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Tick Fever Vaccine Investment Evaluation

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Abstract

Tick fever is a significant disease of cattle in Australia with up to 7 million animals potentially at risk. It is a serious, often fatal complex of diseases caused by one or more of the tick-borne parasites *Babesia bovis*, *Babesia bigemina* and *Anaplasma marginale*.

The Tick Fever Centre (TFC) operates as a unit located within Biosecurity Queensland of the Agriculture, Food, Tourism and Regional Services (AFTRS), Department of Employment, Economic Development and Innovation (DEEDI). It was established at Wacol in 1966 to specifically develop and produce an effective vaccine for the control of tick fever. It currently supplies an average of 850 000 doses each year with 95 per cent used within Queensland (Queensland Primary Industries and Fisheries 2009).

One purpose of the evaluation was to identify the economic benefits provided by the ongoing provision of the tick fever vaccine. The measureable economic benefits accruing to the TFC are mainly due to potential reductions in the rate of mortality incurred in the northern beef herd.

The TFC provides a significant and positive economic benefit to the Queensland and northern beef industry. Even though a number of identifiable economic and social benefits have proven difficult to measure accurately, they do exist and should be seen as adding considerably to the economic benefits quantified in this evaluation.

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1. Introduction

The Tick Fever Centre (TFC) operates as a unit located within Biosecurity Queensland of the Agriculture, Food, Tourism and Regional Services (AFTRS)[1], Department of Employment, Economic Development and Innovation (DEEDI). It was established at Wacol in 1966 to specifically develop and produce an effective vaccine for the control of tick fever. It currently supplies an average of 850 000 doses each year with 95 per cent used within Queensland (QPIF 2009).

This evaluation provides some background to the disease of tick fever before considering the economic and financial benefits provided to industry by the TFC. The cost of providing the service was also calculated.

2. Background

2.1 Tick fever

Tick fever is a serious, often fatal disease of cattle in northern Australia. It is a complex of diseases that is caused by one or more of the tick-borne parasites *Babesia bovis*, *Babesia bigemina* and *Anaplasma marginale*. It is carried by the common cattle tick (*Rhipicephalus microplus*) and largely transmitted through tick bites. In Australia, *Babesia bovis* is the major cause of disease outbreaks accounting for 80 per cent of reported cases (QPIF 2009).

Tick fever is a significant disease of cattle in Australia with up to 7 million animals potentially at risk. The disease was probably introduced as early as 1829 by cattle from Indonesia infested with the cattle tick. There are currently two main forms of tick fever disease in Australia – babesiosis and anaplasmosis.

Babesiosis and anaplasmosis are only found in eastern and northern parts of Australia where the cattle tick is present. One infected tick is sufficient to transmit the infection but only a very small number of ticks actually carry the disease. As few as 1 in 5 000 ticks may be infected with *B. bovis*, while 1 in 500 ticks could be infected with *B. bigemina*. Thus, *B. bigemina* organisms are usually more prevalent in an infected herd with infection rates usually higher for this organism (Mahoney and Mirre 1971).

British and European (*Bos taurus*) breeds are very susceptible to babesiosis with potentially high mortality after infection, especially where *B. bovis* is present. *Bos indicus* breeds such as Brahman, Sahiwal and, to a lesser extent, crosses between *Bos indicus* and *Bos taurus* cattle show resistance to babesiosis with a significantly lower risk of mortality but, despite this, nearly 1 in 5 outbreaks of tick fever involves these breeds. With anaplasmosis, there is no clear evidence that *Bos indicus* cattle are any more resistant to disease than *Bos taurus*.

Cattle that live in tick endemic regions may naturally develop lifetime immunity to tick fever through exposure to the organisms early in life. Calves can be temporarily protected by receiving maternal antibodies from immune mothers through the

[1] Formerly the Department of Primary Industries and Fisheries (DPI&F).

colostrum (first milk). This protection lasts about 3 months and is followed by an age resistance which lasts until the animals are about 9 months old.

Calves exposed to infection during the period of maternal or age resistance rarely show clinical symptoms but develop a solid, long-lasting immunity. Calves that have not been exposed become susceptible to infection later in life as the age resistance gradually wanes with time. A severe, life-threatening infection may well develop with infection and losses likely when tick numbers on a property increase or when susceptible cattle are brought onto a tick-infested property.

Drugs such such as Imidocarb (Imizol® or Imidox®) for babesiosis and Oxytetracycline or Imidocarb for anaplasmosis can be used in the treatment of tick fever. If given early in the course of the infection, the cattle usually recover. However, if treatment is delayed, supportive therapy such as the use of blood transfusions, intravenous administration of fluids, other supportive treatment, good nutrition and shade may be essential if the animal is to survive. Such treatments are prohibitively expensive and difficult to apply within the usual management strategies applied on extensive Queensland beef properties.

Biting flies can transmit the disease (particularly anaplasmosis) but are less efficient vectors than ticks. Mechanical transmission via veterinary instruments (needles, dehorners etc) is also possible and the organism can cross the placenta to the foetus (particularly anaplasmosis).

2.2 Impact of tick fever

Tick fever, whether caused by *Babesia sp.* or *Anaplasma sp.*, is known to create considerable risk for unprotected animals entering cattle tick infested areas. Although high mortality rates from tick fever could occur where tick numbers fluctuate from season to season or where unprotected cattle are introduced into tick infested areas, data on the extent of mortality and morbidity caused by tick fevers are difficult to obtain. In general, tick fever caused by *B. bovis* is normally severe and large numbers of susceptible cattle can get sick and die when an outbreak occurs. Disease caused by *B. bigemina* is usually less severe but can develop very rapidly.

As mentioned previously, *Bos indicus* and *Bos taurus* cattle can be affected by both the diseases but the former are more resistant to the tick themselves and may be more resistant to the tick fever parasites (Chudleigh 1991).

Morbidity effects due to tick fever are difficult to identify. Anaemia will presumably affect milk production in lactating animals and weight gains will most likely be affected which in turn could affect reproductive performance in cows. In addition, damage to the vital organs (e.g. liver) can be severe and may be permanent. Fertility can be affected in male animals but there is some evidence that this is only temporary.

Cattle that survive the infection may take several weeks to regain condition and there is ample evidence that such animals make compensatory weight gains on recovery from the disease.

2.3 Tick Fever Centre

The stated goal of the Tick Fever Centre (TFC) is "to contribute to the sustained productive capacity of Queensland's livestock industries through the provision of products and services necessary for the control of tick fever" (QPIF 2009). The TFC has laboratory, livestock facilities and office accommodation at Wacol plus has recently taken control of two adjacent rural grazing properties near Dalby, Glengarry and Kennlea.

The services provided by the TFC include:

- Tick fever vaccine production and distribution
- Diagnostic tests
- Vaccine Research & Development
- Diagnostic reagents
- Contract/funded research
- Contract manufacture and services
- Disease surveillance
- Core research
- Advisory service (state, national and international)
- Training and education

2.4 Tick fever vaccine

The Queensland Government is the only producer of tick fever vaccine in Australia. Commercial companies are not interested in producing live vaccines such as the tick fever vaccine due to the high costs of production, the animal welfare issues associated with the production technology, the dangers of passing on other undesirable organisms in the blood and the liability implications that may eventuate.

Tick fever vaccine is sold as a chilled vaccine or frozen vaccine (Combavac®) which has to be stored in liquid nitrogen. In 2008-09, the chilled and frozen tick fever vaccines from the Tick Fever Centre made up approximately 90 per cent and 10 per cent of sales, respectively. A 10 year average of 850 000 doses per annum is supplied with 95 per cent used in Queensland.

The current vaccines are based on a production technology that has been refined but remains largely unchanged since development. The vaccines are considered safe when used appropriately and provide lifetime protection against tick fever disease. The market for the product has exhibited some stability and little significant growth for almost a decade. The vaccines have a number of characteristics that make them problematic, namely:

- The vaccines consist of attenuated live tick fever parasites in bovine blood which must infect cattle to be effective.
- The active ingredients are fragile and have a very short shelf-life.

- The active ingredients are also pathogens and that may cause sickness and death in recipient cattle.
- The *Babesia bovis* component of the vaccine may be transmitted by a cattle tick that fed on vaccinated cattle. When this occurs, *B. bovis* might revert to being virulent.
- Because the vaccines are blood-based, they are susceptible to contamination with other infectious organisms.

The current vaccine is considered to be very effective but product liability due to the characteristics of the tick fever vaccine is a concern. Previous liability claims from an enzootic bovine leucosis (EBL) contamination in 1986 cost approximately $6 million ($13.2 million in 2008-09 values) in compensation and legal fees.

Vaccine sales vary from about 25 000 doses in January to over 100 000 doses per month in May, June and July. Approximately 50 per cent of sales occur from May to the end of August, coinciding with seasonal calf weaning activities in the Queensland beef breeding herd. The very short shelf-life of the chilled vaccine and year round demand creates a need for continuous production.

