Miscellaneous Publication No. 17/90
ISSN 0725-847X

National Data Recording System

for the

Live Sheep Export Industry

Report No. 3

January to June 1990

Compiled by A.R. Higgs

The National Data Recording System for the Live Sheep Export Industry is funded by the Australian Meat and Livestock Research and Development Corporation and the Western Australian Department of Agriculture.

Contents

Introduction

This is the third 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 provided on current research activities and publications.

The format is similar to that of the previous reports and provides information on sheep exported from the ports of Fremantle, Adelaide and Portland during the six months to June 30, 1990. Confidentiality is maintained in this series of reports by the use of codes for individual vessels and ports of discharge.

Numbers of livestock exported

The number of sheep exported in the first half of 1990 (Table 1) was 83% of the total for the corresponding period in 1989. The reduction in exports could be attributed almost entirely to continued difficulties with the trade to Saudi Arabia (Figure 1). Exports from Adelaide were affected most; the total exported for the current period was half that for the corresponding period in 1989.

The proportion of sheep in each class was similar in the first half of 1990 to that in the same period in 1989. The exception was a reduction in the number of ram lambs exported in 1990. The downturn in trade with Saudi Arabia, traditionally a major importer of ram lambs, accounts for the reduction.

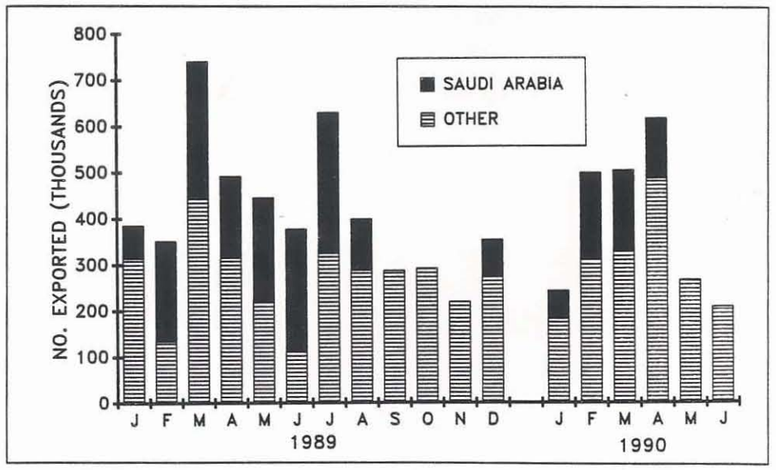


Figure 1. Monthly total of sheep exported by sea from Australia to Saudi Arabia and other Middle East countries for 1989 and the six months to June 30, 1990

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 June 30, 1990.

		Fremantle Middle East	Fremantle SE Asia	Adelaide M. East	Portland M. East	Total
Wethers	-adult	1,159,565	10,829	307,881	541,288	2,019,563
	-hogget	†	0	13,154	15,811	28,965
	-lambs	97,758	0	6,463	23,890	128,111
Rams	-adult	32,574	10,302	6,659	10,919	60,454
	-lambs	25,774	1,365	47,718	33,827	108,684
Ewes	-adult	1,600	0	4,086	0	5,686
	-lambs	6,814	0	0	0	6,814
Total	-sheep	1,324,085	22,496	385,961	625,735	2,358,277
	-goats	4,148	3,035	250	1202	8,635
	-cattle	838	445	454	0	1,737

† hoggets were included in the adult wether category in records held at Fremantle

By destination country (sheep only)

The list of destination countries in Table 2 includes three countries not mentioned in previous reports. Turkey and Italy were the final destinations for two rejected consignments. Egypt was the intended destination for one shipment only.

The number of sheep exported to countries other than Saudi Arabia and the above-mentioned countries remained at levels similar to those in previous periods.

Table 2. The destination country and number of live sheep exported from Fremantle, Adelaide and Portland in the six months to June 30, 1990.

