final report

NORTHERN BEEF PROGRAM

Project code: B.NBP.0510

Prepared by: Geoffry Fordyce and Tim Emery

Queensland Primary Industries and Fisheries

Date published: September 2009

ISBN: 9781741915280

PUBLISHED BY
Meat & Livestock Australia
Locked Bag 991
NORTH SYDNEY NSW 2059

PDS Bow Park

Investigation of effectiveness of practical vaccination protocols for reproductive wastage in north Australian breeder herds

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

Abstract

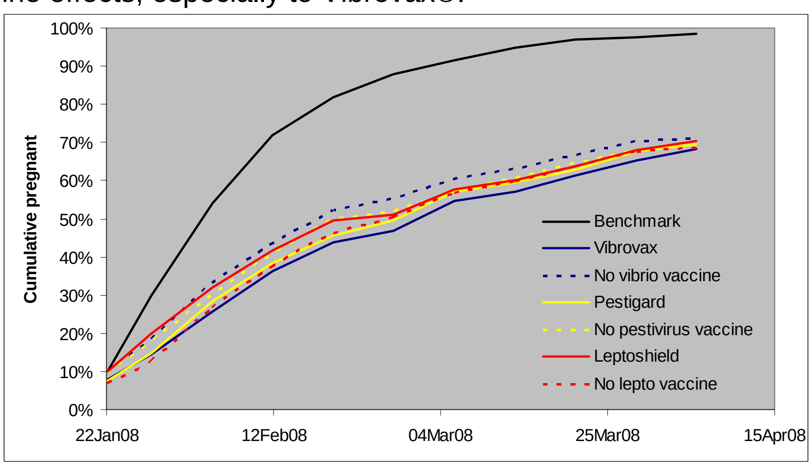
A PDS established north of Julia Creek assessed the viability of vaccines to help reduce the effects of vibriosis, pestivirus and leptospirosis, each of which can reduce profitability. None of the three vaccines used affected either pregnancies or calf loss. However, the extended 2007-08 wet season experienced demonstrated the dramatic over-riding impact of Akabane disease and 3-day sickness, which appeared to be the primary reasons for low pregnancy rates per oestrus (30%) in the 495 maiden heifers. These diseases are spread by biting insects during wet monsoonal conditions. Extreme weather conditions during late pregnancy and calving diluted any effects due to vaccines, and resulted in overall calf wastage of 24%, and a peak of almost 50% when calving during extreme wet conditions. The associated stress and loss in body condition resulted in only ~70% of dry cows and ~40% of wet cows cycling eight weeks into their second mating. As part of this project, recommendations were made for the cost-effective control, including vaccine use, in NW Queensland of vibriosis, pestivirus infection, leptospirosis and arboviral diseases. Recommendations were also made on correct use of vaccines in cattle, as well as how to minimise effects due to extreme weather conditions.

Executive Summary

The North-West Queensland Regional Beef Research Committee identified that reproductive wastage is high and a substantial cost to the industry in their region. MLA-sponsored studies have suggested that losses due to pestivirus in Queensland may be as high as $30M (Kirkland *et al*. 2009). They showed that, even though the vaccine is expensive and requires two injections, it is cost effective when it prevents as little as 1% chronic calf wastage. One estimate of the loss due to vibriosis and trichomoniasis in northern Australia's cattle herd is $6M (Fordyce and Burns 2007). No reliable estimates of industry cost due to leptospirosis are available because the magnitude of the biological effect remains equivocal. The group established a Producer Demonstration Site to examine the imapct of 3 commercially-available vaccines, Vibrovax®, Pestigard® and Leptoshield® on Bow Park Station north of Julia Creek where the target diseases were known to be endemic.

A group of 495 2-year-old, cycling Beefmaster heifers with an average weight of over 400 kg were allocated prior to maiden mating to receive 0, 1, 2 or all 3 of the vaccines, which were administered in Nov-Dec 2007 in accordance with manufacturer's recommendations. The heifers were mated in Jan-Apr 2008. Only pregnant heifers that met the owners' breeding objectives were retained till weaning in two management groups. The heifers experienced an extended wet season and a 3-day sickness epidemic during their maiden mating. During late pregnancy and early calving there was a late arrival of the wet season, which caused acute energy deficiency. This was followed by very high and sustained rainfall over the following 2 months which created boggy, stressful conditions and further exacerbated energy deficiency.

During maiden mating, the heifers experienced high exposure to vibriosis (presumably from neighbours' bulls), leptospirosis (*L. pomona* – pigs are the usual source), and the insect-borne Akabane disease and bovine ephemeral fever (BEF = 3-day sickness). There was no transmission of pestivirus within the heifers during the study period. No vaccine affected heifer pregnancy rates which were 28-31% per 21-days (average oestrus cycle length) and well below the benchmark of 70% per cycle, which is known to be achievable from studies with tropical cattle across Queensland. Akabane disease and BEF were considered the prime reasons for delayed pregnancies and why there were no vaccine effects, especially to Vibrovax®.



Cumulative pregnancies in maiden Bow Park heifers against benchmark levels

Retained pregnant heifers experienced severe dry conditions in late 2008 and extreme wet conditions in early 2009, which resulted in calf loss between confirmed pregnancy and weaning in surviving animals of 24%. Losses were almost 50% for heifers calving in January 2009 (24% of expected calvings). The time of calf loss was unknown, eg, the mortality rate of December calves during January. Pregnancy rates 5 weeks into the 2009 mating were 21% for wet cows and 60% for cows that had lost their calf. Despite some association between calf losses and *L. pomona* exposure, no vaccines affected calf wastage or re-conception rates, presumably because of the over-riding effects of seasonal conditions. Growth of suckling calves was depressed to an estimated 0.64 kg/day.

Each target vaccine caused site reactions in ~10% of animals. Site reactions to SingVac® given concurrently occurred in 3% of heifers.

Field days, with accompanying media releases, were held in April 2008 and May 2009 at which 17 beef businesses in the region were represented. At these days, project activities and outcomes were discussed as part of reaching conclusions for cost-effective control of reproductive diseases in the region. An analysis early in the project indicated that targeted control measures to increase pregnancy rates per cycle and to reduce calf wastage should not exceed $30 per heifer.

Pestivirus control: Vaccination is recommended in heifer groups, prior to maiden mating or to them rejoining the cow herd, if there is evidence that the disease is endemic and a relatively small proportion of the heifers have antibodies. This was the case for the group of heifers used in this project. Whole herd vaccination should be considered in naïve herds unless biosecurity measures can prevent exposure.

Vibriosis management: Vibriosis is endemic in most herds in the region. Where bull segregation from heifers is effective till maiden mating, pre-mating vaccination of heifers is recommended. Annual vaccination of all station bulls is advised. Vibriosis control has been previously associated with elevated pregnancy rates per cycle at Bow Park.

Leptospirosis control: A consistent net financial benefit from vaccination against leptospirosis has not been established in dry tropical regions, and this has not changed as a result of this study. Where feral pig populations are significant, soils have at least fair water-holding capacity, and extended wet conditions are consistent each year, it is possible that vaccination programs starting with weaner heifers may prevent calf wastage.

Managing impact of Akabane disease and BEF: If heifers have not experienced a good wet season as weaners, it may be prudent to mate extra to achieve the numbers of pregnancies required if they experience a good wet as maidens. Current studies with BEF vaccine may indicate its strategic use in heifers.

Vaccination protocols: Vaccination is expensive. It is a significant event for animals, as indicated by pain responses at administration and subsequent site reactions. Vaccines are labile products which may be rendered useless if handled incorrectly. Detailed guidelines for the selection, handling and administration of vaccines were discussed.

