trial long haul voyages of successfully domesticated wild goats.

c. Subject to MLA, industry and AQIS approval validate stage one outcomes by implementing QA program on a long haul trial shipment of goats. Testing will involve following and reporting on outcomes of at least one consignment of captured wild goats from on farm through to receival in market.

This section of the report fulfils Objective 3a: however after milestone 5b [Objective 2] the NO GO decision was agreed upon in terms of further experiments (No Go decision supported by the Livestock Export R&D Committee in June 2014 and further supported by the full research committee on 15 July 2014). However, it was agreed to complete a Final Report based on the findings from Objectives 1 and 2, and to include a revised Best Practice Guidelines [Objective 3a]. Preparation of a draft framework for the publication of 'Best Practice Guidelines for preparation of non-domesticated goats for long haul voyages by sea'.

Because the draft framework for the 'Best Practice Guidelines' is designed as a stand-alone document, it repeats some material previously presented in this report. It uses information from experiments and analyses presented in this report, along with information previously supplied in a review for Meat & Livestock Australia and LiveCorp by Scott Williams, SED Consulting, in 2009 entitled *Preparation of goats for export*. Also, it must be noted as a caveat that because the NO GO decision was agreed upon after Objective 2, Objectives 3b and 3c were not carried out. Therefore, testing of the Best Practice Guidelines has not been completed.

5.1 Best Practice Guidelines for Preparation of Non-domesticated Goats for Long Haul Voyages by Sea'

5.1.1 Introduction

Since 2007, there have been no long-haul shipments of goats, due in part to an unacceptable degree of variation in performance between shipments. Much of this variation in performance can be explained by the type and source of the goat being shipped. If this variation can be overcome there are significant economic benefits to be gained (see Appendix 1: Economic Benefits of Long Haul Sea Transport of Live Goats, a net benefit analysis).

As a caveat, if export were re-instated it is likely that guidelines for preparation would be more onerous. The possible future adoption of these guidelines would also need to be commercially trialled before there was confidence that both animal welfare and the economic benefits meet expectations. Further the issue of management of parasitic burdens would also need to be resolved.

These draft guidelines have been developed to assist goat exporters to deliver healthy consignments of goats with a minimum of on-board mortalities. They are based findings and recommendations from experiments conducted in the report for Meat & Livestock Australia and LiveCorp by Dr David Miller in 2015 entitled *Preparation of rangeland goats for live export*, and from recommendations from a review for Meat & Livestock Australia and LiveCorp by Drs Simon More and Tony Brightling in 2003 entitled *Minimising mortality risks during export of live goats by sea from Australi*a and review for Meat & Livestock Australia and LiveCorp by Scott Williams, SED Consulting, in 2009 entitled *Preparation of goats for export*.

5.1.2 Selection of rangeland goats for export

Exporting country requirements

1. Ensure the goats sourced for export meet the requirements of the importing country.

Property of origin

2. Goats from extensive systems (especially captured rangeland goats) are more prone to disease and death during export than those from intensive production systems. They require very careful preparation before they are suitable to export. Prior to preparation, consideration of the property of origin should take into account factors such as capture methods, transport time, avoiding mixing of unfamiliar family groups, and time of year (parasite burden). See below for details.

3. You must obtain a National Vendor Declaration (NVD) identifying the property of origin of the goats and providing assurance that the goats are not within a treatment or grazing withholding period or export slaughter interval and have not been fed animal-derived products during their lives.

Age/period since weaning

4. Goat bucks of wild capture origin should not be exported by sea if they have a full mouth of incisor teeth, i.e. eight teeth (Fig. 1. Six-tooth bucks should also be avoided. These older bucks show a higher risk of mortality on-board export vessels.

Figure 1: Common dentition scoring of age for goats.

5. Goat kids must have been weaned at least 14 days before sourcing for export and must have a bodyweight of more than 22kg.

Sex and pregnancy status

6. Does should not be selected for export as slaughter animals as spontaneous abortions can occur. Although the ASEL standard requires only that does over 35kg destined for slaughter or feeding be pregnancy tested not-in-kid, this may reduce but not eliminate abortion problems, unless does of all sizes are pregnancy tested. There is insufficient information on sexual maturity and bodyweight in wild capture does to be sure that does will not be pregnant below a specified bodyweight.

7. Lactating does must not be exported unless they have young at foot, in which case they may be exported by air only. This is an ASEL standard.

Horns

8. Horned goats must comply with the ASEL standard.
   (a) are not turned in so as to cause damage to the head or eyes;
   (b) would not restrict access to feed or water during transport; and
   (c) Are no more than 15cms long and blunt or are no more than 22cm long with tips no more than 20cm apart.

General condition

9. Goats must comply with the standard for general animal health and welfare. This includes compliance with the relevant animal welfare code of practice. There is a national *Model Code of Practice for the Welfare of Animals – the Goat*.

10. Goats must not be exported unless they are in condition score 2 to 4 (scale 1-5) (Table 1; Fig. 2) and free from signs of disease.

Table 1: Body condition scores for goats

Score	Backbone	Short ribs	Eye muscle
1	Prominent and sharp	Ends are sharp and easy to press between, over and around	Thin, the surface tending to feel hollow
2	Prominent but smooth	Smooth, well-rounded ends — can feel between, over and around each smoothly	Reasonable depth with the surface tending to feel flat
3	Can be felt, but smooth and rounded	Ends are smooth and well covered — firm pressure is necessary to feel under and between short ribs	Full and rounded
4	Detectable with	Individual short ribs can	Full with a covering

Score	Backbone	Short ribs	Eye muscle
	pressure on the thumb	only be felt with firm pressure	layer of fat
5	Can be felt with firm pressure	Cannot be felt even with firm pressure	Muscle cannot be felt due to a thick layer of fat

BCS 1 **BCS 2** **BCS 4**

Figure 2: Example images of goats in body condition score (BCS) 1, 2 and 4 (left to right).

The other signs of rejection criteria include, but are not restricted to:

- Emaciated or over fat
- Diarrhoea (scouring)
- Anorexia (inappetence)
- Uncoordinated, collapsed, weak
- Unwell, lethargic, dehydrated
- Ill-thrift
- Lameness or abnormal gait
- Abnormal soft tissue or bony swellings
- Dysentery or profuse diarrhoea
- Bloat
- Nervous symptoms (head tilt, circling, incoordination)
- Abnormal or aggressive behaviour/intractable or violent
- Generalised papillomatosis or generalised ringworm, dermatophilosis
- Generalised and extensive buffalo fly lesions
- Generalised skin disease
- Visible external parasites
- Significant lacerations
- Discharging wounds or abscesses
- Blood/discharge from reproductive tract (vulva/prepuce)
- Blindness in one or both eyes
- Cancer eye
- Keratoconjunctivitis (pink eye)
- Excessive salivation
- Nasal discharge
- Coughing
- Respiratory distress — difficulty breathing

- Untipped sharp horns
- Horns causing damage to head or eyes
- Bleeding horn stumps
- Scabby mouth
- Mobs with unusual mortalities over the whole period of pre-export isolation
- Large disparities in size or age (re-draft animals in this case).
- Goats for export should also have a sound mouth.

5.1.3 Pre-embarkation preparation

It is critical that goats are accustomed to human presence and handling, fully adapted to eating a ship-board pellet diet and drinking from troughs before they embark. If they are not, on-board mortalities can be very high because the goats stop eating ('inanition') and are very susceptible to stresses. Stress rapidly leads to infections such as coccidiosis.

The evidence shows that pre-feedlot preparation is the most important part of the process of preparing goats for export.

11. Unmanaged goats should be captured in a manner that is as stress-free as possible because they are particularly susceptible to sudden death, lameness, bruising, injuries, chronic ill-thrift and/or infection resulting from acute stress and/or careless handling. Good capture management includes:
    - Mustering during periods of mild weather;
    - Droving slowly, at the speed set by the tail of the mob;
    - Allowing 24 hours' rest, with feed and water, before journeys of eight hours or more (or otherwise as specified by land transport regulations – see below);
    - Holding the goats in yards large enough to avoid crowding and with shade; and
    - Minimising the use of dogs.

