Linking pre export factors to post delivery performance in cattle exported from northern Australia to Indonesia

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Abstract

This report provides findings from a pilot study involving collection and information from consignments of cattle on export vessels travelling from Darwin to Indonesia. The study arose from industry interest in describing the change in liveweight in animals being exported from Northern Australia to South East Asia (particularly Indonesia) and in identifying factors or drivers that may influence liveweight-based performance measures. This pilot study was specifically designed to test assumptions and methodologies for data collection in order to determine the feasibility of a subsequent larger study that might directly address the above objectives. The pilot study successfully enrolled two voyages and collected data on animal performance and other drivers from one voyage. The study has identified a range of factors that will be important in the design and successful implementation of a larger project. A draft design and indicative budget is described for a 3-year project and it is recommended that a workshop be held with key project personnel to discuss the findings of this report and develop a final proposal and budget.

Executive summary

This report provides findings from a pilot study involving collection and information from consignments of cattle on export vessels travelling from Darwin to Indonesia. The study arose from industry interest in describing the change in liveweight in animals being exported from Northern Australia to South East Asia (particularly Indonesia) and in identifying factors or drivers that may influence liveweight-based performance measures. The longer term outcome of this work is to provide feedback to industry about animal performance that may be useful to guide selection and management and continue to promote a competitive advantage for Australian producers into Asian livestock markets.

This pilot study was specifically designed to test assumptions and methodologies for data collection in order to determine the feasibility of a subsequent larger study that might directly address objectives outlined in the above paragraph. The purposes of the pilot study were to:

- determine the feasibility of a larger study that may address the two objectives of interest (3a and 3b above). Feasibility will be based on things such as availability, accessibility and quality of data that are suitable to address the objectives
- guide the design of a larger scale study to examine the two objectives of interest in detail including consideration of:
    - estimation of required sample sizes (number of trucks and voyages) to allow the two main objectives to be addressed with confidence of getting results of value to the industry
    - resource requirements – people, travel etc
    - design issues – how would data be collected, entered and managed
- guide the development of a budget for the larger scale study

Consignments of cattle were enrolled into the project from two voyages travelling to Indonesia. However, a complete dataset on selected cattle consignments was only obtained for one voyage and this report presents results from one voyage only.

Animal weights were collected an multiple weigh points including during the journey from property of origin to the assembly feedlot (ex-property), arrival at the assembly feedlot, on load-out from the assembly feedlot to the vessel and on discharge from the export vessel in an Indonesian port. In addition there were induction and finish weights (and average daily gain estimates) collected from Indonesian feedlots for these consignments. Additional information has been collected on management of animals at the property of origin and on management and environmental factors during the assembly feedlot and voyage periods.

Animal weights in Australia were collected in aggregated form (pen, trailer or truck) but because replicates were collected (multiple measurements for each consignment) these aggregated weights were still able to be used to derive unbiased estimates of average weight and variability (standard error and standard deviation).

Summary statistics are presented to describe liveweight and weight change at different stages along the export process.

The findings clearly suggest that it is feasible to design a larger study capable of collecting liveweight and other information on animals being exported and on analysing these data to describe performance and identify drivers of performance in the export process. An important component of any larger study will be appointment of dedicated project personnel within Australia and Indonesia to ensure successful collection of data.

Enforcement of the 350kg limit on animals being exported to Indonesia is understood to have resulted in most or all animals being individually weighed prior to load out. Availability of individual animal weights would enhance the ability of a larger study to achieve objectives by improving precision of weight estimates.

A draft design is presented for a 3-year study to address the industry objectives relating to performance of Australian cattle in Indonesian live export markets. The design is accompanied by an indicative budget that has annual costs of $250,000 for each of the three years.

It is recommended that an initial workshop be held to receive background information from the authors of the current report and from MLA/LiveCorp representatives about the proposed project. The meeting would then undertake a facilitated discussion of the design of the project including consideration of objectives, methods and resource requirements. The outcome of this meeting would be a revised project protocol and budget that would be suitable for circulation to industry stakeholders and consideration by MLA / Livecorp for funding.

The budget for this initial workshop is not presented in the draft project budget. It is anticipated that the cost would be as for budgeted cost of an annual steering committee meeting ($11 to $15,000) depending on the number of people and travel costs.

Contents

1 Introduction

This project has developed and applied methods to examine factors contributing to performance of cattle exported from Darwin to Indonesia. The project has concentrated on investigating cattle liveweight changes, and factors which may influence cattle liveweight changes from property of origin to slaughter in Indonesia.

The pilot study is intended to test assumptions and methodologies for data collection. It is critical to note that the pilot study is not intended to provide detailed results that describe the change in liveweight in cattle exported from Darwin to Indonesia nor is it expected to provide details on any associations between liveweight-based performance measures and other explanatory factors. The pilot study is expected to assess feasibility of a larger study that is capable of directly addressing these issues. Feasibility is likely to be based on things such as availability, accessibility and quality of data that are suitable to address the objectives.

2 Objectives

1. Completed a literature review concentrating on health, welfare and productivity of cattle exported to Asia from Australia.
2. Assessed and analysed any relevant historical industry datasets concerning cattle exports
3. Completed a pilot study aimed at meeting the following two broad objectives;
   a. Describing the change in liveweight in animals being exported from Darwin to Indonesia (covering the following periods: property of origin to assembly depot, assembly depot to Indonesia, feedlot period in Indonesia); and
   b. Identifying factors (or drivers) that influence the change in liveweight in exported animals during progression from property-of-origin to slaughter in Indonesia.
   c. Detailed the design and budget for a prospective study to investigate major drivers of performance for cattle exported from Darwin to Indonesia.

3 Literature review

The majority of Australia's 28 million beef cattle are produced in northern states with Queensland accounting for 42% of the national herd. Beef cattle production is the dominant form of land utilisation in northern Australia, covering Queensland, the Northern Territory and the northern parts of Western Australia (Kimberley and Pilbara regions) (Burns, Fordyce et al. 2010).

The northern Australian regions are tropical, have summer maxima that may reach 50 C, relatively warm winters with overnight frosts not uncommon in inland and southern parts of the region. The entire continent of Australia is considered relatively dry with 50% of the country having a median rainfall of less than 300mm per year and 80% less than 600mm (Burns, Fordyce et al. 2010). Northern Australia has a monsoonal rainfall pattern with almost all rainfall falling in a wet season that occurs generally between November and April and the remainder of the year (May to October) forming the dry season (Burns, Fordyce et al. 2010).

Management characteristics for cattle production across northern Australia are highly variable given that the region covers a vast area and ranges across diverse climatic, topographic and geographic conditions. Major beef production characteristics of much of the region include low stocking rates (up to 1 beast to 150 ha), dependence on natural pasture with limited introduction of improved pasture species, weight gain mainly occurring during a pasture growth season that corresponds to the wet and weight loss during the dry season. Continuous mating is common though restricted mating (bulls placed in with cows and then removed at the end of a defined mating period) is increasing in popularity. In many northern regions, cattle are generally handled relatively infrequently with mustering (branding, castration, weaning) occurring twice annually in many stations (April-July and August-September) and once annually on some stations (Burns, Fordyce et al. 2010).

Over time cattle breeds in the far north of Australia have become dominated by *Bos indicus* genetics as a result of the superior production performance of these breeds in the harsh northern environment, a result in part of tolerance to high temperatures and internal parasites, as well as greater tick resistance. The proportion of *Bos indicus* and *Bos indicus* crossbreeds in northern Australia has risen from 5% in 1970 to approximately 85% at present, mainly as a result of widespread use of Brahman cattle and their derivative breeds such as Droughtmaster, Santa Gertrudis, Braford, Brangus, Charbray, Simbrah and Brahmousin (Burns, Fordyce et al. 2010).

3.1 Development of cattle live export into Asia

There have been major changes over the past 20-30 years both in the northern Australian beef production systems and in the Asian market for meat-based protein, that have worked to influence the development of a very strong live cattle export system based on movement of relatively low-cost feeder cattle from northern Australia into Asian feedlots.

In northern Australia there have been improvements in herd management, animal genetics, animal husbandry techniques, feeding and veterinary care in the north, that were facilitated in part by activities associated with the Brucellosis and Tuberculosis Eradication Campaign (BTEC). Investment in property improvements such as fencing, watering points and pasture management occurred along with the transition from a low input system with variable production based on *Bos taurus* breeds to a more intensively managed, productive and profitable system based on *Bos indicus* breeds (Drum and Gunning-Trant 2008).

In Asia, economic development, urbanisation and increasing per capita incomes have been associated with increasing demand for animal protein, generally resulting in increased importation of live animals or chilled/frozen meat products coupled with attempts to increase livestock productivity within Asian countries (FAO 2009).

In a number of Asian countries where demand for animal protein could not be met by internal livestock production systems, there were opportunities for Australian cattle exports to meet the shortfall. Importing live cattle as opposed to boxed (chilled or frozen) beef provided advantages in countries where refrigeration and power were limited and unreliable and where cultural practices favoured fresh or wet-market beef over supermarket cuts. A range of other factors influenced the development of the current live export system including ample supplies of cheap agricultural industry by-products for cattle feed, low costs and ready availability of labour, land, and infrastructure for feedlots and meat processing systems, and lower health and hygiene requirements. This has produced a synergistic system where Australia produces high quality, low cost, live cattle and Asian countries (Indonesia in particular) imports these animals into a feedlot and market system capable of fattening the animals at low cost and moving them to wet markets to meet protein demand (Rutherford 1995).

The live export trade with Asia is based on the combination of comparative low production costs in northern Australia, close proximity to Asian markets, and the ready supply of tropically adapted cattle that are free of major disease threats and capable of rapid weight gain under feedlot conditions. The market has been facilitated by developments in land and sea transportation, cattle breeding, infrastructure, feeding and veterinary care. Cattle can be accumulated at depot feedlots and then rapidly processed and loaded, providing increased assurances concerning supply. The absence of major cattle diseases and particularly FMD provide competitive advantages in accessing markets in Asia when compared to other potential providers of export cattle. The strong demand for live export cattle has contributed to the decline in export accredited abattoirs operating in northern Australia (Rutherford 1995; Drum and Gunning-Trant 2008).

3.2 Summary statistics

Although there has been significant growth in the live export trade since 1990, it still represents a relatively small proportion of national beef production, accounting for about 7 per cent of total Australian cattle turnoff and 6 per cent of the total value of cattle production in the 2006-2007 year (Drum and Gunning-Trant 2008). The domestic market for beef products remains the largest contributor to total value of beef production.

However, northern Australian producers account for the majority of live cattle exports and in northern parts of Australia live export markets may represent very important contributors to individual property (and regional) income.

The changing patterns illustrated in Figures 1 and 2 and in Table 1 for numbers of cattle exported from Australia, provide graphic evidence of the variability in the markets and the influence of various factors operating both within Australia and internationally.

The economic downturn in south east Asian countries in 1998 reduced live cattle demand, especially from Indonesia, and exports to countries such as Indonesia took several years to fully recover. This was followed by a further dramatic decline in cattle exports in 2003-04, as exports to Egypt collapsed following devaluation of the Egyptian currency and exports to Indonesia, Malaysia and the Philippines also fell.

Increasing prices and strengthening in the Australian dollar are considered to have attributed to the decline in exports to the Philippines from about 2000 and beyond. Cheaper South American beef and Indian buffalo meat were important sources of international competition for Australian exports (NT Government 2008). In recent years, devaluation of the Malaysian ringgit against the AUD has also seen a decline in cattle exports to that country and a concurrent increase in Malaysian imports of lower priced Indian beef (Drum and Gunning-Trant 2008).

In 2003-04, the higher value of the Australian dollar, strong domestic competition for cattle for slaughter, competition from Brazilian and Indian beef and buffalo meat in some countries such as the Philippines and slowing Asian economies, resulted in a sharp reduction in the number of live cattle exported.

In 2006 exports to Egypt were suspended following evidence of adverse welfare outcomes for Australian cattle after disembarkation in Egypt. Exports to Egypt were resumed from 2008 following agreements between the two countries concerning protocols for handling and slaughter of Australian livestock and cattle movements resumed in 2010.

The period since 2006-07 has seen progressive increases in demand for live cattle exports, particularly from Indonesia and to a lesser extent in other countries (see Table 1) and there has been strong growth in exports in the last few years.

Australian supply and demand also influences cattle exports as evidenced by a large increase in cattle moving to market in 2002-2003 as a result of drought conditions across much of Australia. The resulting reduction in cattle prices and increased supply saw exports rise in that period.

The gradual strengthening of the Australian dollar over the past decade and the general pattern of rising cattle prices, have increased the price of cattle for importing countries and have contributed to declines in numbers of cattle exported to destinations such as Egypt and the Philippines.

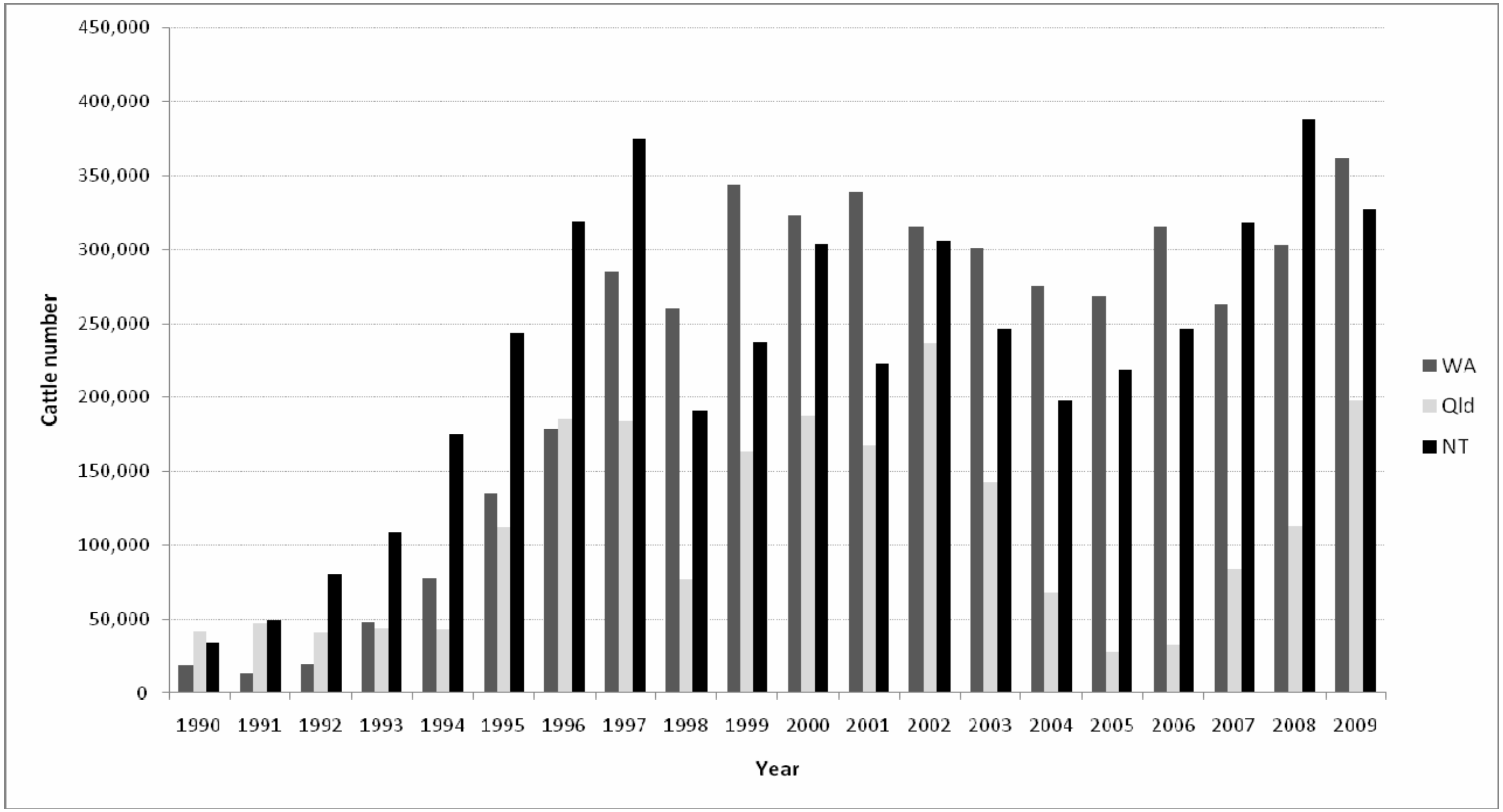

Figure 1: Summary of numbers of cattle exported from Australia for three major exporting states (QLD, NT, WA) from 1990 to 2009 (data from LiveCorp).