Contents

1 Background

A recent review has identified reproductive diseases such as bovine vibriosis, pestivirus or bovine viral diarrhea virus (BVDV) and leptospirosis to be endemic in most north Australian herds (Fordyce *et al.*, 2005). All three diseases may diminish reproductive performance, either by causing failure to achieve pregnancy, or loss during gestation or after birth, especially in the first post-natal week. Pregnancy rate per cycle can vary between 40 and 70% in *Bos indicus* females across northern Australia (Fordyce *et al.,* 2005), thus affecting weaner weights and profitability.

Vaccination is often a valuable component of disease control, yet it is expensive. The recommended protocol for most killed vaccines is two injections 4 weeks to 6 months apart, depending on vaccine. The extra mustering costs and logisitical problems encountered with handling stock in large extensive herds in northern Australia at difficult times means that many producers fail to adopt herd health programs. If producers were confident that vaccination would consistently improve both conception rates and conception patterns, the cost of vaccination may be justified. A two-year producer demonstration was established by the NW Qld Regional Beef Research Committee at Bow Park, 100 km north of Julia Creek, to investigate the potential role of available vaccines in reproductive disease control. Previous work at Bow Park has shown that:

- All the major reproductive diseases are present, as they most likely are for a majority of large northern herds. These diseases include vibriosis, pestivirus, trichomoniasis, leptospirosis, and neosporosis. Cattle in the region are also susceptible to a vast range of insect-borne viruses, especially 3-day and Akabane.
- Effective segregation combined with objective selection and culling of heifers is resulting in groups of heifers and young cows naïve to these diseases (Figure 1). This is of particular concern with vibriosis and pestivirus and may result in major calf loss if disease transmission in these groups occurs at an inopportune time.
- Pregnancy rate per cycle in heifers is less than 50%, with vibriosis suspected as the main cause. This delays average calving date by several weeks, thus lowering weaner weights, with flow on to subsequent years.
- In one observation, losses between confirmed pregnancy and weaning were 17% from first pregnancy, but <10% in later pregnancies; however no infectious agent was indicated as responsible.

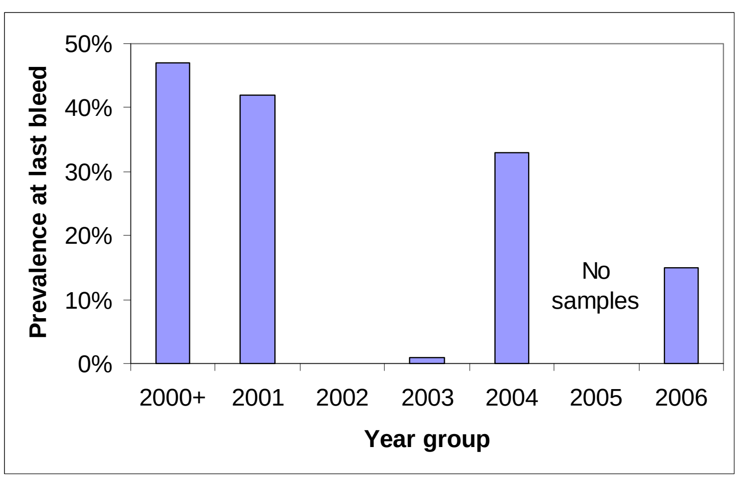


Figure 1. Prevalence of pestivirus at Bow Park demonstrating that No. 02 and No. 03 females were naïve to pestivirus prior to joining the cow herd (No. 01 and older)

2 Project Objectives

By 31 October 2009:

- Examined the impact of vaccination programs on reproductive performance in maiden heifers on a north Australian extensive property.
- Established the losses that may occur due to vibriosis, pestivirus and leptospirosis in unvaccinated maiden heifers.
- Updated recommendations for implementing cost-effective vaccination programs on northern pastoral properties.
- Communicated the results of the project to local producers in the region by way of one or more targeted field days and articles in the rural press.

3 Method

3.1 Location

The study was conducted at Bow Park (20°05' S, 141°95' E), 100 km north of Julia Creek in north-west Queensland. The climate is semi-arid tropical with a pronounced wet and dry season (Figures 2 and 3). Typically, 80% of the 480 mm annual median rainfall occurs from December to March and the temperature frequently exceeds 40°C. The land type is fertile, black-soil, treeless Mitchell grass (*Astrebla spp.*) plains.

