MEAT & LIVESTOCK AUSTRALIA

On farm

Expanded Use of Sugarcane By-products

For intensive beef cattle finishing

FLOT.101A
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FEEDLOTS

EXPANDED USE OF SUGARCANE BY-PRODUCTS FOR INTENSIVE BEEF CATTLE FEEDING – Phase 1

April 1997

Feedlot Consistency and Sustainability Key Program

FLOT.101

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SUMMARY

The Meat Research Corporation's three-year Feedlot Consistency & Sustainability Key Program, initiated three studies in response to an identified likely increase in the real cost of energy dense feedstuffs and the resultant effect on the long term prosperity of the Australian feedlot industry. Other studies examine alternative energy dense feedstuffs for the Australian cattle feedlot industry and the expanded use of high ME based silages. This study examines the expanded use of sugarcane by-products.

Australia has an expanding sugarcane industry located principally in coastal Queensland, but also in northern NSW and at the embryo stage in northern Western Australia. The principal by-product of interest is molasses. Lesser by-products are bagasse, and dunder – a by-product of the fermentation industries.

Molasses is recognised as a valuable and convenient source of metabolisable energy (ME) and minerals for much of the Australian intensive cattle feeding industries. The conventional ration inclusion rates are in the range 3% to 8%. These may occasionally be higher, particularly in starter rations when favourably costed. Some 670,000 tonnes, or 56% of Australian molasses production, was exported in 1996 at prices less than those achieved selling into the domestic market. The greatest exported surplus came from Queensland, in particular from the northern, Herbert-Burdekin and central regions.

Molasses has frequently been a competitively costed source of ME and nutrients for much of the Australian feedlot industry. However, it has been generally **under** utilised. Research and industry experience indicate molasses can be beneficially incorporated at higher inclusion rates in balanced production rations, at least higher than have been generally practised in Australia. When favourably costed, a 15% inclusion rate is feasible, and there are indications that rates of 25% or higher are possible and practical. At these higher inclusion rates molasses may assist significant sectors of the feedlot industry financially, aiding long term prosperity, and possibly underpinning an expanded industry.

Principal reasons for the relatively low inclusion rates in the Australian industry, other than when cost considerations exist, include the following:

- its impact on ration texture;
- the physical handling and feed distribution difficulties sometimes experienced at higher rates;
- the perception that current molasses inclusion rates are at their maximum; and occasionally,
- the belief that molasses as a nutrient source is associated with decreasing efficiency above current (practised) rates.

There is at present insufficient data on inclusion rate responses to assist local and overseas commercial feedlot operators develop the optimum molasses ration inclusion rates for a range of feedstuff costs and production scenarios. This is particularly so in the high (15% to 50%) range.

The Australian industry would benefit if the animal production response to a range of molasses inclusion rates were available and better understood. This would assist the cost/benefit decisions optimising molasses use in production rations.

It is suggested that the **primary** objective of research should be to define the animal production response to a range of molasses inclusion rates. Research should be conducted in the commercial feeding environment where its application can be most meaningfully evaluated. It should also address the issues related to molasses handling.

The **secondary** area for research would be a detailed examination of the factors influencing production and associated with its possible decline at the higher commercial inclusion rates defined above. This research should define and consider how these factors may be ameliorated.

Molasses, it is concluded, can contribute further to much of the **existing** established industry if greater knowledge of its value at higher inclusion rates than normally practised in Australia is available.

In addition, when coupled with crop by-products and/or purpose-grown crops, it may substantially underpin an **expanded** industry in northern Queensland and possibly northern Western Australia.

Bagasse, untreated, is virtually worthless as a feedstuff for the intensive feeding industry. Treated, it has low to medium energy values and may be a roughage source in high concentrate diets, where freight is minimal, and suitable alternatives are scarce.

Dunder has little direct application in the intensive feeding industries, but is apparently constructively used to enhance the handling capability of white cotton seed (WCS) which with an expanding cotton industry will be of increasing importance.

It is concluded the maximum return from a research investment will be in the area of molasses inclusion rates, and further knowledge of molasses as a commercial ruminant feedstuff. Research is not suggested to be warranted on aspects of bagasse or dunder.

Detailed assessments of the by-products are provided with research and development recommendations outlined.

1. INTRODUCTION

1.1 BACKGROUND

The Meat Research Corporation's three-year Feedlot Consistency and Sustainability Key Program is aimed at increasing the profitability of the Australian cattle feedlot industry and developing cost-effective solutions to food safety, animal welfare and environmental imperatives within this sector of industry.

The program has identified a likely increase in the real cost of energy dense feedstuffs. Currently feedgrains are the principal source of nutrient metabolisable energy (ME) and their (in)security of supply is seen as a core problem affecting the long-term prosperity of the Australian feedlot industry. The cost of energy dense feedstuffs in the medium to long term will be driven primarily by their global supply and demand.

It is possible the expanded use of existing feedstuffs or the identification of possible new feedstuffs could assist the industry. It has been postulated one such option for parts of the industry is to better utilise the existing energy dense by-products of the sugarcane industry.

There is already significant experience in the use of sugarcane by-products, particularly molasses, in cattle feeding programs, and considerable research has been conducted world-wide. In Australia molasses usage rates appear suboptimal in parts of the intensive cattle feeding industry. At the same time surplus product is exported to lower return markets. Greater use of sugarcane by-products may assist the industry to develop in predominantly non-grain producing areas, and facilitate specialised activities assisting live cattle export sales and value.

The Meat Research Corporation has initiated three studies. This one examines the expanded use of sugarcane by-products in the Australian intensive beef cattle feeding industries. The others examine alternative energy dense feedstuffs, and high ME based silages.

1.2 PROJECT DEFINITION AND OBJECTIVES

The study is defined as ... *"Phase 1 – A review of the present utilisation of sugarcane by-products for intensive cattle feeding in Australia (eg. feedlots, backgrounding, preshipping, preslaughter) and preliminary feasibility study of options for increased use of sugarcane by-products under the future higher feedgrain price scenario."*

The objective of Phase 1 is to review past research and commercial experience in the utilisation of sugarcane by-products for intensive cattle feeding in Australia and overseas, and on this basis:

- to determine if it would be feasible for the cattle feedlot industry and other intensive cattle feeders in Australia under a higher feedgrain price scenario, and given projected target markets and existing spatial distribution of established feedlots, to utilise more sugarcane by-product profitably;
- to identify any specific areas for R and D which may be required to facilitate the use of sugarcane by-product in the cattle feedlot industry.

2. AUSTRALIAN CATTLE FEEDLOT INDUSTRY

2.1 ESTABLISHED INDUSTRY

Initial interest in the feedlot fattening of cattle in Australia was stimulated in the early 1950s by observations of USA practice and experience with agro-industrial by-products and grains (Biscoe 1960, 1961; Mawson and Sutherland 1960; Howard 1961; Mawson and Arbuckle 1960).

By the early 1960s there was considerable interest and experience in the feedlot fattening of cattle in Australia, using a range of feedstuffs. In 1960 the Kalamina Estate, Ayr, trialed feedlot fattening cattle with rations including sugar industry by-products, grain, meals, urea and minerals (Burns and Edwards 1963).

The industry expanded in eastern Australia during the dry seasons of the mid 1960s and in 1970 Pryor (1970) estimated the turnoff from Queensland feedlots alone to be 10,000 to 20,000 head annually. The larger Australian professional feedlots began to be established in the early 1970s.

2.1.1 Size, Capacity and Utilisation of Feedlots

The current industry is principally based on grain for its nutrient energy and has capacity estimated at about 867,000 head (Table 2.1)

Table 2.1 Australian feedlot industry capacity

	NSW	VIC	QLD	SA	WA	Total
June 1996	292,485	68,050	428,284	40,732	31,500	**851,051**
September 1996	302,265	60,924	399,017	42,318	32,917	**837,461**
December 1996	304,404	58,523	401,454	41,001	30,178	**835,560**
March 1997	322,595	67,424	384,873	42,639	37,213	**854,744**
Est June 1997	336,688	66,866	384,362	42,761	36,513	**867,190**

Source: ALFA/AMLC

The breakdown of feedlot size by cattle holding capacity has been estimated as shown in Table 2.2.

Table 2.2 Breakdown of feedlot industry capacity by size

	Less than 500	500 - 1000	1000 - 10,000	Over 10,000	Total
June 1996	91,720	52,402	299,722	407,207	**851,051**
September 1996	85,987	68,183	281,744	401,547	**837,461**
December 1996	88,147	67,258	277,757	402,398	**835,560**
March 1997	84,236	74,542	288,966	407,000	**854,744**
Est June 1997	83,847	75,302	287,708	420,333	**867,190**

Source: ALFA/AMLC

In recent times there has been a decline in utilisation of feedlot capacity reflecting the state of market conditions, seasonal influences, and feedstuff costs (Table 2.3).

Table 2.3 Percentage utilisation of feedlot capacity 1995 to 1997

	NSW	VIC	QLD	SA	WA	Total
December 1995	56	59	59	65	32	56
March 1996	57	50	48	62	55	53
June 1996	45	54	39	26	42	42
September 1996	39	25	46	10	21	39
December 1996	50	23	46	13	32	44
March 1997	52	44	50	74	52	51
Est June 1997	50	68	52	63	48	53

Source: ALFA/AMLC

Feedlot capacity utilisation by size of feedlot has been estimated as shown in Table 2.4.

Table 2.4 Percentage utilisation of feedlot capacity by size

	Less than 500	500 - 1000	1000 - 10,000	Over 10,000	Total
June 1996	14	30	35	55	42
September 1996	19	26	29	53	39
December 1996	25	32	31	59	44
March 1997	34	38	51	58	51
Est June 1997	29	42	53	59	53

Source: ALFA/AMLC

The distribution of feedlots with capacity less than 5000 head, and greater than 5000 head and export beef plants is illustrated in Diagrams 2.1 and 2.2.

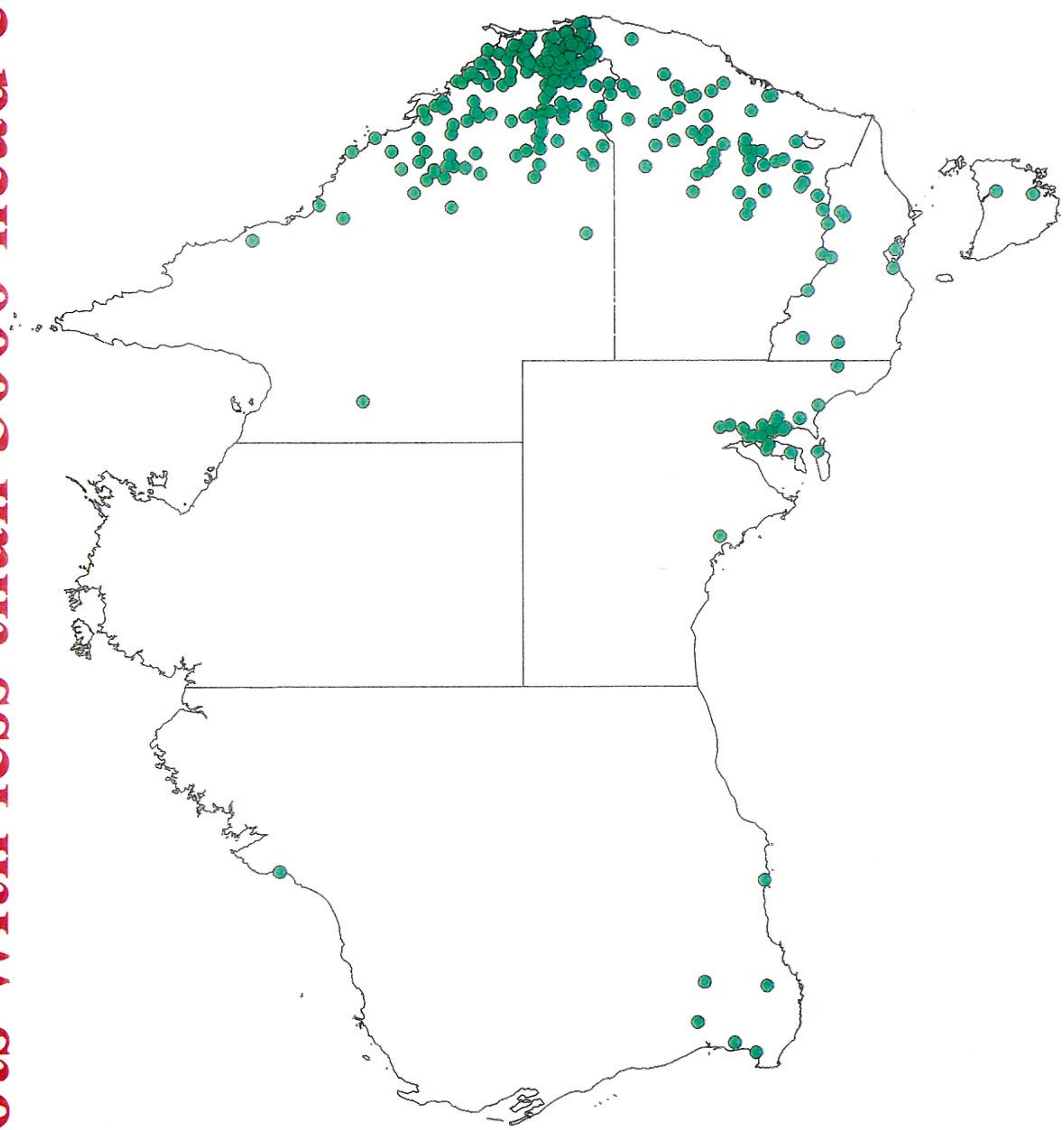
Feedlot capacity has expanded significantly in the period since 1990, with, until recently, market demand ensuring reasonably high capacity-utilisation. In 1994 the utilisation was estimated at 73% (MRC 1995). In March 1997 it was 51%, having recovered from a low of 39% in September 1996.