As the vaccine provides life-long immunity after one vaccination, the total potential number of new animal vaccinations per year in the cattle tick infected regions of Australia could be up to 1.97 million if all suitable animals were vaccinated (ABS 2004). Cattle moving to tick endemic regions may also be vaccinated to provide immunity.

However, due to low tick numbers in some regions, the resistance of tropical breeds to ticks and tick fever together with the attitude of some producers to risk, the total number of animal vaccinations on an annual basis is significantly less than this.

3. Economic analysis

The purpose of this section is to identify the economic benefits provided by the ongoing provision of a service, namely the tick fever vaccine.

3.1 Production benefits arising from the use of tick fever vaccine

Tick fever vaccine effectively controls the disease in tick endemic regions where it is administered appropriately. The reduction in mortality is the major measureable benefit. Morbidity associated with the disease has no easily measureable economic impact under extensive grazing conditions but some loss in productivity is associated with morbidity. In some outbreaks, ancillary costs (mustering, loss of morbidity) of an outbreak are often much more that the mortality costs. For producers involved in the live cattle export particular markets can be lost for 6 to 12 months following a confirmed tick fever outbreak.

Tick fever vaccine also reduces the risks associated with livestock movement from tick free regions to those infested with the cattle tick. Some of the livestock movements facilitated are associated with the movement of genetic material used to improve the performance of beef cattle in tick infested regions; others are associated

with the movement of cattle for fattening or finishing in feedlots. In the past, the vaccine has also facilitated the live cattle export trade, especially to South East Asia. The numbers of livestock in each movement category are unknown and the likely economic impacts difficult to determine, making quantitative assessment of economic benefits accruing to vaccine use very difficult.

The expected reduction in mortality arising from the use of the vaccine has been identified by the TFC as usually the most significant source of benefits and, as some estimates have been made of quantitative benefits in this area, they are the only benefits included in the quantitative economic analysis.

3.2 Analytical framework

This analysis applies a partial equilibrium modelling framework to estimate the economic surplus generated through the use of the vaccine.

Economic benefits are calculated by combining estimates of farm level impacts of the vaccine with measures of elasticity, supply, consumption and price for Queensland, Australian and world beef production respectively provided by Griffith et al. (2006) within the *Dream* model (Wood et al. 2001).

3.3 Benefits of tick fever vaccine use at the property level in the Queensland cattle industry

The TFC has provided estimates of the upper (Table 1) and lower (Table 2) bounds of the expected level of animal deaths saved through the use of the tick fever vaccine (QPIF 2009).

The vast majority of deaths are saved in the tick endemic regions of Queensland with the level of mortalities prevented largely dependant on the proportion of the herd vaccinated, the level of tick resistance held by grazing animals and the incidence of tick fever. Estimates are for the expected *average annual* number of mortalities prevented over time.

In this analysis, the estimates of reduction in cattle mortality provided by the TFC were used as the measure of the impact of tick fever in Queensland. These are the best available data based on past survey data and research investigations carried out by TFC staff and others over a period of years.

Table 1. Estimated reductions in mortality due to use of tick fever vaccines (1) upper bound estimate

Region	Cattle*	Proportion Vaccinated	Mortality - no vaccine		Mortality with vaccine	
			Percent	Actual	Adjusted	Reduction
	Millions	%	%	Number	Number	Number
North	2.69	21.0	0.40	10 760	8 613	2 147
Central	2.96	50.0	0.80	23 672	12 428	11 244
SEQ	1.27	40.0	2.00	25 458	15 784	9 674
Total	6.92			59 890	36 825	23 065

Source: QPIF 2008, *TFC Marketing Plan 2008-09,* QPIF, Brisbane

* Cattle numbers are those cattle within the tick endemic part of Queensland and have been derived from ABS records and estimates.

The variation in the incidence and risk of tick fever across the tick endemic regions of Queensland is reflected in the sub-regions identified in Table 2.

Table 2. Estimated reductions in mortality due to use of tick fever vaccines (2) lower bound estimate

Region	Cattle	Proportion Vaccinated	Mortality - no vaccine		Mortality with vaccine	
			Percent	Actual	Adjusted	Reduction
	Millions	%	%	Number	Number	Number
North	2.69	21.0	0.03	807	646	161
Central	2.96	50.0	0.25	7 398	3 884	3 514
SEQ	1.27	40.0	0.60	7 637	4 735	2 902
Total	6.92			15 842	9 265	6 577

Source: QPIF 2008, *TFC Marketing Plan 2008-09,* QPIF, Brisbane

The TFC estimates that between 6 500 (lower bound) and 23 000 (upper bound) deaths per annum, are prevented through the use of the tick fever vaccine in the Queensland beef industry.

These levels of expected reduction in mortality have been applied to regional farm management production models for beef properties to estimate the change in productivity cost and profitability resulting from the reduction in mortality likely to arise from the use of the vaccine.

The regional beef models were constructed to reflect the dominant production system for each sub-region and incorporate the livestock categories herd performance costs and prices expected within each region. Herd performance parameters include estimates of the average performance of the herd in the region "without" tick fever vaccine but with all other typical management procedures in place.

The number of breeders and weaners modelled for each regional beef production system expected to use the tick fever vaccine are provided in Table 3. The estimate of the total number of weaners vaccinated on an annual basis (742 987) contained in the regional production models is close to the estimate provided by TFC documents (750 000). The amount of vaccine used within the regional herd models therefore accounts for about 90 per cent of the vaccine produced by the TFC. The total numbers of livestock making up the regional herds modelled as using tick fever vaccine account for slightly more than 20 per cent of the total beef herd in Queensland recorded by the ABS in 2005-06 (ABS 2008). The output of beef to be produced by the regional models accounts for slightly less than 20 per cent of the beef produced by Queensland (Griffith et al. 2006). On this basis, the modelled beef herds are thought to represent the likely productivity and profitability of the actual livestock protected by the tick fever vaccine in Queensland.

Table 3. Estimated herd structure for herds protected by tick fever vaccine

Region	Cattle	Proportion Vaccinated	Total protected herd	Breeder component	Weaner component
	million	%			
North	2.69	21.0	564 900	207 097	142 069
Central	2.96	50.0	1 479 504	590 287	436 074
SEQ	1.27	40.0	509 164	208 136	164 844
Total	6.92		2 553 567	1 005 520	742 987

Regional herd models were constructed to reflect the level of mortality expected "with" the vaccine and "without" the vaccine for both the upper and lower bound estimates of mortality. A total of nine regional models were constructed to allow a within-region pair-wise comparison of production impacts.

Example herd model inputs and outputs used to calculate the property level impact of the "upper bound" estimate of reduction in mortality for the North Queensland region are provided in the following tables. Similar tables for the remaining regions are in Appendix 1.

The North Queensland herd model for the properties using vaccine has 207 097 breeders (cows and oldest heifers in Table 4) and 142 069 weaners (Table 4). The opening number (564 901) does not include the calves produced during the year and is equivalent to the protected herd figure (564 900) expected by the TFC. The grazing pressure exerted by this herd is assessed as 524 160 adult equivalents.

Table 4. North Queensland 'high mortality saving' herd model (without tick fever vaccine)

Group	Number	A.E. rating	Adult Equivalents
Cows	157 394	0.95	149 524
Heifers	49 703	0.95	47 218
Heifers	69 614	0.91	63 349
Weaner Heifers	71 035	0.63	44 752
Steers	68 222	1.04	70 951
Steers	69 614	0.95	66 133
Weaner Steers	71 035	0.69	49 014
Calves	144 968	0.16	23 195
Bulls	8 284	1.21	10 024
Total	709 869		524 160
Opening numbers	564 901		

Table 5 shows the herd structure once the model has been adjusted to reflect the lower mortalities arising from the use of the tick fever vaccine. Reductions in mortality have been more heavily weighted against younger classes of livestock with numbers reduced until the herd "with" the vaccine maintains the same grazing pressure or adult equivalent rating as the herd "without" the vaccine.

Spreading reductions in mortality unevenly across livestock classes is thought to best replicate the likely incidence of mortality arising from tick fever in an unprotected herd.

Table 5. North Queensland "high mortality saving" herd model (with tick fever vaccine)

Group	Number	A.E. rating	Adult Equivalents
Cows	156 590	0.95	148 761
Heifers	49 450	0.95	46 978
Heifers	69 917	0.91	63 624
Weaner Heifers	71 007	0.63	44 734
Steers	68 844	1.04	71 598
Steers	69 917	0.95	66 421
Weaner Steers	71 007	0.69	48 995
Calves	144 228	0.16	23 076
Bulls	8 242	1.21	9 973
Total	709 202		524 160

Table 6 indicates the differences in herd structure resulting from the use of the vaccine. One major difference is the reduction in replacement breeders and young females in the herd "with" the vaccine compared to the herd "without" the vaccine. Part of this reduction is offset up by extra sale steers in the herd "with" the vaccine.