Country	Fremantle	Adelaide	Portland	Total
Bahrain	53,250	6,000	8,250	47,500
Egypt	73,190	0	0	73,190
Kuwait	322,661	91,487	312,895	727,043
Oman	153,478	0	28,442	181,920
Qatar	149,456	0	0	149,456
Saudi Arabia	231,143	210,877	86,483	524,417
S.E. Asia	22,496	0	0	22,496
Turkey	17,707	0	0	17,707
U.A.E.	285,266	67,597	86,058	438,921
Yemen	9,000	0	0	9,000
Other (Italy)	28,934	0	33,607	62,541
Total	1,346,581	385,961	625,735	2,358,277

Mortality rates

Sheep

The mortality rate was 2.1% for sheep exported from Fremantle in the first half of 1990 (Figure 2). This figure is higher than for the first half of each year from 1985 to 1989. Analysis of death rates by half of the year has shown higher rates in the second half in four of five years (Higgs *et al.* 1990). Therefore, it is likely that the annual mortality rate for 1990 will exceed 2%.

Death rates by class of sheep (Figure 3 and Table 3) were similar to those in the first half of 1989. The exception was a small increase in hogget wether death rates to slightly above that of wether lambs in the same period.

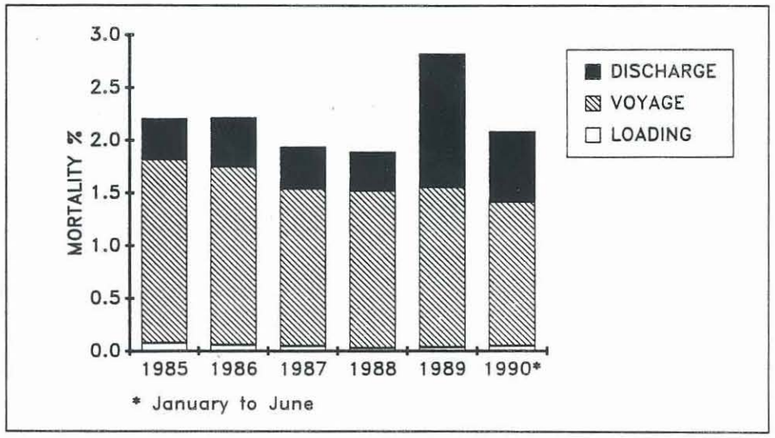


Figure 2. Annual mortality (%) for sheep exported live from Fremantle to the Middle East.

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 first half of 1990.

Sheep		Fremantle	Adelaide	Portland
Wethers	-adult	1.42	0.85	1.21
	-hogget	0.90	†	0.75
	-lambs	0.83	0.49	1.21
Rams	-adult	1.14	1.31	0.79
	-hogget	1.56	0.68	1.55
	-lambs	1.74	1.69	2.41
Ewes	-adult	1.81	0.17	n/a
	-lambs	2.06	n/a	n/a
Total	-sheep	1.31	0.92	1.20

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

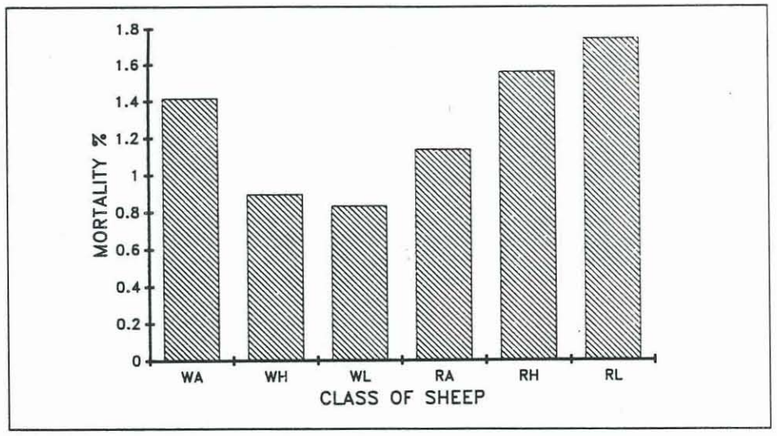


Figure 3. Mortality (%) by class of sheep for 22 voyages from Fremantle to the first port of discharge in the Middle East in the first half of 1990.

