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Investigating options to modify the aggressive behaviour of entire male cattle, sheep and goats and the potential impacts on market acceptance and animal productivity

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Abstract

This project arose following concerns by sections of the industry that, in exporting entire males to meet export market preferences, welfare considerations may sometimes be compromised due to aggressive behaviour and injury. Extensive consultations with all sectors of the livestock export industry were followed by a situation analysis of mortality levels and behavioural and welfare problems along the export chain in exported entire male sheep, goats and cattle. While there are significant aggression problems and recognised welfare concerns in the shipment of dairy breed bulls and feral and semi-feral male goats, these issues were not a major concern for rams or beef breed bulls of either *Bos taurus* or *Bos indicus* strains.

Little detailed information is available on causes of mortality in entire males during export, and further investigation of these aspects appears warranted. An analysis of market preferences for entire males was undertaken and current and future opportunities for the export trade in entire males were assessed. In the absence of good data on the value of the export trade in entire males, a preliminary analysis suggested that for all species, the entire male trade had a value in 2004 of about $70 M, or almost 10% of the trade, for animals for which there are restricted domestic market opportunities.

A literature review was undertaken incorporating relevant scientific information, together with considerable anecdotal information from industry. Modifications to handling and management strategies, changes in the genetic composition of the current feral goat population, nutritional manipulation of aggressive behaviour, and the use of immunological castration techniques (goats and dairy bulls) were identified as possible options for modification of aggressive behaviour, some of which are recommended for further research. Given increasing community concerns on animal welfare issues, consideration needs to be given to a progressive phase out of the export of harvested feral goats, and their replacement with either castrates or ‘domesticated/managed’ goats of feral origin and their crosses.

Executive Summary

Background

Australia is currently the largest exporter of livestock to over 40 countries world-wide, the estimated value of these exports in 2004 being $ 711 Million. Exports of sheep, cattle and goats are an important component of the Australian livestock industries, and have provided producers with increased market options. For example there is a preference for entire males in many markets in the Middle East and SE Asia, a demand that does not exist in the domestic market.

Welfare issues continue to be raised in relation to the trade, one area of concern being problems of aggressive behaviour in some shipments of entire males, a problem that may contribute to both pre-shipment and shipboard mortalities, to the general health and welfare of such animals, and to meat quality at slaughter.

Project Objectives

The objectives of the project were:

- To quantify the export market preference for entire males and the basis of this preference.
- By undertaking a situation analysis of all components of the trade in entire males, to determine current and future opportunities for entire male exports; estimate the value of the trade; define the extent and nature of aggression problems and assess their impacts on mortalities and welfare.
- Through a review of scientific literature, and drawing on industry experience and information, to develop and to recommend a range of options to enhance welfare of animals, while taking into account market sensitivities, and production and commercial implications.

The study specifically related to the export of entire males by sea, and issues relating to air transport have not been considered.

Project Outcomes

- There is a perceived preference by many involved in the trade in the Middle East and SE Asia for the importation for slaughter of entire males of all species, based on traditional cultural preferences, and also associated with some religious festivals. Traditional 'wet market' traders also prefer the increased yield from entire males, and lean meat is preferred in some Asian soups and 'stir frys'.
- The proportion of entire males being exported varies by year, by destination and by species. For sheep exported over the past decade, on average about 10% are rams; for cattle, for which only very recent data is available, the best estimate is that about 6% are bulls, and for goats, where gender data is also not available, a majority (≈ 90%) are thought to be entires.
- Death rates during export of entire male sheep have been marginally higher in rams than overall sheep death rates (rams 1.6%, 1.1%, 1.1% vs 1.3%; 0.88%, 0.75% all sheep) in 1997-2002, 2003, and 2004.
- Overall death rates in all cattle exported have significantly declined over time, and in 2003 and 2004 were 0.11% and 0.10%. Death rates in bulls shipped to Middle East ports in 2003 and 2004 were 0.45% and 0.54%, similar to overall death rates on these voyages of 0.45% and 0.43%. Mortalities on long haul voyages to the Middle East have consistently been higher than to the closer SE Asian ports
- Death rates in goats have declined over the past two years to between 0.8-0.9%, compared to about 1.8% from 1999-2002.
- In rams, with good management and supervision, aggression problems are infrequent and not considered to be of major concern from a welfare perspective.

- In dairy breed bulls, but rarely for beef breed bulls, in some shipments aggressive behaviour can result in significant management difficulties with consequent welfare considerations.
- In feral and semi-domesticated feral goats, extreme aggressive behaviour can sometimes result in unacceptable levels of injury, contributing to increased death rates and creating significant welfare problems.
- In the absence of readily accessible information on the economic value of the trade in entire males, some "best-bet estimates" were made using the data generated for the project. The value of the trade in entire male sheep, cattle and goats during 2004 was estimated to be about $23M, $42M and $4.7M respectively, with a total value of about $70 M. This represents about 9.8% of the overall value of the livestock export trade.
- Options for modifications of behaviour patterns include:
  - Selection for temperament
  - Genetic selection practices to change breed composition
  - Group size and stocking density effects
  - Handling and management strategies
  - Nutritional impacts
  - Endocrine manipulation of behaviour
  - Chemical or pharmacological manipulation of behaviour
  - Light manipulation and photoperiodic effects
  - Modification of testicular function
  - Ship-board pen modifications

Recommendations

- More detailed investigations should be undertaken on specific causes of death in entire males of all species while in transit.
- It is recommended that the industry should start recording numbers and mortalities in entire, dairy breed bulls and in entire male goats with a split between feral and domestic goats, in order to assist with future management of these classes of livestock.
- Training packages for on-farm and export depot stock persons should also include low stress stock handling procedures and general livestock management best practices to enhance welfare of exported cattle and goats.
- Best-practice management procedures need to be well documented and followed in exporting dairy breed bulls, covering a range of procedures to minimise aggressive behaviour and injury.
- Additional research is recommended to identify any specific nutritional substances that could be incorporated in rations to reduce aggressive behaviour. Likely candidates would include magnesium salts and protected tryptophan.
- Additional research should be undertaken on the use of current and new generation anti-GnRH vaccines as a means of temporarily inhibiting testicular function and reducing levels of aggression, specifically in dairy breed bulls and in feral goats.
- Consideration needs to be given to a progressive phase-out in exports of recently harvested feral goats, given the welfare issues and mortalities associated with the export of these animals, recognising that managed/domesticated feral goats would be acceptable for export.
- It is recommended that some market survey and consumer education activities be undertaken in importing countries to encourage a move away from entire male goat imports to wether goats (recognising the current preference for entire males), given the management difficulties and welfare issues involved in exporting entire male goats.
- A review should be commissioned to examine currently available information on cross-breeding plans for domesticated feral goats, and on performance of feral and crossbred goats under pastoral and intensive conditions, in order to provide condensed, objective information for breeders and others interested in supplying the goat live export market.

Contents

1 Background

1.1 Background to the Australian Livestock Export Trade

Contrary to popular belief, Australia has a long history of exporting livestock, going back to the 1840s with the remount horse trade to India (Parsonson 1998). From about 1876, and for the next two decades, considerable numbers of cattle from Central Queensland were shipped to New Caledonia and other Pacific Island destinations (McDonald 1988), while from the 1890s cattle were shipped from northern ports to a number of SE Asian destinations (Buchanan 1933, Durack 1983). Sheep exports also date back as far as the 1890s when trade with New Zealand and South American countries was first established (Parsonson 1998). However it is only in the past 10-15 years that the livestock export trade has expanded to its present levels.

Australia currently leads the world as the largest exporter of livestock, but this position is under challenge, particularly in the cattle sector, with emerging competitors such as Brazil and, to a lesser extent, India. Live exports of cattle, sheep and goats make significant contributions to the productivity of the Australian livestock industries. In 2003-2004, estimated values of these exports were $840M (Australian Bureau of Statistics (ABS) 2004). Livestock are exported to over 40 countries world wide, and while markets are in a state of moderate flux at the moment, live exports remain an important component of several sectors of the Australian livestock industry.

The live export trade has also provided Australian livestock producers with increased market options and a demand for certain classes of livestock that does not exist in the domestic market. For example, cattle producers in NW Western Australia, the Northern Territory and, to a lesser extent northern Queensland, have benefited greatly from the trade in feeder steers and slaughter cattle, including entire males, to SE Asian, Middle Eastern and other markets (Hughes 2000). There is also general consensus that these exports have put a floor in the market that has increased the profitability of the northern industry. Were this trade not to exist, then outlets for many of these cattle would be restricted and freight costs for shipments to either Queensland or southern Western Australian destinations would impact on industry profitability (Heatley 2000).

Australia is the largest goat exporter in the world, a high proportion of goats being feral or semi-feral animals originating mainly in the pastoral areas of Western Australia, Queensland and western New South Wales. No significant domestic market exists for such animals, and export markets for goats have assisted the economic situation of many pastoral producers in these regions. However trade in such animals is raising concern because of welfare and mortality issues, and the long-term continuation of the trade in feral and semi-feral goats will depend on a satisfactory resolution of these issues.

Despite considerable improvements, the livestock export industry continues to be challenged by opponents of the trade in respect of on-board death rates, on general animal welfare issues and on economic grounds, all of which have the potential to lead to increased efforts to ban the trade. While over the past few years there has been a consistent reduction in shipboard mortality rates for all species, welfare issues continue to be raised, and considerable research on a range of these matters is now being undertaken.

This criticism of the trade has been particularly marked when major disasters due to ship breakdowns or adverse climatic conditions have occurred. This led to a review in 2004 of all aspects of the livestock export industry (Keniry Review), the development of new standards for the trade

(DAFF 2005), with a greater degree of government intervention than existed previously, all designed to enhance the welfare of exported livestock.

1.2 Time trends and extent of the trade

The numbers of all animals exported has varied considerably over the past few years. Time trends in the numbers and values of live exports of sheep, cattle and goats are indicated in Figures 1 to 6 below.

1.2.1 Sheep

Almost all (99%) of the sheep currently exported go to Middle Eastern countries, with only small numbers to other destinations. At the present time about 83% of all sheep are being exported from Western Australia reflecting greater availability of suitable animals, and shorter transit times when compared to departures from eastern ports (LiveCorp 2005).

In 2004, sheep exports totalled almost 3.4 million, down considerably from a peak of almost 6.5 million in 2001, and the lowest level since 1990 (Figure 1). There are no clear seasonal patterns in sheep exports, though month-to-month variations are obvious over the past three years (Figure 2). Though the major Saudi Arabian sheep market has been closed for several years, it has just recently re-opened, which may result in some up-turn in total numbers of sheep exported.

Between 1997-2001, approximately 10% of all sheep exports were entire males (Norris and Norman, 2003), but this figure increased in 2003 to 16.5%, and to 16.7% in 2004 (Norris and Norman, 2004, 2005). A majority (66-77%) have been ram lambs, with adult rams representing 13-26% of entire male shipments and the balance hogget rams (Tables 1,2,3). There are significant regional differences in the proportions of entire male sheep shipped to Middle Eastern markets. Most entire ram shipments have been from Western Australia where rams exported have represented from 10-21% of all sheep exports, with only relatively small numbers of rams shipped from Adelaide and Portland since 1997. Tables 1, 2 and 3 summarise information on entire ram exports over the period 1997-2004.

Figure 1. Annual Sheep exports by volume and FOB value (Livecorp Statistics 2005)

Figure 2. Monthly Sheep exports for last 3 years by volume and FOB value (Livecorp Statistics 2005)

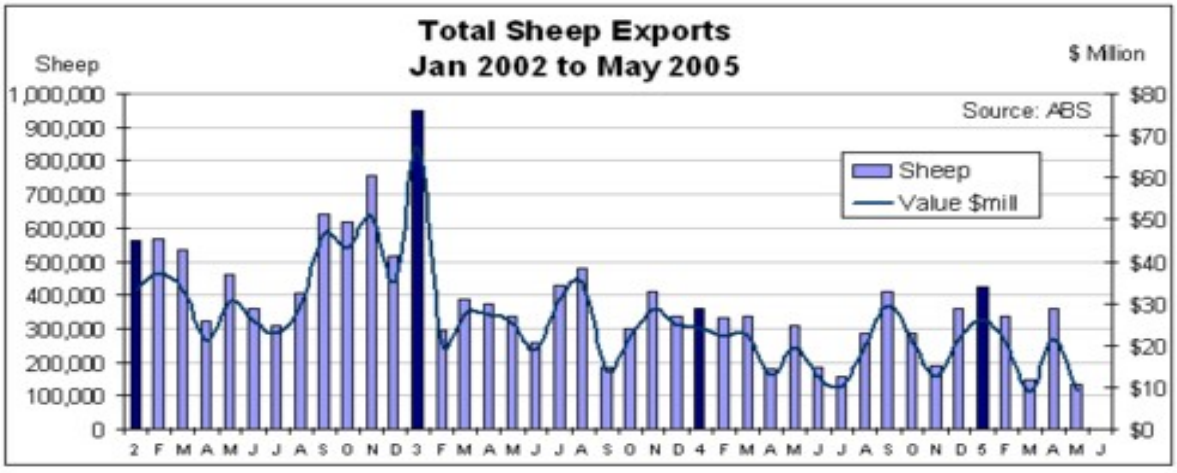


Table 1. Sheep data 1997-2001. Entire rams by load port, as proportion of total shipments and by age of ram (Norris and Norman 2003)

Ram Class	Fremantle	Adelaide	Portland	Total	% rams by age
Adults	436,837	69,524	888,862	595,223	**26.4**
Hoggets	156,564	4,755		161,319	**7.1**
Lambs	1,444,340	45,685	4,525	1,494,550	**66.4**
Total rams	2,037,741	119,964	93,387	2,251,092	
Total exported	19,801,011	2,670,416	4,005,259	26,476,686	
% rams by port	**10.3**	**4.5**	**3**	**8.5**	

Table 2. Sheep data 2003. Entire rams by load port, as proportion of total shipments and by age of ram (Norris and Norman 2004)

Ram class	Fremantle	Adelaide	Portland	Total	% rams by age
Adults	63,005	26,479	11,587	101,071	**13.4**
Hoggets	64,538	5,313	2,l639	72,490	**9.6**
Lambs	511,259	63,305	4469	579,033	**76.9**
Total rams	638,802	95,097	18,695	752,594	
Total exported	3,007,854	843,283	694,948	4,546,085	
% rams by port	**21.2**	**11.2**	**2.7**	**16.5**	

Table 3. Sheep data 2004. Entire rams by load port, as proportion of total shipments and by age of ram (Norris and Norman 2005)

Ram Class	Fremantle	Adelaide	Portland	Total	% rams by age
Adults	87252	9150	6374	102776	**18.6**
Hoggets	48497			48497	**8.8**
Lambs	397771	3028		400799	**72.6**
Total rams	533520	12178	6374	552072	
Totals exported	2,790,798	257,617	244,534	3,292,949	
% rams by port	**19.1**	**4.7**	**2.6**	**16.7**	

1.2.2 Cattle

The SE Asian markets which dominate the live cattle export trade, are predominantly for feeder steers, though some shipments have included young or cast-for-age *Bos indicus* bulls. Most shipments of entire males of both dairy and beef breed bulls have been to Middle Eastern markets, while shipments to north Asia and to China have been predominantly slaughter cattle or dairy heifers respectively.

Numbers of cattle exported have declined over the past few calendar years from a peak of almost 1 million head in 1997 and again in 2002, to 774,000 in 2003 and 635,000 in 2004 (Figures 3 and 4). These significant year to year variations in cattle exports have reflected economic trends, comparative currency variations particularly in SE Asia, and the loss of significant markets such as the Philippines and Libya. As for sheep, while there are variations in numbers exported on a monthly basis, there are no clear seasonal trends in export patterns over the past three years (Figure 4), though most shipments from northern ports are in the later half of the year.

Data on entire males is only available from July 2002 onwards, and for shipments to the Middle East only (Table 5, Section 4.1). In 2003, entire bulls accounted for almost 76% of all cattle exports to these destinations (Norris and Norman 2004), the corresponding figure for 2004 being 84% (Norris and Norman 2005).

A majority of these shipments have been 'micky' (unbranded, uncastrated, semi-feral) beef breed bulls from the north. However from time to time there have been significant shipments of Friesian and other dairy breed bulls from South Australia, Victoria and Western Australia (Norris and Norman 2003).

Although actual numbers are currently not recorded by the Australian Bureau of Statistics (ABS), smaller numbers of entire male cattle are also exported to SE Asian markets, mainly being 'micky' bulls (unbranded, uncastrated) or cull bulls from northern Australia, rather than bulls specifically bred for the export market. In 2004, of cattle exported to SE Asian ports from Darwin, from where about 34% of all cattle were exported (LiveCorp 2005), over 16,000 were bulls, representing about 7% of all shipments from that port (L MacKinnon, pers comm.).