Although the changes in herd structure seem relatively minor when spread over a herd of more than 500 000 head the overall efficiency of the herd is improved with a larger component of the herd contributing to sales and a lower component covering for mortalities in female stock. It is also important to note that this gain in efficiency is not achieved through an increase in grazing pressure making any economic gains real and not contrived.

Table 6. Differences in the North Queensland 'high mortality saving' herd models

Group	Without tick fever vaccine	With tick fever vaccine	Difference
	Number	Number	Number
Cows	157 394	156 590	-804
Heifers	49 703	49 450	-253
Heifers	69 614	69 917	303
Weaner Heifers	71 035	71 007	-28
Steers	68 222	68 844	622
Steers	69 614	69 917	303
Weaner Steers	71 035	71 007	-28
Calves	144 968	144 228	-740
Bulls	8 284	8 242	-42
Total	709 869	709 202	-667

Table 7 identifies the changes in income and variable costs resulting from the use of tick fever vaccine to protect 21 per cent of the beef cattle in the tick-infested part of North Queensland.

Table 7. Gross margin differences in the North Queensland 'high mortality saving' herd models

	Without vaccine	With vaccine	Difference
	$	$	$
Gross Revenue			
Breeder Herd Sales	106 505 429	107 887 666	**1 382 237**
Variable Expenses			
Bull Purchases	8 120 000	7 878 500	**(241 500)**
Breeder Herd Yard Fees Livestock Levy	644 335	652 250	**7 915**
Livestock Freight Costs	1 668 222	1 686 554	**18 332**
Fodder - Breeders	5 177 425	5 151 000	**(26 425)**
Fodder - Dry Stock	4 922 715	4 932 340	**9 625**
Fodder Bulls	165 680	164 840	**(840)**
Fodder - Weaners	1 420 690	1 420 140	**(550)**
Pregnancy Testing	1 035 485	1 030 200	**(5 285)**
Buffalo Flies - all stock	1 694 703	1 694 922	**219**
Ticks Worms - all stock	0	0	**0**
5 in 1 branding tags	724 840	721 140	**(3 700)**
Trivalent vaccine	0	497 049	**497 049**
Vibrio - all stock	41 420	41 210	**(210)**
Leptospirosis treatment	430 762	428 564	**(2 198)**
Drench growth promotant	843 894	845 544	**1 650**
Total Variable Expenses	**26 890 171**	**27 144 253**	**254 082**
GROSS MARGIN	**79 615 258**	**80 743 413**	**1 128 155**

Herd sales are expected to rise by more than $1.3 million across the region with some variable expenses reduced significantly. The total cost of the vaccine is estimated to be about $0.5 million per annum, leading to an improvement in the total gross margin for the region of approximately $1.12 million. The cost apportioned to tick fever vaccine use does not include an allowance for application or mustering costs as the vaccine is expected to be applied as a part of ongoing property operations.

Table 8 identifies the level of change in production and profitability indicators for the North Queensland region. It is important to note that even though the gross margin increases by about 1 per cent, the cost of producing beef slightly reduces and the volume of beef produced increases by more than 1 per cent.

Table 8. Gross margin diagnostics for the North Queensland 'high mortality saving' herd models

	Without change	With change	Change	% change
	$	$	$	%
G.M. per A.E.	151.89	154.04	2.152	1.42
Cost of per kg beef produced	0.7598	0.7571	(0.0027)	-0.359
Net beef price (cents per kg dressed)	$2.98	$2.98	0.00	
Kilograms of beef sold (dressed)	35 695 727 kg	36 159 929kg	464 202 kg	1.30

Table 9 summarises the expected impact of the tick fever vaccine at the property level for each of the regional models and vaccination scenarios. The proportional changes in cost and output are used in the economic surplus calculations undertaken in the next section. The gross margin values indicate the potential total farm level benefits of applying the vaccine and may or may not indicate the level of economic benefits associated with the tick fever vaccine.

A number of factors which were not included in the gross margin calculation impact on the overall level of economic benefits. They include the elasticities for supply and demand that apply to the extra output, the marginal change in the cost of producing the output, whether the output is consumed within the region or exported and the relative prices for exported and locally consumed output.

Table 9. Expected impact range for tick fever vaccine at the property level in Queensland

Region	Beef production unvaccinated herd	Proportional change in cost with vaccination	Proportional change in output with vaccination
	Kg dressed weight	%	%
High mortality saving			
North	35 695 727	-0.359	1.30
Central	116 724 420	-2.15	2.29
SEQ	44 465 161	-2.03	3.21
Low mortality saving			
North	35 695 727	1.66	0.098
Central	116 724 420	0.47	0.71
SEQ	44 465 161	-0.81	1.52

If North Queensland beef producers can only save the predicted lower bound estimate (161 mortalities) by applying the vaccine to more than 142 000 weaners per annum, they would be better off by about $372 257 in not applying the vaccine. Conversely, if North Queensland beef producers can save the 2 147 mortalities predicted as the upper bound estimate of benefit, the gross margin for the region could be increased by $1 128 155. (Data not shown)

4. Economic surplus accruing to the use of the tick fever vaccine

4.1 Modelling framework

The analyses completed in an evaluation estimates the potential economic benefits that may be provided to Queensland through funding an investment or project. The question addressed is – what are the likely economic benefits to Queensland compared to the total costs of the investment?

Most often, the expected outcomes of an evaluated investment or project are new technologies that improve productivity either through higher levels of production or saving on the level of inputs for existing enterprises. When primary producers adopt technology, the unit cost of production is expected to be reduced because of increased yields, reductions in output losses, lower costs for inputs or increased efficiency of input use. The consequence of innovation adoption is normally an increased supply which, depending on the relationship between demand and prices, can lead to price reductions.

The same evaluation framework will be applied to the evaluation of the Tick Fever vaccine even though the technology is well developed and has reached a stable level of adoption. The economic benefits to be estimated in this case relate more to the ongoing provision of a service to industry, not necessarily to the benefits associated with an innovation or new technology.

The objective of the analysis, in either case, is to quantify the expected aggregate benefits to society as a whole. This is usually done through applying a model that estimates the percentage downward shift in a commodity supply function resulting from the introduction of new technology or production strategy and calculating the change in total economic benefits as a result of this at the producer level and down the marketing chain. The shift in any given year will be derived from the technology's projected potential reduction in per unit production cost and the adoption rate of the technology. The projected per unit cost reduction is derived from the changes in yield and cost of production per unit e.g. per hectare, per tonne, identified in the farm level analysis.

In an economic surplus model, the reduction in cost per unit of production at each level of production is represented by a parallel downwards shift in the supply curve. The resulting benefits are measured as an increase in surplus, shaded in Figure 1 below.

Figure 1 represents a simple static form of the model, in which the change in surplus (change in benefits) occurs in a single period of time.

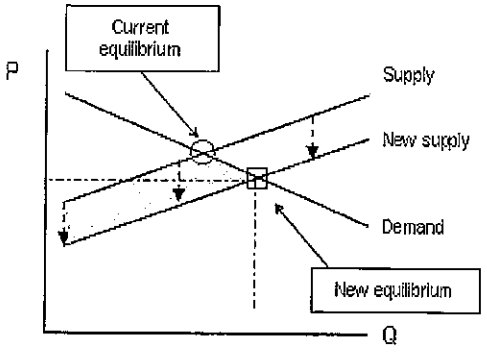

Figure 1. Static model of surplus change when costs of production decrease

In the dynamic model the size of the surplus will be affected by:

- The responsiveness of supply and demand to productivity changes
- The existing market equilibrium
- The size of the shift in the supply curve
- Characteristics of the industry (e.g. size, rate of adoption)

The DREAM benefit-cost analysis program (Wood et al. 2001) was selected as the modelling framework. This program is based on the economic principles developed in Alston et al. (1998), and it has been widely used in impact assessment studies over a number of years by many different national and international institutions.

DREAM has a number of different sub-models representing different types of market situations. One of these is the "horizontal multi-market" option. This provides a means of assessing the economic impact of a new technology in the context where the product under study is (relatively) freely traded across a number of regions, a situation closely approximated in the Australian beef industry.

4.2 Measuring the economic benefits of tick fever vaccine

This current study closely follows the approach used by Griffith et al. (2006) in their assessment of investment in the latest iteration of the Beef CRC.

Griffith et al. (2006) chose the year 2001-02 as the base year for the price and quantity data as this was the most recent year where the full set of required data was available. This year was also "*considered to be broadly representative of the peaks and troughs of the world beef market during the coming couple of decades, taking into account the inevitable consequences of the US cattle* cycle (Griffith and Alford 2005, 2002) *and the increasing risks associated with market disruptions caused by droughts and disease outbreaks*" (Griffith et al. 2006).

The original base price and quantity data used by Griffith et al. (2006) are given in Table 10. Notes explaining calculations relating to these data are provided below the table.