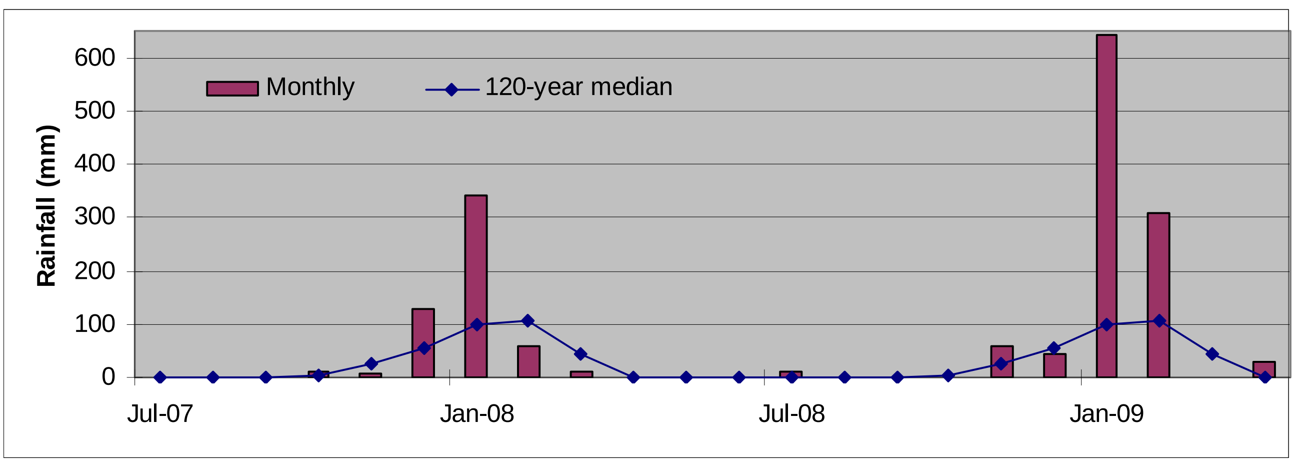


Figure 2. Rainfall during the Bow Park PDS

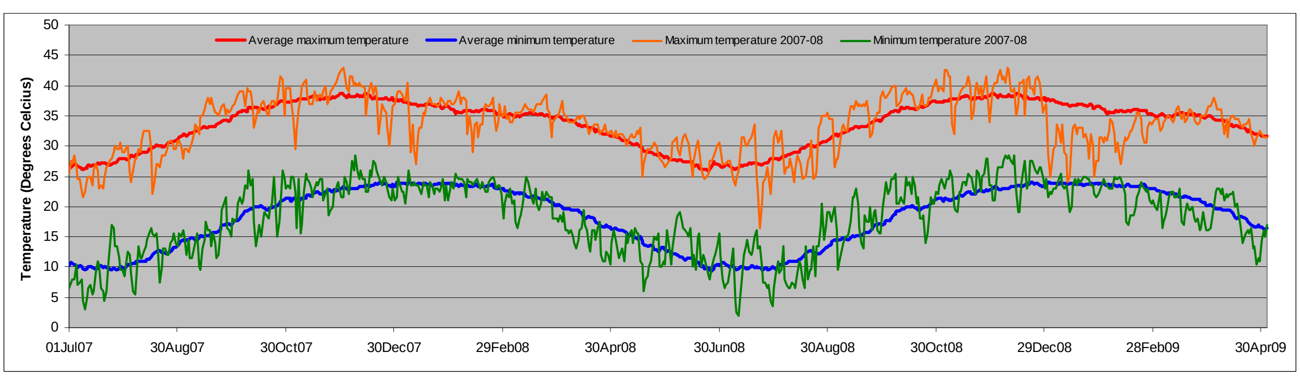


Figure 3. Ambient temperatures during the Bow Park PDS

3.2 Animals and management

In September 2007, 576 two-year-old Beefmaster (~50% *Bos indicus*) maiden heifers were routinely classed (Top, Average and Bottom) and allocated as a single group to a 9000-acre paddock. In November 2007, 15 heifers 1-3.5 months pregnant were given 2 mL Estrumate® to terminate the pregnancy. These and other non-pregnant heifers (n=495) were allocated to treatment groups. In December 2007, a pre-mating BBSE, including sperm morphology, was conducted on 11 two-year old home-bred bulls at which time they received Vibrovax™. Mating was between 22 January and 28 April 2008. Two neighbours' bulls (one bull from each of two neighbours) were removed from the paddock prior to introducing the allocated bulls. Non-pregnant heifers were culled in April 2008. Later in 2008, pregnant heifers that did not meet owners' breeding objectives were culled. Some selected heifers were transferred to the bull-breeding herd. The 2009 mating commenced on 8 March. The QPIF Ethics Committee approved the project (SA 2007-09-212).

3.3 Experimental design

Individually-identified heifers were allocated (Table 1) by stratified randomisation on height within condition score and class to a 2 x 2 x 2 multi-factorial experiment with treatments being either vaccinated or not with three vaccines manufactured by Pfizer Australia (Table 2). Top class heifers were allocated only to VPL and VP treatments and bottom class heifers to L and Nil treatments. Average class heifers were allocated to all 8 treatment groups. Primary vaccinations, including SingVac®, were administered in Nov 2007, two months prior to mating, and boosters a month later.

Table 1. November 2007 allocation of heifers to the Bow Park PDS

Vaccines#	Heifer class			All		Heifers vaccinated against each disease#		
	Top	Av	Low	**Total**	%	**V**	**P**	**L**
VPL	62	17		**79**	16%	79	79	79
VP	62	17		**79**	16%	79	79	
VL		48	2	**50**	10%	50		50
PL		50		**50**	10%		50	50
V	1	51		**52**	11%	52		
P		48		**48**	10%		48	
L	1	17	52	**70**	14%			70
Nil		14	53	**67**	14%			
Total				**495**		**260 - 53%**	**256 - 52%**	**249 - 50%**

V=Vibrovax® (5mL dose), P=Pestigard® (2mL dose), L= Leptoshield® (2mL dose)

Table 2. Vaccines used in the Bow Park PDS

Vaccine	Batch	Expiry	Pack	Dose
SingVac 3 Year	07502B01	24-Jan-09	500 mL	2 mL x 1
Vibrovax	7732-17802	Mar-09	250 mL	5 mL x 1
Pestigard	7003-01002	Feb-09	250 mL	2 mL x 2
Leptoshield	7503-15406	Mar-08	500 mL	2 mL x 2

3.4 Measurements

Heifers were mustered for classing on 6 September 2007, and for measurements on 8 November 2007, 6 December 2007, 28 April 2008 and 8 May 2009. Body condition score (BCS) (5-point scale) was measured at each muster. Hip height (cm) and P8 fat depth (mm) were recorded at allocation. Ovarian function and foetal age were measured using real-time ultrasound (Honda 2000V with 60 mm 10 MHz linear array probe) at each muster. Foetal ageing to 25 days was possible. Calving date was predicted using a gestation of 284 days (9.33 months). At weaning in May 2009, calves were counted and a random sample weighed.

Samples collected for later assays of antibody titres:

- Serum: 20 random heifers September 2007.
- Serum: 163 animals in December 2007 and April 2008. These were selected to represent each treatment, but with a bias towards having been vaccinated or not with Pestigard®.
- Serum: 40 heifers in May 2009 selected on the basis of having had Leptoshield® or not.
- Vaginal mucus: 46 heifers in April 2008; 24 were selected as having been vaccinated or not with Vibrovax® and the balance were non-pregnant heifers.
- Preputial scraping from all 11 bulls in December 2007 and April 2008.

Due to the high cost of assays, targeted testing was conducted on selected samples.

3.5 Industry communication

Field days to discuss project outcomes and recommendations on reproductive disease management were held on site in April 2008 and May 2009 at the end of mating the heifers as maidens and first lactation females, respectively. On each day, participants from the region inspected the cattle and participated in lengthy discussion.

4 Results and Discussion

4.1 Results

4.1.1 Weather and pasture

Temperatures were close to the long-term average over the study period. January 2008 was very wet and was accompanied by widespread 3-day sickness. The recent pattern of short wet seasons and drier-than average years was repeated in 2008 with a break in the season not experienced till 1 January 2009. Cattle had continual access to high-quality feed till November 2008. The extremely high rainfall in January-February 2009 (Figure 2) caused sustained flooding and boggy conditions with low ambient temperatures (Figure 3) on the back of very dry hot conditions, thus stressful calving and early lactation conditions and very low feed availability.

4.1.2 Heifer growth

At allocation in November 2007, the heifers had a hip height of 136.5±4.5 cm with a P8 (rump) fat thickness of 10±3 mm. Scales were unavailable to weigh heifers, but data from other research indicates the average weight was well in excess of 400 kg. The heifers gained 5±3 cm in hip height in the 18 months between allocation to the project in November 2007 and the end of the study in May 2009. Average condition score was 4±0.3 for dry heifers and cows during the project and 2.6±0.8 for wet cows in May 2009. Vaccines had no effect on growth.

4.1.3 Vaccine site reactions

About 20-25% of heifers had a site reaction one month after vaccination in December 2007, with little difference between vaccines. Figure 4 shows the reactions to both single and multiple vaccines. At the same time as other vaccines all heifers received a SingVac® injection that caused a reaction in 3% of heifers. This was about a third of the incidence of reactions due to other vaccines.