Diagram 2.1

Feedlots with less than 5000 head capacity

Source: MRC 1996

Feedlots with less than 5000 head capacity

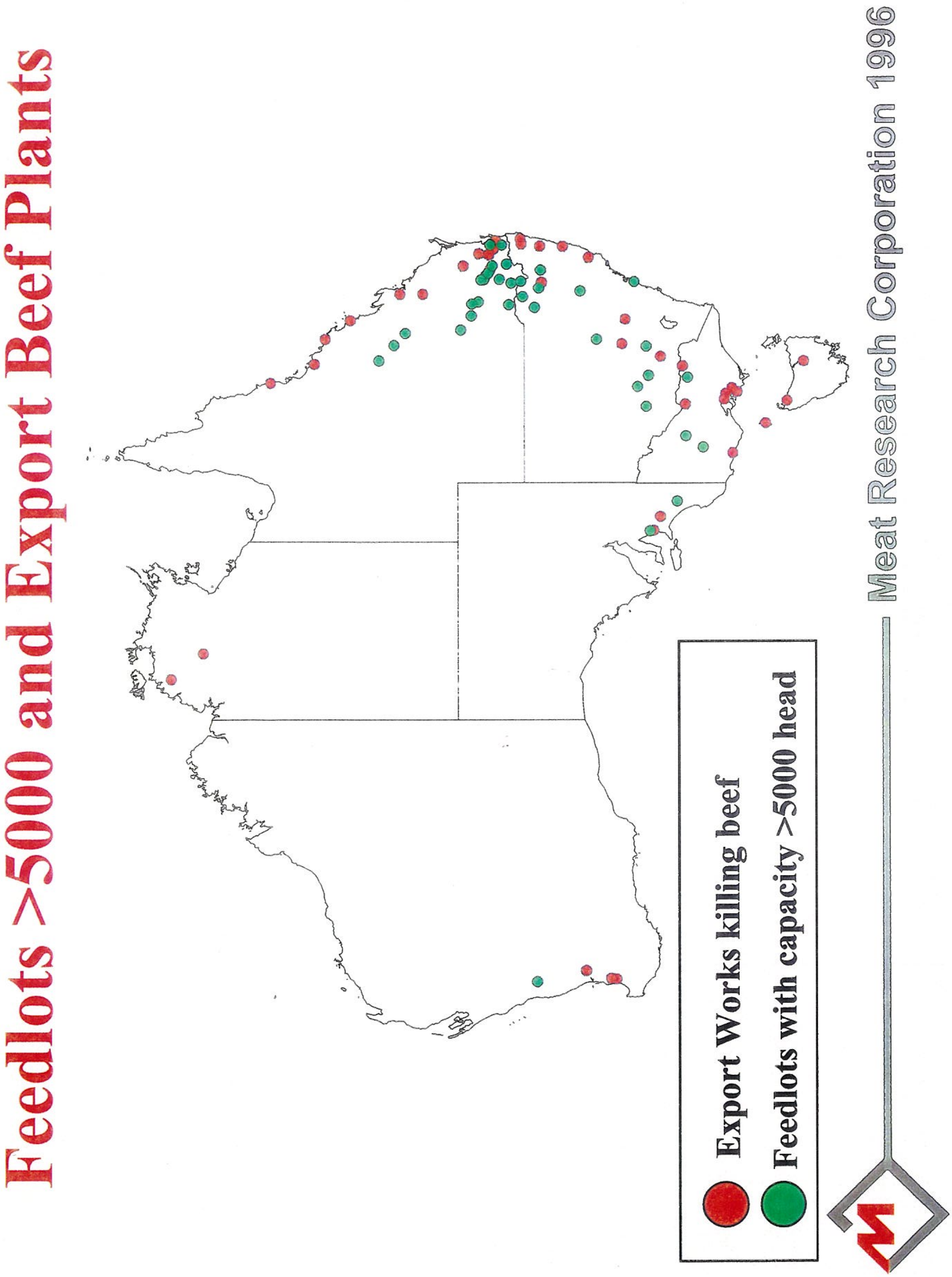


Meat Research Corporation 1996

Diagram 2.2

Feedlots with greater than 5000 head capacity and export beef plants

Source: MRC 1996



2.1.2 Feedstuff Consumption

The feedlot industry feedstuff consumption was estimated in 1994 as shown in Table 2.5.

Table 2.5 Consumption of feedstuff by the Australian feedlot industry in 1992-93 and 1993-94

	1992-93		1993-94	
	'000 tonnes	%	'000 tonnes	%
Sorghum	265	18.0	205	10.0
Barley	523	35.0	782	37.0
Wheat	181	12.0	376	18.0
Other Grains	63	4.2	61	3.0
Molasses	57	3.8	86	4.0
Other Concentrates	104	7.0	134	6.0
Cotton Seed Hulls	73	5.0	50	2.0
Other Roughage	236	16.0	419	20.0
TOTAL	1,503	100.0	2,173	100.0

Source: ALFA/AMLC

Grains, the principal source of ME, represented 69% and 68% of feedstuffs consumed in the above observed periods. Molasses represented 3.8% and 4.0% respectively. Meyers Strategy Group (1995) determined that feedstuff costs represented 88% of total feedlot production costs, and that grain comprised some 80% of feedstuff costs. Thus grain costs, normally representing some 65% to 70% of total feedlot production costs, have a significant impact on the overall cost of production and profitability in the Australian feedlot industry.

Meyers Strategy Group (1995) estimated the feedlot industry in 1992-93 accounted for 23% (1,672,000 tonnes) of domestically consumed feedgrains in Australia. In 1994 it was assessed (MRC 1995) the feedlot industry required 1,506,000 tonnes of feedgrains annually, representing 28% of the estimated 5,453,000 tonnes then used by all Australian domestic livestock industries. The development of the feedlot industry and increased use of feedgrains in the dairying industry (expanded to 1,175,000 tonnes annually) had doubled the domestic demand for feedgrains over the previous ten years to 1994.

2.2 DEVELOPMENTS

There are future developments forecast for three possible intensive cattle feeding situations in Australia:

- the existing and established feedlot industry;
- a future expanded feedlot industry;
- an intensive live cattle export support feeding industry.

The **Existing and Established Feedlot Industry** produces a quality product for the export and domestic market. It relies largely on grain as the principal ME source and is located with appropriate slaughter, processing and packaging infrastructure nearby (Refer 2.1).

The industry is expected to recover from its current depressed state of activity and to increase production above 1994 levels to the year 2000 and beyond. Projected total Australian beef production increases range between 11% (pessimistic) and 18% (optimistic) with exports increasing between 14% and 29% respectively (MRC 1995). A disproportionately greater amount of this increase will be from the feedlot industry, which will experience continued competition from US exporters in established Australian grainfed beef markets.

A **Future Expanded Feedlot Industry** would produce an improved quality meat product for export and domestic markets. A changing export market emphasis away from manufacturing beef will in time conceivably encourage the development of a feedlot industry in northern Australia, supplying the expanding broad Asian markets with a superior product to that currently possible off northern grasslands.

This industry will be dependent on identifying suitable feedstuffs at commercially viable costs. Located beyond where conventional grain sources are available it would be largely based on yet to be established purpose-grown crops, agro-industrial by-products, imported feedstuffs, or combinations of these.

An **Intensive Live Cattle Export Support Feeding Industry** in northern Australia would depot, hold, process, precondition, and grow out cattle to meet market weight specifications.

The recent phenomenal growth in the northern Australian live cattle export trade involves principally feeder cattle destined for the expanding feedlot industries in South East Asia. In excess of 500,000 head, which was over 70% of Australia's live cattle exports, were loaded out of northern Australian ports in 1996. Most stock originate from the Northern Territory and are shipped via Darwin, with increasing numbers moving from northern Western Australia and Queensland, including east coast seaports (Table 2.6).

Table 2.6 Live cattle exports from Australia in 1996

Load Port	Total Cattle Exports
Adelaide	29,273
Brisbane	14,391
Broome	24,072
Cairns	4,930
Devonport	3,569
Darwin	384,045
Fremantle	52,944
Geraldton	29,215
Karumba	55,295
Melbourne	474
Portland	7,356
Perth	20
Port Hedland	13,481
Sydney	4,449
Townsville	765
Wyndham	38,033
TOTAL	723,085

Source: ALFA/AMLC

As the Asian feedlot industry becomes more sophisticated it is expected to place greater emphasis on size, quality and condition of stock on arrival. Animal health, and the reliability, suitability and consistency of supply will increasingly be price determinants.

Conceivably a specialised support feeding industry will develop in northern Australia to hold, grow out and prepare cattle for live export shipments, provided suitable feedstuffs are available at commercially acceptable costs.

Such a support feeding sector could be less capital intensive than the established feedlot industry, involving feeding stock for a range of feeding periods to better meet the live cattle market requirements. The feeding regimes will however remain dependent on relatively high energy feedstuffs sourced locally, and currently not readily available. This study addresses this need and highlights the scope for sugarcane by-products to provide part of these ration requirements.

3. AUSTRALIAN SUGARCANE INDUSTRY

3.1 ESTABLISHED INDUSTRY

The sugarcane industry is the source of Australia's second largest export crop. Sugar is Queensland's second largest rural commodity. Queensland produced 95% of Australia's raw sugar in 1994 with the rest produced in northern NSW. Western Australia commenced raw sugar production on a small scale in the 1995 season.

In 1994-95 Australia was the world's largest exporter of raw sugar, exporting approximately 80% of its total raw sugar production. Australia produces 4.4% of world sugar and exports 14.4% of total global free sugar trade (Queensland Sugar Corporation, 1996a).

In 1996 there was a 5.4% expansion in the land assigned to sugarcane in Queensland or an increase of 25,306 ha to 483,778 ha at end of June 1996. The expansion was greatest in north Queensland with 4,090 ha granted in the Victoria mill area. The Queensland industry has expanded 35% during the period 1989-1996. The 1997 expansion is expected to be of similar size to 1996, with the possibility of a new mill on the Atherton Tablelands (Queensland Sugar Corporation, 1996b).

There are 29 raw sugar mills sited amidst the farms supplying them with sugarcane (Queensland 25; NSW 3; WA 1). Queensland and NSW mills crushed some 35,000,000 tonnes of sugarcane in 1994, approximately 37,400,000 tonnes in 1995, and 39,560,000 tonnes in 1996. The new Ord mill in Western Australia crushed an estimated 500,000 tonnes in 1996.

3.2 LOCATION OF SUGARCANE INDUSTRY

Most of Australia's sugarcane lands are situated within 50 kilometres of the coastline. The location of the Queensland and NSW mills is illustrated in Diagram 3.1, and their production in Table 3.1.