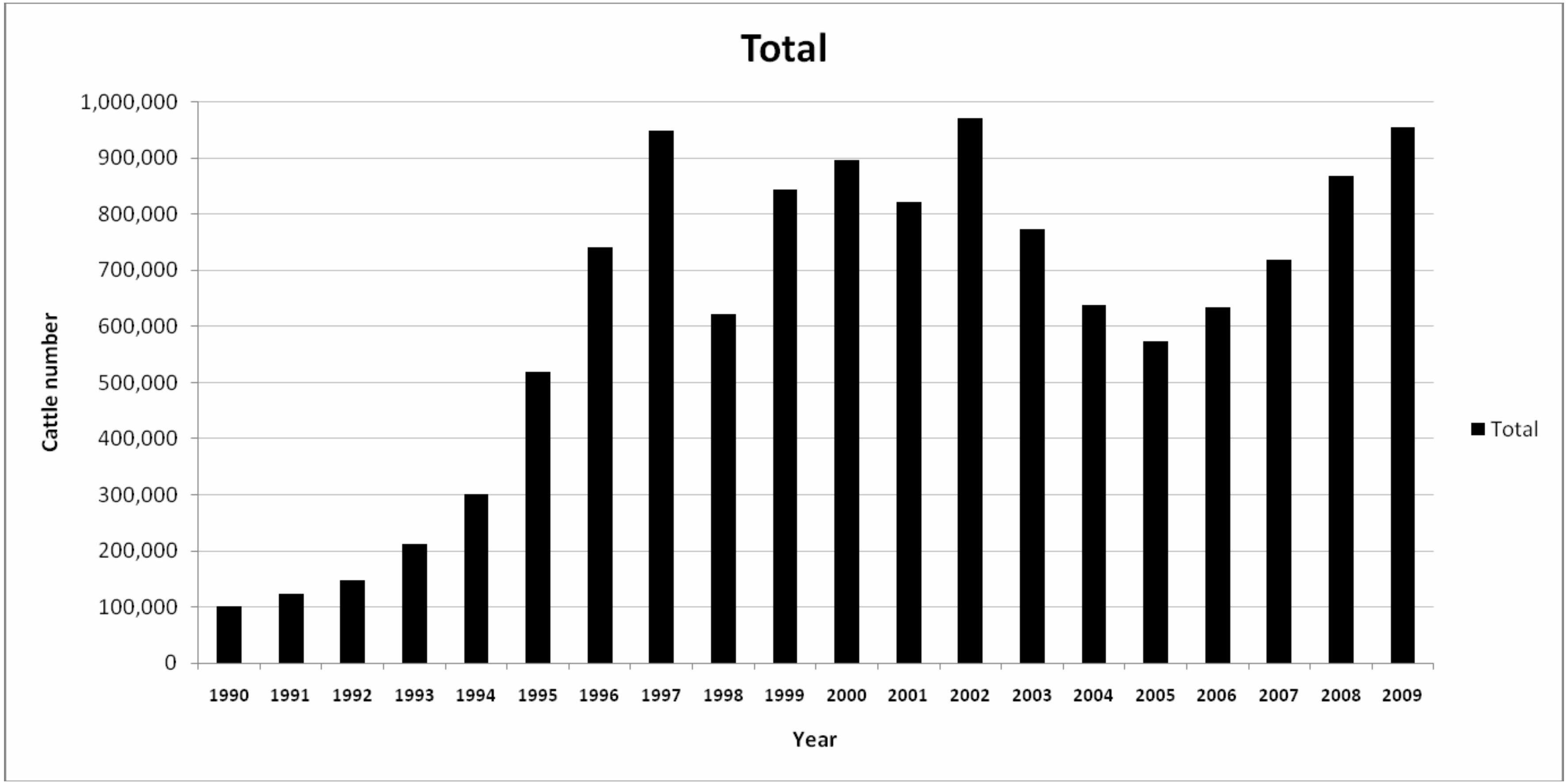

Figure 2: Summary of total cattle numbers exported from Australia (data from LiveCorp)

Table 1: Summary of numbers of cattle exported from Australia arranged by country of destination, for the period from 1990 to 2009 (data from LiveCorp)

Destination	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Indonesia	8,061	12,668	24,981	58,299	118,034	228,422	388,974	428,077	41,174	159,548
Philippines	22,625	19,873	56,604	93,475	128,130	209,192	206,317	259,702	215,961	268,784
Malaysia	22,512	25,495	23,298	24,799	29,773	38,891	44,484	73,752	43,587	65,227
Egypt	0	0	0	0	0	15,541	52,210	37,539	119,579	240,482
Israel	0	0	0	0	0	0	1,485	0	8,719	8,715
China	0	0	8	87	0	0	110	1,380	240	0
Japan	31,503	30,976	21,696	16,613	11,130	10,050	15,481	19,857	17,148	12,362
Saudi Arabia	646	0	0	0	0	0	0	1,100	0	0
Jordan	768	1,132	4,563	2,451	18,128	37,560	40,736	13,186	4,765	23,065
Other	15,003	34,785	21,669	19,032	14,080	15,782	27,474	124,205	156,585	51,551
Total	100,350	123,797	148,256	213,073	301,147	519,010	741,098	948,063	621,121	844,229

Destination	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Indonesia	296,653	289,525	426,458	387,160	359,560	347,967	386,566	516,992	644,849	772,868
Philippines	223,773	97,411	115,522	96,016	46,918	20,941	13,159	20,354	10,791	12,860
Malaysia	56,772	77,925	92,009	87,955	47,541	38,067	56,484	35,018	20,263	13,651
Egypt	207,551	203,206	145,015	7,583	0	6,961	0	0	0	0
Israel	15,837	34,966	47,777	43,213	20,947	32,027	79,443	36,895	51,721	36,901
China	285	1,985	9,372	44,138	73,911	32,512	9,879	8,785	12,767	32,798
Japan	14,393	17,957	14,028	22,034	18,098	25,269	21,944	21,083	19,770	16,039
Saudi Arabia	0	20,800	54,277	15,969	0	17,522	27,586	16,254	18,303	18,346
Jordan	34,154	16,980	5,935	5,163	830	27,578	0	0	0	0
Other	39,982	65,513	62,657	47,115	36,619	34,553	33,318	58,938	89,216	23,102
Total	895,982	822,474	971,880	774,248	637,748	572,799	634,314	719,482	868,510	954,143

Table 2: Monthly summary of live cattle exports from the three major exporting states of Australia, for the last three years (data from LiveCorp)

2007	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
NT	10,549	10,336	18,304	11,394	16,935	54,823	42,826	47,662	25,585	35,248	13,579	30,850	318,091
Qld	1,260	2,172	4,926	21,756	4,583	21,387	4,111	14,725	3,674	1,351	2,490	1,263	83,698
WA	28,410	22,292	20,130	6,901	33,217	24,922	27,112	29,382	21,235	26,377	11,444	12,064	263,486
Total	48,717	36,983	46,381	48,760	58,229	101,175	74,380	93,797	50,515	66,588	41,248	52,709	719,482

2008	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
NT	30,630	25,378	45,770	20,027	34,351	46,907	31,701	44,943	36,646	24,258	23,108	24,610	388,329
Qld	2,823	1,199	2,630	14,685	5,900	1,236	15,605	2,607	19,357	5,157	16,462	24,778	112,439
WA	21,095	31,545	21,795	8,527	23,159	18,695	20,299	37,495	17,686	36,327	33,272	33,311	303,206
Total	**60923**	63,021	74,309	57,143	67,151	67,403	70,422	87,158	76,057	74,720	75,959	94,244	868,510

2009	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
NT	16,615	20,245	22,503	26,188	28,021	21,839	32,023	23,632	47,762	24,415	33,586	30,499	327,328
Qld	4,204	4,644	24,902	12,931	14,924	31,288	1,877	9,018	23,539	18,980	31,762	19,980	198,049
WA	20,488	21,333	33,195	21,638	48,161	22,550	41,921	26,669	37,494	20,333	35,771	32,584	362,137
Total	42,781	48,977	83,843	62,714	91,743	82,459	82,225	65,620	119,349	71,153	106,536	96,743	954,143

2010	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
NT	27,626	13,688	32,187	26,840	11,657	19,259	28,138	20,935					180,330
Qld	4,827	16,048	2,240	1,199	14,684	18,266	10,156	6,800					74,220
WA	25,850	37,673	23,775	22,759	40,164	12,147	26,118	43,578					232,064
Total	68,217	78,650	71,280	60,448	72,158	63,883	70,128	81,477					566,241

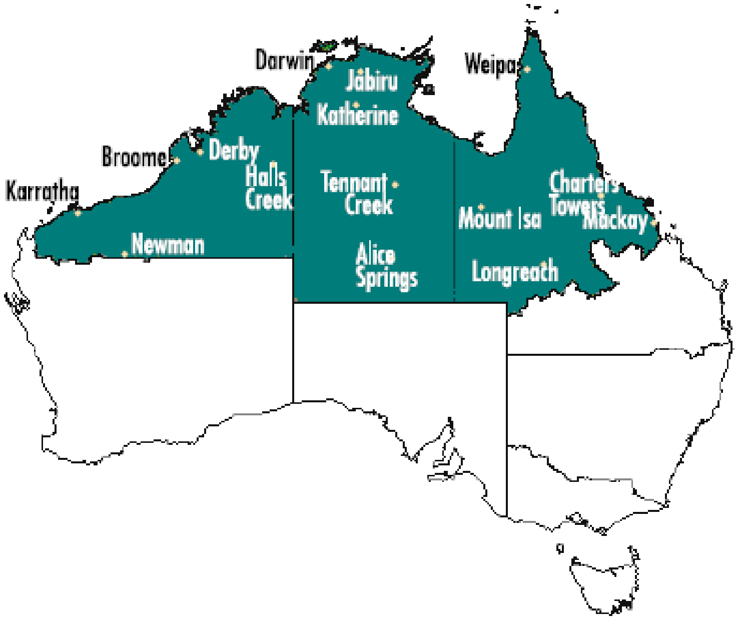

Figure 3: Northern Australia live export zone (Martin, Mellor et al. 2007)

It is also important to note variation over time in the market destinations for different areas within the northern Australian cattle producing regions. More than 80% of total live exports originate in the area shown in Figure 3 and this area accounts for just over a third of the Australian beef herd (Martin, Mellor et al. 2007; Drum and Gunning-Trant 2008)

As illustrated in Figure 4, only a relatively small number of properties sell most of their turnoff for live export each year. These properties are concentrated in the core live export areas stretching from the Top End of the Northern Territory across to the Kimberley area of Western Australia (Martin, Mellor et al. 2007; Drum and Gunning-Trant 2008). Other areas may move cattle either into the live export market or into the domestic market depending on market forces and cattle production.

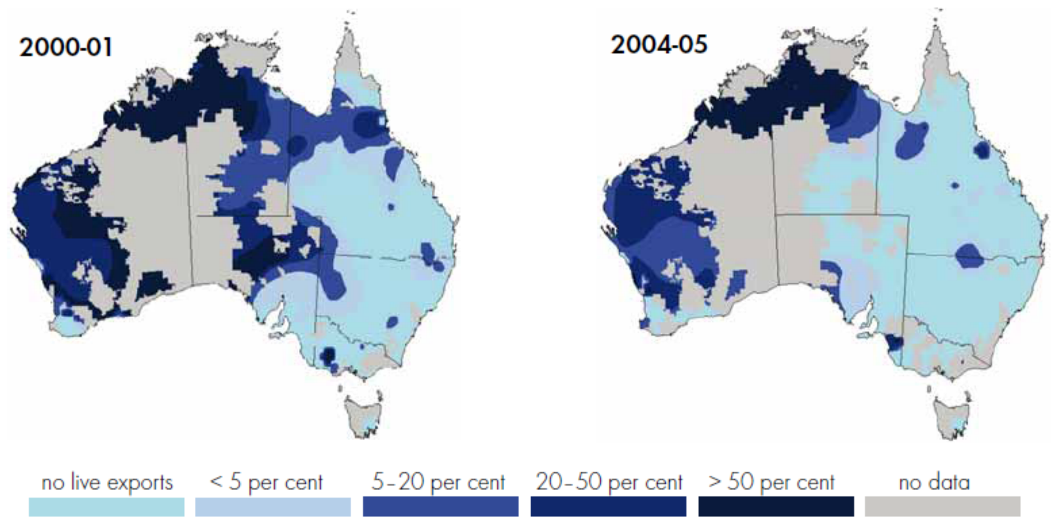

Figure 4: Proportion of beef cattle sold for live export (Martin, Mellor et al. 2007)

Table 3: Summary statistics for port of loading for cattle exported from Australia to south east Asia in 2009 (Norris and Norman 2010).

State	Port	Voyages	Cattle
QLD	Mackay	1	2,909
	Townsville	11	124,432
	Mourilyan	6	8,259
	Weipa	1	1,701
	Karumba	10	18,058
NT	Darwin	123	348,247
WA	Wyndham	27	75,730
	Broome	46	98,768
	Port Hedland	15	23,382
	Geraldton	28	48,695
	Fremantle	20	45,284

Exports to south east Asia are mostly loaded in the far north of Australia as shown in Table 2, with Darwin and Townsville being the major two loading ports. It is important to note that while cattle are generally sourced and transported within the same state from which they are exported, they can be transported from other states to a particular loading port. For example, cattle from Queensland may be trucked to Darwin to load out of the port of Darwin. In some cases these animals may be transported many thousands of kilometres prior to loading (Petherick 2005).

Movement of cattle exports from northern ports have traditionally been strongly influenced by season with most movements occurring in the dry period and reduced movements in the wet as a result of difficulty in mustering and aggregating cattle and in transporting them from property to port. However, as shown in Table 2, the patterns of numbers of cattle exported per month from northern ports (NT for example), has tended to become less variable over recent years with a noticeable increase in exports during the period from December to about April when the wet season would traditionally be expected to limit cattle movements. This change is likely to have been influenced by strong demand for export cattle and by investment in improved infrastructure (sealed roads, better yards, smaller holding paddocks closer to yards etc) and by better industry integration (movement of cattle to properties closer to ports or with capacity to handle cattle all year round) to take advantage of constant demand. A seasonal peak is still apparent in the second half of the year but it is less distinct in more recent years.

3.3 Impact on northern beef producers

Market forces influence research and development into cattle production and influence herd structure, breed composition, and changes in production systems and management. This is all part of a rational system where food suppliers may strive to understand client requirements and ensure that production is modified to address requirements (Bindon and Jones 2001). The beef industry in general has been described as a flexible production system capable of responding to a dynamic set of influences (markets, seasons etc) (Bortolussi, McIvor et al. 2005).

Northern beef producers have two or three main market options including live export, slaughter, and sale or transfer to a growing or finishing operation (either pasture or feedlot based or both) (Bortolussi, McIvor et al. 2005; ABARE 2010).

The live export trade is generally recognised as providing increased price competition for producers, constant or stable demand, more predictable and often higher returns compared to alternative domestic markets. In turn these patterns are credited with contributing to increased investment in property improvements and improved livestock management (better genetics, managed mating, nutritional supplementation), and improved capital value of northern properties. There has been corresponding industry investment in export chain facilities including export assembly yards, holding property developments, transport capacity, export vessel capacity and in off-shore facilities including feedlots and handling/transport capacity in the destination countries (Clarke, Morison et al. 2007).

Asian live export markets (and particularly Indonesia) tend to promote supply of predominantly Brahman or Brahman cross cattle with feeder steers ranging in weights of between 280-350 kg, slaughter steers (350-500kg) and feeder heifers 270-340 kg (Clarke, Morison et al. 2007). Recent changes in implementation of Indonesian policy have enforced an upper weight limit of 350 kg for animals imported into Indonesia and eliminated exports of heavier (slaughter ready) animals to that country.

The increased focus over time of feeder animals into the export trade and particularly to the Indonesian feedlot market, has contributed to changes in the way northern beef cattle are managed, along with concurrent general improvements in property and animal management and domestic markets heavily dependent on feedlot-finished beef marketed within increasingly tight specifications. The effect of these factors has been a gradual shift in northern production systems away from a traditional heavy weight bullock (500-600 kg) turned off at 3 to 4.5 years of age or more, to a younger and smaller product (300-400 kg liveweight animal at 18-30 months of age) (Lapworth 2000). The younger and smaller product is more versatile and capable of being sent direct to abattoirs, to grass growing or fattening operations or to feedlots, and of movement either north into the live export market or south into the domestic market.

Bortolussi et al (2005) suggest that Asian live export markets prefer cattle to have high (at least 50%) *B.indicus* content while the local domestic feedlot sector generally prefers cattle with lower *B.indicus* content. Cross breeding may be a strategy used by many breeders in the northern regions to maintain market access and flexibility while still benefitting from the *indicus* breed adaptations to the harsh northern environment. The authors also acknowledged that many producers may not have any firm structured goals in using cross breeding and that it may be a rather ad hoc process (Bortolussi, McIvor et al. 2005).

The sale of younger animals has resulted in challenges for the northern industry. These animals are lighter in weight and therefore value per head is lower. Composition of breeding herds and of turn off stock have changed with breeders making up a higher proportion of the herd and females making up a higher proportion of turn off. In the past inefficiencies in reproduction and high loss rates have tended to keep the breeder proportion of northern herds relatively low and typically all females were retained to maintain the breeder herd so turn off was predominantly made up of male animals (Lapworth 2000). Improvements in station management and infrastructure have assisted producers apply management changes necessary to move towards turning off younger animals including investment in infrastructure and improvements in breeding efficiency such as bull testing, controlled mating, pregnancy testing, weaning, and nutritional supplementation at critical periods of the year.

Turning off younger and smaller animals also allows producers to run increased numbers of breeders.

There has been continued improvement in cattle quality and breeding management – with some herds increasing the percentage and quality of Brahman in the herd, others using more cross breeding (introducing Euro cross bulls to the herd) and the live export industry is credited (along with other drivers) with continuing the momentum that BTEC created in the northern Australia (Clarke, Morison et al. 2007).

The export trade has also seen investment in road and rail and other related infrastructure including assembly depot yards and port facilities. At the same time development in national industry infrastructure has seen northern processing plants close with domestic meat markets being serviced through large-scale processing plants mainly located in the south eastern areas of Australia (Lapworth 2000).

3.4 Indonesian cattle market

In the 1980s and early 1990s Indonesian demand for animal protein exceeded the capacity of internal supply. Government policy was designed to encourage imports of live animals for feedlot and breeding purposes based on differentiated tariffs. Imported breeder cattle attracted zero tariff, feeder cattle incurred a 10% tariff, and imported frozen beef incurred a 35% tariff. The policy had the effect of encouraging investment in feedlot systems and processing and discouraging imports of processed or boxed beef (Hadi, Ilham et al. 2002).