Table 10. Base Price and Quantity Data, Beef and Veal, 2001/02

Region	Production	Consumption	Beef Exports		Cattle	Exports	Price
	(ktcw)	(ktcw)	(ktcw)	(ktsw)	(ktcw)	(head)	($AU/tonne)
NSW	474	296	204		0.733	3 877	3 130
VIC	355	171	144		8.464	44 785	3 223
QLD	978	129	556		28.507	150 829	2 634
SA	86	54	37		4.571	24 184	2 714
WA	96	68	21		62.608	331 258	2 550
TAS	45	17	21		-		2 773
NT	1	7	-		50.121	265 190	2 592
Australia	2 034	742	1 292	984	155	820 139	
US	11 762	12 268	-506				4 016
Japan	457	1 207	-750				5 110
Korea	190	580	-390				4 295
Rest of the World	35 753	35 399	354				4 016
World	50 196	50 196	0				

Source: Unless otherwise noted, all data are from MLA Statistical Review July 2001 - June 2002
Notes: Consumption in each state is calculated as 35.5 kg/capita times state population for 2001-02 as given in ABS (2003), Australia at a Glance cat. no.1309.9; live weight of 350kg and an average dressing percentage of 54 per cent. In the model, these equivalents are added to production in each Australian State, to ROW consumption and to both world production and consumption In the model WA is split into north and south. In the absence of firm data, production is set equal in both halves and demand is set to 50 in the south and to 18 in the north; Domestic prices are for steers 260-300 kg HSCW; NT price is an average of QLD and WA; US price is Australian boneless cow beef,90 per cent CL, FAS; Japan price is Australian chilled boneless grassfed fullset FAS; Korea price is unit value of all Australian beef and veal exports to Korea, FOB

The values used in the Beef CRC analysis were able to be aggregated and simplified for use in the current analysis due to the concentration of impacts within the tick endemic regions of Queensland with no real ability of the technology to be gainfully used outside of those regions. Table 11 provides the base price and quantity data applied in the current analysis.

Table 11. Tick fever vaccine model parameters

Region	Consumption	Production	Price
	Ktcw	ktcw	$AU /tonne
North Qld	4.71	35.70	2 634
Central Qld	15.40	116.72	2 634
SEQ	5.87	44.47	2 634
Rest of Queensland	103.03	781.11	2 634
Rest of Australia	613.00	1 056.00	3 130
Rest of World	49 454.00	48 162.00	4 016
World	50 196.00	50 196.00	

The base elasticity values for the Beef CRC analysis have been used as the inputs for the current analysis (Table 12). The values applied in the current analysis are marked with an *.

Table 12. Base Supply and Demand Elasticity Values

Region	Supply Elasticity	Demand Elasticity
NSW*	1	-0.33
VIC*	1	-0.33
QLD*	0.75	-0.27
SA	1	-0.33
WA (North/South)	0.75/1.00	-0.27/-0.33
TAS	1	-0.33
NT	0.75	-0.27
US	1	-3
JAPAN	0.7	-2
KOREA	0.7	-2
ROW*	1	-5

In this analysis, the current rate of use of vaccine is expected to continue into the foreseeable future. That is, the current proportion of the cattle industry using the vaccine is considered likely to do so for the foreseeable future. The life of the investment was considered to be 20 years and a discount rate of 5 per cent was applied.

Table 13 identifies the proportional changes in output and cost predicted for each region by the farm level models and the subsequent shift in the supply curve (k factor) predicted by the DREAM program.

Table 13. Supply shift variables used by DREAM

Region	Beef production	Proportional change in cost with vaccination	Proportional change in output with vaccination	k factor predicted by DREAM
	(ktcw)	%	%	
High mortality saving				
North	35.70	-0.359	1.30	1.65
Central	116.72	-2.15	2.29	4.39
SEQ	44.47	-2.03	3.21	5.18
Low mortality saving				
North	35.70	1.66	0.09	-1.57
Central	116.72	0.47	0.71	0.24
SEQ	44.47	-0.81	1.52	2.31

4.3 Measuring the economic cost of providing the tick fever vaccine

The TFC earns significant income from the sale of vaccine to industry while industry pays a significant cost to use the vaccine. As a part of the assessment of impact at the property level, the cost of the vaccine to industry has already been included. To ensure that this cost is not double counted in the economic analysis, it needs to be removed from the assessment of the cost of providing the service.

The TFC is also a part of a large, publicly funded Government Department that provides significant financial and other support to the TFC, enabling the provision of the vaccine to industry. The total cost is difficult to determine as such things as corporate support are difficult to apportion within Government Departments. Conversely, the TFC also provides services not related to the vaccine and even if the vaccine was not produced some of these services relating to tick fever would continue to be supplied by departmental personnel.

To simplify the process of costing the service provided by the TFC, the policy for the implementation of full cost pricing in Queensland is applied (Queensland Treasury 1994). In this analysis, the TFC is treated as a Significant Business Activity (SBA) under the National Competition Policy (NCP) with costs allocated according to that policy.

To comply with the policy, the SBA must:

- Meet all fixed and variable costs (including tax equivalents)
- Achieve an appropriate rate of return on equity over the medium term
- Charge prices that reflect a similar cost structure to that faced by a private sector competitor
- Allow for "disadvantages" such as
  - Public sector employment conditions
  - Inability to adjust staffing numbers for peaks and troughs
  - Community service obligations

The policy stipulates the formation of a cost "benchmark" that includes:

- operating costs
- non-current assets used (capital costs)
- taxes and tax equivalents
- costs of debt financing
- competitive neutrality adjustments
- Crown indemnity where provided in respect of insurance;
- tied clients;
- intellectual property ;
- Worker's Compensation premiums;
- possible lack of tendering costs for government

The cost of providing the TFC was modelled in an investment analysis spreadsheet formulated using standard guidelines (Robinson and Barry 1996). The output of the spreadsheet is summarised below (Table 14). Variable costs provided by the TFC business plan have been adjusted to remove capital expenditure.

Table 14. Inflows and outflows calculated for the TFC investment analysis

Year	Inflows	Capital costs	Variable costs	Total outflows	Surplus/ Deficit
	$	$	$	$	$
0		20 931 913		20 931 913	-20 931 913
1	3 380 180	1 155 183	3 527 451	4 682 634	-1 302 454
2	3 088 579	0	3 377 906	3 377 906	-289 327
3	3 132 914	0	3 371 180	3 371 180	-238 266
4	3 177 277	0	3 398 056	3 398 056	-220 779
5	3 226 168	6 000	3 422 652	3 428 652	-202 484
6	3 318 294	104 415	3 451 118	3 555 533	-237 239
7	3 325 971	28 828	3 460 236	3 489 064	-163 093
8	3 357 053	0	3 460 236	3 460 236	-103 183
9	3 383 516	34 964	3 460 236	3 495 200	-111 684
10	3 476 331	189 130	3 460 236	3 649 366	-173 035
11	3 425 023	135 639	3 460 236	3 595 875	-170 853
12	3 400 329	86 551	3 460 236	3 546 787	-146 459
13	3 371 467	28 828	3 460 236	3 489 064	-117 597
14	3 356 903	0	3 460 236	3 460 236	-103 333
15	3 361 553	6 000	3 460 236	3 466 236	-104 683
16	3 409 260	104 415	3 460 236	3 564 651	-155 390
17	3 440 763	127 143	3 460 236	3 587 379	-146 616
18	3 357 053	0	3 460 236	3 460 236	-103 183
19	3 384 745	50 958	3 460 236	3 511 194	-126 449
20	23 926 954	397 000	3 460 236	3 857 236	20 069 718

The following assumptions were made when adjusting the information provided in the TFC 2008-09 business plan to form the cost "benchmark":

- The analysis of the TFC investment incorporates all expected capital and direct operating costs associated with the TFC and identified in the TFC 2008-09 business plan.

- Inflows are included to offset the expenditure on vaccine shown in the property level analysis. They are largely comprised of vaccine sales with adjustments made to reflect the expected real price increases.

- It is assumed that the TFC has sufficient staff resources to undertake management activities associated with running the centre as a "stand alone business". On this basis no allowance for overheads associated with the Departmental management structure have been included as a cost.

- The amount of public liability insurance potentially required by a non-government business providing a blood based vaccine similar to the tick fever vaccine could not be easily estimated and is not included.

- The imputed "taxation liability" of the TFC was estimated using the company tax rate and adjusting vaccine prices and income until an internal rate of return of 7.5 per cent was achieved. Tax was levied on net income produced at this level of return.

If the life of the TFC investment is taken to be 20 years and the required rate of return on the investment is 7.5 per cent per annum, then the net cost to society of providing the vaccine is assessed as $1.6m per annum.

If the life of the TFC investment is extended to 30 years and the same discount rate maintained, the net cost to society is assessed as $1.8m per annum. As the TFC has been producing vaccine for more than 30 years and is likely to continue to do so for some time, the higher estimate of annual net cost to society of $1.8m per annum will be used in this analysis. Using a slightly higher cost for the provision of the service may cover part of the potential insurance and other unforseen costs of the hypothetical business.