Refer to 'Module 6 – Husbandry' in the MLA *Going into goats* guide for good advice on goat handling, available from the MLA website: www.mla.com.au.

Location of pre-embarkation premises

12. As far as possible, the pre-embarkation domestication process should take place in premises in a similar region to the property of origin.

Duration and general management of the pre-embarkation period

13. Previous ASEL requirements stated that goats should be accustomed to being handled and to eating and drinking from troughs for at least 21 days before transfer to the ship. However, this step in the export process should be dictated by the required outcome rather than a specific time period. Evidence suggests that 21 days with appropriate backgrounding and handling is sufficient to attain behavioural benchmarks (such as flight speed, aggression and eating behaviour) deemed as indicators of reduced stress. Further evidence suggests that goats arriving with, or acquiring, enteric pathogen burdens that can lead to ill thrift, don't display signs of

illness or high cases of mortality until 35 days or more in the pre-embarkation feedlot. However it is acknowledged that a set time period, albeit a 'blunt instrument', does allow auditing/monitoring systems to have a checkpoint. Future requirements may need to take this into consideration to impose a longer depot period (>35 days) before transfer to the ship.

High-quality backgrounding is described as an active rather than passive process: in other words, the goats should not simply be confined but should be handled as regularly as possible through activities such as drafting, weighing and drenching. Patience is a virtue. Check the goats daily by walking quietly amongst them for at least 20 minutes. Interactions with the goats should follow principles of low stress stock handling – refer to 'Module 6 – Husbandry' in the MLA *Going into goats* guide for good advice.

When goats are adequately domesticated they should not take undue fright when people walk amongst them. They should also be eating and drinking from troughs. Benchmarks for some behavioural and performance indicators were detailed in the report for Meat & Livestock Australia and LiveCorp by Dr David Miller in 2015 entitled *Preparation of rangeland goats for live export* (see below). These benchmarks, which were designed for goats destined for long haul live export, may equally be applicable for general health and welfare of non-exported goats.

The benchmarks indicated minimum standards to be achieved for:

- Live weight / body condition score (BCS) - must not lose weight (>10%) and/or condition (>0.5 condition score) in two consecutive weeks prior to (potential) transport.
- Mortality – the rate of deaths must not exceed 1% per week.
- Feed (pellet) intake – at least 50% of animals must be observed eating the a pelleted diet similar to what they would encounter on ship
- Agonistic behaviour – using sub-samples of animals to form a test group, and placing them in a confined pen, the number of agonistic contacts must not exceed 10 in a two minute period immediately after confinement.
- Flight speed - using a sub-sample of animals to form a test group, the group flight speed must not exceed 1.5m/s over the first 10 metres (i.e. total time must be over 7 seconds per 10 m) on release from a pen or race with a human present in it.

In this report an investigation into Qualitative Behavioural Assessment (QBA) as a tool to indicate readiness to export (domestication) was assessed. QBA has emerged as a scientifically validated method for quantifying the behavioural expression of an animal which reflects its psychological as well as physical state. The principal of QBA draws upon good stock-person skills of observation, hence reinforcing the value of checking goats regularly, i.e. if something "*doesn't look right*" trust your instincts.

14. Goats that do not adapt to confinement should be humanely put down. This includes goats that do not eat hay or pellets for three to four days. Recommended methods for humane destruction of goats are outlined in the *Model Code of Practice for the Welfare of Animals – the Goat.* http://www.dpi.nsw.gov.au/agriculture/livestock/animal-welfare/codes/national

15. Aggressive or dominance behaviour can be a problem for intensively managed goats. There are benefits of segregation based on weight, sex and age, and removal of either overly aggressive animals or those who are particularly bullied.

A possible management tool that might be considered to lessen the social stress associated with aggression between male intact goats is the use of the anti-GnRH vaccine Improvac®. This vaccine has been shown to decrease agonistic behaviour in male rangeland goats, and therefore should be investigated for use with veterinary advice, and if cost effective, as part of a domestication protocol or on-board to minimise dominance behaviour in bucks. Improvac® is currently registered for use in pigs with a protocol of an initial vaccination followed by a booster after a 28 day interval, and a ‘zero day’ withholding period. This product and its protocol have been proven to be effective in goats (Bishop *et al.* 2015).

Nutrition

16. Provide ready access to water at all times.

17. Where goats have been captured from unmanaged systems, provide feed of a type that is readily accepted – especially natural scrub and other roughage such as hay. Access to browsable material is desirable because it permits normal behaviour. The goats will need to adapt to a feedlot ration but this must be a gradual and planned process of about 3 weeks, so initially roughage and pellets should be offered together with the roughage slowly decreased over the first few weeks based on evidence by regular monitoring of the majority of goats eating the pellets.

18. Evidence suggests that offering a better nutritional quality pellet has no effect on behavioural or performance indicators of readiness to export. Therefore, a pellet of similar nutritional value and conformation to that offered on-board ship should be chosen. As a guideline, Dr John Milton from Independent Lab Services designed the following pellet ration that was successfully trialled in the report for Meat & Livestock Australia and LiveCorp by Dr David Miller in 2015 entitled *Preparation of rangeland goats for live export.*

    Per tonne: 270kg Wheat Seconds, 160kg Lupins, 155kg Oat husks, 170kg Lupin straw, 170kg Barley straw, 32kg Canola seconds, 20kg Watheroo Bentonite, 6.0kg Salt, 5.0kg Ground limestone - at least 30% Calcium, 5.0kg Gypsum – at least 17% Sulphur, 4.0kg Acid buff, 2.0kg Di-Calcium Phosphate, 1.0kg Lamb TMV (from Advanced Feeds P/L), 200 grams Rumensin-100 to provide 20 grams of Monensin Sodium.

    Providing: 12% crude protein, 3.4% fat, 10 MJ/kg DM metabolisable energy.

19. The use of experienced *mentor* or *trainer* goats may be beneficial. Introducing into a flock a small number of experienced goats that have been accustomed to the feedlot environment has been shown to be useful in encouraging goats to explore and sample the foreign feed and water

sources. Care needs to be taken to select experienced goats of similar sex, age and size as the majority of the flock so that dominance issues don't arise.

Treatments

20. All goats should be vaccinated against clostridial diseases, enterotoxaemia (pulpy kidney), and tetanus and treated for internal and external parasites, including coccidia, at the start of the pre-feedlot period. If goats have not previously been vaccinated they should receive two doses four to six weeks apart. If they have previously been vaccinated, a booster dose is advised.

    Refer to 'Toolkit 6 – Husbandry' in the MLA *Going into goats* guide for further information about vaccination.

    It is also recommended (see 21) that the goats be given an anthelmintic for parasites, particularly to control *haemonchus*, *teladorsagia* and *trichostrongylus* species.

    As for the method to control *eimeria* (coccidiosis), the method used in the experiments is described in the report for Meat & Livestock Australia and LiveCorp by Dr David Miller in 2015 entitled *Preparation of rangeland goats for live export.* The main control for coccidiosis is the anti-coccidial Baycox® (Toltrazuril) drench, which is not registered for goats in Australia. However, evidence suggests that Baycox®, using the suggested protocol for sheep, is not a suitable treatment to prevent mortality from coccidiosis in rangeland goats in a feedlot scenario. Also, the cost of treatment with Baycox® (about $20 per animal), and the long withholding period (56 days) would preclude this as a viable option for most depot owners.

    An alternative for coccidiosis control are the various sulphonamide products available, again not registered for goats. There are reports that these are useful, however an Australian Pesticides and Veterinary Medicines Authority (APVMA) review found was that historically recommended dose rates for oral treatment of coccidiosis in sheep with sulfadimidine have varied markedly.

