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Impact of infectious diseases on beef cattle reproduction

Investigations of Pestivirus and Neospora in BeefHerds in Eastern Australia

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Abstract

Bovine pestivirus, or bovine viral diarrhoea virus (BVDV), is an important cause of reproductive failure in cattle but its impact in Australia is unclear. Even less is known about the more recently identified protozoon, *Neospora caninum*. The aim of this project was to define the impact of these infectious agents on beef production in Australia.

Beef breeding herds representative of the Australian industry were studied. Pestivirus infection was widespread, with active spread in many herds. Herds progress through cycles from high susceptibility, to disease outbreaks after introduction of the virus followed by herd immunity and reduced losses. Without continuous circulation of this virus, the proportion of susceptible animals quickly rises, giving rise to further outbreaks if control measures are not adopted. The impact ranges from the loss of a few calves through to half of the calves born in one year. In contrast, although *N. caninum* was present, especially in Queensland, its impact appears to be very low. Recommendations are given to minimise the spread of pestivirus and reduce losses in Australian herds.

Executive Summary

The profitability of a beef breeding enterprise relies heavily on the efficiency of reproduction. While there are many causes of reproductive loss, there are a number of infectious agents that collectively are responsible for a significant proportion of that wastage. Their impact may be apparent during pregnancy, in the perinatal period or even around and after weaning. Some of these agents, such as campylobacter, leptospires and trichmonads, have, for many years, been known to cause reproductive disease. Others such as bovine pestivirus, or bovine viral diarrhoea virus (BVDV), and *Neospora caninum*, have more recently been recognised as reproductive pathogens. However, there is little reliable information available on the economic impact of this virus on the Australian beef industry. *Neospora caninum* is even more recently recognised as a bovine pathogen and its significance is poorly understood.

The aim of this project was to define the impact of these infectious agents on beef production in Australian herds to provide an economic basis on which to make decisions on control measures. Breeding herds of a range of sizes and management systems representative of the Australian pastoral beef industry were studied in NSW, Queensland and Victoria. In NSW and Victoria, herds with reproductive loss identified at any point from joining through to yearling age were recruited. In Queensland, where there was a specific aim to study large extensive herds, especially in central and northern Queensland, herds with known or potential reproductive problems or, importantly, co-operative owners interested in herd health investigations and improvement, were recruited. Herds were preferentially selected on the basis of a high probability of active pestivirus or *Neospora* infections, but testing for other major reproductive pathogens was undertaken for exclusion purposes. An agreed range of parameters were measured, samples collected and observations made in study herds. These included pregnancy, calving and weaning rates. Pregnancy diagnosis was undertaken in all herds and, when possible, supported by ultrasound scanning. Recognised reproductive loss, including abortions, stillbirth and calf deaths at least to weaning were investigated. After recruitment to the project, herds were studied for at least 1 full reproductive cycle, from joining through to weaning.

The transmission of pestivirus under extensive conditions was also studied in several large Queensland herds where there was evidence of active spread. Groups of young cattle were selected at weaning and blood samples collected at intervals usually over a 2-5 month period and in one instance 11 months. Estimates of the rate of virus spread through extensive herds were determined to model the spread and impact of pestivirus in very large extensively managed herds.

In NSW and Victoria, 8 problem herds were studied. Presenting clinical signs at the time that these herds were first investigated ranged from abortions detected at pregnancy testing, the birth of congenitally deformed calves through to the sudden deaths of cattle up to 18 months of age. Pestivirus infection was widespread, with active transmission continuing in most of these herds. In addition to testing for antibodies to pestivirus, blood samples were also tested for the presence of BVDV to identify persistently infected animals that are the reservoir of this virus in a population. In most of these herds the extent of losses due to pestivirus was probably underestimated. Identified losses ranged from 10% to 55 % with high level losses (approaching 50%) observed in both commercial and stud herds. There was a greater likelihood of heavy losses in larger herds and also a greater potential for continuing losses due to the population dynamics of pestivirus infection. The prevalence of infection with *N. caninum* in herds in both NSW and Victoria was found to be very low,

ranging from 1% to 4%. There was no association observed between *Neospora* infection and the occurrence of reproductive disease in any of these herds.

In Queensland, reproductive performance was studied in 1 small, 2 medium sized and 10 very large herds. Only 4 of these herds showed evidence of active spread of pestivirus during the study period, usually at a low level. Consequently, the losses attributable to pestivirus infection in these herds were low. Importantly, in 3 herds that were recruited because of evidence of a high prevalence of infection with *N.caninum*, the entire breeding herd appeared to be susceptible to pestivirus while in others about half of the breeding herd was susceptible. In herds with past evidence of infection, the prevalence (and probably immunity) ranged from 5-70%, with few over 50%. Without considerable attention to herd biosecurity, the scope for future losses in these herds could be very high.

In contrast to the situation with pestivirus, there was often a moderate prevalence of infection with *N. caninum*. This parasite was detected in all of the Queensland herds, with the prevalence in most herds ranging from 4-25%, with one herd 33-60% and another >75%. Although this parasite was widespread, significant losses induced by this agent could only be identified in one herd. In most herds, there was no impact. There was little evidence of losses associated with other reproductive pathogens, with perhaps low losses due to leptospirosis in one herd and campylobacter in another.

Transmission of pestivirus under extensive conditions was studied in detail in 3 herds in Queensland. These studies were supplemented with data from 2 of the herds engaged in the reproductive investigations. Transmission rates observed in these herds usually ranged from approximately 10-30% per month but, in one very large herd, spread of pestivirus was extremely slow at 0.5% per month. These transmission rates have important implications for the industry. Firstly, they show that this virus can spread through large herds relatively quickly, but on the other hand, by the time animals reach breeding age, many may still be susceptible. Even in herds where high infection rates and natural immunity have been achieved, virus transmission is often interrupted following the death of the persistently infected animals. As a result herds progress through cycles from high levels of immunity to susceptibility with disease outbreaks after introduction of the virus if control measures are not adopted. The impact ranges from the loss of a few calves through to half of the calves born in one year. In contrast, although *N. caninum* was present, especially in Queensland, its impact appears to be very low.

These studies have highlighted several key messages for industry. Even low levels of pestivirus transmission in breeding herds may result in significant reproductive loss. The impact of this virus can be readily reduced through the adoption of practises that reduce its spread in the cattle population. These are directed at maximising herd biosecurity and include screening of replacement breeding stock, ensuring that breeders are immune before joining and preventing the mixing of mobs of unknown pestivirus status while pregnant. Extra vigilance is required when cattle are agisted or when stock management is changed. Although manipulation of known persistently infected (PI) animals can be effective in enhancing herd immunity, their shortened life expectancy reduces the efficiency of such strategies. Vaccination is likely to be cost effective in most breeding herds where there is potential for the introduction of pestivirus. Seed stock producers should adopt ‘best practice’, only selling animals that have been shown to be free of pestivirus. The adoption of pestivirus control has benefit for all cattle producers, including those in the breeding, grazing or the feedlot sectors as a reduction in the number of PI animals is likely to reduce reproductive wastage as well as losses in feedlots from respiratory and other diseases that are enhanced in animals with compromised immune function.

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1 Background

The profitability of a beef breeding enterprise relies heavily on the efficiency of reproduction. A cow may be considered to be inefficient if it fails to produce a marketable calf at regular intervals, ideally each year. To deliver a return to the producer, the calf must as a minimum, survive until weaning. While there are many causes of reproductive loss, there are a number of infectious agents that collectively are responsible for a significant proportion of that wastage. Their impact may be apparent during pregnancy or some may cause losses at varying times after parturition, at least up until weaning. Among the recognised reproductive pathogens are bacteria (e.g. *Campylobacter*, leptospires), protozoa (trichomonads, *Neospora*) and viruses (pestivirus or BVDV). Some of these agents have, for many years, been known to cause reproductive disease (*Campylobacter*, leptospires, trichmonads). Effective control measures are available for several. Other agents such as pestivirus and *Neospora* have more recently been recognised as reproductive pathogens. Pesti virus has been wide spread in Australia for many decades and St .George et al (1967) reported a cattle prevalence of 60.6% and a herd Prevalence of 89%.

In a recent MLA commissioned review of accessions to state diagnostic veterinary laboratories, pestivirus was identified as an important cause of disease. However, globally, there is limited information available on the precise economic impact of this virus and no such information is available for the Australian beef cattle industry. Nevertheless, in many countries, vaccines are used as part of control measures to prevent pestivirus infection. In a number of European countries, a decision has been made to work towards eradication of this virus in an effort to reduce its impact on national herds. In other countries, such as the USA, groups of producers are interested in voluntary control programs for pestivirus. In Australia, the launch of a commercial vaccine to control pestivirus infections was imminent at the start of this project. With this in mind, a number of veterinarians and others interested in animal disease control and herd health were debating the merits of vaccination and also strategies for the cost-effective use of such a tool, especially as viral vaccine can be relatively expensive.