5. Results

The inputs to the modelling framework were implemented in the DREAM program and simulated under two separate scenarios. One scenario calculated the economic benefits for the lower bound estimates of mortality savings and the second scenario calculated the economic benefits for the upper bound estimates of mortality savings. Results of the analysis are presented in Tables 15 and 16.

Table 15. Results for the 'low mortality saving' scenario (Present value from 2008-09 to 2028-29)

Region	Producer	Consumer	Total	Costs	Net	B/C ratio
	$'000	$'000	$'000	$'000	$'000	
North Queensland	-18 294	0	-18 294	0	-18 293	
Central Queensland	9 189	2	9 192	0	9 192	
South East Queensland	34 156	1	34 156	0	34 156	
Rest of Queensland	-92	12	-80	23 534	-23 633	
Rest of Australia	-125	72	-52	0	-52	
Rest of World	-4 544	4 666	123	0	121	
Total NPV Benefits	20 290	4 754	25 044	23 554	1 490	1.06

Table 16. Results for the 'high mortality saving' scenario (Present value from 2008-09 to 2028-29)

Region	Producer	Consumer	Total	Costs	Net	B/C ratio
	$'000	$'000	$'000	$'000	$'000	
North Queensland	19 410	6	19 416	0	19 415	
Central Queensland	170 815	19	170 835	0	170 834	
South East Queensland	77 026	7	77 033	0	77 033	
Rest of Queensland	-983	130	-853	23 554	-24 406	
Rest of Australia	-1 329	771	-557	0	-557	
Rest of World	-48 484	49 787	1 303	0	1 303	
Total NPV Benefits	216 455	50 721	267 177	23 554	243 623	11.34

If the TFC reduces mortality in the beef herd equivalent to the 'low mortality savings' scenario on average, then the total benefits provided by the vaccine would only cover the net cost of providing the vaccine.

If the TFC reduces mortality in the beef herd equivalent to the 'high mortality savings' scenario on average, then the total benefits provided by the vaccine exceed the net cost of providing the vaccine by about 11 times.

In the low mortality scenario, beef producers located in North Queensland have their total surplus reduced by approximately $18m over the life of the investment while producers located in South East Queensland gain benefits due to the higher risk associated with the disease in that region. Central Queensland producers gain a significant share of the total benefits only if higher levels of mortality are prevented.

Consumers gain between 20 per cent and 25 per cent of the total benefits produced by the vaccine with 98 per cent of total consumer benefits accruing to consumers outside of Australia.

The level of mortality prevented by the tick fever vaccine, on average, is unknown but is thought to be somewhere between the two values estimated by TFC staff. If the vaccine produces savings in mortality equivalent to the midpoint of the estimates, then the benefits of providing the vaccine outweigh the costs by about 3.5 to 1 (Table 17).

Table 17. Results for the 'median mortality saving' scenario (Present value from 2008-09 to 2028-29)

Region	Producer	Consumer	Total	Costs	Net	B/C ratio
	$'000	$'000	$'000	$'000	$'000	
North Queensland	-4 227	2	-4226	0	-4 226	
Central Queensland	33 394	6	33 401	0	33 401	
South East Queensland	56 393	2	56 395	0	56 395	
Rest of Queensland	-316	42	-275	23 553	-23 828	
Rest of Australia	-428	248	-179	0	-179	
Rest of World	-15 611	16 030	419	0	419	
Total NPV Benefits	69 204	16 331	85 535	23 553	61 981.2	3.63

The vaccine can be considered to be a mature technology where the majority of economic benefits to accrue to the part of industry using the vaccine. There appear to be no measureable social or environmental benefits.

6. Discussion

The TFC provides a significant and positive economic benefit to the Queensland and northern beef industry. Even though a number of identifiable economic and social benefits have proven difficult to measure accurately, they do exist and should be seen as adding considerably to the economic benefits quantified in this evaluation.

The benefits of the service provided by the TFC accrue almost 100% to industry, indicating that the policy of "beneficiary pays" could be implemented. Application of guidelines provided by the Queensland Treasury to calculate an appropriate price for the vaccine suggests that industry is currently receiving a considerable price subsidy.

Increasing vaccine prices by the proportion identified in this evaluation is expected to prove to be very problematic and such increases are not seen as a ready solution to reducing the cost to the State of providing the vaccine to industry. A number of integrated options for the future operation of the TFC need to be closely considered if the gap between the cost of providing the vaccine and the price paid by industry is to be reduced.

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Appendix 1. Herd model parameters

North Queensland

Table 18. North Queensland 'low mortality' herd model (without tick fever vaccine)

Group	Number	A.E. rating	Adult Equivalents
Cows	157 394	0.95	149 524
Heifers	49 703	0.95	47 218
Heifers	69 614	0.91	63 349
Weaner Heifers	71 035	0.63	44 752
Steers	68 222	1.04	70 951
Steers	69 614	0.95	66 133
Weaner Steers	71 035	0.69	49 014
Calves	144 968	0.16	23 195
Bulls	8 284	1.21	10 024
Total	709 869		524 160
Opening numbers	564 901		

Table 19. North Queensland 'low mortality' herd model (with tick fever vaccine)

Group	Number	A.E. rating	Adult Equivalents
Cows	157 436	0.95	149 564
Heifers	49 621	0.95	47 140
Heifers	69 625	0.91	63 359
Weaner Heifers	71 033	0.63	44 751
Steers	68 245	1.04	70 975
Steers	69 625	0.95	66 144
Weaner Steers	71 033	0.69	49 013
Calves	144 940	0.16	23 190
Bulls	8 282	1.21	10 021
Total	709 840		524 157

Table 20. Differences in the North Queensland 'low mortality' herd models

Group	Without tick fever vaccine	With tick fever vaccine	Difference
	Number	Number	Number
Cows	157 394	157 436	42
Heifers	49 703	49 621	-82
Heifers	69 614	69 625	11
Weaner Heifers	71 035	71 033	-2
Steers	68 222	68 245	23
Steers	69 614	69 625	11
Weaner Steers	71 035	71 033	-2
Calves	144 968	144 940	-28
Bulls	8 284	8 282	-2
Total	709 869	709 840	-29

Table 21. Gross margin differences in the North Queensland 'low mortality' herd models

	Without vaccine	With vaccine	Difference
	$	$	$
Gross revenue			
Breeder herd sales	106 505 429	106 598 539	93 110
Variable costs			
Bull purchases	8 120 000	8 109 500	(10 500)
Yard fees & livestock levy	644 335	644 990	655
Livestock freight costs	1 668 222	1 669 577	1 354
Fodder – breeders	5 177 425	5 176 425	(1 000)
Fodder – dry stock	4 922 715	4 923 030	315
Fodder – bulls	165 680	165 640	(40)
Fodder – weaners	1 420 690	1 420 660	(30)
Pregnancy testing	1 035 485	1 035 285	(200)
Buffalo flies –all stock	1 694 703	1 694 700	(3)
5 in 1, branding, tags	724 840	724 700	(140)
Trivalent vaccine	0	497 231	497 231
Vibrio	41 420	41 410	(10)
Leptospirosis treatment	430 762	430 678	(84)
Drench, Growth promotants	843 894	843 948	54
Total variable expenses	26 890 171	27 377 774	487 602
Gross Margins	79 615 258	79 220 765	(394 492)

Table 22. Gross margin diagnostics for the North Queensland 'low mortality' herd models

	Without change	With change	Change	% change
	$	$	$	%
G.M. per A.E.	151.89	151.14	(0.752)	-0.49
Cost of per kg beef produced	0.76	0.77	0.0129	1.703
Net beef price (cents per kg dressed)	2.98	2.98	(0.00)	
Kilograms of beef sold (dressed)	35 695 727'kg	35 729 097kg	33 370kg	0.0935

Central Queensland

Table 23. Central Queensland 'high mortality' herd model (without tick fever vaccine)

Group	Number	A.E. rating	Adult Equivalents
Cows	454 521	0.96	436 340
Heifers	135 766	0.96	130 335
Heifers	214 766	0.95	204 028
Weaner Heifers	218 037	0.70	152 626
Steers	0	0.99	0
Steers	214 766	1.02	219 061
Weaner Steers	218 037	0.78	170 069
Calves	442 715	0.17	75 262
Bulls	23 611	1.21	28 569
Total	1 922 219		1 416 290
Opening numbers	1 479 504		

Table 24. Central Queensland 'high mortality' herd model (with tick fever vaccine)

Group	Number	A.E. rating	Adult Equivalents
Cows	458 061	0.96	439 739
Heifers	130 031	0.96	124 830
Heifers	215 904	0.95	205 109
Weaner Heifers	218 207	0.70	152 745
Steers	0	0.99	0
Steers	215 904	1.02	220 222
Weaner Steers	218 207	0.78	170 201
Calves	441 069	0.17	74 982
Bulls	23 524	1.21	28 464
Total	1 920 907		1 416 291