    Generally, for *eimeria*, *salmonella*, *giardia* and *cryptosporidium* control, methods to minimise the following predisposing factors should be adhered to:

    - Minimise stress (environmental, nutritional and management)
    - Avoid overcrowding of goats in damp conditions where food and water are liable to faecal contamination.
    - Provide feed and water troughs in which goats cannot defecate.

21. Where possible, it is advised that a faecal worm egg count (WEC) be conducted on the animals on arrival at the goat depot and be used as a management tool. There are numerous service providers in each state that can carry out this service, or there are courses for producers in each state, such as that run by the NSW Department of Primary Industries

(http://www.dpi.nsw.gov.au/agriculture/profarm/courses/faecal-egg-counts).

22. You must keep records of any treatments applied to goats prior to export, including vaccines, for at last two years after the date of export.

5.1.4 Land transport to embarkation point

General standards

23. Ensure the land transport of export goats meets the requirements of the importing country.

24. As a minimum, you must observe the livestock transport requirements of your state/territory.

    Ensure that the transporter observes the standards of the relevant state / territory regulations. These include the requirement for a travel plan, maximum water deprivation and minimum rest times, curfews, loading densities and ensuring fitness for travel.

Protection from cold stress

25. Goats are particularly susceptible to cold stress. Goats should not be moved during cold or wet weather except in a covered crate. Endeavour to transport goats, especially rangeland goats, from pastoral areas to southern export points during warmer months only.

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7 APPENDIXES

7.1 Appendix 1: Economic Benefits of Long Haul Sea Transport of Live Goats, a net benefit analysis

7.1.1 Summary

The Department of Agriculture and Food (DAFWA), Meat and Livestock Australia (MLA) and Murdoch University worked together on a project 'W.LIV.0159 – Preparation of Rangeland Goats for Live Exports' to revive the animal transport by sea on voyages above 10 days duration.

The Australian live goat industry suffered a major setback following the Keniry Review on Livestock Exports as a result of which long haul live goat exports were restricted by Australian Quarantine and Inspection Service (AQIS) and since 2007 there has been a complete suspension of long haul goat exports. Live goat exports from Australia fell from a high of 136,125 goats in 2002 to 77,414 goats in 2010. The existing suspension of long haul goat exports has affected the number of markets into which Australian goat exporters can export. The existing regulation limits export voyage time to ten days hence limits the live goat industries marketing options.

Currently 98 per cent of goat exports are exported by air transport to predominantly Asian markets with Malaysia being a significant importer. However prior to the suspension of long haul goat exports, Australian exporters were well positioned to export to the Middle East and to other markets.

A number of initiatives have been put forward to address the incidence of high mortality rates for live animal exports. The goat industry is also looking at exporting domesticated goats instead of rangeland goats. These initiatives are expected to reduce the mortality rates of live animal exports.

It is against this background that a DAFWA economist has been requested to conduct a net benefit analysis (NBA) to assess the post farm gate live export implications of the re-establishment of long haul live goat exports. In completing the NBA, three options were analysed:

- Option 1: The business as usual case in which a total of 1.77 million live goats are expected to be exported for the 20 year period using air transport to existing markets.
- Option 2: A total of 2.78 million live goats are expected to be exported for the 20 year period to existing and new markets by sea transport.
- Option 3: This option is similar to Option 2 in that a total of 2.78 million live goats are expected to be exported for the 20 year period. However the analysis assumes that over the 20 year period, 45 per cent of the live goats are exported by air to existing markets with the remainder exported by sea to new markets.

The table below summarises the results from the analysis. Net benefits are defined as net costs savings, that is, difference between Option 1 and Option 2 costs and difference between Option 1 and Option 3 costs.

Over the 20 year period, the re-establishment of long haul live goat exports will result in average net benefits of $15.76 per goat in Option 2 and $8.31 per goat in Option 3.

Table 1: Net project benefits

	Net average benefits per goat	Aggregate net benefits
Option 1	$-	$-
Option 2	$15.76	$43,791,652
Option 3	$8.30	$23,082,750

The most benefits are attained if all goats are exported by sea, (Option 2) rather than if air and sea transport are used (Option 3). This is because the sea freight charges are cheaper than the air freight charges despite the additional costs of feed and the high risk of mortality associated with sea freight.

The benefits from re-establishing long haul goat exports are driven by scale and market access economies. Scale efficiencies are achieved by exporting more goats using existing facilities hence reducing the unit cost per head. The market access economies are achieved by using sea transport which has lower unit costs per goat when compared to air transport.

7.1.2 Introduction

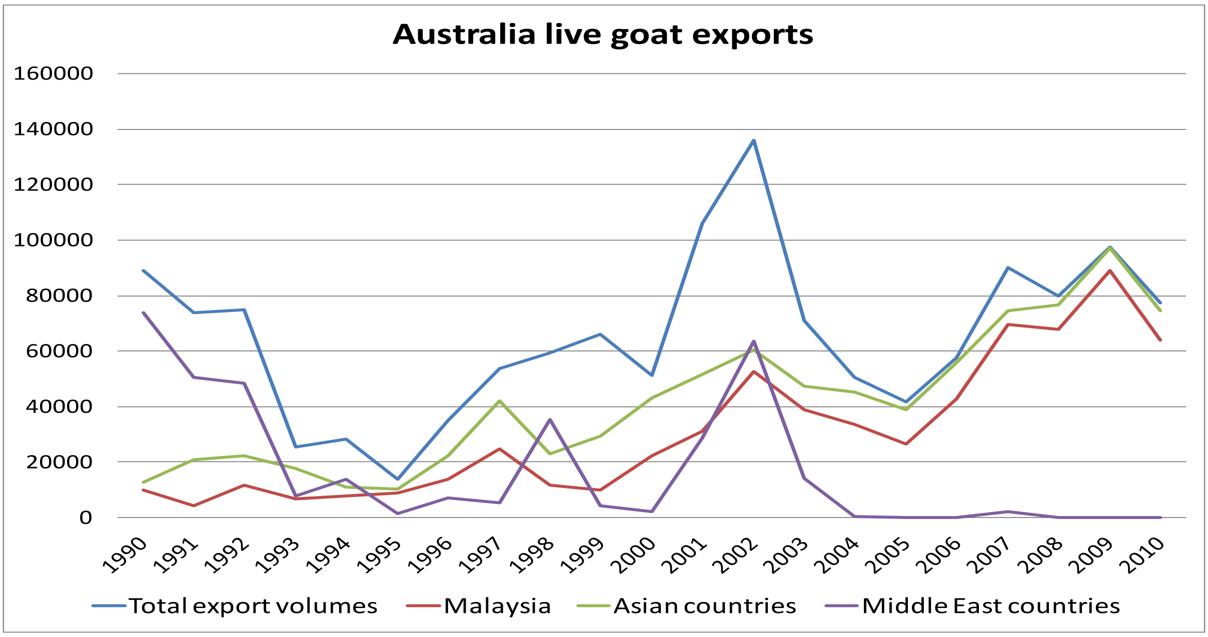
DAFWA, MLA and Murdoch University worked together on a project 'W.LIV.0159 – Preparation of Rangeland Goats for Live Exports' to revive the transport of goats by sea on voyages above 10 days duration.

The project is in line with the DAFWA's strategic investment priority of Improving markets and trade.

The Australian goat Industry suffered a major setback following the recommendations from the Keniry Review in 2003. The Review was prompted by animal welfare issues arising from the Cormo Express Incident in which a shipload of sheep to Saudi Arabia was rejected on grounds that 6 per cent of the sheep were infected by scabby mouth. The sheep consignment spent 80 days on voyage before it was accepted by Eritrea. This led to 9.82 percent mortality. As a consequence to the incident and the review, long haul shipments were restricted by AQIS and in 2007 there has been a complete suspension of long haul goat exports. The existing regulation limits export voyage time to ten days hence limits the live goat industries marketing options.