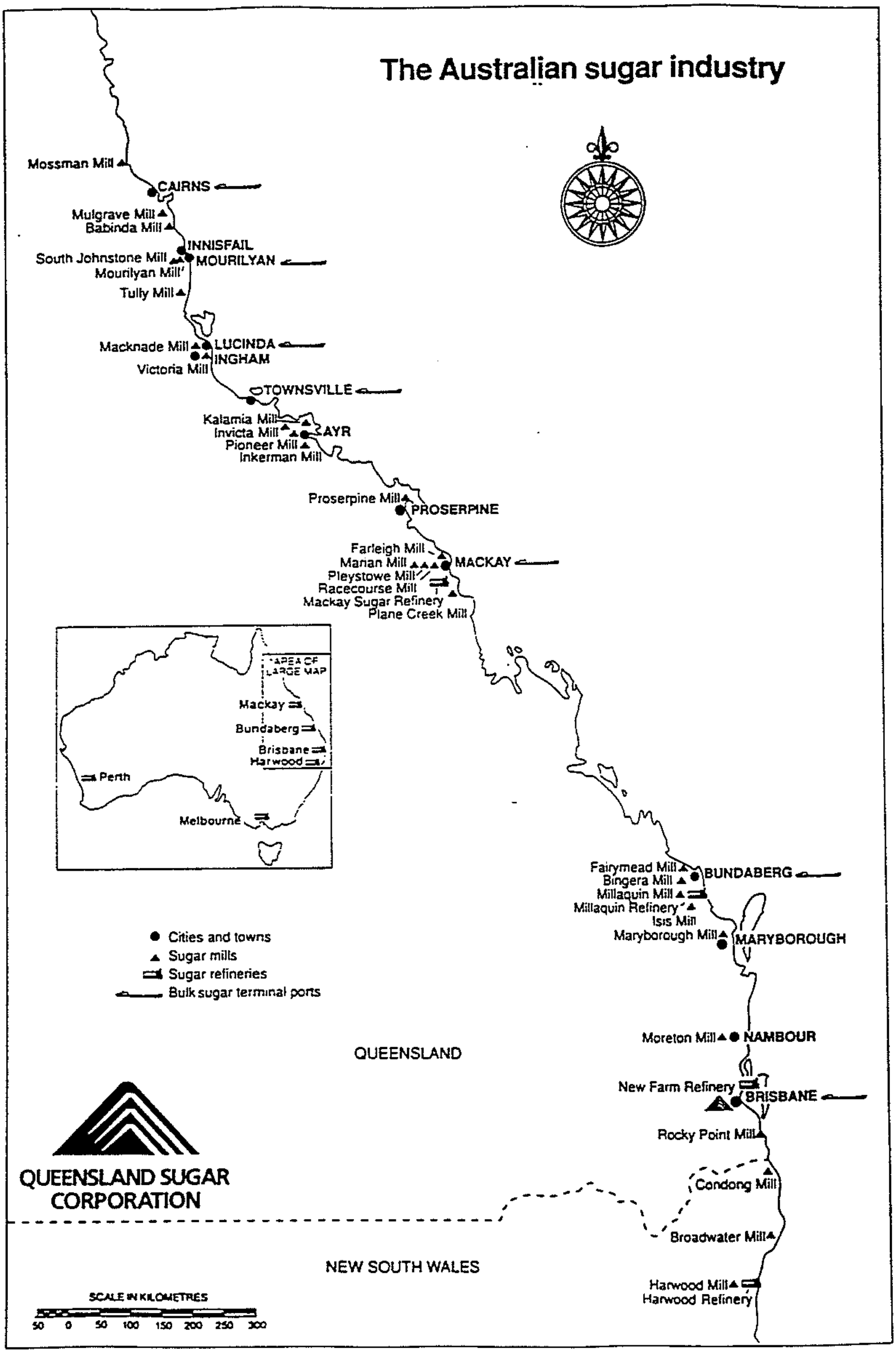

The Australian sugar industry
Mossman Mill
CAIRNS
Mulgrave Mill
Babinda Mill
INNISFAIL
South Johnstone Mill
MOURILYAN
Mourilyan Mill
Tully Mill
Macknade Mill
LUCINDA
INGHAM
Victoria Mill
TOWNSVILLE
Kalamia Mill
Invicta Mill
AYR
Pioneer Mill
Inkerman Mill
Proserpine Mill
PROSERPINE
Farleigh Mill
Marian Mill
MACKAY
Pleystowe Mill
Racecourse Mill
Mackay Sugar Refinery
Plane Creek Mill
AREA OF LARGE MAP
Mackay
Bundaberg
Brisbane
Harwood
Perth
Melbourne
Fairymead Mill
BUNDABERG
Bingera Mill
Millaquin Mill
Millaquin Refinery
Isis Mill
Maryborough Mill
MARYBOROUGH
Cities and towns
Sugar mills
Sugar refineries
Bulk sugar terminal ports
QUEENSLAND
Moreton Mill
NAMBOUR
New Farm Refinery
BRISBANE
Rocky Point Mill
Condong Mill
Broadwater Mill
QUEENSLAND SUGAR CORPORATION
NEW SOUTH WALES
Harwood Mill
Harwood Refinery
SCALE IN KILOMETRES
50 0 50 100 150 200 250 300

Table 3.1 Cane crushed and raw sugar produced by mill area *

Mill Area	1994 Season		1995 Season	
	Cane Crushed (tonnes)	Raw Sugar Produced (tonnes actual)	Cane Crushed (tonnes)	Raw Sugar Produced (tonnes actual)
QLD				
Mossman	976,520	129,150		
Mulgrave	1,428,361	180,455		
Babinda	848,575	98,474		
Mourilyan	847,785	103,420		
South Johnstone	1,004,195	123,489		
Tully	1,365,668	170,467		
Northern	6,471,104	805,455	7,388,363	873,831
Macknade	1,189,100	177,538		
Victoria	2,698,896	380,789		
Invicta	1,813,455	234,753		
Pioneer	1,817,902	289,124		
Kalamia	1,387,260	237,280		
Inkerman	1,714,585	277,158		
Herbert-Burdekin	10,621,198	1,596,642	12,338,266	1,726,794
Proserpine	1,545,732	232,192		
Farleigh	1,594,384	222,323		
Racecourse	1,695,919	234,127		
Pleystowe	1,627,942	241,735		
Marian	2,019,365	315,320		
Plane Creek	1,489,069	215,561		
Central	9,972,411	1,461,258	10,117,600	1,382,268
Fairymead	1,179,253	172,567		
Millaquin	894,933	134,510		
Bigera	1,059,213	150,371		
Isis	1,014,347	147,012		
Maryborough	650,308	87,374		
Moreton	557,904	71,257		
Rocky Point	425,946	53,490		
Southern	5,781,904	816,581	5,433,932	762,450
QLD TOTAL	32,846,617	4,679,936	35,278,161	4,745,343
NSW				
Condong		70,417		
Broadwater		97,697		
Harwood		79,985		
NSW TOTAL		248,099	2,094,541	244,629
TOTAL		**4,928,035**	**37,372,702**	**4,989,972**

* Excludes Western Australia Ord mill.

Note: Production excludes small tonnages retained by some mills for sale to local growers and mill workers.

Source: Queensland Sugar Corporation; Australian Sugar Milling Council; NSW Sugar Milling Co-operative

3.3 LOCATION RELATIVE TO INTENSIVE BEEF CATTLE FEEDING INDUSTRIES

Diagrams 3.2 and 3.3 illustrate the distribution of the established feedlot industry and identify the spread of feedlots and their size (greater than and less than 5000 head), in relation to the sugarcane mills, and diagram 3.4 the distribution of beef cattle in Australia.

3.4 SUGARCANE BY-PRODUCTS

The crushing of sugarcane takes place over a period of around five months with harvesting and processing usually commencing in late June and ending in December. There are two methods most commonly used for harvesting.

- Green cane harvesting involves cutting the cane green, and allowing the leafy tops of the cane stalks to fall to ground to act as a protective trash blanket. This practice is being increasingly applied with some 40% of the overall Australian crop, including 98% of the Herbert River crop is harvested in this manner.
- Burnt cane harvesting involves burning the sugarcane prior to harvest.

By-products of the sugarcane industry production process are: molasses, bagasse, dunder, cane tops, ash and filter mud.

Molasses is the dark syrup separated from the raw sugar crystals during the milling process.

Bagasse is the expended cane fibre remaining after the juice has been extracted from sugarcane.

Dunder is a secondary by-product produced from fermented molasses in the production of ethanol and rum.

Cane tops are the leafy tops left as a trash blanket following green cane harvesting, where it reduces soil erosion, preserves sound agronomic practice and assists in cost saving for much of the farming industry.

Ash and filter mud comprise the boiler ash 'scrubbed' from the mill stacks, and the residue left after the sugarcane juice has been clarified. Both are used as soil conditioners on cane farms and gardens, and have little use in the intensive cattle feeding industries.

Molasses, bagasse and dunder are the sugarcane by-products reviewed for expanded use in the intensive beef cattle industries.