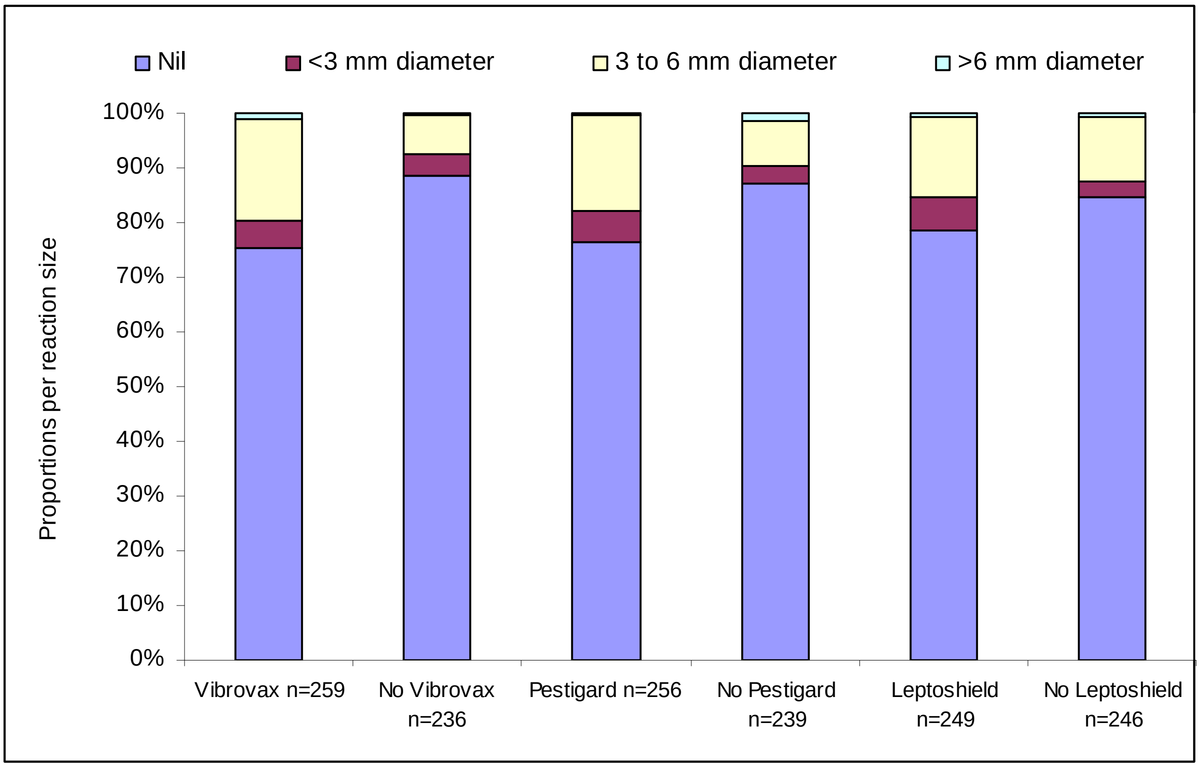


Figure 4. Reaction sites (diameter in mm) one month after vaccination

4.1.4 Heifer fertility

In November 2007, 84% of heifers had a *corpus luteum* (CL). Unpublished Beef CRC studies show that in unmated cycling females, approximately 20% do not show either a CL or CA at a random assessment. The Bow Park heifers were all well grown, with most weighing (visual estimate) in excess of 350 kg, which suggested a very high proportion would be cycling. There was also no relationship between height and percentage cycling. Mating commenced 2.5 months after scanning and after further growth. This data collectively suggests it is very likely that almost every heifer was cycling before the commencement of mating.

During the 2008 mating, pregnancy rate per 21-day cycle was 28-31% per cycle in all treatment groups (Figure 5). This value is below the benchmark rate for tropical cattle in Queensland of 60-70% per cycle (Fordyce *et al.*, 2005). The pregnancy rate after 2.4 months of mating was 69%.

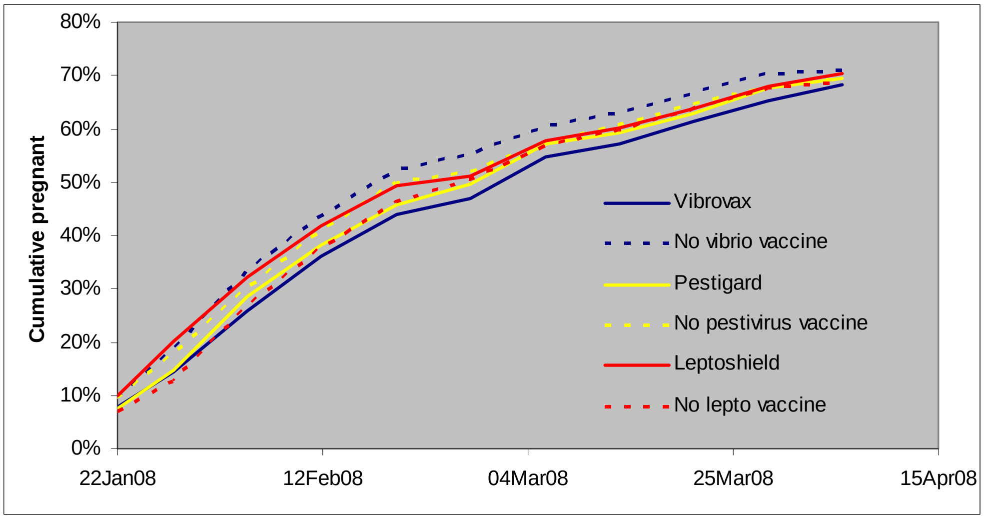


Figure 5. Vaccine effects on heifer pregnancies

4.1.5 First-lactation fertility

In May 2008, 217 of the retained heifers remained for assessment. Of these, 24% had failed to rear their pregnancy to weaning, with no differences between vaccine treatment groups (Table 3). Losses from those calving in Jan 09 (8% of expected calvings) were significantly higher ($P<0.05$) than in those that calved in Oct-Nov 08 (63% of expected calvings; Figure 6). The time of calf loss was unknown, eg, the mortality rate of December calves during January. Dry and wet cows were in forward and backward condition, respectively, and pregnancy rates, which were unaffected by previous vaccination, were low in the first 5 weeks of mating (Table 3). In excess of 70% and 40% of dry and wet cows had achieved post-partum cyclicity by 8 weeks into mating.

Using a method which matches calf weights with conception patterns and expected birth dates, the estimated average suckling calf growth rate was 0.64 kg/day, which is well below normal (expected >1 kg/day) and was reflected in the appearance of the calves.

Table 3. Vaccine effects on cows in May 2009

	Dry cows			Wet cows			Foetal & calf
	n	Condition	Pregnant	n	Condition	Pregnant	Loss
Vibrovax®	34	3.7	50%	89	2.3	19%	28%
No vibriosis vaccine	19	3.6	79%	75	2.3	23%	20%
Pestigard®	30	3.7	57%	87	2.3	21%	26%
No pestivirus vaccine	23	3.6	65%	77	2.3	21%	23%
Leptoshield®	26	3.6	58%	71	2.3	27%	27%
No lepto vaccine	27	3.7	63%	93	2.3	16%	23%
All	**53**	**3.7**	**60%**	**164**	**2.3**	**21%**	**24%**

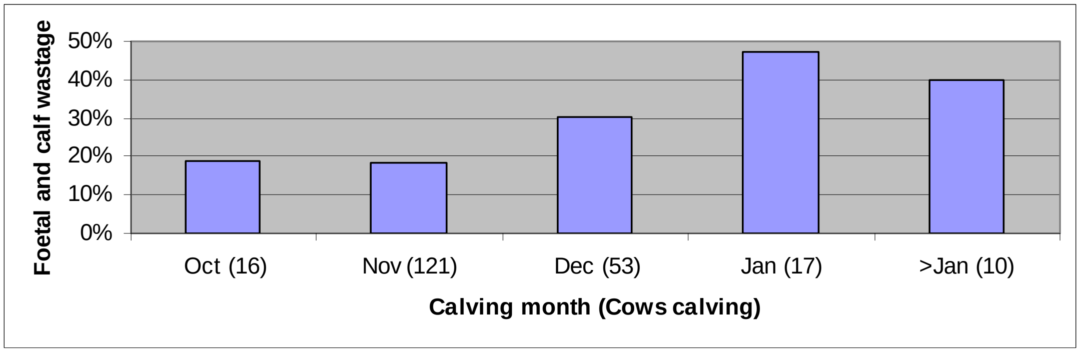


Figure 6. Month of calving effects on foetal and calf loss in the Bow Park PDS

4.1.6 Disease prevalence

Venereal diseases. No Bow Park bulls showed evidence of either *Campylobacter* or *Tritrichomonas* infection prior to mating on the basis of PCR testing (McMillan *et al*. 2005) of preputial scrapings. However, at the end of mating in 2008, 4 bulls were positive for *Campylobacter*. At this time, 13 of 24 tested heifers had vaginal mucus antibodies to *Campylobacter* (Figure 7). The source of this disease is most likely to have been neighbours' bulls which strayed into the paddocks prior to the official start of mating. The 3% of heifers pregnant over a 2.5-month range at allocation were likely to have strayed to achieve pregnancy as a straying bull would have impregnated many more heifers. These heifers could also have experienced vibriosis and harboured the organism. Antibody reflects disease challenge and not vaccination, which is why the prevalence was similar (54% either positive or suspect) in vaccinated and unvaccinated heifers (Figure 7). The prevalence of antibody was also similar in heifers that conceived and those that did not conceive.