Following the Cormo incident, goat exports from Australia fell from 136,125 goats in 2002 to 77,414 goats in 2010. Currently 98 per cent of goat exports are exported by air transport to predominantly Asian markets with Malaysia being a significant importer. However prior to the suspension of long haul goat exports, Australian exporters were positioning themselves to export increasing numbers of live goats to the Middle East and to other markets.

Figure 1 summarises the historical data for live goat exports from Australia. Malaysia and the Middle East countries have been historically the main destinations for Australia's live goat export. Following the Cormo Express incident in 2003, exports to Middle East countries have declined to zero.



Source: LiveCorp Goat Statistics

Figure 1: Australia live goat exports

In recent years, most of the live goats have been exported to Malaysia. This trend has been guided by industry regulation that restricts exports of goats by sea to a maximum of ten days. In 2010, 77,414 goats were exported out of Australia. 96.4 per cent was exported to Asian countries with Malaysia importing 64,075 goats. Singapore and Brunei are the other markets for Australian goats.

In recent times, several reports have been commissioned by MLA, to identify factors that may contribute to the reporting of incidence of high mortality rates for live goat exports. In response to these reports, MLA set out a program to review the scientific information and consult with industry stakeholders about the opportunity to restore long haul voyages of live goats and consider strategies to overcome the prevailing issues that currently constrain this trade.

7.1.3 Net Benefit Analysis

Net Benefit Analysis Methodology

The methodology adopted in conducting a NBA is summarised in Figure 2 below.

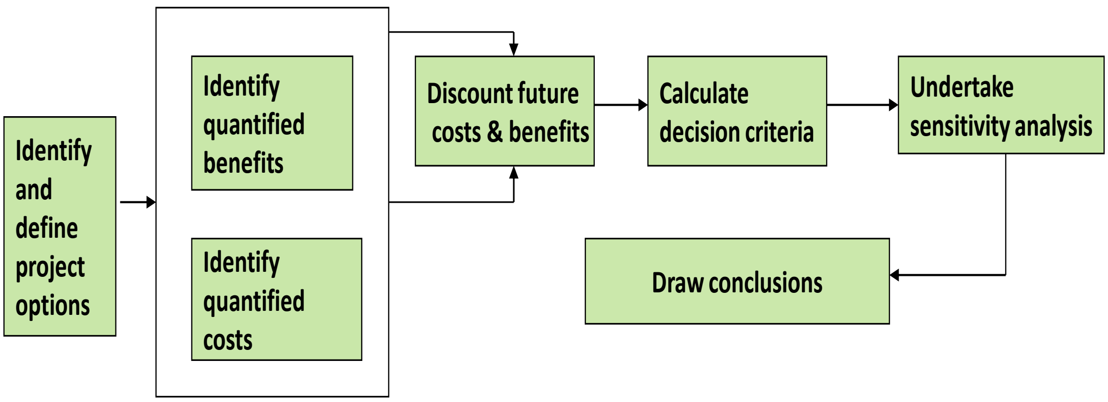


Figure 2: Net Benefit Analysis Methodology

Each of the items are discussed in the following sections

Net Benefit Analysis Options

Table 2 gives a description of the options that were analysed in the NBA

Table 2: Net Benefit Analysis Options

Option	Description
Option 1	• Short haul goat exports by air transport to Malaysia • Assume export volumes are similar to 2010 volumes

Option 2	• Long haul goat exports using sea transport to the identified markets.
	• 3 Markets are analysed,
	  • Market 1 - Asian markets with journey time less than 10 days
	  • Market 2 - Middle East markets with journey time between 10 and 20 days
	  • Market 3 - markets with journey time greater than 20 days
	• Assume export volumes are similar to Pre 2003 Cormo Incident volumes.

Option 3	• Mixture of short and long haul goat exports using air and sea transport to identified markets.
	• 3 markets are analysed,
	  • Market 1 - Asian markets with journey time less than a day
	  • Market 2 - Middle East markets with journey time between 10 and 20 days
	  • Market 3 - Other markets with journey time greater than 20 days
	• Assume export volumes are similar to Pre 2003 Cormo Incident volumes.

7.1.4 Benefits and Costs

Project benefits
No pure benefits have been analysed. Net cost savings are used as a measure of benefit.

Project costs
Capital expenditure
There is no planned capital expenditure in the project case. During the Pre Cormo period, export goats used the same trucking, depots and AQIS accredited centres as the live export sheep industry. Hence the assumption is that the existing facilities are capable of handling the anticipated growth in exports.

Export logistics costs
Export logistics costs have been categorised into five cost elements. By so doing the cost implications of re-establishing long haul exports and increasing export volumes can be clearly analysed. These are:

- Pre-departure costs which include all quarantine charges, health protocol and treatment and export levy.
- Freight charges which is the cost associated with air or sea freight
- Feeding costs which are the costs of feeding the live animal during transport by air or sea.

- Mortality costs which are the costs associated with mortalities from air or sea transport.
- Other voyage costs which include stockman charges and insurance costs associated with air or sea freight.

Assumptions

Key modelling assumptions
These are outlined in Table 3 below.

Table 3: Key modelling assumptions

Item	Assumption
Key drivers	• Re-establishment of long haul goat export • Increased annual goat exports to levels seen Pre- 2003 – 100 000 goats.
Analysis commencement period	2011
Term of the analysis	20 years
Discount rate	7%
Farm gate goat price	$57.50
2011 export volumes ^	Option 1 - 78, 390 Option 2 - 100, 000 Option 3 - 100, 000

Notes: ^2011 export volumes for Option 1 are based on actual 2010 export volumes plus 1.3 per cent historical growth rate.

Farm gate price is used to estimate mortality costs. The cost estimate is taken to be the average of $55 per goat and $60 per goat.

Forecast export volumes
The net benefit analysis relies on historical growth rate to estimate the net benefits of the re-establishment of long haul goat exports. Figure 3 shows the expected trend in export volumes based on the estimated historical growth rates.

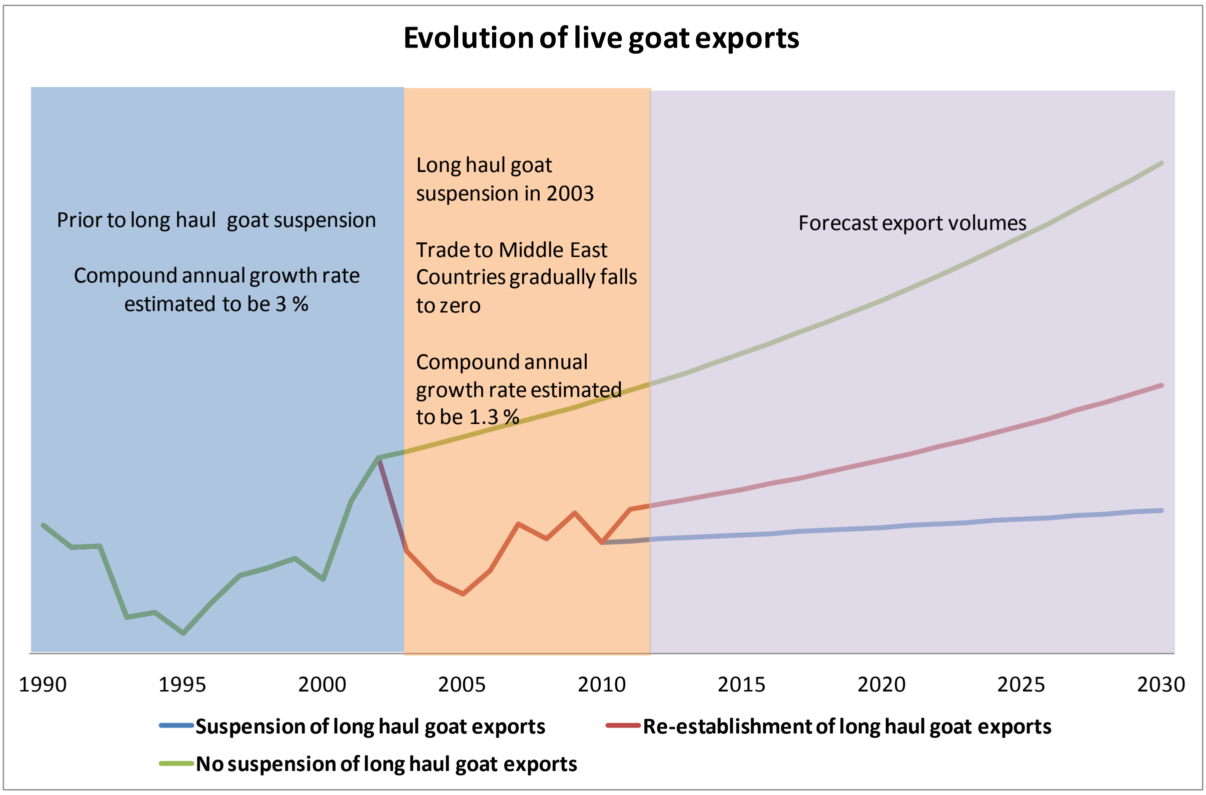


Figure 3: Evolution of live goat exports

The estimated compound annual growth rates are applied to base year numbers to obtain estimates of forecast export volumes.

