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National Data Recording System for the Live Sheep Export Industry

Report No. 2

July to December 1989

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Contents

Introduction

This is the second report in a series that provides summary information on the export of livestock from Australia to the Middle East and South East Asia.

The main body of the report focuses on mortality records collected as part of the national data recording system for the live sheep export industry. Additional information is incorporated on current research activities and publications.

The format is similar to that of the previous report and provides information on sheep exported from the ports of Fremantle, Adelaide and Portland during the six months to December 31, 1989. Confidentiality is maintained in this series of reports by the use of codes for individual vessels and ports of discharge.

Numbers of livestock exported

To the Middle East and South East Asia

During the report period a dispute with Saudi Arabian officials developed. This dispute and the subsequent Australian Meat and Livestock Corporation suspension of shipments to Saudi Arabia greatly reduced the numbers of sheep exported from Australia (Figure 1). The number of sheep exported to other Middle East destinations remained stable during this period.

As with the previous six month period, similar proportions of each class of sheep were exported from each port (Table 1). The exception was a reduced number of ram lambs exported in the second half of the year to 27% of the total for the first half. Saudi Arabia was previously a major importer of ram lambs and therefore the dispute explains this reduction.

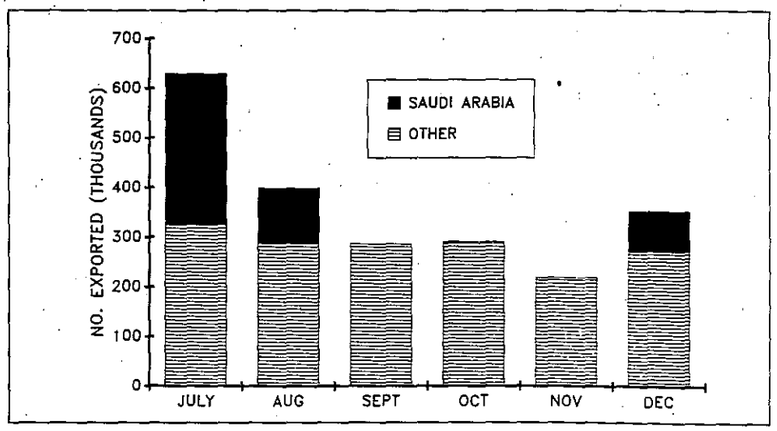

Figure 1. Monthly total of sheep exported by sea from Australia to Saudi Arabia and other Middle East countries for the six months to December 31, 1989.

Table 1. The number and class of sheep and the number of goats and cattle exported by sea from Fremantle, Adelaide and Portland in the six months to December 31, 1989.

		Fremantle Middle East	Fremantle SE Asia	Adelaide M. East	Portland M. East	Total
Wethers	- adult	1,144,923	1,100	289,281	477,136	1,912,440
	- hogget	†	0	3,433	2,976	6,409
	- lambs	122,681	465	5,532	41,263	169,941
Rams	- adult	39,510	11,350	2,167	9,569	62,596
	- lambs	33,873	175	5,720	1,671	41,439
Ewes	- adult	0	0	0	0	0
	- lambs	1,764	558	0	0	2,322
Total	- sheep	1,342,751	13,648	306,133	532,615	2,195,147
	- goats	3,942	100	0	1,943	5,985
	- cattle	390	4,196	0	201	4,787

† hoggets were included in the adult wether category due to a change in recording methods at Fremantle

By destination country (sheep only)

In the first six months of 1989, 44% of the total number of sheep exported went to Saudi Arabia. This was reduced to 23% of the total exported in the second half of 1989 (Table 2). Only one shipment was delivered to Saudi Arabia from the beginning of September to the end of the year.

The numbers of sheep exported to other Middle East countries were similar in the first and second halves of 1989.

Table 2. The destination country and number of live sheep exported from Fremantle, Adelaide and Portland in the six months to December, 1989.