Pestivirus. In September 2007, 3 of 20 heifers had pestivirus antibody titres of 2+ or 3+. In April 2008, 2 of 20 heifers had a 2+ titre using the AGID test. In May 2009, 6 of 24 heifers had titres of 1+ or 2+. This indicates that the study group may have been exposed to a pestivirus carrier as late as early 2007 when they were approximately 18 months of age, but no further viral transmission occurred during the study, presumably because the carrier animal(s) had died.

Arboviruses. These are viruses that are spread by biting insects which abound during hot, moist periods. Tests that detect antibody caused by up to 2,000 known alpha, flavi- and orbi-viruses found that sero-conversion to none of these had occurred (Figure 7). During heifer mating, about 30% of heifers contracted Akabane virus and a further 30% contracted ephemeral fever (BEF = 3-day sickness; Figure 7) - assuming that titres post-mating were related to transmission during mating.

Leptospirosis. Challenge with leptospirosis was significant during mating in 2008. Table 5 shows the high antibody levels to *L. pomona* occurring in heifers conceiving during that mating. The prevalence to antibodies to *L. hardjo*, which is the organism native to cattle, was about ~15% in May 2009 (Table 4). However the prevalence of *L. pomona* antibodies was close to 50%. This organism is native to pigs and is known to cause foetal loss and calf deaths. There was no overall significant difference in antibody prevalence between cows that failed to rear a calf, and those that weaned a calf. However, within vaccinated cows, a positive titre was more prevalent ($P<0.05$) in those that experienced calf loss (Table 4). Data from Tables 4 and 5 suggests that the antibody present in May 09 may have been either from challenge in the 2008 or 2009 wet seasons.

Heifer	***Pregnant***	***Vaccine treatment***			***Antibody titres (levels)***				
	Apr-08	Vibro	Pesti	Lepto	AF&O V	Pesti V	Akabane	3-day	Vibrio
320	CL				-ve	-ve	14	64	44
324	CL				-ve	-ve	24	-ve	0
510	CL				-ve	-ve	-ve	32	0
537	CL				-ve	-ve	-ve	-ve	26
713	CL				-ve	-ve	15	-ve	72
736	CL				-ve	-ve	-ve	-ve	48
744	CL				-ve	-ve	-ve	-ve	0
808	CL				-ve	-ve	-ve	32	0
812	CL				-ve	-ve	-ve	-ve	24
866	CL				-ve	-ve	-ve	-ve	56
138	3								41
244	3								0
260	2.75								26
348	3								0
309	3								60
527	3.25								0
307	2.5								25
436	3								48
631	2.5								0
704	2.75								0
765	3.25								30
731	F:16					-ve			0
743	CL					2+			0
824	CL					-ve			29

Figure 7. April 2008 prevalence of infectious disease antibodies in 24 Bow Park heifers selected to represent various vaccine treatments and whether they conceived or not; Colour codes:

Pregnancy		***Vaccines***		***Antibodies***			
Empty	Pregnant	Vaccine	No vaccine	No test	Negative	Suspect	Positive

Table 4. Prevalence of antibody to leptospirosis in May 2009 in 30 cows selected to represent those vaccinated or not against the disease, and those that reared a calf or lost the calf between confirmed pregnancy and weaning (Note: time of loss was unknown)

		Leptoshield® vaccine		No Lepto vaccine	
No. 2009 calving outcome		Calf loss	Weaner	Calf loss	Weaner
Number of cows		9	6	9	6
L. hardjo	Negative	7	4	9	5
	Suspect	0	1	0	0
	Positive	2	1	0	1
		22%	17%	0%	17%
L. pomona	Negative	2	4	2	3
	Suspect	2	2	1	0
	Positive	5	0	6	3
		56%	0%	67%	50%

Table 5. Example of high prevalence of challenge with leptospirosis at Bow Park

	Vaccine	Mating outcomes			SA antibody		
	Nov 07	Pregnant	May 09		Apr 08	May 09	May 09
Heifer	Leptoshield	date	Calf	Preg	L pomona	L hardjo	L pomona
868	No	27Jan08	Loss#	Preg	-ve	-ve	200
867	No	20Mar08	Loss	Preg	-ve	-ve	800
249	No	11Feb08	Loss	Preg	1600	-ve	200
276	No	11Feb08	Wean	Empty	6400	-ve	800
312	Yes	12Jan08	Loss	Empty	100	-ve	-ve
167	Yes	11Feb08	Wean	Preg	200	-ve	-ve
434	Yes	11Feb08	Loss	Empty	800	-ve	100
328	Yes	27Feb08	Loss	Preg	800	-ve	200

Time of loss is unknown, ie, whether it was aborted or died at or after birth

4.1.7 Industry communication

A total of 13 stations in the region had personnel attend the field days held at Bow Park at the end-of-mating foetal ageing in 2008 and 2009 (Table 7). A total of 36 people from beef business in the region attended. The discussion on these days was primarily about:

- the spread, effects and control of the diseases in focus
- the study being undertaken at Bow Park

The use of vaccines to control reproductive disease at Bow Park was put in perspective through a gross margin analysis which examined the effect of increasing pregnancy rates per cycle and reducing calf loss between confirmed pregnancy and weaning (Table 6). This detailed analysis examined time of pregnancy, and losses of pregnancies before calving and their effects on weaner crop and its weight and value. By including detailed assessment of changes in heifer values and sales from the herd, an overall financial impact of earlier pregnancies and reducing calf loss was derived. This showed that up to $30 can be spent per heifer in disease control in heifers to achieve these outcomes, and especially on increasing pregnancy rates per cycle.

Table 6. Projected effects of changes in pregnancy patterns and calf wastage at Bow Park when mating 500 heifers weighing 380 kg from late January to late April 2008

Pregnancies		**Current**			**Aim**
Pregnancies		**Slow**	**Slow**	**OK**	**OK**
Calf loss		**High**	**Low**	**High**	**Low**
Pregnant/cycle		45%	45%	65%	65%
Conceptions	29-Feb-08	55%	55%	76%	76%
	31-Mar-08	82%	82%	95%	95%
	30-Apr-08	92%	92%	99%	99%
	31-May-08	97%	97%	100%	100%
	30-Jun-08	99%	99%	100%	100%
Calf wastage		16%	8%	16%	8%
Calf birth weight	(kg)	35	35	35	35
Calf GR	(kg/d)	1.00	1.00	1.00	1.00
Gestation	(Days)	284	284	284	284
Empty heifers		8%	8%	1%	1%
		40	40	5	5
Cow mortaility		1.0%	1.0%	1.0%	1.0%
	Dry	0	0	0	0
	Wet	5	5	5	5
Cows at weaning	Dry	109	72	79	40
	Wet	386	423	416	455
Weaners born	20-Nov-08	231	253	319	350
(Av for sub-group)	24-Dec-08	113	124	80	87
	24-Jan-09	42	46	17	18
	Total weaners	**386**	**423**	**416**	**455**
Av birth date	(weeks)	07-Dec-08	07-Dec-08	29-Nov-08	29-Nov-08
Late weaners	Number	42	46	17	18
	Proportion	11%	11%	4%	4%
Weights	Steer calves	187	187	195	195
1-May-09	Heifer calves	173	173	180	180
Cow weights	Dry cows	515	515	515	515
	Wet cows	450	450	450	450
Values	Steer wnrs	$1.80	$1.80	$1.80	$1.80
01 Jun ($/kg live net)	Heifer wnrs	$1.60	$1.60	$1.60	$1.60
	Dry cows	$1.30	$1.30	$1.30	$1.30
	Wet cows	$1.10	$1.10	$1.10	$1.10
Group value	22-Jan-08	$247,000	$247,000	$247,000	$247,000
(net)	1-May-09	$382,367	$387,221	$391,872	$397,631
	Increase	$135,367	$140,221	$144,872	$150,631
	Increase/heifer	$271	$280	$290	$301
	(cf current)		**+$10**	**+$19**	**+$31**
Sales/Shift	Steers	$65,032	$71,225	$73,071	$80,030
1-May-09	Heifers	$53,359	$58,441	$59,956	$65,666
	Dry cows	$72,708	$48,070	$53,024	$26,512
Retain Jun 09	Weaned cows	$191,268	$209,484	$205,821	$225,423