Neospora caninum is even more recently recognised as a bovine pathogen and its significance is poorly understood. It is known that this protozoon parasite can cause abortion in cattle and reduced viability of calves. Dogs are an essential element of the life cycle of this parasite. Consequently, infections in cattle are more frequently encountered in areas with large populations of dogs (both domestic and feral). The role than other canids, such as foxes and dingoes, in the life cycle of *N. caninum* is unclear. Some overseas studies have suggested that cattle that have been infected with *N. caninum* may repeatedly lose calves following *in utero* infection of the foetus. Although there can be a moderately high prevalence of antibodies to this organism in breeding cattle in some regions of Australia, the incidence and frequency of abortions and calf losses have not been determined.

The aim of this project was to study the impact of infectious agents, and especially pestivirus and *Neospora*, on reproductive performance in Australian beef cattle. Data from this project may provide a more rational basis on which to make decisions on control measures. While both pestivirus and *Neospora* infections were investigated it was expected that only a proportion of herds would have active infection with both agents. Therefore, efforts were made to ensure that both pathogens were adequately represented by the selection of herds with differing status for pestivirus and *Neospora* infections. Herds of different sizes and management structures were selected to be representative of the pastoral beef industry in Eastern Australia.

2 Project Objectives

The individual objectives for this project were:

1. To define the losses associated with pestivirus and *Neospora* infections through case studies in beef breeding herds over a range of management systems and environments;

2. To assess pestivirus transmission rates in large extensive herds by the strategic monitoring of groups of cattle where active infection was occurring;

3. To model the impact of key infectious diseases on reproduction in beef herds and carry out an economic analysis of those impacts.

3 Methodology

As the aim of the project was to study the impact of the target agents in herds that were representative of the pastoral beef industry of Eastern Australia, an emphasis was placed on the selection of herds from New South Wales and Queensland but herds from Victoria were also included. The project was coordinated and supervised by a team of veterinarians and pathologists with experience that was considered appropriate for this project. The group initially included from New South Wales Department of Primary Industries, Dr P. Kirkland (Virology Laboratory, EMAI and project leader), Dr K. Walker (representing the Regional Veterinary Laboratories in NSW) and Queensland Department of Primary Industries and Fisheries, Drs G. Fordyce (Charters Towers), R. Holroyd (Rockhampton) and J. Taylor (Veterinary Laboratory Toowoomba). Professor M. McGowan, (University of Queensland) joined the project team after the first year. The project team met at least twice each year to review progress, discuss problems and coordinate further investigations, usually face to face but from time to time by teleconference.

3.1 Selection of project herds

The field studies consisted of a series of case studies and intensive investigations of herds that were spread across Eastern Australia and, to establish virus transmission rates in large extensive herds, were complimented by serological monitoring of several herds in which active infection was occurring. The project originally allowed for up to 14 commercial herds to be studied. The original plan had been to study 8 herds in Queensland (4 large extensive herds (>1000 breeders), 2 medium sized herds (500 breeders) and 2 smaller herds (up to 250 cows) with the remaining 6 herds to be located in NSW (4 herds) and Victoria (2 herds). However, during the course of the project, difficulties were experienced with recruitment or continuing access to some herds but this was offset by the involvement of additional herds, with data available from a total of 21 herds (6 in NSW, 13 in Queensland and 2 in Victoria).

HERD RECRUITMENT	QLD	NSW	VIC	Total
Planned	4 + 2 + 2	4	2	14
Actual	13	6	2	21

To study virus transmission, the original plan had been to study infection rates in an experimental herd. This approach was abandoned due to a combination of logistics and gaining animal ethics committee approvals and was replaced by studies in 3 herds in which natural infection was occurring. Finally, data from serological surveillance of a large number of herds across Australia became available from another source. Although not formally part of the project investigations, these data, combined with information from diagnostic investigations, have been included to place the results of the herd studies and economic assessments into the context of the industry at large.

3.1.1 Herds in New South Wales and Victoria

Herds in NSW and Vic with reproductive loss identified at any point from joining through to weaning (or in one instance, as yearlings) were recruited. Herds were identified through submissions to diagnostic laboratories and through contact with veterinarians who specialise in cattle reproduction. Herds were preferentially selected on the basis of a high probability of active pestivirus or *Neospora* infections.

3.1.2 Herds in Queensland

In the extensive herds of the Central and North Queensland pastoral regions, diagnostic investigations are undertaken less frequently. Therefore, herds were selected initially on the basis of identifying a cooperative owner who has a herd with suboptimal reproductive performance and has facilities that will allow intensive monitoring to be undertaken. When available, preference was given to herds in which pestivirus or *Neospora* infections appear to be active. For the virus transmission studies, herds with evidence of recent transmission or infection in weaners were selected for intensive monitoring.

3.1.3 Serological surveys and diagnostic data

Since late 2006, Pfizer Animal Health has been encouraging veterinarians and producers to establish the pestivirus status of breeding cattle. To facilitate this, the company has met the cost of laboratory testing of serum samples from a cross section of herds. This usually involved the submission of 8-12 samples from unjoined heifers, mature cows and sometimes first calf cows. Samples have been collected from all states and submitted to EMAI for testing. Results are available for 2007 and 2008. The company has given approval for use of these data.

To compliment this information, diagnostic records from the Virology Laboratory at EMAI have been screened. The proportion of herds in which persistently infected animals were identified in 2007 or 2008 has been determined.

3.2 Field methods

3.2.1 Servicing veterinarians

In NSW and Victoria, all herds were examined and sampled by the private veterinary practitioner who was normally engaged by the owner. In some instances, follow-up sampling was undertaken by

a government veterinary officer. Data were usually collected by the project team. In Queensland, herds were serviced by the project team.

3.2.2 Collection of baseline data

The specific observations, measurements and sampling that were undertaken varied depending on the nature of the herd, owner co-operation and facilities available. This information is summarised for each herd in Appendix 1 (NSW & Victoria) and Appendix 2 (Queensland). In general, current and previous reproductive performance data were collected. This included joining percentage (of bulls to females), results of pregnancy diagnosis, calving, branding and weaning parameters. In all herds comprehensive herd reproductive investigations were completed to compliment the primary diagnostic investigation (where this was undertaken). In most herds there have been examinations for *Campylobacter* and *Trichomonas* infections in bulls and cows and serological profiles for leptospirosis, pestivirus and *Neospora* infections. Target groups are usually unjoined heifers, calved heifers and mature cows (have produced 3 or more calves). In large herds, representative subsets of animals from these groups were sampled because it was not practical to sample the larger group. In the smaller and most of the medium sized herds in NSW and Victoria, the entire group was sampled whenever possible.

3.2.3 Reproductive assessments and herd health monitoring

In NSW and Victoria, herds were currently experiencing a pestivirus problem or had affected animals, indicating that there had recently been infection in the herd. Consequently, blood samples were collected to determine the current pestivirus and *Neospora* status of animals on the property and the herd records examined to gather evidence of its past virus status and reproductive performance. Prospective reproductive monitoring of the breeding herd was also undertaken (usually by rectal palpation) to determine the outcome for the current joining and where appropriate, the following year. Samples were collected from aborted foetuses, stillborn and abnormal calves and perinatal calf deaths. These samples were subjected to routine diagnostic investigations to establish a cause of the presenting problem. In some cases, at or soon after weaning, blood samples were collected from all calves to determine whether any were persistently infected with pestivirus.

In the extensive herds in Queensland, where the impact of the pathogens of interest was not immediately apparent, systematic monitoring of the selected proportion of the breeding herd was undertaken for at least one full reproductive outcome i.e. from mating until weaning the calf the following year. Blood samples were collected from the target age groups that had been screened at the start of the project and tested for antibodies to BVDV and *Neospora*. Condition scores for females were assessed at each observation. Data for joining percentages, pregnancy, calving, branding and weaning performance were collected although all of these were not possible on each property. Ultrasound was used to monitor reproductive function in the early stage of pregnancy with follow up rectal palpation at about mid-term. Recognised reproductive loss, including abortions, stillbirth and calf deaths were investigated where possible.

3.3 Virus transmission studies

3.3.1 Herd selection

A number of herds were initially screened to determine whether there was likely to be active virus transmission in the herd. Several sites were abandoned without any animal handling or sampling because the probability of recovery of the animals for follow-up sampling was not sufficiently high to warrant commencement. These studies were eventually undertaken in 3 large herds in North Queensland and involved groups of 199, 306 and 506 weaners. Full details of these herds are provided in Appendix 3. Data for pestivirus incidence were also available from 2 of the large herd study sites and these were also used to calculate transmission rates.