Figure 3. Annual Cattle exports by volume and FOB value (Livecorp Statistics 2005)

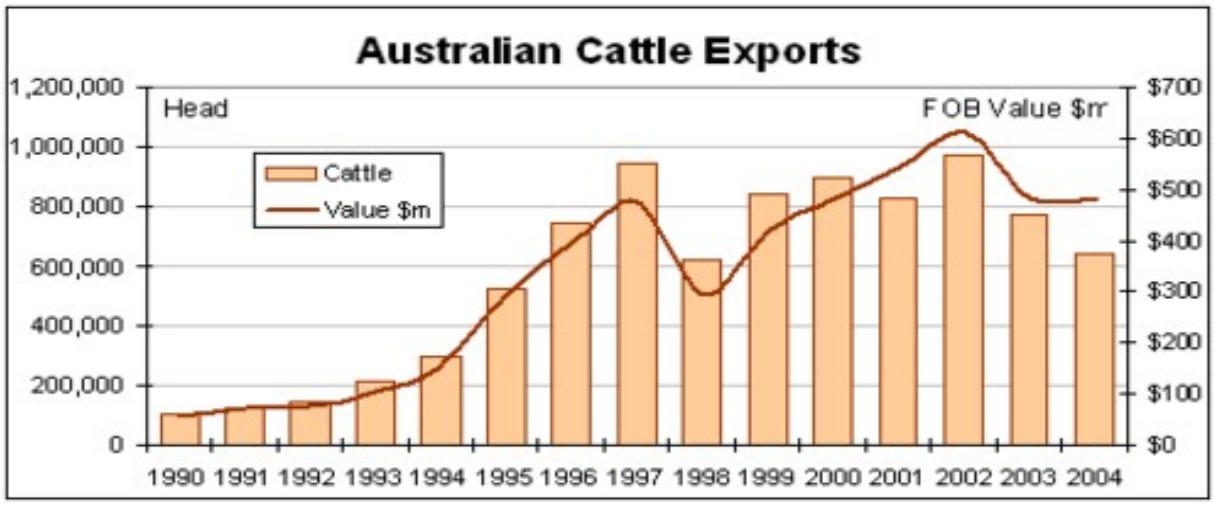
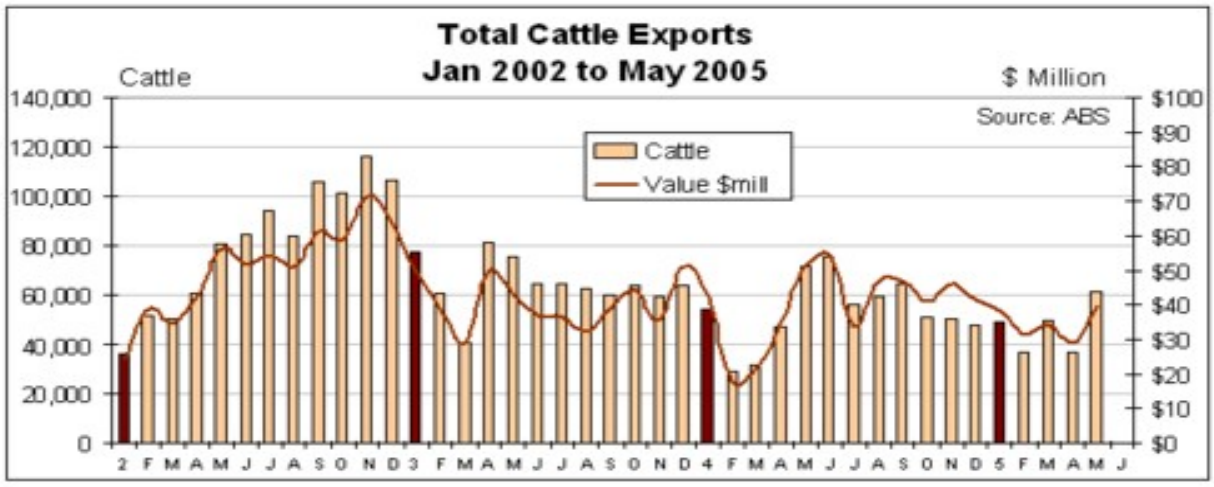


Figure 4. Monthly Cattle export trends for last 3 years by volume and FOB value (Livecorp Statistics 2005)

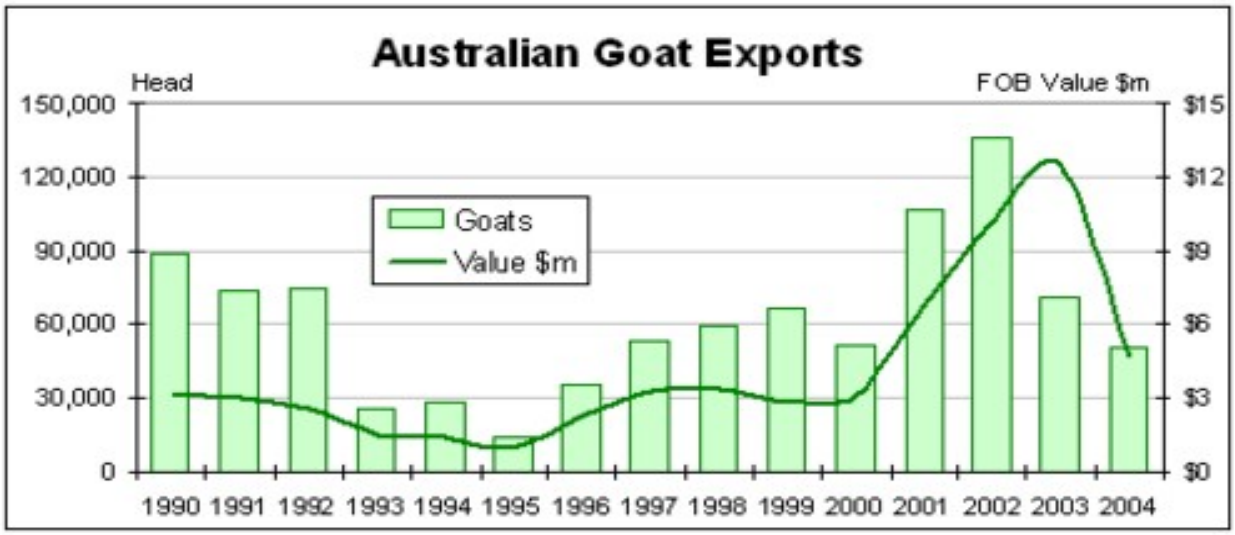


1.2.3 Goats

Numbers of goats exported have also varied over the years, reaching a peak in the 2002 calendar year when about 135,000 goats were exported but declining to about 50,000 in 2004 (Figure 5). There has been a marked decline to Middle Eastern destinations and a smaller decline to SE Asian destinations (Table 6, Section 4.1). In 2004, almost 90% of all goat exports were to SE Asia (Malaysia, Singapore, Brunei). There are also some distinct seasonal patterns of exports, peak numbers being exported in the last quarter for each of the last three years (Figure 6). This probably reflects increasing demands by Islamic countries for entire goats at around the time of specific religious festivals. Gender composition data is not available for goats, though this is probably not important, since a majority exported have been entire males, with some wethers.

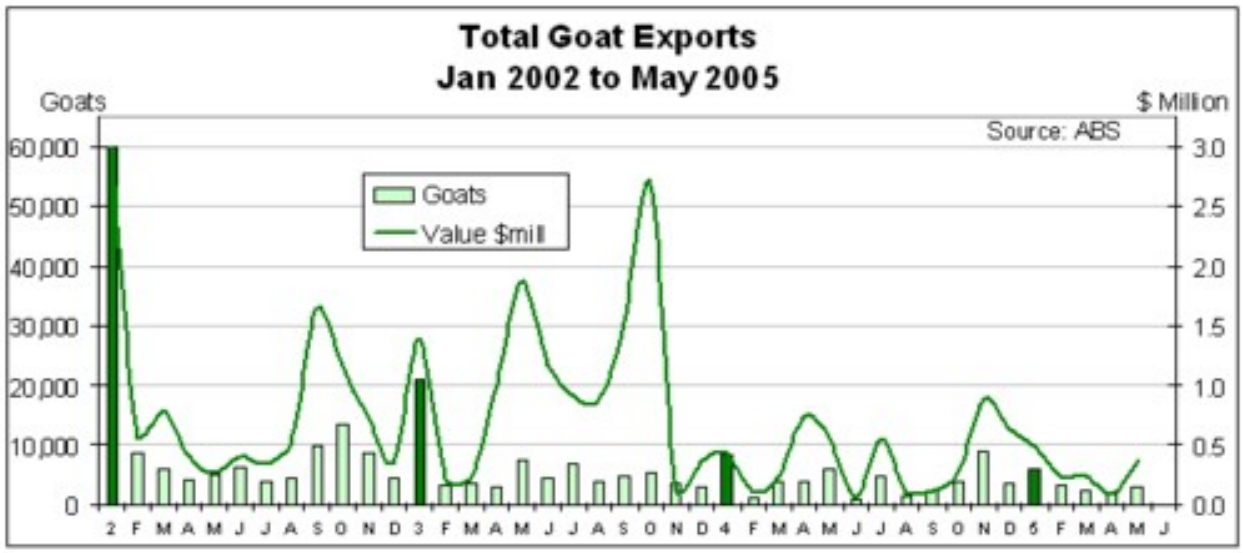
It should be noted that there are some discrepancies between sets of data (Norris et al 2003-2005; ABS) on the extent of the goat trade. The data of Norman and Norris (2003, 2004, 2005) is derived from information from ship Masters reports and from “Yellow Books” which record more detailed information on ship-board mortalities. It does not include numbers exported by air, a shipment route which is increasing in importance (eg in 2004, over 20,000 goats were exported by air). In contrast, the statistical data provided by ABS includes both sea and air transport information.

Figure 5. Annual Goat exports by volume and FOB value (Livecorp Statistics 2005)



A majority of goats are exported from Western Australia and South Australia, with smaller numbers from the NT. Most goats exported are either feral, “semi-domesticated” feral or feral cross goats, the large majority being entire males (Norris and Norman 2003, 2005, More and Brightling 2003).

Figure 6. Monthly Goat export trends for 3 years by volume and FOB value (Livecorp Statistics 2005)



2 Project Objectives

The objectives of the project were to:

- Identify and quantify the livestock export market preference for entire males, in particular bulls, rams and billy goats, and the basis of this preference (e.g. lean meat or cultural requirements).

- Identify and make recommendations on the options along the entire live export chain to supply entire males to Australia's live export customers. The recommendations must improve the animal welfare of the animals while taking into account market sensitivities, production and commercial implications.

3 Methodology

3.1 Background data reviews and situation analyses

In undertaking the project, information on the background to the livestock export trade was reviewed, data on time trends and the extent of the trade for each species were analysed and, where available, published information on overall death rates and death rates in entire males was collated and analysed.

3.2 Discussions with industry and stakeholders.

The consultancy team of Keith Entwistle and Sandi Jephcott participated in the MLA/LIVECORP LiveExport R&D Forum in Brisbane in late May 2005, which provided an opportunity to meet with a number of key people in all sectors of the export industry. Extensive discussions were then undertaken with over 85 individuals and organisations involved in the live export trade in order to draw on evidence and experience which could be used to develop options for modifications of aggressive behaviour in exported entire males. Opinions were also sought on future prospects for the trade overall and for entire males specifically. Visits were also made to South Australia, Victoria, Western Australia and the Northern Territory as well as visits to other individuals and organisations in Queensland and New South Wales. Contacts are listed in Appendix 1.

3.3 Review of Literature

An additional component of the project was to undertake a review of scientific literature on behavioural characteristics in entire males, and on options for modifications of aggressive behaviour. However, because of the paucity of objective data in some areas, this review is not a traditional review of the scientific literature. Rather, it is a combination of relevant published scientific information, extrapolations from accepted biological principles, together with considerable anecdotal information derived from the experience, judgements and assessments of a range of individuals, commercial organisations and R&D groups involved in the live export trade. Wherever possible, an attempt was made to verify the latter type of information against published information, but some subjective judgements by the authors have been necessary.

4 Results and Discussion

4.1 Situation analyses in relation to death rates in exported entire male livestock

4.1.1 Sheep

Eighty-three percent of all sheep are exported from Western Australia, with almost all going to Middle Eastern countries, reflecting greater availability of suitable animals, and shorter transit times when compared to departures from eastern ports.

Entire rams have represented about 10% (range 8.5-16.7%) of all sheep shipments from Australian ports since 1997 (Section 1.2). Only relatively small numbers and proportions of rams have been shipped from Adelaide and Portland since 1997 (see Tables 1, 2, 3).

Death rates in different classes of exported sheep have been analysed in detail by Norris and Norman (2003, 2004, 2005). Ignoring major catastrophes such as the Cormo Express incident, sheep death rates have shown a significant decline in recent years from 1.26% in 2001 to 0.75% in 2004 (Norris and Norman 2005). Overall mortality rates of all sheep exported in 2003 were 0.88%, and were 1.1, 1.0 and 0.9% for adult, hogget and ram lambs respectively. The pattern in 2004 was similar, death rates being highest in adult rams (1.1%) and of similar levels in hogget and lamb rams (0.9%, 0.8%) (Norris and Norman 2004, 2005). For entire males, this data is summarised in Table 4.

In the period 1997-2002, death rates in adult rams (1.6%) and in ram lambs (2.7%) were higher than the mean rate for all sheep (1.3%), being highest in shipments from Portland. However in shipments during 2003 and 2004, death rates in rams were only marginally higher than for other classes of sheep, and were from rams mainly shipped from Portland and Adelaide respectively, though involving only very few animals.

It is unclear why death rates for entire rams have been slightly higher than overall mean death rates, as there have been no systematic studies of causes of mortalities in exported rams (R.Norris, pers comm.). There are also some port of origin impacts, with death rates in rams exported from Fremantle tending to be lower than from either Adelaide or Portland in 2003 and 2004 (Norris and Norman 2004, 2005). These aspects are discussed in a later section of the report.

Discussions with representatives from groups (exporters, veterinarians, researchers, feedyard operators) involved in the live sheep trade indicate that *aggression problems in adult entire rams are of a minor nature only*, occur only in the first few days of pre-shipment assembly, the impacts of which can be minimised by simple management procedures including segregation of horned and polled rams. Information provided by representatives of a number of the above industry groups indicates that *aggressive behaviour is not a problem in either hogget or lamb rams* that have usually constituted more than 75% of all entire rams exported.

Table 4. Death rates in entire male sheep by age, year and port of loading (Norris and Norman 2003, 2004, 2005)

Age	Year	Fremantle	Adelaide	Portland	Ram Death %	All Sheep Death %
Adults	1997-2002	1.7	1.4	2.9	1.6	**1.3**
	2003	1.1	1	1.4	1.1	**0.9 ****
	2004	1	2	0.8	1.1	**0.7**
Hoggets	1997-2002	1.1	0.6	n/a*	0.8	
	2003	0.9	1.3	2	1	
	2004	0.9	n/a	n/a	0.9	
Lambs	1997-2002	1	1.6	7.1	2.7	
	2003	0.9	0.9	1.1	0.9	
	2004	0.8	2.2	n/a	0.8	

* n/a not applicable (no sheep in this class loaded)

** Excludes Cormo Express data

4.1.2 Cattle

The SE Asian markets dominate the live cattle export trade, are predominantly in feeder steers, though some shipments have included young or cast-for age *Bos indicus* bulls where there have apparently been few aggression problems. Most shipments of entire males have been to a range of Middle Eastern markets (Section 1.2), and it has been on these longer haul voyages where aggression problems in some bull shipments have raised welfare concerns.

For cattle, overall death rates in calendar years 2003 and 2004 were 0.11% and 0.10% respectively, a significant decline on previous years where death rates over the period 1995-2002 averaged 0.23% (Norris and Norman 2003).. In both years, in longer voyages to the Middle East/North Africa and to Mexico, higher death rates (0.08-0.45%) occurred than on shorter voyages to SE Asia (0.05%) (Norris and Norman 2004, 2005), but even these low levels to the Middle East and elsewhere are of concern from a welfare perspective.

Data on entire males is only available from July 2002 onwards, and for shipments to the Middle East only. Death rates from 2002 onwards were marginally higher in adult bulls (0.45 and 0.54%) and in bull calves (0.62 and 0.34%) than in other classes of cattle (Norris and Norman 2004, 2005). Table 5 summarises information on numbers and mortality rates in 2003 and 2004 of entire males to the Middle East, a large majority (76-84%) of cattle exported to these destinations being entire males.

Norris et al (2003) reported that the risk of death on Middle Eastern voyages was three times greater for cattle exported from southern compared to northern ports. Reasons for some of these differential death rates are discussed in section 4.2.2 of this report.