For Option 1, the compound annual growth rate that is applied is 1.3 per cent. The assumption is that export volumes will continue to grow at the same rate as they have been following the suspension of long haul live goat exports.

For Option 2 and Option 3, the compound annual growth rate that is applied is 3%. In these options, the assumption is that long haul live goat exports is re-established and growth is similar to prior the suspension of long haul goat exports.

Distribution of trade between markets over time

Table 4 below shows the distribution of trade between the different markets following the re-establishment of long haul goat exports.

Table 4: Distribution of trade between markets over time.

Market	2011-2020	2021-2030	2031-f
Existing market	100%	100%	100%
Market 1 and 1A	50%	45%	38%
Market 2	25%	27.5%	31%
Market 3	25%	27.5%	31%

Source: DAFWA

In Option 1, 100 per cent of the trade goes to existing markets for the 20 year analysis period.

In Option 2 and Option 3, three separate markets are identified. Market 1 and 1A, trade is mainly to Asian markets. The difference is on the mode of transport in which case Market 1 export is by sea and in Market 1A export is by air. The share of export volumes for 2011 is based on the average historical market share to Asian countries before the suspension of long haul live goat exports.

Market 2 and Market 3 goats are exported to Middle East and other countries. The share of export volumes for 2011 is the remainder of the export volumes shared equally between the two markets.

For the 20 year analysis period, the analysis assumes there is trade redistribution amongst the identified markets which captures a possible decline in one part of the market and or growth in other markets as a result of the reestablishment of long haul live goat exports. The impact of this trade redistribution is assumed to be insignificant because in aggregate terms export volumes are increased.

Mortality rates
This analysis uses historical data associated with different journey times to estimate the mortality costs for each option. The DAFWA data is available from 1993 to 2010 for different markets. Table 5 below summarises the mortality rates used in the analysis. The rates remain fixed throughout the project period with annual changes in export volumes driving the change in mortality.

Table 5: Mortality rates

Market	Journey time period	Assumption
Existing market & Market 1A	1 day or less	0.004%
Market 1	Between 1 day and 10 days	1.454%
Market 2	Between 10 days and 20 days	1.949%
Market 3	Greater than 20 days	2.148%

Source: Greg Norman, DAFWA

Export logistics costs per goat
The logistics costs used in the analysis are summarised in Table 6 below.

Table 6: Export logistics costs per goat

Market	**Air transport**	**Sea transport**
Pre departure costs		
Quarantine agistment, feeding and drenching, etc	$6.00	$6.00
Health protocol and treatments	$6.00	$6.00
AQIS Charges	$0.22	$0.22
Export Levy	$0.50	$0.50
Land transport	$1.20	$1.20
Freight charges	$67.00	$35.00
Feeding costs^	$0	$0.57
Other voyage costs		
Stevedoring and port charges	$0	$0.70
Insurance and finance	$0	$1.00
Stockman charges	$0	$0.45

Notes: Source: Garry Robinson, Wellard Rural Exports
^Feeding costs are in per goat per day basis.

7.1.4 Results

Undiscounted annual cost estimates
Figure 4 shows the actual annual costs for each of the options. Freight charges, feeding costs and mortality costs are the major cost items and are presented in the chart.

Freight charges
Option 2 has the least compared to Option 1 and Option 3. Freight charges for Option 3 are slightly lower than the Option 1 charges indicating that for Option 3, air freight charges for the 45 per cent of exports are significantly high compared to the sea freight charge for the remaining 55 per cent of exports.

Feeding costs
Option 1 has none and, as expected, Option 2 incurs more feeding costs than Option 3 because all the exports are transported by sea.

Mortality costs
Mortality in Option 1 is significantly lower, ranging from $165 to $210 over the 20 year period. Mortality costs in Option 2 are greater than those in Option 3 because of the higher risk of mortality associated with all exports being transported by sea transport compared to mixture of air and sea transport. Total costs over the 20 year period show that Option 2 has the lowest annual costs.