Indonesia’s beef cattle production has traditionally been dominated by smallholders fattening domestic native cattle purchased from smallholder breeders. Large commercial feedlot operations were introduced in 1990, when the government allowed the import of feeder cattle from Australia. The initial program was intended to foster partnerships between feedlots and smallholders and required feedlot operators to supply smallholders with imported feeder cattle, feed and technical assistance. Feedlots would then purchase fattened cattle (Drum and Gunning-Trant 2008). This system was intended to foster development of internal beef production systems.

The Asian financial crisis in 1997 and associated devaluation of the Indonesian rupiah caused a steep increase in the relative price of imported cattle and a sharp decline in exports that did not recover until several years later. The crash had a severe impact on the entire feedlot, processing and marketing system that had been dependent on Australian live beef imports. Indonesian policy was revised following the crash and tariffs were adjusted to zero for imported feeder cattle and 5% for imported boxed beef. An inadvertent effect of these changes as the economies have improved over subsequent years has been to make imports of boxed beef more competitive relative to live cattle (Hadi, Ilham et al. 2002). A secondary and unintended consequence of the crash was the increased flow of native cattle into the market system with further reductions in the production capacity of the Indonesian beef herd. This in turn is likely to increase reliance on Australian cattle supplies as the financial situation recovered and the feedlot and market system regained strength.

Since the economic crisis, the business partnership between feedlot and smallholder appears to have effectively ceased with investment being directed more into larger scale, intensive feedlots capable of carrying and finishing large numbers of cattle (Hadi, Ilham et al. 2002). The main provinces for feedlot development under the former partnership system were Lampung, West Java, Middle Java, East Java and Yogyakarta. These locations were generally selected based on locations to facilitate efficiency of import of feeder cattle (proximity to ports) as well as proximity to agricultural areas that provide ample quantities of by product or custom produced feed stuffs. Lot feeding of beef cattle provides a convenient way of using roughage and waste product from plantation agriculture (e.g. waste products from the pineapple canning factory in Lampung). Minimising costs of feed supply and quarantine and animal transport costs are important factors driving profitability (Hadi, Ilham et al. 2002). A number of Australian and international interests have now invested in feedlot operations in Indonesia, moving towards integration of Indonesian feedlot operations into an international cattle production system starting in Australia and ending in Indonesian markets, supermarkets and restaurants.

There is variable demand across Indonesian feedlots for domestic vs imported cattle. Domestic cattle are cheaper to purchase but tend to have poorer weight gains in the feedlot. In Indonesian feedlots, the average daily weight gain (ADG) ranges from 0.6-0.7 kg/day for Bali cattle, 0.8-0.9 kg/day for Onggol cattle from Sumba, about 0.8 kg/day for British breed imported cattle, and 1.0–1.3 kg/day for imported Brahman cross cattle (Hadi, Ilham et al. 2002; Sullivan and Diwyanto 2007). The higher ADG values are generally more profitable though the smaller size of some native cattle may mean that more animals can be fed for the same price as fewer of the larger Australian imports.

Imported cattle from Australia are generally considered to provide important advantages over locally produced cattle, including:

- large and readily available supply of cattle conforming to a uniform standard and high quality;
- large capacity per shipment, short time interval from sourcing in Australia to arrival in Indonesia and a low risk of adverse outcomes or losses during the export process;
- cattle are generally tropically adapted and capable of high growth rates under Indonesian feedlot conditions; and
- pricing on a liveweight basis where cattle are weighed (Hadi, Ilham et al. 2002).

According to Indonesian government regulations, the maximum allowable weight of imported feeder cattle is 350 kilograms, but import statistics show significant imports of heavier cattle weighing up to 400 kilograms or more in recent years. This may reflect both an Indonesian demand for heavier cattle, variation in availability of cattle in Australia that do meet policy specifications and also a lack of measurement of cattle weights in Australia to ensure compliance. In Indonesia, cattle less than 350 kilograms are fattened in feedlots, but heavier cattle are slaughtered immediately (Hadi, Ilham et al. 2002).

The feedlot system continues to be heavily reliant on Australian cattle since no other source in the region can meet the suite of requirements (numbers, consistency and quality, disease free status, ability to grow well under Indonesian conditions) (Hadi, Ilham et al. 2002). It is noted that the continued success of this system is dependent on policy support from both countries and on the ability for normal market forces to flow through the system and influence supply and demand as well as meet requirements for each of the market segments. If distortions in the system are introduced through poor government policies there is the potential to run down the domestic breeder herd and increase Indonesia's reliance on imported live cattle and beef (Hadi, Ilham et al. 2002).

3.4.1 Market segments

There are four major market segments for consumer access to beef products: wet markets, supermarkets, meat shops and the hotel trade (hotel, restaurant and institutions). The general trend is that conventional wet markets are declining by about 10 – 15% per year while supermarkets are increasing their market share (Sullivan and Diwyanto 2007).

There are wet markets in all parts of the country. Markets normally are open only to about 10 am. The market chain generally starts with feedlot operators providing cattle (live or processed) to wholesalers or traders who in turn provide meat to wet market retailers. Most of the trade at wet markets is in the form of hot meat because of the lack of cold storage. Prices for beef are less than in supermarkets and the type of animal preferred may depend on market forces. When demand is high (holiday season) retailers want large animals because they can dispose of the whole carcass. If market demand is low, then smaller size animals are in demand (Sullivan and Diwyanto 2007). Sixty per cent of beef customers in wet markets are household consumers, up to 30% are stallholders such as meatball soup peddlers and 10% of customers are restaurants and supermarkets (Hadi, Ilham et al. 2002).

Most larger towns and cities have supermarkets, but not all sell beef. Buyers are made up of households (65%), restaurants (25%), and others such as catering firms (10%). Supermarket meat is generally considered to be more tender, leaner and more hygienic, and provides a convenient shopping venue with variable packaging sizes and a defined price (Hadi, Ilham et al. 2002). There may be differentiation even within the supermarket category with western-style supermarkets catering to tourists and expatriates and marketing high-value meat, while other supermarkets may be focused on lower price products for a domestic market.

There are also meat shops in most provincial capital cities and some district capital cities, though in limited numbers. Meat shops account for a small proportion of meat sold and tend to stock mostly native cattle and sell to household customers. Meat shops offer a service throughout the day (as opposed to wet markets that tend to open only in the early morning) and offer an intermediate quality and priced product (Hadi, Ilham et al. 2002).

The hotel trade is a growing market segment. Beef from local cattle is preferred for certain Indonesian dishes because of its texture, for example for rendang. Up-scale restaurants and hotels are major users of imported Australian and New Zealand beef (Sullivan and Diwyanto 2007).

It is interesting to note that recent surveys of several provinces in Indonesia indicated that many consumers still prefer beef from native cattle to beef from imported cattle (Brahman cross) or imported boxed beef. Local beef is particularly more suited to common dishes such as meatballs and beef curry, the demand for which is especially strong in Lampung and Java. Only a small proportion of beef consumers, particularly supermarket shoppers, were indifferent to whether the beef is from local cattle or imported beef. The demand for beef from imported cattle or imported beef is tending to increase, especially in hotel, restaurant and supermarket outlets. The main reasons are the declining availability of domestic cattle, the tenderness of beef from imported cattle or imported beef, and the growing number of consumers who do not care about the source of their beef. The market for beef will increase steadily in the future as per capita income and population increase (Hadi, Ilham et al. 2002).

3.4.2 Recent changes for Indonesian export

Indonesian policy concerning importation of Australian cattle was modified in mid 2010 with announcements that the 350 kg weight limit would be strictly enforced and that limits would be placed on the number of permits released for Australian cattle. The changes appear to have resulted in part from lobbying of local producers complaining about over supply of beef in the local markets and subsequent falling prices. Some reports suggested that the changes were also attributed in part to Indonesian policy of improving self sufficiency in beef production.

The 350 kg weight limit has been official policy for some time but enforcement has been variable and market demands for heavier cattle have resulted in many non-compliant cattle being approved for export into Indonesia in the past several years.

There appears to be considerable uncertainty over the situation and about future developments, with Australian government and industry representatives working with Indonesian officials to explore solutions to the issue. Australian industry representatives have indicated concern over the impact of a potentially large reduction in cattle moving to Indonesia and particularly in the closure of an export market for older, heavier cattle from the far northern Australian regions that may not have feasible alternative destinations. Reductions in cattle numbers flowing in the Indonesian system will reduce beef availability and put pressure on the sustainability of the feedlot system as well as forcing beef prices up and placing pressure on producers who may be encouraged to sell local cattle (including breeders) into the market system. In addition, over supply on the Australian end may force cattle into the southern domestic market and put downward pressure on prices with similar potential effects on other export markets. At the same time there have been increased market opportunities for export cattle to other countries including Egypt, Libya, Israel and Jordan so the overall effect of the Indonesian decision on Australian cattle prices and market access is unclear.

3.5 Competitiveness of Australian cattle exports

The live export trade is subject to all the vagaries of a supply and demand system. The supply side of the equation is influenced by a large number of factors (season, property development, nutritional management, genetics etc). The demand side is influenced by culture, affluence, climate, health, previous experience, marketing, etc. The two are linked by a distribution system that is itself influenced by policy (importing and exporting country), transport issues, infrastructure, exporters, agents and community perceptions and lobbying. Supply and demand can be complex systems and factors such as the international value of the AUD, and markets in other countries (Japan, USA, Europe etc) may influence the pricing, availability and attractiveness of Australian beef that may go to markets such as the SE Asian system or to alternative destinations depending on all of these factors (Lapworth 2000).

Factors operating within Australia that modify cattle supply and pricing are likely to influence export markets (Martin, Mellor et al. 2007; Drum and Gunning-Trant 2008). Drought conditions for example may result in increased turn off of cattle with an associated decline in prices. The long term trend has been for cattle prices within Australia to be progressively rising, placing pressure on market systems.

The international exchange rate of the Australian dollar against other currencies and particularly those of importing countries is a major factor influencing export trade. Exchange rates have contributed to severe fluctuations in export markets including the sudden collapse of the Egyptian market in 2003-2004 and the recent decline in the Philippine market (Martin, Mellor et al. 2007; Drum and Gunning-Trant 2008).

Economic growth and increasing per capita income in importing countries is an acknowledged driver of animal protein demand and is highly likely to continue to strengthen future demand for Australian live cattle and beef exports (Martin, Mellor et al. 2007). There is a suggestion that within the broad trend for increasing animal protein demand as income rises, there is a differentiation with consumers in many countries preferring beef over alternative sources of protein but when income levels are not high enough consumers will revert to cheaper protein sources including fish and poultry. Recent years have seen global markets and many national economies suffer as a result of the global financial crisis and the International Monetary Fund predicts a gradual recovery over several years with variable impacts at individual country levels (FAO 2009).

The rapid growth in the middle class in a number of Asian countries is likely to be increasing the potential market in the middle and high price segments while general population increases may be further increasing low price demand as well (Rutherford 1995).

Australia has a major competitive advantage in Asian markets as a result of proximity to the markets and freedom from diseases that may constrain market access. There are no competing suppliers who can provide live cattle as cheaply as Australia into many Asian countries because of increased transport distances and costs. South American countries and India are potential providers of cheap boxed beef products and the Indonesian market for Australian beef is particularly reliant on Indonesian policy restricting entry of beef from Brazil and India due to concerns over FMD risk (Drum and Gunning-Trant 2008). The Philippines has increased imports of cheaply priced buffalo and beef meat from India and Brazil in association with a reduction in imports from Australia.

Productivity growth in the Australian beef industry will also be important in maintaining and improving competitiveness in international markets. In the past two decades the northern cattle industry has generated relatively high productivity growth rates and has been competitive in its ability to attract and maintain investment. If the northern beef industry is able to record better productivity growth than its competitors into the future, then this will further enhance Australia's competitiveness in live cattle export markets (Martin, Mellor et al. 2007; Drum and Gunning-Trant 2008).

3.6 Animal health, welfare and performance in the export process

Australia is a world leader in animal welfare practices and has a range of standards and codes of practice that govern animal welfare during routine animal management and transportation[a] as well as during the live export process[b]. In addition livestock industry bodies and Australian government representatives work closely with importing countries to promote and improve animal welfare as well as support markets in importing countries. State and territory governments are responsible for animal welfare arrangements within their jurisdictions and set and enforce animal welfare standards through state legislation. Model codes of practice for various livestock species and activities (land transport of cattle for example) are available from the CSIRO web site[c]. Interested readers are referred to these links for more detailed information.

[a] http://www.animalwelfarestandards.net.au/

[b] http://www.daff.gov.au/animal-plant-health/welfare/export-trade/v2-1

[c] http://www.publish.csiro.au/nid/22/sid/11.htm

The *Model Code of Practice for the Welfare of Animals: Land Transport of Cattle*[d] specifies maximum times that cattle may be deprived of water, which include prior to and post-transportation, and which essentially determine maximum journey times. These range between 8 h for heavily pregnant cows to 36 h for mature cattle, although this latter time can be extended to 48 h if the cattle are fit, conditions are good and the total journey can be completed within 48 h. If journeys take longer than 48 h, the cattle have to be unloaded and rested with access to food and water after each 36 h of time deprived of water. These allowances include the practice of curfewing or enforced deprivation of feed and/or water prior to loading to minimise faecal and urine spoilage of the transport vehicle and subsequent problems with animals slipping. Curfewing is also undertaken when animals are sold by weight in an attempt to standardize the measurement of liveweight or prediction of carcass weight (Hogan, Petherick et al. 2007).

Data on cattle subjected to known curfews with or without transportation provide indications of the extent of weight loss during transport. Animals may lose 8-15% of body weight depending on the period of deprivation. Weight loss occurs more rapidly in the early stages of deprivation and then further weight loss occurs at a reduced rate. Knowles et al (1999) reported that on cattle transported for 31 hours that lost 8% of body weight. 70% of this loss occurred in the first 14 h, 89% in the first 21 h and 95% by the 26th hour (Knowles, Wariss et al. 1999).

Ridley (1996) provided useful data on weight loss under different transport scenarios in export steers in February and March under northern conditions. Steers weighed 321-328 kg when full off pasture. There was no difference when this initial weighing was done at either 8am or 3pm. Animals mustered from the paddock and loaded straight onto a truck (loaded full) and trucked 500km (8 hr journey), lost 18-19 kg on the journey (weighed immediately on unload, prior to being given feed or water). Animals mustered and held over night on water and then weighed immediately before loading on to the truck at 8am, lost 13-20 kg overnight and then a further 13-17 kg on the truck journey. Animals held overnight on feed (ad lib access to pangola hay) and water, lost 19-21 kg overnight and a further 13-16 kg on the truck journey (Ridley 1996).

A further group of 54 animals from four properties were trucked the same distance in March. The animals had lost 21-23 kg from overnight holding on water alone (7.2 to 75% of initial weights of 289-305 kg). The animals were loaded full (straight out of the paddock) at 8am and trucked for 8

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[d] http://www.publish.csiro.au/nid/22/pid/2483.htm

hours. They lost 5.3 to 6.1% of weight on the journey (15 to 17 kg lost from load weights of 280 to 294 kg). There was no difference between the four properties (Ridley 1996).

Recovery from feed and water deprivation is often judged by the rate of return of live weight to pre-deprivation levels though it is recognized that this may be complicated by other factors including changes in an animal's environment and/or diet. Animals that are exposed to new environments or diet may incur weight loss as they adapt to a new situation. In such situations, live-weight change alone may be of limited value as a predictor of recovery from feed and water deprivation. Alternative measures include comparison of daily feed intakes to determine when the animal may reach an intake similar to that observed prior to the implementation of a changed environment (Hogan, Petherick et al. 2007).

Exports to south east Asia are considered short haul voyages, with durations of less than ten days. Shipments to the Middle East take longer than ten days and are considered long haul voyages. According to Livecorp (2007) voyages to the Middle East take between fourteen and twenty-one days, voyages to Indonesia, the Philippines, Malaysia and the rest of south east Asia take between three and seven days and voyages to China, Japan or Korea take between ten and fourteen days (Drum and Gunning-Trant 2008).

There appears to be relatively little published data describing animal performance through the export process into Asia. A QLD research project in the late 1990s involved producers sending cattle to Toorak Research Station (near Julia Creek) where they were grown out on grass and then exported from Townsville or Karumba to the Philippines. Weight gains at different stages were monitored. The animals were 194 kg on arrival at Toorak and grew to 349 kg over 293 days (final weight before transport to wharf). They lost 8.1% of weight during transport (wharf weight of 327 kg) and then gained 5kg during the voyage (332 kg on unload in the Philippines) (Lapworth 2000).

Ainsworth (2002) described findings based on observations of liveweight and health outcomes in mature cows exported from Darwin to Asia (Ainsworth 2002). Animals were assigned to different groups during the voyage with groups receiving different types of management (diet and other treatments) in order to facilitate development of best practice recommendations. Average loading weights of cows ranged from 396 to 419 kg and six of seven groups lost weight during the voyage (average losses ranged from 7 to 30 kg) while one group gained 4 kg. Animals that lost minimal weight during the voyage were considered to perform best in the feedlot environment though animals in this trial were only feedlotted for relatively short periods of time (Ainsworth 2002). The results were consistent with an expectation that improvements in voyage performance may deliver more positive outcomes in feedlot performance as well.

A larger-scale project was performed in the late 1990s and early 2000s that aimed to address questions about suitability of different types of Australian cattle to the Asian export market (Ridley and Schatz 2006). The project had arisen in part over concerns that some Australian cattle were developing excess fat in Asian feedlots and that this was an undesirable characteristic that had the potential to adversely impact demand for Australian cattle in the Asian market. An experimental feedlot was developed at Katherine Research Station to feed cattle in conditions similar to Asian feedlot situations. This work allowed development of maturity growth curves (MTG) for different types and breeds of cattle. The results provide information on the importance of late maturing traits in developing breeding programs aiming at providing feeder cattle for Asian feedlot markets.