Country	Fremantle	Adelaide	Portland	Total
Bahrain	84,665	0	71,000	155,665
Kuwait	485,724	72,550	268,770	827,044
Oman	106,867	0	43,667	150,534
Qatar	147,102	0	0	147,102
Saudi Arabia	198,804	233,583	63,500	495,887
Singapore	13,648	0	0	13,648
Yemen South	39,060	0	0	39,060
U.A.E.	280,539	0	85,678	366,217
Total	1,356,399	306,133	532,615	2,195,147

Mortality rates

Sheep

The mortality rates for 1989 were higher than for previous years (Figure 2). A breakdown of these data into the first and second halves of each year for the last five years shows a consistently higher rate in the second half (Figure 3). The main difference between the rates for 1989 and previous years comes from the discharge phase in the second half. More detailed discussion on the discharge mortality results and the effects of the dispute are given in the section on mortality by quarter of the year.

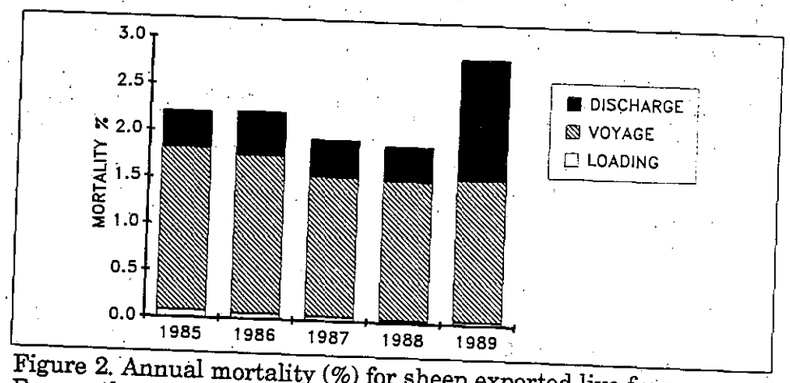

Figure 2. Annual mortality (%) for sheep exported live from Fremantle to the Middle East.

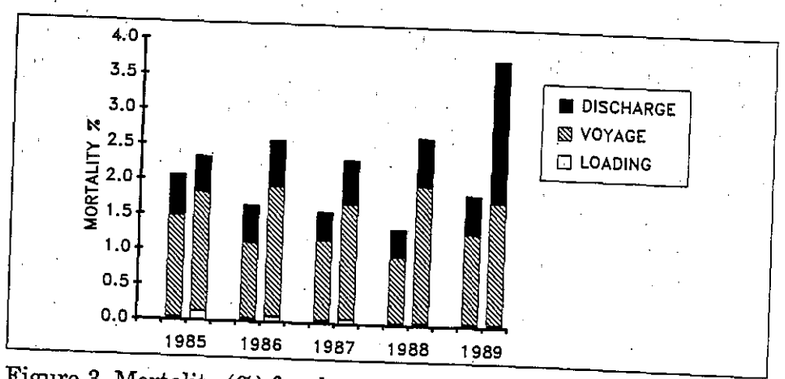

Figure 3. Mortality (%) for sheep exported live from Fremantle to the Middle East for the first and second halves of each year from 1985 to 1989.

The mortality rates for wethers (adults, hoggets and lambs) and adult rams were similar to those recorded in the first half of the year (Table 3 and Figure 4). However, the rates for hogget rams and ram lambs were considerably lower in the second half.

Few ram hoggets were exported in the first and second halves of 1989. Consequently, mortality records from a few shipments greatly influenced the total for each six month period.

For ram lambs, there was a trend to lower mortality rates in the second half for sheep loaded in Fremantle and Portland. Data from future voyages will be needed to be more confident of this trend.

Insufficient ewes were exported in the second half to make valid comparisons of mortality rates.

Table 3. Mortality (%) by class of sheep for the voyage from Fremantle, Adelaide and Portland to the first destination port in the Middle East in the second half of 1989.