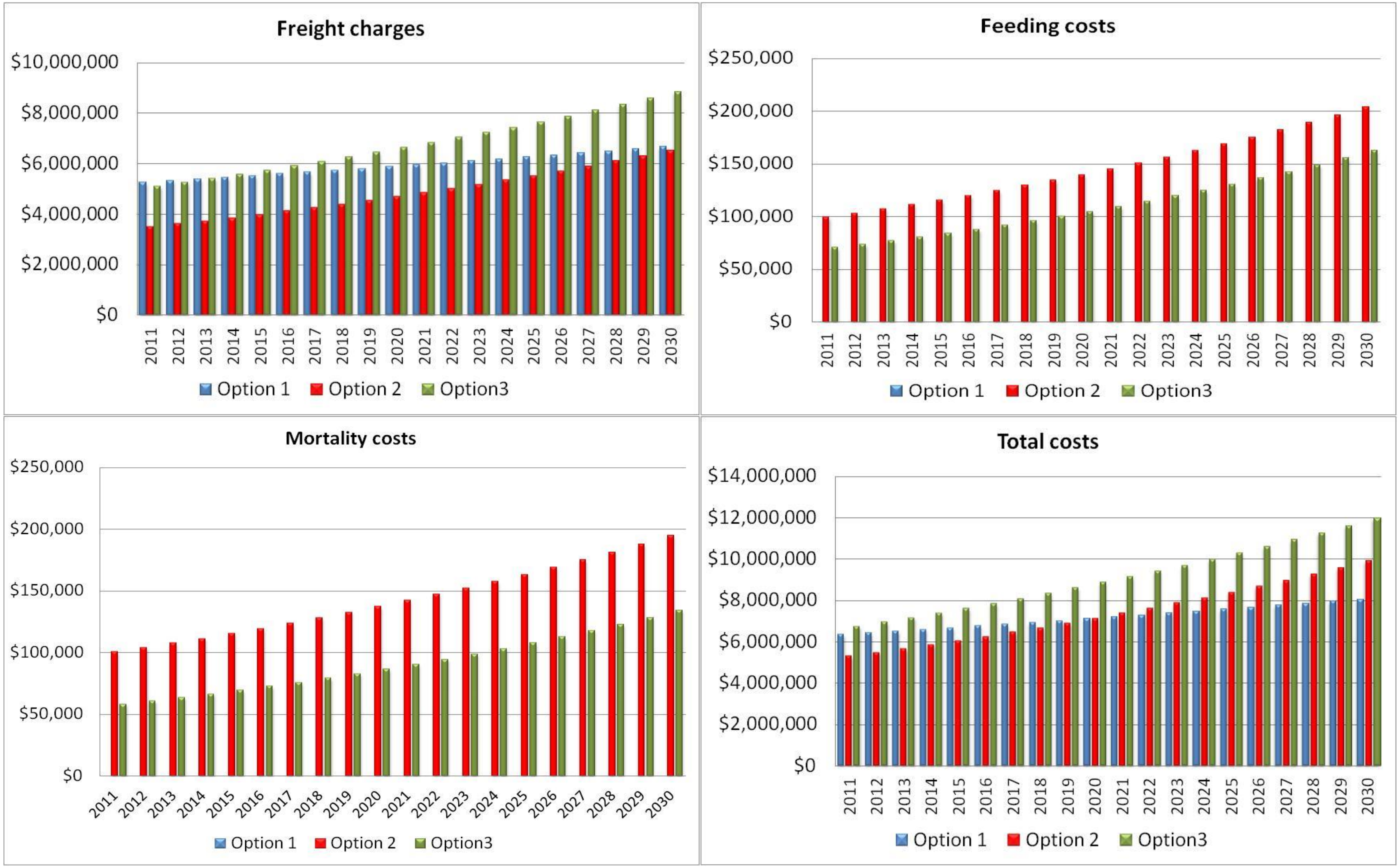


Figure 4: Annual undiscounted export logistics costs

Aggregate Present Value Costs
Table 7 shows the aggregate present value costs and the cost per goat for the three options. Looking at the aggregate costs, Option 3 has the highest cost over the period of analysis while Option 2 has the least costs. The main reasons why Option 3 has the highest cost relate to increased export volumes when compared to Option 1 and the use of air transport to export more than 45 per cent of the export volumes.

The cost per goat however shows that both Option 2 and Option 3 have the least cost per head, with costs per goat of $30.11 and $37.56 respectively.

Table 7: Aggregated Present Value Costs

	Present Value Cost per goat	Present Value Costs
Option 1	$45.87	$79,001,518
Option 2	$30.11	$77,737,116
Option 3	$37.56	$96,714,754

Net Benefits
Since all the project benefit items are the result of cost reductions relative to the business as usual case (Option 1), costs from Option 2 and Option 3 are subsequently subtracted from Option 1 costs to determine the level of benefits attributable to the re-establishment of long haul live goat exports.

In Table 8, the average benefit to exporters from the re-establishment of long haul goat exports is $15.76 per goat in Option 2 and $8.31 in Option 3. This translates to aggregate benefits of between $18.6 million and $35.3 million over the 20 year period.

Table 8: Net Project Benefits

	Net average benefits per goat	Aggregate net benefits
Option 1	$-	$-
Option 2	$15.76	$43,791,780
Option 3	$8.31	$23,082,750

Sensitivity Tests
Sensitivity tests were conducted to assess how changes in key analysis drivers could affect the net benefits of the re-establishment of long haul goat exports. Two assumptions were altered, the export volumes and the mortality rates.

<u>Export volumes</u>
Two scenarios were tested, a less than anticipated increase in export volumes or significantly high export volumes. The results are shown in Table 9 below.

Table 9: Sensitivity test on export volumes

	Decrease by 20%		Increase by 20%	
	Net average benefit per goat	**Aggregate net benefits**	**Net average benefit per goat**	**Aggregate net benefits**
Option 2	$15.76	$35,033,322	$15.76	$52,549,983
Option 3	$8.31	$18,446,200	$8.31	$27,699,301

The sensitivity test on export volumes shows that the net benefit per goat remains constant when export volumes are decreased or increased. However the aggregate net benefits over the 20 year period decreases or increases by $8.8 million in Option 2 and $4.7 million in Option 3 following a decrease or an increase in export volumes.

<u>Mortality rate</u>
Two scenarios were tested, a decrease in mortality rate by 20% and an increase in mortality rate by 20% (e.g. in Market 3, 20% adjusted up and down, respectively, mortality rates of 1.718% and 2.578%). The results are shown in Table 10 below.

The sensitivity test on mortality rate shows that the net benefit (net cost savings) from the re-establishment of long haul live goat exports increases when the mortality rate is reduced by 20 per cent. In Option 2, the net benefits are $15.87 per goat, which is an 11 cents increase. In Option 3 the net benefits are $8.38 per goat, which is an 8 cent increase.

If on the other hand, there is higher than expected mortality, then the net benefits decrease by 11 cents in Option 2 and by 8 cents in Option 3.

Table 10: Sensitivity test on mortality rate

	Decrease by 20%		Increase by 20%	
	Net benefits per goat	**Aggregate net benefits**	**Net benefits per goat**	**Aggregate net benefits**
Option 2	$15.87	$44,112,249	$15.64	$43,471,056
Option 3	$8.38	$23,281,960	$8.23	$22,883,541

7.1.5 Conclusions

The net benefit analysis was conducted to assess the post farm gate live export implications of the re-establishment of long haul goat exports.

It should be noted that this net benefit analysis does not address or investigate the additional costs associated with the proposed changes to the Best Practice Guidelines if export were re-instated, and also the flow on effects to other players in the goat industry supply chain and or the effects to other livestock industries that could result from the re-establishment of long haul goat exports.

Within the analysis which was undertaken, three options were analysed,

- Option 1: The business as usual option in which close to a total of 1.77 million live goats are expected to be exported for the 20 year period using air transport to existing markets.
- Option 2: In this option, a total of 2.78 million of live goats are expected to be exported for the 20 year period to existing and new markets by sea transport.
- Option 3: This option is similar to Option 2 in that a total of 2.78 million of live goats are expected to be exported for the 20 year period. However the analysis assumes that over the 20 year period, 45 per cent of the live goats are exported by air to existing markets with the remainder exported by sea to new markets.

The caveat to the above options is that the costs associated with proposed changes to previous pre-export management, that were highlighted in the draft Best Practice Guidelines in this document (Objective 3), were not incorporated into the economic net benefit analysis, and if incorporated would likely reveal a less attractive economic proposition for the export of captured goats.

Over the 20 year period, the re-establishment of long haul live goat exports will result in average net benefits of $15.76 per goat in Option 2 and $8.31 per goat in Option 3. The most benefits are attained if all goats are exported by sea (Option 2) rather than if air and sea transport are used (Option 3). This is because the sea freight charges are cheaper than the air freight charges despite the additional costs of feed and the high risk of mortality associated with sea freight.

The benefits from re-establishing long haul goat exports are driven by scale and market access economies. Scale efficiencies are achieved by exporting more goats using existing facilities hence reducing the unit cost per head. The market access economies are achieved by using sea transport which has lower unit costs per goat when compared to air transport.

Changes in export volumes have no impact on the net benefit per goat however they affect the aggregate net benefits over the analysis period.

Changes in mortality rates increases or decreases net benefit per goat by 8 cents and 11 cents.

7.2 Appendix 2: Livestock Production Assurance record keeping requirements

Livestock Production Assurance (LPA) is a simple on-farm food safety program which enables producers to back up claims made on the LPA National Vendor Declaration and Waybill (LPA NVD/Waybill). When a producer signs an LPA NVD/Waybill, they are showing their compliance with LPA.
Key aspects of management that should be recorded through LPA and are required for the certification of an Approved Property for the live export are:

- **Livestock treatments** - Including date, identification of mob, number of stock, product, batch number, expiry date, withholding periods (WHP) and export slaughter intervals (ESI) and date safe for slaughter.
- **Grain and fodder treatment record** - Including date, silo/storage identification, amount, product, batch number, expiry date, WHP/ESI and date safe for use.
- **Crop, pasture and paddock treatment record** - Including date, paddock identification, area, product, batch number, application rate and method, expiry date/ date of manufacture, WHP/ESI, and the date paddocks are safe to graze.
- **Record of purchased or introduced livestock** - Keeping the sender copy of the LPA NVD/Waybill, which records the date, LPA NVD/Waybill number, number of stock, identification, breed, sex, age, agent/sale, vendor (name and address) and Property Identification Code (PIC).
- **Livestock feeding record** - Including date, commodity vendor declaration (CVD) number, origin of feedstuff, description of feedstuff, amount, storage location, identification of livestock fed and time of feeding (start and finish dates).
- **Records of livestock sold** - Copies of the LPA NVD/Waybill showing the date, LPA NVD/Waybill number, number of stock, identification, breed, sex, age, purchaser/ agent/ sale, date and time of yarding, transport company and vehicle registration number.
- **Property risk assessment** - Property risk assessment report and a record of possible contaminated sites, the reason or risk identified, results received (if soil samples were conducted), description of how the site is managed to eliminate the risk of livestock contamination.