Diagram 3.2

Feedlots with less than 5000 head capacity in relation to sugarcane mills

Source: MRC 1997

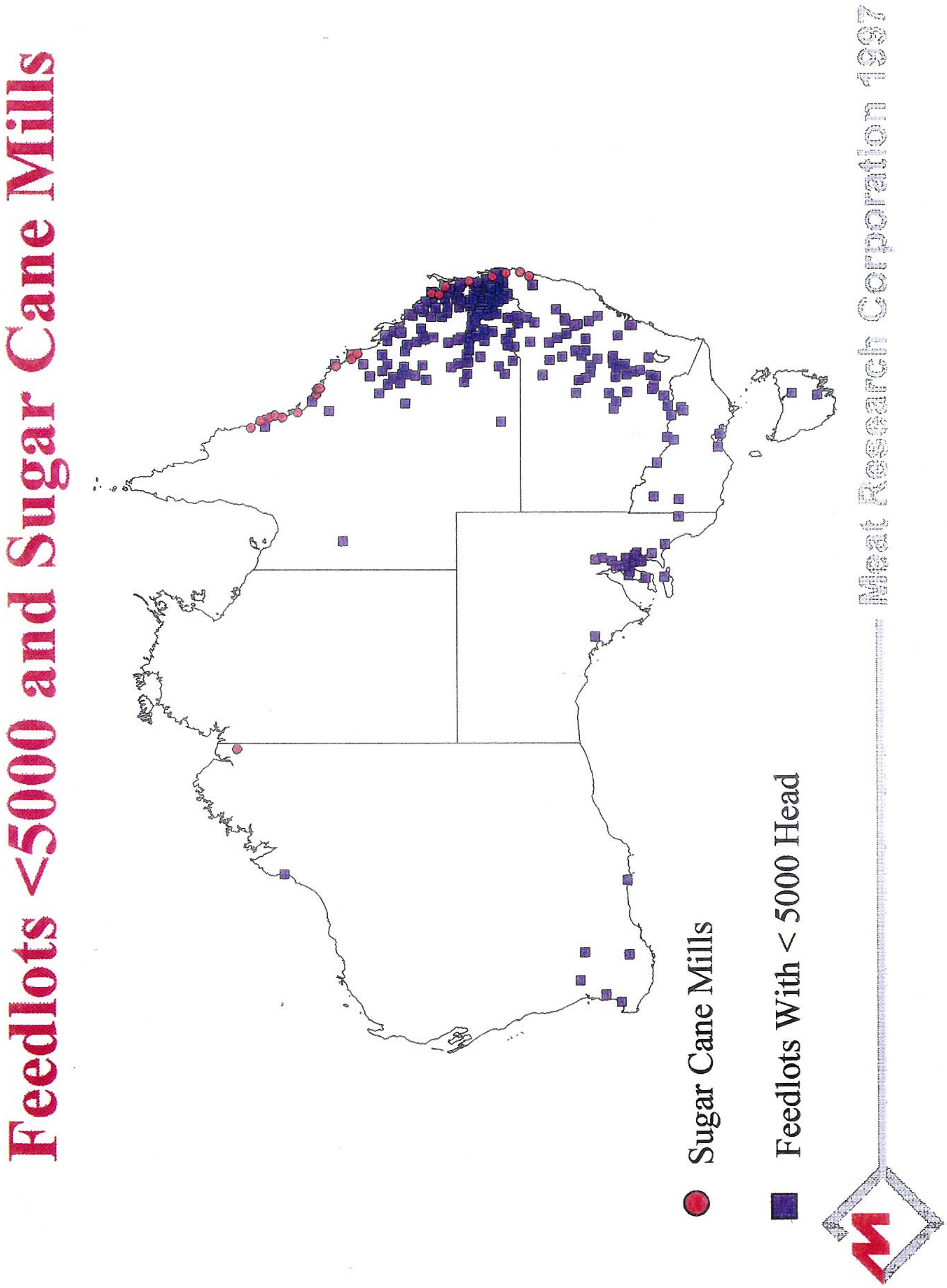


Diagram 3.3

Feedlots with greater than 5000 head capacity in relation to sugarcane mills

Source: MRC 1997

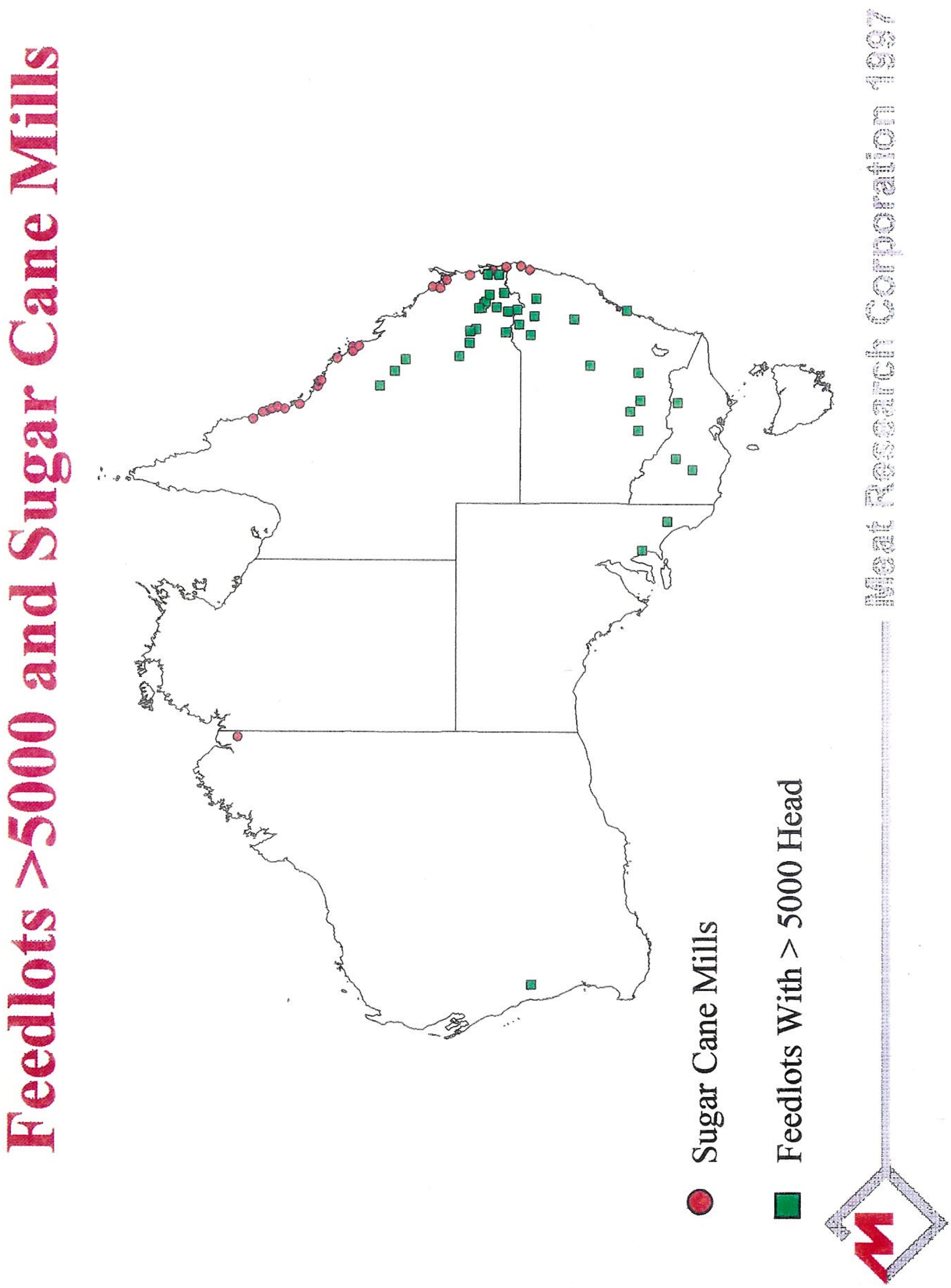
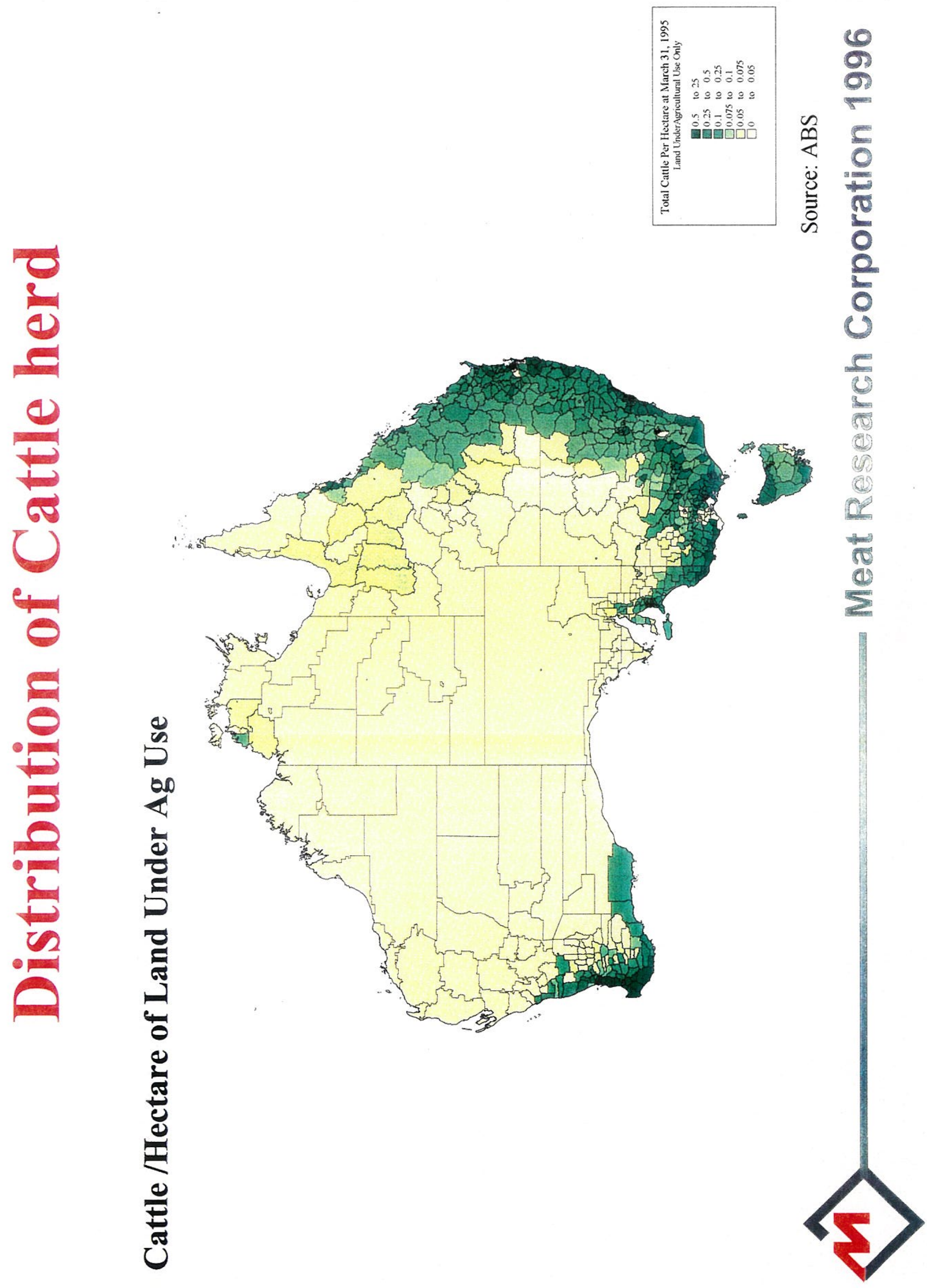


Diagram 3.4

The distribution of beef cattle in Australia



3.4.1 Molasses

Australian cane blackstrap molasses is used as a raw material in the fermentation (ethyl alcohol, rum, yeast, lysine and monosodium glutamate) and stock feed industries supplying the domestic and export markets. Table 3.2 indicates production and export figures.

Table 3.2 Molasses production and export statistics

Season	Industry Production (tonnes)	Bulk Export (tonnes)	Exports / Total Production (%)
1989	743,400	428,200	57.6
1990	697,300	269,500	38.6
1991	626,700	121,900	19.5
1992	860,700	371,700	43.2
1993	910,000	277,800	30.5
1994	1,048,000 [2]	434,594	41.5
1995	1,100,000 [2]	515,000	46.8
1996	1,200,000 [2,3]	670,000 [1]	55.8

[1] Estimate
[2] Approximate
[3] Excludes Western Australia Ord mill, 15,000 tonne estimate

Source: Australian Molasses Trading Pty Ltd

A survey of individual mills conducted in the course of this study (December 1996) has estimated the production of molasses by region for the 1996 season (Table 3.3). For several mills not responding, a conversion factor common to the mills in their region was applied to their total cane crushed to complete the assessment.

Table 3.3 Estimated molasses production and exports 1996 season

Mill Area	Industry Production (tonnes)	Exports/Total Production (%)
Queensland		
Northern	207,000	94
Herbert-Burdekin	371,100	94
Central	351,900	28
Southern	190,000	7
Total Queensland	1,120,000	59
Total NSW	80,000	nil
Total WA	15,000	93 (includes to Perth)

Source: Individual mill survey, 1996
Australian Molasses Trading Pty Ltd

The WA sugar mill is capable of doubling throughput and hence molasses production. However an expansion of this industry is currently dependent on the outcome of land title claims. Substantial uncertainty exists.

The 1996 survey of mills highlighted the strong divergence in the destination for molasses between areas. In NSW and southern Queensland, molasses is almost solely marketed on to the domestic market, to the cattle feedlot, pastoral and dairy industries, and for yeast manufacture and for alcohol distillery usage. In northern Queensland and the Ord almost all molasses is exported, with the intermediate Queensland regions also exporting significant proportions.

Exported molasses can, over time, be redirected to the domestic market. Molasses sold into the domestic market in 1996 generally achieved a greater return to the mill than that exported. The 1996 survey of mills indicated domestic sales were in the low $60s/tonne in northern Queensland mills, increasing to the low to mid $70s/tonne in central Queensland, and low $80s/tonne in southern Queensland and NSW. Discounting is prevalent to some clients, so that prices are as low as $50/tonne in southern Queensland. Cartage rates for molasses in bulk tanker loads are quoted by several contractors in the range of $0.08 to $0.10/tonne/km.

Molasses storage capacity is less than production in some areas, creating a seasonality in availability unless advance purchase arrangements are made.

There are seasonal and regional source variances in the quality and composition of molasses. The range of quality specifications achieved are described (Australian Molasses Trading Pty Ltd, personal communications) as:

Degrees Brix [1]	85.0° - 86.5°
Total Sugars as Invert	48.0% - 52.0%

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1 Brix A term commonly used to indicate the sugar (sucrose) content of molasses. It is expresed in degrees and was originally used to indicate the percentage by weight of sugar in sucrose solutions, with each degree Brix being equal to 1% sucrose (Ensminger et al 1990).

The characteristic composition of Queensland molasses is presented in Table 3.4 (Wythes et al 1978), together with National Research Council (1996) values for comparison.

Table 3.4 Composition of Queensland molasses (DM basis) compared to National Research Council (1996)

Nutrient		Nutrient Value	
		Queensland Value [1]	National Research Council 1996
Dry Matter [2]	%	76.4 (72.2 - 79.7)	74.3
Ash [2]	%	13.6 (10.1 - 16.7)	13.3
Sucrose	%	45.8 (40.0 - 51.5)	-
Reducing Sugars	%	19.5 (11.6 - 26.5)	-
Calcium	%	1.2 (0.94 - 1.53)	1.00
Chlorine	%	3.0 (1.73 - 5.18)	-
Magnesium	%	0.6 (0.21 - 0.99)	0.42
Nitrogen	%	0.9 (0.69 - 1.19)	0.93
Phosphorus	%	0.1 (0.05 - 0.10)	0.10
Potassium	%	5.2 (3.52 - 6.76)	4.01
Sodium	%	0.1 (0.03 - 0.22)	0.22
Sulphur	%	0.7 (0.40 - 1.44) -	0.47
Cobalt	ppm	2.7 [3]	-
Copper	ppm	10.7 (4.3 - 17.0)	65.7 1.59
Iodine	ppm	<6.5	2.1
Iron	ppm	247.0 (154 - 401)	263.0
Manganese	ppm	82.4 (26.9 - 179.5)	59.0
Molybdenum	ppm	-	1.59
Zinc	ppm	11.6 (7.5 - 21.7)	21.0

[1] Mean and (range), based on 30 mill values
[2] Value as percentage of fresh molasses
[3] Mid season sampling only

Source: Wythes et al (1978; National Research Council (1996)

The composition of Queensland molasses is similar to that described by the National Research Council (1996) with some variation in mineral content. The ME of Australian molasses has been typically assessed as 11.0MJ/kg (there are higher estimates) in comparison with the National Research Council value of 10.9MJ/kg. The general literature records the assessed ME of molasses from a number of sources in the range 10.9 to 12.7MJ/kg. In the USA molasses is standardised to about 77° Degrees Brix.

Regional composition differences recorded by Wythes et al (1978) are presented in Table 3.5.

Table 3.5 Regional composition of Queensland molasses (DM basis)

Nutrient		Nutrient Value				Average LSD [1]
		Northern	Burdekin	Central	Southern	
Dry Matter	% [2]	77.1a [3]	75.6a	77.0a	75.8a	2.1
Ash	% [2]	12.1b	14.4a	12.7b	15.3a	1.4
Sucrose	%	43.6a	46.0a	46.3a	47.4a	3.4
Reducing Sugars	%	22.8a	21.2ab	19.4b	14.4c	2.8
Calcium	%	1.24a	1.18a	1.07a	1.12a	0.16
Chlorine	%	2.07c	2.66b	3.15b	4.04a	0.45
Magnesium	%	0.39c	0.64b	0.60b	0.79a	0.13
Nitrogen	%	0.98a	0.95ab	0.84b	0.83b	0.11
Phosphorus	%	0.07ab	0.08a	0.06b	0.08a	0.01
Potassium	%	4.65b	5.35ab	4.95b	5.82a	0.66
Sodium	%	0.05b	0.12a	0.11a	0.13a	0.05
Sulphur	%	0.50b	0.89a	0.53b	0.99a	0.14
Copper	ppm	11.7a	9.6a	8.9a	11.9a	3.0
Iron	ppm	329.0a	235.0b	195.0b	229.0b	54.0
Manganese	ppm	148.0a	38.0c	63.0bc	81.0b	25.0
Zinc	ppm	14.1a	9.7b	9.2b	13.6a	3.5

[1] LSD (P = 0.05) average is given; exact value used for significant difference testing.
[2] Values as percentage of fresh molasses.
[3] Means in the same row followed by the same letter do not differ significantly at $P < 0.05$.
Source: Wythes et al (1978)

An extensive QA program involving molasses analysis has not identified any residues of potential concern to the beef industry (Crimmins, personal communications).

3.4.2 Bagasse

Bagasse is a highly fibrous residue, which is mostly used as fuel in low efficiency boilers, providing almost all the fuel required to power the sugar mills. It also currently provides approximately 20 megawatts of power to the Queensland electricity grid. This will be further increased upon the completion of an expanded generating unit at the Invicta mill. Bagasse is also used in the manufacture of paper and as a garden mulch. An estimated 12,800,000 tonnes of Australian bagasse would have been produced in 1996.

It is estimated, following the 1996 mill survey, there may be some 100,000 tonnes of surplus bagasse annually, a figure which could change with more efficient boiler usage if warranted. This contrasts with Tudor and Inkerman (1989) who estimated about 5% to 10% of the bagasse produced is excess to requirements, and is either burnt or dumped (ie. 640,000 to 1,280,000 tonnes in 1996) annually.

Typically, the average composition of bagasse is presented in Table 3.6 (Tudor and Inkerman, 1989).

Table 3.6 Composition of bagasse (DM Basis)

Nutrient		Nutrient Value
Dry matter	%	50
Ash	%	2-4
Cellulose	%	41
Hemicellulose	%	31
Lignin	%	20-22
Sugars	%	2-4
Crude protein	%	1-2

Source: Tudor and Inkerman (1989)

The in vitro DM digestibility approximates 30%, and ME values have been assessed to be 3MJ/kg DM.

3.4.3 Dunder

Dunder, or bio-dunder is a waste product of the fermentation process. It is available from ethanol production units at Sarina and Rocky Point, and rum distilleries at Bundaberg and Beenleigh.

The quantities produced annually are:

Sarina	300,000 tonnes
Bundaberg	35-55,000 tonnes
Rocky Point	25-30,000 tonnes
Beenleigh	3,500 tonnes

A typical analysis of the product from each source is indicated in Table 3.7.

Table 3.7 Composition of Queensland dunder (DM Basis)

Nutrient		Nutrient Value			
		Sarina	Bundaberg	Rocky Point	Beenleigh
Dry matter	%	35.0	10.4	14.0	16.7
Ash	%	27.3	30.8	-	-
Fat	%	1.0	0.1	-	-
Carbohydrates	%	57.4	-	-	-
Crude Protein	%	13.4	12.5	8.0	14.2
Calcium	%	2.4	0.2	1.5	1.6
Magnesium	%	1.5	0.2	1.0	1.1
Phosphorus	%	0.2	0.0	0.1	0.1
Potassium	%	9.6	9.2	10.6	11.2
Sulphur	%	1.0	1.0	1.5	1.6

Source: Personal communications with each location

On-site variations occur.