Sheep		Fremantle	Adelaide	Portland
Wethers	- adult	1.95	†	2.03
	- hogget	0.56	†	0.50
	- lambs	0.95	†	0.85
Rams	- adult	1.43	†	1.99
	- hogget	0.92	n/a	n/a
	- lambs	0.78	†	0.81
Ewes	- adult	n/a	n/a	n/a
	- lambs	4.25	n/a	n/a
Total	- sheep	1.78	2.21	1.92

† mortality by class not available
n/a not applicable (no sheep of this class were loaded)

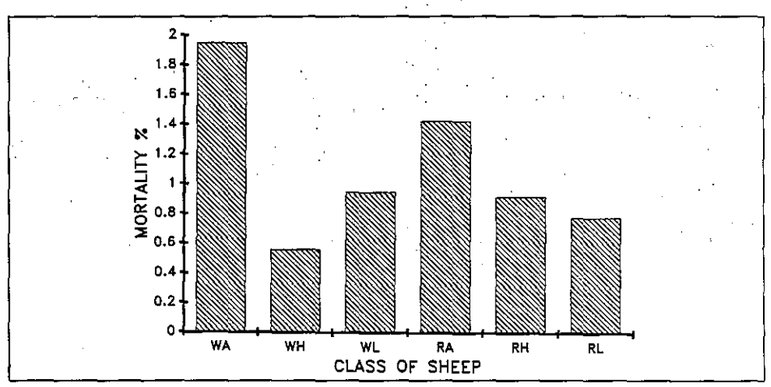

Figure 4. Mortality (%) by class of sheep for 22 voyages from Fremantle to the first port of discharge in the Middle East in the second half of 1989.

WA = wether adults WH = wether hoggets WL = wether lambs
RA = ram adults RH = ram hoggets RL = ram lambs

Goats

Mortality rates for goats were considerably higher than for sheep during the second half of 1989 (Table 4). This observation was similar to that recorded in the first half. Death rates in goats were as high as 15.9% and 17.5% for individual shipments from Fremantle and Portland respectively.

Table 4. Mortality (%) of goats during all stages of shipping (loading, voyage and discharge) from Fremantle, Adelaide and Portland to the Middle East and South East Asia in the second half of 1989.

Goats	Fremantle M East	Fremantle SE Asia	Adelaide M East	Portland M East
1989 (July to December)				
No. of voyages	10	2	0	4
No. loaded	3,942	100	n/a	1,943
No. dead	274	0	n/a	244
Percentage dead	6.95	0	n/a	12.56

Cattle

Very few cattle were exported to the Middle East and South East Asia in the second half of 1989 (Table 5). However, as in the first half, mortality rates were much lower in cattle than in sheep and goats on similar voyages.

Table 5. Mortality (%) of cattle during all stages of shipping (loading, voyage and discharge) from Fremantle, Adelaide and Portland to the Middle East and South East Asia in the second half of 1989.

Cattle	Fremantle M East	Fremantle SE Asia	Adelaide M East	Portland M East
1989 (July to December)				
No. of voyages	4	8	0	1
No. loaded	437	544	n/a	201
No. dead	2	0	n/a	0
Percentage dead	0.46	0	n/a	0

Mortality by quarter of the year

Mortality rates of sheep during all stages of shipping for the third quarter of 1989 were consistently high for shipments from all ports (Table 6). Analysis of these figures showed that the main contribution came from ships with more than one port of discharge during the period after arrival at the first port.

During the early stages of the dispute with Saudi Arabia, seven vessels were delayed during the discharge phase. The temperature and relative humidity in the Gulf at the time of the dispute were dangerously high for the livestock on these vessels. Consequently, the mortalities that occurred after arrival at the destination ports were higher than would normally be expected.

To analyse the effect of the dispute on mortality rates during discharge, data from vessels loaded at Fremantle were examined. Mortalities from the entire discharge phase of three voyages plus one additional shipment, which was rejected at another port as a result of the dispute, account for only 25% of the discharge mortalities in the second half.

Had there been no delays at discharge it is likely that substantial mortalities would still have occurred on these vessels in the prevailing conditions.

Data from ships loaded in Portland showed that the main contribution to the high mortalities in the second half came from an epidemic on one vessel that occurred on the first night at the first port of discharge. Therefore, this high result was not attributed to the dispute.