3.3.2 Herd Monitoring

Herds were monitored for periods ranging between 2 and 11 months. Blood samples were collected at the start and end of the monitoring period for testing for pestivirus antibodies and for detection of persistently infected animals. Where active infection did occur, the average incidence per month was calculated as a difference between the initial and final prevalence divided by the duration of monitoring.

3.4 Laboratory methods

3.4.1 Participating laboratories

The laboratory aspects of this project were restricted to 2 laboratories. Samples from the herds in NSW and Victoria were tested at EMAI while the samples from the Queensland herds were submitted to the DPI & F veterinary laboratory at Toowoomba. The 2 laboratories used the same test methods for pestivirus and *Neospora*. Reagents for these tests were produced at EMAI.

3.4.2 Bovine viral diarrhoea virus

The principal test for antibodies to BVDV was the agar gel immunodiffusion (AGID) test. If additional testing was required to confirm the status of an animal, the virus neutralisation test was used. Both assays followed the Australian Standard Diagnostic Procedure. When testing was carried out to detect the presence of the virus, an antigen capture enzyme linked immunosorbent assay (ELISA) was used, based on a commercial kit for the testing of extracts from white blood cells or tissues. If a more sensitive assay was required to confirm the status of a sample, virus isolation in cell culture or PCR were used. In Queensland these assays were conducted at the DPI & F laboratory in Brisbane.

3.4.3 Neospora caninum

Antibodies to *Neospora caninum* were detected using an indirect ELISA developed at EMAI.

3.4.4 Other pathogens

Testing for the detection of *Campylobacter foetus*, leptospires and *Tritrichomonas venerealis* utilised standard diagnostic procedures. Microagglutination tests were used to test for antibodies to *L. hardjo* and *L. pomona*.

3.5 Economic modelling and assessment

3.5.1 Methodology - Queensland

The intention was to assess economic impacts of both pestivirus and *Neospora*, firstly by establishing representative models of herd production systems in tropical Queensland, and then by altering model inputs to match the potential ranges of the effects of these diseases .

The system of static and dynamic models developed by Holmes (2006) would have been used. The base models used (Table 1) were representative of production systems in spear grass forest and Mitchell grass downs in tropical Queensland. The capital value of the herds is approximately $1.4M.

Table 1. Input parameters for infection-free status of base herds used in economic modelling

	Mitchell grass downs age groups				Goldfields spear grass age groups			
	Weaner	Yearling	2 years	3+ years	Weaner	Yearling	2 years	3+ years
Weaning rates			82%	75%			80%	70%
Female mortality	2%	2%	4%	3%	3%	2%	4%	3.5%
Steer mortality	2%	1%	1%	1%	3%	1%	1%	1%
Female net value	$221	$356	$444	$500	$194	$351	$405	$518
Steer net value	$279	$370	$566	$875	$245	$370	$605	$827
Pre-mating female sales	20%	20%	0%	0%	19%	9%	0%	0%
Post-mating female sales			15%	10%			17%	12%
Female husbandry	$27	$16	$16	$16	$27	$21	$21	$21
Steer husbandry	$6	$5	$5	$5	$9	$8	$8	$8

3.5.2 Methodology – New South Wales and Victoria

In NSW and Victoria, the intention was to use an established economic model for pestivirus (P. Holmes, unpublished), based on an 'average' 250 breeding cow self-replacing herd in southern Australia. The model is considered to be conservative and does not take into account the impact of acute transient infection (e.g. respiratory disease, reduced growth rates) on non-breeding animals.

3.6 Additional sources of data

In order to place the findings of this project in the context of the national beef herd, data were also analysed from a pestivirus surveillance project sponsored by Pfizer Animal Health, Australia. The company has paid for serological testing undertaken by private veterinary practitioners to determine the pestivirus status of breeding herds owned by their clients. Because herds were sampled

throughout Australia, it was considered to be an appropriate data set to include as it would provide a broader overview of the prevalence of pestivirus. These data were complemented by an analysis of diagnostic records to determine the number of herds in which PI animals were detected in 2007 & 2008 – the same time interval as the serological profiles of herds were established.

4 Results and Discussion

4.1 Participating Herds

4.1.1 NSW/Victoria

In NSW 6 herds were studied in detail. There were 2 small herds (<250 cows), 3 medium sized (250-500) herds including one stud herd and one large herd (>1,000 breeders). In Victoria there were 2 herds, 1 small and the other a large stud. Each of these herds had been recruited because of a recently diagnosed pestivirus problem. These herds are described in detail in Appendix 1. It was not possible to identify a herd in NSW with a possible *Neospora* problem. A herd with poor reproductive performance and a high seroprevalence to *N. caninum* was identified in on the NSW North Coast but was abandoned after initial screening due to poor record keeping and animal identification.

4.1.2 Queensland

There were 13 herds recruited for reproductive monitoring in Queensland. Ten of these were large herds (>500 cows), 2 herds were medium sized (250-500 cows) and there was 1 small herd (<250 cows). Three additional herds were recruited for virus transmission studies. A detailed description of these herds is provided in Appendix 2 and Appendix 3.

4.2 Pestivirus and Neospora status of project herds

4.2.1 Herds with an identified problem (NSW & Vic)

The serological status of the herds in NSW and Victoria that had been recruited because of a known pestivirus problem is summarised in Table 2. Most of these herds had a very high prevalence of antibodies to pestivirus at the start of the project investigations with clear evidence of active or recent infection. Persistently infected animals were identified in most of these herds although the source of infection that leads to the reproductive problem was rarely apparent. The serological prevalence of *N. caninum* was consistently very low.

Table 2: Summary of seroprevalence of pestivirus and *Neospora caninum* in herds in NSW and Victoria

Herd	Year	Age/Group	BVDV AGID							Neospora ELISA			
			Neg	1	2	3	≥3	Total	%+ve	Neg	+ve	Total	%+ve
N1	2002	Unjoined	3	2	36	11	0	52	94				
		Heifers	0	2	1	1	6	10	100				
		1st calvers	0	2	7	1	-	10	100				
		Mature cows	0	3	4	3	-	10	100				
N2	2005	Unjoined	9	2	11	8	12	42	78.6	40	2	42	4.8
		Heifers	0	6	29	15	1	51	100	51	0	51	0
		1st calvers	0	6	45	9	0	60	100	57	3	60	5.0

Herd	Year	Age/Group	BVDV AGID							Neospora ELISA			
			Neg	1	2	3	≥3	Total	%+ve	Neg	+ve	Total	%+ve
		Mature cows	1	11	106	27	0	145	99.3	76	2	78	2.6
N3	2005	Unjoined	0	0	12	7	0	19	100	14	5	19	36
		Heifers	2	1	5	11	13	32	94	31	1	32	3
		1st calvers	0	2	8	5	1	16	100	16	0	16	0
		Mature cows	0	5	16	3	10	34	100	34	0	34	0
N4 Stud	2005	Unjoined	15	0	9	24	38	86	82.6	86	0	86	0
		Heifers	7	4	18	14	1	44	84.1	39	5	44	11.4
		1st calvers	1	5	30	35	3	74	98.6	72	2	74	2.7
		Mature cows	0	8	8	1	0	17	100	15	2	17	11.8
N4 comm	2005	Heifers	4	4	65	59	0	132	97.0	132	0	132	0
		1st calvers	2	14	62	10	0	88	97.7	88	0	88	0
		Mature cows	7	98	132	27	1	267	97.4	267	0	267	0
N5	2005	Unjoined	15	0	1	8	1	25	40	25	0	25	0
		Heifers	40	20	30	21	13	124	67.7	121	3	124	2.4
		1st calvers	1	2	20	3	0	26	96	26	0	26	0
		Mature cows	0	4	18	3	0	25	100	25	0	25	0
	2006	Weaners	92	1	5	15	67	180	51				
		1st calvers	12	7	25	6	0	50	76	50	0	50	0
N6	2005	Unjoined	8	0	2	9	5	24	75				
		Heifers	14	1	11	5	0	31	45				
		1st calvers	0	8	15	4	0	27	100				
		Mature cows	0	9	46	4	1	60	100				
V1	2005	5-7 mth calves	103	2	0	0	1	106	3	100	6	106	6
		Steers 18 mths	11	8	51	8	9	87	87				
		Mature cows	3	32	87	2	0	124	98	122	2	124	2
V2	2007	4-5 mth calves	212	8	6	11	10	247	14				

4.2.2 Herds of unknown status (Qld)

Although none of herds in Queensland, with one possible exception, had a proven pestivirus or *Neospora* problem, the serological status of representative groups of cattle had been established at the start of the project. The exception was the small herd (Q16) in southern Queensland that had a reduced calving rate that was thought to be associated with pestivirus infection. The pestivirus and *Neospora* status of the Queensland herds is summarised in Table 4 below (see Section 4.3.1).