Dunder is most commonly used as a fertiliser recycled to sugarcane growing areas. There may in the future be environmental issues making this practice increasingly difficult in some localities. Small amounts, estimated at 1% to 5%, are used as components of cattle feeding regimes.

Dunder, when available, is at nominal cost from Bundaberg, Rocky Point and Beenleigh. The higher DM Sarina product costs $9.13/tonne ex mill, bulk. Dunder from Sarina is estimated to have an ME of 8.0 to 9.0MJ/kg DM (Usher, Hunter, personal communications).

4. NUTRITIONAL PROPERTIES OF SUGARCANE BY-PRODUCTS

4.1 INTRODUCTION

The nutritional properties of molasses, bagasse and dunder are examined in relation to their relevance to the Australian intensive beef cattle feeding industries. Their composition has been previously described.

4.2 MOLASSES

Typically, Australian molasses is 76.5% DM, has an ME value of 11.0MJ/kg, crude protein of 5.0% and mineral composition as illustrated in Tables 3.4 and 3.5. Sugars contribute approximately 65% of the solids of which sucrose accounts for some 70% (Wythes et al 1978; Kumble et al 1996). Seasonal and regional source variations occur.

Molasses is attractive to most livestock promoting appetite by its flavour and smell, which can mask unpalatable feed elements. In addition, its physical properties enable it to improve ration composition by minimising fines, dustiness, and ingredient separation.

Molasses is a valuable and convenient feedstuff source of ME and potassium for much of the Australian intensive cattle feeding industries. It is also commonly the basis of commercial liquid supplements carrying micro components for balanced rations.

The use of molasses by the intensive cattle feeding industries depends on availability and relative cost compared with the alternative feedstuffs available. The cost of molasses ME at various molasses costs is illustrated in Table 4.1. These costs are related to the costs of a range of alternative feedstuffs in Table 4.2.

Table 4.1 Cost of ME ($/100MJ) sourced from molasses at various costs

Molasses ($/tonne)	DM (%)	Molasses DM Basis ($/tonne)	ME * ($/100MJ)
60.00	76.5	78.43	0.71
75.00	76.5	98.04	0.89
90.00	76.5	117.65	1.07
105.00	76.5	137.25	1.25
120.00	76.5	156.86	1.43
135.00	76.5	176.47	1.60
150.00	76.5	196.08	1.78

* Note: ME value 11.0MJ/kg assumed.

Table 4.2 Breakeven feedstuff costs for ME when molasses costs $60, $90, $120 and $150 /tonne As Is

FEEDSTUFF		Metabolisable Energy (indicative DM Basis)		Dry Matter	*When the cost of molasses is ...* ($/tonne As Is)			
					$60	$90	$120	$150
		Range	Assessed		*the cost of ME is ...*			
Name	Description	(MJ/kg)	(MJ/kg)	%	$0.71/100MJ	$1.07/100MJ	$1.43/100MJ	$1.78/100MJ
					and the breakeven feedstuff cost supplying ME at the same cost is ... ($/tonne As Is)			
BARLEY	Grain	12.7-13.7	13.0	88.0	82	122	163	204
FATS & OILS		34.0 - 37.0	35.5	99.0	251	376	501	626
LUCERNE	Hay-Spring	8.5 - 10.0	9.2	90.0	59	89	118	148
	Hay-Winter	7.2 - 8.4	7.8	90.0	50	75	100	125
MAIZE	Grain	13.5-14.2	13.7	88.0	86	129	172	215
	Silage	9.2-11.3	10.3	37.0	27	41	54	68
MOLASSES		10.9 - 12.7	11.0	76.5	**60**	**90**	**120**	**150**
SORGHUM	Grain	11.0-13.4	12.0	88.0	75	113	151	188
WHEAT	Grain	13.0-14.0	13.3	88.0	83	125	167	209
WHITE COTTON SEED		14.2-14.8	14.5	92.0	95	143	190	238

Transport is a significant factor in determining the overall on-site molasses cost for much of the established feedlot industry. Molasses has however the advantage of requiring very little further processing, as is the case for many of the competing feedstuffs. Table 4.2 illustrates that molasses at $90/tonne in the ration, equates to (processed) barley at $122/tonne in the ration as a source of ME, and provides a cost advantage when barley exceeds $122/tonne or WCS exceeds $143. Similarly, when molasses is costed at $120/tonne, it provides a cheaper source of ME than (processed) barley above $163/tonne or WCS above $190/tonne. A full appreciation of the feedstuff nutrient profile and cost will determine the most cost effective inclusion rate in a well formulated ration, acknowledging the animal performance expected.

Anecdotal evidence and enquiry indicate that molasses is commonly included in Australian feedlot finishing rations at 3% to 8% (as fed), with occasional instances to 15% and to 20% in starter rations. The feedlot industry survey of 1992-93 and 1993-94 conducted when the majority of feedlot capacity was in northern NSW and southern Queensland, indicated an approximate 4.0% inclusion rate overall in feedlot rations (Table 2.5). In California, typical inclusion rates are 12% to 15% with 12% being a standard minimal usage overall (Geary, personal communications).

Molasses inclusion rates in balanced feedlot rations can be categorised as:

Conventional	0% - 15%	As fed
High	16% - 50%	As fed
Extremely High	51% +	As fed

4.2.1 Conventional Inclusion Rate

There is a great deal of industry experience and evidence supporting the **conventional (0%-15%)** ration inclusion rates (Pate 1983; Ensminger et al 1990).

The majority of feeding data suggests the feeding value of molasses does not decline when added at conventional (0%-15%) levels. Pate (1983) in review concludes the addition of up to 10% molasses to concentrate fattening diets has a stimulating effect on animal performance, improving feed intake, rate of gain and/or feed utilisation. Preston (1987) concludes that with molasses at inclusion rates less than (approximately) 20% DM, the soluble carbohydrates in molasses tend to be complementary rather than competitive with little or no depression in the degree to which the basal feed resource is fermented. Beyond 20% DM however, there appears increasing competition for substrate by rumen micro organisms with the result that the basal diet is used less and less, as the proportion of molasses increases.

It is concluded, molasses is an acknowledged and valuable feedstuff widely used internationally at conventional inclusion rates to 15% of feedlot production diets.

4.2.2 High Inclusion Rate

There are a diverse range of studies recording the contribution of molasses at **high (16%-50%)** ration inclusion rates, but few of recent origin. Reports vary, generally indicating molasses to be a satisfactory feedstuff in rations as high as 30%, and possibly higher, when there is careful attention to balancing the ration, and to ration texture.

Above approximately 15% inclusion, molasses by its physical nature increasingly necessitates robust and efficient mixing equipment to ensure satisfactory homogeneous blending with other ingredients. In a low moisture ration it can create a 'gluggy' feed texture in the feedbunk.

In review, Pate (1983) concludes the feeding of fattening diets containing 20% to 40% molasses reduces rate of gain and/or feed efficiency, but to a degree that is explained by the energy content of molasses relative to the energy content of the ingredients for which it is substituted. The majority of the feeding data do not suggest the energetic efficiency of molasses itself declines, when its level in the diet exceeds the 10% to 20% level.

Church (1971) relates cattle can perform *"very well on finishing rations containing 20% to 25% molasses"*. Lofgreen and Otagaki (1960) fed (approximately 300kg liveweight) steers mixed rations progressively comprising up to 40% molasses for 133 days without any ill effect on health. The rations were not however of equal nutrient or chemical composition. The higher inclusion rate rations had lower crude protein levels (9.2% CP for 40% inclusion compared with 11.6% CP for 25%, and 14.3% CP for 10%) and differing mineral composition, almost certainly adversely masking the result. Molasses included at 25% and 40% was utilised with decreasing efficiency compared with 10%, and associated with progressively lower rates of growth and fat deposition. However the treatment ration composition differences confuse the results, leading to possible misinterpretation.

Subsequently, Lofgreen (1965), feeding 280kg heifers 169 days, concluded net energy values were similar in rations containing 5%, 10% and 15% molasses replacing barley, while at 20% net energy values were only slightly depressed. Animals performed similarly with only slightly lower carcase grades and superior ADG and feed efficiency compared with the controls (Pate 1983). Again, in the Lofgreen (1965) study, as molasses (CP 3.6%) replaced barley (CP 13.1%) ration CP and phosphorus levels fell, adversely detracting from the high molasses rations performance ability, and confusing interpretation.

Nofziger (1968) demonstrated fattening steers (approximately 360kg) fed on average for 92 days high energy rations comprising 6% molasses and 0%, 6% and 13% raw sugar (calculated to be isocaloric and isonitrogenous) showed no significant differences in ADG (approximately 1.36kg, pre ionophore era) and carcase characteristics. The lots receiving higher sugar rations enjoyed significantly improved efficiency of feed utilisation over those receiving no sugar. The sugars as invert for molasses approximate 50% on which basis the 13% raw sugar level equates to 26% molasses equivalent with respect to sugars. The ration had 6% molasses included suggesting the total sugars as invert approximate an equivalent to that supplied by a 32% molasses inclusion rate. No digestive disturbances were noted throughout the feeding period. The author maintains the upper limit of molasses usage in balanced cattle diets is more a matter of the mineral component than the energy (sugar) component of molasses (Nofziger, personal communications).

Pate (1983) cites two studies (Beardsley et al 1971; Olbrich and Wayman 1972) where raw sugar was superior to corn meal as an energy ingredient in steer finishing diets. The substitution of raw sugar for up to 48% of corn meal did not affect rate of gain, but increasing levels tended to improve DM feed efficiency by about 10%. This indicates that the pure sugars, which are the principal component of molasses, do not adversely affect the performance of finishing cattle even when included into their diets at high levels.

In South Africa the substitution of maize meal with up to 21% molasses fed to 200kg steers for approximately 165 days (standardised ration chemical composition) did not influence rate of liveweight mass or carcase mass gain, although efficiency of gain declined slightly on the highest rate (Van Niekerk and Voges 1976). This is in agreement with Lishman (1967) who concluded that molasses feeding did not significantly influence live weight gain or any of the carcase parameters investigated when it was used to supply 0%, 10%, 20% or 30% of the TDN of the ration. It concurs also with Stewart (1970) who found no significant differences in milk production or composition, in rations where molasses meal replaced maize meal up to 25% of ration.

In Britain, experiments showed molasses could be fed to dairy cows up to 31.2% of ration DM without adverse effect (Yan and Roberts 1992), and a diet containing 31.0% molasses (DM basis) with a 16% crude protein level was satisfactory for feed intake and milk production by dairy cows (Yan and Roberts 1993).

In a northern NSW commercial feedlot, true ADGs of 1.5kg were achieved on a finishing ration containing 25% molasses (as fed). This was improved to 1.8kg daily when the ration was further fine tuned (Lean, personal communications).

Currently, at Lae, PNG, 2.0 to 2.5 year old cattle fed principally molasses with protein meal and mineral additives ad lib, and separately available daily cut grass green chop ad lib are, it is claimed, repeatedly achieving true ADG of 1.1kg over 85 days in a commercial 950 head feedlot. The molasses component is estimated equivalent to 35% of ration DM (Shiel, personal communications). Buldgen et al (1990) report on the satisfactory feeding of up to 40% molasses in a balanced ration to bull calves and adult males in Senegal.

The physical nature of molasses and its effect on ration characteristics are the most commonly expressed deterrent to increasing feedlot ration inclusion rates in Australia.

It has been suggested, however, by Geary (personal communications) and Nofziger (personal communications) that it should be technically and physically practical to feed molasses at up to 30% inclusion rates in balanced feedlot rations. For reasons of cost this is not common in the USA, where molasses is generally more expensive relative to the alternative feedstuffs, than in much of Australia.

There are a number of practical considerations when molasses is included at these rates.

- Physically mixing and delivering in conventional equipment. It may aid to reduce brix to 75.0° - 76.0°; add ration ingredients other than molasses first, then add 2% to 4% water, then add molasses; use a surfactant.
- Balancing the easily and rapidly fermentable molasses carbohydrates with adequate NPN.
- Paying attention to overall ration mineral balance (possibly countering high potassium levels) and additives.
- Including an ionophore, if not already present. Many of the early experiments investigating the use of molasses did not include these ingredients, which are now normal additives in commercial feedlot rations.
- Paying attention to the number of daily feeds, possibly increasing these to four or five.
- Extending the rate of build-up in ration, perhaps over at least 7 to 10 days.
- Assessing the laxative effect on cattle, which will relate to compatibility with, and quality of the accompanying ration components.

Thus, in summary, although not commonly practised, research and industry experience indicates molasses inclusion rates can frequently be beneficially increased above the conventional range (0% to 15%) when favourably costed. As inclusion rates rise through the high (15% to 50%) range there is an apparent eventual decline in ADG and feed use efficiency to a degree initially explained by the energy content of molasses relative to the energy content of the ingredients for which it is substituted. The degree to which this occurs has not been closely studies, nor well recorded, and there is inadequate data to determine the optimum high range inclusion rates relative to ingredient to costs, for a particular commercial feeding situation.

4.2.3 Extremely High Inclusion Rate

There has been interest in developing growing and finishing rations using molasses as the major energy source at **extremely high (50%+)** ration inclusion rates. This has been principally in the world's tropical areas where molasses is underutilised and alternative forms of suitable ME are scarce, particularly in the Carribean.