One shipment from Adelaide took 18 days from the time of arrival at the first port to the end of discharge. The delay in discharge for this ship was due to the dispute. The daily mortality rate remained stable throughout the voyage and less than 2% of the sheep died during the 18 day "discharge" period. The second voyage from Adelaide in the third quarter (with a single port of loading) was not delayed at any point. However, almost 2% of the sheep died in a 24 hour period in association with high temperatures and high relative humidity.

High mortalities on other shipments were not associated with any delay at discharge. The combination of high temperature, high relative humidity and light winds in the Persian Gulf during August and September was associated with high mortalities both while the ships were at sea in the Gulf and particularly when they were in port. This is reflected in the high mortalities in the third quarter of the year.

Table 6. Mortality for all stages of shipping (loading, voyage and discharge) and all classes of sheep loaded at Fremantle, Adelaide and Portland for the third and fourth quarters of 1989.

All sheep	Fremantle	Adelaide	Portland
July to September			
No. of voyages	16	2†	3
No. loaded	729,317	163,523	313,037
No. dead	34,390	5,739	15,537
Percent dead	4.72	3.51	4.96
October to December			
No. of voyages	14	1	3
No. loaded	564,664	80,798	219,578
No. dead	14,870	1,614	5,217
Percentage dead	2.51	2.00	2.38

† one voyage loaded at Adelaide and Fremantle not included

Mortality by ship (for adult wethers)

A comparison between ships is best done by comparing mortality to first port and by matching as many factors as possible in the analysis. Two very significant factors are the class of sheep and the port of origin. It is clear from the previous section that the time of year can also affect the outcome.

Observations which are common between the first and second halves of 1989 include the consistently low death rates for ship 12 and the high rates for ship 4. Most voyages of other vessels were in the 'medium' category (Tables 7a, 7b and 7c).

Table 7a. Number of voyages in low, medium and high mortality rate categories (wethers only, to first port of discharge) for ships loaded at Fremantle.

Ship (code)	Mortality rate Low <1.0%	Medium 1.0-2.0%	High >2.0%	Total
1	-	4†	-	4
2	-	1	-	1
3	-	2†	-	2
4	-	1†	2	3
9	-	2	-	2
10	-	2††	-	2
11	-	2†	1	3
12	5	-	-	5
14	-	1†	1	2
15	-	4	-	4
17	-	1	-	1
23	-	-	1	1
Total	5	20	5	30

† Includes mortality for all classes of sheep on one voyage
†† Includes mortality for all classes of sheep on both voyages

Table 7b. Number of voyages in low, medium and high mortality rate categories (wethers only, to first port of discharge) for ships loaded at Adelaide.

Ship (code)	Mortality rate Low <1.0%	Medium 1.0-2.0%	High >2.0%	Total
13	-	1†	-	1
20	-	1	-	1
27	-	-	1	1
Total	0	2	1	3

† Includes mortality for all classes of sheep

Table 7c. Number of voyages in low, medium and high mortality rate categories (wethers only, to first port of discharge) for ships loaded at Portland.

Ship (code)	Mortality rate Low <1.0%	Medium 1.0-2.0%	High >2.0%	Total
1	-	-	1†	1
3	-	-	2	2
8	-	1	-	1
23	-	2	-	2
Total	0	3	3	6

† Includes mortality for all classes of sheep

Spatial pattern of mortality

Comparisons of mortality in different areas of a ship are best made using the same class of sheep. On some voyages a valid comparison is not possible.

Identifying areas of consistently high or low mortality will assist in determining those factors that contribute to the cause of deaths on board ships.

Deck

Mortality rates throughout 1989 showed that consistent patterns related primarily to the deck type. It was common for the deck with the highest death rate to be in the enclosed section of the ship. Conversely, the deck with the lowest mortality rate was frequently in the open decks. In addition, the lowest mortality rate was often in the lower decks of the open sheephouse; this also applied to ships that only have open decks.