7.3 Appendix 3: Management protocols

Management protocols for the preparation of domesticated goats for the purposes of long-haul live export

Introduction

Only domesticated goats according to the definition of a *domesticated goat for the purposes of long-haul live export* may be considered for long-haul live export. All other goats, including wild captured or rangeland goats, must not be live exported via long-haul transportation.

These management protocols have been developed to assist supply chain participants in the management and preparation of domesticated goats for the purposes of long-haul live export. They are intended to complement rather than replace the following and should always be considered in conjunction with:

- State and territory requirements for land transport;
- The *Australian Standards for the Export of Livestock (Version 2.3) 2011*[2] (ASEL);
- The *Australian Animal Welfare Standards and Guidelines for the Land Transport of Livestock;* and
- Any requirements of the importing country.

Definition

A **domesticated goat for the purposes of long-haul live export** is one which complies with each and all of the following:

a) Displays the distinct characteristics of a recognised breed and whose pedigree can be demonstrated to be at least a first cross (F1) of that breed.

b) Has been born and raised on the property of origin and subject to *animal husbandry* since birth;

c) Has been ear tagged for the purposes of whole-of-life traceability on the property of birth;

Protocols

1. Validation of breed

The goats intended for long-haul live export must display the distinct characteristics of a recognised breed and be of a pedigree that can be demonstrated to be at least an F1 (*table 1)* of that breed.

A recognised breed is a breed for which standards have been developed, usually by a breed society (*table 1*).

[2] Australian Government Department of Agriculture, Fisheries and Forestry (2011), *Australian Standards for the Export of Livestock* (Version 2.3), published April 2011.

Table 1: Recognised goat breeds in Australia, for the purposes of long-haul live export

Dairy	**Meat**	**Fibre**
Saanen	Boer	Angora
Toggenburg	Kalahari Red	Cashmere
British Alpine	Savannah	
Anglo Nubian	Rangeland	
Australian Melaan		
Australian Brown		

A producer must be able to demonstrate the mob-based pedigree of all goats within a long-haul live export consignment and declare this pedigree in writing. This must be in the form of an exporter statutory declaration or the Livestock Production Assurance National Vendor Declaration and Waybill (Goats) (LPA NVD/Waybill (Goats)).

2. Animal husbandry

a) Animal husbandry in the context of long-haul live export of domesticated goats must include but is not limited to:

i. Containment for the purposes of management

ii. Ear tagging

iii. Vaccination:

- This must involve as a minimum the administration of a clostridial (5 in 1) vaccination in the first 12 months of the animals life followed by a second vaccination or "booster dose" four to six weeks later. Annual vaccinations are then required. This provides protection against enterotoxaemia (pulpy kidney), tetanus, blackleg, black disease, malignant oedema and swelled head in rams.
- Additional vaccinations may be required by the importer as indicated in the importing country protocol.

iv. Internal parasite control

- This must involve as a minimum the drenching of all goats with a registered drench upon introduction to the 21 day on-farm pre-dispatch conditioning yard. Details of registered drenches are available from the Australian Pesticides and Veterinary Medicines Authority website.
- Additional anthelmintic controls may be required by the importer as indicated in the importing country protocol.

v. Drafting for the purposes of management

b) Detailed records must be maintained for goats destined for long-haul live export and only goats for which detailed whole-of-life records have been maintained can be considered for long-haul live export.

3. Selecting goats

a) Only goats which satisfy the definition of a *domesticated goat for the purposes of long-haul live export* can be considered for long-haul live export. These goats must also meet the importing country's requirements.

b) All goats must have been tagged on the property of birth with an approved National Livestock Identification System (NLIS) ear tag for the purposes of providence and traceability. An approved NLIS ear tag is imprinted with the NLIS logo and the Property Identification Code (PIC) or, in Western Australia the registered brand rather than the PIC. This ear tag should also incorporate a unique identifier where evidence of individual treatments is required.

c) All goats must be accompanied by a fully completed LPA NVD/Waybill (Goats) from property of birth.

d) Goats must not be obese or emaciated. Goats must be of a condition score two (2) to four (4) on a scale of one (1) to five (5) as outlined in *table 2*.

Table2: Body condition scores for sheep and goats

Score	Backbone	Short ribs	Eye muscle
1	Prominent and sharp	Ends are sharp and easy to press between, over and around	Thin, the surface tending to feel hollow
2	Prominent but smooth	Smooth, well-rounded ends — can feel between, over and around each smoothly	Reasonable depth with the surface tending to feel flat
3	Can be felt, but smooth and rounded	Ends are smooth and well covered — firm pressure is necessary to feel under and between short ribs	Full and rounded
4	Detectable with pressure on the thumb	Individual short ribs can only be felt with firm pressure	Full with a covering layer of fat
5	Can be felt with firm pressure	Cannot be felt even with firm pressure	Muscle cannot be felt due to a thick layer of fat

e) Goats must be of an age consistent with four (4) tooth or less.

f) Kids may only be sourced for export if they have been weaned for at least 14 days and have a minimum body weight of 22kg unless otherwise approved by the relevant Australian Government agency.

g) Lactating does must not be exported.

h) Goats must not be sourced for export from or through the ports of Darwin, Weipa or Wyndham from 1 November to 31 May in the following year (inclusive).

i) Horned goats must only be sourced for export as slaughter and feeder animals if the horns:

   i. Are not turned in so as to cause damage to the head or eyes;

   ii. Would not restrict access to feed or water during transport; and

   iii. Are no more than 15cm long and blunt or are no more than 22cm long with tips no more than 20cm apart; or

   iv. An exemption has been granted by the relevant Australian Government agency.

4. On-farm

a) Goats must have been subject to *animal husbandry* procedures since birth and records of proof of husbandry must be maintained.

b) Management practices must be in place to minimise the effects of cold weather on goats when consolidated for pre-export conditioning, at the Registered Premise[3] and during transport. This should include the provision of adequate shelter.

c) All does destined for slaughter or as feeder animals must be pregnancy tested by ultrasound within 30 days of export and certified not to be pregnant, by written declaration, by a person able to demonstrate a suitable level of experience and skill.

d) All does destined for breeding must be pregnancy tested using ultrasound foetal measurement within 30 days of export and certified, by written declaration, by a person able to demonstrate a suitable level of experience and skill, to be not more than a maximum of 100 days pregnant at the scheduled date of departure.

e) Goats must undergo pre-export conditioning for a minimum of 42 days before transfer to a Registered Premise. This is to include regular handling and involve the provision of feed and water from troughs. Pre-export conditioning may take place on the individual supplier's property provided they have adequate facilities in place.

[3] Premises used for the holding and assembling of livestock for export by sea or the pre-export quarantine or isolation of livestock for export by sea.

f) Goats found not to be eating or losing weight during pre-export conditioning should be excluded from the consignment.

g) Goats must be segregated based on sex, weight and age during the pre-export conditioning period and any animal demonstrating dominance behaviour that is adversely affecting the welfare of any other goat should be removed from the consignment.

h) Goats held on-farm prior to transportation to the Registered Premise must be fed a ration that at least meets the maintenance requirement of the goat. This is three (3) percent of their body weight for goats younger than four (4) tooth and two (2) percent of body weight for four (4) tooth and older.

i) Goats must not be sourced for export unless they have become conditioned to eating and drinking from troughs for a minimum of 42 days before being transferred to the Registered Premise.

j) Goats demonstrating any of the conditions identified in *table 3* should be excluded from the proposed export consignment. Any other condition that could be defined as an infectious or contagious disease, or would mean that the goat's health or welfare would decline or that the goat would suffer significant distress during transport, also requires the goat's rejection from export.