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

In the second half of 1989, ram lamb and ram hogget death rates were higher than in adult wethers. In contrast, death rates in the young ram classes were low in the first half of 1989 and 1990. This suggests that the seasonal difference in death rates, seen in adult wethers (Higgs *et al.* 1990), may also be present in other classes of sheep.

Goats

Mortality rates for goats (Table 4) were higher than for sheep in the first half of 1990. This is in common with findings in previous reports. The highest mortality rate for an individual consignment was 8.4% which is approximately half the highest death rate recorded in the second half of 1989. It may be that goats are subject to the same seasonal differences in death rates as sheep, with higher rates in the second half.

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 first half of 1990.

	Fremantle		Adelaide	Portland
	M East	SE Asia	M East	M East
1990 (January to June)				
No. of voyages	8††	1	1	4††
No. loaded	2,754	3,035	250	894
No. dead	70	†	21	17
Percentage dead	2.54	†	8.40	1.90

† data unavailable
†† data unavailable for one voyage

Cattle

Several small consignments of cattle were exported from Fremantle and only one from Adelaide in the reporting period (Table 5). Death rates were much lower in cattle than in sheep which is consistent with records from previous years.

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 first half of 1990.

	Fremantle		Adelaide	Portland
	M East	SE Asia	M East	M East
1990 (January to June)				
No. of voyages	6	8	1	0
No. loaded	838	445	454	n/a
No. dead	3	1	2	n/a
Percentage dead	0.36	0.22	0.44	n/a

Mortality by quarter of the year

Low death rates for shipments from Adelaide (Table 6) can be attributed mainly to the requirement that all wethers for export to Saudi Arabia are not more than three years of age; young wethers have lower death rates than older wethers. Exports from Adelaide were dominated by the trade with Saudi Arabia; four of five shipments were prepared for Saudi Arabia in the current period. Also, in most cases all sheep were discharged at one port.

Similarly, low death rates were observed in shipments from Fremantle to Saudi Arabia but they represented only a small proportion of the exports from that port. Consequently there was little effect on the total death rate in each quarter for Fremantle.

A low mortality for one of the two shipments from Portland in the second quarter contributed to the low total death rate in that period.

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 first and second quarters of 1990.

	Fremantle	Adelaide	Portland
January to March			
No. of voyages	12††	3	4†
No. loaded	525,097	210,877	418,878
No. dead	10,836	2,854	8,408
Percentage dead	2.06	1.35	2.01
April to June			
No. of voyages	11††	2	2
No. loaded	714,930	175,084	172,913
No. dead	14,996	1,948	2,069
Percentage dead	2.10	1.11	1.20

† one voyage loaded at Portland and Fremantle not included
†† data unavailable for one voyage in the first quarter and two in the second. These voyages carried a total of 55,000 sheep.

Mortality by ship (for adult wethers)

A comparison between ships is best done by comparing mortality to the first port of discharge and by matching as many factors as possible in the analysis. Two significant factors are the class of sheep and the port of origin. The time of year can also affect mortality.

A comparison of the results presented below (Tables 7a, 7b and 7c) with those for 1989 showed a better performance for two ships and a poorer performance for another two ships. The apparent improvement for ships 4 and 11 can be attributed to the younger class of wethers carried. Three of four voyages of ship 9 were in the high mortality category for the current report period. Data from 1989 showed one voyage in the high mortality category and four in the medium category. Ship 15 had two high mortality voyages compared to none in 1989.