A majority of bull shipments have been ‘micky’ (unbranded, uncastrated, semi-feral) beef breed bulls from the north (Norris and Norman 2005). Some of these ‘mickys’ are from well managed properties, are calves that have missed the muster or being branded at the last mustering round, and exporting

these animals eliminates the stress of castration at an older age. Others however are traditional older feral 'mickeys' from poorly managed properties. Very few bulls are being specifically bred for the SE Asian export market. However numerous shipments of Friesian bulls from South Australia, Victoria and Western Australia, have been made, and in some cases aggression problems have been a significant concern.

In discussions with all sectors involved in the live cattle trade (exporters, veterinarians, researchers, feedyard operators), there was a general view that provided good management practices were in place, and animals were well handled, *aggression problems in beef breed bulls were not a major problem,* occurred mainly in the first few days of pre-shipment assembly, and were usually not a problem during shipping. However *aggression problems can be significant in some shipments of dairy bulls*, particularly Friesians more than about 18 months of age, and at weights greater than about 300-350kg (M McCarthy pers comm.). Problems have occurred particularly when different groups of bulls were mixed together during both pre-shipment assembly and during shipping, and adverse aggressive behaviour has contributed to increased mortalities.

Table 5. Bull exports and death rates by class to Middle Eastern destinations in 2003 and 2004 (Norris and Norman 2004,2005)

	2003	**2004**
Total cattle	105,837	61,625
Bulls adult	48,365	29,599
% Total	45.7	48.0
Bulls calf	31858	22432
%Total	30.1	36.4
Bulls as %Total	75.8	84.4
Death rate bulls %	**0.4-0.6**	**0.3-0.5**
Overall death rate %	**0.4**	**0.4**

4.1.3 Goats

Death rates (Table 6) have been high in some goat shipments, ranging across years from 1.8% down to 0.8% more recently (Norris and Norman 2003, 2004, 2005). This reduction in mortality is probably a direct result of the recent standard (DAFF 2005) that requires goats must be held 'behind wire' for at least 3 weeks prior to shipment. In the case of entire male goats, death rates during shipping have tended to be higher than for other species.

Between 1993-2002 death rates ranged from 1.04 - 4.55% (Norris and Norman 2003), but in the past two years have decreased to between 0.8-0.9% (Norris and Norman 2004, 2005). In some years death rates have been higher in mature bucks, but in other years young animals have experienced greater mortalities (Norris and Norman 2004, 2005). As for sheep and cattle there appear to have been no detailed investigations into causes of mortality in entire male goats (R Norris pers comm.). Details of an analysis on goat mortalities undertaken by More and Brightling (2003) are discussed subsequently (Section 4.2.3)**.**

The export goat industry remains constrained by a number of fundamental factors including the opportunistic nature of 'harvesting' of feral and semi-feral goats to supply inconsistent levels of demand. There is a wide variation in quality of goats, and there have only been limited attempts at genetic improvement of quality, primarily through crossing feral goats with Boer goats. Stress factors associated with harvesting and transport can lead to high mortalities in the pre-shipment period, and inanition and enteric diseases can contribute to high mortalities during assembly and shipment (More and Brightling 2003). In addition, abnormal sexual behaviour, and high levels of aggressive behaviour, including bullying and constant riding of smaller goats, is a problem with most goat shipments.

Anecdotal comments from industry, and limited published information, suggest that of all the livestock species exported, *entire male goats are the most difficult to handle, and aggressive behaviour and management difficulties are greater than in either bulls or rams. A consequence has been that death rates have tended to be higher in goat shipments than in shipments of other species.*

Table 6. Goat exports and death rates by destination 1999 to 2004. (Norris and Norman 2003, 2004, 2005)

Destination	1999-2002	2003	2004
Middle East	124,800	16,552	1021
SE Asia	97307	36048	20801
Total exports	229,492	52,600	23,048
Death rate %	**1.8**	**0.8**	**0.9**

4.2 Defining the extent & nature of animal aggression associated with the trade

4.2.1 Sheep

A majority of those from all sectors in the trade who were contacted or were visited believed that aggression problems in entire male sheep were not a significant issue either from an injury perspective, from greater mortalities or from a welfare perspective. From a death rate perspective, the data of Norris and Norman (2003, 2004, 2005) summarised in Table 4 indicates that in the three data year sets examined, male death rates varied between years and between port of origin, highest death rates occurring in lamb shipments from Portland between 1997-2002.

When this data was pooled across ram ages and recalculated for each data set, then ram death rates were 2.27% (overall death rate all sheep 1.3%); 0.94% (overall death rate all sheep 0.88%), and 0.86% (overall death rate all sheep 0.75%) for 1997-2002, 2003 and 2004 respectively. Other than for the 1997-2002 data, where there were significantly higher death rates in rams compared to overall death rates, death rates in rams were only marginally higher than overall death rates.

It is unclear why death rates for entire rams have been slightly higher than overall mean death rates, since there have been no systematic studies of causes of mortalities in exported rams (R.Norris, pers comm.). The analyses of Norris and Norman (2003) suggest that the major contributing cause of deaths in transit is failure to eat, which predisposes sheep to inanition and to deaths from salmonellosis. From the data available it is not possible to draw firm conclusions as to whether the same factors operate in relation to increased mortalities in exported rams, though this is likely. Other speculative reasons for the higher death rates in older age groups of rams could include: higher levels of stress with increasing age; a poorer capacity in older animals to adapt to dietary changes, with consequent inanition; or a consequence of interference with feeding ability in horned rams, particularly where pen densities are higher than optimal. In a study on mortalities in wethers exported from Western Australia, Higgs et al (1999) found an association between farm of origin and regional location of source farms and mortality rates. These authors also concluded that regional variations in mortalities were consistent with earlier work indicating that duration of the growing season and fatness of sheep were risk factors for mortality. In the case of rams, there are also some port of origin impacts, with ram death rates from Fremantle tending to be lower than from either Adelaide or Portland in 2003 and 2004 (Norris and Norman 2004, 2005).

In conclusion, feedback from experienced participants in the live sheep trade suggests that there are *rarely significant aggression problems in exported entire rams that are contributing to higher mortalities* in this class of animal. Further discussion on this point occurs in Sections 4.1.1 and 4.3.1 of this report, but it is important to recognise that if mortalities in entire rams were excluded from calculations of overall mortalities in exported sheep, then these would be even lower that currently reported.

4.2.2 Cattle

In contrast to the sheep export trade, there are few reports of studies to investigate reasons for mortalities in exported cattle, nor have reasons for differential death rates between classes of cattle been examined. The exception is the recent report by Norris et al (2003) who found that the risk of death on Middle Eastern voyages was three times greater for cattle exported from southern ports compared to northern ports. The likely reason is the higher *Bos indicus* content of cattle exported from northern ports compared to southern ports.

The major cause of death on these voyages was heat stroke; *Bos indicus* cattle are more able to tolerate conditions of high temperatures and humidity (Carvalho et al 1995). Trauma, including lameness (either of structural origin or resulting from pre-shipment and/or on-board environmental conditions) was a problem with some shipments (Norris et al 2003), but no specific examination of reasons for mortalities in bulls were undertaken in this study.

In the case of the Middle Eastern bull trade, anecdotal information from industry indicates that in some shipments of dairy bulls there have been higher death rates resulting from injuries due to aggression and abnormal sexual behaviour patterns. Other anecdotal information from veterinarians and stockmen involved in the export trade suggests that on-board ship, there are greater problems with heavier and older bulls, often resulting from foot and lower limb lameness problems, bulls remaining lying down, being more susceptible to heat stress when recumbent, reductions in feeding with consequent loss of condition, and sometimes death.

A number of veterinarians with up to 30 years experience in the live cattle trade from northern ports have expressed the view that aggression was not a major problem with most beef breed bulls exported from that region. These viewpoints covered both cast-for-age Brahman and Brahman derived bulls, as well as 'micky' bulls of either *Bos taurus* or *Bos indicus* origin from extensive pastoral properties.

Several large pastoralists involved in the export trade expressed similar views, as did one stockman with considerable shipboard experience in exporting bulls. However the qualification of each of these sector representatives was that animals had to be well handled, pre-conditioned for transit and shipment and exposed to minimal stress.

In contrast, aggression problems in some export shipments of dairy bulls have created significant difficulties with injuries to both animals and handlers, and increased mortality and morbidity rates. In these circumstances there have been valid concerns in relation to welfare issues and OHS issues with staff. The increased aggression of dairy bulls has been recognised and described previously and is discussed later in this report.

4.2.3 Goats

The feral and semi-feral origin of most exported male goats is seen as the major contributing factor to aggression problems in this species (More and Brightling 2003). All individuals with whom livestock exports were discussed were unanimous that the most significant problems of aggression, injury and induced mortality occurred with the export of entire male goats**.** To quote one experienced export veterinarian "they are disgusting animals; sexual behaviour is outrageous; libido extraordinary and dominance extreme". The extent to which these problems reflect the feral background (environmental effect) or the genetic composition of most exported billy goats is debatable, and this aspect is explored later in this report.

Abnormal sexual behaviour, high levels of aggressive activity including bullying and constant riding of smaller goats are problems with many goat shipments. While these can be minimised by penning goats into similar sizes, culling of larger and more aggressive goats pre-shipment, and removal and segregation of 'buller' goats, injuries and deaths remain a problem.

Mortality rates in goats, whilst declining over recent years have continued to be at higher levels than either sheep or cattle (Norris and Norman 2003). These aspects have been considered in more detail in the report by More and Brightling (2003), and are also considered in a later section here. *Aggression problems in goats are a significant cause of mortality, partly due to the feral origin of most exported goats. High level shipboard management is essential to minimise these problems.*

4.3 Current approaches to the problem

4.3.1 Sheep

It has been concluded that aggressive behaviour in rams during assembly or export is not a significant problem. When first assembled there may be some riding behaviour in groups of recently mixed groups of adult rams, sometimes in hoggets, though rarely in lambs. Experience suggests that this behaviour rarely persists for more than a few days, and removal of aggressive animals does not have to be done very frequently.

There can however occasionally be some fighting and head butting between horned and polled rams. The normal management practice of segregation of horned and polled rams during pre-shipment and on-board minimises these behavioural problems. Animals are also usually segregated on a weight basis (usually 3-4 weight ranges), and sometimes on an age basis (adult rams separately to hogget and lamb rams), which minimises any aggression problems by larger animals towards smaller animals.

Adequate feed trough space (current standards 3-5cm/hd depending on season), and maintenance of reasonable pen densities dependent on pen size and numbers (DAFF Standard 4 0.33—0.34 m^2 for average 54 kg animal) with daily monitoring of animal health and behaviour are now pre-requisites for sheep exports. Where these standards are in place, and with supervision by stockmen and veterinarians, *incidents of aggressive behaviour are considered to be infrequent and not a major cause for concern from a welfare perspective.*

4.3.2 Cattle

As for sheep, for many shipments of entire males aggressive behaviour is not considered a significant welfare issue (see Sections 4.1.2, 4.2.2). For bulls of beef breed origin, even those semi-feral ‘micky’ bulls from extensive pastoral properties in the north, best practice in relation to cattle handling is believed to have a big impact in minimising subsequent behavioural problems.

Mustering and initial on-property yard handling involving ‘low stress’ handling techniques, followed by short periods of yard feeding before road transport to holding facilities has been demonstrated to be successful. Once cattle are inducted at assembly depots, techniques such as placing cattle in yards close to traffic and human movement, having strange animals (horses, donkeys) constantly with cattle, background music and slow movement through yards are believed to have a big impact on fearful and aggressive tendencies, to the point where these can be largely minimised before shipment. Drafting bulls into size/weight ranges and ensuring that these groupings are maintained when bulls are loaded into pens on-board is a general practice and considered by many to be an important part of the process of minimising aggression and enhancing animal welfare.

On long haul trips to the Middle East there are some leg and feet problems seen in heavier bulls, including knuckling over. The weight restriction of 650 kg is appropriate if pen floor conditions and pen density to allow cattle to lie down, are all critical to minimising this problem. Leg problems are also minimised by penning heavier bulls on decks level with the loading and unloading facilities so they are not required to walk up or down the steep ramps between decks.

Once on-board, animals exhibiting aggressive behaviour need to be identified, and animals being constantly ridden (‘bullers’) by others need to be removed to other pens to minimise injuries. A problem however is that other animals sometimes then become the ‘buller’.

For some shipments of dairy bulls, aggression problems have sometimes meant that numbers of animals have to be removed from pens, which can create logistical and space problems. Drafting and penning on a size/weight basis is probably more critical in minimising aggression in dairy bulls, as is the presence of experienced stockman to manage behavioural problems.

4.3.3 Goats

All individuals with whom livestock exports were discussed were unanimous that the most significant problems of aggression, injury and induced mortality occurred with the export of entire male goats. The extent to which these problems reflect the feral background of most exported billy goats is a bit debatable. Does the problem of behavioural excesses have a genetic background or is there also an environmental component, reflecting lack of domestication? Probably both effects are operating, since although aggression problems are less in domesticated goats and in Boer and Boer cross goats, they can still occur.

A number of exporters no longer export large (>70kg) billy goats since previous experience suggests that animals of these sizes exhibit the greatest degree of aggressive behaviour.

Segregation on a weight basis is now standard procedure to minimise problems of larger goats riding smaller goats, and this together with removal and segregation of smaller ridden goats is widely practised. Smaller goats will frequently recover from riding injuries once a refuge is available, but as they often move between pens on board ship, aggression problems can re-appear. Good stockmanship, frequent human contact and frequent monitoring are essential to minimise welfare problems. The current requirement that goats must be 'behind wire' for at least 3 weeks before shipment has significantly improved the problems with goats (More and Brightling 2003).

4.4 Market preferences for export of live animals and of entire males

Customs, political, and economic concerns, religious and cultural beliefs and absence of suitable infrastructure including refrigeration and storage capacity are some of the reasons quoted for the preference of many importing counties for the importation of livestock rather than importing processed meat products (Hughes 2000, Brown 2005).

In the case of entire male imports, market preferences are governed by a number of factors. For many Islamic countries, these preferences are based on religious, cultural and nationalistic beliefs associated with religious festivals. This is important particularly where some ethnic and religious groups have strong beliefs relating to the consumption of meat from non-mutilated male animals (non-castrated, intact tails). In many Islamic societies, there is apparently more status associated with eating meat from an entire male as against a castrate (S Petty pers comm.). It has also been traditional in many Islamic countries to rear and consume meat from entire males, probably due to lack of experience with castration and, in smallholder situations, the negative consequences resulting from death of an animal from castration wound infections (D Heath, pers comm.).

There are two main Islamic festivals where a lot of meat is eaten. These are:

- Festival of sacrifice or Haj festival (also known as Qurban in south east Asia, Byram in Turkey and Eid- ul-adha in the Middle East) where animals are sacrificed in the memory of the Prophet Ibraheem. Bulls are preferred for cultural rather than religious reasons

(Fazal.R.Muhammed pers comm). This festival occurs in January but progressively changes over years.

- Festival of Eid-ul-fitiri (after fasting for Ramadan), which usually occurs in October/November each year.

According to Fazal.R.Muhammed, a Muslim supervisor with the Australian Federation of Islamic Councils, the preference for entire males is cultural rather than religious. There is no requirement in the Islamic religion to slaughter entire males. This cultural preference may change with time as younger people lose interest in tradition and understand meat quality and the improved tenderness and flavour from young castrated male cattle (D Heath pers comm.).

In addition to these preferences, there is also a preference for the consumption of lean meat showing little fat cover. In Midddle Eastern markets, the preference is because of the better yield from lean carcasses, whereas in SE Asian markets, leaner meat is preferred because it is more appropriate for Asian type meals, including stir frys and broths.

For shipments to many Islamic countries, the proportion of entire males goats loaded often increases around and prior to the Islamic Haj and Ramadan festivals, in addition to year-long trade requirements. This seasonality in demand for entire males changes between years, as a result of changes between years in the timing of the Haj. In future years, synchronising the supply chain for availability and shipment of entire rams and goats to coincide with the Haj may become more difficult (More and Brightling 2003).

Contrary to popular belief amongst exporters within Australia, Robert Abelesz from the Adass Israel Kosher Approval & Certification Authority, assures that for Jewish people, both male and female entire and desexed animals (cattle, sheep, goats, deer etc.) are Kosher, as long as they are slaughtered and processed according to Jewish law. Most Kosher meat actually comes from castrated animals. Jews are not permitted to castrate, though, once an animal has been castrated there are no restrictions re Kosher.

Similarly, an Israel importer (Doran Shany pers comm.), confirmed that the reason for preferring bulls to steers was different between Israel & Palestine. In principle, both countries preferred bulls for slaughter due to traditional religious reasons, however more recently in Israel, steers are becoming more widely accepted. In Palestine at present, there is still a strong preference for bulls. On average, 75-80% of bulls imported into Israel are destined for Palestine and 20% remain in Israel.