Table 3: Conditions that exclude goats from live export

Category	**Rejection criteria**
Systemic conditions	Uncoordinated, collapsed, weak Unwell, lethargic, dehydrated Ill-thrift
Musculoskeletal system	Lameness — footrot, foot abscess, arthritis, fractures etc or abnormal gait Abnormal soft tissue or bony swellings
Gastrointestinal system	Dysentery or profuse diarrhoea Bloat
Nervous system	Nervous signs (eg head tilt, circling, incoordination) Abnormal or aggressive behaviour/intractable or violent
External/skin	Generalised skin disease Visible external parasites Cutaneous myiasis (flystrike) Significant lacerations Discharging wounds or abscesses External skin cancer Blood/discharge from reproductive tract (vulva/prepuce)

Category	Rejection criteria
Head	Cancer eye Keratoconjunctivitis (pink eye) Excessive salivation Nasal discharge Blindness in one or both eyes Bleeding horn stumps Coughing Respiratory distress – difficulty breathing Scabby mouth
Other	Mobs with unusual mortalities or mortalities of more than 0.5% over the whole period of pre-export preparation

5. Registered Premise

a) Goats must be segregated based on sex, weight and age and any animal demonstrating dominance behaviour that is adversely affecting the welfare of any other goat should be removed from the consignment.

b) Wherever possible, groups should be maintained throughout the preparation process and on board the ship as each disruption to a group (including the introduction of new members) triggers a renewed period of dominance behaviours until equilibrium is re-established.

c) Goats are required to spend a minimum of five (5) days clear (not including the day of arrival and day of departure) in a Registered Premise to allow for acclimatisation to the feed ration prior to export. It is not recommended that this period be extended unnecessarily as this increases the risk of disease associated with the build-up of pathogens in confined quarters.

6. Transport

a) State and territory requirements for land transport, as well ASEL requirements, the *Australian Animal Welfare Standards and Guidelines for the Land Transport of Livestock* and any requirements of the importing country, must be observed in transporting goats from the property of origin to the Registered Premise, from the Registered Premise to the port of disembarkation and during loading onto the vessel.

b) Wherever possible, groups should be maintained during transport as each disruption to a group (including the introduction of new members) triggers a renewed period of dominance behaviours until equilibrium is re-established.

c) Goats must be protected from exposure during land transport and goats should not be transported in exposed stock crates during cold wet weather.

d) Goats that are not fit to load must not be loaded.

7. On-board

a) Goats must be located in a well ventilated, unexposed location on the vessel.

b) Goats should be segregated based on sex, weight and age.

c) Wherever possible, groups established at the Registered Premises should be maintained on board the ship as each disruption to a group (including the introduction of new members) triggers a renewed period of dominance behaviour until equilibrium is established.

8. Nutrition

a) Pellets fed at the Registered Premise and on-board the vessel should be of a quality and quantity that at least meets the maintenance requirements of the goats and the pellet specifications outlined in *table 4*. Sheep and cattle pellets are not necessarily appropriate for goats, especially if they contain urea.

In addition, 200 g/head/day chaff or roughage must be made available.

Table 4: Pellet specifications for goats

Pellet composition	Specification
Moisture content	< 12%
Ash as a percentage of dry matter)	< 13%
Crude protein as a percentage of dry matter)	= 12%
Urea as a percentage of dry matter)	= 0%
Acid detergent fibre (as a percentage of dry matter)	18–30%
Metabolisable energy	> 9.0 MJ/kg dry matter

b) Goats at the Registered Premise must be provided with the same pellets they will receive on the vessel, *ad libitum*, along with at least 200 g/day/goat of chaff or roughage (unless under curfew).

c) Good quality water should always be provided *ad libitum* (unless under curfew) and checked regularly, especially in hot weather.

d) Water and feed troughs should be cleaned regularly and positioned so as to minimise fouling.

e) Non-feeders should be identified and removed from the export consignment.

9. Documentation

a) All consignments must be accompanied by a fully completed LPA NVD/Waybill (Goats) and copies of LPA NVD/Waybills (Goats) from property of origin.

b) All goats within a consignment must be tagged with an approved NLIS ear tag representing the place of birth. Where an NLIS ear tag has been lost, this ear tag may be replaced with a transaction tag and the replacement noted on the LPA NVD/Waybill (Goats).

c) A record of all vaccines, veterinary medicines and agricultural chemicals used to vaccinate or treat livestock sourced for export must be maintained and kept for at least two (2) years after the date of export.

d) A statutory declaration must be provided by the supplier to the exporter confirming the mob based pedigree of the goats in the consignment. This may be via the LPA NVD/Waybill (Goats).

e) Whenever livestock are moved from one property to another with a different PIC, a mob-based movement must be recorded on the NLIS database. This includes movements from the property of origin to the Registered Premise.

7.4 Appendix 4: Planning, Extension and Communication

1. 4th March 2011 – Planning Meeting and Industry Feedback

Location: Teleconference

Meeting objectives:
1. Provide background and design proposals for W.LIV.0159 project.
2. Develop and plan initial experimental program.
3. Gauge industry impact of proposed project.

Attendees:
1. Catherine Stockman (Murdoch University)
2. David Miller (Murdoch University)
3. Tim Johnson (DAFWA)
4. Keros Keynes (Depot operator, WA)
5. Blair Bryce (MLA)
6. David Beatty (MLA)
7. Rick Gates (GICA, NSW)
8. Paul Elisio (Producer, SA)

2. 10th May 2012 – Planning Meeting and Industry Feedback

Location: Murdoch University

Meeting objectives:
1. Provide update and review results from W.LIV.0159 project.
2. Develop and plan future experimental program.
3. Visit Improvac trial site.

Attendees:
1. David Miller (Murdoch University)
2. Tim Johnson (DAFWA)
3. Keros Keynes (Depot operator, WA)
4. Garry Robinson (WRE)
5. Blair Bryce (MLA)
6. David Beatty (MLA)
7. Rick Gates (GICA, NSW)
8. Bob Grinham (Producer, WA)

3. 14th November 2012 – Industry Conference ('Glorious Goats')

Location: Italian Club, Fremantle WA

Meeting objectives:
1. Glorious Goat seminar information day organised by WAGMIC, including an update on MLA project W.LIV.0159.

Attendees:

Over 100 attendees representing the goat producers, depot owners, researchers, retailers, restauranters, chefs and general public, including:

1. David Miller (Murdoch University)

2. Tim Johnson (DAFWA)
3. Tony Gray (DAFWA)
4. Mathew Young (DAFWA)
5. Keros Keynes (Depot operator)
6. Blair Bryce (MLA)
7. Robert Anderson (MLA)
8. Scott Hansen (MLA)
9. Glen Telford (GICA, chairman)

4. 4th April 2014 – Goat Research Outcomes Workshop

Location: Geraldton DAFWA

Meeting objectives:
1. Industry extension and feedback on findings from MLA project W.LIV.0159.
2. Visit to trial site.

Attendees:
1. David Miller (Murdoch University)
2. Tony Gray (DAFWA)
4. Mathew Young (DAFWA)
3. Keros Keynes (Depot operator)
5. Julie Petty (MLA)
7. Blair Bryce (Beaufort River Meats)
8. Neil Grinham (Meka Station, Yalgoo, WA)
9. John Craig (Marron Station, Carnarvon, WA)
10. Simon Kopke (Weebo Station, Leonora, WA)
11. David Steadman (Pastoralists & Graziers Assoc., WA)

5. Publications

Bishop C.C., Fleming P.A., Barnes A.L., Collins T., Miller D.W. (2015). Immunisation against gonadotrophin-releasing hormone (GnRH) reduces agonistic behaviours in male rangeland goats. Anim. Prod. Sci. 56: 1882-1887.

Al-Habsi K., Yang R., Williams A., Miller D.W., Ryan U. (2016). Longitudinal prevalence and clinical impact of enteric pathogens in captured rangeland goats. Exp. Parasitol. (submitted)