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			Total
	Low <1.0%	Medium 1.0-2.0%	High >2.0%	
1	-	1	1	2
2	1	-	1	2
3	-	2	-	2
4	1	-	-	1
8	2	-	-	2
9	-	1	3	4
11	2	-	-	2
12	2	1†	-	3
15	0	3	2	5
Total	8	8	7	23

† Includes mortality for all classes of sheep on one voyage

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			Total
	Low <1.0%	Medium 1.0-2.0%	High >2.0%	
13	1	-	-	1
22	-	2†	-	2
23	-	1	-	1
27	1	-	-	1
Total	2	3	0	5

† Includes mortality for all classes of sheep on one voyage

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
2	1	1†	-	2
7	-	1	-	1
23	-	1	1	2
27	1†	-	-	1
Total	2	3	1	6

† Includes mortality for all classes of sheep on one voyage

Spatial pattern of mortality

Comparisons of mortality in different areas of a ship are best made using the same class of sheep. 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 records over the past 18 months show that death rates by deck tend to reflect whether the deck is in the open or enclosed section of the sheep-house. In conditions of high temperature and humidity, death rates are more likely to rise on the top deck of the open sheep-house, particularly on large ships, than on lower decks. It is likely that the combined effects of convection and radiation account for this observation.

Open and enclosed decks

Death rates in enclosed decks were significantly higher than in open decks on 21 of 40 voyages (53%) in 1989. The pattern for the first half of 1990 was not as strong as in 1989 with only 6 of 19 voyages (32%) having higher death rates in the enclosed decks and four with higher death rates in the open decks (Table 8).

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	-	1	1	2
4	-	1	-	1
7	-	-	1	1
8	1	1	-	2
9	2	1	1	4
11	-	2	-	2
12	-	1	1	2
15	1	2	2	5
Total	4	9	6	19

Temperature and relative humidity were recorded every 15 minutes with data loggers on one voyage of ship 15. The loggers were located centrally in the open and enclosed sections of the sheep-house. A comparison was made between the environmental data and the wether mortality rates.

Death rates rose steadily to a peak on day 8 and subsequently declined (Figure 4a). A breakdown of the death rates in the open and enclosed sections of the ship (Figure 4b) showed a higher daily rate in the enclosed section on most days, particularly in the middle stages of the voyage. Interestingly, a similar rise in death rates in upper tiers (Figure 4c) also occurred in the middle stages of the voyage suggesting the possibility of a common cause.

Temperatures in the enclosed section of the ship (Figure 5) were at moderately high levels from day 1, showed daily fluctuations of less than 5°C and had a peak (average) on day 7. Temperatures in the open section were more than twice the range in the enclosed section and were 5°C to 10°C cooler at most times.

Daily fluctuations in relative humidity were greater in the open section, and the range was at a slightly lower level in the enclosed section. If the same absolute amount of moisture was present in two airspaces, the one with the higher temperature will have the lower relative humidity. Therefore, the higher temperatures in the enclosed section explain the slightly lower relative humidity readings. The combination of these two factors resulted in 'hotter' conditions in the enclosed section.

The death rate pattern closely followed the changes in the environmental conditions, with a peak temperature on day 7 corresponding to a peak death rate in the enclosed section on day 8 (deaths were counted in the morning of each day). Although the peak death rate in upper tiers was not identical to that in the enclosed decks, there were many similarities in the profiles. This suggests that environmental conditions play a role in the 'tier effect.'

Upper and lower tiers

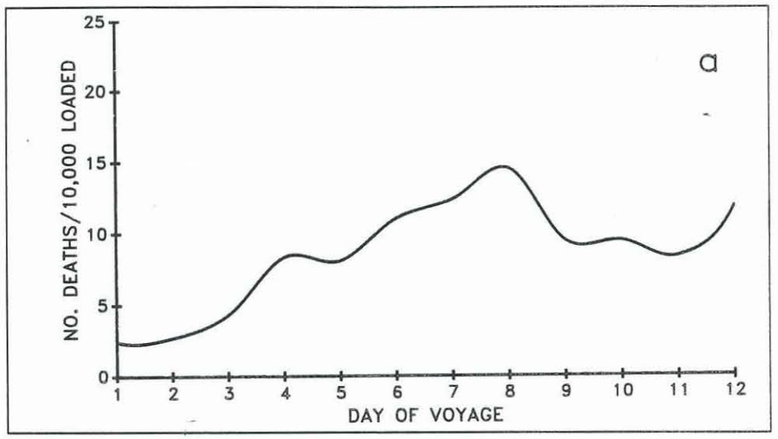
In 1989, death rates were higher in upper tiers in 19 of 44 voyages (43%). Data for the first half of 1990 was similar to that for 1989 with 9 of 24 voyages (38%) having higher death rates in upper tiers (Table 9).