4.5 Analyses of previous, current & future opportunities for entire male exports

4.5.1 Sheep

In addition to ongoing yearly demand, there is, as mentioned, some seasonality in demand for entire rams and goats, coinciding with the Islamic Haj festival. There also appears to be a seasonality in demand from SE Asian importing countries also related to Islamic religious festivals including Ramadan and Leboran. The timing of the Haj festival advances each year (More and Brightling 2003), and concerns have been expressed by some (D Jarvie, G Robinson pers comms.) of the capacity of industry to meet these changing seasonal demand situations.

This is because, in the Western Australian sheep areas with a Mediterranean type climate, there is a marked seasonality of lambing. This could mean that over time some asynchrony could develop between time of lambing, time of availability of suitable sheep and time of demand. Availability of ram and hogget lambs of required size and weight for shipment at times around the Haj festival could thus be constrained. The problem may then become one of limited supply in the face of continued demand.

It is difficult to be too prescriptive in terms of the future of the trade in entire male sheep. In discussions with a wide range of people involved in the trade, some pessimism was expressed about long-term prospects of the live sheep trade. Some exporters were of the view that continued strength of the Australian dollar would be a constraint and would minimise our competitiveness with other exporting countries.

Others expressed the view that the continuing decline in the Australian sheep flock would, in combination with any wool price increases, put some pressure on availability of sheep for export due to competing pressures for build-up in flock numbers. Some exporters also expressed concern that increased administrative costs associated with meeting new regulatory and legislative requirements were further reducing existing small profit margins to the point where profitability of, and continued involvement in the sheep export trade was in doubt.

In contrast, others were more optimistic about the trade, pointing out that in Western Australia in particular, many sheep producers had structured their operations to ensure continuity of supply of entire males suitable for export markets, including the utilisation of cross breeding programs with imported meat type breeds such as the Damara, Awassi, Dorper and Dohne, to produce animals more suited to the trade.

4.5.2 Cattle

As indicated, information on entire male cattle has only been documented since July 2002, but anecdotal evidence indicates that in the past, entire male cattle have been an ongoing feature of the trade to the Middle East, and to a lesser extent to SE Asian destinations.

Historically many of the bulls exported have been ‘micky’ beef breed bulls and older cull bulls from extensive and sometimes poorly managed properties in NW Western Australia and the Northern Territory. This situation is likely to continue into the future while low levels of station infrastructure and management continue. However in other situations on well-managed properties, some entire males, resulting from missed musters or missing at branding, will continue to be available in smaller numbers, together with some older cull bulls. It should be emphasised that the export trade in entire males (and other classes of exported cattle) in these northern regions is very important to many local producers because of the absence of domestic markets and/or lack of slaughtering facilities within reasonable travelling distance.

The trade in entire males to several Middle Eastern countries including Israel, Jordan and Palestine is a variant of these practices in that these markets require younger and smaller animals for both feeder and slaughter purposes (MLA 2004). Some shipments to these destinations have included significant numbers of Friesian dairy bulls and it is in larger bulls of this type where aggressive behaviour has been a problem. The preference for Friesian bulls in these markets reflects a historical background of importations of this type of animal from Europe before BSE outbreaks occurred. However there is now an acceptance by traders in those countries that beef breed bulls are acceptable and increasing numbers of these type of bulls are being consigned to those markets (N Brown pers comm.).

There is a weight restriction on the export of older bulls, i.e. 650 kg because of welfare and potential injury concerns, but in some small shipments of high value breeding bulls, exceptions to this weight limit can be made. In addition to the year-long trade, there is a seasonal demand for bulls from the Middle East associated with the Haj festival, demand for bulls for the Haj currently being during the Australian summer months.

Because of the short time frame over which information on entire male cattle is available, attempts to calculate the value of this component of the trade are fraught with considerable conjecture. For example, about 5-6% of shipments of cattle from Darwin were estimated to be entire males (R Ainsworth pers comm.), suggesting that of the 219,000 head shipped in 2004, approximately 11,000-13,000 were bulls. However actual figures for bulls shipped in 2004 from Darwin were 16,000 bulls (L MacKinnon pers comm., LiveCorp 2005), a figure considerably in excess of other estimates.

The future of the trade in entire male cattle is closely linked with Middle Eastern market access. Those involved in the trade were generally optimistic about long-term prospects for the export of entire males, but continued availability was a concern to some. Improvements in general management and in infrastructure of many extensive northern properties, while regarded by all as highly desirable, were seen as possibly having long term effects on the availability of entire males ('mickys') which presently constitute the bulk of bull exports to the Middle East.

Some exporters were of the view that continued strength of the Australian dollar would be a constraint and would minimise our competitiveness with other exporting countries particularly Brazil. The emerging strength of Brazil as a supplier of both beef and live animals was also of concern for the longer-term viability of the bull trade. As for sheep, other exporters expressed the view that increased administrative costs associated with new regulatory, and legislative requirements were further reducing existing small profit margins, and could impact on viability of the live cattle export trade.

Future opportunities in the Middle East for the entire male live cattle trade will be governed by a wide range of factors, including competition from other suppliers in Africa and South America, the relative strength of the Australian dollar, our ongoing capacity to supply the right product at the right time, delivered in good condition and meeting market requirements, and changing consumer preferences in importing countries.

With increasing education and a developing middle class, perceptions of meat quality are improving. In some Asian countries, the traditional preference amongst the older generation for bull, ram and billy goat meat is being replaced by a preference amongst the younger generation for higher quality (juicer, more tender and better taste) cuts from feedlot steer meat.

4.5.3 Goats

No data is available on the breakdown by class of exported goats, as a majority have been entire males, preferred by all importing countries. To a large extent, the goat export industry has been based on an opportunistic 'harvesting' operation of feral and semi-domesticated feral goats in response to market demands (More and Brightling 2003). In this situation 'supply' has sometimes been a constraint (M Hayward pers comm.). It is estimated that approximately 90% of goats in Western Australia and 40% in Queensland are derived from unmanaged production systems (More and Brightling 2003). Whilst this situation is changing in some areas, particularly in the eastern

states, where there are now greater management inputs into semi-domesticated feral goats, quality issues and levels of productivity remain a problem with goats of feral origin.

Numbers and values of goats exported reached a peak in 2002 (Figure 5) but have declined significantly since then. As for sheep and cattle, there has been some seasonality of demand associated with the Haj festival, in addition to year round demand (Figure 6). There has also been a quite marked shift in recent years away from Middle Eastern markets to SE Asian markets which now take a majority (≈ 90%) of goats exported, many of which are now shipped by air.

A number of exporters were of the view that future opportunities for the live goat export trade will be dependent on continuity of supply of good quality livestock, well handled and less likely to be affected by stresses associated with assembly and shipping. In the medium to long term, improvements in quality can be achieved through genetic gains from cross breeding and via improved management systems including improved nutrition and husbandry. There is also a strong view amongst exporters and others that larger older bucks should be excluded from shipments, and that there should be a shift towards the export of wethers rather than entire goats. The latter shift will be more difficult to manage given preferences of many importers for entire males, though there is an apparent acceptance by importers for the need for this change (More and Brightling 2003). Welfare considerations will also be an increasing constraint on a trade based on feral animals. The recommendations by More and Brightling (2003) regarding cessation of the trade in export of feral goats on long voyages, and constraining the trade to the export of 'domesticated/managed' feral or crossbred goats would, if implemented, be a big step towards minimising welfare concerns and reducing death rates in transit.

Competition from other goat suppliers in Africa, India and North Asia, and the relative strength of the Australian dollar, were other factors identified. From all perspectives, welfare issues associated with aggression in male goats need to be addressed, to counter poor perceptions by many of the export goat trade.

4.6 Estimating the value of the export trade in entire males

The calculations undertaken here to estimate the value of the export trade in entire males are based on the data assembled for this project and, where necessary, appropriate assumptions have been made. No previous analyses of the value of the trade were identified.

For the entire male sheep trade, extrapolations from the data of Figure 1, and assuming an average of 10% of all sheep exported were males (Tables 1, 2, 3), the value of these animals ranged from approximately $20-22M between 1995 and 2000, and from approximately $34-41M between 2001 and 2002. However sheep export numbers and values (and numbers and values of entire males) decreased considerably in 2003 with a further decrease in 2004. *Estimates of the value of entire male sheep exports were approximately $35 million and $23 million in 2003 and 2004,* due in part to the absence of Saudi Arabia as a market, but also reflecting the strength of the Australian dollar in depressing demand.

For cattle, estimation of the value of the entire male component of the trade is limited due to the absence of data before 2002 on numbers. Consequently a number of assumptions have been made. Approximately 16,000 bulls were shipped from Darwin in 2004 representing about 7% of all cattle exported from there (L MacKinnon pers comm., LiveCorp 2005). When shipments to the Middle East from other ports (52,000, Table 5) are added to this figure, then a minimum estimate of bulls

exported (excluding other possible shipments from other ports to SE Asian destinations) is approximately 68,000 bulls, of which about one-third were bull calves exported to Middle Eastern destinations (Table 5).

This represents about 8.8% of all cattle exports of 774,000 head in 2004, which had a value of $477 million, with the *value of entire male cattle exports in 2004 estimated to be approximately $42 million.*

In the case of goats, numbers of entire males are not known with certainty, as this data is not collected. However assuming that at least 90% of goats exported are entire males (More and Brightling 2003), then for 2004 where the total value of exported goats was $4.7 million (LiveCorp 2005) *entire male shipments would have been valued at about $4.2 million.*

Including data for all three species, it is estimated that the export trade in entire males had a *value in 2004 of about $70 million, representing about 9.8% of the value of all livestock exports.*

In the case of the cattle and goat components, and some sheep components of this trade, domestic markets for the majority of exported animals would either not be available or would be limited and, but for the export market, it can be assumed that producers would not have received significant returns for these animals.

5 Literature Review

5.1 Background to review

The review of the scientific literature on aggressive behaviour in entire males, and on identification and evaluation of options for modifications of this behaviour forms one component of the project.

However, because of the paucity of objective data in some areas, this review is not a traditional review of the scientific literature. Rather, it is a combination of relevant published scientific information, extrapolations from accepted biological principles together with considerable anecdotal information derived from the experience, subjective judgements and assessments of a range of individuals, commercial interests and organisations involved in the live export trade. Wherever possible, an attempt has been made to verify the latter type of information against published information, but subjective judgements have been made by the authors when needed.

5.2 Introduction

The live export trade in livestock from Australia traditionally supplies the ‘wet markets’ of importing countries in the Middle East and in many parts of SE Asia. In these regions, where much of the meat is processed, transported, sold and consumed within 24 hours of slaughter, very little of the product is refrigerated before or after sale. Because of tradition, in some cases religious and cultural preferences, and as a consequence of the absence of processing and storage capacity for meat, there is a very strong preference for the purchase of livestock to supply such markets, rather than the use of chilled or frozen meat products. Australian exports of live animals into overseas markets, have however led to flow-on effects including a greater demand for Australian imported meat products including chilled and frozen lamb, mutton, beef and goat meats (Anon 2005). Other indirect benefits from the live export trade in importing countries have included significant improvements in animal welfare (Brown 2005), in slaughtering and processing techniques (Brown 2005, Beere 2005)

and in improved food safety (Brown 2005). Some of these impacts have also resulted in flow back effects to other sectors of the Australian livestock industries including abattoir design and equipment supply, refrigerated storage infrastructure developments and feedlot design and operations (N Brown pers comm.)

Were the supply of Australian livestock to be constrained in our current markets, evidence suggests that these would be quickly supplied by a number of other exporting countries, few of whom are concerned with animal welfare issues or with improving processing procedures and enhancing the food safety chain (Brown 2005).

In all Islamic societies, there is a strong cultural preference for the consumption of red meat from entire male animals (Hughes 2000, Brown 2005). In the Middle East this is particularly prominent at and around the time of the traditional pilgrimage to Mecca, the Haj, where sacrificial slaughterings form part of the ceremonial proceedings. Similarly there is an increased demand in SE Asia for entire males prior to and around Ramadan and other religious festivals. In addition to these preferences, there is also a preference for the consumption of lean meat showing little fat cover. (Section 4.4).

Patterns of behaviour of entire male domestic ruminants are frequently different from those of male castrates or of females. Overt sexual behaviour is frequently displayed by male ruminants, both to females and to other animals in a group. In extreme cases this translates into aggressive behaviour to other members of a group, can lead to physical injury both to the aggressed and to the aggressor, can disrupt feeding behaviour, and can reduce performance of other animals in a group, all of which effects have welfare implications.

In natural grazing situations, these abnormal behaviour patterns are not as important a problem, as challenged animals have more spatial flexibility to avoid conflict scenarios. However once animals are restrained in smaller areas, as during pre-shipment assembly or while penned on board ship, avoidance of aggressors is often very limited. Aggression problems can then have significant impacts on the welfare of some animals, and in some cases can contribute to higher death rates in exported livestock.

5.3 Behavioural physiology and endocrinology in entire males

In all domesticated livestock, selection for behavioural characteristics played an important part in the early stages of development of breeds. Man needed animals that were responsive to human control and domestication, had reduced agility compared to feral animals, were adapted to certain environmental conditions, and which were capable of being maintained in large social groups, with a hierarchical group structure.

In cattle (Albright and Arave 1997), sheep (Keeling and Gonyou 2001) and goats (Addison and Baker 1982), the social hierarchy is established at a young age. Dominance has been defined in terms of one animal inhibiting the behaviour of another, and a dominance order in a group covers all these relationships (Beilharz and Zeeb 1982). Dairy calves reared together from birth tend to delay establishment of dominance longer than those reared individually (Le Neindre and Sourd 1984). It is a little more difficult to differentiate between dominance and aggression, since initially some form of aggression, eg fighting, leads to either inhibition of or strengthening of behaviour in one animal, leading to dominance. In a herd structure, dominance relationships tend to be long term but can be disrupted by changing group composition, or by reducing group size, where individual recognition among herd mates appears to be less demanding than in large groups (Albright 1993). In the case

of bulls of dairy breeds, the findings of Le Neindre and Sourd (1984) may have long term management implications in relation to subsequent aggressive behaviour in such bulls reared for beef production, and then assembled and mixed into large groups for export.

Acquisition of dominance may be determined at an early age in farm livestock, and dairy calves reared together from birth tend to delay establishment of dominance longer than those reared individually (Le Neindre and Sourd 1984). This latter concept may have long term management implications in relation to subsequent aggressive behaviour in dairy breed bulls reared for beef production and then assembled and mixed into large groups for export.

A number of factors can potentially contribute to dominance in livestock, including genetic effects (breed differences); hormonal effects, particularly those due to testosterone (Bouissou 1990), physical attributes such as size and age (Tennessen et al 1985) and possible environmental effects such as weather and pen conditions, nutrition and stocking density (Phillips 2002).

There is scientific evidence, and considerable anecdotal information from industry that problems associated with dominance and aggressive behaviour in entire males during pre-shipment and on board ship can be minimised by segregating animals into different weight/size ranges (Hinch et al 1982, Norris et al 2003). Similarly in animals that are under-fed during confinement or where access to feed is restricted, subjective assessments and experience suggest that aggressive problems can be greater than when better quality diets of sufficient quantity are provided with adequate feed-trough space.

In farm livestock, aggression and dominance are interrelated but not necessarily synonymous in terms of social structure. Dominant animals probably have been aggressive in the past, in order to obtain their dominant positions, but a dominant animal may not need to be aggressive always (Beilharz and Zeeb 1982). In entire males there is a further problem in differentiating behaviour due to sexual activity from that due to dominance and aggression within a group of other males (Petherick 2003).

The agonistic behaviour of cattle is multiplied under conditions of high density (Kondo et al 1989) as can occur in feedlot situations or in small pens in transit. However once social groupings are established and animals become familiar with surroundings and with herd mates, stress levels are reduced and animals appear to have an increased comfort level (Kondo et al 1984). The key principle of minimising group social changes and of loading and transporting animals with their designated social herd mates is extremely important in minimising stress and reducing agonistic behaviour (Tennessen et al 1985, Keeling and Gonyou 2001).

Male homosexual behaviour is widespread in farm animals (Dagg 1984), but there is limited information on, and only a poor understanding of behavioural, genetic, physiological or endocrine influences on this trait in farm livestock (P Hemsworth pers comm). This makes the development of behavioural modification strategies more difficult. In sheep, ram homosexual behaviour is common (Perkins and Fitzgerald 1992, Alexander et al 1999). It has been suggested by these and by other authors (Dagg 1984) that this may represent dominance displays, aggressive acts or atypical sexual orientation. However this does not help us explain the physiological basis for either aggression or sexual behaviour.