4.3 Reproductive performance

4.3.1 Impact of pestivirus

Each of the 8 herds studied in NSW and Victoria experienced losses of varying degrees as a result of pestivirus infection in the breeding herd. Presenting problems at the time that herds were first investigated ranged from abortions detected at pregnancy testing, the birth of congenitally deformed calves through to the sudden deaths of cattle up to 18 months of age. Pestivirus infection was widespread, with active transmission continuing in most of these herds. In addition to testing for

antibodies to pestivirus, blood samples were also tested for the presence of BVD virus to identify persistently infected animals that are the reservoir of this virus in a population.

The investigations that were undertaken were usually retrospective in nature and as a result, were likely to underestimate the physical impact of this virus on herd production. The minimum losses experienced in these herds are summarised in Table 3. Identified losses of calves (either as a foetus or postnatally) ranged from 10% to 55 % with high level losses (approaching 50%) observed in both commercial and stud herds. There was a greater likelihood of heavy losses in larger herds and also a greater potential for continuing losses due to the population dynamics of pestivirus infection. Although the extent of these losses varied, each was significant in the context of the size of the herd. As well as the identified losses, some indirect losses such as impaired growth rates and ill-health in acutely infected animals should also be taken into account. It was estimated that in some of these herds (especially stud herds) it could take from 5 to 8 years for herd production to return to normal (see Table 3) if there was no flexibility available in culling breeding females. Further details for each herd are presented in Appendix 1.

Table 3. Summary of the impact of pestivirus in NSW and Victorian herds

Herd Identification	Herd Size	Presenting problem	Type of Losses Identified	Time to return to normal production
N1:South West Slopes	400-550 breeders	Abortion and perinatal deaths	Reduced marking and weaning rates; Deaths of PI weaner	5 years
N2:Central Tablelands	300 breeders	Weaner mortalities	Reduced marking rates; Deaths of PI weaners	8 years
N3:South West Slopes	100 breeders	Abortions and congenital defects		5 years
N4:Central Tablelands	500 commercial cows; 300 stud breeders	Weaner illthrift	Reduced marking rates; calf deaths; deaths of breeders; Culling of PI bulls	6-7 years#
N5:South West Slopes	1250 breeders	Abortions and weaner deaths	Reduced marking rates; Early sale of weaners	Not determined
N6:South Coast	90-100 breeders	Weaner illthrift	Poor growth and death of weaners	1 year
V1: Victoria - Western Districts	150 breeders	Sudden death in steers	Death of Steers	Not determined
V2: Victoria - Western Districts	1500 breeders	Weaner illthrift	Culling of stud heifers and bulls	Not determined

Based on owner estimates

In Queensland, there was evidence of active pestivirus transmission in 4 of the herds during the study period, usually at a low level, and often in younger cattle. No pestivirus related losses were definitively identified in these herds, perhaps as a result of the extensive management but reduced pregnancy rates in one herd were probably due to pestivirus infection. In 3 other herds, there was evidence of infection at or just before the time when the herds were recruited to the project. However, 2 of these herds were using a pestivirus vaccine throughout the project period and no losses attributable to pestivirus infection were identified. Importantly, in 3 herds that were recruited because of evidence of a high prevalence of infection with *N.caninum*, the entire breeding herd appeared to be susceptible to pestivirus. In most of the other Queensland herds more than half of the breeding animals were susceptible, providing scope for substantial losses. This risk is particularly high in at least one herd were there was a low level of ongoing transmission in one mob. In herds with past evidence of infection, the prevalence (and probably immunity) ranged from 5-70%, with few over 50%.

The pestivirus status of individual herds and evidence for reproductive loss has been summarised in Table 4 with a detailed description for each herd provided in Appendix 2.

Table 4 Summary of the pestivirus and Neospora status of Queensland herds.

Herd ID	Herd Location*	Herd Size	Mob Size	BVDV prevalence	BVDV transmission	Neospora prevalence	Reproductive Loss
Q1	Capricornia	2000	75; 60	Not detected	No evidence	Med-high (33-60%)	Not detected
Q2	Capricornia	600	55; 46	16-30%	Past, declining immunity	Low (4-12%)	Lepto - possible low level impact;
Q3	Capricornia	660	194; 188	Not detected	No evidence	Medium (14-21%)	Neo - possible low level impact on weaning; not on pregnancy rates
Q4	Northern Goldfields	>2,000	230	Mean 70% (36-100%)	Active	Medium (32%)	Neo – nil; BVDV not determined; Campylobacter present, little impact
Q5	Northern Goldfields	>2,000	327	5-22%	No evidence	Low (4-17%)	Not detected
Q6	Northern Goldfields	>2,000	106; 175	Not detected	No evidence	Medium (21%)	Campylobacter 2 bulls – perhaps delayed conception; pregnancy rates satisfactory
Q7	Upper Flinders	2,000		Heifers - 1% Cows – 45%	Very low rate	Low (6%)	Campylobacter causing some foetal loss
Q8	Lower Burdekin	4,000	230	Heifers - 14% Cows – 36%	On-going low level transmission	Medium (22%)	Neo – significant; BVDV not detected but significant potential; Campylobacter present
Q9	Lower Burdekin	1,500	2 x 220	4-46%	Probably at time of vaccination	Low-medium (2-23%)	None detected
Q10	Upper Flinders and Capricornia	500	150; 154; 169	100%	Extensive infection prior to study commencing	Low (6-7%)	Neo – no impact; BVDV – all immune; Probable losses due to hypovitaminosis A
Q11	Burnett	500	238; 240	91-100%	Recent BVDV infection – PIs detected	High (74-94%_	Neo – no evidence of losses; BVDV – past loss, herd vaccinated
Q12	Capricornia	800	200; 206; 307	33-70%	Little evidence of transmission	Medium (0-25%)	None detected but herd vaccinated for BVDV
Q13	Maranoa	120	120	Heifers - home 98% intro 17%; Cows -100%	Recent in cows; active in young stock	Medium (13-20%)	BVDV probably reduced pregnancy rate Neo – no impact

*** Based on Bureau of Meteorology Forecast Areas**

4.3.2 Impact of *Neospora caninum*

The prevalence of infection with *N. caninum* in herds in both NSW and Victoria was found to be very low, ranging from 1% to 4%. There was no association observed between *Neospora* infection and the occurrence of reproductive disease in any of these herds.

In Queensland, in the 13 herds where reproductive analyses were conducted, *Neospora* was detected consistently, although the prevalence varied both between herds and between mobs in an individual herd. The prevalence was low (<10%) in 4 herds, low to moderate in 1 herd, moderate (10-30%) in 6 herds, high (30-50%) in 1 herd and very high (>50%) in one herd. In the herd with a very high prevalence, the proportion of seropositive animals ranged from 74-94%. Despite the relatively high infection rates in these herds, there was no evidence of loss associated with *N. caninum* in 11 of these herds (including the herd with the highest prevalence) and marginal or low level losses in 1 herd. *Neospora* was only identified as a significant cause of loss in one herd. These results are summarised in Table 4 (see Section 4.3.1 above) and specific details for each herd are provided in Appendix 2.

4.3.3 Impact of other pathogens

The herds studied in this project were specifically selected either as a result of an identified disease problem associated with pestivirus infection or were herds where there was potential for losses due to pestivirus or *Neospora* infections. In some of the large or medium size herds in Queensland, the status of these pathogens was unknown at the start of the study but there was interest in identifying factors that could result in suboptimal reproductive performance. Overall, there was selection against herds in which other reproductive pathogens may be important. Nevertheless, there was a low prevalence of leptospirosis in one NSW herd and one medium sized herd in Queensland. *Campylobacter* infection was identified in 3 of the large herds in Queensland and was associated with low levels of embryo-foetal loss in 2 of these. Vitamin A deficiency was suspected as a cause of perinatal losses in one herd in Queensland.

4.4 Pestivirus transmission in extensive herds

In the 3 large Queensland herds where groups of cattle were specifically selected for study, the rates of pestivirus transmission ranged from 9-26% per month. In these herds, after observation periods ranging from 2-11 months, the seroprevalence in individual mobs ranged from 63-84%. Specific details for each study group are included in Appendix 3.

In contrast, in one of the large herds (Q8) that was included in the reproductive study, a very low monthly transmission rate of 0.5% was observed. After 5 months, the prevalence of seropositive animals, a group of heifers, was less than 10%.