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).

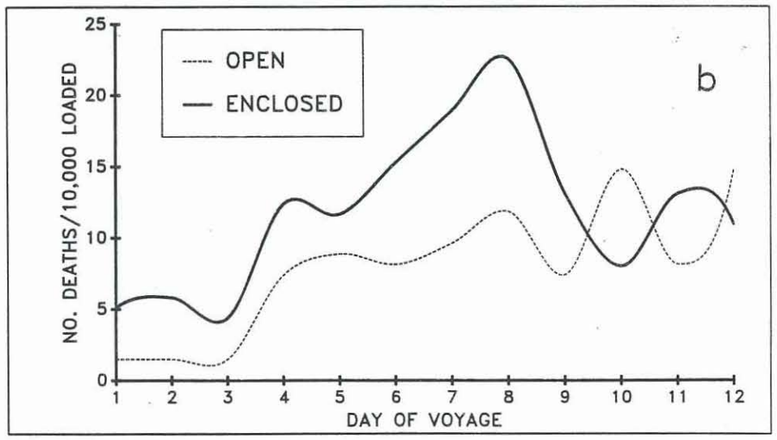
Ship (code)	Relative mortality rate between deck types Upper>Lower	Not Different	Lower>Upper	Totals
1	-	1	-	1
2	-	1	1	2
3	-	1	1	2
4	-	1	-	1
7	1	-	-	1
8	-	1	1	2
9	3	1	-	4
11	-	1	-	1
15	1	3	1	5
22	-	1	-	1
23	3	-	-	3
27	1	-	-	1
Total	9	11	4	24

Figure 4. Daily data from one voyage of ship 15 to the Middle East showing:

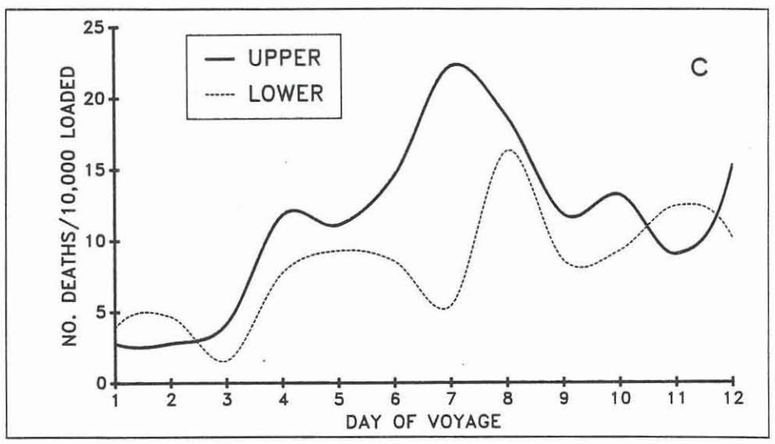
(a) death rate for all classes of sheep



(b) wether death rate in open and enclosed decks; and



(c) wether death rate in upper and lower tiers.