Open and enclosed decks

Death rates in enclosed decks were higher than in open decks on more than half of the voyages in the second half of 1989 (Table 8). This is comparable to that recorded for the first half of 1989. The pattern is similar for each ship, with the exception of ship 12.

Mortality data for hoggets on ship 15 did not show the same trend to higher mortalities in the enclosed decks seen in adult wethers on the same ship. The younger class of wethers (three years old) carried on ship 12 may therefore be part of the reason for the different pattern for this ship.

Approximately 19% of sheep exported by sea from Australia were carried in enclosed decks in 1989. Adult wethers carried in enclosed decks had an 18% greater risk of death before reaching the first destination port when compared to adult wethers carried in open decks. The extra deaths associated with enclosed decks amounted to approximately 1,300 sheep and at an average value of A$63 each, represents a loss of A$81,900.

Table 8. The number of shipments by vessel where wether mortality to the first port was higher (P<0.05), similar (P>0.05) or lower (P<0.05) in open decks compared to enclosed decks.

Ship (code)	Relative mortality rate between deck types: Open> enclosed	Not different	Enclosed> open	Totals
1	-	-	3	3
4	-	-	1	1
8	1	-	-	1
9	-	-	1	1
11	-	1	1	2
12	-	4	1	5
14	-	-	1	1
15	1	1	2	4
17	-	1	-	1
Total	2	7	10	19

Upper and lower tiers

The proportion of voyages with higher mortality rates in upper tiers (the 'tier effect') was greater in the second half than in the first half of 1989 (Table 9). Data from the whole year showed that 19 voyages had higher wether mortalities in upper tiers, 22 showed no difference and three had higher mortalities in lower tiers.

Table 9. The number of shipments by vessel where wether mortality to the first port was higher in upper tiers (P<0.05), not different (P>0.05) or higher in lower tiers (P<0.05).

Ship (code)	Relative mortality rate between deck types: Upper> Lower	Not different	Lower> upper	Totals
1	1	2	-	3
2	-	-	1	1
3	3	-	-	3
4	1	-	-	1
8	1	-	-	1
9	1	-	-	1
11	-	2	-	2
14	1	-	-	1
15	1	3	-	4
17	-	1	-	1
23	2	1	-	3
Total	11	9	1	21

Average figures for 1989 showed that approximately 45% of sheep were carried in upper tiers. The risk of death before arrival at the first destination port was approximately 17% greater in upper tiers. Therefore, the extra deaths associated with upper tiers amounted to approximately 2,600 sheep and at an average value of A$63 each, represents a loss of A$163,800.

Ships 3, 14 and 23 had higher mortalities in upper tiers on most voyages in 1989. Apart from high death rates on the uppermost tier of these and other ships, the 'tier effect' was not consistent between decks on any ship.

Forward and aft sections

Only four comparisons of wether mortality between forward and aft sections were made during the report period.

The mortality was higher in the forward section on one voyage (P<0.05), not different on two voyages (P>0.05) and higher in the aft section on one voyage (P<0.05). No consistent trend has emerged for an individual ship or across all ships.

High mortality voyages and epidemic spikes

The opportunity to closely examine the relationship between high temperatures, high relative humidity and death rates arose in a research voyage in August 1989. Mortality data for this voyage are shown in Figure 5a.

Data loggers were used to measure temperature and relative humidity from eight locations every 15 minutes during the voyage. The data from one logger located in a central position in the sheephouse are shown in Figures 5b and 5c.

The graph of mortality by day of voyage showed a tenfold increase in mortality from day 12 to day 14. Mortalities were recorded in the morning on each day of the voyage. Consequently, reasons for a rise in mortalities on days 13 and 14 were sought in the days prior to and including day 13.

The relative humidity during the latter stages of the voyage remained above 80% at most times of the day. On day 12 the temperature increased to a maximum of 37°C with the average of 31°C and a minimum of just below 25°C. However, on day 13 the average temperature increased to just above 36°C with temperatures remaining above 32°C throughout the day. The most dramatic increase in mortality was associated with the temperatures experienced on day 13.