Table 25. Differences in the Central Queensland 'high mortality' herd models

Group	Without tick fever vaccine	With tick fever vaccine	Difference
	Number	Number	Number
Cows	454 521	458 061	3 540
Heifers	135 766	130 031	-5 735
Heifers	214 766	215 904	1 138
Weaner Heifers	218 037	218 207	170
Steers	0	0	0
Steers	214 766	215 904	1 138
Weaner Steers	218 037	218 207	170
Calves	442 715	441 069	-1 646
Bulls	23 611	23 524	-87
Total	1 922 219	1 920 907	-1 312

Table 26. Gross margin differences in the Central Queensland 'high mortality' herd models

	Without vaccine	With vaccine	Difference
	$	$	$
Gross revenue			
Breeder herd sales	347 686 803	354 987 318	7 300 515
Variable costs			
Bull purchases	22 725 500	22 032 500	(693 000)
Yard fees & livestock levy	2 056 420	2 103 600	47 180
Livestock freight costs	5 263 269	5 359 423	96 154
Fodder – breeders	17 708 610	17 642 760	(65 850)
Fodder – dry stock	15 148 105	15 193 885	45 780
Fodder – bulls	472 220	470 480	(1 740)
Fodder – weaners	10 901 850	10 910 350	8 500
Pregnancy testing	2 951 435	2 940 460	(10 975)
Buffalo flies –all stock	4 438 512	4 439 514	1 002
5 in 1, branding, tags	2 213 575	2 205 345	(8 230)
Trivalent vaccine	0	1 483 808	1 483 808
Vibrio	118 055	117 620	(435)
Leptospirosis treatment	1 227 796	1 223 232	(4 564)
Drench, Growth promotants	2 596 818	2 604 666	7 848
Total variable expenses	87 822 165	88 727 642	905 477
Gross Margins	259 864 639	266 259 676	6 395 037

Table 27. Gross margin diagnostics for the Central Queensland 'high mortality' herd models

	Without change	With change	Change	% change
	$	$	$	%
G.M. per A.E.	183.48	188.00	4.515	2.46
Cost of per kg beef produced	0.7544	0.7455	(0.0089)	-1.17
Net beef price (cents per kg dressed)	2.98	2.97	(0.00)	
Kilograms of beef sold (dressed)	116 724 420 kg	119 324 899 kg	2 600 479 kg	2.23

Table 28. Central Queensland 'low mortality' herd model (without tick fever vaccine)

Group	Number	A.E. rating	Adult Equivalents
Cows	454 521	0.96	436 340
Heifers	135 766	0.96	130 335
Heifers	214 766	0.95	204 028
Weaner Heifers	218 037	0.70	152 626
Steers	0	0.99	0
Steers	214 766	1.02	219 061
Weaner Steers	218 037	0.78	170 069
Calves	442 715	0.17	75 262
Bulls	23 611	1.21	28 569
Total	1 922 219		14 16 290
Opening numbers	1 479 504		

Table 29. Central Queensland 'low mortality' herd model (with tick fever vaccine)

Group	Number	A.E. rating	Adult Equivalents
Cows	455 629	0.96	437 404
Heifers	133 969	0.96	128 610
Heifers	215 123	0.95	204 367
Weaner Heifers	218 091	0.70	152 663
Steers	0	0.99	0
Steers	215 123	1.02	219 425
Weaner Steers	218 091	0.78	170 111
Calves	442 199	0.17	75 174
Bulls	23 584	1.21	28 537
Total	1 921 809		1 416 291

Table 30. Differences in the Central Queensland 'low mortality' herd models

Group	Without tick fever vaccine	With tick fever vaccine	Difference
	Number	Number	Number
Cows	454 521	455 629	1 108
Heifers	135 766	133 969	-1 797
Heifers	214 766	215 123	357
Weaner Heifers	218 037	218 091	54
Steers	0	0	0
Steers	214 766	215 123	357
Weaner Steers	218 037	218 091	54
Calves	442 715	442 199	-516
Bulls	23 611	23 584	-27
Total	1 922 219	1 921 809	-410

Table 31. Gross margin differences in the Central Queensland 'low mortality' herd models

	Without vaccine	With vaccine	Difference
	$	$	$
Gross revenue			
Breeder herd sales	347 686 803	349 971 062	2 284 258
Variable costs			
Bull purchases	22 725 500	22 508 500	(217 000)
Yard fees & livestock levy	2 056 420	2 071 185	14 765
Livestock freight costs	5 263 269	5 293 355	30 086
Fodder – breeders	17 708 610	17 687 940	(20 670)
Fodder – dry stock	15 148 105	15 162 475	14 370
Fodder – bulls	472 220	471 680	(540)
Fodder – weaners	10 901 850	10 904 525	2 675
Pregnancy testing	2 951 435	2 947 990	(3 445)
Buffalo flies –all stock	4 438 512	4 438 829	317
5 in 1, branding, tags	2 213 575	2 210 995	(2 580)
Trivalent vaccine	0	1 483 015	1 483 015
Vibrio	118 055	117 920	(135)
Leptospirosis treatment	1 227 796	1 226 364	(1 432)
Drench, Growth promotants	2 596 818	2 599 284	2 466
Total variable expenses	87 822 165	89 124 057	1 301 892
Gross Margins	259 864 639	260 847 005	982 366

Table 32. Gross margin diagnostics for the Central Queensland 'low mortality' herd models

	Without change	With change	Change	% change
	$	$	$	%
G.M. per A.E.	183.48	184.18	0.693	0.38
Cost of per kg beef produced	0.75	0.76	0.0059	0.78
Net beef price (cents per kg dressed)	2.98	2.98	(0.00)	
Kilograms of beef sold (dressed)	116 724 420 kg	117 538 140 kg	813 720	0.70

South-East Queensland

Table 33. South-East Queensland 'high mortality' herd model (without tick fever vaccine)

Group	Number	A.E. rating	Adult Equivalents
Cows	161 310	0.97	156 471
Heifers	46 826	0.97	45 421
Heifers	47 299	0.92	43 515
Weaner Heifers	82 422	0.71	58 520
Steers	0	0.97	0
Steers	81 598	1.03	84 046
Weaner Steers	82 422	0.82	67 586
Calves	166 509	0.18	29 972
Bulls	7 285	1.21	8 815
Total	675 671		494 345
Opening numbers	509 162		

Table 34. South-East Queensland 'high mortality' herd model (with tick fever vaccine)

Group	Number	A.E. rating	Adult Equivalents
Cows	167 099	0.97	162 086
Heifers	41 957	0.97	40 698
Heifers	41 969	0.92	38 611
Weaner Heifers	83 599	0.71	59 355
Steers	0	1.03	86 083
Steers	83 576	0.82	68 551
Weaner Steers	83 599	0.18	30 104
Calves	167 245	1.21	8 854
Bulls	7 317		494 343
Total	676 361	1.03	86 083

Table 35. Differences in the South-East Queensland 'high mortality' herd models

Group	Without tick fever vaccine	With tick fever vaccine	Difference
	Number	Number	Number
Cows	161 310	167 099	5 789
Heifers	46 826	41 957	-4 869
Heifers	47 299	41 969	-5 330
Weaner Heifers	82 422	83 599	1 177
Steers	0	0	0
Steers	81 598	83 576	1 978
Weaner Steers	82 422	83 599	1 177
Calves	166 509	167 245	736
Bulls	7 285	7 317	32
Total	675 671	676 361	690

Table 36. Gross margin differences in the South-East Queensland 'high mortality' herd models

	Without vaccine	With vaccine	Difference
	$	$	$
Gross revenue			
Breeder herd sales	137 161 179	144 122 164	6 960 985
Variable costs			
Bull purchases	6 884 500	6 415 500	(469 000)
Yard fees & livestock levy	792 645	844 000	51 355
Livestock freight costs	2 009 197	2 118 665	109 468
Fodder – breeders	7 284 760	7 316 960	32 200
Fodder – dry stock	4 711 730	4 602 915	(108 815)
Fodder – bulls	145 700	146 340	640
Fodder – weaners	2 472 660	2 507 970	35 310
Pregnancy testing	2 081 360	2 090 560	9 200
Buffalo flies –all stock	1 527 486	1 527 348	(138)
5 in 1 branding tags	832 545	836 225	3 680
Trivalent vaccine	0	568 473	5 68 473
Vibrio	36 425	36 585	160
Leptospirosis treatment	430 842	432 746	1 904
Drench Growth promotants	984 120	1 003 050	18 930
Total variable expenses	30 193 970	30 447 337	253 367
Gross Margins	106 967 209	113 674 826	6 707 617

Table 37. Gross margin diagnostics for the South East Queensland 'high mortality' herd models