MTG curves were derived from empty liveweight measures (liveweight following 24 hrs off feed and 16 hrs off water) in samples of cattle of known age, specified maturity type and with specified fat depth in mm as measured at P8 (Ridley and Schatz 2006). MTG curves show a theoretical relationship between age (months) and liveweight (kg) at which an animal has specified fat depth at P8. The curves are based on the knowledge that cattle will deposit increasing amounts of fat relative to muscle as they reach a mature weight. The propensity for age and weight at which this shift occurs (from muscle growth to fat growth) is important since it determines how much liveweight can be added to a particular maturity type of cattle without exceeding fat limits imposed by market specifications. MTG curves can therefore be used to describe the weight gain possible before cattle may become over fat.

Given that feed costs are relatively low in South East Asia, an important driver of return is the weight gain achieved by cattle in Indonesian feedlots before they are slaughtered. If animals mature earlier then they either require slaughtering earlier based on decisions about when animals might be moving from muscle growth to fat deposition, or they may lay down increasing amounts of fat and become less attractive in the market. Given reasonable assumptions about achievable growth rates in Indonesian feedlots and the desired weight gain, the information can be used to describe specifications for cattle to be sourced at the Australian end, with specifications varying depending on expectations of the MTG curves for different breed and sex combinations (Ridley and Schatz 2006).

The authors acknowledge that the value based description system outlined in the report may not become directly relevant until such time as the Asian market becomes sophisticated enough to develop differential prices with premiums being offered for cattle that meet particular market specifications(Ridley and Schatz 2006). As the Asian export market matures and differential prices develop for feeder cattle that may (or may not) meet desired specifications, there may well be a place for something akin to the backgrounding step commonly seen in southern Australia where young cattle are developed to reach specifications required for entry into the feedlot phase of production. Differential prices with premiums for ideally specified cattle into the Asian feedlot system would be expected to drive cattle selection and management at the property-of-origin level and also perhaps lead to the development of backgrounding operations. There is considerable scope to extend this work in a future project collecting observations on current performances and market desirability for cattle in Indonesian feedlots and retail markets.

Data on cattle and sheep mortality during sea transport from Australia are collected annually by the Australian Maritime Safety Authority (AMSA) from ship masters' reports. Incorporated in the AMSA Marine Orders 43 are 'trigger levels' on mortality rates during long and short haul voyages. If these levels are reached, the ship's master is obliged by law to report them to AMSA so that an investigation can be initiated. The trigger levels are 2 per cent for sheep, 1 per cent for cattle on long haul voyages and 0.5 per cent for cattle on short haul voyages (Drum and Gunning-Trant 2008).

Mortalities during live export are generally very low; 0.24% from 4 million cattle exported between 1995 and 2000 (Norris et al., 2003). The annual mortality rate for all cattle exported from Australia over the past two years for which data are available were 0.12% in 2008 and 0.1% in 2009 (Norris and Norman 2010). Voyages to Asia generally had the lowest mortality rates with 45% of all voyages reporting zero deaths and overall mortality rates to south east Asia averaging 0.08%.

3.7 Future prospects for Australian cattle exports

The future prospects for the Australian live export sector are likely to depend on several key factors. Population and income growth are likely to continue to strengthen demand in countries already receiving Australian cattle and to open up markets in additional countries.

Increased availability of refrigeration, urbanisation and affluence, are all likely to strengthen the potential for boxed beef products and potentially erode the position of the wet market and live animal trade. Against this is the strong cultural favouring of the live market system in some countries, and religious beliefs influencing the way animals should be slaughtered, that may continue to support a live animal trade and wet market system. The current synergy between northern Australia's extensive production of cheap cattle, and the cheap supply of labour, infrastructure and feedstuffs in Asian countries may change as these countries continue to develop and as natural resource and agricultural production systems change. However, feedstuff availability and cost in Asian are likely to favour the live export of feeder cattle for finishing in Asian countries for some considerable time.

Alternative future scenarios such as development of feeding systems in northern Australia and processing capacity allowing northern cattle to be finished and slaughtered and exported as boxed beef, are understood to be under consideration but would seem likely to be directed at niche markets rather than more general application.

Further development of the feedlot and processing industry within Indonesia with Australian animals being finished in Indonesia and then meat products being on sold to other countries throughout Asia has also been raised as a possible plausible future development, but this development is based on continuation of the current production and supply systems within Australia (NT Government 2008).

Even within major markets such as Indonesia there is considerable scope for additional expansion of the trade simply to meet anticipated increases in Indonesian consumption of beef. Despite the growth in demand for beef in south east Asia, beef still makes up a relatively small proportion of the total meat consumed per person. In 2005, beef accounted for between 10 and 20 per cent of total annual meat consumed per person with the dominant source of animal protein in many countries continuing to be poultry meat (Drum and Gunning-Trant 2008).

Government and industry representatives continue to explore development of new export markets for Australian beef and efforts are being directed for example at development of markets in Vietnam and Malaysia that may be based on supply of Australian feeder cattle into Asian feedlot systems (similar to the Indonesian market) (NT Government 2009). There are a range of additional potential markets in mostly untapped areas of South-East Asia, including Vietnam, Taiwan, Hong Kong, Macau, and mainland China, as well as countries in areas further afield than Asia.

The common themes of developing country expansion and prosperity, increased protein demand and ongoing capacity of Australia to rapidly and reliably deliver high quality, disease free beef cattle to these markets are likely to continue into the mid term future, suggesting that short haul export of northern cattle has a strong and expanding future potential. It is noted that these markets are likely to continue to be highly sensitive to changes in relative prices and exchange rates and saleyard prices of Australian cattle may have major impacts on specific markets (Drum and Gunning-Trant 2008).

Competing livestock producers such as South American countries (Brazil) and India for beef and buffalo products, represent threats to Australia's market share, particularly if they are able to gain disease free status for key diseases such as foot-and-mouth disease (FMD) (Drum and Gunning-Trant 2008).

Disruption of major markets such as the Indonesian market either as a result of policy changes restricting Australian exports or opening up of the Indonesian trade to cheaper competing products (Brazil, India), would have potentially important adverse effects on the Australian beef industry. Cattle removed from the Indonesian trade would then need to find alternative markets either in other countries or in the Australian domestic market. To a limited extent this has occurred in 2010 as a result of policy changes implemented in Indonesia that restricted exports from Australia. If this were to happen on a large scale or over a prolonged period, it would have a negative effect on domestic beef prices.

In recent years there have been reports of Indonesian policy decisions to accept zone-based FMD free status for Brazil and consequently allowing importation of Brazilian boxed beef into Indonesia. In early September 2009, the Indonesian Government issued a ministerial decree allowing imports of boneless beef from Brazil. This was followed later in September 2010 by reports that the Indonesian Supreme Court had rejected this approach and maintained a policy that required national freedom from FMD as a requirement for importation of beef products[e]. As a result plans to import Brazilian beef into Indonesia were halted.

Continued improvements in product quality and suitability for market will be important drivers of competitiveness for Australian producers in international markets. Implementation of NLIS within Australian cattle systems provides previously unimagined opportunities for collection of detailed individual animal data at all stages of the production and market chain to monitor and improve performance. Data and information generated from the combination of electronic ID recording and

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[e] http://qcl.farmonline.com.au/news/state/livestock/news/indonesia-drops-brazil-beef/1930715.aspx

ancillary measures such as liveweight, fertility, feedlot performance and carcass data, provide tremendous potential to improve decision making and animal selection based on suitability of cattle for market and on effectiveness of various management changes to improve performance (Clarke, Morison et al. 2007).

4 Historical data

There was discussion at meetings prior to the initiation of this study about the possible value of accessing and analysing existing datasets related to performance of animals in the live trade to Indonesia. Attempts have been made to contact representatives from exporters to confirm presence and availability of historical data that may be suitable for analysis. No such datasets have yet been able to be retrieved or assessed as a result of these discussions. The authors remain willing to assess any data that is available and would welcome feedback from industry on this matter but in the absence of such data, all efforts have been directed at prospective data collection as described in the remainder of this report.

5 Pilot voyages

5.1 Methods

Two voyages were selected for inclusion in the study based on criteria including concentrating on vessels with smaller to moderate total cattle capacity, carrying cattle to single port and to a small number of destination feedlots (to facilitate following lines of cattle), and where exporters were likely to be amenable to having a member of the project team accompany cattle on the vessel and to the feedlot in Indonesia. An attempt was made to seek shipments destined for Indonesian feedlots with capacity for individually weighing and identifying cattle.

Two to three lines of cattle were then selected from each voyage for inclusion in the study. It was recognised that cattle were unlikely to be individually weighed from the time when they left the property of origin to arrival at the Indonesia destination feedlot. In almost all cases weights in Australia were likely to be measured at the truck level, at the individual trailer level, or at some other form of aggregation such as a pen of animals. At the Cloncurry saleyard for example, cattle were unloaded from trucks and weighed in pens containing about 25 animals at a time.

Discussions were held with exporters during the course of the two pilot voyages to determine whether a sample of animals from selected shipments could be individually weighed at selected time periods (on arrival at export assembly yards for example and on discharge for export assembly yards for loading on to the export vessel). However, it was not possible to individually weigh any animals because of concerns over time and labour costs and potential impacts of additional handling on animal weight and performance in the export process.

As a result of this restriction a decision was made to concentrate on collecting aggregate weights from all animals in selected shipments instead of trying to collect individual animal weights from a random sample of animals in the selected lines.

A questionnaire was developed to collect limited information from vendors of selected shipments of cattle in order to summarise information about management of the cattle and breeding in an attempt to relate these parameters to performance in the export process.

Voyages and lines of cattle were selected by Mr Adam Hill in discussion with exporters. Contact details for vendors were provided by Ms Robyn Tynan (AusVet Animal Health Services) who contacted vendors by telephone and completed the questionnaire.

Truck weights and other information about shipments were collected from the exporters or from assembly feedlot yard management as either paper records or electronic files. Mr Adam Hill accompanied the first voyage as a stockman on the vessel and observed the cattle during the voyage. Mr Adam Hill made a second journey to Indonesia coinciding with the arrival of the second voyage and accompanied the cattle from port of discharge to the Indonesian feedlots. Data and information on performance of cattle in the Indonesia feedlot(s) were obtained electronically from feedlot management in Indonesia.

5.2 Voyage 1

The first voyage involved the MV Maysora departing from Darwin on 2 September 2009 and discharging at Panjang, Indonesia on 7 September 2009.

Three lines of cattle from three different properties were selected for inclusion in the study.

Table 4: Summary of information obtained by telephone from vendors of selected lines of cattle

	Shipment		
	A	**B**	**C**
State of origin	NT	NT	QLD
Date delivered	27-Aug-09	27-Aug-09	27-Aug-09
Assembly feedlot	Cedar Park	Cedar Park	Berrimah
Date loaded	2-Sep-09	2-Sep-09	2-Sep-09
Date discharge	7-Sep-09	7-Sep-09	7-Sep-09
Sex	Heifer	Steers	Heifers
Curfew			
feed	9 hrs	Unknown	Unknown
water	1 hr	0 hr	Unknown
Born on the property	No	Yes	Yes
If not, age at move	Weaning	Not applicable	Not applicable
Bull selection	stud bulls	paddock bulls	home bred
Breeding	year round	year round	year round
Calf wgt at weaning	170	120-250	140-240
Weaning	tailed & night yarded for few days	yard fed, then tailed & night yarded	yard fed then tailed and night yarded

The three consignments arrived at the export assembly feedlot (two to Cedar Park and one to Berrimah) on the same day and were loaded out on the same day. Consignment C had incurred the longest journey to the assembly feedlot, travelling from Queensland, while the other two consignments originated near Elliott (Consignment A) and north-east of Tennant Creek (Consignment B).

Table 5: Count of animals contributing to each weighing

	Count		Indonesia
Consignment	**ex-property**	**load-out**	**Induction at feedlot**
A	312	500	420
B	1080	498	496
C	1784	1736	543

Summary data presented in Table 3 show the results of weighings for the three lines of cattle enrolled in the study. Cattle were weighed at a point between the property of origin and the assembly feedlot during the journey to the feedlot (either Cloncurry or Katherine depending on where the property of origin was located). At Katherine the animals were weighed on trucks but the print out provided weight breakdowns for each trailer (and a separate weight for the prime mover). This provided additional replicates of weights for each shipment of animals.

It is apparent that the number of animals contributing to each weighing varies over time. The reason for this is because the study was not attempting to following individual animals at each point in time to make statements about survival for example. A fundamental issue was having weights based on a reasonable sized sample from each selected shipment in order to be able to describe the weight change over time but not necessarily tracking every animal. On some occasions such as the ex-property weighing for Shipment A, there were additional truckloads of cattle in this shipment but weights were only recorded for a sample of three trucks on the initial weighing. At this stage the project had been attempting to select three truckloads and then individually weigh those animals on arrival at the assembly feedlot and on load-out. When individual animal weighing was found to be not achievable, an attempt was made to collect weights on as many aggregates (trucks, pens or trailers) as possible from the selected shipments in order to maximise the number of replicates.

On arrival at the assembly feedlot trucks are weighed but staff at the assembly feedlot may not necessarily record weights separately for each truck. At both assembly feedlots arrival weights at the truck level were recorded on pieces of paper (weighbridge printout) that were not retained. As a result the only available information from this weighing is a single aggregate total (count of number of animals, total weight and average weight per animal). A single measurement does not allow estimation of variance and therefore prevents estimation of standard errors and confidence intervals.

When animals departed the assembly feedlot to travel by truck to the port of Darwin for loading onto the export vessel, truck weights were recorded as a single weight per truck and count of animals loaded on that truck. This produced a smaller number of replicate measurements for each consignment and would be expected to result in a larger standard error estimate when compared to the weighings with larger numbers of replicates (trailer or pen weights).

Table 6: Summary statistics on weights measured at different times for the three consignments. n refers to the number of measurements.

Consignment	Wgt site	Wgt time	Wgt level	n	mean	sem	CI_low	CI_up
A	Katherine	ex-property	Trailer	18	288.72	1.45	285.89	291.56
A	Cedar Park	arrival at feedlot	Consignment	1	283.39	NA	NA	NA
A	Berrimah	load-out	Truck	3	294.36	2.12	290.20	298.53
A	Indonesia	Indonesia discharge	Truck	27	274.81	2.32	270.27	279.35
A	Indonesia	Indonesia induction	Animal	420	273.09	2.32	268.54	277.63
A	Indonesia	Indonesia finish	Animal	420	412.48	2.32	407.93	417.02
B	Katherine	ex-property	Trailer	8	375.67	2.69	370.95	380.94
B	Cedar Park	arrival at feedlot	Consignment	1	371.69	NA	NA	NA
B	Berrimah	load-out	Truck	3	376.26	2.13	372.09	380.44
B	Indonesia	Indonesia discharge	Truck	37	348.09	2.13	343.91	352.26
B	Indonesia	Indonesia induction	Animal	496	349.13	2.13	344.95	353.31
B	Indonesia	Indonesia finish	Animal	496	519.49	2.13	515.31	523.67
C	Cloncurry	ex-property	Pen	73	311.11	1.12	308.90	313.31
C	Berrimah	arrival at feedlot	Consignment	1	272.20	NA	NA	NA
C	Berrimah	load-out	Truck	10	307.15	1.14	304.92	309.39
C	Berrimah	Indonesia discharge	Not weighed	-	-	-	-	-
C	Berrimah	Indonesia induction	Animal	539	307.47	2.05	303.45	311.48
C	Berrimah	Indonesia finish	Animal	539	426.91	2.05	422.90	430.92

Note that where n=1, this means there was a single measurement available for the entire consignment. Where the weight level is "animal" the weights were recorded for individual animals and the value of n in this case is a count of animals that were weighed at this point. Where n is greater than 1, it means that animals were weighed in some aggregated form (pen, trailer or truck).