There is little evidence that molasses inclusion rates above 50% will achieve acceptable livestock performance in the intensive feeding industry. When molasses inclusion rates exceed 50%, the digestibility of all types of feeds that accompany molasses is often depressed to the point of only half the value recorded when molasses is not given (Encarnacion & Hughes-Jones 1981).

In his review, Pate (1983) concludes that in general the production data suggest the metabolisable nutrients of diets containing extremely high levels of molasses are less efficiently utilised than those of diets formulated from more conventional concentrate.

Preston (1987) on the other hand, claims in review that molasses can be safely fed to ruminants at greater than 70% of ration DM. He refers to a commercial feedlot (10,000 head) in Cuba applying such a program (Preston and Willis 1974; Preston and Leng 1987), citing other workers (Munoz et al 1970). The growth rates recorded are however poor (ADG 0.89kg) for the undescribed cattle with little supporting data. Recently Sansoucy (1996), FAO, referred to an operating Cuban commercial beef fattening system developed over 25 years, wherein rations comprising 91% (70% DM) molasses with urea, mineral mix, fish meal and restricted forage achieved ADG between 0.7 and 0.8kg and DM conversions at best between 10 and 12. Apparently the program's performance has not improved with time.

In Sudan, bull calves fed rations with increasing molasses (0%, 25%, 50%) so total ME remained roughly consistent, recorded declining daily growth rates (1.37, 0.99, 0.69kg), declining conversion efficiency (5.2, 7.1, 11.8 DM basis), and increased mortality (Gaili and Ahmed 1980).

In northern NSW Sundstrom and Palmer (1977) recorded ADG of 0.73kg for yearling 235kg cattle fed 82 days with free access to 88% molasses mix and restricted roughage. Reworking the data, the molasses rate was 68% DM, the feed conversion 9.9 DM over 82 days.

Hence, the reported instances of feeding extremely high (50%+) molasses rations indicate molasses at these inclusion rates is unable to support adequate animal production. All have in common: poor growth rates (generally ADG 0.8kg or less); unsatisfactory feed conversion rates; problems with cattle adapting to rations; high culling rates; high incidence of animal sickness, in particular cerebro cortical necrosis (CCN) also known as polio encephalomalacia (PEM), and high mortality. There is diverse reasoning in the literature regarding these problems and their causes, but basically they remain little understood and unresolved.

The low animal production apparent with extremely high molasses inclusion rates currently discourages the significant use of molasses as the major energy source at these rates in the Australian intensive feeding context when evaluated in terms of true cost of gain, the facility turnover rates, and real and opportunity investment returns.

Recently in north Queensland (Swans Lagoon) molasses with meal, mineral and ionophore additives has been fed as an ad lib production supplement to cattle grazing native pasture as roughage in what is virtually a low cost feedlot system. Cattle without supplement lost 0.37kg daily on the pasture, and with supplement gained 0.7kg daily. The molasses was estimated to be 60% of DM intake. There were no sick cattle, nor was culling necessary. It has been demonstrated in a number of subsequent studies that animal performance improves as grain replaces molasses as a proportion of intake (Lindsay, personal communications).

4.2.4 Summary

When favourably costed, molasses is conventionally used in Australian feedlot finishing rations in the range of 3% to 8%, occasionally to 15% and 20% in starter rations, but rarely higher. There is, however, substantial evidence supporting the proposal that molasses could be constructively used at higher inclusion rates to 15% in balanced production rations, certainly at rates higher than conventional industry practice.

Furthermore, research and experience elsewhere indicate high inclusion rates of 25%, possibly 30% appear to be technically sound. Eventually however, as molasses inclusion rates progressively increase, the marginal efficiency of utilisation of molasses ME will decline, which eventually detracts from the ever-higher inclusion rates, on a marginal basis. This response is ill defined. In the commercial situation there will be an optimum ration inclusion rate, relative to the cost of molasses and alternative energy sources, and the marginal effect on production of increasing inclusion rates which is difficult to determine on current knowledge.

Research examining the likely animal production response to increasing molasses inclusion rates in the combined conventional and high 0% to 50% range in balanced production rations would assist industry to determine site-specific optimum rates for a range of feedstuff cost scenarios, and product values.

The decline in production associated with extremely high (50% +)molasses inclusion rates in finishing rations, discourages their application in the Australian intensive feeding industries.

Present indications are research in the very high (50%+) inclusion rate area has little potential to benefit the established industry or a new industry located to capitalise on proximity to supplies of molasses.

The difficulties in handling, mixing and delivering rations with high molasses inclusion rates using conventional equipment, need to be addressed. This is best achieved by conducting any trial work in a commercial setting and addressing the problems as they arise.

Additionally, the laxative effect of higher molasses inclusion rates possibly altering the pen environment, reducing waste DM and altering the quantity and nutrient content of pen surface runoff requires consideration. There may also be an increased incidence of feedyard insects associated with higher molasses inclusion rates.

4.3 BAGASSE

Raw, bagasse is almost worthless as a cattle feed due to its high degree of lignification and low digestibility, low protein, and low ME values (Roxas 1983; Tudor et al 1986; Ensminger et al 1990).

The nutritive value of low quality roughages can be improved by chemical, physical and enzymic processes (Tudor and Inkerman 1989; Allen et al 1997). It has been demonstrated that increases in digestibility and voluntary consumption of low quality roughages and bagasse have resulted from alkali (sodium hydroxide) treatment. Tudor and Inkerman (1989) outline the potential of alkali-treated bagasse as a feed for ruminants detailing procedures improving its nutritive value, commercial feeding observations, its keeping qualities, its management, and cost of treatment and packaging estimates. Basically, treated alkali bagasse (TAB) has OM digestibility increased to some 60% and a medium ME value estimated as 7.0 to 7.5MJ/kg DM. Following trials in commercial feedlots TAB has been determined to be a satisfactory total roughage component in balanced high concentrate finishing rations when as low as 10% of ration DM (Tudor and Inkerman 1989; Tudor, personal communications).

The TAB process has been developed further commercially by Canefibre Products at the Pioneer mill, Brandon, Queensland. The processed product normally has a little molasses added and is pelleted to increase density and improve transport economies, handling and storage. TAB is the basis for a range of compounded feeds of which the specification for the two basic pelleted products are indicated in Table 4.3.

Table 4.3 Canefibre Products, Brandon, basic pelleted products

		Min Molasses	Max Molasses
TAB / Molasses		90:10	75:25
Cost (bulk ex mill)	$/tonne As Is	$100.00	$110.00
Dry Matter	%	85	85
Assessed ME	MJ/kg	7.6	8.0
ME	$/100MJ	$1.55	$1.62

Source: Canefibre Products, Brandon

The range of pelleted compounded products are easily handled and palatable to stock. The nutrient values logically reflect the composite of the ingredients. They have medium nutrient energy values with corresponding medium animal performance (Canefibre Products, personal communications).

An enzymic process of treating bagasse is being commercially developed by Technoport Pty Ltd near the Broadwater mill, northern NSW. A compounded product is produced comprising 90.5% treated bagasse, 8.5% molasses and 1.0% urea. This has been independently evaluated (Table 4.4) for the company.

Table 4.4 Technoport Pty Ltd, Broadwater, 'Marble Magic'

			Components
Cost (bulk ex mill)		$/tonne As Is	$60.00
Dry matter		%	32
Crude protein	(DM)	%	9.2
AD fibre	(DM)	%	53.3
Digestible DM	(DM)	%	43.6
Assessed ME		MJ/kg	6.5
ME		$/100MJ	$2.87

Source: Technoport Pty Ltd, Brisbane

The product's assessed ME value is relatively low and the cost high. The high moisture nature of 'Marble Magic' disadvantages it when freight is incurred, and complicates storage. It is claimed tested residue free (Technoport Pty Ltd, personal communications).

The product has been trialed as the sole roughage source in two commercial south east Queensland feedlots where results sighted indicated (a) steers (430kg) fed 146 days had ADG 1.5kg, on a finishing ration of 68% treated product and 32% concentrates (44% and 56% DM basis), and, (b) steers fed 100 days had ADG 1.29kg on a finishing ration of 82% treated product and 18% concentrates (63% and 37% DM basis). Carcase characteristics were claimed to be satisfactory. Exact trial conditions are unknown.

It is concluded that treated bagasse generally appears to be an adequate and effective form of roughage in high concentrate diets. It has medium to low ME values. Depending on location where used, and the source and treatment applied, cost will be the major consideration when comparing it with the available alternative sources of ME and roughage.

4.4 DUNDER

The composition and availability of dunder varies considerably in relation to source (refer Table 3.7). Its generally low DM content means its effective DM cost increases rapidly with transport.

The CSR Sarina Distillery produces the most concentrated product, with estimated ME value of 8.0 to 9.0MJ/kg DM (Usher, Hunter, personal communications). It also has a high mineral content, particularly potassium.

Using the same format as Table 4.1 for molasses, Table 4.5 illustrates the cost of ME sourced from dunder.

Table 4.5 Cost of ME ($/100MJ) sourced from Sarina dunder at various costs after providing for freight

Dunder ($/tonne)	DM (%)	Dunder DM Basis ($/tonne)	ME * ($/100MJ)
10.0	35.0	28.57	0.34
20.0	35.0	57.14	0.67
30.0	35.0	85.71	1.01
40.0	35.0	114.29	1.34
50.0	35.0	142.86	1.68
60.0	35.0	171.43	2.02

* Note: ME value 8.5MJ/kg assumed

Applying the same methodology as that used in Table 4.2, the breakeven cost for ME from dunder in relation to molasses is set out in Table 4.6.

Table 4.6 Breakeven feedstuff costs for dunder ME when molasses costs $60, $90, $120 and $150 /tonne As Is

FEEDSTUFF		Metabolisable Energy (indicative DM Basis)		Dry Matter	*When the cost of molasses is ...* ($/tonne As Is)			
					$60	$90	$120	$150
		Range	Assessed		*the cost of ME is ...*			
Name	Description	(MJ/kg)	(MJ/kg)	%	$0.71/100MJ	$1.07/100MJ	$1.43/100MJ	$1.78/100MJ
					and the breakeven feedstuff cost supplying ME at the same cost is ... ($/tonne As Is)			
DUNDER			8.5	35.0	21	32	42	53
MOLASSES		10.9-12.7	11.0	76.5	60	90	120	150

With molasses at $90.00/tonne, the breakeven for dunder on the basis of ME is $32/tonne allowing for freight up to approximately 225km from Sarina. When molasses is less, the breakeven distance contracts.

Dunder is also a source of minerals and gums. However, its high mineral content, particularly potassium, may be a source of toxicity at high levels, and the value of this mineral content is largely unknown. There is no apparent recorded assessment of dunder as a source of nutrients for intensively fed beef cattle in Australia, and very little reference overseas.

Locally, it is reported cattle with ad lib access to dunder and good tropical pasture appeared to benefit from the dunder (Usher, personal communications), when the dunder was estimated to represent 20% of DM intake, but there is no objective data.

Overseas, Soldevila and Latorre (1982) found when evaluating the nutritive values of dried condensed molasses solubles (CMS) (ie. dried dunder), that once CMS exceeded 6% of the ration (presumably on DM basis) fed to 190kg heifers, ADG declined. This decline was greater when above 9% of the ration, and feed conversion efficiency deteriorated when CMS exceeded 12%. Similarly, Potter et al (1985) demonstrated reduced ADG and less efficient feed conversion when steers were fed CMS in excess of 5% of diet DM in Florida.

Dunder is used as a carrier of nutrients to grazing animals (Hunter, personal communications) and is being developed commercially as a natural coating applied to white cotton seed (WCS), where it improves handling qualities (Procoat, personal communications). The coating binds the white cotton fibre to the seed enabling it to be handled in the same manner as grain, using conventional grain handling equipment. In addition, the coated WCS has a higher density (increased approximately 16%) enabling more efficient storage and lower freight costs.

It is concluded that because of its low DM and consequent high freight costs, dunder currently has limited potential as a source of nutrients in the intensive feeding industries. Moreover, overseas studies have shown that CMS adversely affects production at even relatively low inclusion levels. Dunder does however have value, (1) as a coating for WCS that facilitates handling, transport and storage, and also, as a possible liquid carrier of supplementary foodstuffs, eg. urea, phosphorus.

4.5 SWOT ANALYSES

4.5.1 Molasses

Strengths

- Large domestic surplus, currently exported.
- Palatable feedstuff, with high ME (DM) values and significant minerals (eg. potassium)
- Competitively costed ME and mineral source at point of supply.
- Frequently a competitively costed ME and mineral source for much of the established intensive beef cattle feeding industry.
- Constructive starting ration component enhancing appeal and supplying ME and minerals.
- Capacity to enhance ration mix by reducing dustiness, and aiding texture.
- Further processing unnecessary for intensive cattle feeding rations.
- Easily transported in bulk, stored and handled with appropriate equipment.
- Seasonally available when demand greatest.
- A satisfactory carrier for additives.
- Greatest point of supply surplus is in north Queensland and northern Western Australia where live cattle export trade is developing, and a future intensive feeding industry is possible.

- Analysis to date indicates very minimum residue risk.

Weaknesses

- ME values less than grain; low crude protein values; nil fibre; low phosphorus.
- At high inclusion rates tends to clog conventional feedlot mixing equipment, increasing mechanical energy requirements.
- Inadequate knowledge of animal production patterns at high (15% to 50%) inclusion rates in soundly balanced rations.
- At high and very high (50%+) inclusion rates, efficiency of ME utilisation progressively declines. Animal performance is unsatisfactory at very high rates.
- As a liquid, molasses requires specialised transport, storage and handling equipment.
- Supply is seasonal.
- Greatest supply surplus is in north Queensland, away from established industry.
- Storage capacity to retain and use what is currently exported, is possibly inadequate.
- Effective cost of dry matter freight is greater for molasses (76.5% DM) than most feedstuffs.
- Composition varies during season and between sources.
- The economic attractiveness of molasses as a feedstuff relates to relative cost of all potential ration components and their composition.
- At high inclusion rates, may have laxative effect depending on other ration components, possibly adversely affecting pen floor environment.
- Effect of high inclusion rates on waste, and possibly the environment is unknown.
- Need to pay greater attention to livestock waters, to maintain freshness.
- May ferment if excess water added.