	Without change	With change	Change	% change
	$	$	$	%
G.M. per A.E.	216.38	229.95	13.570	6.27
Cost of per kg beef produced	0.68	0.66	(0.0289)	-4.22
Net beef price (cents per kg dressed)	3.08	3.08	(0.01)	
Kilograms of beef sold (dressed)	44 465 161 kg	46 809 550 kg	2 344 388 kg	5.27

Table 38. South-East Queensland 'low mortality' herd model (without tick fever vaccine)

Group	Number	A.E. rating	Adult Equivalents
Cows	161 310	0.97	156 471
Heifers	46 826	0.97	45 421
Heifers	47 299	0.92	43 515
Weaner Heifers	82 422	0.71	58 520
Steers	0	0.97	0
Steers	81 598	1.03	84 046
Weaner Steers	82 422	0.82	67 586
Calves	166 509	0.18	29 972
Bulls	7 285	1.21	8 815
Total	675 671		494 345
Opening numbers	509 162		

Table 39. South-East Queensland 'low mortality' herd model (with tick fever vaccine)

Group	Number	A.E. rating	Adult Equivalents
Cows	163 042	0.97	158 151
Heifers	45 373	0.97	44 012
Heifers	45 697	0.92	42 041
Weaner Heifers	82 776	0.71	58 771
Steers	0	0.97	0
Steers	82 190	1.03	84 656
Weaner Steers	82 776	0.82	67 876
Calves	166 732	0.18	30 012
Bulls	7 295	1.21	8 827
Total	675 881		494 345

Table 40. Differences in the South-East Queensland 'low mortality' herd models

Group	Without tick fever vaccine	With tick fever vaccine	Difference
Cows	161 310	163 042	1 732
Heifers	46 826	45 373	-1 453
Heifers	47 299	45 697	-1 602
Weaner Heifers	82 422	82 776	354
Steers	0	0	0
Steers	81 598	82 190	592
Weaner Steers	82 422	82 776	354
Calves	166 509	166 732	223
Bulls	7 285	7 295	10
Total	675 671	675 881	210

Table 41. Gross margin differences in the South-East Queensland 'low mortality' herd models

	Without vaccine	With vaccine	Difference
	$	$	$
Gross revenue			
Breeder herd sales	137 161 179	139 245 660	2 084 481
Variable costs			
Bull purchases	6 884 500	6 744 500	(140 000)
Yard fees & livestock levy	792 645	808 040	15 395
Livestock freight costs	2 009 197	2 041 998	2 801
Fodder – breeders	7 284 760	7 294 525	9 765
Fodder – dry stock	4 711 730	4 679 005	2 725)
Fodder – bulls	145 700	145 900	200
Fodder – weaners	2 472 660	2 483 265	10 605
Pregnancy testing	2 081 360	2 084 150	2 790
Buffalo flies –all stock	1 527 486	1 527 446	(41)
5 in 1 branding tags	832 545	833 660	1 115
Trivalent vaccine	0	562 873	562 873
Vibrio	36 425	36 475	50
Leptospirosis treatment	430 842	431 420	578
Drench Growth promotants	984 120	989 796	5 676
Total variable expenses	30 193 970	30 663 052	469 083
Gross Margins	106 967 209	108 582 607	1 615 398

Table 42. Gross margin diagnostics for the South-East Queensland 'low mortality' herd model

	Without change	With change	Change	% change
	$	$	$	%
G.M. per A.E.	216.38	219.65	3.268	1.51
Cost of per kg beef produced	0.68	0.68	(0.0003)	-0.04
Net beef price (cents per kg dressed)	3.08	3.08	(0.00)	
Kilograms of beef sold (dressed)	44 465 161 kg	45 167 398 kg	702 237 kg	1.58

Appendix 2. Industry analysis

Beef and dairy cattle production

In 2007-08, Queensland accounted for 47 per cent (11.7 million) of the total beef cattle numbers (24.9 million) in Australia (Table 43). The distribution of the remaining 13.1 million beef cattle is 22 per cent in New South Wales, 9 per cent in Victoria, 8 per cent in Northern Territory and Western Australia and 6 per cent in the rest of Australia.

Dairy cattle in Queensland account for only a small proportion (7 per cent) of the total dairy cattle in Australia. Victoria has the majority (62 per cent) of the dairy cattle.

Table 43. Beef and dairy cattle number, by State (2007-08)

State	Beef Cattle '000	Beef Cattle %	Dairy cattle '000	Dairy cattle %
New South Wales	5 330	22	321	13
Victoria	2 254	9	1 583	62
Queensland	11 731	47	174	7
South Australia	966	4	160	6
Western Australia	2 013	8	101	4
Tasmania	444	2	198	8
Northern Territory	2 041	8		
Australian Capital Territory	3	0		
Australia	24 784	100	2 536	100

Source: Australian Bureau of Statistics (ABS) 2009, *Agricultural commodities 2007-08*, cat. no. 7121, ABS, Canberra.

Beef cattle production is the most important agricultural industry in Queensland accounting for 35 per cent ($3 388 million) of the total value of agricultural production of $9 785 million in 2007-08 (ABS 2009)

The number of Queensland producers engaged in beef cattle farming ranged from 11 285 in 2001-02 to 13 506 in 2007-08, an increase of 20 per cent over the period. For the past seven years Queensland consistently accounted for around 33 per cent of the beef cattle producers in Australia. The number of Queensland producers engaged in dairy farming decreased by 41 per cent from 1292 in 2001-02 to 762 in 2007-08 (Table 44).

Table 44. Beef cattle and dairy cattle farming

	Beef Cattle			Dairy Cattle		
Year	Queensland	Australia	% Queensland	Queensland	Australia	% Queensland
2001-02	11 285	34 110	33.1	1 292	11 135	11.6
2002-03	11 879	36 208	32.8	1 258	11 003	11.4
2003-04	11 505	35 501	32.4	1 120	10 359	10.8
2004-05	12 136	35 979	33.7	956	9 881	9.7
2005-06	13 934	42 691	32.6	911	9 371	9.7
2006-07	14 274	44 914	31.8	813	8 993	9.0
2007-08	13 506	41 640	32.4	762	8 792	8.7

Source Australian Bureau of Statistics (ABS) 2009, *Australian commodities, Australia,* cat. no. 7121, ABS, Canberra.

In 67 per cent of the years from 1997-2008, Queensland accounted for 50 per cent or more of the beef and veal production in Australia (Table 45).

Table 45. Queensland and Australia beef and veal production by Quarter, 2001-02 to 2007-08

Quarter	Queensland	Australia	Per cent of Australia
	tonnes	tonnes	%
Sep-97	228 478	508 373	44.94
Sep-98	235 771	510 705	46.17
Sep-99	251 995	506 314	49.77
Sep-00	271 148	523 865	51.76
Sep-01	296 316	547 599	54.11
Sep-02	275 082	552 323	49.80
Sep-03	264 038	502 061	52.59
Sep-04	294 271	562 993	52.27
Sep-05	284 227	514 753	55.22
Sep-06	306 832	559 741	54.82
Sep-07	280 717	541 634	51.83
Sep-08	275 816	548 418	50.29

Source: Australian Bureau of Statistics (ABS) 2009, *Livestock products, Australia,* cat no 7215.0, ABS, Canberra.

Table 46 shows that around 280 000 Queensland cattle were transported to other States.

Table 46. Interstate Cattle Movement 2007-08

State of origin	State of destination	Number of cattle
Queensland	New South Wales	158 311
Queensland	Northern Territory	111 721
Queensland	South Australia	4 164
Queensland	Victoria	1 536
Queensland	Western Australia	1 050
Queensland	Tasmania	36
	Total	276 818
New South Wales	Queensland	274 376
Northern Territory	Queensland	214 757
South Australia	Queensland	17 746
Victoria	Queensland	9 730
Western Australia	Queensland	661
Tasmania	Queensland	876
	Total	518 146

The cattle in Queensland are located on approximately 20 000 beef cattle properties ranging in size from 50 to 10 000 head. There are estimated 8.1 million cattle in tick-infested parts of Australia. Of these, 6.9 million are in Queensland involving 10 000 properties.

Exports

In 2007-08, Queensland exported 694 117 tonnes of meat and meat preparations worth around $3 billion (Table 47). The volume of Queensland meat and meat preparations exports was around 40 per cent of the volume of Australian exports of meat and meat preparations. The value of exports of Queensland meat and meat preparations was almost half of the Australian value of exports of meat and meat preparations.

Table 47. Meat and meat preparations exports (tonnes and A$)

Year	Queensland		Australia		Per cent of Australia	
	tonnes	A$ million	tonnes	A$ million	% tonnes	% A$
2003-04	648 058	2 750	1 437 629	5 757	45.1	47.8
2004-05	705 607	3 344	1 591 210	6 936	44.3	48.2
2005-06	702 645	3 302	1 559 954	6 709	45.0	49.2
2006-07	732 941	3 382	1 690 189	7 079	43.4	47.8
2007-08	694 117	3 092	1 635 412	6 542	42.4	47.3

Source: ABS 2009, Trade Data, unpublished report
http://datahub.govnet.qld.gov.au/economy/trade-report-commodities/index.shtml

Live exports of pure bred bovine animals for breeding from Queensland decreased from 6.6 per cent of Australian exports in 2003-04 to only 0.3 per cent of Australian exports. Although there was also a decrease in exports of live bovine animals (excluding pure bred breeding stock) in 2007-08 accounting for 8.9 per cent of Australian exports, the change in export value was not that much if compared to the 2003-04 export value percentage of 11.2 per cent (Tables 48 and 49).