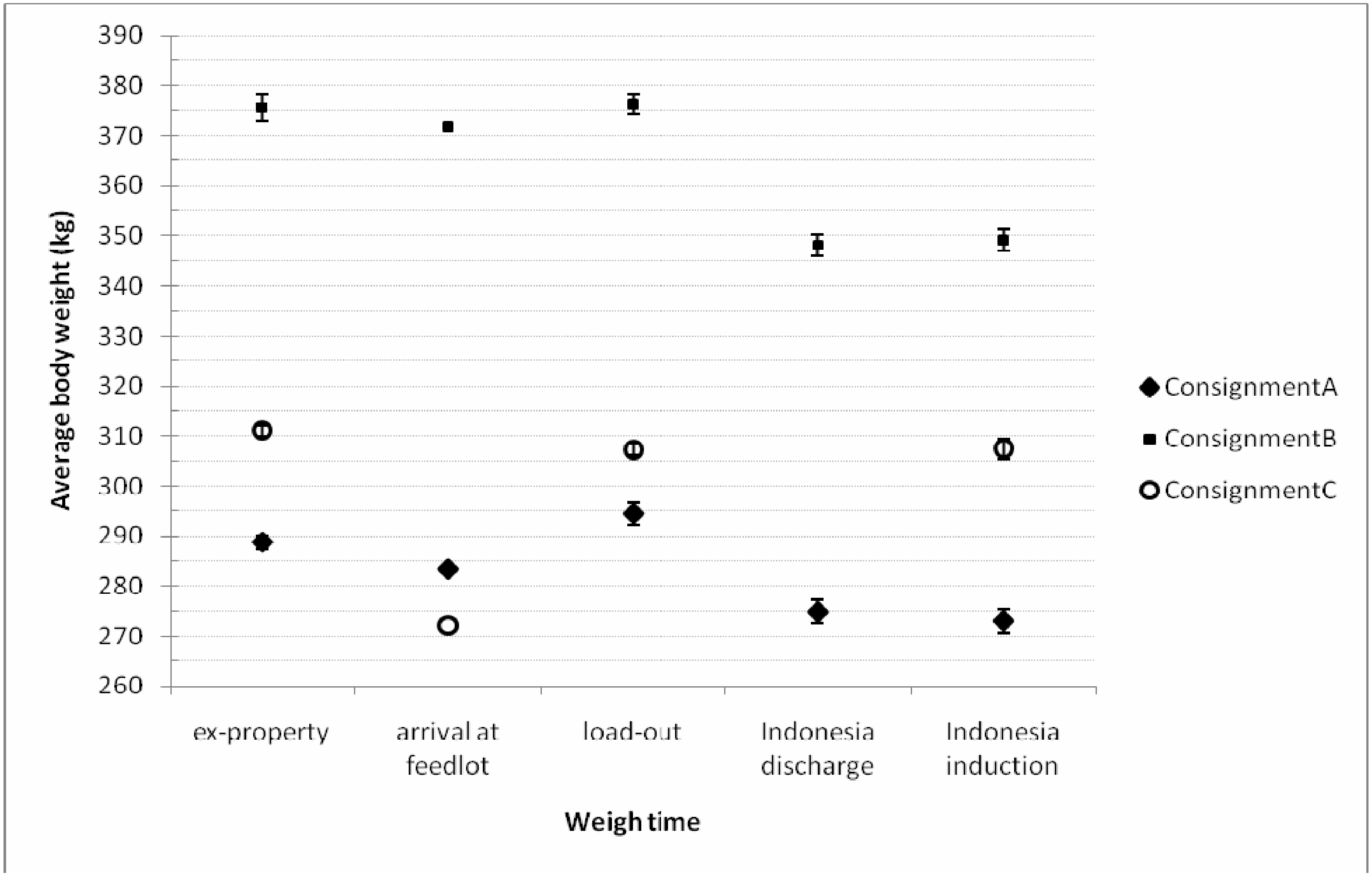

Figure 5: Average body weight measured for three consignments at different time periods during the export process. Bars represent one standard error either side of the mean. Only single measurements were available for weight at *arrival at feedlot* and Consignment C had no weight measurements available at *Indonesia discharge*.

Table 7: Average weights at ex-property, arrival at feedlot and load-out for three consignments and weight changes between selected weigh points. sem= standard error of the mean.

	Consignment		
	A	B	C
Ex-Property			
Ave wt	288.7	375.7	311.1
sem	1.5	2.7	1.1
Arrival at feedlot			
Ave wt	283.4	371.7	272.2
sem		not available	
Load out			
Ave wt	294.4	376.3	307.2
sem	2.1	2.1	1.1
Change from ex-property to			
Arrival at feedlot	-5.3	-4.0	-38.9
Load-out	5.6	0.6	-4.0
Indo discharge	-13.9	-27.6	NA
Indo Induction	-15.6	-26.5	-3.6
Change from load out to			
Indo discharge	-19.6	-28.2	NA
Indo Induction	-21.3	-27.1	0.3

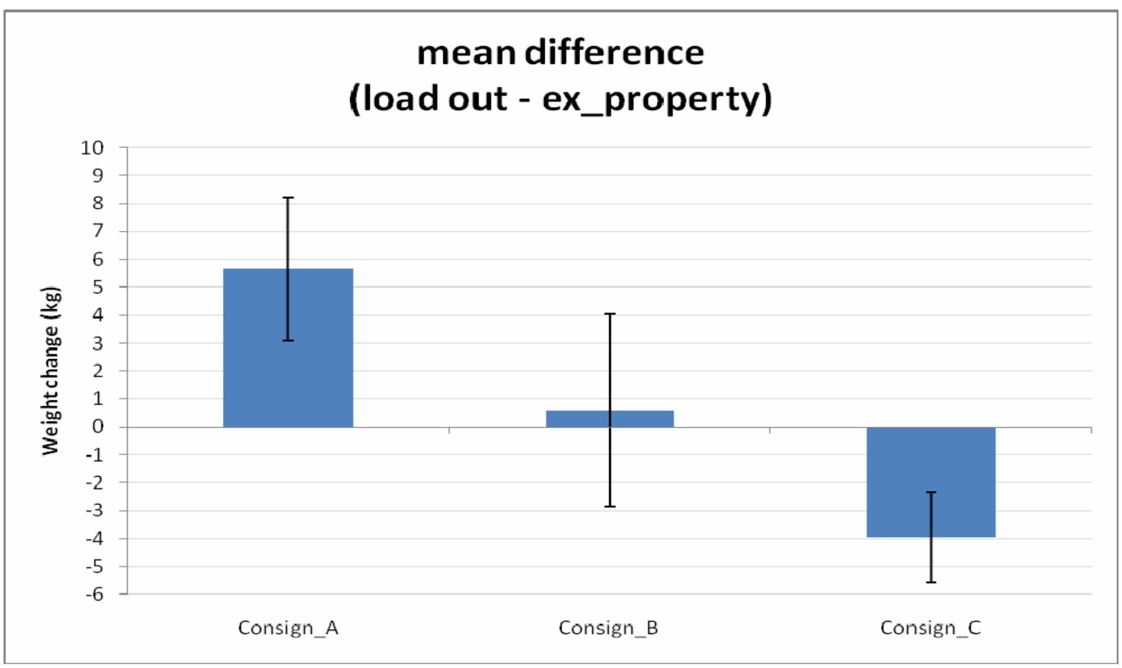

Figure 6: **Difference in mean weight between ex-property weight and load-out weight for each consignment. Bars represent one standard error either side of the mean.**

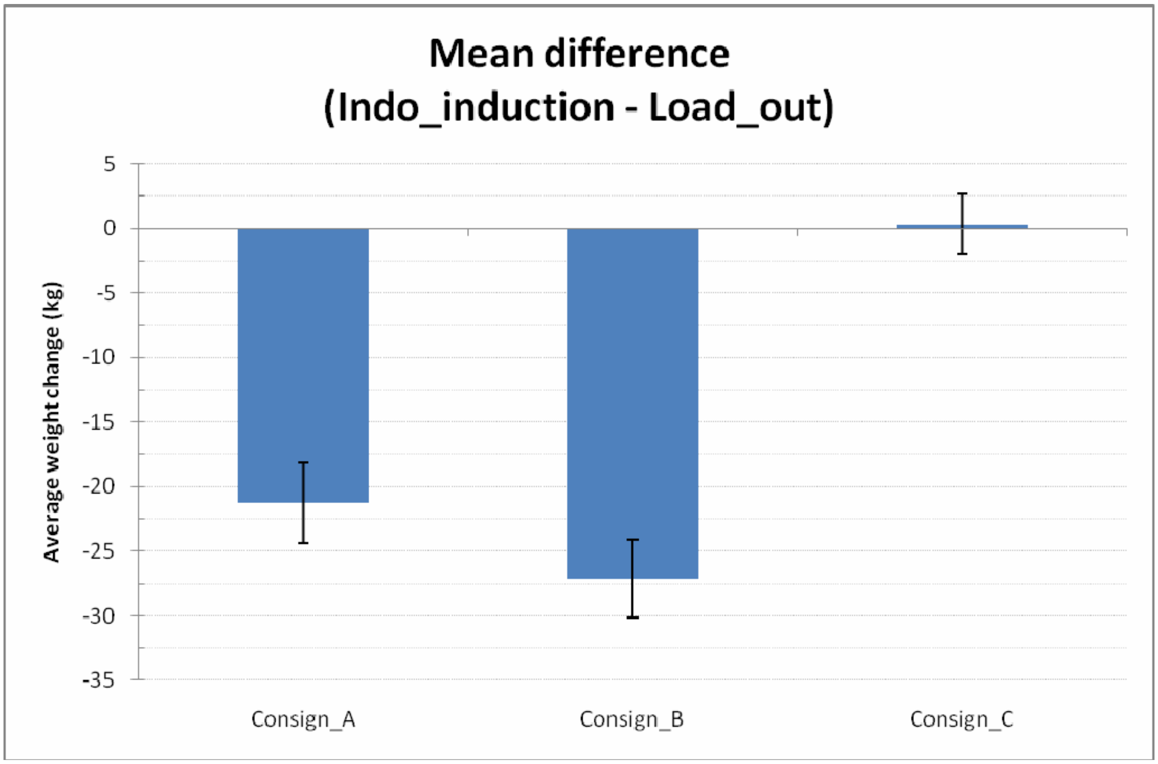

Figure 7: Difference in mean weight between Indonesia-induction and load-out weight for each consignment. Bars represent one standard error either side of the mean.

Table 7 provides a summary of the body weight at selected weigh points and changes in body weight over different stages of the export process.

It is interesting to note the direction and magnitude of change over different stages. All cattle lost weight during the journey from property to assembly feedlot. No weight data were available for animals prior to loading on the property of origin so the full magnitude of weight change for this stage of the process is not able to be assessed. The starting weight was a weight measured at varying points along the journey from property of origin to the assembly feedlot and it is likely that by the time this first weighing occurred, animals had already incurred some weight loss from an unknown starting weight prior to being loaded onto trucks. Animals may have been handled differently during the journey and initial weighing and in some cases animals are unloaded and held in yards before being weighed. It is notable that Consignment C (from QLD) lost the most weight from the ex-property weighing to the feedlot arrival weighing (Table 7). By the time of load-out animals had regained most of this initial weight loss probably through rehydration and gut fill. Consignment A animals had actually gained more weight relative to the ex-property weight.

Caution is appropriate in interpreting the level of weight change here since pre-loading management and journey factors may have influenced the initial weight and there is considerable potential variation in body weight that may be attributed to variable gut fill at different weigh periods. The amount of curfew time for animals at property of origin prior to being loaded and the initial part of the journey from property to the ex-property weighing may have influenced the initial weight. If animals had lost relatively more weight prior to the first weighing then this could explain a smaller (additional) loss of weight from ex-property to feedlot arrival and an apparently larger (relative) weight gain during the feedlot period (to load-out).

It is also interesting to note the relative weight changes occurring during the voyage (from ex-property or load-out to discharge at Indonesia or induction into Indonesian feedlots). Consignments A and B lost considerable weight during the voyage while Consignment C appeared to maintain weight.

A member of the project team (Mr Adam Hill) accompanied the cattle on the vessel during the first voyage and made observations of behaviour and appetite each day. Appetite was assessed by inspection of feed troughs to determine whether available feed was being eaten or whether feed was being left in the troughs and by assessment of the level of gut fill. Behaviour was assessed by visually observing cattle in multiple pens at different times of the day and night. Cattle that were standing quietly, some lying down, chewing their cud and generally appearing comfortable, were assessed as calm. Agitated cattle tended to be more alert and more likely to be moving around the pen including sudden movements in response to noise or other stimuli, had very few animals lying down, very few animals chewing their cud.

Table 8: Visual assessment of appetite and behaviour on each day of the voyage

	Appetite			Behaviour		
Day	**A**	**B**	**C**	**A**	**B**	**C**
1	reduced	reduced	reduced	agitated	agitated	calm
2	reduced	reduced	good	agitated	some unsettled	calm
3	reduced	reduced	good	some unsettled	some unsettled	calm
4	reduced	reduced	good	some unsettled	some unsettled	calm
5	reduced	reduced	good	some unsettled	some unsettled	calm

The recorded changes in weights during the voyage were very consistent with the observations of cattle behaviour and appetite and suggested that the QLD cattle adjusted quickly to the on-board environment and resumed eating and normal behaviour. Consignments A and B appeared to have more difficulty adjusting to the on-board environment and while some of the pens appeared to settle down and resume eating and normal behaviour, in general these two consignments continued to show variable and reduced appetite throughout the voyage.

There may have been an influence of deck on the performance of cattle during the voyage but the limited data collected during this voyage do not allow this hypothesis to be tested. Consignment C animals were housed on the main or highest deck (deck 7) while the other two consignments were housed on lower decks – mainly deck 2 with a small number of Consignment B cattle also housed on deck 3.

Daily voyage reports were reviewed to assess temperature, humidity and ventilation for the voyage. All parameters were considered to be very comfortable for the duration of the voyage and the weather was noted as very good. Wet bulb temperatures ranged from 29 to 32 degrees and were predominantly between 30 and 31 C. Dry bulb temperatures ranged from 24 to 29 C and were mostly between 26 and 28 C. Humidity ranged between 65 and 86%. There were only three observations above 80% (deck 5 on day 4: 86%, deck 7 on days 4 and 5: 85%). All other recordings ranged from 65 to 79%. Ventilation on all decks was noted as performing at 100% throughout the voyage.

Consignments A and B were sent to one feedlot. The two consignments originated from different properties within Australia and were also separated by gender (A=heifers and B=steers). Records on liveweights after discharge in Indonesia were obtained from feedlot operators as electronic files. Records were inspected for implausible values and values that may not have been consistent with normal healthy animals. A number of animals (n=8) in consignments A and B were found to have short days on feed (<40 days) and to have lost considerable weight during the feedlot period. These animals were considered likely to have been having trouble adapting to local conditions and diet or to have suffered from some condition or disease that was affecting growth. One animal had an implausibly high final weight and an ADG that exceeded 9 kg per day. These nine records were removed from all analyses leaving the dataset more likely to be representative of a population of normal healthy animals.

Table 9: Mean induction weights for two consignments (A and B) at induction into an Indonesian feedlot, standard error (sem) and 95% confidence intervals.

	wgt induction	sem	CI_low	CI_up
heifer (A)	273.1	1.7	269.7	276.5
steer (B)	349.1	1.6	346.0	352.3

The two groups were significantly different at induction ($p<0.001$).

Table 10: Mean finish weights for two consignments (A and B) at induction into an Indonesian feedlot, standard error (sem) and 95% confidence intervals.

	wgt finish	sem	CI_low	CI_up
heifer (A)	414.7	2.9	409.1	420.3
steer (B)	520.7	2.6	515.6	525.9

Finish weights were significantly different between the two groups ($p<0.001$).

Table 11: Mean Average Daily Gains (ADG) for two consignments (A and B) at induction into an Indonesian feedlot, standard error (sem) and 95% confidence intervals.

	ADG	sem	CI_low	CI_up
heifer (A)	1.23	0.02	1.19	1.27
steer (B)	1.50	0.02	1.47	1.54

The ADG values for the two groups were significantly different ($p<0.001$).

Table 12: Summary statistics for days on feed (DOF) for the two groups, displaying count of data values (n), minimum, maximum, 10th, 25th, 50th, 75th, 90th percentiles and the mean.

DOF	heifer (A)	steer (B)
n	416	491
min	46	49
p10	82	100
p25	98.5	111
p50	123	117
mean	112	115
p75	126	120
p90	130	126
max	175	283

Statistical comparison of DOF for heifers vs steers indicated that steers were fed for significantly longer ($p=0.004$). It may be possible that animals were being fed to different target weights and for different market segments.

Records also indicated that heifers received HGP implants prior to departure from Australia while the steers did not.

Consignment C cattle were sent to two feedlots (feedlot1 and feedlot2). Feedlot data were only obtained for 543 animals from the total of 1736 animals that were loaded onto the vessel. In discussions with feedlot management it was felt that obtaining records on a sample of cattle would meet the purposes of the study and was felt to be easier to manage than asking for complete sets of records. The sample of animals for which data were provided were not purposefully selected in any way and may be considered to be a sample of convenience. While they were not selected in a process that involved random sampling from all possible animals, the sample is considered likely to be representative of the entire consignment since there was no reason to believe that any bias had been applied in choosing which records to provide to the project team.

Four animal records were removed from the dataset prior to analysis. These included one animal that died during the feedlot period (prior to reaching slaughter weight). No reason was recorded in the dataset for the death. An additional three animals were salvage slaughtered after 12, 46 and 124 days on feed. These animals were removed because they did not proceed through to a finishing slaughter weight and because the incomplete dataset really precluded any assessment of animal health and mortality issues. The final dataset is therefore considered to represent performance of healthy Australian cattle from induction to slaughter under Indonesian feedlot conditions.

Analysis of the subsets of cattle inducted into the two different feedlots indicated that there was likely to have been a purposeful approach to determining which cattle went to which feedlot.

Table 13: Counts of the number of animals sent to each of two feedlots from Consignment C, arranged by Teeth score, Frame score and Fat score. Mean induction weights are provided to illustrate the association of teeth score, frame score and fat score with animal weight.

Teeth	Feedlot 1	Feedlot 2	Total	Mean induction weight
0	71	5	76	303.9
2	160	260	420	305.8
4	38	2	40	333.3
6	1	0	1	317
8	2	0	2	272
Total	272	267	539	307.5

Framescore				
2	20	0	20	258.7
3	190	264	454	302.7
4	62	3	65	355.8
Total	272	267	539	307.5

Fatscore				
1	1	0	1	212
2	19	0	19	260.4
3	243	266	509	308.2
4	9	1	10	368.5
Total	272	267	539	307.5

The summary data presented in Table 5 are consistent with an apparent decision to send a more uniform subset of cattle to Feedlot 2 compared with Feedlot 1.

This is supported by the fact that the induction weights for each feedlot were significantly different ($p<0.001$) with feedlot 1 animals having a heavier mean induction weight and a considerably larger standard deviation indicating more variability in induction weight, compared with feedlot 2 animals.

Table 14: Summary statistics for days on feed (dof), induction weight, finish weight and average daily gain (adg) arranged by feedlot. p10 = 10th percentile, SD= standard deviation.