The critical levels associated with the increased mortality were above 35°C and 80% relative humidity. The prolonged period above these levels on day 13 coincided with the rapid rise in mortality seen on day 14.

However, despite the continued hot conditions on day 14, the mortality rate on day 15 dropped by two thirds. This observation supports the hypothesis that some sheep are more susceptible than others to the effects of high temperature and humidity.

Data from another voyage of a different ship also showed a dramatic increase in mortalities after a rise in temperature to 36°C with the relative humidity at 75%.

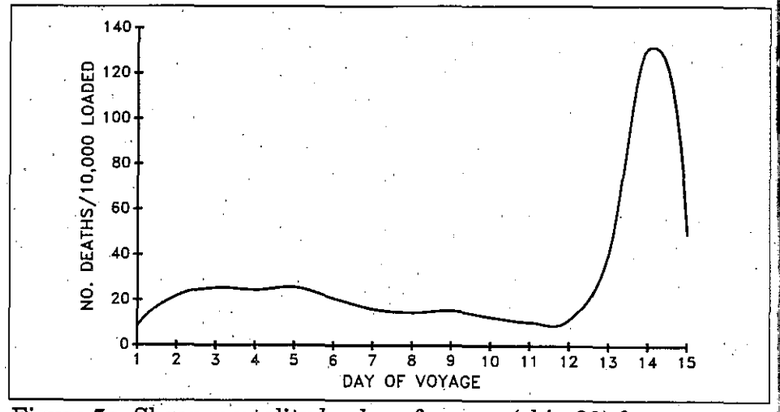

Figure 5a. Sheep mortality by day of voyage (ship 23) from Fremantle to the Middle East.

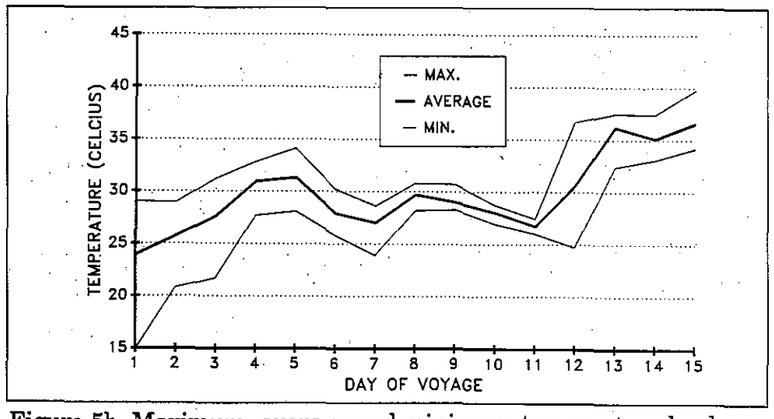

Figure 5b. Maximum, average and minimum temperature by day of voyage (ship 23).

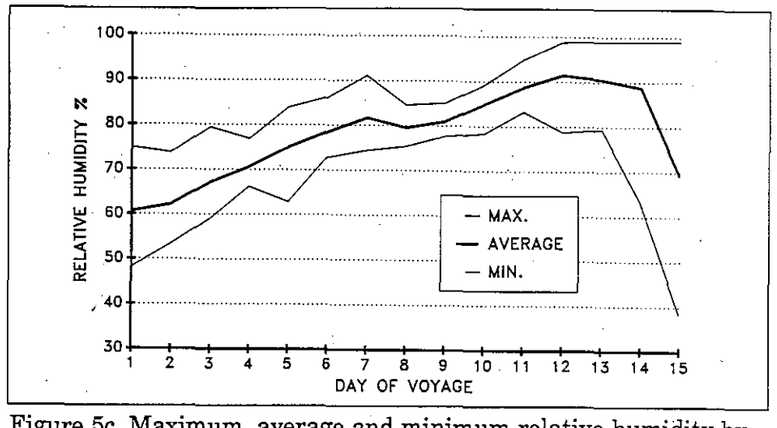

Figure 5c. Maximum, average and minimum relative humidity by day of voyage (ship 23).