Aspects of this study (up to the end of maiden mating) were used as part of a project at the University of Queensland by one of the co-authors (Tim Emery). The thesis abstract is attached as Appendix 1.

Press releases on this project were prepared and published around the time of both field days.

Table 7. Attendance of Bow Park PDS field days

	28-Apr-08	8-May-09		
	All	All	Same	New
Regional properties	9	8	4	4
Beef producers	12	13	6	7
Veterinarians and Advisors	2			
Industry suppliers	2			
Stockmen	2	4		4
R&D support	2	3	1	2

4.2 Discussion

4.2.1 Pestivirus

Pestivirus was endemic in the Bow Park herd. There is clear evidence that transmission was occurring in the cohort of animals used in the PDS prior to allocation. However, the persistently-infected animal spreading the disease appears to have either died (>50% of PI animals die annually) or been culled. Therefore, Pestigard® was expected to have no impact on conception pattern, which is the observed outcome. Only 10% of heifers had prior exposure to pestivirus and this mob remained highly susceptible to infection and associated calf loss. The usual strategy of mixing these cattle with older station cows after weaning their first calf is likely to expose them to infection. The owner has previously observed significant reductions in fertility of cows at this stage, and the effect may be at least partially attributable to pestivirus.

4.2.2 Vibriosis

This PDS and previous studies at Bow Park have indicated a high incidence of vibriosis in maiden heifers. This disease is very difficult to eliminate from extensively-managed herds, even with a high level of animal control such as that achieved at Bow Park. In the 2008 mating, vibriosis, which appeared to come from mixing with neighbours' bulls (specific period was unknown), did not appear to be a primary cause of failure to conceive though it may have made some contribution. This was evidenced by the failure of Vibrovax® vaccine to improve pregnancy rates. A small percentage of heifers may have had pre-trial exposure to vibriosis, but the level of exposure is unlikely to have affected the result. In previous drier years, there was strong evidence that vibriosis was the primary reason for a reduction of the pregnancy rate in heifers from >60% per cycle to 30-50% per cycle.

4.2.3 Leptospirosis

There was clear evidence of a high incidence of leptospirosis at Bow Park, especially of *L. pomona* whose natural host is the pig and is considered a pathogenic leptospire in cattle. Leptoshield® vaccination 12 months prior to first calving did not appear to influence the likelihood of calf loss. However, the extreme weather conditions experienced in 2008-09 may have diluted its potential impact. Calf loss was associated with high antibody titres (in vaccinated animals only) which suggested that leptospirosis may have caused some losses. Vaccination against leptospirosis should start before the leptospires first infect animals and establish in the kidney pelvis. First vaccination did not occur in the Bow Park heifers till 2 years of age, and not as weaners, and this may also partially explain lack of vaccine effect on calf loss.

4.2.4 Arboviruses

Viruses spread by biting insects (called Arboviruses) emerged as the most likely reason why low pregnancy rates per cycle occurred in maiden heifers during the 2008 mating. This was potentiated by very wet conditions. Extensive testing of blood samples taken from heifers indicated that the main two problem viruses were Akabane virus and Bovine Ephemeral Fever virus (commonly referred to as 3-day sickness). At least one of these viruses was contracted by over half the heifers. Both appeared to have caused either temporary cessation of cycling, fertilisation failure, or embryo loss. In addition, BEF may have also caused temporary sub-fertility in the bulls, though this was not tested. The overall effect was to dilute any potential impact of vaccine treatments in this study. The extreme weather conditions during calving prevented any observations of potential effects of Akabane virus on calf survival, as it is recognised for causing abnormalities (especially arthrogryposis – deformed limbs) in surviving foetuses.

4.2.5 Climate

Extreme weather conditions, which substantially reduced energy availability, thus intake, in the pregnant and calving cows for two months at least, caused substantial calf wastage in this study, especially in cows that calved during periods of high rainfall. The Jan 09 total was only exceeded last century in 1974.

4.2.6 Vaccination procedures

Strong perceptions exist within the beef industry that only one or two vaccines cause significant site reactions. This study showed that reactions to SingVac® injection when conducted correctly, can be less than for other vaccines; it caused reactions in 3% of animals, whereas the other 3 vaccines each caused a reaction which was palpable one month later in ~10% of animals. There was good interactive discussion with field days' attendees on the effects of all vaccines, and the principles of handling and administration.

5 Success in Achieving Objectives

All objectives in this project were met. Comments on each objective are given.

5.1 Vaccines and reproductive performance

Objective: Examined the impact of vaccination programs on reproductive performance in maiden heifers on a north Australian extensive property.

A well-designed 2 x 2 x 2 factorial study to which almost 500 cycling 2-year-old heifers were allocated, was implemented and followed through to its planned conclusion. However, concurrent weather conditions caused both substantial direct effects, and indirect effects through arboviral diseases, to dilute any potential effects of the vaccines given to the point that any effects were not apparent.

5.2 Losses from Vibrio, Pestivirus and Lepto

Objective: Established the losses that may occur due to Vibriosis, Pestivirus and Leptospirosis in unvaccinated maiden heifers.

The outcome for this objective was similar to the first. There was certainly evidence that a significant proportion of trial animals were challenged with both *Campylobacter* (vibriosis organism) and *L. pomona*. However, pestivirus transmission did not occur during the study. The animal(s) responsible for pre-trial transmission is/are most likely to have died prior to allocation to the study.

5.3 Vaccination recommendations

Objective: Updated recommendations for implementing cost-effective vaccination programs on northern pastoral properties.

This objective was covered fully both from a principles perspective and for the specific diseases in focus in this project. The recommendations made are presented in Section 7 and Appendix 2.

5.4 Communicated project results

Objective: Communicated the results of the project to local producers in the region by way of one or more targeted field days and articles in the rural press.

Two very successful field days were held for this project. They attracted participants from as far afield as Mt Isa, and included several respected beef industry people. These days were augmented by press releases.

6 Impact on Meat and Livestock Industry

Reproductive diseases can have a very large impact on individual business in specific years. The effects may be chronic or occasional. From a north Australia beef business perspective, Kirkland et al. (2009) suggested that losses due to pestivirus may be as high as $30M. One estimate of the loss due to vibriosis and trichomoniasis in the northern Australian cattle herd is $6M (Fordyce and Burns 2007). No reliable estimates of industry cost due to leptospirosis are available because the magnitude of the biological effect remains equivocal.