4.5 Economic assessments

4.5.1 NSW and Victorian herds

The financial loss in these herds could not be determined because it was not possible to access the full herd production data and financial records. It was estimated that some of these herds would take from 5-8 years to fully recover from the impact of the pestivirus infections that occurred if breeder

culling strategies were not able to be instigated. This does not take into account the impact of acute transient infection (e.g. respiratory disease, reduced growth rates) on non-breeding animals.

4.5.2 Queensland – Economic modelling

There was little evidence of pestivirus or *Neospora* impact during this study.

4.6 National prevalence of pestivirus infection

4.6.1 Pestivirus serology

Results were available for serological profiles of 336 herds across all Australian states (see Appendix 5). Active infection with pestivirus was found in at least 60% of all herds sampled. All heifers were susceptible in 22% of heifer groups and 8% of cow groups. Importantly, in 36% of cow mobs and 52% of heifer mobs at least half of the animals were susceptible (see Table 5). Overall, this is a situation that favours the long term persistence of pestivirus and where there is scope for this virus to induce further economic loss. All animals were immune in only 20% of herds. Collectively, these results indicate that there may be a need for the adoption of control measures to reduce the impact of pestivirus on the national breeding herd.

Table 5 – Prevalence of pestivirus in heifers and cows in Australian herds

	Prevalence				Extreme	
	0-25	**26-50**	**51-75**	**76-100**	**0**	**100**
Heifers	21*	31	44	4	22	20
Cows	15	21	20	44	8	21

* Percentage of herds

4.6.2 Detection of persistently infected cattle

Persistently infected animals were detected in 354 new herds during 2007 &. As these were herds for which samples had been submitted because of a disease investigation, they represent only a small proportion of the total number of herds with PI animals. Based on the serological profiles, over the 2 years of this study, it is likely that there are PI animals in about 70% of breeding herds. This figure corresponds to earlier findings of St. George in 1967.

4.7 Discussion

The original project proposal allowed for the study of 6 herds in NSW & Victoria and 8 herds in Queensland. Ultimately, 8 herds were investigated in NSW & Victoria and 13 herds in Queensland. These variations were effected to take advantage of opportunities to investigate herds that were considered to have the potential to contribute meaningful data for the project. Initial plans to study transmission rates of pestivirus under conditions prevailing in Northern Australia by the introduction of persistently infected animals into groups of susceptible animals were abandoned due to difficulties associated with obtaining animal ethics committee approvals and concerns about possible adverse effects on the farms were the studies might be conducted. Eventually the studies involved large groups of young cattle managed under natural conditions. While these studies provided data that

was indicative of the northern beef industry, it was more difficult to obtain any details of the number of PI animals that were responsible for the spread of virus in the study groups.

4.7.1 Impact of pestivirus

In NSW and Victoria, presenting problems at the time that herds were first investigated ranged from abortions detected at pregnancy testing, the birth of congenitally deformed calves through to the sudden deaths of cattle up to 18 months of age. Pestivirus infection was widespread, with active transmission continuing in most of these herds. As these herds were being investigated after BVD virus had already been widely transmitted, the extent of losses due to this virus was probably underestimated. Identified losses ranged from 10% to 55 % with high level losses (approaching 50%) observed in both commercial and stud herds. Since pestivirus transmission can be heavily influenced by management practices that result in segregation of persistently infected animals from other stock, there is a greater potential for heavy losses in larger herds due to the likelihood that there will be more management groups. Because of the potential for segregation of virus carriers (PI animals) from breeders or potential replacements, there is also a greater potential for ongoing losses in large herds due to the population dynamics when there are a number of breeding groups on a farm. In addition to the identified losses, because of the imbalance created in self-replacing herds when there has been a loss of calves or yearlings, resulting in fewer heifers available for selection, it was estimated that productivity in some of these herds would not return to normal for several years. In some instances an entire generation was lost (as a result of a 'salvage slaughter' operation) and the recent problem compounded when pregnant replacements from interstate became infected.

In Queensland, only 4 of the project herds showed evidence of active spread of pestivirus during the study period, usually at a low level. Consequently, the losses attributable to pestivirus infection in these herds were low. Importantly, in 3 herds that were recruited because of evidence of a high prevalence of infection with *N.caninum*, the entire breeding herd appeared to be susceptible to pestivirus while in others about half of the breeding herd was susceptible. In herds with past evidence of infection, the prevalence (and probably immunity) ranged from 5-70%, with few over 50%. Without considerable attention to herd biosecurity, the scope for future losses in these herds could be very high.

The entry of pestivirus into a herd can be subtle, perhaps through the purchase of a single pregnant cow that is carrying a persistently infected foetus. Even with a high level of knowledge of pestivirus control, it is not possible to detect these infected calves prior to birth, requiring a high level of scrutiny of introductions, including complete isolation of pregnant and recently calved introductions until their progeny are tested and shown to be free of persistent infection with pestivirus. In reality, as this rarely happens, or carries significant dangers, it is essential to highlight the risks associated with the introduction of pregnant animals. For many herds with a very high proportion of susceptible breeding stock, risks from the immediate "neighbourhood" need to be highlighted. Sources of infection from within other breeding groups on property have been discussed but 'over the fence' exposure should not be overlooked. As a source of introduction, it can be very subtle, and when detected, the damage to a herd has usually taken place. Practical options to minimise these risks (e.g. avoiding running pregnant females near boundaries of a property) should be emphasised in advisory material.

In the herds studied in NSW and Victoria, losses were considered to be representative of the industry at large, with the impact ranging from the loss of a few calves through to half of the calves born in one year. This impact, combined with other losses that were not quantifiable, would indicate that pestivirus is a potentially significant reproductive pathogen of beef cattle. In the absence of control

and/or rigorous herd biosecurity measures, it is clear that most herds in time probably experience an outbreak as herd immunity wanes and the virus is re-introduced.

4.7.2 Pestivirus transmission

In the 3 large Queensland herds where groups of cattle were specifically selected for study, the rates of pestivirus transmission were sufficiently high to probably produce an immune heifer population by the time animals reach breeding age.

In contrast, in one of the large herds, a very low monthly transmission rate of 0.5% was observed. It is highly likely that there would be large numbers of susceptible animals of breeding age but with one or more persistently infected animals remaining in the herd. As a consequence, persistent low level losses would be likely if the current management practices continued. If there was a change in herd management and/or structure, or a group of pregnant animals were yarded with a PI animal, a higher level of loss could occur.

These transmission rates have important implications for the industry. Firstly, they show that this virus can spread through large herds relatively quickly, but, on the other hand, where lower than average rates of spread of the virus occurs, by the time animals reach breeding age, many may still be susceptible. Even in herds where high infection rates and natural immunity have been achieved, virus transmission is often interrupted following the death of the persistently infected animals. As a result herds progress through cycles from high levels of immunity to susceptibility with disease outbreaks after introduction of the virus if control measures are not adopted.

Similarly, even in herds where the virus is endemic and PI animals remain, disruption to 'normal' transmission patterns can have devastating consequences. This was observed in several of the NSW herds following agistment of groups of animals on other properties as a result of drought. In one instance, infection of large numbers of susceptible pregnant animals occurred when they returned to the home property. In another situation, widespread infection is believed to have occurred following mixing of different groups of animals whilst on agistment. Such occurrences have been regularly encountered during routine diagnostic investigations undertaken in NSW.

4.7.3 National significance of pestivirus

The finding of evidence of active or recent infection with pestivirus in more than 60% of the herds involved in the serological profiling is consistent with past estimates. When this is combined with the observation that about half of the animals are susceptible in 40% of herds, there is ample evidence of the scope for the long-term persistence of this virus in a population.

With such a high proportion of susceptible animals in these herds, the likelihood of a casual introduction of the virus establishing and spreading becomes much higher. The risk to these susceptible animals could arise from:

a) within the herd where the virus is endemic in one mob but not another and infection occurs when animals are moved between groups. There were several examples of this in the NSW herds and there were a number of examples in the serological profiling where one age group was fully susceptible and yet there was clear evidence of active infection in another.
b) neighbouring properties as a result of 'over the fence' contact or as a result of animals straying;
c) other introductions such as the purchase of new stock;

d) infection when animals are moved to another property on agistment as a result of drought. Agistment can also create susceptible groups when they are segregated from an endemic source of infection.

Examples of each of these avenues of virus entry and spread were observed in the NSW and Victorian herds that were studied.