Aggressive and sexual behaviour in males is dependent on a functional brain-pituitary-testicular axis, and in particular the secretion of testosterone by the testis (D'Occhio 1993). Social interactions between males are probably primarily related to the inherent sexual behaviour of these males Behavioural results from mixing groups of strange bulls or steers provide some evidence of the role

hormones play in aggression, since mounting behaviour is highest in intact bulls (Hinch et al 1982) suggesting hormonal effects probably due to differences in circulating testosterone levels (Price et al 2003).

However neither testosterone nor luteinizing hormone (LH) levels provide a measure to predict sexual or aggressive behaviours in bulls (Bindon et al 1975, Price et al 1986). Reductions in circulating testosterone levels using immunisation against GnRH will reduce but not entirely eliminate aggressive behaviour in cattle and sheep and goats (Jago et al 1997a,b, Kiyma et al 2000, Godfrey et al 1996), and these aspects are discussed subsequently.

The 'buller' steer syndrome, in which one or a number of cattle persistently ride one or more particular individuals within the group, is a major behavioural problem in feedlot cattle (Taylor et al 1997). Similarly when bulls are run in groups such as in intensive dairy bull beef production systems on pasture (M Deland and R Hebart pers comms.), aggression problems can arise, and injuries can be caused by excessive mounting or riding behaviour by some aggressive bulls. Often the bulls being ridden and those riding keep changing, and constant surveillance is needed. Removal of the 'buller' animal is often needed, but other submissive animals may then become 'bullers'. Similar problems have been reported in sheep (Perkins and Fitzgerald 1992), and in goats (Addison and Baker 1982).

The common methods of controlling homosexual behaviour are removal of ridden animals, minimising disturbances, reducing stocking rates and group sizes, ensuring the animals are comfortable and satisfied nutritionally. Other novel methods of controlling homosexual and aggressive behaviours include placing a donkey or another animal of a different species in the group, or spraying groups of animals showing homosexual behaviour with a strong smelling antiseptic substance such as Hibitane (Kilgour and Dalton 1984, S Hood pers comm.).

However the exact sequence of endocrinological events that determine the level of aggression displayed by males remains unclear. Some studies (eg Price et al 1986) were unable to demonstrate any relationships between circulating testosterone (T) and LH levels in either libido or aggressive behaviour in bulls during periods of sexual rest. However a subsequent study by the same authors (Price et al 2003) suggested that animals with higher T levels were often more aggressive than those with lower T levels.

In sheep, Alexander et al (1999) found that T levels did not differ between high or low performing rams or rams exhibiting male-oriented behaviour preferences. In the latter two groups, LH concentrations also remained unchanged, regardless of sex of the stimulus animal, though T concentrations were increased in the low performing group when exposed to rams.

In another sheep, study Perkins and Fitzgerald (1992) found that male oriented homosexual rams exhibited more overt sexual behaviour responses, but aggression was not affected. Further these animals did not exhibit an endocrine response to oestrus ewes, but in some individuals, sexual behaviour directed towards males increased T concentrations, but not LH concentrations.

In feral goats, reproductive and agonistic behaviour is not constant throughout the year but varies seasonally under the influence of photoperiod and nutrition (Restall 1992, Walkden-Brown et al 1994), with peak activity of rutting in autumn or after drought breaking rains in arid regions. During the rut in feral goats there are marked increases in pituitary (LH and FSH) hormone and T concentrations that increase male odour and aggressive and sexual behaviour patterns (Walkden-Brown et al 1994).

Dominance patterns in groups of male goats have been described by Shank (1972) and by Godfrey et al (1996), including descriptions of aggressive behaviour. Aggressive behaviour in goats is more common when new animals are introduced into an existing group, when different mobs are mixed, when there is a big range in size of animals, during over-crowding or where there is competition for either available feed, or feed or water trough space (Godfrey et al 1996).

However we do not know if aggressive behaviour in male feral goats has only a physiological/endocrinological basis, or whether there is an additional inherent psychological component reflecting the feral origin of these animals.

A Canadian study (Tennessen et al 1984) on bulls and steers transported by road over short times (max 2 hrs) suggested little differences in stress experienced by either group, but all animals were trucked in the company of pen-mates. It was suggested that the presence of herd mates may have a supportive and/or buffering effect on levels of aggression and on an animal's ability to cope with the novelty of transport. However it is difficult to extrapolate these findings to those that may occur during extended shipboard transport.

Further work (Tennessen et al 1985) found that stress levels were considerably increased when young bulls and steers were re-grouped, that levels of aggression increased with age, and aggression increased markedly in a group of bulls when strangers were introduced, but subsequently declined. Levels of aggression can be influenced by management and environmental factors such as environmental temperatures, precipitation, pen floor conditions, pen size, feed-bunk access, time of year as with goats (Restall 1992) and placement of feeding and watering facilities (Wieringa 1990).

Where problems of aggression, leading to injury or disruption of activities are occurring in exports of entire males, these factors need to be taken into consideration in the development of management systems. Application of good recognised animal husbandry procedures for cattle managed under high stocking densities should be employed to minimise behavioural problems and maximise animal welfare considerations. Potentially practicable options are discussed in the following sections.

5.4 Options for modification of behaviour patterns to minimise aggression.

There are a number of options for modifying/controlling aggressive behaviour in entire males being exported. Not all of these are likely to be practicable, some may be costly, while others may be unacceptable to importers of livestock or to consumers of meat products from imported livestock.

5.4.1 Selection for temperament

There is a mounting body of evidence that temperament in domestic livestock is moderately heritable and is related to a number of production parameters including growth rates, fertility and meat quality (Burrow 1997, Burrow et al 1999).

Whilst strong relationships may not exist between measures of temperament and extent of aggressive behaviour, poor temperament in some livestock can disturb normal group social patterns, which in turn could contribute to the development of behavioural problems in groups of animals during pre-shipment and in transit (Burrow and Dillon 1997).

Additionally, there is evidence that temperament is related to weight loss during road transit, and for the initial recovery period (Burrow et al 1998). Assuming that similar relationships apply in sea

transit, then pre-shipment culling of animals of poor temperament should reduce stresses, minimise weight losses, and enhance overall welfare of exported cattle. It has not been possible to identify similar information for sheep and for goats.

Thus short-term phenotypic improvements in temperament of a group of animals may be achieved by selective removal of animals of poor temperament, but in order to achieve longer term gains in improvement of this trait, genetic selection practices need to be put in place.

In relation to aggressive behaviour however, single trait genetic selection for good temperament is unlikely to be applied in extensive livestock breeding operations, unless there are clear indications of a strong link between temperament scores and measures of aggression (regardless of links to other production traits).

To our knowledge such links have not been established for cattle and for goats where aggression problems during export have been identified as a problem. There also needs to be a payment response, that is, exporters would need to pay premium prices for animals with genetically better temperament.

Additionally currently applied genetic selection programs are unlikely to be effective other than over a long time frame, and are likely to be applied only when opportunities for genetic selection for a range of more economic production traits have been put in place. Whilst gene markers are now being identified for a range of production traits in a number of livestock species, the problem with their possible application to identify animals with a high level of male aggression is that we do not know if this trait reflects a genetic or a strong environmental component. For feral goats, it probably reflects the latter.

5.4.2 Genetic effects on aggressive behaviour

Changing the genetic composition of a group of animals, or selecting for export animals of different breeds or types may result in a progressive reduction in levels of aggressive behaviour, provided these breeds or types meet market requirements.

For example, considerable anecdotal information suggests that levels of aggression in feral x Boer crossbred male goats are considerably less than in feral goats and that aggressive behaviour in purebred Boer male goats is minimal compared to feral or crossbred animals (A Brightling, G Robinson, N Thorne, R Ainsworth pers comm.). As indicated however, It is difficult to determine whether such differences in aggressive behaviour reflect an environmental component (goats of feral origin) or whether these differences have a genetic component. Boer goats are a domesticated breed, and they, and crossbreds will have a lower stress response to contact with humans, and in response to strange environments, suggesting a strong genetic component.

In cattle, there is considerable anecdotal information from veterinarians and stockmen that aggression problems during export are significant in Friesian and other dairy breed bulls, but are not a major problem in beef breed bulls of either *Bos taurus* or *Bos indicus* strains (R Ainsworth, P Arnold, N Thorne, G Beckett pers comm.). Additional evidence confirming these observations is that dairy bulls are generally more aggressive than beef breed bulls (Purcell and Arave 1991, Albright and Arave 1997).

In summary, genetic selection to reduce aggressive behaviour in entire males is not a practicable option for cattle, sheep and goats destined for live exports.

However where feral goats are being domesticated, changing the genetic composition of the flock through crossbreeding offers one option for reducing aggression problems. In the case of dairy breed bulls being exported, some end-market analyses may be needed to clarify if beef breed bulls, in which aggressive behaviour is not a major problem, can satisfy market requirements equally as well. Where this may not be the case, then good management practices need to be put in place, both during pre-shipment and whilst in transit, to minimise aggression problems. Some of these options are discussed subsequently.

5.4.3 Group size effects and stocking density effects

There can be behavioural implications in livestock in relation to group size. Mention has been made of the social relationships that develop in most domestic livestock, which, over time, tend to minimise overt agonistic behaviour. However when groups of animals contain individuals of varying ages, size/weight, presence or absence of horns or when new animals are introduced to the group, agonistic behaviour may still be part of the social structure of the group (Fraser 1980, Addison and Baker 1982), and can have welfare implications when animals are being exported.

Both published information (More and Brightling 2003) and anecdotal information from industry indicates that these problems are particularly severe in feral and semi-domesticated goat shipments to the Middle East and to SE Asia, and careful management is essential to reduce problems of aggression and resultant injuries. Some of these management strategies are discussed in a later section of this review.

Under pen conditions and with high stock densities, if feed or water trough space is limiting, it tends to be the dominant animals that access food and water when they want, and while subordinates may not be denied access, they may have to wait until more dominant animals move away before accessing food and water (Petherick and Kilgour 2000). In conditions of high pen densities, even space to rest can be a consideration (Stricklin and Gonyou 1981), and in goats, opportunities for smaller or aggressed animals to escape are probably important.

There is some objective evidence from goats (Cowley and Grace 1988), and considerable anecdotal experience, that size of pen (and hence numbers per pen) can also influence the level of aggressive behaviour particularly in feral goats (More and Brightling 2003). This correlation has also been seen in dairy bulls (Kondo et al 1989). However we have not been able to locate experimental evidence from shipboard conditions to confirm these observations. Similarly, Petherick and Kilgour (2000) in work in cattle feedlots also noted that small groups and small pens tend to exacerbate the negative effects of any social hierarchy.

Some additional evidence on group size and stocking density effects on entire bull behavioural aspects is available from dairy bull beef intensive grazing systems used in New Zealand and in South Australia (Everitt 1973, Everitt and Ward 1974, Anon 2004, J Reeves pers comm.). In these systems, large groups of mainly Friesian bulls are reared and grown out under a very intensive rotational grazing system on improved pastures, animals being moved to fresh pasture at 2-4 day intervals. Under South Australian conditions, depending on the size of the operation, group sizes range from 15-20 to 50-60, animals being of similar size/weight, run at high stocking densities (3-7/ha), and achieving very high daily weight gains.

Provided low stress handling techniques are used, group composition remains unchanged, animals are routinely handled or trucked to slaughter with their herd mates and adequate feed is available,

aggressive behaviour is not a significant problem (M.Deland, B Hebart pers comms). However where new animals are introduced, groups are mixed while handling in yards, during transit or while in lairage, or when animals are only on a moderate (as against poor or good nutritional planes) then aggressive behaviour can become an important management issue (J Reeves pers comm.), as well as increasing bruising levels and incidence of dark cutters at slaughter. The key principles to minimising aggressive behaviour in these management systems are low stress handling, good nutritional levels and continued segregation into established social groups.

5.4.4 Handling and management strategies

There is very little published information on the application of a range of management strategies for modification of aggressive behaviour in entire males. However there is considerable anecdotal and subjective information that the application of some basic husbandry and management procedures can minimise aggression problems and enhance the welfare of exported animals. While many general principles of husbandry and management apply to all livestock species, their importance will vary between species.

In discussions with a very wide cross section of the livestock export industry it was evident that problems of aggression in entire rams were minimal, and that there were no major welfare consideration related to the export of these animals.

In the case of cattle there was widespread consensus in the industry that, provided good management practices were applied, aggression and consequent welfare problems were generally not an issue with the export of beef breed bulls of either *Bos taurus* or *Bos indicus* strains. However there were well identified problems of aggression and poor welfare outcomes associated with many export shipments of dairy breed bulls, particularly Friesian bulls.

In the case of goats, in some shipments, particularly of feral goats, aggression leading to increased death rates can be a significant problem, whilst in other shipments, involving domesticated feral goats or feral crossbreds, the extent of the problem has not been as great. Because of these within and between species differences, the discussion that follows is presented on a species basis, recognising however that common principles apply.

Sheep

Management practices that will minimise problems of aggression, many of which are in routine use in the preparation of entire rams for export include:

- Age identification and removal of old rams prior to feed lot entry
- On-farm partial dehorning where large horns are present
- Pre-shipment feed lotting/housing to accustom animals to pelleted diets used on ship
- Pre-shipment shearing of rams with more than about 2.5 cm wool.
- Identification and sometimes removal of non-feeders during pre-shipment period
- Segregation of animals on a size/weight basis (most rams drafted up into three – four size ranges during feed-lotting) and maintaining segregation during shipment
- Segregation of horned from polled rams and maintaining segregation during shipping
- Ensuring pen density on-board is appropriate for size/weight of animals and meets legislative requirements (DAFF 2005), with additional 10% space for horned rams.
- Where required on-board, removal and hospitalisation of non-feeders, sick animals and those subjected to aggressive challenges or injured as a result of aggressive behaviour.

- Ensuring adequate feed and water trough space is available, and that feed supply is adequate to ensure that any dominance and aggression problems do not limit access to feed and water for submissive animals.

Information provided to us from a number of sectors of the trade suggests that if the above principles and processes are followed, aggressive behaviour in entire rams is at very low levels and does not constitute a major welfare problem. However as pointed out earlier, shipboard mortalities in rams are marginally higher than for other classes of animals. From a welfare perspective, some additional research appears warranted to define the background to, and causes of these mortalities and to develop recommendations to further reduce losses in entire male sheep.

Cattle

As mentioned, general consensus in the industry is that major problems related to aggression occur primarily in exported dairy breed bulls, many of which have been reared under intensive or semi-intensive conditions. Many exported beef breed bulls are feral or semi-feral 'mickey bulls', sometimes of very poor temperament. Following yarding, pre-conditioning prior to shipment tends to minimise problems of poor temperament and aggression. Again there is little published information on options to minimise aggression and enhance welfare of bulls. The following points have been distilled from widespread discussions with industry, together with published information where available.

- Recently captured semi-feral 'mickey' bulls should be restrained in yards, provided with feed and water, and minimally disturbed for up to 48 hrs, prior to trucking to export holding depots.
- Anecdotal experience from industry suggests that the presence of a strange animal (horse, donkey) in the yard with cattle assists in calming and quietening fractious animals, as does the presence of continued background noise such as music (B Leishman pers comm.)
- Other experience (N Thorne pers comm.) has been that at export holding yards, placing semi-feral animals closer to roadways and to traffic movement in and out of the yard, exposes them to more movement activity and human presence, and is more effective in acclimatising these animals to ship board conditions.
- During pre-shipment, and during induction periods, cattle should be frequently handled through yards, using low-stress handling techniques (Grandin 1989, 1993), avoiding the use of dogs, whips and electric prodders.
- The standard time spent in pre-shipment or export yards is 4 to 5 days. With semi-feral or 'mickey' bulls, 10 days is considered a more appropriate time period to allow adaptation to new conditions (N Thorne pers comm.).
- A feeding strategy found useful during pre-shipment assembly is to initially provide round bales of hay in the middle of the yard for bulls that are not trough trained (N Thorne pers comm.). Feed should also be provided in troughs and bulls should be gradually trained to eat from the troughs.
- Where animals have been run in established social groups these must be maintained during pre-shipment and on-board. Considerable levels of stress occur, and changes in physiological and behavioural patterns are disrupted when unfamiliar cattle are re-grouped (Tennessen et al 1985).
- During both pre-shipment and on-board, animals should be grouped on a size/weight basis (mean $\pm$ 50kg).
- Segregation of horned from polled animals with maximum horn length of 12cm (DAFF 2005).