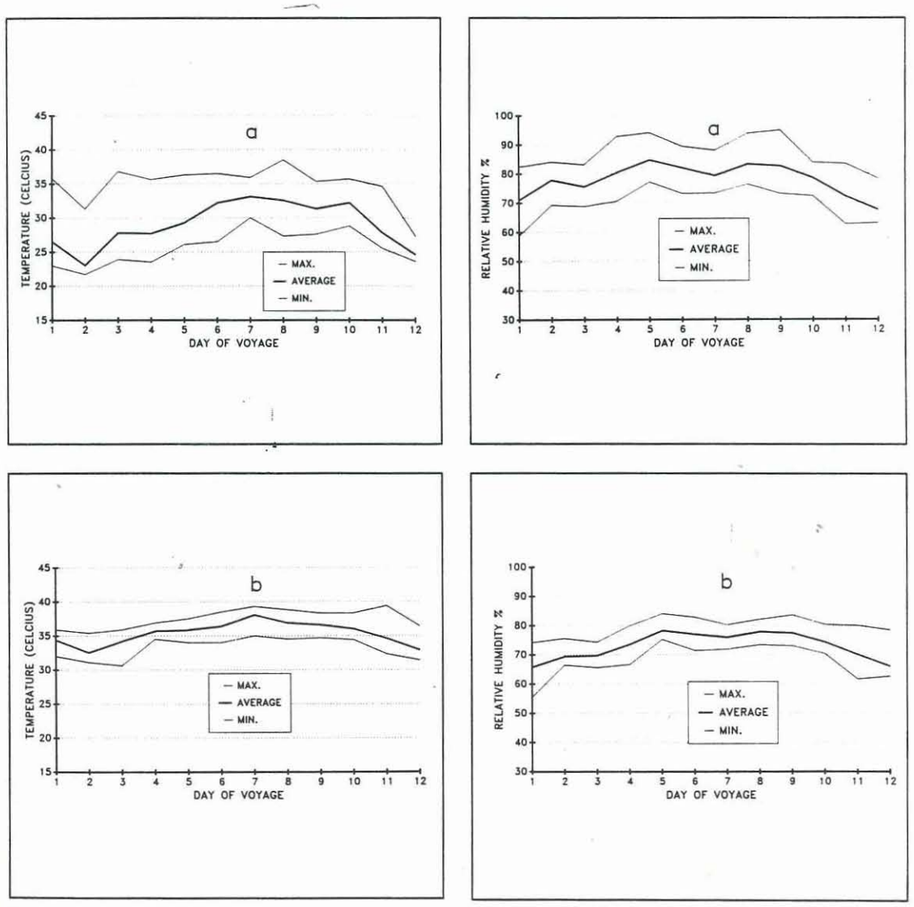


Figure 5. Temperature and relative humidity by day in the (a) open and (b) enclosed section on one voyage of ship 15.

Forward and aft sections

Only one comparison of wether death rates in forward and aft sections was made in the current period. On this occasion the death rate was higher in the forward section. In 1989 there were three voyages with higher death rates in the forward section, seven were not different and two were higher in the aft section. No clear pattern has emerged.

High mortality voyages and epidemic spikes

A sudden rise in temperature from 29°C to 36°C with relative humidity at 87% was associated with an increase of more than six fold in daily death rate on one voyage. Epidemics of mortality have been seen on other voyages in association with rapid rises in ambient temperature. In each case it has been sudden (less than 24 hours) rather than gradual changes in environmental conditions that have been associated with epidemics.

Discharge mortality

Death rates were consistently high at port 5 during the current period (Tables 10 and 11). The number of deaths during the discharge phase was approximately equal to the total during the voyage on one occasion. An average of only 10,000 sheep per day were discharged at this port. The contribution of this phase of export to the total mortality is substantial, particularly during the northern hemisphere summer.

Previous reports also identified high death rates at port 5, particularly in the second half of 1989.

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	-	1	-	1
4	-	1	-	1
5	-	-	5	5
8	1	2	1	4
9	-	1	-	1
17	-	1	-	1
24	1	-	-	1
26	1	-	-	1
Total	3	6	6	15

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	0.13		1
4	0.17		1
5	1.03	0.68 - 1.28	5
8	0.37	0.04 - 0.72	4
9	0.33		1
17	0.36		1
24	0.08		1
26	0.05		1
Total	0.45	0.04 - 1.28	15

Research update

Why is the death rate higher in the second half of the year?