Discharge mortality

Conditions of high temperature and relative humidity in the Gulf during the second half of 1989 accentuated the effect of slow discharge at destination ports. Death rates at port 5 were consistently high during the report period (Tables 10 and 11). The total mortality on one voyage of ship 15 more than doubled as a result of deaths during the discharge phase at this port.

Factors that may have contributed to the low mortality for port 1 included the prompt commencement of discharge after arrival, the continued discharge at all hours of the day or night and the younger class of wethers that were exported.

During hot conditions at sea, it is common practice to assist with the ventilation of the sheephouse by altering course in a 'zig zag' fashion. When a ship is in port there is no opportunity to increase ventilation and therefore the speed of discharge becomes critical, particularly in hot conditions. The effect of hot conditions during the discharge phase was well demonstrated in 1989 with the high mortality rates in the third quarter.

Table 10. The number of shipments by port of discharge (single port voyages only) in low, medium and high death rate categories during discharge.

Port of discharge (code)	Discharge mortality rate <0.1%	0.1 to 0.5%	>0.5%	Total%
1	2	3	-	5
4	-	-	1	1
5	-	-	4	4
8	-	-	1	1
9	-	-	1	1
24	-	1	-	1
Total	2	4	7	13

Table 11. Total discharge mortality rate and range by port of discharge for single port voyages only.

Port of discharge (code)	Discharge mortality rate Total%	Range%	Number of voyages
1	0.09	0.03 - 0.15	5
4	1.21		1
5	1.52	0.92 - 2.98	4
8	1.42		1
9	2.40		1
24	0.50		1
Total	1.25	0.03 - 2.98	13

Research update

Cause of death now understood

Australian research has now clearly identified the major causes of death in sheep during live export to the Middle East. More than half of all deaths are caused by sheep refusing to adapt to pellet feeding (*the shy feeding syndrome*). Some of these inappetant sheep succumb to salmonellosis and the rest suffer serious metabolic abnormalities which lead to death.

Salmonellosis is caused by a bacterium which produces inflammation of the fourth stomach and intestines in sheep. Infected sheep excrete massive numbers of salmonella bacteria in the faeces. The stress of cold, wet, windy weather interferes with normal body defenses against infection. Contamination of feed and drinking water with faeces occurs in every feedlot but good feedlot design and management can minimise this effect.

The extent to which salmonellosis contributes to the syndrome largely depends on conditions in the preshipping feedlot phase. Inclement weather, feeding hay on the ground, temporary ground water, inadequate feed troughs and a prolonged feedlot period all promote the development of salmonellosis.

Shy feeder syndrome — the tip of the iceberg

The Victorian Department of Agriculture and Rural Affairs (DARA) research team reports that the shy feeder syndrome probably causes substantial losses further down the export chain. Many shy feeders survive the voyage to the Middle East and although bright, alert and otherwise healthy at discharge they have lost weight and are often fairly thin. The following table estimates the magnitude of the problem on three research voyages.

Voyage number	% with major weight loss (more than 20% of initial weight)	%died from shy-feeding syndrome	Estimated potential loss (%)
1	2.3	0.4	2.7
2	1.8	0.9	2.7
3	2.4	0.8	3.2

These "survivors" pose a significant problem for the industry. Middle East importers do not like thin sheep and these animals are usually drafted out immediately on arrival. They are either slaughtered at a loss, or given special management to regain weight, either way they represent an additional cost to the industry. It is also likely that shy feeders undetected in the cull will contribute to deaths in the Middle East feedlot and condemnations at the abattoir. Consequently, the benefits of treatment or prevention of the shy feeder syndrome will be greater than just reducing shipboard mortality rates.

Why won't some sheep eat?

The fourth "voyage" of the DARA shipboard simulation shed (the "SS Werribee") showed that changes in the physical form of the feed, to more familiar forms like loose hay instead of pellets, could reduce the shy feeder syndrome by up to 80%.