- During loading, heavy weight bulls should be loaded into pens located at about loading ramp level, to reduce the need to ascend or descend ramps, in order to minimise chances of foot injuries. Straw should be provided on the floor of pens to minimise foot and claw wear.
- Ensuring pen density on-board is appropriate for size/weight of animals and meets legislative requirements (DAFF 2005), with allowances for voyage duration, timing and port of loading.
- In cases of injury to 'bullers' due to aggressive behavior, injured bulls should be removed to hospital pens for treatment. However experience indicates this does not always solve the problem, since on removal other 'bullers' are identified and become the aggressed animals.
- Foot and claw injuries often become a major problem in riding rather than ridden bulls resulting from excessive wear and stresses associated with constant mounting. Injuries may mean bulls spend considerable periods lying down, are reluctant to rise and walk, may reduce feed intake, loose body condition and may themselves become the victims of other mounting bulls.
- Anecdotal comment from some involved in the trade suggests that in cattle shipments containing pregnant heifers, transferring aggressive dominant bulls into pens of heifers or cows solves most male aggression problems.
- Other anecdotal experience from industry suggests that spraying cattle with water containing a strong smelling antiseptic may also reduce mounting behaviour (S Hood pers comm.).
- Aggressive behaviour is a greater problem where nutrition is limiting, and good quality, adequate diets must be available.

Goats

A majority of goats exported are either feral or semi-domesticated feral entire males in which aggression problems can be severe, with injuries, deaths and loss of weight common during on-board shipment (More and Brightling 2003). As mentioned, aggression problems are not as severe in feral crosses or in entire males of other breeds, and cross breeding is one obvious approach to minimising problems.

There is very little published information on options to minimise aggression and enhance welfare of male goats. The following points, similar to those mentioned for sheep, have been distilled from discussions with industry, from the report by More and Brightling (2003), and from published information where available.

- Changes to earlier procedures whereby it is now a requirement that goats be held in holding facilities for minimum 21 days before shipment (N. Buchanan pers comm., DAFF Standards 2005).
- Age identification and removal of older and more aggressive bucks at feed lot entry.
- Partial dehorning where large horns are present (general rules appear to be when horns prevent access up drafting race, where horns turned in and may cause damage to head and eyes, would endanger other animals, would restrict access to feed and water during transport).
- Pre-shipment feed lotting/housing to accustom animals to pelleted diets used on ship, with provision for shelter in outdoor yards where these are used.
- Segregation on a size/weight basis (drafted up into three – four size ranges during feed-lotting) and maintaining segregation during shipment.
- Ensuring animals are kept in smaller groups in pre-shipment holding areas, and not left as a large group in one large yard.
- Ensuring pen density on-board is appropriate for size/weight of animals and meets legislative requirements (DAFF 2005) with additional 10% space for horned goats.

- Where required, on-board, removal and hospitalisation of non-feeders, sick animals, and those subjected to aggressive challenges or injured as a result of aggressive behaviour.
- Where possible, penning of goats on the vessel in single tier pens (More and Brightling 2003).
- Providing 'buller' goats with opportunities for escape from aggression, and maintaining segregation of smaller animals.
- Ensuring availability of adequate feed and water trough space so that dominance and aggression problems do not limit access to feed and water for submissive animals, both in pre-shipment holding areas, and on board ship.
- Ensuring adequate supplies of good quality chaff and/or hay for treatment and feeding of non-eaters during transit.
- Ensuring that feed and water troughs are cleaned frequently to minimise contamination problems. Contrary to popular belief, goats are actually 'fussy' animals so should be provided with adequate good quality hay and pellets. Goats will not eat soiled or wet feed and, if this is not replaced, stress induced behaviour such as bulling increases (N Thorne pers comm.).

5.4.5 Nutritional Impacts on aggressive behaviour

One key to managing behaviour is managing stress. Poor nutritional management can induce stress and stress can produce or increase nutritional deficiencies (NRC 2000). Hence attention to some nutritional principles may assist in manipulation of entire male behaviour.

In animals assembled for export or in ship-board transit, basic nutritional principles should be applied to ensure appetite is satisfied, which will assist in minimising adverse behaviour such as aggression and riding. These principles, some of which are included in management options listed above include:

- Do not under- or over-feed.
- Maintain adequate roughage.
- Feed animals at the same time every day.
- Allocate adequate bunk space and water trough space.
- Ensure stocking rate and/or pen density is appropriate for the species and class of animal.
- Ensure a balanced ration is fed that provides recommended protein, energy, mineral and vitamin levels.
- Maintain consistency in the ration.

Published information (Albright and Arave 1997) and some anecdotal evidence indicates that animals on a poor or sub maintenance nutritional plane for short periods exhibit higher levels of aggressive behaviour. But whether this reflects competition for available feed or a physiological response to restricted intake is not clear. Where animals are on a high plane of nutrition, or conversely on low nutritional levels for long periods, their libido and aggressive behaviour is either at normal levels or is reduced (Entwistle and Holroyd 1993).

As mentioned, levels of agonistic behaviour among bulls have been observed to increase with increasing age. Therefore, it seems desirable in intensive feeding situations (in Australia or in importing countries) to feed diets with a high energy content, enabling bulls to reach a desirable slaughter weight and carcass composition at the youngest age possible (MacNeil et al 1989).

There have been anecdotal and unsubstantiated recommendations that feeding certain minerals, amino acids and vitamins such as magnesium, tryptophan and Vitamin B1 will assist in reducing stress levels and modifying behaviour. If the diet is balanced these nutrients should be adequate in a ration and feeding to excess may only result in a limited response if at all.

Magnesium (Mg) absorption through the digestive tract may be decreased with excessive levels of calcium (Ca) and phosphorus (P); excess fat in the diet; high iron (Fe) levels; imbalanced Na:K ratio; or excessive levels of potassium (K) and protein (creating high ammonia levels in the rumen) as seen in lush pastures. These pastures are also deficient in neutral detergent fibre (NDF) and induce a fast rate of passage of nutrients through the gut, again reducing the animal's capacity to absorb Mg. Inclusion of ionophores, such as rumensin, and salt improves absorption of magnesium. Among other physiological roles, Mg is involved in neuromuscular transmission, and as an antagonist for adrenalin release, and this is probably where it is thought to have a role in modifying behaviour.

Magnesium deficiency (most commonly seen as grass tetany) is manifest clinically by a range of symptoms including hyperirritability and tetany, peripheral vasodilation, anorexia, muscular incoordination and convulsions, many of these symptoms responding quickly to Mg therapy, giving rise to clinical conclusions that Mg is involved in modification of behavioural responses, through inhibition of adrenalin release. In cattle there are reported genetic differences in Mg requirements, Mg absorption being greater, and therefore, requirements lower in Brahman compared to dairy and British breed cattle (McDowell 1992).

Gardner et al (2001) and D Pethick (pers comm.) found that feeding MgO to sheep and cattle prior to and during a stressful period decreased glycogen loss associated with stress and increased rate of glycogen repletion following stress. This was only significant if Mg was fed at higher levels and responses from sheep were better than from cattle. Magnesium has been shown to reduce the stress response in hypomagnesemic sheep suffering hypothermia, possibly through a reduction in adrenalin output via an antagonistic interaction with Ca (Gardner et al 2001).

This suggests that the effects of supplemental Mg will only be demonstrated when animals are placed under an increased stress load as occurs during transport. Changes in behaviour were not recorded in these studies but the results suggest that dietary supplementation with Mg is a possible method of stress reduction that needs to be further investigated.

There have also been suggestions that chromium levels in the diet may have an impact on responses to transport stress (Chang and Mowat 1992, Andersson 1994). However reports of production or behavioural responses to supplemental chromium have been conflicting, and in non-stressed cattle addition of chromium to feed-lot diets had no effect on weight gains or carcass traits (Danielsson and Pehrson 1998). It is doubtful if increased chromium levels in ship-board rations would result in beneficial reductions in aggressive behaviour in cattle or goats, though there may be some impacts on reducing transport stress effects.

Thiamine (Vitamin B_1) is the coenzyme responsible for all enzymatic reactions providing energy to the body, including the brain. Polioencephalomalacia (PEM), a central nervous system disorder in grain fed cattle, sheep and goats has been linked to thiaminase activity or production of a thiamine antimetabolite in the rumen. Affected animals respond to treatment with thiamine.

Again this is probably where it is thought that thiamine may be able to modify behaviour. However, supplementation of high-concentrate diets with thiamine has yielded inconsistent results, because

animals with a functional rumen can generally synthesize adequate amounts of thiamine (NRC 2000).

Tryptophan, one of the essential amino acids, must be received preformed from food or supplements; non-essential aminos can be made from essential amino acids, or other non-essential amino acids. Tryptophan is a precursor to serotonin and studies with humans and animals indicate that serotonin can promote feelings of well being, calm, personal security, relaxation, confidence and concentration (NRC 2000).

In times of stress, particularly chronic stress, circulating levels of cortisol decrease tryptophan levels (NRC 2000), thus a positive response to tryptophan supplementation can be seen. In poultry, broilers fed diets with supplemental tryptophan show lower pecking behaviour than unsupplemented birds. Other studies have found that tryptophan significantly decreases the stereotyped self-mutilating behaviour that sometimes develops in caged monkeys. More recently, R Warner (pers comm.) observed reduced stress levels in pigs fed tryptophan.

There are also commercial products containing tryptophan marketed as calming agents for fractious horses. Responses in ruminants have been less successful, as tryptophan is degraded in the rumen and there is a need for rumen protection of the amino acid (NRC 2000). In addition, the substance is costly but further research on the use of the compound to reduce aggression could be beneficial.

Recent research by Horticulture and Food Research in New Zealand has led to the development of a product claimed to minimise transport stress in livestock (D Ferguson pers comm.). However information on composition of the product, and on responses, is commercial-in-confidence, and we cannot make any conclusions on potential efficacy of the product for behavioural modifications.

In conclusion, dietary incorporation of magnesium, vitamin B_1 and tryptophan may result in behavioural response in entires, but either the diet would have to be deficient, animals would need to be stressed for responses to occur, and the products would have to be available at a reasonable cost. Additional research may be warranted to examine responses in ruminants being exported.

5.4.6 Endocrine manipulation of behaviour

Immunological castration

Sexual behaviour in males is dependent on a complex inter-relationship between hormones produced in the brain, anterior pituitary and the testis. Testicular function and behavioural characteristics in males are regulated by the secretion of Luteinizing Hormone (LH) and Follicle Stimulating Hormone (FSH) from the pituitary, which are in turn, regulated by the secretion of Gonadotropin Releasing Hormone (GnRH) from the hypothalamus. Androgens, including testosterone (T) and oestrogen (E), secreted primarily by the testes are key regulators of growth rate (GR), feed conversion efficiency (FCE) and carcass leanness and are also associated with the induction of aggressive and sexual behaviour in the male.

Hence, bulls are more efficient than steers since they grow more rapidly (proportionately 0.1 to 0.15 times faster), require less food per unit gain (proportionately 0.87) and produce leaner carcasses (Adams and Adams 1992, Adams et al 1993, 1996). However, in the past it has been recognised that aggressive and sexual behaviour of bulls has led to management and carcass quality problems. This is particularly applicable to *Bos taurus* beef bulls and dairy bulls. From all reports, *Bos indicus* bulls seem to be less aggressive and easier to manage in intensive situations.

Understanding these hormonal pathways, and recognising the need to maximise growth and minimise behavioural problems in feedlots and in other intensive situations, has led to the development of vaccines against GnRH (Finnerty et al 1996). GnRH in itself is not immunogenic, and therefore requires conjugation to antigenic carrier proteins for effective immunisation.

The antibodies raised against GnRH inhibit the release of gonadotrophins from the pituitary, and in turn, T production in the testes ceases temporarily. This is accompanied by a transient decrease in testicular size, which, once antibody titres decline, will return to approximately pre-treatment size.

A variety of GnRH conjugates have been used to immunise bulls against GnRH including the commercially released *Vaxstrate* (GnRH-ovalalbumin) (Jago et al 1996, 1997a,b, 1999), and a porcine product, *Improvac* designed to minimise boar taint in intact boars. These forms of conjugated GnRH have extended the effect of the vaccine from 6 months to 15 months. Recently there have been further advances in anti-GnRH vaccines through the use of molecular biology and recombinant DNA techniques, ie the incorporation of GnRH into vector delivery systems (D'Occhio 2003).

Immunisation against GnRH is a possible approach to inhibiting androgenic reactions without severe reductions in anabolic performance. It also has animal welfare benefits when compared to surgical castration and may have less adverse consumer reaction than the use of hormonal growth promotants (HGP). However in those cultures and slaughtering regimes where the testes are left on the carcass to indicate the slaughtered animal was an entire male, there could be some consumer reaction against animals with smaller than normal testes.

Most studies since the early 1980s largely on *Bos taurus* beef or dairy bulls have shown that anti-GnRH immunisation of pre- or peri-pubertal calves retarded testicular development; reduced spermatogenic and steroidogenic activity and animals exhibited live weight gains and carcass and meat quality characteristics intermediate between steers and bulls (Robertson 1982). This has occurred with either one (Adams et al 1996) or two vaccinations, the second vaccination being given anywhere from 2 weeks to 4 months later. Results have been positive but more variable with post-pubertal bulls.

However, some studies have shown up to 50% non-responders in pre- or peri-pubertal bulls (Lobley et al 1992; Robertson 1982). Some animals also show a 'rebound' phenomenon. There is a need for a reliable immunisation procedure so that minimum periods of T suppression can be guaranteed in all treated animals (Lobley et al 1992). Some believe this variability is caused by a natural variation in immune response among animals (Jago et al 1997b), while Price et al (2003) concluded there is also year to year variation in conjugate activity.

Several groups around the world are working on better forms of immunisation against GnRH. Dr Jerry Reeves from Washington State University has followed the fusion protein approach and has conjugated GnRH to albumin. Conversely, Dr Terry Nett from Colorado State University has conjugated a GnRH agonist to the Poke Weed Anti-viral (PAP) protein. PAP has potent cytotoxic activity once it enters the cytoplasm of a cell but is incapable of entering a cell by itself. The GnRH agonist would be used to specifically deliver PAP to cells expressing GnRH agonist (M D'Occhio and A Kenny pers comm.).

In addition to testicular, meat quality and carcass changes following anti-GnRH immunisation, a number of studies (Huxsoll et al 1998, Jago et al 1999, Price et al 2003) have demonstrated that the

procedure reduced sexual and aggressive behaviour, though in a recent Australian study (D'Occhio 2003) these effects could not be demonstrated.

The objective of current work at the University of Queensland (A Kenny pers comm.) is to treat bulls with GnRH-PAP leading to death of gonadotrophe cells thereby suppressing reproductive function and sexual and agonistic behaviour in cattle. Studies recently conducted on post-pubertal *Bos taurus* beef bulls and Brahman bulls in Queensland (D'Occhio 2003) showed limited suppression of T and of any increase in GnRH antibodies in Brahman bulls. This could be a combination of a dose effect, or perhaps a unique hormonal response from *Bos indicus* cattle.

Bulls in both Queensland studies (D'occhio 2003) were given repeated injections at 1 or 2 weekly intervals. However, each of these vaccinations only contained 1000µg GnRH conjugate. These vaccines were a commercial pig vaccine (Improvac) and a prototype cattle vaccine. Obviously, there is a substantial difference in concentrations of GnRH in experimental vaccines and current commercial vaccines. Jago et al (1997 & 1999) used the previously commercial Vaxstrate vaccine at a dose of 3mg GnRH conjugate.

Primary vaccinations in most overseas studies referred to throughout this review included GnRH or GnRH conjugate levels> 3mg, with a reduced dose in the booster vaccine. These levels led to peaks in anti-GnRH titres (40-80%) between 3 and 5 months after primary vaccination and a steady decline after this. Testosterone levels were generally back to 'bull' level between 6 and 9 months post-vaccine. However, measurable effects of the vaccine continue after the testosterone levels have returned to 'normal' levels, for example slower growth rate, better quality carcasses (measured by USA quality grades) and, reduced adverse behaviour. This is particularly seen in cattle vaccinated in the pre- or peri-pubertal period (Finnerty et al 1996).

As mentioned, anti-GnRH immunisation also has effects on sexual and aggressive behaviour in cattle, sheep and goats (Jago et al 1997a, b, Kiyma et al 2000; Godfrey et al 1996). Finnerty et al (1996) recorded that bulls in which the prepubertal rise in testosterone is delayed for 2 months by immunisation with GnRH experienced a significant reduction in testis size and in sexual and aggressive behaviour, compared with control bulls, effects which lasted until slaughter 18 months later. However these animals had similar growth and carcass characteristics to control bulls. In relation to the growth and carcass responses, Adams et al (1993, 1996) suggested that residual levels of T secretion in immunised bulls have anabolic effects sufficient to sustain a high rate of growth for an extended period.

In the study by Finnerty et al (1996) dairy bulls were immunised at 8-10 weeks of age (pre-pubertal) with a booster a month later. Ten days before slaughter (18 months after the experiment started) when bulls were 20 months old, the control bulls had a total combined general aggressive and sexual activity score proportionally 1.3 times higher than immunised bulls.