Opportunities

- When favourably costed, make greater use of molasses as a feedstuff at higher inclusion rates than is conventional in Australian intensive feeding industry.
- Research animal performance for progressively increasing inclusion rates in balanced production rations. Develop performance database enabling improved ongoing optimum inclusion rate determinations for changing feedstuff costs.
- Develop low cost storage system.
- Develop ability to mix and deliver at high inclusion rates (engineering, mixing practice, chemical surfactant).
- Better understand potential contribution to improving meat quality when fed pre slaughter.
- Use as energy source in pastoral backgrounding production feeding systems.

- Support intensive feeding activities for live export trade in north Queensland and northern Western Australia, in conjunction with other feedstuffs.

Threats

- Competition for supply from established non agricultural consumers, namely the fermentation processes and yeast manufacturers, locally and overseas.
- Competition from grazing industry as a production supplement, particularly in drought.
- Inability to develop satisfactory systems to efficiently mix and deliver high inclusion rates.

4.5.2 Bagasse

Strengths

- Surplus supplies available.

Weaknesses

- Untreated, almost worthless as a feedstuff for intensive cattle feeding industries.
- Treated, a low to medium ME value feedstuff, with comparatively medium to high ME costs at point of supply, depending on treatment process.
- Treated, a low nutrient roughage.
- Treated with NaOH, relatively high sodium levels may adversely raise effluent and dry waste sodium levels in intense feeding operations.
- Depending on treatment process, treated form may have low DM, adversely affecting effective DM freight costs.

Opportunities

- Nutritive value can be improved by chemical, physical and/or enzymic processes.
- Treated, bagasse appears an effective roughage in high concentrate diets.
- Source of fibre in compounded feeds.

Threats

- Expansion of cotton industry will increase competition from better quality cotton industry by-products (eg. cotton seed hulls [CSH]).
- The expansion in sugar mill electricity generating capacity utilising bagasse as boiler fuel, may reduce supplies.
- Increased use in paper manufacture, and as a landscaping material.

4.5.3 Dunder

Strengths

- Source of ME and minerals, reasonably costed at point of supply.
- Suitable carrier for supplementing nutrients.
- Suitable natural coating for WCS improving handling and storage capability.

Weaknesses	• Low DM limits shipping distance before nutrient costs become relatively excessive. • Overseas research indicates once ration inclusion rate exceeds 5% (DM), animal performance decreases.
Opportunities	• Carrier for micro nutrients. • Cost reduction if as result of diminished fertiliser usage, a larger surplus develops.
Threats	• Expanded use as fertiliser.

5. POTENTIAL EXPANDED USE OF SUGARCANE BY-PRODUCTS IN INTENSIVE CATTLE PRODUCTION SYSTEMS

5.1 INTRODUCTION

Of the sugarcane by-products, molasses offers most scope for expanded use in the Australian intensive beef cattle feeding industries. In addition, it can contribute to supplemental production feeding systems for grazing stock. Bagasse and dunder may also be able to contribute to the intensive industries in special but only limited circumstances.

The potential for the expanded use of sugarcane products is assessed in three intensive feeding systems: the **existing and established feedlot industry**; a **future expanded feedlot industry**; and the **intensive live cattle export support feeding industry** (Refer 2.2).

In all instances, the opportunity for feedstuff inclusion in ration reformulation remains determined by applying the commercially and technically sound principles of least cost ration formulation, least cost of gain to achieve the desired product, and maximising returns on funds employed at each site.

5.2 ESTABLISHED INDUSTRY

Within the established feedlot industry each feedlot site evaluates feedstuffs within its own cost structure and ration formulation principles, and to achieve its own specific objectives. Most sites currently rely largely on grain as the principal source of ME.

Molasses offers the industry a valuable and convenient source of ME and minerals (favourably costed at point of supply), for feeding in conjunction with a range of feedstuffs in balanced production rations.

Furthermore, for a large sector of the established industry molasses frequently compares favourably on site as a source of ME (refer Table 4.2) relative to grains and cotton industry by-products. This advantage naturally changes with time and season. Freight can be a significant component of the molasses cost at the feedlot, favouring establishments nearer the point of supply.

Generally, the Australian industry's conventional ration formulation practices appear commonly to under-exploit the use of molasses, even when favourably costed.

This is largely a result of the following:

- problems associated with physically handling higher inclusion rates;
- the perceived impact on ration texture of high inclusion rates; and/or
- concern as to animal performance and health at higher levels, inspired by the observed laxative effect of molasses on occasions.

Experience and research elsewhere indicate, however, molasses can be beneficially used at higher rates than commonly practised by much of the established Australian industry. Rates to 15% can be technically sound, and rates of 25% or even higher may be possible. Utilised at higher inclusion rates on a permanent or seasonal basis depending on location, molasses would provide increased support to a significant sector of the industry now dependent largely on grain. This would be particularly true when grain costs are high.

Research is warranted to clarify animal production expectations in the higher 15% to 50% range in balanced production rations for the established industry. This research should also address such practical aspects as mixing and delivery problems.

There is inadequate knowledge to contemplate within the established industry, a sector which might extend its operation to use molasses at the very high inclusion rates (50%+). Research in this very high range is considered secondary to an understanding of the use of molasses in the high (15% to 50%) range in Australia.

Bagasse, in its untreated form is virtually worthless as a feedstuff for the intensive feeding industry. Treated, it has value as a roughage, but there is very little of the established industry who would benefit from it replacing existing roughage sources such as that provided by silages and hays, and CSH.

Treated bagasse is a low to medium source of ME generally comparatively unattractive on a cost basis for the established industry.

Dunder, because of its low DM content, and hence high DM freight costs, has little to offer the established industry.

5.3 EXPANDED INDUSTRY

A northern Australian feedlot industry has not yet developed, due largely to a general lack of suitable local feedstuffs and market outlets requiring cattle to be fed. This is despite early trial work on the Ord River Irrigation Area in the early 1970s. Its development will be dependent on identifying attractive feedstuffs at attractive costs.

Such an industry could conceivably produce an improved meat product for growing Asian markets to Australia's immediate north, expanding the northern cattle industry's marketing spheres along with the rapidly expanding live cattle export markets.

The availability of molasses in north Queensland and northern Western Australia is in the short term unlikely to be sufficient alone, to encourage the industry's establishment and growth in these areas. However, combined with the ready availability of other compatible feedstuffs, it is potentially an important contributing feedstuff component.

The expected expansion of the cotton industry in central and north Queensland, and consequent increased production of WCS, and CSH, may with molasses, underpin a viable expanded feedlot industry supporting the already existing meat processing facilities. This could be further enhanced if cassava can be satisfactorily grown locally, or even imported, in common with other potential crops. This is the subject of a complementary study.

Likewise, in northern Western Australia molasses in conjunction with complementary feedstuffs could underpin the establishment of a limited feedlot industry. These feedstuffs could again be the by-products of a developing cotton industry as in Queensland, new purpose grown crops, or even imported feedstuffs (cassava) from Asia.

In these northern Australia areas, greater knowledge of, and the ability to use molasses at the higher than conventional inclusion rates, will aid an expanding industry.

Bagasse, if commercially treated as presently at Brandon, may contribute within a relatively short distance to a developing intensive feeding industry as a source of roughage. However, it is not cheap and is unlikely to be a cost effective or satisfactory source of nutrient energy. It probably has little to contribute to an informed, cost conscientious, developing intensive feeding industry.

Dunder has little to offer a newly developing industry, due to its low DM and consequent high DM freight costs, except as a coating that enhances the handling characteristics of WCS.

5.4 LIVE CATTLE EXPORT TRADE

This industry, which has expanded rapidly of late in northern Australia, is increasingly important to the northern Australia cattle industry and the region as a whole.

Shipped cattle are fed on pasture and/or pellets after mustering, prior to shipment and whilst in transit. It is conceivable that further industry growth, and a greater need to ensure a continuity of livestock supply of assured quality, will encourage the industry to increase intensive feeding, backgrounding and growing out. This will place greater emphasis on ration quality and costs.

Molasses can contribute to the backgrounding of cattle for export, as a pasture production supplement. In addition it can contribute as a ration component in a controlled intensive feeding environment. Its properties (palatability, ME and mineral source) can significantly enhance the quality of starter rations. Its ultimate value will however depend on its cost, including a freight component from its point of supply to feeding site.

Clearly, the short term and long term requirements of this trade are similar to those for an expanded northern Australia feedlot industry (refer 5.3).

Currently, lucerne cubes delivered Darwin at $400/tonne equate to ME at some $5.50 to $6.00/100MJ. The cost of like feed at Karumba is similar. This is relatively expensive feed. Molasses may, in conjunction with other products, offer a part alternative.

Molasses may contribute to commercially compounded pelleted products comprising treated bagasse, molasses, and additives aboard ship. Such recently developed products are delivered to Darwin for example, similarly costed to the established existing products available in the trade. An alternative and attractive product might be based on molasses and CSH. It is possible that better quality products may eventually be landed cheaper, when greater emphasis is directed to nutrient values and costs.

Dunder, as a natural coating for WCS enables this product to be handled conventionally and reduces freight by increasing density. The dunder coated WCS is an easily handled high ME value, high crude protein, palatable feedstuff able to be delivered to northern export ports at similar costs per tonne to lesser quality products, and as such may assist the live cattle export industry.

Concurrent with the expanding live cattle export trade has been the reduction in export meat works in northern Western Australia and the Northern Territory. These have been reduced from ten in 1980 to two in 1996. At the same time, the average age of turn off for cattle has fallen from 5 to 6 years to 1 to 2.5 years. This has reduced grazing pressures and permitted more sustainable range management in the absence of compensating increased breeder numbers.

Significantly the live cattle export activity with developing background feeding experience and operational expertise, could be the precursor or catalyst to a northern feedlot industry. This may be particularly so in northern Western Australia, where a feedlot industry might market improved quality meat into Asian markets in addition to live cattle. Molasses at relatively high inclusion rates, and in conjunction with other feedstuffs, could be an important ration component for this industry.

5.5 ENVIRONMENTAL ASPECTS

Overall, there appear low potential environmental impact risks from the expanded use of sugarcane by-products in the intensive cattle feeding industries.

Higher molasses inclusion rates may, recognising the product's occasional laxative effects, have an effect on the pen floor environment, and the subsequent quantity and quality of pen surface runoff. The effects are almost certainly manageable.

The treated alkali bagasse (TAB) retains sodium from the NaOH (2.5%) treatment. This will eventually accumulate in the effluent and waste. In an intensive feeding operation special care may be necessary to manage sodium accumulation in the environment where effluent and waste are spread.

6. CONCLUSIONS

Australia has an expanding sugarcane industry located principally in coastal Queensland, in northern New South Wales, and at the embryo stage in northern Western Australia, which is adjacent to major cattle producing areas.

Three sugarcane industry by-products have been considered in regard to their expanded use in the intensive cattle feeding industries: molasses, bagasse and dunder.

Molasses is a recognised, valuable, palatable high energy feedstuff used world-wide in intensive cattle feeding activities when favourably costed. Australia exports approximately half of its molasses production (1996 - 670,000 tonnes) receiving a lesser value than when selling into its domestic market.

Molasses is widely used in the Australian intensive cattle feeding industry as a source of energy and minerals and for its physical qualities. It is commonly delivered to site favourably costed in relation to alternative ME sources, and as such is a valuable feedstuff.

It is concluded, however, molasses is frequently underutilised by much of the established Australian intensive cattle feeding industries, even when favourably costed. Experience and research have shown production diet inclusion rates to 15% to be technically sound. This generally exceeds conventional Australian practice. Furthermore, research has indicated molasses to be beneficially included in soundly formulated production rations to 25% and higher. At these inclusion rates animal performance and product quality are maintained.

The reasons for the lower molasses inclusion rates in Australia, even when well costed, include the physical problems associated with mixing and delivering rations containing higher levels, concern as to animal performance and health at higher rates, and a general lack of understanding of the opportunities.

As molasses inclusion rates further increase in the high range (15% to 50%), animal production eventually commences a decline which is also related to associated feedstuff and ration qualities. The marginal significance of this decline under commercial conditions is little understood, and there is insufficient data on which commercial industry can base and apply the cost/benefit analysis necessary to determine optimum inclusion rates.

It would be advantageous to the Australian industry to research the effect of high (15% to 50%) molasses inclusion rates in local commercial production rations examining the marginal responses. Soundly conducted, this would enable commercial industry to determine optimum inclusion rates for a range of feedstuff cost and animal production scenarios. This should offer a short payback period on investment funds committed.

A secondary line of research following the better definition of the effects of increasing inclusion rates in the high (15% to 50%) range would be to examine in detail the factors influencing and limiting production at the higher rates, to provide the basis for their possible amelioration.

Molasses, in conjunction with the increased availability of by-products of an expanding cotton industry, and either new purpose-grown or imported feedstuffs, may substantially underpin an expanded intensive cattle feeding industry in northern Australia, in particular north Queensland and northern Western Australia. A greater appreciation of the practicality and response to the higher inclusion rates will also aid an understanding of the contribution that molasses can make to such an expanded industry.

Bagasse, untreated, is virtually worthless as a feedstuff for the intensive feeding industry. Treated, it has low to medium energy values and may act as a roughage in high concentrate rations. The indications are that treated bagasse will generally compete unfavourably on a cost basis as a source of nutrients and roughage for the established and an expanded industry.