Shipboard rations are usually pelleted, so in this experiment 600 sheep were fed pellets made from hay, and another 600 were fed the same ration in unprocessed form. The pellet-fed group suffered the normal level of shy feeding (2.3%) but the unprocessed-hay-fed group had only 0.3% - one sixth the normal level.

While this is far from a final solution to the industry's health problems it means the main reason for shy feeding could be simply the unfamiliar form of the feed. If so, one solution would be to prepare rations which all sheep will recognise and accept as food but which can also be carried in bulk and distributed efficiently on board ship. Another solution would be improved methods of adapting sheep to pellets.

Treatment of shy feeders

The Western Australian Department of Agriculture (WADA) research team recently conducted an experiment to see if appetite could be "turned on" in shy feeders. A group of 5,000 wethers were treated with Ivermectin (to kill worms) and vitamin B12 at receival in the feedlot. The treatment produced 21% fewer shy feeders at the end of the feedlot period than a similar group of 5,000 untreated sheep.

The remaining (non-responding) shy feeders were then treated with magnesium and vitamins B1 and E before shipment to the Middle East. The mortality due to shy feeding and salmonellosis during the first 12 days of the voyage was 48.4% lower in the treatment group than untreated controls.

The results indicate that although appetite is controlled by a variety of intrinsic biological mechanisms, these mechanisms can be modified by treatment. The research team hopes to identify which components of the treatment were effective and hence gain an improved understanding of the reasons for shy feeding.

The ultimate aim of this work is to relate these reasons to the "line effect" where shy feeders (and shipboard deaths) are more common in some farm groups of sheep than in others. Information that will lead to the exclusion of high mortality lines from export is identified by the WADA team as the most likely method of reducing mortality rates. The team estimates that lines with more than 4% mortality during shipping account for about half of all deaths (a cost to the industry of approximately $4m per year). These high mortality lines make up some 12 to 15% of the total sheep shipped.

Feeding to maintain liveweight

A Western Australian experiment showed that 67 kg wethers needed 1.4 kg per head per day of typical industry pellets (metabolisable energy 9.9 MJ/kg DM) to maintain liveweight under simulated shipping conditions.

Although this feed requirement is not substantially greater than many shippers would choose to feed this class of sheep, the level is some 35% higher than can be predicted from the international literature for 67 kg wethers kept indoors.

The experiment was repeated with 52 kg wethers and pellets with metabolisable energy 10.2 MJ/kg DM. The results showed that to maintain liveweight required 1.5 kg per head per day. This was approximately double that predicted from the literature for 50 to 55 kg animals kept indoors.

The higher intake needed for the 52 kg animals compared to the 67 kg animals was probably related partly to the time of the year when these experiments were conducted. The heavyweight wether trial was done in summer and the lighter animals were studied in the winter in an open sided shed. Consequently, there was probably an increased energy requirement to maintain body temperature in the 52 kg wethers. The fact that larger animals use energy slightly more efficiently than smaller animals may also have contributed.

It is clear from these results that Merino wethers require much more feed to maintain bodyweight, when under export conditions, than is predicted from the literature on housed sheep. Blood samples are being analysed for metabolic clues to explain this increased requirement.

Published studies

A number of studies relevant to the live sheep export industry are published in the scientific literature. The following is a list of some recent publications.

McDonald, C.L., Norris, R.T., Speijers, E.J., Ridings, H. (1990). Feeding behaviour of Merino wethers during simulated shipping. *Aust. J. Exp. Agric.* (in press).

Norris, R.T., McDonald, C.L., Richards, R.B., Hyder, M.W., Gittins, S.P., Norman, G.J. (1990). Management of inappetant sheep during export by sea. *Aust. Vet. J.* (in press).

Norris, R.T., Richards, R.B., Dunlop, R.H. (1989). An epidemiological study of sheep deaths before and during export by sea from Western Australia. *Aust. Vet. J.* **66**:276-279.

Norris, R.T., Richards, R.B., Dunlop, R.H. (1989). Pre-embarkation risk factors for sheep deaths during export by sea from Western Australia. *Aust. Vet. J.* **66**:309-314.

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