As with many other studies, Finnerty et al (1996) and Jago et al (1997a, b) observed that a high degree of sexual activity in prepubertal bulls and steers changes to aggressive activity between 10 and 18 months age, and the duration and intensity of this activity increased with age (Price et al 2003).

Similarly Jago et al (1997a) immunised Friesian bull calves at 2, 4 and 7.5 months with boosters 14 days later. Bulls were slaughtered at 16 months and were compared to surgically castrated steers and control bulls. At slaughter 86% of immunised bulls had normal testosterone levels. Behavioural changes did not occur until a month after second immunisation with agonistic behaviour increasing

in immunised bulls 5 to 6 months after the booster vaccination. Behaviour was ranked between steers and bulls at the final test. Even though the effects of immunocastration diminished with time, the typical pubertal pattern of behaviour for bulls was not seen in immunocastrates. All the immunocastrated bulls acted similarly, irrespective of timing of vaccination programs, indicating that bulls can be successfully immunised at 7.5 months with only one booster 2 weeks later, that will reduce aggressive behaviour at least until 17 months of age.

It seems that this difference in sexual behaviour score for bulls and immunocastrates, between 10 and 17 months age, can be largely attributed to differences in the ability to complete copulation rather than differences in the sexual motivation of the animals (Jago et al 1997a).

In subsequent studies Jago et al (1999) immunised post-pubertal 18 to 20 mth Friesian bulls and gave a booster 2 weeks later. Aggressive behaviour of immunocastrates declined to be lower than bulls 5 weeks after vaccination, though differences were not as great as when prepubertal immunisation was used (Jago et al 1997a), indicating that experience as well as androgen levels are important in determining the effect of castration on bull behaviour. These results demonstrate that immunocastration of post-pubertal bulls 7 weeks before slaughter is a potential means of reducing problematic bull behaviour and improving meat quality although this is likely to be at the cost of reduced weight gain. However it appears that multiple booster immunisations may be needed to suppress aggressive behaviour for long periods (Jago 1997b).

In a study with beef breed bulls, Huxsoll et al (1998) found a significant reduction in aggressive characteristics of beef bulls that had been immunised at 1, 4 and 6 months of age with a booster immunisation at feedlot entry at 12 months. Similarly Price et al (2003) immunised beef breed bulls at 4 months of age, with a booster at 12 months. Reduced aggressive behaviour, compared to control bulls, and at levels comparable to steers, was observed when animals were tested at 16 months. Similarly, Jago et al (1996) vaccinated post-pubertal (17 months) mixed breed bulls and found from day 0 to slaughter (22 months), rates of sexual and aggressive behaviour declined in all groups to be similar to steers. However, there was a tendency for bulls to show higher levels of both sexual and aggressive behaviour during lairage.

In summary, in the studies outlined above, there have been such wide variations in a number of factors (bull breed, bull age, GnRH conjugate type, dose level, number of immunisations) to make it impossible to validly compare and contrast results and outcomes. However as a general conclusion, immunocastration is successful in reducing rates of sexual and aggressive behaviour of pre- or peri-pubertal bulls but may have a reduced affect on post-pubertal bulls. These outcomes need to be re-evaluated, but suggest that anti-GnRH immunisation of young dairy bulls offers promise as a means of reducing aggressive behaviour of such animals during export, at least until about 20 months of age

Immunocastration has not been consistently successful in rams (Jeffcoate et al 1982). However, Kiyma et al (2000) found that immunocastration of lambs fed to a slaughter weight of 58kg decreased testicular weight and reduced feedlot performance, and sexual behaviour was reduced to levels comparable to those of castrated males.

In a study by Godfrey et al (1996), adult male Australian feral goats were immunised with Vaxstrate, (two immunisations at either days 0 and 14 or 0 and 28). Following immunisation, there were reductions in testicular size by day 56 and in 90% of immunised goats, testes remained small for more than one year. Odour scores were also lower in immunised goats and agonistic behaviour exhibited by immunised animals was intermediate between castrated animals and untreated entires.

An ideal vaccine to reduce aggressive behaviour problems in farm animals would be one that:

- Required only a single vaccine or implant.
- Induced a behavioural response within 2 weeks.
- Induced a sustained immune response.
- Could be reversed if necessary.
- Had limited impact on growth and maximum impact on sexual and aggressive behaviour (the required effect on meat quality depends on the market – in western societies consumers would like to increase the fat in bulls; in eastern societies, maintaining leanness and bull characteristics is desirable).
- Could be produced and sold at a realistic price.
- Satisfied welfare, food safety and cultural acceptance of the vaccine. Immunocastration compounds are classified as vaccines not hormones which is extremely advantageous from a residue and public perception point of view.

Current immunocastration technology requires significant additional research before it could be widely adopted to reduce problems of aggression in dairy breed bulls being exported. The need for a booster immunisation to achieve good antibody titre levels, the rapidity with which, and the level of the immunological response achieved, and duration of the response in relation to levels of aggression are all areas that require further research.

Nevertheless, there appear to be opportunities for the application of the technology to reduce aggression in exported dairy breed bulls and in goats which have been under intensive management prior to export.

Hormonal Growth Promotants

Steroids act at the hypothalamic loci level to suppress GnRH secretion itself. Insertion of steroid-containing (oestrogenic) implants in prepubertal bulls will suppress early stages of testicular growth and development (Adams et al 1993) and, therefore may reduce aggressive and sexual interactions amongst feedlot bulls and the adverse effects on meat quality of shipping and handling on such animals.

There have been a multitude of studies examining responses to implanting bulls with hormonal growth promotants (HGP), the results of which have been extremely variable, with no obvious explanations for this variation. One consistent finding is that testicular weight and scrotal circumference of bull calves is retarded by zeranol (Ralgro) implantation prior to 7 months of age, but will recover to a considerable degree as the animal ages, even with continued zeranol implantation (Newman et al 1990).

Although T secretion is reduced in zeranol implanted calves, more mature animals actually become refractory to implantation. Indeed, serum concentration of T does not vary with implant status in bulls 12 months of age or older (Adams et al 1993).

Newman et al (1990) implanted bulls with zeranol between 3 and 11 months of age. At about 8 months of age bulls were placed in a feedlot; reimplanted on day 84; and killed on between days 140 and 160. In this trial, zeranol implantation suppressed aggressive and sexual activity at about 1 year of age, but by the time of slaughter, implanted animals reacted to contact with non-familiar animals with as much aggressive activity as non-implanted bulls.

These findings are consistent with those of several other studies using zeranol (Ralgro) and oestradiol/ progesterone (Synovex C and S) based implants, in that HGP implants reduce

aggressive and sexual behaviour in bulls < 12 to 14 months of age but have limited effect after this period (Gregory and Ford 1983; Vanderwet et al 1985). Finally, Newman et al (1990) recommended that to achieve any reductions in behavioural responses, bulls should be implanted with a steroid-containing (oestrogenic) implants before 6 months of age and be slaughtered before 14 months of age, both of which conditions would be difficult to achieve with bulls exported from Australia. The use of HGP implants and immunocastration using GnRH immunisation do not have any synergistic effects (Adams et al 1993).

In contrast, Gregory and Ford (1983) concluded that treatment with the anabolic agent, Zeranol, had little or no effect on rate of testicular growth or aggressive male behaviour when first administered at about 12 months of age, and Vanderwet et al (1985) found a similar lack of behavioural responses to zeranol with younger bulls.

When Synovex implants (Synovex C 100mg progesterone and 10mg oestradiol benzoate at 3 mths plus Synovex S 200mg progesterone; 20mg oestradiol benzoate at 7 months) were administered to bulls at weaning and at feedlot entry there were decreased serum concentrations of T at these times (Adams et al 1993). In this study, the use of HGP implants and immunocastration using GnRH immunisation did not have any synergistic effects.

From the available evidence, it can be concluded that there is no benefit in the use of any HGP implants for suppressing adverse behaviour in larger bulls destined for export. Unless a very aggressive implant program is adopted commencing in the prepubertal period, behaviour of these older age groups of bulls will not be modified; there will be adverse affects on growth rates; and negligible benefits on meat quality.

5.4.7 Chemical or pharmacological manipulation of behaviour

There are reports that the compound Delmadinone acetate (DMA) has anti steroidogenic effects in laboratory animals and reduces libido in dogs. However a detailed literature search failed to locate any references to its use in ruminants.

In the study reported earlier investigating pen size effects, MacNeil et al (1989) found that when some bulls were given a tranquiliser (acetyl promazine) at the initial stages this had no long-term effect on behaviour or performance. It was speculated that because the few days required to establish a social order in young bulls represented only a small fraction of the total feeding period, sedation was inconsequential to the behavioural characteristics measured.

Most pharmacological agents used for sedation in farm animals such as acetyl promazine and xylazine are central nervous system depressants that have a relatively short duration of action, and whilst useful for short-term sedation of fractious animals are not suitable for routine use for minimising aggressive behaviour. Searches of the literature and extensive discussions with veterinary colleagues have failed to identify any chemical or pharmacological agents which can have long-term effects in modifying aggression, and which would not have significant food residue problems. The authors are also aware that MLA has recently called for expressions of interest for a funded project to examine the potential role of analgesic agents from an animal welfare perspective. Given the likely outcomes of that project and our lack of success in identifying any agents, we have not progressed this option further.

5.4.8 Light manipulation and photoperiodic effects

Photoperiodic control of reproductive function is well recognised in sheep and goats in temperate and probably sub-tropical environments (Lindsay 1996), though most attention has been directed towards photoperiodic effects in females. There is some published information on seasonality of sexual activity in male sheep and goats but very little on any seasonal changes in aggressive behaviour (as distinct from sexual behaviour). Given the relative low level of problems of aggressive behaviour in sheep, this species is not considered further here in relation to any manipulations via photoperiodic effects.

In a recent review on male goat reproduction, Delgadillo et al (2004) distinguished between 'photoperiodic flexible breeds' such as Australian cashmere goats where the annual breeding season can be manipulated through nutrition (Walkden-Brown et al 1994), and 'photoperiodic rigid breeds such as Creole goats from sub-tropical Mexico, where sexual activity can be controlled by altering the photoperiod (Delgadillo et al 2001). In the latter study, patterns of sexual activity could be stimulated in Creole goats in Mexico, through a regime of artificial long day length together with melatonin implants.

Given that in goats, levels of sexual activity are related to levels of agonistic behaviour (Godfrey et al 1996), any manipulation of sexual activity may influence the extent of agonistic activity. However while long day length and melatonin treatment increases activity, what is needed is a treatment regime that does the reverse i.e. decreases sexual activity and reduces agonistic behaviour.

Whether this can be achieved by a regime involving short day length treatment (reduced lighting pre-shipment and on-board), and whether such an approach would be practicable, does not appear to have been examined. A more detailed review of literature on photoperiodic control in goats would be a starting point to any small scale studies to determine whether levels of aggression in entire males could be manipulated by such a regime.

5.4.9 Other Approaches

Several other approaches have been examined in an attempt to reduce aggressive behaviour in rams, bulls and billy goats.

Handling procedures
The range of different approaches in the handling of entire males for export have been discussed in earlier sections of this literature review

Modification of testicular/scrotal function
Hinch (1978) and Hinch et al (1982) have examined behavioural patterns including aggressive behaviour in groups of steers and in bulls sterilised by relocating the testes into the inguinal canal ('artificial' cryptorchidism'). Such bulls are variously described as artificial cryptorchids or 'short scrotum' bulls. There were relatively few behavioural differences between steers and 'short scrotum' bulls before 15 months suggesting there are few management implications in exporting bulls at 15 months and younger, provided they have been reared and maintained in social groups.

In the cryptorchid bulls there was a dramatic increase in frequency of aggressive and mounting behaviour at 18 months of age despite the fact that T production in these animals would probably have been lower. Similar observations as to the time of development of aggressive behaviour in grazing Friesian bulls have been made by Mickan et al (1976). Bass et al (1976) did not find any

effect of the procedure on bull behaviour at 17 months, though T levels were lower than in those reported for bulls.

A producer in the Northern Territory (B Kelly pers comm) who supplies *Bos indicus* bulls to the export trade produces cryptorchid bulls from younger calves, as he believes they have better growth rates than steers. However aggression can become a problem in older animals confirming the results mentioned above. From a management perspective, given the better growth rates of these animals, it may be possible to turn them off at an acceptable export weight before behavioural issues become a major problem. A small scale study (G Jayawardhana pers comm.) in the NT found that growth rates in cryptorchid bulls were better than control and HGP treated (Compudose 400) steers, but similar to steers treated with another HGP product (Revalor S). The cost of producing cryptorchids was far less than the cost of HGP implants, animals were acceptable for the SE Asian export market, and reached export weights in advance of steers. However, for strict Islamic traditionalists, artificial cryptorchids may not be acceptable during the festival periods, as normal sized testicles are not visible.

There have been a number of attempts to develop chemical castration techniques to minimise stresses associated with surgical castration. A number of sclerosing agents such as lactic acid and zinc tannate have been used injected into the testis, but frequently with untoward and unacceptable side effects such as obvious pain and discomfort and testicular necrosis. Growth rates in chemically castrated animals have been similar to surgically castrated steers, but the former develop typical entire male characteristics and behaviour (Fordyce et al 1989, Strydom et al 1993), probably reflecting the fact that steroidogenic production capacity of testicular tissue is not completely destroyed.

This approach is totally contraindicated on welfare grounds and has no application in exported livestock, due to costs, welfare considerations and the pathological damage caused to the testes, which are an item of human consumption in many importing countries.

Ship Board pen capacity and pen modifications

Recommendations have been made (Brightling 2001) when exporting goats, of providing ‘escape capacity’ for submissive animals being subjected to aggressive behaviour by other goats, and of providing other secure animal proof pens where such animals can be allowed to recuperate. An additional point is that recovery of these animals is enhanced where suitable diets including hay and chaff can be provided (D Jarvie, G Beckett pers comms.).

In cattle, there is anecdotal information from industry that removal and relocation elsewhere of very aggressive bulls minimises behavioural problems and injury, but that conversely, removal of ‘bullers’ merely results in a re-alignment of social ranking, identification by aggressors of another ‘buller’, and continuance of mounting problems (G Beckett pers comm.).

In attempting to control ship-board problems of aggression in bulls and goats, a suggested option has been the use of an electrified ‘hot-wire’ suspended from the pen roof. Animals mounting other animals would come in contact with the wire(s), receive a mild electric shock and would dismount. Repeated shocks could induce a habituated response whereby mounting activity is reduced. There have been some suggestions that this approach has been used in intensive indoor bull rearing situations in Europe (M McCarthy pers comm.) but an extensive search of the literature failed to locate any references to the technique. Similar repeated challenge approaches have been used in the training of other animals, eg dogs, and in confining cattle and horses within a defined area by the use of an electrically energised fence.

To our knowledge, this option has not been examined in a shipboard situation, and may warrant some investigation. Whilst some criticism may be expected at this the approach on welfare grounds, a balance has to be drawn between the welfare of the aggressor and that of the aggressed animal injured by acts of aggression.

Little information is available on optimal pen heights for shipment of goats, but based on anecdotal evidence it has been suggested that to enhance welfare, goats should be shipped in single-tier rather than double tier pens (More and Brightling 2003). Some research and monitoring of these recommendations needs to be done.

6 Success in achieving objectives

All objectives were achieved. Extensive discussions were held with all sections of the live export industry, over 85 individuals and organisations being contacted and visits made to sheep and cattle properties involved in the trade, to export yards and holding facilities and to ships being loaded for export.

An extensive review of relevant scientific literature was completed together with other information derived from industry and is incorporated in this report. A section of this report also identifies a range of potential strategies for modification of aggressive behaviour, and the value or otherwise of these options is assessed.

An analysis of data on the extent of the problems relating to aggression in entire males was completed, options for modification of behavioural patterns described and areas for further research identified.

Finally a series of recommendations are made in relation to various aspects of the export trade in entire male sheep, cattle and goats.

7 Impact on Meat and Livestock Industry

7.1 Impact of options to modify aggressive behaviour on extent of the trade.

7.1.1 Sheep

Assuming that the recently re-established trade with Saudi is maintained, and that there is a recovery in Australian sheep numbers, a moderate growth in exports in the medium-term is forecast, but these forecasts are qualified (Anon 2005). Medium-term projections are for a growth in the trade of almost 2 million sheep over the next four years. Assuming that entire rams continue to be a similar component (currently about 10%) of the trade in the medium-term, and that growth in exports of this class of animal follows similar trends, on current figures an additional 200,000 rams could be required over the next four years. Capacity to supply these additional animals will be dependent on flock recovery patterns, seasonal conditions, prices received, strength of the Australian dollar and market demand.

However as an outcome of this project, it has been concluded that aggression and consequent specific welfare issues in entire males are not important in sheep. Hence no detailed consideration has been made of any impacts of modification of behaviour options, and there are unlikely to be any impacts on the trade.