The seasonal fluctuation in shipboard death rates that have intrigued researchers for years may now be explained according to recent Western Australian Department of Agriculture (WADA) studies. The work draws a link between season, age, fatness and metabolic cycles.

Masters' Reports and The National Data Recording System have shown that death rates aboard ship are significantly higher in the second half of the calender year than in the first half and that the death rate in mature wethers (three years and older) is higher than in younger sheep. Several WADA research voyages have confirmed that fat sheep (fat lines and individually fat sheep) are more at risk of death than lean sheep. With this in mind the WADA team set out to explain these observations by studying the blood chemistry of adult Merino wethers exported during May (low death rate period) and August (high death rate period). The feedlots, ships, and voyage duration were all similar but the results were quite revealing.

In May, sheep with loss of appetite (the main predisposing factor for death at sea) were able to use their reserves of body fat for internal energy supply and consequently few died (0.83%). However, in August, inappetant sheep were unable to convert their fat reserves to energy for more than a few days and the mortality rate was much higher (3.27%).

The explanation suggested by the research team was that sheep coming from dry pastures in the first half of the year are normally losing weight because of low energy rations and are therefore adjusted to fat utilisation. Therefore, their body chemistry is geared to cope with a period of inappetance . By contrast, in August, sheep are coming from green pastures where their dietary energy intake is high enough to allow body fat reserves to build up again and they gain weight. Their body chemistry is geared in the opposite direction. Fasting under these circumstances is not associated with efficient fat utilisation. It seems as though the chemical mechanisms for fat utilisation are caught 'out of phase' in August and are unable to adjust.

The results have given direction to future research which will now look specifically at long-term (seasonal) control of appetite in sheep. The challenge will be to find methods to restore appetite in export wethers, especially at the high risk times of the year.

Reports from the Victorian Department of Agriculture and Rural Affairs (DARA) suggest that a similar pattern may occur in sheep shipped from eastern Australia. Voyage mortality rates, from a study of Masters' reports, were found to be strongly associated with time of year. Statistical analysis showed that rates were highest in June-August and lowest in February-April.

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.

Higgs, A.R.B., Norris, R.T. and Richards, R.B. (1990). Season, age and adiposity influence death rates in sheep exported by sea. Aust. J. Agric. Res. (submitted).

McDonald, C.L., Norris, R.T., Speijers, E.J. and Ridings, H. (1990). Feeding behaviour of Merino wethers during simulated shipping. *Aust. J. Exp. Agric.* **30**:343-8.

Norris, R.T., McDonald, C.L., Richards, R.B., Hyder, M.W., Gittins, S.P. and Norman. G.J. (1990). Management of inappetant sheep during export by sea. *Aust. Vet. J.* **67**:244-7.

Richards, R.B., Hyder, M.W., Fry, J., Costa, N.D., Norris, R.T. and Higgs, A.R.B. (1990). Seasonal metabolic factors may be responsible for deaths in sheep exported by sea. *Aust. J. Agric. Res.* (submitted).

Thomas, K.W., Kelly, A.P., Beers, P.T. and Brennan, R.G. (1990). Thiamine deficiency in sheep exported live by sea. *Aust. Vet. J.* **67**:215-8.

Acknowledgements

Many people assisted in the collection of this information and I am again indebted to the ships' Masters and Officers who willingly documented the data.

Officers from the South Australian and Western Australian Departments of Agriculture, the Victorian Department of Agriculture and Rural Affairs and the Australian Quarantine and Inspection Service were involved in the collection and distribution of reports.

The exporting and shipping companies have continued with their support for which I am grateful.

Individual contributions vital to the production of this report have come from Barry Richards, Richard Norris, Andrew Kelly, Bruce Graham, Seng Koh, Chris Etherton, Lloyd Ross, Max Caithness and Ted Clements.