The data obtained during this and related studies provide some insight into the scale of the losses that may be induced by pestivirus infection. In NSW, persistently infected animals are identified in approximately 200 herds each year. The submission of samples to a diagnostic laboratory for confirmation of pestivirus infection can be considered a reasonable guide to the occurrence of a disease problem on these properties. Further, the proportion of farms with an identifiable reproductive problem and one for which specimens are submitted for laboratory confirmation is not high. It is likely that pestivirus infection will ultimately result in a clinical impact to some extent and active pestivirus infection has been identified in about 60% of all breeding herds. Taken together, these data would suggest that nationally, perhaps several thousand herds (or more) could experience some degree of pestivirus induced reproductive loss. In Queensland chronic low level losses probably incur substantial loss in the beef industry however the results from this project failed to demonstrate any effect on reproductive outcomes in all herds sampled. Collectively, these assessments, which are believed to be conservative and do not take all aspects of the impact of pestivirus into account, suggest that pestivirus infection is causing substantial reproductive loss across the national beef herd. These estimates do not take into consideration “downstream” effects of pestivirus infection in feedlots where this virus has been shown to be a major contributor to the bovine respiratory disease complex.

4.7.4 Impact of *Neospora caninum*

The prevalence of infection with *N. caninum* in herds in both NSW and Victoria was found to be very low, ranging from 1% to 4%. There was no association observed between *Neospora* infection and the occurrence of reproductive disease in any of these herds.

In contrast to the situation with pestivirus, in Queensland there was often a moderate prevalence of infection with *N. caninum*. This parasite was detected in all of the Queensland herds, with the prevalence in most herds ranging from 4-25%, with one herd 33-60%. Although this parasite was widespread, significant losses induced by this agent could only be identified in one herd. In most herds, there was no impact.

Although dingoes have not been proven to be a source of *N. caninum* in Australia, other canids are known to be involved in the dissemination of this protozoon parasite. The results of this and other studies would suggest that dingoes, and perhaps other wild canids, probably play an important role in the spread of this parasite. The 2 properties with the highest seroprevalence (Q1 and Q11) are adjacent to areas of hills and mountains which provide a haven for dingoes. Both properties are adjacent to a national park and incursions of dingoes are common. In 4 Queensland properties, transmission of *N. caninum* (as judged by an increase in seroprevalence) was detected during the winter and spring months but no reproductive effects were observed, with the exception of one heifer group in which there was a lower pregnancy rate in seropositive animals. In most instances, cattle would have been in the latter stages of pregnancy when infected but in one herd cows could have been in the early stages of pregnancy.

This lack of apparent impact of *N. caninum* raises an important question, namely, what is the trigger for the outbreaks of reproductive loss, especially abortion, that have occurred from time to time. Although infection with *N. caninum* may not have occurred when breeding age animals were pregnant, there is a body of published literature that suggests that there can be repeated losses of pregnancies in seropositive animals as a result of persistent infections of the female. Such a phenomenon did not appear to occur, or was present at an extremely low level, in this study. The reason for the lack of impact of *N. caninum* was not determined but possible explanations could include:

- Lack of primary infections during pregnancy or at critical stages of pregnancy;
- Differences in the virulence and pathogenicity between strains of *N. caninum* present in Australia and other countries;
- An absence of concurrent other pathogens such as BVDV. There are a number of documented occurrences of dual infection with BVDV and *N. caninum* resulting in abortions with evidence of foetal infection with *N. caninum*. Whether the infection with *N. caninum* is predominantly incidental or whether this parasite is the primary pathogen remains unclear in an Australian context.
- Differences in pathogenesis associated with bovine host genotype.

At this stage, however, it is clear from the herds in Queensland that infection with *N. caninum* is an infrequent or low level cause of reproductive loss in beef herds under Australian conditions.

4.7.5 Impact of other pathogens

There was little evidence of losses associated with other reproductive pathogens, with perhaps low losses due to leptospirosis in 2 herd herds (one in NSW, one in Qld) and *Campylobacter* in 2 Queensland herds. However, these observations should not be taken to indicate that some of the relatively well known pathogens such as *Leptospira*, *Campylobacter* and trichomonads are no longer a problem. This is clearly not the case as they are frequently encountered, especially in large extensive herds. Although in each instance diagnostic tools and recognised control measures are available, there is still a need to continue to include their control in any advisory program aimed at improving reproductive performance.

5 Success in Achieving Objectives

The project has been successful in achieving some of its objectives. Data were collected from herds extending from the far north of Queensland to southern Victoria. Because of the field nature of the project and the number of co-operating producers involved, with mostly commercial herds, the quality of data available sometimes differed from initial expectations and was inadequate for robust economic analysis. However, in some circumstances, opportunities arose that were not expected and were not included in the original project plan. Some of these were pursued and yielded additional data of considerable value to the project. As these studies were field based, observational in nature and documenting actual events rather than experimental infections, they will add value to the project and the messages that will be conveyed to the industry at large. The project has emphasised on the one hand the possible significance of pestivirus on beef cattle production in Australia and on the other has raised questions about the role that *Neospora caninum* plays, especially in large extensively managed herds where the prevalence can be high. The variable levels of immunity to pestivirus in the herds studied and the ease with which the virus can be introduced to a herd justify the active promotion of awareness of the risks and need to assess

individual control measures on property. This is particularly important when the role of this virus in the BRD complex in feedlot cattle is also considered. A reduction in the prevalence of infection in the breeding sector will not only bring direct benefits to cattle breeders but should also bring indirect benefits to the feedlot sector.

6 Impact on Meat and Livestock Industry – now & in five years time

As a result of this project, there should be a better understanding of the impact of infectious agents, and especially pestivirus and *Neospora*, on reproductive performance in Australian beef cattle. The extent of economic loss due to these agents could not be measured accurately, but even low levels of pestivirus transmission in breeding herds can be assumed to result in some economic loss. Of concern, and probably not appreciated by many affected producers, is the fact that after an outbreak, herds can continue to suffer an economic loss for as long as 5-7 years if swift action is not forthcoming.

These studies have highlighted several key messages for industry. The impact of this virus can be readily reduced through the adoption of practices that reduce its spread in the cattle population. These are directed at maximising herd biosecurity and include screening of replacement breeding stock, ensuring that breeders are immune before joining and preventing the mixing of mobs of unknown pestivirus status while pregnant. Extra vigilance is required when cattle are agisted or when stock management is changed. Although manipulation of known PI animals can be effective in enhancing herd immunity, their shortened life expectancy reduces the efficiency of such strategies. Maintenance and safe manipulation of PI animals in a herd presents both a number of challenges and risks, to the extent that such a practice probably should not be recommended as a routine control measure. Vaccination is likely to be cost effective in most breeding herds where there is potential for the introduction of pestivirus however, if whole herd vaccination is implemented, the herd will become naïve and vaccination would need to continue indefinitely. However, seed stock producers should adopt ‘best practice’, only selling animals that have been shown to be free of pestivirus.

The adoption of pestivirus control has benefit for cattle producers, including those in the breeding, grazing or the feedlot sectors as a reduction in the number of PI animals is likely to reduce reproductive wastage as well as losses in feedlots from respiratory and other diseases that are enhanced in animals with compromised immune function. Although this virus can take a lengthy period to declare its presence in a herd, with the rigorous adoption of proven control measures, further spread and ongoing impact could be arrested within a period of 1-2 years. The virus could be eliminated from most herds within such a time frame. Consequently, if there was widespread promotion of pestivirus control within the beef breeding sector, the source and load of viruses to the rest of the industry could be substantially reduced in the short term and eliminated in the long term. While pestivirus eradication is not being recommended, with an aggressive advisory program, major gains could be achieved within 5 years and losses reduced but these gains would be quickly eroded unless strict ongoing movement requirements were imposed on all cattle from non-assessed regions of Australia. This has been proven in a number of countries where pestivirus control measures are advanced.

7 Conclusions and Recommendations

In conclusion, pestivirus control should be recommended for all sectors of the beef industry:

- stud and seedstock producers – both to prevent direct losses and to minimise dispersal to other herds
- commercial breeders – to reduce losses associated with reproductive effects of pestivirus and to minimise the number of PI animals reaching feedlots.

This project and other studies have shown that pestivirus control measures can result in direct and indirect commercial benefits for many producers. Control of this virus in the seed-stock sector should be considered part of 'best practice'.. There is a need to produce advisory material that does not have a direct link with the supplier of a commercial product that is promoted for pestivirus control. MLA and state Departments of Primary Industries could play a major role in this effort. To this end, as a first stage in increasing awareness of the need for pestivirus control and adoption of "best practices" in the seedstock sector, NSW DPI has initiated a series of meetings with the beef and dairy cattle breed societies and other peak bodies, including the Royal Agricultural Society of NSW. A range of advisory material is available through the internet and has been widely sourced by producers throughout NSW and some from other states. Similar strategies are recommended in other states. With a co-ordinated effort, significant gains can be made towards reducing the impact of pestivirus on the Australian beef industry.

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9 Appendices

9.1 Appendix 1 - Detailed records and observations for herds in NSW and Victoria

Herd Summary N1
South West Slopes NSW

This is a commercial Angus beef breeding herd located in Southern NSW on a 2000 ha property consisting of flat and undulating to hilly land. There was improved rye grass and clover pasture on the flat and undulating land with native pasture on the hill country.