7.1.2 Cattle

Forecasts for the live cattle export trade in the short-term are a little pessimistic, numbers being predicted to fall to 560,000 head in 2006, the major challenges being strong domestic prices, a rising Australian dollar, increasing fuel and transport costs and competition from imported meats from Indian and South American sources (Anon 2005). While meat trade prices remain high, increased numbers of young cattle from northern Australia are also likely to be diverted to southern grow-out properties and feedlots, further limiting numbers available for export.

Concerns were also expressed by some exporters in relation to possible future animal welfare issues and the increasing costs associated with new regulations on the trade. A single market (Indonesia) now accounts for almost 60% of the live cattle trade, increasing the level of risk to the trade. Medium term projections for the trade are for exports to reach 750,000 cattle by 2009, a figure still well short of levels achieved in 2002.

The entire male share of the trade is likely to follow similar trends to those of the overall trade. Options which may reduce aggression and enhance welfare of exported bulls are unlikely to impact on market share for entire males, unless there is an increase in demand for bulls for cultural reasons, or additional demand from new markets in other Islamic countries.

Pre-shipment management procedures as outlined appear to be the most appropriate method of reducing the limited problems of aggressive behaviour, and of enhancing welfare of beef breed bulls from northern Australia. A possible long term constraint to the trade in this type of bull could however be the continued availability of uncastrated bulls from northern herds, as a result of improvements in management. These are likely to lead to marked reductions in the availability of ‘micky’ bulls.

Additionally, there appears little interest in or incentives for northern producers to raise entire bulls for the export trade. Any changes in this direction would be determined by a range of factors including long term demand prospects for bulls, prices in the domestic and export markets for steers, and management issues including cattle control (S Petty pers comm.). In addition, large scale north Queensland trials comparing the profitability of exporting bulls and steers of similar age indicated that a price premium of $0.10/kg would be needed for producers to retain bulls for live export (D Dixon, J Griffith pers comms.).

In the case of bulls of dairy breed origin, any major increase in demand for this type of animal would probably be accompanied by an increase in the incidence of aggressive behaviour problems. Research into, and the development of a range of practicable options for reducing aggressive behaviour needs to be undertaken to ensure that welfare problems do not inhibit developments in this trade. Because this class of cattle is usually under total control on-farm, the selective use of immunocastration techniques at the appropriate time prior to shipment appears to be an option that would enhance welfare during shipment but not have permanent impacts on subsequent growth. These options need to be examined in some well-controlled studies.

7.1.3 Goats

Given the current situation in the export goat industry of heavy reliance on shipments of feral and semi-feral males, and the documented aggression problems such animals have, legitimate concerns have been expressed on welfare grounds regarding continuation of this trade (More and Brightling 2003). There are a range of options including genetic changes in the export goat herd structure, more intensive management systems for domesticated feral goats, a progressive shift to the export of castrates rather than entires, and better pre-shipment and shipboard management systems that are available that will enhance welfare of exported goats and assist to maintain what is currently an 'opportunistic' industry.

Unless some of these changes are put in place, welfare considerations may have a big impact on the medium and long-term prospects for the trade. However, all the options available will come at a cost to the producer and the exporter. Unless premiums are received for better quality animals delivered in excellent condition, it is difficult to see how the trade can survive in its present form in the face of increasing community concerns and pressures regarding welfare issues.

8 Recommendations

Sheep

1 That some detailed investigations be undertaken to determine the cause of higher death rates in entire males compared to wethers during shipment to Middle Eastern ports, and the predisposing factors that may contribute to those mortalities.

2 That following these studies, selection procedures, management strategies and practices pre-shipment, and whilst in transit be reviewed where appropriate, with the objective of reducing death rates in entire males during export. Current best practices in use include shedding of rams in assembly feedlots to reduce impacts of inanition and salmonellosis, selection of rams off-shears and/or pre-shipment shearing, segregation of horned and polled rams, drafting of groups on a weight basis (and if appropriate, on an age basis-adult rams separate to hogget and ram lambs), ensuring adequate feed and water trough space, maintaining specified pen densities, daily monitoring of animal health and behaviour and removal and segregation of at-risk sheep.

Cattle

3 That in the case of entire bulls of beef breed origin, derived from or shipped from northern Australia, a range of best practice procedures be documented and adopted, aimed at acclimating infrequently handled or semi-feral cattle to more intensive environments. These could include

- Mustering and initial on-property yard handling involving low stress handling techniques
- Short periods of yard feeding before road transport to holding facilities
- Following induction at assembly depots, accustoming animals to background noise, the presence of humans and to being moved through yards (Section 4.3.2)
- Drafting and loading bulls in size/weight ranges and maintenance of these groups on board
- Loading of heavier animals to decks level with loading/unloading facilities
- Isolation of extremely aggressive or 'buller' animals to reduce behavioural problems and enhance welfare

- Identification of suitable ration formulations for pre-shipment and short voyage transport.

4 In the case of dairy breed bulls being exported to Middle Eastern destinations, on-farm and shipment best practice procedures should include:
- Where bulls have been raised on-farm or in feedlots in social groups, maintaining that grouping during pre-shipment and in transit
- Drafting of groups of mixed origin into similar size/weight classes
- In the case of bulls of mixed origin, allowing sufficient time pre-shipment for removal of aggressive dominant and non-aggressive subordinate bulls and re-establishment of social groups and of dominance hierarchies
- Where aggression becomes a significant on-board problem, isolation of aggressive bulls and removal and isolation of 'bullers'.
- Loading of heavier animals to decks level with loading/unloading facilities
- The development of packages of recommendations for best practice procedures for shipment of dairy breed bulls on long-haul voyages

5 In dairy bulls, the use of anti-GnRH immunisation procedures should be investigated as a method for reducing aggression in situations where bulls have been in hand for some time prior to export. Timing of vaccination becomes less of an issue in this management system compared to extensive grazing systems.

6 New generation anti-GnRH vaccines becoming available should be investigated for their efficacy in changing behavioural patterns, and to determine the extent and duration of testicular reduction, an issue that may have marketing consequences in some importing countries. Outcomes of a current MLA project at the University of Queensland, (Dr M D'Occhio), using a GnRH-PAP immunisation approach to suppress reproductive function and sexual and agonistic behaviour in bulls, will be relevant to the live export of dairy bulls.

7 In relation to ship-board control of aggression, one option that may warrant further investigation is the use of an electrified 'hot-wire' suspended from the pen roof. Bulls mounting other animals would come in contact with the wire(s), receive a mild electric shock and would dismount. Repeated shocks may induce a habituated response whereby mounting activity is reduced. Similar approaches have been used in the training of other animals eg dogs, and in confining cattle and horses within a defined area by the use of an electrically energised fence. Whilst the approach may be criticised by some on welfare grounds, a balance would have to be drawn between the welfare of the aggressor and that of the aggressed bull, many of whom are injured by acts of aggression.

8 While it has not been possible to identify any specific nutritional substances that could be incorporated in shipboard rations to reduce aggressive behaviour, compounds such as magnesium and protected tryptophan need to be investigated for their potential value in reducing aggressive behaviour. Pending these studies, all diets, particularly those for dairy bulls, should have at least 1% magnesium incorporated together with adequate protein levels.

9 Though it has not been possible to identify any long term sedating agents that could be incorporated in shipboard rations to reduce aggressive behaviour, the outcomes of a concurrent MLA funded project on pharmacological interventions to improve welfare should be taken onto account in progressing this matter.

10 Under veterinary supervision, sedation and anti-inflammatory agents could be used strategically for behaviour control and pain relief when experiencing difficulties with bulls on board ships.

Goats

11 It is recommended that, given the significant levels of mortality that can be experienced in captured feral goats during export, only those goats of feral origin that have been managed (domesticated) for a period after capture, or throughout their lives, should be exported.

12 This recommendation should be phased in over a 1-2 year period, recognising that conversion of goat operations from an un-managed production system as occurs in many pastoral areas, to a managed system will require additional infrastructure and management changes.

13 While recognising the current preference for entire males in most export markets, it is recommended that some market survey and consumer education activities be undertaken in importing countries to encourage a move away from entire male imports to imports of wether goats, given the management difficulties and welfare issues involved in exporting entire male goats.

14 A review should be commissioned of available information on the performance of feral and domesticated goat breeds (and their crosses) under both pastoral and intensive situations, with particular reference to behavioural and production characteristics, carcass attributes and economic values, in order to provide objective information for breeders interested in supplying the live export market.

15 Implementation of breeding plans by producers for domesticated feral goats, to enable movement towards a cross breeding system using Boer and other meat goat strains, to reduce aggressive behaviour problems, and to improve carcass and meat attributes.

16 All low stress animal behaviour management strategies outlined should be applied to goats during pre-export handling and on board. This includes appropriate handling, pen management and nutritional levels.

17 The use of anti-GnRH immunisation procedures to reduce aggression in entire male goats should be investigated, together with management issues related to this approach. While vaccination may not be practicable for recently ‘harvested’ feral animals, timing of vaccinations becomes less of an issue in goats under managed conditions.

18 As for cattle, new generation anti-GnRH vaccines becoming available should be investigated for their efficacy in changing behavioural patterns, and to determine the extent and duration of testicular reduction, an issue that may have marketing consequences in some importing countries.

All species

19 While recognising the current preference for entire males in many Islamic export markets, it is recommended that some market survey and consumer education activities be undertaken in importing countries to ascertain the strength of the future market for entire males, with the aim to encourage a move away from entire male imports to imports of castrated males, given the management difficulties, inconsistent supply, higher mortality rates and welfare issues involved in exporting entire males, particularly dairy bulls and billy goats.

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10 Appendices

10.1 Appendix 1. List of Contacts

STATE	NAME	LOCATION	AFFILIATION	ROLE	CONTACT TYPE
South Australia	Mrs J Lloyd	Kingston	LiveCorp Res C'Tee member	Meat sheep producer	Phone
	Mr G Clarke	Mt Barker	Chair SA Exporters Assoc	Exporter	Phone/meeting
	Mr V Burton	Adelaide	Ausland Livestock	Exporter	Meeting
	Dr B Siebert	Roseworthy	Univ Adelaide	Nutritionist	Meeting
	Dr N Buchanan	Adelaide	PI &R SA	Veterinarian	Meeting
	Mr A Curtis	Adelaide	" "	Research Leader	Phone
	Dr B Hancock	Roseworthy	" "	Research Leader	Phone
	Mr M Deland	Naracoorte	" "	Researcher	Meeting
	Mr J Cooper	" "	" "	Technical Off.	Meeting
	Mr B Hebart	" "	" "	Extension Off.	Meeting
	M/S E Hocking	" "	" "	Extension Off.	Phone
	Mr J Reeves	Penola	Dairy Beef Prod.	Producer	Meeting
	Mr R Reeves	"	" "	"	Meeting
	Mr T Ellis	"	" "	"	Meeting
	Mrs Sally Hood	Keith	" "	"	Meeting
	Mr J Fulton	Millicent	" "	"	Meeting
	Mr A Graham	Penola	" "	"	Meeting
	Dr R Ibrahim	Adelaide	Al- Mukairish Australia	Exporter	Meeting
	Dr K McGrath	Millicent	Vet Consultant	Veterinarian	Meeting
Victoria	Dr L Cummins	Hamilton	Vet Consultant	Veterinarian	Phone
	Prof M Goddard	Melbourne	Univ Melbourne	Researcher	Meeting
	Prof P Hemsworth	Werribee	DPI Vic	Researcher-Behaviour	Meeting
	Dr J Barnett	"	"	"	Meeting
	Dr G Cronin	"	"	"	Meeting
	Dr E Jongman	"	"	"	Meeting
	Dr A Brightling	Melbourne	Elders	Veterinarian	Meeting
	Dr J Moran	Kyabram	DPI Vic	Researcher	Phone
Western	Mr J Stoate	Broome	Producer	Producer./Exporter	Phone/meeting

Australia					
	Dr R Nickels	Geraldton	Vet Consultant	Veterinarian	Phone
	Mr B Leishman	Dongara	Producer	Producer./Exporter	Meeting
	Mr J Edwards	Perth	Al-Mukairish Australia	Exporter	Meeting
	Dr P Arnold	Perth	Vet Consultant	Veterinarian	Meeting
	Dr D Jarvie	Fremantle	Wellard Rural Exports	Veterinarian	Meeting
	Mr D Kerr	Baldivis	"	Livestock Manager	Meeting
	Mr G Robinson	Perth	Emanuels	Exporter	Meeting
	Mr J Tillett	Baldivis	"	Feedlot Manager	Meeting
	Mr K Brooks	"	"	Livestock Manager	Meeting
	Dr W Ryan	Perth	Kondinin Group	CEO	Meeting
	Dr A Lavery	Baldivis	Fowler Holdings	Veterinarian	Meeting
	Mr K Fowler	"	" "	Exporter	Phone
	Mr K Goad	Perth	Landmark	Live Export Manager	Meeting
	Dr R Norris	Perth	WA Agric	Veterinarian	Meeting
	Prof D Lindsay	Perth	Univ WA	Anim Behaviourist	Meeting
	Mr A Moore	Perth	Elders (formerly Fares Exports)	Exporter	Meeting
	Mr P Smith	Karratha	WA Agric	Beef Officer	Phone
	Dr M McCarthy	Perth	Vet consultant	Veterinarian	Phone
	Dr B Gabbedy	Perth	Vet Consultant	Veterinarian	Phone
	Mr P Lang	Perth	MLA Export Co-ordinator	WA Export Co-ord.	Phone
	Mr A Fellows	Geraldton	Producer/Exporter	Exporter	Phone
Q'Land	Dr G Smith	Charters Towers	Vet Consultant	Veterinarian	Phone
	Dr A Guilfoyle	Clermont	Vet Practitioner	Veterinarian	Phone
	Dr B Pott	Townsville	" "	Veterinarian	Phone
	Dr D Cadogan	Brisbane	FeedWorks	Nutritionist	Phone
	Dr R Dixon	R'hampton	Qld DPIF	Nutritionist	Meeting
	Dr C Stacey	Brisbane	Maunsells	Env. Engineer	Meeting
	Mr G Robertson	Brisbane	TV Fairfax Pastoral	Pastoral Supervisor	Phone
	Dr S Blakely	Toowoomba	Precision Beef	Exporter/ Veterinarian	Meeting
	Dr R Trivett	Toowoomba	Ex GRM/Austrex	Exporter/LiveCorp Res C'Tee member	Meeting
	Dr M D'Occhio	Brisbane	University of Qld	Researcher	Meeting
	M/s A Kenny	Gatton	University of Qld	PhD student	Meeting
	Mr A Wood	Townsville	Exporter	Exporter	Phone

	Mr S Millard	Brisbane	NAPCO	Producer	Phone / Meeting
	Mr H Elliot	Bowenville	NAPCO	Livestock Manager Wainui Feedlot	Meeting
	Mr J Griffith	Brisbane	AustAsia	Exporter/Livecorp Res C'Tee member	Phone
	Mr G Beckett	Brisbane	Contractor	Export Stockman	Phone
	Mr D Dixon	Cloncurry	AA Company	Property Manager	Phone
	Mr FR Muhammed	Brisbane	Aust. Fed. Islamic Councils	Muslim supervisor	Phone
Northern Territory	Dr R Ainsworth	Darwin	Vet consultant	Veterinarian	Phone
	Mr S Ellison	Darwin	Flinders International	Exporter	Phone/Meeting
	Mr D Heath	Darwin	Nth Australian Cattle Co.	Exporter	Phone/Meeting
	Dr S Petty	Darwin	Heytesbury Beef	Producer	Meeting
	Mr B Kelly	Pine Creek	"Jindare"	Producer	Meeting
	Mr N Thorne	Adelaide River	Nick Thorne Exports and Livestock	Exporter	Meeting
	Mr L MacKinnon	Darwin	NTLEA	CEO	Meeting
	Dr R Harmata	Darwin	AQIS	Veterinarian	Meeting
	Dr G Jayawardhana	Darwin	NT DPI & F	Veterinarian	Meeting
	Mr B Angel	Darwin	Contractor	Export Stockman	Meeting
Other	Dr H Roeger	Brisbane	AQIS	Veterinarian	Phone
	Dr N Brown	Bahrain	MLA	Veterinarian	Meeting
	Dr G Hinch	Armidale	UNE	Researcher	Meeting
	Dr D Ferguson	Armidale	CSIRO	Researcher	Meeting
	Dr D Adams	Canberra	AFFA	Veterinarian	Phone
	Mr P Underwood	Sydney	MLA	Project officer	Phone
	M/S J Cleeve	Sydney	LiveCorp	Program Manager	Phone/Meeting
	Mr M Hayward	Sydney	MLA	Program Manager	Meeting
	M/S R Nivison	Sydney	MLA	Project officer	Phone / meeting
	Mr D Shany	Israel	Puma Investments Ltd	Importer	Phone