Variable	Feedlot 1	Feedlot 2	Total
Days on feed (DOF)			
min	74	67	67
p10	74	79	74
p25	74	79	75
p50	75	79	79
p75	75	80	79
p90	79	81	80
max	126	123	126
Mean DOF	76	80	78
SEM (DOF)	0.28	0.28	0.2
SD (DOF)	5.6	3.2	4.9
Induct wt	318.1	296.6	307.5
SEM (induct)	1.63	1.64	1.16
SD (induct)	34.4	15.8	28.9
Finish wt	429.5	424.3	426.9

SEM (finish)	2.103	2.123	1.494
SD (finish)	41.03	26.7	34.8
ADG	1.472	1.603	1.54
SEM (adg)	0.016	0.017	0.012
SD (adg)	0.28	0.26	0.28

The mean induction weights, DOF and ADG were different between the two feedlots ($p<0.001$) with animals inducted into feedlot 1 having a larger induction weight, fewer days on feed and a lower ADG compared with feedlot 2. There was a non-significant tendency for feedlot 1 to have a heavier finish weight than feedlot 2 ($p=0.08$).

Most animals in the consignment had a teeth score of 2 and there were relatively few animals in other categories. Animals with a teeth score of 2 were then assessed to determine the effect of fat score and frame score on ADG.

Table 15: Summary statistics for ADG arranged by feedlot and frame score. Data limited to 420 cattle with teeth score=2

		Feedlot		
Framescore		1	2	Total
2	Mean	1.24	.	1.24
	SD	0.37	.	0.37
	Count	4	0	4
3	Mean	1.48	1.61	1.57
	SD	0.28	0.26	0.28
	Count	111	257	368
4	Mean	1.48	1.43	1.48
	SD	0.28	0.15	0.27
	Count	45	3	48
Total	Mean	1.47	1.61	1.55
	SD	0.29	0.26	0.28
	Count	160	260	420

Table 16: Summary statistics for ADG arranged by feedlot and fat score. Data limited to 420 cattle with teeth score=2

		Feedlot		
Fatscore		1	2	Total
2	Mean	1.35	.	1.35
	SD	0.33	.	0.33
	Count	6	0	6

3	**Mean**	1.47	1.61	1.56
	SD	0.29	0.26	0.28
	Count	147	259	406
4	**Mean**	1.57	1.61	1.58
	SD	0.16	0.00	0.15
	Count	7	1	8
Total	**Mean**	1.47	1.61	1.55
	SD	0.29	0.26	0.28
	Count	160	260	420

Results presented in Tables 8 and 9 suggest that of the 2-tooth animals, the best ADG values were achieved by animals in frame score=3.

Frame score and fat score were correlated and of the 368 animals with frame score=3, a total of 365 (99%) also had a fat score=3.

Of the 420 2-tooth animals, most had both a frame score=3 and a fat score=3 (n=365, 87% of 420).

Within the subset of animals with teeth score=2 and framescore=3, the ADG for feedlot 2 was significantly higher than the ADG for feedlot 1 ($p<0.001$) suggesting that there may be some management or nutritional factors operating at the feedlot level that are influencing performance beyond the inherent animal factors.

5.3 Voyage 2

Three consignments of cattle were enrolled for a second voyage that departed Darwin in mid December 2009. The same protocol that had been developed for the first voyage was also applied in this second voyage. It was not possible for a project team member to accompany the cattle on board the voyage and there was no opportunity to collect customised observations during the voyage.

Unfortunately it has not been possible to obtain detailed liveweight data and other ancillary data for the second voyage. There were a number of reasons for this and these have been outlined as an addendum to this final report.

No further analyses have been conducted on voyage 2 data.

6 Analysis of historical industry datasets

There was considerable interest in the planning period for this project in the possible benefits of collecting historical datasets relating to animal performance (particularly liveweight) for animals that had been exported to Asian countries in past years. There was an expectation that historical datasets would be available given the fact that liveweight measurements are so important to the export process, underpinning sale prices at different steps along the export chain. There were suggestions that different export operators may have collected relatively detailed datasets at particular time periods in the past including observations on a range of different factors at the animal or mob level that might allow analyses to address the objectives of the project.

Discussions were held with export industry stakeholders in an attempt to confirm the existence of historical datasets and to discuss the feasibility of seeking access to such data. There were concerns over commercial sensitivities in a competitive industry. The project team provided assurances that all data and information provided would be treated as confidential and no identifying information would be released. In addition reporting of results of any analyses would be limited to summary information only.

It is noted that project team members have had considerable previous experience in different situations in the assessment of historical datasets. It is generally unusual to gain access to historical data that are sufficiently complete and of sufficient quality to allow analyses to address objectives that might not have been considered when the original data were collected. It is critical to perform detailed quality assessment of such data prior to analysing them for another purpose. A brief outline of assessment of historical datasets has been adapted from work conducted under a previous MLA project and is presented in an appendix to this report.

No datasets were identified or provided to the project team as a result of these discussions. This objective was not able to be pursued further.

7 Sample size ramifications of findings

Part of the objectives of the current study was to use findings from the current study to inform design of possible further more expansive or detailed studies to address the objectives of describing liveweight change in exported cattle and identifying drivers of variability in liveweight change.

Results of the current report on mean and variance for liveweight measures (body weight and ADG) are useful in informing sample size estimations for study designs. Weight measures may be made at the individual animal level or at some aggregated level as discussed in the findings of the current report. The preferred approach will be to collect individual animal data and link records to an animal using unique animal identification codes such as the NLIS tag number.

Clustering is an important issue for sample size estimation and analyses conducted on export animals since animals are naturally clustered into mobs as consignments of cattle for export. Each consignment will be managed in the same way since they will mostly originate from the same property and cohort. When animals are managed during transport and in feedlots they are also clustered in pens within each consignment. When clustering is present, individual responses are not independent, variances tend to be biased downwards and statistical analyses tend to be more likely to produce spurious results. Clustering also affects sample size requirements, where one needs to take account of the within-cluster variability, the between-cluster variability and the number of individuals per cluster.

The unit of analysis is also important when considering sample size requirements. Outcomes such as liveweight or ADG that can be measured at the individual animal level, can then be adjusted during analyses for the effects of clustering to ensure that findings are unbiased. In these cases sample sizes can be estimated using based on assumptions about individual animal means and variances. In some cases such as feedlot trials where feed conversion rates may be of interest and feed is measured and allocated at the pen level, it is more appropriate to consider the unit of analysis as the pen rather than the individual animal.

Three sets of sample size estimations were conducted:

- Observational studies of liveweight changes in consignments travelling from property to assembly depot and on by voyage to Indonesia.
- Observational studies of ADG differences in cattle within an Indonesian feedlot to determine associations between animal and consignment level drivers on performance under Indonesian conditions.
- Experimental studies being performed in Indonesian feedlots to assess the effects of particular defined changes such as different diets on ADG.

7.1 Observational studies based on liveweight

The first approach was directed at measurement of liveweight in animals at different stages in the export process up to induction into Indonesian feedlots. The purpose was to be able to measure sufficient animals to be confident of detecting differences of the order of 10 to 30 kg in mean liveweight. These estimates were derived from observations of the mean loss in liveweight experienced by consignments during the voyage in the current study. The purpose of these analyses would be to identify drivers that may explain why some groups of animals lose (or gain) more weight than others during the voyage or transport phases of export.

In this situation the expectation is that an observational trial would be conducted and multivariable analyses performed to assess multiple possible drivers simultaneously. Under this scenario it is difficult to accurately predict required sample sizes since the number of drivers that may be assessed in one analysis is unknown and there are potential complications posed by interactions between potential drivers. It is not uncommon to collect data on as many as 20 variables and then to present as many as 10 of these in a multivariable statistical model and then reduce these to 5 significant variables retained in a final model. The expectation is that a model should be capable of handling 5 explanatory variables in a final model with some of these being assessed as two-way interactions. If a final statistical model contained five main effect variable and two interaction terms and most of these were categorical, it is expected that the model may contain as many as 10 to 20 terms or coefficients

Sample size estimations used assumptions derived from observations of liveweight (mean and SD) in animals in the current study. It was assumed that SD ranged from 10 to 30 and that meaningful effects (differences in liveweight between low and high groups) were of the order of 10 to 30 kg. In order to account for clustering initial sample size estimates were increased by a factor of 1.5 as an estimate of variance inflation. The results suggested that a minimum of about 100 to 200 animals were required for each coefficient in a final statistical model. If there were 20 coefficients in a final model, this is equivalent to a total sample size of some 2,000 to 4,000 animals. Total sample sizes in excess of this figure will be highly likely to result in meaningful results.

It is also necessary to consider the way these animals might be selected to ensure that a wide range of combinations of potential drivers are represented. Since many drivers are operating at the level of the consignment, it is more important to collect data from a relatively large number of different consignments as opposed to collecting data from a larger number of individual animals that are derived from only a small number of consignments. It is convenient to work in lots of 180 animals (representing the number of feeder animals that may be carried on a road-train). If one to two road-trains were selected from each of 10-15 consignments in a load-plan for a particular voyage, and if this approach was then applied to multiple voyages over the course of one to three years (anticipated duration of a larger scale project), it should meet sample size requirements to allow effective observational analyses to identify drivers.

The choice between selecting animals from consignments or alternatively measuring all animals in selected consignments is likely to be dependent on whether individual animal liveweight is routinely being measured on all animals at key points. If this is the case then it may be possible to collect liveweight data on all animals. If animal weights are not being routinely collected then this imposes additional burdens on project staff and industry operators. These issues are discussed in more detail in the design section of this report.

7.2 Observational studies based on ADG in Indonesian feedlots

The second set of sample size estimations was directed at the Indonesian feedlot situation and was intended to inform the situation where all animals in the feedlot were being managed in the same routine manner and where analyses were then being directed at identifying animal or consignment characteristics that might be influencing performance in the feedlot. Examples might include the effect of animal age, induction weight, frame score, fat score, breed composition, prior management in Australia and so on. The intent would be to identify characteristics that are associated with good (or bad) performance in the feedlot situation and allow industry to use the information to better prepare animals for export or to select animals based on expected performance. Here measurements are being made at the individual animal level for outcomes of interest (ADG) and animals are clustered into feedlot pens or consignments.

In this situation the expectation is that an observational trial would be conducted and multivariable analyses performed to assess multiple possible drivers simultaneously. The approach is very similar to that described for the previous scenario. It is assumed a final statistical model might contain five main effect variable and two interaction terms and may contain as many as 10 to 20 terms or coefficients

Sample size estimations used assumptions derived from observations of ADG (mean and SD) in animals in the current study. It was assumed that SD ranged from 0.3 to 0.4 and that meaningful effects (differences in ADG between low and high groups) were of the order of 0.2 to 0.3 kg/day. In order to account for clustering initial sample size estimates were increased by a factor of 1.5 as an estimate of variance inflation. The results suggested that a minimum of about 60 to 100 animals were required for each coefficient in a final statistical model. If there were 20 coefficients in a final model, this is equivalent to a total sample size of some 1,200 to 2,000 animals. Total sample sizes in excess of this figure will be highly likely to result in meaningful results.

As for the above scenario it is more important to collect data from a relatively large number of different consignments as opposed to collecting data from a larger number of individual animals that are derived from only a small number of consignments. It is convenient to work in lots of 180 animals (representing the number of feeder animals that may be carried on a road-train). If one to two road-trains were selected from each of 10-15 consignments in a load-plan for a particular voyage, this should meet sample size requirements to allow effective observational analyses to identify drivers. It is assumed this approach would then be applied over multiple voyages to allow analyses to incorporate assessment of time of year and voyage as potential drivers.

7.3 Experimental studies based on ADG in Indonesian feedlots

The third set of sample size estimations was also directed at the Indonesian feedlot situation and was intended to inform the situation where a trial was intended to assess whether a change in diet might produce an improvement in ADG. In this case the unit of analysis was the feedlot pen since this is the level at which any manipulations (changes in feed or management) may be applied. It was assumed that each pen contained about 150 animals though it is recognised that pen size may vary from feedlot to feedlot. Animals clustered within pens were assumed to have intra-class correlations of 0.2 reflecting similarity of animals within each pen. Assessment of observed data on ADG derived from the current study indicated that the difference between quartiles for ADG in the three consignments was about 0.2 to 0.3 kg/day. This means that if the lowest quartile of animals based on ADG were able to be shifted into the growth levels that were achieved by the next quartile, they would need to gain about 0.2 to 0.3 kg/day (moving from ADG values of 0.9 to 1.19 kg/day to values of 1.29 to 1.47 kg/day). Manipulations that achieved an increase in ADG of 0.2 kg/day were therefore considered likely to result in meaningful improvements in feed lot performance. The standard deviation of ADG observed in the current study ranged from 0.28 to 0.37.

Table 17: Number of pens of animals in each of two groups that would be required to have at least an 80% chance of detecting differences in Average Daily Gain (ADG) between groups at differing magnitudes and standard deviations. All estimates assume each pen contains 150 animals and that the threshold of statistical significance is set at P≤0.05. Estimates adjusted for effect of clustering by using an intra-class correlation coefficient of 0.2.

ICC=0.2

Diff in ADG	0.15	0.2	0.3
SD=0.3	14	9	5
SD=0.4	24	14	7

Table 17 shows the number of feedlot pens required to achieve statistical power of 80% in a trial aiming to show differences between two groups. The approach is based on an experimental design for example where two different diets may be trialled in a feedlot. The outcome of interest is ADG. Two different estimates are used for standard deviation (SD=0.3 and SD=0.4) reflecting the range of SD values observed in the current dataset. Three different levels of difference or treatment effect were assessed. This is the assumed difference between the two groups and took the values 0.15, 0.2, 0.3. These values covered the range of differences between quartiles of ADG for the animals in the study and are considered to reflect meaningful levels of difference in a feedlot trial. The lower end is approximately equal to 10% of mean overall ADG.

The results should be interpreted as indicative counts of the number of pens required in each group. For example where the expected difference is 0.2 kg/day (middle column) and the expected SD is 0.4 (worst case scenario), then a trial would require 14 pens in each of two groups. Each pen contains about 150 animals so this means enrolling about 2100 animals total in each group (14*150=2100) and 4200 animals in total.

8 Discussion

This report has provided analyses on data derived from the first voyage only. Unfortunately data from the second voyage were not able to be collected and the opportunity to analyse two voyages has been lost. While this is regretful it does not interfere with the ability of the project to address objectives.

A complete dataset was collected for the first voyage. There were considerable difficulties in obtaining animal liveweights at different steps in the live export process within Australia. Typical animal management at the time this project was completed, did not involve collection of individual animal liveweight data. Animals were generally weighed after leaving the property en route to the assembly feedlot but this weight was typically recorded only as an aggregate total weight and total count of all animals in a consignment to allow estimation of total weight and average weight for the consignment. A similar pattern was generally followed for subsequent weights recorded at arrival at the assembly feedlot and on loud out. At some locations animals were unloaded from trucks and weighed in pen-lots before being re-loaded onto trucks to resume the journey. At other locations weights were recorded either as a single weight for one road-train unit or as a combined print out that listed separate weights for the individual components of a single road-train (prime mover and each trailer). Records from weigh points were presented in some cases as paper records only and were aggregated at the point of data entry so that a single total weight and count of animals in a consignment may be the only record entered into an electronic file. On other occasions a spreadsheet file was developed that listed the aggregate weights for pens or trucks.

The major potential constraints that were identified in the project proposal document submitted by the authors prior to the study commencing were difficulties in collecting individual animal weight measures and being forced to rely on weights (and other measures) collected at truck or consignment levels, and difficulties in tracking animals in order to be able to link observations from one point to observations from another point. These issues were confirmed as problems based on the findings of the current study.

Individual animal NLIS tag data were being collected in accordance with regulatory requirements for animal movements but these records were only being collected for recording of animal movement data. No other individual animal data (such as liveweight or other health or performance measures) were being routinely collected. There was no way to link a separate record of NLIS data to aggregate weight data or other measures collected about animals or journeys. Not all animals that are exported have NLIS tags inserted as a result of regulations allowing animals to move without NLIS tags if they are moving direct from property of origin within the Northern Territory to export. Discussions were held with Indonesian feedlot operators to determine if they might use NLIS tags as individual animal identification records for routine management of animals and performance records through the Indonesian feedlot situation. Feedlots were using alternative means of animal identification including insertion of tags at induction and were not routinely using Australian NLIS tags. As a result there was no benefit to the study of collecting NLIS tag data during this project.

Discussions were held with assembly depot operators and exporters about the feasibility of individually weighing a sample of animals from selected consignments. However, there were concerns about the potential adverse impact of additional handling on animal behaviour and growth as well as labour and time requirements to complete these tasks. As a result, it was not possible to collect individual animal weights.

Having a project team member present at the assembly feedlot around the time when cattle arrived and also being present at load out, was essential for capture of weight data. In some cases weight data and counts of animals in each aggregation (pen or truck) for each consignment, were available as electronic files. In a number of occasions these data were only available as paper print outs of truck and pen weights that may not be routinely stored in a manner that ensured reliable and complete records or that ensured all records could be traced to particular consignments. This meant that the most reliable method of collecting weight data was to personally visit assembly depots and remain in close contact with key personnel to collect disparate data records close to the time when animals were processed and then manually build up a dataset of records for each consignment.