Table 48. Live cattle export value (A$)

Year	Queensland			Australia		
	Live pure bred bovine animals, for breeding	Live bovine animals, (excl. pure bred breeding stock	Total	Live pure bred bovine animals, for breeding	Live bovine animals, (excl. pure bred breeding stock	Total
2003-04	9 477 092	35 609 228	45 086 320	143 390 653	317 850 418	461 241 071
2004-05	196 030	31 879 278	32 075 308	89 912 909	374 059 944	463 972 853
2005-06	732 700	24 522 742	25 255 442	46 157 514	357 792 833	403 950 347
2006-07	848 425	47 551 046	48 399 471	59 493 504	437 427 496	496 921 000
2007-08	250 083	39 906 994	40 157 077	90 158 817	450 511 369	540 670 186

Source: ABS 2009, Trade Data, unpublished report
http://datahub.govnet.qld.gov.au/economy/trade-report-commodities/index.shtml

Table 49. Queensland percentage of Australian live export values

Queensland	Live pure bred bovine animals for breeding	Live bovine animals (excl. pure bred breeding stock)	Total
	%	%	%
2003-04	6.6	11.2	9.8
2004-05	0.2	8.5	6.9
2005-06	1.6	6.9	6.3
2006-07	1.4	10.9	9.7
2007-08	0.3	8.9	7.4

As shown in Table 50, the live cattle export numbers (live pure bred bovine animals for breeding) decreased by 99.9 per cent from 8 608 120 in 2003-04 to just 12 837 in 2007-08. There was a similar trend Australia-wide with the decrease in numbers between 2003-04 and 2007-08 estimated at 46 per cent.

The change in the number of export of live bovine animals in Queensland that are not for breeding purposes is not as significant with only a 3 per cent decrease in number from 2003-04 to 2007-08.

Table 50. Live cattle export numbers

Year	Queensland			Australia		
	Live pure bred bovine animals, for breeding	Live bovine animals, (excl. pure bred breeding stock	Total	Live pure bred bovine animals, for breeding	Live bovine animals, (excl. pure bred breeding stock	Total
	Number	Number	Number	Number	Number	Number
2003-04	8 608 120	19 289 397	27 897 517	38 833 265	192 030 813	230 864 078
2004-05	13 330	14 780 258	14 793 588	14 420 401	191 730 268	206 150 669
2005-06	42 335	15 870 139	15 912 474	10 422 095	182 710 669	193 132 764
2006-07	162 399	22 418 481	22 580 880	13 581 153	216 139 405	229 720 558
2007-08	12 837	18 707 231	18 720 068	20 872 710	241 153 849	262 026 559

Source: ABS 2009, Trade Data, unpublished report
http://datahub.govnet.qld.gov.au/economy/trade-report-commodities/index.shtml

Table 51. Queensland as percentage of Australian live export numbers

Queensland	Live pure bred bovine animals, for breeding	Live bovine animals, (excl. pure bred breeding stock)	Total
	%	%	%
2003-04	22.2	10.0	12.1
2004-05	0.1	7.7	7.2
2005-06	0.4	8.7	8.2
2006-07	1.2	10.4	9.8
2007-08	0.1	7.8	7.1

Table 52. Export of Cattle by State 1989-90 to 2007-08

Year	Queensland	Australia	Per cent of Australia
	Number	Number	%
1989-90	36 642	98 439	37.2
1990-91	39 373	111 325	35.4
1991-92	53 261	137 007	38.9
1992-93	35 384	167 005	21.2
1993-94	42 623	250 455	17.0
1994-95	57 082	402 120	14.2
1995-96	163 209	649 715	25.1
1996-97	193 328	895 283	21.6
1997-98	123 594	722 796	17.1
1998-99	114 840	729 899	15.7
1999-00	218 115	853 809	25.5
2000-01	169 992	861 132	19.7
2001-02	150 829	820 726	18.4
2002-03	253 835	1 007 886	25.2
2003-04	71 443	681 908	10.5
2004-05	49 671	624 419	8.0
2005-06	34 920	577 737	6.0
2006-07	65 632	675 812	9.7
2007-08	56 087	769 187	7.3

Source: MLA 2009, *Market statistics database,*
<http://marketdata.mla.com.au/default.asp?RegionID=1&CategoryID=46&ClassificationID=44>

Industry outlook

Bos indicus cattle are more prevalent than *Bos taurus* breeds in the tick-infested central to northern regions of Queensland. In a 1999 producer survey, *Bos Taurus* herds were more prevalent in the South-East (13 per cent) but represented less than 2 per cent of herds in the North. Crossbred herds were fairly evenly distributed amongst regions (Table 53).

There are continuing trends to feedlot cattle before slaughter and a change in extensive grazing operations from family management towards large company owned operations such as Australian Agricultural Co. and Northern Australian Pastoral Co. These industry leaders have introduced European bulls into their breeding programs to improve productivity and meet demand of feedlot operations. Companies such as Woolworths are demanding at least 75 per cent *Bos taurus* content for their retail meat trade. However, the *Bos taurus* animals are more susceptible to ticks and tick fever and any trend towards tick susceptible cattle in tick endemic regions may be increasingly problematic as chemical resistant ticks spread.

Table 53. Breed type by region (1999 survey)

ABS region	*Bos taurus*	¼ *B. indicus*	3/8 *B. indicus*	½ *B indicus*	Over ½ *B. indicus*	Full *B indicus*	Herd
	%	%	%	%	%	%	No.
Brisbane Moreton	14	16	33	14	12	10	49
Wide-bay	13	13	27	22	22	5	88
Fitzroy	6	7	30	14	31	14	118
Mackay	2	10	22	12	27	27	41
Northern	4	0	0	21	29	46	24
Far North	0	5	5	20	55	15	20
North West	0	3	9	18	30	39	33
Total	7	9	24	17	27	17	373

Source: QPIF 2008, *Tick Fever Centre Marketing Plan 2008-09, QPIF, Brisbane*

Table 54. Queensland herd composition over recent years

Livestock class	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
	'000	'000	'000	'000	'000	'000	'000
Bulls and bull calves used or intended for service	273	233	280	298	287	329	
Other calves under one year	2 290	1 949	2 114	2 091	2 132	2 135	
Cows and heifers one year and over	5 762	5 380	5 638	5 844	5 745	5 589	6 113
Other cattle one year and over	2 959	2 946	3 213	3 147	3 189	3 442	5 617
Total meat cattle and calves	11 284	10 507	11 245	11 380	11 354	11 495	11 731
Total milk cattle and calves	260	233	255	221	194	189	174
Total cattle and calves	11 544	10 740	11 500	11 600	11 548	11 684	11 905

Production trends

Meat cattle numbers in Queensland have increased from 2001-02 to 2007-08 by an average of 0.74 per cent per annum while Australian meat cattle numbers only increased by an average of .07 per cent over the same period. For the past seven years, the meat cattle numbers in Queensland increased by 4 per cent while Australian numbers increased by only less than one per cent.

Table 55. Meat Cattle Number by State 2001-02 to 2007-08

State	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08
	'000	'000	'000	'000	'000	'000	'000
NSW	5 593	5 419	5 416	5 335	5 862	5 609	5 330
Vic	2463	2 491	2 390	2 540	2 646	2 575	2 254
Qld	11 284	10 507	11 245	11 380	11 354	11 495	11 731
SA	1 201	1 209	1 164	1 223	1 161	1 067	966
WA	1 980	1 815	1 962	2 011	2 275	2 223	2 013
Tas	432	482	496	498	501	481	444
NT	1 777	1 683	1 730	1 729	1 798	1 912	2 041
ACT	10	8	8	9	9	11	3
AUST	24 739	23 615	24 410	24 725	25 605	25 373	24 784

Source: ABS 2009, Cat No 7121.0

Table 56. Queensland and Australia Beef and Veal Production by Quarter 2001-02 to 2007-08

Month/Year	Queensland	Australia
Sep-97	228 478	508 373
Sep-98	235 771	510 705
Sep-99	251 995	506 314
Sep-00	271 148	523 865
Sep-01	296 316	547 599
Sep-02	275 082	552 323
Sep-03	264 038	502 061
Sep-04	294 271	562 993
Sep-05	284 227	514 753
Sep-06	306 832	559 741
Sep-07	280 717	541 634
Sep-08	275 816	548 418

Source: ABS 2009, *Livestock products, Australia,* cat no 7215.0, ABS, Canberra