1.1 Herd Selection Criteria

This herd was selected on the basis of an abortion problem in a heifer mob that was apparently due to pestivirus, with the possibility of secondary involvement of leptospirosis. There had been 5 abortions at the time of submission of the first affected foetus that was aborted close to term. Leptospires were detected in the foetal stomach contents but no other abnormalities were detected. No samples were tested for pestivirus. A second foetus was submitted one week later and was show to be infected with pestivirus, with BVDV antigen detected in lung tissue that was tested in the antigen ELISA. The peritoneal fluid was blood stained but no leptospires or other organisms were detected. An intensive investigation of the herd was subsequently initiated as part of this research project.

1.2 Monitoring methods for this herd

Diagnostic investigations for the abortion problem were undertaken in the first 2 weeks of August 2003. Calving occurred from August to September. Blood samples were initially collected from 10 pregnant or recently calved heifers, 10 second parity cows and 10 mature cows and tested for BVDV and leptospira antibody titres. Blood samples were also collected from the 2003 heifers prior to joining and tested for antibodies to BVDV. Complete diagnostic investigations were undertaken on aborted foetuses, (when available) and any sick or dead calves. Pregnancy diagnosis of all 2003 joined heifers was undertaken by ultrasound, blood samples were taken and breeding records were collected. Blood samples were collected from the progeny of these heifers in 2004 and tested for BVDV and neospora serology and, where appropriate, for the detection of persistent BVDV infections by antigen ELISA. Blood samples were also collected from a small number of cows in 2004 and tested for antibodies to neospora.

1.3 Herd Management

The herd was run as 4 separate breeding groups in 2003 and 5 separate breeding groups in 2004. The 5 breeding groups consisting of maiden heifers, parity 2 cows, parity 3 cows, parity 4 cows and mature cows. Within the maiden heifer group, there were 2 separate smaller subgroups. None of the females were vaccinated for leptospirosis or campylobacter infection. Heifers were joined at about 14 months of age. Steers were sold at about 15 months of age.

In early January 2003, after joining had been underway for about 1 month, the maiden 2002 heifers were moved to another property at Delegate near Cooma which was purchased by the owner in November 2002. Since November 2002 cows and heifers were moved between the 2 properties. The heifers were in good body condition when moved and showed no signs of ill-health. These heifers returned to the home property on 20/7/2003, a few weeks before the onset of calving.

Further details of the herd history are not available because the property and herd was sold part way through this study and the owner was not able to provide further detailed information. Nevertheless, this property has been included in the study because there is sufficient information available to provide an indication of the impact of BVDV on this herd.

1.4 Reproductive performance

At the time that this project commenced in July 2003, the cows were about to calve and a pregnancy rate was not known. Diagnostic testing had been initiated prior to this as a result of a significant abortion problem, as described in Section 1.1. The animals in the affected mob (maiden heifers first joined in late 2002) were monitored through the subsequent joining and their progeny from both joining's were also assessed to determine their BVDV status. For simplicity of presentation, the results are provided separately (from pregnancy diagnosis to weaning) for the 2 years.

a) 2003 calving

- Pregnancy rate

In 2003, there was no pregnancy diagnosis undertaken. The calving rates for the adult cattle were reported to be normal (specific data unavailable) but there was an obvious abortion problem in the maiden heifers. The performance of the adult cattle can be judged by the marking rates (see below)

- Calving rate

Of the 120 heifers that were joined, 66 live calves were born – a calving rate of 55%.

- Marking rate

In November 2003 the calves were marked. The results for the different age groups were:

Table 1.1:

Group	Number	Calves marked	Marking rate
Heifers (2002) *	120	61	51%
1st calf cows (parity 2)	32	22	69%
4 YO cows (parity 3)	74	71	96%
Mixed age older cows	167	165	99%

* Problem group

These results show that a further 5 of the progeny of the heifers had died between calving and marking at 2 months of age. There also appears to be a significant reduction in marking rates for the first calf (parity 2) cows, with very good rates for the older females.

- Post marking calf losses and weaning rate

Of the 61 calves that were marked in November 2003 from the 2002 heifer joining, a further 6 calves were lost or were considered abnormal. There was one 2 month old calf that died after being noticed to be weak, staggering and depressed. No significant bacteria were cultured from a range of tissues. Histopathology revealed a multifocal nephropathy with some perivascular lymphoid accumulations. These changes were considered to be consistent with an immune-mediated nephropathy that is observed in BVDV PI animals. Testing of spleen in the BVDV antigen ELISA confirmed that this animal was infected with BVDV. Three more calves died suddenly at about 2-3 months of age but were not suitable for laboratory examination. Finally, there were 2 calves that were noticed to be

illthrifty at about 3-4 months of age when yarded for administration of a booster clostridial vaccination in January 2004. There was no evidence of infestation with helminths, liver fluke or coccidia. Blood samples confirmed that both calves were persistently infected with BVDV. One of these calves died 3 months later in early April 2004 and the other calf died soon after. At weaning there were 55 surviving calves – a weaning rate of 46%.

b) 2004 calving
After the next joining in November-December 2003, pregnancy diagnosis in the 2002 (now parity 2) problem group and 2003 (maiden) heifers was undertaken by ultrasound when the cows were about 2 months in calf. Due to relocation of animals associated with sale of the property, pregnancy diagnosis could not be conducted on the other animals. However, the owner was able to provide marking rates for all groups. The breakdown of reproductive performance by age and management group was:

Table 1.2:

Group	Number	Pregnant	Pregnancy rate	% branded of those detected as pregnant.
Maiden Heifers (2003)	206	194	94%	90%
1st Calf cows (Parity 2) *	51	49	96%	100%
1st Calf cows (other Parity 2)	108	n.a.	n.a.	87%
Mature Cows – Parity 3	36	n.a.	n.a.	97%
Older cows - mixed ages	177	n.a.	n.a.	96%

* Previous problem group

1.5 Prevalence of BVDV and *N. cani*num at commencement
Investigations in this herd commenced with the diagnosis of an abortion due to BVDV infection. As the cattle were close to calving, a serological profile of the breeding groups for BVDV was established soon afterwards. Later, a more detailed sampling of the 2002 and 2003 heifers was completed with another follow-up sampling at pregnancy testing. Limited serology was undertaken for neospora. The BVDV results are summarised in the following section.

1.6 Evidence of transmission of BVDV and *N. caninum* during the study period
The serological profile that was conducted close to calving in 2003 indicated that there had been recent and extensive BVDV infection in the maiden joined heifer group and presumptively while these animals were pregnant. There was a very high proportion of strong reactors (3 & ≥3) in the BVDV AGID (see Table 3 below). This group had experienced a number of abortions and a number of clinically abnormal calves were delivered by these heifers. There was also an indication of infection in the relatively recent past in the mature cows and unjoined heifers. In 2004, due to the very high prevalence of BVDV infection found in 2003, further sampling of the cows was not

undertaken. Blood samples were collected from all heifers that were not pregnant but none showed evidence of recent infection. There were 2 pregnant animals that were seronegative. One seroconverted later in pregnancy. Blood samples were collected from the progeny of the problem heifer group calf crop at about 7 months of age. There was clear evidence of active transmission. Of the 14 seronegative calves identified, only 4 were available for collection of samples to determine their BVDV status. All 4 were shown to be persistently infected.

There was limited testing for *Neospora* undertaken. None of 49 7 month old calves was seropositive and a single positive cow was found from 7 sampled towards the end of the project. Unfortunately, other adults were no longer available for sampling.

Table 3:

Age/ Group	BVDV AGID						
	Neg	**1**	**2**	**3**	**≥3**	**Total**	**%+ve**
2003 Results							
Unjoined heifers (2003)- Mob 1	2	1	19	4	-	26	92
Unjoined heifers (2003)- Mob 2	1	1	17	7	-	26	96
Heifers (2002)*	-	2	1	1	6	10	100
2nd calf cows	-	2	7	1	-	10	100
Mature cows	-	3	4	3	-	10	100
2004 Results							
Empty heifers (2003)	-	1	11	-	-	12	100
2nd calf cows [a]	1	4	41	2	1	49	98
2003 calves [b] (7 mths)	14[c]	-	19	8	8	49	71

* Problem mob at time of initial investigation
[a] Sampled 15/04/2004
[b] Remaining progeny of problem mob
[c] 4 calves available to determine BVDV status – all 4 were persistently infected

1.7 Evidence of infections with BVDV and *N. caninum* during the reproductive cycle of interest

Although investigations in this herd were hampered by the sale of the property and the investigation commenced at a time when BVDV had been widely transmitted through the herd, it is clear from the serology results that the infection had been very recent and during the current breeding cycle, especially in the heifer mob that experienced an abortion “storm”. There was also some indication of relatively recent infection in some of the mature cows but it was not possible to assess whether

infection may have occurred at a critical stage of pregnancy. There was a low prevalence of infection of the breeding cattle with *Neospora* and no evidence of vertical transmission in a larger group of weaners that were sampled.