The Bow Park PDS provided an opportunity to clearly outline the impact of these diseases on the business outcomes for beef producers in NW Queensland, and to provide considered advice on cost-effective control strategies. There is a lag period of at least 2 years usually before application of these strategies can realise increased profits, as this only occurs through sales of extra progeny which are the result of reduced reproductive wastage.

Gradual uptake of recommendations available from this PDS and other sources will see a reduction in impact of reproductive diseases in many herds. The Cash Cow project which is currently running may better quantify losses generally, but most importantly will provide methods for individual producers to quantify financial loss due to these diseases, thereby accelerating appropriate adoption of control strategies.

The specific impact of this PDS is only likely to have a small effect within 5 years, but it will be an important contributor to all inputs that achieve change to better practice by those who had direct involvement.

7 Conclusions and Recommendations

7.1 Pestivirus

- Pestivirus is endemic on most large stations in northern Australia. It is very difficult to achieve elimination of this virus from these herds.
- When producers are able to effectively segregate heifers from the rest of their herd, including bulls, till maiden mating which is usually at 2 years of age, strategic use of Pestigard® using cattle vet advice is strongly recommended. Kirkland *et al*. 2009 showed that, even though the vaccine is expensive and requires two injections, it is cost effective when it prevents as little as 1% chronic calf wastage.
- Where heifer segregation is not effective, exposure and immunity to pestivirus at a younger age is much more likely. As well, investments such as fencing are likely to be of higher priority than vaccination against reproductive disease.
- Where heifer segregation is achieved, they should be screened for evidence of transmission using an antibody test on blood from a sample of approximately 20 heifers. If previous and near-future transmission is likely to be limited, then vaccination with Pestigard® prior to first mating is recommended.
- Strategic vaccination of females segregated till they wean their first calf is also recommended before mixing them with the main herd, if animals have not previously been vaccinated, and antibody testing indicates a high prevalence of previously-unexposed animals.
- Herds without endemic pestivirus need to maintain a high level of biosecurity, and this may include regular vaccination to prevent potentially-severe business losses.

7.2 Vibriosis

- *Campylobacter* is endemic on most stations in northern Australia. It is very difficult to achieve elimination of this bacterium from these herds. Most herds should have an annual vaccination program for bulls.
- When producers are able to effectively segregate heifers from the rest of their herd, including bulls, till maiden mating which is usually at 2 years of age, annual vaccination with Vibrovax® is cost-effective and strongly recommended. Only one injection is required at approximately 18 months of age, which is when many producers conduct selection of replacement breeding animals.
- Where heifer segregation is not effective, exposure and immunity to vibriosis at a younger age is much more likely. As well, investments such as fencing are likely to be of higher priority than vaccination against reproductive disease.

7.3 Leptospirosis

- Antibody titres to *Leptospira spp*. occur on most stations in northern Australia. However, a consistent net financial benefit from vaccination against leptospirosis has not been established in dry tropical regions, and this has not changed as a result of this study.
- *L. pomona* is the prime pathogenic leptospire that may cause cattle abortions and is spread from pigs, especially during wet conditions. Where feral pig populations are significant, soils have at least fair water-holding capacity, and extended wet conditions are consistent each year, it is possible that vaccination programs starting with weaners may prevent calf wastage. However, the cost-benefit should be established before implementing such programs.
- Letospirosis is transmissible to humans via cattle urine. Preventing urine shedding, thus exposure to farm workers, appears to be the main current reason for vaccination.

7.4 Arboviral diseases

- Wet seasons are regularly accompanied by arboviral infections. If heifers have not experienced a good wet season as weaners, it may be prudent to mate extra to achieve the numbers of pregnancies required if they experience a good wet as maidens.
- If further work can clearly indicate that BEF is a significant contributor to loss in early pregnancy, and an efficacious vaccine is available, then consideration may be given to strategic vaccination of yearling heifers.

7.5 Severe weather

- Implement management that maintains good condition and high energy reserves in cattle.
- If possible, implement mating management that allows cows to calve outside periods when there is a high probability of extreme environmental conditions.
- In fencing developments, consider the requirement for non-boggy, high ground that is accessible to all cattle in all paddocks. This should preferably be at the down-stream end of large flat paddocks.
- Keep in good with the rain gods.

7.6 Use of vaccines

Recommendations are provided in Appendix 2.

8 Acknowledgments

The NW Queensland Regional Beef Research Committee under the leadership of Zander McDonald initiated and managed this project. Guy & Deborah Keats and their staff hosted this study in a very professional manner that enabled all objectives to be satisfactorily achieved. Pfizer Australia, through their representatives, Andrew Bodycoat and Dr Lee Taylor, supplied the vaccines used in the treatments in this study. Queensland Primary Industries and Fisheries strongly supported this project: Paul Hickey and colleagues provided administrative support; Vivienne Doogan provided biometrical support for design and for allocation of animals to the study; Ian Gray, Rebecca Hall, Neil Cooper, and Cindy McCartney provided technical assistance on site; Dr Jim Taylor, Dr Jane Oakey, Bruce Corney and their supporting laboratory staff in Townsville, Toowoomba and Yeerongpilly carried out serology of serum and mucus samples and provided valuable technical feedback. Finally, the project has only been possible with the financial support of MLA administered by Rodd Dyer, Dr Wayne Hall and Dr Geoff Niethe.

9 Bibliography

Fordyce, G., Holroyd, R.G., and Burns, B.M. (2005). Minimising pregnancy failure and calf loss. Final Report, Project NBP.336, Meat and Livestock Australia, Sydney.

Fordyce, G. and Burns, B.M. (2007). Calf wastage – how big an issue is it? *In:* Proceedings, Northern Beef Research Update Conference, 21 – 22nd Mar 2007, Townsville. pp 21-27.

Kirkland, P.D., Fordyce, G., Holroyd, Taylor, J. and McGowan, M.R. (2009). Impact of infectious diseases on beef cattle reproduction: Investigations of pestivirus and *Neospora* in beef herds in eastern Australia. Final Report, Project AHW.042, Meat and Livestock Australia, Sydney. Submitted for approval.

McMillen, L., Fordyce, G., Doogan, V.J. and Lew, A.E. (2006). Comparison of culture and a novel 5' *Taq* nuclease assay for the direct detection of *Campylobacter fetus* subsp. *venerealis* in clinical specimens from cattle. *Journal of Clinical Microbiology* **44**(3):938-945.

10 Appendices

10.1 Appendix 1: Extracts from UQ thesis

Undergraduate thesis
Efficacy of vaccines in improving conception rates of north Australian maiden heifers

Timothy Michael James Emery
School of Land, Crop and Food Sciences
Submitted for the degree of Bachelor of Agricultural Science
ANIM 4611 – Research Project
27 October 2008

Abstract
Beef cattle producers in northern Australia rely heavily on their herd's reproductive performance to remain economically viable. Conception rate is a key indicator of performance and can be severely reduced when naive animals gain exposure to reproductive diseases. Vaccination is an effective form of disease prevention, although its expense often seems unjustifiable. The aim of this study was to determine if conception rates in maiden heifers increased as a result of vaccinating against bovine vibriosis, bovine viral diarrhea virus (BVDV) and leptospirosis prior to joining.

The study was conducted at Bow Park in north-west Queensland, using 500 cycling, two-year old Beefmaster heifers and 11 station-bred bulls. The efficacy of commercialised vaccines manufactured by Pfizer Australia (Vibrovax®, Pestigard® and Leptoshield®) to improve conception rate was tested using a 2x2x2 multifactorial design. This design assigned half the heifers to receive each type of vaccine prior to joining. Eight treatment groups were devised, with each group receiving 0, 1, 2 or 3 vaccines. The joining period was 22 January to 28 April 2008, after which foetal ageing was conducted to determine estimated date of conception. Blood and vaginal mucus samples were collected at various stages to monitor the disease prevalence.