Dunder has little direct application in the intensive feeding industries. It is however an effective natural coating for WCS improving its handling and storage ability. As such it may indirectly benefit the live cattle export trade support feeding industry.

There appears little merit in further researching aspects of bagasse or dunder in relation to the intensive feeding industries.

7. RECOMMENDATIONS FOR FURTHER RESEARCH AND DEVELOPMENT

7.1 IDENTIFICATION

There is scope to make greater use of molasses as a feedstuff in the intensive feeding industries when favourably costed. Increased use is perceived to be currently constrained by limited local and overseas production knowledge on its use at inclusion rates greater than currently practised, particularly in the high (15% to 50%) range. It would be advantageous to the existing industry and to an expanded industry, to have greater knowledge of animal production at the higher inclusion rates.

There appears little real benefit to the industry in furthering research into the use of bagasse or dunder.

The following constraints have been identified as potential areas for further research with respect to molasses.

7.1.1 Molasses – Inclusion Rates

The intensive feeding industry generally appreciates the nutritional contribution of molasses. Inclusion rates for much of the industry, however, appear overall to be at suboptimum levels. They are less than those indicated possible by high level users in Australia and in the USA, and by what might be frequently financially advantageous in Australia. The literature records the satisfactory use of molasses overseas at even higher inclusion rates (15% to 50%), which where possible and practical could assist much of the Australian industry.

Research is suggested as follows.

Firstly

- To develop for commercial industry in Australia, meaningful guidelines for optimising (physically and financially) production ration molasses inclusion rates under a range of feedstuff scenarios.

  This research would assess the effect on performance, cost of gain, and value of product (meat), of feeding molasses at various rates within the high range (15% to 50%).

  Feeding trials would determine and clarify the marginal effect on production (ADG, CR, carcase and meat quality characteristics, etc) of increasing molasses inclusion rates in sound practical production rations under commercial scale pen conditions. Trials would be repeated for several cattle feeding scenarios.

  Rates assessed might be 0% to 35% in steps of 5%; 0% to 36% in steps of 6%; or 0% to 37.5% in steps of 7.5% as necessary for the desired results.

It is emphasised that the research should be designed and conducted in an environment enabling its maximum commercial interpretation, evaluation and application.

- To review, explore, and develop the means of improving the efficiency of physically mixing and delivering molasses at a range of feedlot ration inclusion rates (in conjunction with the above).

- To prepare for industry a paper collecting and reviewing the available relevant information on molasses handling, storing and delivery systems for a range of capacities, with a view to enabling potential users to be better equipped.

This should be capable of completion relatively swiftly with combined sugarcane and cattle industry co-operation and involvement. It should also offer a short payback period.

Secondly

- Having determined and defined the trend in performance in relation to a range of molasses inclusion rates, to examine in greater detail the factors influencing performance and to determine how or if these can be ameliorated.

  This would incur investigating a range of variables and their effect under more intense research conditions, but of necessity should retain a focus on eventual commercial industry application.

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Pate, F.M - University of Florida, Ona, Florida
Sansoucy, R - FAO, Rome
Shiel, C - Ramu Sugar Ltd, Lae, PNG
Tudor, G - Agriculture WA, Bunbury
Usher, J - CSR Sarina Distillery, Sarina
Williams, H - J H Williams & Sons Pty Ltd, Murwillumbah

APPENDIX 1
Terms of Reference

EXPANDED USE OF SUGARCANE BYPRODUCTS FOR INTENSIVE BEEF CATTLE FEEDING - PHASE 1

TERMS OF REFERENCE

THE CONSULTANCY SERVICES

BACKGROUND

The business plan for the Feedlot Consistency and Sustainability Key Program (FCSKP) has identified the likely increase in the real price of energy dense feedstuffs, and the security of its supply, as a core problem affecting the long term viability of cattle feeding in Australia. The increase in the price of energy dense feedstuffs in the medium to long term will be driven primarily by global supply and demand. Under a scenario of long term upward pressure on the price of feedgrain, it is postulated in the FCSKP business plan that intensive cattle feeding could gain competitive advantage by better use of existing energy dense by-products of the sugar industry.

Notwithstanding the considerable amount of world-wide research on feeding cattle sugarcane byproducts, particularly in the Carribean and South America countries, molasses in Australia feedlot rations is used sparingly[1] due mainly to handling problems and lower daily liveweight gains in cattle from high molasses diets compared to high grain rations and hitherto geographic location of feedlots being closer to a feedgrain source than a molasses source. Future higher feedgrain prices, coupled with the advent of a universal post slaughter grading system applied to Australian beef suggests a *prima facie* case could be made for using more sugar byproducts, but particularly molasses which is currently available (ex sugar mill) at about $0.95 per 100MJ metabolisable energy compared to say grain sorghum presently available (ex farm gate) at about $1.60 per 100MJ metabolisable energy[2]. This price differential could be expected to widen with an increasing world shortage of feedgrain although it would be unusual for some attendant rise in the price of molasses not to occur. A potential widening differential between the price of ME from molasses and feedgrain is the essence of the re-awakening of interest in sugar byproduct feeding under MRC's FCSKP. Of particular interest is the potential to increase the use of molasses-based supplements in the backgrounding phase, and the potential to reduce the cost-of-gain by manipulation of the feedlot starter and finisher rations and pre-conditioning cattle for live export. It is further postulated that a significant widening differential between the price of ME from feedgrains and molasses could have long term implications on feedlot spatial distribution and industry structure.

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[1] Feedlot rations in northern Australia commonly comprise 3% to 10% molasses ; some feedlots occasionally use up to 20% for short periods.

2 Based on molasses price of $75/t and 8MJ ME per kg and grain sorghum price of $170/tonne and 11 MJ ME per kg

There is approximately one million tonnes of molasses produced in Queensland annually of which 25% is presently used for stockfeed but 50% is exported onto a lower priced export market. Also. around 12 million tonnes of bagasse , another sugar industry by-product, is produced annually. It is highly fibrous but when treated with alkali has a digestibility of around 60%. Canefibre Products (a joint venture between CSR and Fibretech) have developed the infrastructure to handle bagasse based ration formulations. The use of sugarcane byproducts to feed cattle is most likely to apply to feedlots geographically located close to the sugarcane belt along the Queensland and northern NSW coast, and, in the future, on the Ord R in NW Western Australia. Apart from conventional target markets for lot fed cattle it is speculated that the northern industry could use a low cost lotfeeding enterprise to pre-condition live export cattle for shipping. Much of the feeding work which has been done with molasses in the Carribean has had the objective to maximise feed energy from molasses (rations up to 90% molasses) but this has been at the expense of average daily gain which is of the order of 0.8 kg/day and the higher risk of *polioencephalomalacia*. For the Australian Industry, given that molasses might be, in the future, an even more competitively priced source of ME, the issue becomes how to maximise the use of molasses in the diet consistent with acceptable, market dictated, average daily weight gain and meat quality given that roughage (through alkali-treated bagasse or alternatives) is unlikely to be a constraint and given other protein sources are available (e.g. grain legumes grown on the Burdekin).

The Meat Research Corporation ('the Corporation') intends to initiate a new R&D project to re-evaluate the potential role of sugarcane byproducts for intensive feeding of cattle feedlot industry in light of future possible increases in the cost of energy dense feedgrains. A 3-phased project is envisaged, comprising:

> Phase 1 A review of the present utilisation of sugarcane byproducts for intensive cattle feeding in Australia (eg. feedlots, backgrounding, pre-shipping, pre-slaughter) and preliminary feasibility study of options for increased use of sugarcane byproducts under the future higher feedgrain price scenario;
>
> Phase 2 Specific technical research into issues and constraints identified in the first phase;
>
> Phase 3 Catalysing commercial development and application of any process or product.

The Terms of Reference hereunder relate to Phase 1 of this R&D stream.

OBJECTIVE

The objective of Phase 1 is to review past research and commercial experience in the utilisation of sugarcane byproducts for intensive cattle feeding in Australia and overseas and on the basis of this: (a) determine if it would be feasible for the cattle feedlot industry and other intensive cattle feeders in Australia, under a higher feedgrain price scenario and, given projected target markets and existing spatial distribution of established feedlots, to profitably utilise more sugarcane byproduct and (b) identify any specific areas for R&D which may be required to facilitate the use of sugarcane byproduct in the cattle feedlot industry.

REQUIREMENTS UNDER THE CONSULTANCY

Scope

Phase 1 will be a desk study, the outcome of which will determine if the Project should progress to Phases 2 and 3. The scope is not intended to focus exclusively on a review of the technical aspects of, and opportunities for, increased sugar byproduct feeding but is intended, in addition, to identify potential structural, environmental and financial implications for the Australian Industry of a future competitively priced source of ME from sugarcane byproducts. The purpose of Phase 1 is to clearly understand the Industry context in which intensive sugarcane byproduct feeding is feasible (if at all) before undertaking specific further R&D. The scope of the work will thus include, but not necessarily be limited to, the following:

- description of the nutritional properties of feedstuffs derived from sugarcane, a literature review of nutritional limits for cattle and documentation of current knowledge of least cost ration formulations using sugarcane byproducts suitable for production feeding of cattle;

- documentation from past research of the effect of various levels of sugarcane byproduct feeding on meat quality and animal health;

- documentation of the present production of sugarcane byproducts in Australia by region and utilisation by cattle industry subsectors, particularly the cattle feedlot subsector;

- given a trend towards relatively lower unit cost of ME from molasses, demarcation of the geographic zones (and current feedlot capacity therein) which could beneficially increase the proportion of molasses in the ration, consistent with market imperatives; and

- identify and comment on present, or future potential constraint (e.g. environmental, crop residue, legislative) which might preclude, or make less favourable the substitution of feedgrains with sugarcane byproducts as a source of ME and propose R&D initiatives which might be undertaken to overcome these constraints.

Methodology

Phase 1 will involve, (a) a brief review of the scientific literature in relation to nutritional properties of sugarcane byproducts, the limitations as a cattle feedstuff and cattle production therefrom, (b) a sample survey (by mail and/or phone) of lotfeeders and other intensive feeders to gauge present level of utilisation of sugarcane byproducts and constraints to expanded utilisation, (c) an analysis of the likely impact of differential molasses/feedgrain price trends on increased use of sugarcane byproducts by the Industry, and (d) preparation of terms of reference for future possible R&D to overcome identified constraints.

Output

The output of the research will be a Report which will be presented, in the first instance, as a Draft Final Report for the consideration and comments of the Corporation and the FCSKP Consultative Group. The Final Report will be revised to address comments made on the Draft Final Report and re-presented to the Corporation. The report will contain an Executive Summary which will, as far as possible, read as a stand alone document which effectively summarises the full document in a form suitable for Industry. The report will indicate if specific Phase 2 R&D is required and Terms of Reference for the such Phase 2 components. A list of contacts interviewed during the course of the research will be appended. If the Consultant has access to commercial-in-confidence data, germane to the study outcome, the MRC would not require this to be presented in the Report nor sources identified. Subject to agreement between the parties involved, such commercial-in-confidence data may be presented in an unpublished, Part 2 document.

Six bound copies of the Draft Final and Final Reports will be provided to the Corporation as well as a disk copy of the Final Report using agreed software.

Consultative Group

This project is a component of the MRC's FCSKP which has a Consultative Group of Industry representatives. The outcome of this project will be referred to this group for endorsement prior to acceptance of the Final Report.

Access to Information

Where information is available which may assist the Consultant in meeting the requirements of this research, such information may be provided to the Consultant on a confidential, or other basis as indicated, by the Corporation and members of the FCSKP Consultative Group. Confidential information would not be reproduced in the report, consistent with the caveats mentioned under 'Output'.

Timing

The Corporation is anticipating that a contract with the Consultant to proceed with the Phase 1 Review and Feasibility Study will be finalised by 27 September. An elapse time of 3 months to complete the Report is envisaged with the Final Report of the Phase 1 Review and Feasibility Study being delivered to the Corporation by 20 December, 1996. Within the first fortnight of the Study, the Consultants will deliver a brief Inception Report in which suggestions (if any) on fine tuning of the Study scope and potential outcomes will be presented for consideration by the Corporation and FCSKP Consultative Group.

Costing

The Corporation seeks a quotation for the full Phase 1 review to be carried out under these Terms of Reference. The details of costing provided to the Corporation will include professional fees, calculated on a daily rate for each person, or party involved, and will cover professional services of the Consultant, provision of office facilities, electricity, local telephone/facsimile calls, postage, clerical/secretarial services and indirect costs (overheads). Out-of-pocket expenses will be reimbursed at cost for travel and accommodation, long distance telephone/facsimile and external costs of report preparation.

Progress payments will be made by the Corporation against completion of the components of the review identified with milestones agreed to by the Corporation. Final payment by the Corporation will be subject to written acceptance of the Report by the Corporation. All payments will be subject to receipt of invoices from the Consultant.

Subcontracting

Certain activities and analysis may be subcontracted by the Consultant to other parties. In this case full details of the party or parties to be sub-contracted, their capabilities and background and the activities or analysis which they would perform in the context of this review will also be provided to the Corporation . Notwithstanding this, the responsibility for the performance of the sub-contractor will rest completely with the prime Consultant with whom the MRC would be contracted.

Reporting and Liaison

The consultant shall report to the Corporation through Mr. David Skerman. Apart from an Inception Report at the end of the first fortnight, the Consultant will provide a brief statement of progress (by letter or facsimile) at the end of each fortnight.

Confidentiality

The Consultant may divulge that the Review is being undertaken at the request of the Corporation. Otherwise the specification of the Review, contents and conclusions of the Review and the Report produced are strictly confidential. The Consultant may not disclose any details or information in respect of the Review to any party without prior written consent of the Corporation.