It is important to note that the most preferred approach to data collection is to collect measurements of both outcomes and possible explanatory factors (often termed risk factors or drivers) at the individual animal level and to link these measurements to a reliable method of animal identification that can be used to track animals through time and link observations collected at different points (in time and space) to the same animal. The most reliable method of animal identification is the NLIS tag number. Major outcomes of interest might include liveweight and other health or performance measures (illness, death). Potential explanatory factors include a wide range of observations at animal, truck or consignment levels (age, breed, sex, distance travelled, property of origin, management of animals, weaning history, climate, feed quality and quantity, disease testing information etc). Collecting observations at the individual animal level provides maximal replication (numbers of observations), and allows statistical analyses to estimate precise and valid measures of effects including both mean or average effects and variance. Having multiple records is essential to generate variance estimates and variance estimates are essential to allow statistical comparisons to determine whether particular effects are significant or not and to determine which drivers or explanatory factors are more or less important in influencing each outcome of interest.

In this case it was not possible to collect individual animal observations within Australia.

The project team then explored options of collecting data at varying levels of aggregation with the primary goal being to collect multiple observations (replicates) within each consignment. An example of this is collecting liveweight data at the level of the pen, trailer or truck. In each case, it was essential to collect the total weight for each aggregation (pen for example) and the count of animals within that pen at the time of weighing. The same approach was followed for trailer and truck level aggregations. When combining measures, each aggregate measure is weighted by the count of animals contributing to that measure in order to generate overall estimates of mean and variance.

Table 6 provides a summary of the level at which measurements were recorded and the number of replicates generated by the different approaches. On one weigh point (at arrival of animals into assembly feedlots) the only data available were a single total weight and count of animals in each consignment. This does provide a valid estimate of mean liveweight but does not permit estimation of variance and does not allow statistical comparisons of this weight to other weights at different stages. In some cases where weights were recorded at the truck level, there were only 3 replicates in an entire consignment. In other cases where truck weights were recorded for each trailer that comprised a road-train or where weights were recorded for pens of animals that had been unloaded from trucks, it was possible to collect larger numbers of replicates.

Individual animal weights were collected from induction into Indonesian feedlots and at the end of the feedlot period (prior to slaughter). Individual animal level weights are generally preferred since they offer potential to increase replicates (number of observations at each weigh point) and improve precision. However, aggregated weights (pen, trailer or truck level) do provide replicates with the capacity to estimate unbiased average weights and also estimate variances and allow statistical comparisons. Inspection of statistical outputs indicates that standard error or standard deviation estimates derived from aggregated weighings tended to be higher than those derived from individual animal weighings. However, aggregated weighings do provide the capacity to make inferences about performance across different stages of the export process, provided that the number of replicates (number of observations) is relatively large.

It was not possible to track individual animal performance from observations in Australia (ex-property weights and assembly depot weights) through the Indonesian feedlot. This meant that weight comparisons were performed assuming independent measurements, in effect making the comparisons slightly more conservative. If individual animal identity and performance data were able to be collected and individuals tracked using NLIS identity for example, it would be possible to further increase precision and the ability to report performance and investigate factors that may drive performance variability.

Table 4 provides a summary of information derived from questionnaires completed by telephoning the vendors of each consignment at the property of origin. The design of the questionnaire and the questions that were asked was informed by discussions with industry representatives and was intended to focus on explanatory factors that might be expected to be associated with performance of animals. Because there were only three consignments it was not possible to statistically analyse outcome data to try and assess the relative impact of these explanatory factors. The approach does indicate that it is possible to collect data on explanatory factors at the level of the property of origin and to incorporate this information into analyses.

The patterns of weight change reported in this project provide insight into factors influencing cattle performance during export and also highlight the potential benefits of more closely monitoring weights and performance measures in the future.

Animals that travelled the furthest from property of origin to assembly feedlot lost the most weight between the first weighing (after leaving property of origin and during the journey) and load-out. The animals that travelled the shortest distance actually gained weight from the ex-property weighing to the load-out weighing while the third consignment had a load out weight that was very similar to the ex-property weight.

Observations made during the voyage were consistent with a range of industry reports indicating that short haul voyages are relatively uneventful and that animals generally tolerate conditions on board export vessels very well. There were apparent differences in the ease with which different consignments of cattle adjusted to the experience as evidenced by observations of behaviour. The consignment (C) that behaviourally appeared to adapt most readily, was also associated with the best weight performance during the voyage based on weight change from load-out in Darwin to discharge or induction in Indonesia. The other two consignments lost considerable liveweight (average loss between 20-30 kg per animal) during the voyage (from load-out to Indonesian induction). These observations indicate that there is scope for improvement in performance of animals during the voyage. Identification and implementation of measures either in Australia or during the voyage that might prevent losses per animal of this magnitude may result in meaningful economic returns.

There is very little data in available scientific literature that describes performance measures in Australian cattle exported to south east Asian countries such as Indonesia. Lapworth (2000) described limited data based on observations of cattle exported to the Philippines that suggested animals had gained several kg during the voyage. Animals in that study spent an average of 61 days in the Philippine feedlot and gained an average of 0.95 kg per day during that period. The project was conducted by QLD DPI staff and commenced in 1997. It is likely that conditions during the voyage and in the Philippine feedlot may have been different to those experienced by the cattle monitored in the current project.

It is recognised that even though there may not be published literature describing animal performance through the export chain, industry representatives with direct involvement in the export industry and in Indonesian feedlots have tremendous experience and knowledge of the processes and of animal performance. The feedlots receiving cattle from the three consignments that were enrolled in the voyage described in this report were very well managed and collected individual animal data about a range of parameters including liveweight.

The literature review describes reports in a small number of publications that refer to expected weight gains for different types of cattle including Australian and local Indonesian cattle, under Indonesian conditions. The performance of the three consignments in Indonesian feedlots was consistent with previous literature suggesting ADG values of between 1.2 to 1.4 kg/day for Australian cattle (Hadi, Ilham et al. 2002; Sullivan and Diwyanto 2007). Observed ADGs for the three consignments ranged from 1.2 to 1.6 kg/day confirming that Australian cattle perform well under Indonesian conditions.

There was apparent variation in body weight and ADG for animals in Indonesian feedlots that may be attributed to animal characteristics such as age, frame score and fat score, as well as gender.

The limited analyses conducted in this report do not allow clear conclusions to be made about explanatory factors for some of these differences. An important purpose of the pilot study approach was to assess feasibility of further studies that may address the objectives as opposed to providing detailed information on factors that explain variability in performance.

In general there appears to be sufficient variation in performance between and within consignments at different stages of the export process to suggest that there it would be feasible to design and implement studies assessing variability in performance during the voyage and feedlot periods of the export process and assigning variation in performance measure to explanatory factors.

Multiple weigh points at different stages of the export process do allow liveweight performance (change in body weight or ADG) to be assessed for each stage of the export process (journey from property to assembly feedlot, recovery of weight in assembly feedlot, effect of voyage, performance in Indonesian feedlot). It is also feasible to collect data on factors relating to property of origin and animal management prior to export and associate these factors with performance at various stages through the export process. Similar associations can be conducted with ship-board data relating to location of animals on the vessel and climatic or environmental conditions, and with performance in the Indonesian feedlots.

Such studies could lead to identification of management factors and animal types that may minimise risk of weight loss during export and maximise growth during the feedlot period. Development of systems capable of this sort of monitoring then offer the potential to further explore associations with experimental studies to examine the effects of manipulating management factors (changes in pre-transport experiences of animals, vaccinations, pre-feeding, variation in diet, etc) and directly assessing the impact of such changes on outcomes of interest.

It is noted that since these two voyages were completed, there has been a tightening of the controls over weight limits for animals being exported to Indonesia with animals having to be under 350kg weight to be exported. Consignment B was associated with average liveweights prior to load out that exceeded the 350 kg limit.

It is understood that enforcement of the 350kg limit is likely to result in animals being individually weighed prior to entering the assembly depot. The routine collection of individual animal weights at various weigh points has the capacity to increase the precision with which weight can be monitored and potentially increases the ability of similar studies to detect associations between liveweight change and other factors (animal or management or environmental).

There are a number of sensitivities concerning provision of data and information to researchers for studies such as this one. In some cases property management were concerned about providing data and information that may allow their property to be identified in any reports. Care has been exercised during this study to ensure that no identifying information is included in any output and that only summary information is provided about performance outcomes and other factors. Exporters are also very sensitive about provision of information concerning management or performance of animals that could be associated with competitive or commercial advantage in the export industry. Modifications to management and or selection of animals in the export process that result in small improvements in performance at the individual animal level, may amplify to significant commercial advantages when considered across an annual total of animal exports.

This pilot study has demonstrated that it is possible to collect liveweight measures on animals and information on other potential explanatory or causal factors and that these approaches may be used to explore options for further improving performance in cattle destined for export to Indonesia or other Asian destinations. Findings from the data collected in this study have been used to inform the design of further studies to detect small improvements in performance at the animal or pen/truck level and provide estimates of sample size requirements necessary for such studies. While the current study has demonstrated that there is potential value to industry from this work, the success of future work in this area is dependent on industry commitment and in particular on the ability to track individual animals and collect individual animal health and performance data through multiple stages of the export process.

9 Design and budget for prospective study

The current study was intended to test assumptions and methodologies for data collection and to inform the feasibility and design of a larger project that might then directly address defined objectives.

The purposes of the pilot study were to:

- determine the feasibility of a larger study that may address the two objectives of interest. Feasibility will be based on things such as availability, accessibility and quality of data that are suitable to address the objectives
- guide the design of a larger scale study to examine the two objectives of interest in detail including consideration of:

    - estimation of required sample sizes (number of trucks and voyages) to allow the two main objectives to be addressed with confidence of getting results of value to the industry
    - resource requirements – people, travel etc
    - design issues – how would data be collected, entered and managed
- guide the development of a budget for the larger scale study

9.1 Scope

The scope remains unchanged and covers animal performance over two periods:

- from property-of-origin to induction into Indonesian feedlots including:
    - transport from property-of-origin to export assembly depot
    - maintenance in export assembly depot until load-out onto an export vessel
    - voyage from Australian port of departure to Indonesia
    - discharge in Indonesia and transport to feedlot
    - maintenance in feedlot (or adjacent environment) until induction into the feedlot
- from induction into Indonesian feedlot until exit to slaughter (feedlot period)

9.2 Objectives

The objectives remain unchanged:

1. Describing the change in liveweight in animals being exported from Darwin to Indonesia (covering the following periods: property of origin to assembly depot, assembly depot to Indonesia, feedlot period in Indonesia); and
2. Identifying factors (or drivers) that influence the change in liveweight in exported animals during progression from property-of-origin to slaughter in Indonesia.

9.3 Feasibility

A number of issues were either identified in the planning of the pilot project or were encountered during the pilot project. While an expanded future project to address the objectives is considered feasible there are a number of issues that must be addressed and incorporated into the design to ensure a high likelihood of success.

9.3.1 Dedicated project staff for data collection

It was not possible during the pilot study to collect data meeting project requirements from routine industry records because normal industry operating practices did not extend to keeping records of liveweight at either the animal or aggregated level (pen, trailer or truck). Weight records were collected but tended to be most reliably stored as a single total weight for a consignment along with a count of animals in that consignment. Data on explanatory factors or drivers were not routinely collected either. This means that customised approaches would have to be developed for collection of data and that sufficient resources have to be directed to the project to ensure these systems can function effectively and reliably. The practical effect of these issues is that at least one labour unit would need to be appointed within Australia with responsibility for managing the project and possibly additional labour unit(s) within Indonesia.

It is suggested that a position be funded by the project within the Northern Territory Department of Primary Industry, Fisheries and Mines (DPIFM) and housed at departmental facilities at Berrimah. This person may be enrolled for a post-graduate degree (Masters or PhD) or appointed as a project manager without post graduate enrolment. In addition, there is considered to be value in appointing one or more persons to positions in Indonesia to assist in activities at Indonesian feedlots and particularly with collection and collation of data on feedlot performance of Australian cattle. Discussions have been held with Mr Neil MacDonald (Director of Primary Industry Research, NT DPIFM) to confirm the feasibility of such an appointment.

The CEO of the Northern Territory Livestock Exporters Association (NTLEA) was involved in the pilot study and was pivotal to the success of the project. However, the normal demands of the NTLEA position meant that this individual could not devote all of his time to the project. The other project staff involved in the pilot project were based in southern Queensland and were also not able to be present in Darwin with the exception of specific planned trips.

Industry operators were in general supportive of the project and were willing to provide access to facilities and records to facilitate data collection during the pilot project. The key issue was the need to have someone from the project regularly contacting and visiting operations to ensure data collection occurred at key points.

It is understood that changes in Indonesian protocols concerning the 350 kg weight limit have resulted in collection of individual animal weights at some time points. If this continues it offers potential a future project to access these records electronically. However, it is unlikely that individual animal weights will be measured on all possible weighing occasions and it is therefore likely that the experiences of the pilot project will continue to represent expected circumstances meaning that data collection will require dedicated project staff.

A similar constraint was experienced in the Indonesian feedlot situation and once again it is suggested that reliable collection of data will be greatly facilitated by one and possibly more dedicated staff in Indonesia to visit feedlots and collect data according to defined and agreed templates. The number of staff required in Indonesia is likely to depend on the number and location of feedlots that are participating in the project and it is likely that there may grounds for one position at each of two locations for example to cover major feedlot areas.

Having dedicated staff to facilitate data collection is considered the most critical issue likely to ensure success of a future project.

9.3.2 Industry support and commercial sensitivities

There was good industry support for the project during the pilot study but commercial sensitivities were raised on a number of occasions in discussions with industry stakeholders. The live export industry is competitive and individual operators are interested in both developing and protecting practices that may confer commercial advantages. Examples might include use of particular management or diet strategies that may result in small positive weight gains at the individual animal level and that when considered cumulatively over the course of a year, might amount to a meaningful improvement in net return.

The development of data collection systems and analytical approaches based on describing performance and identifying drivers, is considered directly suitable for assessing the impact of various management strategies on performance measures. It is not clear whether this sort of approach which is directly aimed at increasing commercial returns, might be considered by some to be more appropriately addressed by individual operators as part of routine business investment as opposed to R&D funded and managed by peak industry bodies such as MLA and LiveCorp. The authors are of the view that there is scope for industry funded R&D to address the issues as described in this report and therefore that this work is appropriate for MLA and LiveCorp to proceed with. This does not preclude individual operators from pursuing R&D objectives of their own.

With respect to the feasibility of a larger scale project as described in this document, it is essential to obtain broad industry support and commitment for the project.

9.3.3 Individual animal data vs aggregated data

The most preferred approach for collection of liveweight data is to combine individual animal weights with unique animal identification records (NLIS). This provides the most detailed baseline dataset to which can be added a wide variety of other observations either at the individual animal level (tooth eruption, frame score, fat score, condition score, health data, gender, treatments, etc) or at mob or consignment levels.

Individual animal data is really only feasible if industry is already collecting such data (weights and NLIS identity) and the project can then leverage additional data collection opportunities on top of this. If industry is not already routinely collecting individual animal data then the same reluctance to subject animals to another handling procedure as observed in the pilot study, is likely to preclude the addition of such measurements.

Even if individual animal data can be collected on some occasions it is almost certain that individual animal weights will not be collected at all the time points of interest to the study and aggregated data will still be necessary.

9.3.4 Tracking animals

NLIS records provide an effective method of tracking and linking disparate measurements performed on the same animals. Experiences in the pilot study suggest that NLIS data are not routinely used currently for any purpose other than as required to log transport of animals within Australia. Indonesian feedlot staff do not appear to be using NLIS tags to track animals and instead appear more likely to insert their own tags for tracking purposes. This means that future studies are unlikely to be able to link measurements in Australia and those in Indonesia to the same animal. This is likely to have some adverse effects on the ability of future studies to link factors that may occur in Australia to outcomes experienced in Indonesia at the individual animal level. However, such associations can be made by using data aggregated to the consignment level and this is not a major factor in determining whether or not future studies are feasible.

9.3.5 Data collection systems

The scale of a future study in terms of total animal numbers (thousands of animals) and measurements (multiple variables and multiple measurements per variable for each animal), mean that effective management of the study will require development of a customised database and associated web site.

9.4 Methods

9.4.1 Outcomes

The major outcomes of interest are derived from liveweight and include liveweight and average daily gain (ADG).

The preferred unit of measurement for liveweight is at the individual animal level in conjunction with a unique animal identification record such as the NLIS tag number. Where this is not possible a fall back option is to collect data at some level of aggregation (pen, trailer or truck).

It is expected that weights will be measured at defined points including:

- ex-property (during the initial journey from property of origin in to the assembly depot
- on arrival at assembly depot
- on load-out from assembly depot
- on discharge at Indonesian port
- on induction into Indonesian feedlot
- on exit from Indonesian feedlot for slaughter

9.4.2 Explanatory factors or drivers

Table 18: List of major explanatory factors of interest for period from property of origin to Indonesian induction

Level	Variable	Comment
Animal	mob id Individual animal id (NLIS) Breed Sex Age Temperament	

	Behaviour	
	Other	condition score, class, quality
Station of origin	Location	
	Management	weaning/breeding practices, bull selection
Truck journey to depot	mob id	
	truck id	
	date yarded	
	curfew details - time last fed, water on/off	
	date & time loading started	
	date & time loading finished & journey started	
	date & time arrived at depot	
weigh station	weigh date	
	weigh location	
	aggregate weight (gross - tare)	
	number of animals in pen/trailer/truck	
	animal line/mob ID	
	truck id	
Depot	mob id	
	individual animal ID (NLIS)	
	individual animal weight	
	condition score	
	Feed type, quality, quantity,…	
	Yard design	
	Management in depot	
	Duration in depot	arrival date, load out date
Ship	Ship ID	
Voyage	Date/time loading started	
	Date/time loading finished	
	Duration of voyage	
	Feed type, quality, quantity,…	definition(s) needed
	Weather	definition(s) needed
	Loading density	
	Location	deck, pen, ...
	Observations on animal behaviour, appetite etc	
Discharge	Date of arrival at port	
	Port of discharge	
	Date/time unloading started	
	Date/time unloading ended	

Explanatory factors of interest in the Indonesian feedlot phase of the study will depend on discussions with feedlot operators. It is anticipated that environmental factors (location, climate, feedlot design and structure), management (staff numbers and training, daily routines, hospital pen management, treatments), water and diet, and animal or consignment characteristics would all be of interest to feedlot operators concerned about maximising performance in the feedlot situation.