Results indicated that there was no significant treatment effect on conception rates over mating. Furthermore, none of the vaccines had an effect on the probability of conception. It was discovered that a very low conception rate of 30% per cycle occurred during the joining period. Vibriosis transmission was evident, although minimal, thus did not contribute to the low conception rates. Blood samples revealed that BVDV transmission did not occur during the mating period. Antibodies against leptospirosis were not assessed, however the vaccine did not show an impact on conception rate.

It is undeniable that an additional external factor was the main cause of low conception rates. Suspected causes include Bovine Ephemeral Fever (BEF), Akabane virus or the 'phantom cow' syndrome. Vaccinating heifers against endemic disease does not necessarily always produce the desired results, such as an improvement in conception rate per cycle. Further research is required to investigate potential contributors to reduced conception rate per cycle in maiden heifers.

10.2 Appendix 2: Some principles for using vaccines

Timing and suitable vaccines are important

- Killed vaccines usually require 2 initial injections at least 4 weeks apart to have effect. If practical constraints delay the second shot till up to 4 months after the first, then there is a fair chance of good protection, though it may be less than ideal. If the second shot is not given, the vaccine may provide only low protection, but may be better than no vaccine. Once the animal has protection, most of these vaccines are required annually to sustain protective immunity.
- Some killed vaccines (examples are two of the available botulism vaccines) have been formulated to enable one shot initially.
- Killed vaccines are a mix of the bug (minced up) and compounds called adjuvants that stimulate the development of immunity. Water-soluble adjuvants are preferred, but sometimes oily adjuvants are used to get enough stimulation; examples include SingVac® and Vibrovax®. This extra stimulation also can cause extra and prolonged site reactions if not given properly.
- Live vaccines have altered organisms to cause immunity but not disease. Most require one shot.
- It is difficult to vaccinate calves against some of these diseases, but they require protection. They can get this from antibodies in colostral milk at birth. The best way to maximise these antibodies is to give annual vaccinations at the last muster each year when cows are handled prior to calving. Diseases like pestivirus can spread during mating, and vaccination before calving is strongly recommended in herds where this disease is a problem.
- Vaccinate animals before likely exposure to the disease but as close to the likely period of transmission as possible. Examples are giving Vibrovax to bulls (see below) and heifers prior to mating, and giving BEF vaccine to at-risk cattle prior to the wet season.
- Some vaccines can interfere with development of immunity from other vaccines given at the same time. Tick fever vaccine can do this; avoid it with priming injections, but OK with boosters.

Vaccination is a significant procedure for the animal

- All vaccines cause significant reactions and pain for up to a week, to the point of lameness in the odd few even when given properly. A swelling will be seen on most animals at the injection site in the days after injection. Severe reactions are rare, but if it does occur, contact the manufacturer to have the case investigated.
- The needle should be sharp and clean and be inserted as gently as possible. The best needles are capped, but are only available in ¾” (Monoject 16G); ½” needles would be ideal if available.
- Vaccines based on gram negative bacteria (most bacterial vaccines we use) can cause toxicity problems (endotoxins) in some cattle, especially in intensive systems, if multiple vaccines are given. Therefore, if practical, avoid using more than 2 bacterial vaccines at once.
- The stress of vaccination, especially against vibrio, may cause temporary sub-fertility in bulls. Therefore, bull vaccination should be completed as earlier as two months pre-mating.

Vaccines must be handled properly to ensure efficacy and safety

- Vaccines should be treated a bit like milk. They are sterile, carefully manufactured proteins and other compounds. If they are exposed to freezing, heat or light they can be broken down and become useless. Their sterile packaging enables much longer shelf life than milk, but they must be kept refrigerated. This needs to be maintained crush-side during vaccination. Once a pack is open, its sterility is lost, and it must usually be used within a week, as long as it can be kept chilled and clean. Some vaccines must be used within 1 day; others within 30 days; check labels for specific advice.
- Use clean gear. Re-usable guns should be disassembled, cleaned, sterilised and reassembled between each use. Disposable guns should be replaced after use.

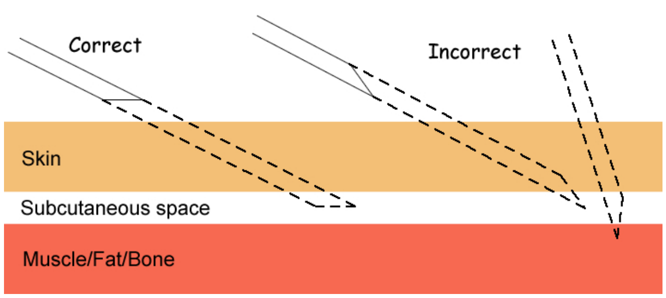
- Don't miss the animal and get yourself. A 16 gauge needle hurts. If you inject yourself with vaccine it can cause nasty prolonged reactions. It is VERY important to ensure you do not accidentally vaccinate a person with an oil-based vaccine (eg, SingVac®) as it can cause very serious reactions that may require surgical excision and cause significant permanent damage; if this occurs seek medical attention immediately.

Give the vaccine to achieve sterile deposition in the target position with minimal animal discomfort

- Avoid vaccinating wet cattle as the chance of infection at the injection site is much greater.
- Avoid injecting more than one vaccine into the same site. Good practice is to determine which vaccine goes where before a group of cattle is done, eg, either side of neck, forward or back part of neck area. Try to keep injection sites at least a hand width apart.
- Most vaccines for cattle should be given under the skin, especially oil-based vaccines. If the vaccine is given into muscle, severe reactions can occur. The preferred site is above the backbone in the neck area forward of the hump. This recommendation will minimise potential carcass damage. It is also a good site because of the constant skin movement which improves absorption.
- The paralumbar fossa (the ding in front of the "hip" = tubal coxa) is a difficult injection site to use correctly. It is not acceptable in programs such as Cattle Care. If used, take extra care to achieve injection under the skin, especially in poor cattle in which it is possible to inject the vaccine into the abdominal cavity and even the rumen.
- The anal fold is an UNACCEPTABLE site for vaccination – too many nerves, blood vessels, and opportunities for infection, apart from being adjacent to several valuable cuts.

Set your gear up properly

- Two common problems when injecting with a repeat-vaccinator gun are (i) Persistent post-vaccination lumps, especially after using oil-based vaccines, and (ii) High resistance to injection on the first attempt, rectified by deeper insertion of the needle at a more perpendicular angle. Both of these problems are often caused by incorrect orientation of the needle on the syringe.



A needle is a pipe cut at an angle with razor sharp leading edges. The objective when vaccinating is to get the opening of the needle resting between the skin and underlying tissues. This is achieved by orientating the needle so that at entry at about 45^o to the skin, THE BEVEL IS PARALLEL WITH THE SKIN.

If the bevel faces away from the skin, the opening of the needle may still be in the skin at first injection attempt, thus the high resistance. A more perpendicular entry is required to counter this, which results is the leading edge of the needle cutting into underlying tissues, with potential for intramuscular vaccine injection - thus the lumps.
Always have a pair of pliers in the vaccination kit to correctly orientate the needle. Easily done with a robust metal gun. But it can be a challenge with disposable guns.

- Oils in vaccines will cause standard rubbers in guns to perish quickly. If using either Vibrovax or SingVac, fit with oil-resistant rubbers.