The starting position in the feedlot is to collect induction and end weights and basic information on other factors to allow simple characterisation of the performance (including animal and consignment level variability) of Australian animals in the Indonesian feedlot situation. There are then varying levels of increased project intensity that involve collection of additional data on explanatory factors.

Finally, there is potential to consider experimental studies to assess impacts of interventions. It is suggested that experimental studies not be considered within the scope and budget of an initial study because such studies are likely to be focused on one operation and activities and costs are very difficult to anticipate without detailed knowledge of hypotheses under consideration including treatment groups and outcomes that may be applied/measured.

9.4.3 Project management

It is suggested that a project steering committee be formed with tentative appointments consisting of the following skills and suggested personnel:

- Animal nutrition and growth including particular expertise in Australian and Indonesian systems:
    - Dr Dennis Poppi, University of Queensland
    - Dr David Ffoulkes, NT DPIFM
    - Mr Neil MacDonald, NT DPIFM
- Epidemiology, statistics, project management
    - Dr Nigel Perkins, AusVet Animal Health Services
- Northern Territory Livestock Exporters Association
    - Mr Adam Hill, CEO NTLEA
- Representatives from MLA and LiveCorp
- Other representatives as required

It is recommended that the steering committee meet initially to consider the current report and develop a final project design and budget for consideration by industry and MLA.

In the event that a full-scale project is subsequently developed it is suggested that the project steering committee meet annually in Darwin for the duration of the project.

It is recommended that a project managerial position be created within the Northern Territory Department and funded by the project. Mr Neil MacDonald has provided estimates of annual cost for a P2 level position, consistent with an expectation that the person appointed to this position would have sufficient skills and experience to independently manage the project.

It is suggested that consideration be given to appointment of Indonesian-based personnel to the project team (either full or part-time appointments may be considered) to liaise with Indonesian feedlots for management of the project and assist in data collection and collation within Indonesia.

9.4.4 Project duration

It is expected that the project will have a 3-year duration with the first 3 to 6 months required for development of relationships with industry stakeholders in Australia and Indonesia, appointment of personnel and finalising systems for data collection. This would then be followed by about two yers of data collection from export voyages to Indonesia. There would then be a period of several months for final analyses and report writing.

There is scope to manage this project either as a post-graduate project or as a technical project without any associated post-graduate degree.

9.4.5 Description of activities

Activities are divided according to geography into Australian, voyage and Indonesian-based activities.

The core Australian activities will be based around assembly depots supplying cattle to Darwin and possibly those supplying other northern ports. Close relationships will need to be developed with exporters and with operators of assembly depots to facilitate collection of data from consignments of cattle entering the export process.

In addition it is expected that additional information will be gathered from vendors of cattle (property-of-origin) mainly through telephone or email contact. In some cases visits to properties may be arranged to perform additional procedures such as weighing animals or collecting other information.

Project staff will be expected to accompany some (but not all) voyages.

At the Indonesian end there is expected to be a baseline set of data to be collected from all enrolled consignments that is based around liveweight performance in the feedlot, health data, feed and management information and carcass characteristics. It is expected that the project will incorporate descriptions of market chains in the Indonesian system including specifications of desired products and the association with live cattle characterstics. It is expected that there will be opportunities for nested studies including for example ultrasound measurement of body fat and other characteristics in either live animals or carcasses that may be used to determine performance or market suitability. Consideration should be given to whether NLIS tag recording offers useful value in Indonesian systems for allowing individual cattle data to be traced from property of origin to carcass characteristics in Indonesia.

9.5 Budget

A draft indicative budget is presented in Table 19 that provides an estimate of project costs for a 3 year project. The budget estimate is intended to provide an indication of cost for the project to achieve goals and to allow flexibility for the steering committee to design project activities. It is anticipated that the budget would be revised following the initial steering committee meeting.

Table 19: Indicative budget for a 3-year project

	Salary costs				
	Australia	**Indonesia (AUD)**	**Meeting costs**	**Operating**	**Total**
Year 1	152000	30000	11000	57000	250000
Year 2	156000	30000	14000	50000	250000
Year 3	162000	30000	16000	42000	250000

Assumptions underpinning the budget are summarised below:

- Salary costs for Australia include salary and on-costs for a P2 level position (project manager) within the NT DPIFM ($132,000, $136,000 and $142,000 over the 3 years) with the remainder allocated to professional fees for services provided by Australian-based consultants including statistical services and project management.
- Salary costs for the P2 position within the NT DPIFM include base salary, holiday pay, superannuation and other allowances, 50% of on-costs (assuming NT DPI will cover the remaining 50% of on-costs), and allowances for estimated annual travel as part of the role.
- Salary costs for Indonesia are AUD equivalents intended to cover salary for Indonesian-based personnel and associated travel and other costs. These estimates are subject to change based on more detailed advice on these costs.
- Meeting costs cover annual costs for the steering committee including economy air fares from Brisbane to Darwin for 3 people, meeting room hire, catering and accommodation and

per diem costs for the expected total contingent of 8 to 10 people. The budget does not cover travel and accommodation costs for MLA or LiveCorp representatives.

- Operating costs are intended to cover purchase of a computer and relevant software for the project manager position, consumables, travel and accommodation for project manager to travel to Indonesia and allowances for purchase of equipment (NLIS reading equipment, ultrasound) and unallocated operating costs to cover additional activities such as nutritional analyses of feed/faecal samples or other measurement and laboratory procedures that may be conducted.

9.6 Recommended approach to progression of the project concept

It is recommended that an initial workshop be convened comprising individuals identified in this report as candidates for serving on the project steering committee. The purpose of this initial workshop would be to receive background information from the authors of the current report and from MLA/LiveCorp representatives about the proposed project. The meeting would then undertake a facilitated discussion of the design of the project including consideration of objectives, methods and resource requirements.

The outcome of this meeting would be a revised project protocol and budget that would be suitable for circulation to industry stakeholders and consideration by MLA / Livecorp for funding.

The preferred location of the initial workshop is likely to be Darwin but may be held in an alternative location (Brisbane for example) depending on which location might be most convenient from a travel perspective. It is also suggested that the Research Program Manager for Livestock Production Systems in ACIAR (Dr Peter Horne) be invited to this workshop since ACIAR are understood to be actively involved in a range of production related projects in Asian countries including Indonesia.

The budget for this initial workshop is not presented in the draft project budget. It is anticipated that the cost would be as for budgeted cost of an annual steering committee meeting ($11 to $15,000) depending on the number of people and travel costs.

10 Bibliography

ABARE (2010). "Australian beef: Financial performance of beef cattle producing farms, 2007-08 to 2009-10." 10.1. http://www.abare.gov.au/publications_html/livestock/livestock_10/livestock_10.html Accessed 1 July 2010.

Ainsworth, R. (2002). Investigating current best practice in the export of beef cows by sea, MLA LiveCorp. Report Number LIVE.207.

Bindon, B. and N. Jones (2001). "Cattle supply, production systems and markets for Australian beef." Australian Journal of Experimental Agriculture 41: 861-877.

Bortolussi, G., J. McIvor, et al. (2005). "The northern Australian beef industry, a snapshot. 1. Regional enterprise activity and structure." Australian Journal of Experimental Agriculture 45: 1057-1073.

Burns, B., G. Fordyce, et al. (2010). "A review of factors that impact on the capacity of beef cattle females to conceive, maintain a pregnancy and wean a calf—Implications for reproductive efficiency in northern Australia." Animal Reproduction Science 122(1-2): 1-22.

Clarke, M., J. Morison, et al. (2007). Assessing the value of the livestock export industry to regional Australia, MLA LiveCorp Report. LIVE.326.

Drum, F. and C. Gunning-Trant (2008). Live animal exports: a profile of the Australian industry. , ABARE. Research report 08.1. http://www.abare.gov.au/publications_html/livestock/livestock_08/livestock_08.html Accessed 1 July 2010.

FAO (2009). The state of food and agriculture: Livestock in the balance, Food and Agriculture Orgnisation. http://www.fao.org/docrep/012/i0680e/i0680e.pdf Accessed 1 July 2010.

Hadi, P., N. Ilham, et al. (2002). "Improving Indonesia's beef industry." ACIAR Monograph Number 95. http://www.aciar.gov.au/publication/MN095 Accessed 1 July 2010.

Hogan, J., J. Petherick, et al. (2007). "The physiological and metabolic impacts on sheep and cattle of feed and water deprivation before and during transport." Nutrition Research Reviews **20**: 17-28.

Knowles, T., P. Wariss, et al. (1999). "Effects on cattle of transportation by road for up to 31 hours." Veterinary Record 145: 575-582.

Lapworth, J. (2000). The expanding live cattle trade in Northern Australia. 9th Congress of the Asian-Australasian Association of Animal Production Societies (AAAP) and 23rd Biennial Conference of the Australian Society of Animal Production (ASAP), Sydney, Australia, Asian-Australasian journal of animal sciences

Martin, P., T. V. Mellor, et al. (2007). Live cattle export trade: importance to northern and southern Australian beef industries, ABARE. 07.1. http://www.abare.gov.au/publications_html/livestock/livestock_07/Beef07.pdf Accessed 10 July 2010.

Norris, R. and G. Norman (2010). National livestock export industry shipboard performance report 2009, MLA LiveCorp Report W.LIV.0270.

NT Government (2008). Rural Industries and Fisheries. Budget Papers Number 17. Darwin, NT Government. **17**. http://www.nt.gov.au/ntt/financial/budget08-09/papers/econ_over/industries_fisheries.pdf Accessed 1 September 2010.

NT Government (2009). Growing our primary industries: partnerships for productivity. Darwin, Northern Territory Government. http://www.nt.gov.au/d/Content/File/p/pi/growingourPI_21_10.pdf Accessed 1 September 2010.

Petherick, J. C. (2005). "Animal welfare issues associated with extensive livestock production: The northern Australian beef cattle industry." Applied Animal Behaviour Science 92: 211-234.

Ridley, P. (1996). Transport weight loss in export feeder steers. NT Technote Number 95: 1-9.

Ridley, P. and T. Schatz (2006). Meeting post weaning market specifications for the live cattle export trade to South East Asia. Report from MLA Project Number NAP 3.111.

Rutherford, A. (1995). "Australian beef exports: Dead or alive?" Review of Marketing and Agricultural Economics **63**(2): 340-348.

Sullivan, G. and K. Diwyanto (2007). A value chain assessment of the livestock sector in Indonesia, US Agency for International Development. http://pdf.usaid.gov/pdf_docs/PNADL491.pdf Accessed 20 September 2010.

11 Appendix: Modified framework for assessment of statistical aspects of data quality

11.1 Background

Projects designed to collect data on industry performance measures often have to consider access to historical datasets that may have been collected by industry stakeholders during normal commercial operations. This brief report is an attempt to describe some of the statistical issues relevant to availability and quality of such datasets.

There appears to be no universally agreed definition of quality. Fitness for purpose is a commonly expressed term which incorporates the notion that quality cannot just be defined in relation to some abstract concept of "excellence", but should be seen in relation to the demands of the user of the final product [2].

This document briefly describes the development of a quality assessment framework that can be used to assess historical records that may be considered for subsequent use for different purposes. The approach in developing this framework has been to apply principles as described in mainstream statistical quality assessment guidelines in a manner similar to that outlined by Paiba et al (2006) in a veterinary surveillance example[1;3-6].

11.2 User needs

The principal users of outputs in relation to this project are industry stakeholders that MLA and LiveCorp represent including livestock producers, processors and exporters.

Historical datasets may be available from any of the above stakeholders and are considered likely to include data on liveweight in particular as well as other animal and mob level variables that may have been of interest for particular purposes at the time the data were collected.

11.3 Steps in the process where statistical quality might be assessed

There are a number of chronological steps that must occur for historical data to be sourced, combined, processed and analysed and finally reported. There are statistical quality issues that are relevant at each of these steps.

1. Issues relating to data at each of the potential sources
2. Sampling of sources and data within each source
3. Data entry, processing and analysing
4. Data analysis and primary outputs

11.4 Dimensions of statistical quality

The UK Office for National Statistics describes six dimensions of statistical quality, presented in Table 20.

Table 20: Dimensions of statistical quality.

Dimensions of quality	**Comment**
1. RELEVANCE	The degree to which the statistical product meets user needs in coverage, content and detail
2. ACCURACY	The closeness between an estimated result and the unknown true value
3. TIMELINESS AND PUNCTUALITY	Punctuality refers to the time lag between the actual delivery date of data & the target date when the data should have been delivered. Punctuality is the degree to which data produced are up to date.
4. ACCESSIBILITY AND CLARITY	Accessibility is the ease with which users are able to access the data, including formats & supporting information. Clarity refers to quality & sufficiency of the metadata & additional advice.
5. COMPARABILITY	The degree to which data can be compared over time and domain (sub-population)
6. COHERENCE	The degree to which data that are derived from different sources or methods but which refer to the same phenomena are similar.

It is necessary to determine which statistical quality dimensions are relevant for this task and then to develop appropriate specific measures that can be used to assess different dimensions. Every measure or indeed every dimension need not be assessed for every output or data source. The assessment framework can be considered as a toolbox from which appropriate measures may be selected and applied when and if required.

For the purposes of this project, the quality dimensions of most interest are **relevance, accuracy, accessibility and clarity, comparability** and **coherence.** Timeliness and punctuality are less relevant given that this report is focussed on historical data.

11.5 Specific measures of statistical quality

11.5.1 Relevance

Each time a sample of records is obtained, a list of variables would be compiled from inspection of the dataset and assessment made of relevance to the objectives of the current project. This process is likely to include:

1. summary description: variable name, data type (text, categorical, ordinal, continuous, distribution pattern, summary statistics)
2. source of original data, collection method and intended use
3. relatedness to one or more of the desired variables (how closely does the data collected for a variable match the desired variable in terms of definition, format, scale)
4. completeness: missing data and how uniform the data are through the sample (are all the data coded and entered in the same manner such that they are suitable for analysis)

11.5.2 Accuracy

Likely to be able to be assessed only for a subset of data where data from more than one source are intended to be representing the same variable. If these requirements are met then a direct comparison can be performed to look for level of agreement.

11.5.3 Accessibility and clarity

Attempts to access historical data will involve contacts with various industry stakeholders. During this process information and data can be collected about the following:

1. Log of communication
2. Description of records that are kept by the organisation that are related to livestock export
3. What was involved in gaining approval for access to records? Was it a simple process completed in a single phone call or did it require more complex communications or meetings?
4. Contact person and contact details for individual responsible for providing access to records
5. Description of records that are made available to the project including
    a. location (address)
    b. centralised or not (number of repositories, coverage)
    c. type: paper vs electronic
    d. time period covered by historical record

e. time from agreement to provision of records
f. level of ease for access to records once approval had been granted

6. Metadata: what explanatory information is available about records including information about source, date collected, variable definitions, format, explanation of abbreviations, comments.

11.5.4 Comparability

1. Over time:
   a. comparisons of data within each organisation over different time periods
   b. does the organisation continue to collect data on the same variable(s) currently or have there been any changes in the way information is collected or the type of information?
2. Over domain:
   a. comparisons of data collected on the same (or similar) variables between different organisations.

11.5.5 Coherence

Can data from different sources be combined in a broader (perhaps national) database and be used to make inference about livestock exports? Incorporates information from several of the above measures.

It is noted that even where coherence is an issue (meaning that disparate data sources may not be able to be combined into a single analysis) there may still be value in analysing separately datasets from different sources.

11.6 Summary result

Much of the statistical quality framework outlined above is subjective in nature and will not result in quantitative measures of quality. It is anticipated that descriptive summary statements and discussion will be generated about dimensions of statistical quality for an historical dataset in relation to user needs or project objectives. In some cases assessment of feasibility, accessibility, application, usefulness etc may be conducted on a sample of historical data and used to make a decision about whether additional work is warranted to collect, compile and analyse a larger dataset from historical records.

11.7 References

1. Eurostat. Assessment of quality in statistics. *Fifth Meeting of Eurostat, Luxembourg.* 2002; http://www.unece.org/stats/documents/2000/11/metis/crp.2.e.pdf. Accessed 10 October 2010

2. Hofman P, Worsfold E. DESIRE - Development of a European Service for Information on Research and Education. 1997. *http://www.ukoln.ac.uk/metadata/desire/quality/quality.pdf*. Accessed 1 October 2010

3. Office for National Statistics (2007). Guidelines for measuring Statistical quality. *HMSO, London* 2007. http://www.statistics.gov.uk/STATBASE/Product.asp?vlnk=13578. Accessed 1 October 2010

4. Paiba G, Roberts S, Houston C, et al. UK Surveillance: combining datasets to provide quality assured surveillance measures. *Proceedings of the 11th International Symposium on Veterinary Epidemiology and Economics* 2006. Available at www.sciquest.org.nz:

5. UKGovTalk. e-Government Metadata Standard, Version 3.0. 2004. *http://www.esd.org.uk/standards/egms/* Accessed 1 October 2010

6. Veterinary Surveillance Division. Report on Third Meetings of the Business Assurance Groups (BAGs). 2004. *http://www.defra.gov.uk/foodfarm/farmanimal/diseases/vetsurveillance/documents/bag1204.pdf*. Accessed 1 October 2010