1.8 Impact of BVDV and *N. caninum* on reproductive outcome

In the 2003 calving season, evidence of BVDV infection was detected in the problem group of heifers while they were pregnant. At least 20 abortions were recognised even though the herd was not always under close observation. There were also unexplained and unexpected calf deaths in the perinatal and pre-weaning periods. A limited number of foetuses and calves were available or suitable for laboratory examination. Nevertheless, BVDV infection was confirmed in both an aborted foetus, a calf that died in the perinatal period and in 2 very poorly grown calves. Later, when surviving weaners were examined, each of 4 seronegative animals was shown to be persistently infected with BVDV. While the status of the other 10 calves was not determined before they were sold, it is highly probable that a proportion of those would also be persistently infected. Other causes of abortion, especially leptospirosis, were excluded from the abortion and perinatal mortality problems.

The marking rates that were observed in 2003 for the different age groups highlight the extent of the problem in the heifer group. There was a very low marking rate (as could be expected after the abortions and perinatal deaths) but also a reduced weaning rate (46% of heifers joined weaned a calf). Of these weaned calves, some were shown to be persistently infected with BVDV and therefore also considered to be a loss to production. The marking rate in the first calf (parity 2) cows was also low. It is possible that this was associated with BVDV infection as there are some indications of recent infection in this age group but there were no problems reported by the owner that could be attributed to possible pestivirus infection. It is more likely that this reduced rate was due to the stresses of lactation in young animals during a second pregnancy, but most likely a reflection of a reduced pregnancy rate rather than losses of foetuses or neonates. Although there is some evidence that older cows may have been infected with BVDV at some stage during pregnancy, their reproductive performance to marking was good and no later problems were reported.

In the 2004 breeding cycle, there was a high level of immunity to BVDV. There were 2 heifers that were seronegative, with one seroconverting while pregnant. The progeny of this heifer was normal. The remaining seronegative heifer and its calf were both tested to detect the presence of BVDV antigens – neither animal was shown to be persistently infected. One dead calf was submitted at calving. Pathology investigations were consistent with a diagnosis of death due to dystocia and foetal oversize. Overall the calving rates observed in all age groups in the herd were within expected ranges, especially considering the adverse seasonal conditions.

The original source of virus for this herd could not be identified. It is possible that there was a PI animal within one mob and the groups were mixed when they were moved to another property soon after joining had commenced. An alternative and perhaps more likely possibility, is that when the animals were moved to the property at Delegate, they came in contact with one or more PI animals there. Due to the extent of transmission that occurred, it is clear that the animals had direct contact with at least one PI for a period of time. The fact that there was limited evidence of recent infection in the older cattle could be interpreted in support of a PI being present in the mob. However, if there was proximity between the aborting heifers and cows, the foetuses and later PI calves would

produce sufficient virus to result in further transmission on the property. Nevertheless, it is clear that BVDV had almost certainly been present in the herd previously based on the serology results for the older cattle.

1.9 Other factors causing reduced reproductive efficiency

Although there were a number of abortions and calf deaths that could not be investigated, there was a representative collection of material tested and BVDV confirmed. No other causes were identified. It is therefore not unreasonable to suggest that most if not all of the reproductive loss in this herd was due to BVDV. Although sampling was very limited, the prevalence *N. caninum* was very low and consistent with other herds in this region. There was no evidence that *N.caninum* contributed to the reproductive loss.

1.10 Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

In the short term there is little or no scope for further losses due to BVDV because there are only a few susceptible animals remaining after the extensive virus transmission that occurred in 2003/04. However, because most of the PI animals have already been removed (or sold or died), it is likely that the current high level of herd immunity will quickly decline as it is likely that subsequent generations of breeders will not become infected and naturally immunised. In the absence of rigorous biosecurity, vaccination of replacement females would be recommended to prevent future outbreaks.

Herd Summary N2
Central Tablelands

This is a medium size commercial beef shorthorn breeding herd, located at Cumnock in Central Western NSW. Cattle graze a mixture of native and predominantly improved pastures and dry-land lucerne. Winter wheat and sorghum crops are also grown.

2.1 Herd Selection Criteria

This herd was selected on the basis of an apparent pestivirus problem that was diagnosed after the submission of one dead and one sick live weaner steer for post-mortem in late December 2004. The affected calves were about 7-8 months old. There had been deaths of 25-30 calves over a period of 6-8 weeks. Affected calves were in good condition but showed a range of enteric or respiratory signs for 2-7 days before dying. There were some sudden deaths and also some ill-thrifty calves. After a diagnosis of pestivirus infection had been made, one of the owners sought information on the internet and contacted EMAI for further information. The family was interested in investigating the entire herd and establishing the extent and origin of the problem.

2.2 Monitoring methods for this herd

As the presenting problem was the product of BVDV infection of breeding females at least 15 months earlier, the initial activity was to collect blood samples from all breeders and replacement heifers. These samples were tested for BVDV and *Neospora* antibodies and where appropriate, BVDV antigen. Pregnancy diagnosis was routinely performed. Therefore one of the owners was able to review all herd records and provide a summary of reproductive performance for the preceding 3 joining periods (Spring 2001-2003), the last being the joining that led to the birth of the PI calves. In the next year reproductive records were again collected and all new calves tested for BVDV antigen as there was potential for ongoing foetal infection due to the presence of PI animals in the herd.

2.3 Herd Management

Generally, animals were joined in several age-related breeding groups of 40-50 females with single sires in separate paddocks. Joining extended for a period of 9 weeks. Towards the end of this period an additional bull was sometimes added if the group was large. Heifers were weighed prior to joining and joined at 14-16 months of age and at least 300Kg bodyweight. All animals were vaccinated for clostridial diseases and leptospirosis. Calves were usually weaned at about 6-8 months of age. Steers were sold at about 450-500Kg direct to a feedlot for finishing.

Normal herd management plans had been severely compromised by 3 years of severe drought and the need to agist animals at Narromine, Nyngan and Scone (locations each more than 100 km away). The owner was also concerned that the suboptimal nutrition had affected conception rates. Some groups of cows and heifers that had been sent away on agistment did not return and were eventually sold as the drought became worse. Animals that failed to conceive were also sold, though some were re-joined in early summer and sold “in calf”.

2.4 Reproductive performance

The results of pregnancy testing and marking for the 3 years prior to the detection of the BVDV problem are summarised as follows:

Table 2.1:

Joining Year & Group	Number joined	Number pregnant	Pregnancy rate	Calves Branded	Branding rate
2001					
Heifers	68	64	94%	57	84%
Cows	239	214	90%	209	87%
2002					
Heifers	51	49	96%	48	94%
Cows	223	196	88%	179	80%
2003					
Heifers	56	42	75%	42*[a]	75%
Cows	223	176	79%	147* [b]	66%
2004					
Heifers	68	52	76%	40 [c]	59%
Cows	169	149	88%	147	87%
2005					
Heifers	Nil (all sold)				
Cows	234	218	93%	207	88%

*Problem year:

- [a] Heifers – 10 surviving calves PI
- [b] Cows – 22 weaners died post marking, rest weaners sold for slaughter.
- [c] Some PI calves born (total not determined)

2.5 Prevalence of BVDV and *N. caninum* at commencement

Investigations in this herd commenced with the diagnosis of weaner deaths due to BVDV infection. As this problem was the outcome of infection at least 14-15 months earlier, a serological profile of the breeding groups was established soon afterwards. Blood samples were collected from all heifers and cows on the property and were tested for antibodies to BVDV and *Neospora*. The results are summarised in the following section.

2.6 Evidence of transmission of BVDV and *N. caninum* during the study period

The whole herd sampling indicated that there had been widespread recent infection in the breeding herd. There were a number of strong reactors (3 & ≥3) in the BVDV AGID (see Table 2). A number of BVDV persistently infected animals were identified both during the initial diagnostic investigation and during the sampling of calves that were born during the course of the study. There was little evidence of *Neospora* infection in the herd.

Table 2.2:

Year	Age/ Group	BVDV AGID							*Neospora* ELISA			
		Neg	1	2	3	≥3	Total	%+ve	Neg	+ve	Total	%+ve
2005	(sampled 3/05)											
	Heifers (03)	0	6	29	15	1	51	100	51	0	51	0
	1st calvers (02)	0	6	45	9	0	60	100	57	3	60	5.0
	Cows – agisted	1	16	41	16	4	78	98.7	144	1	145	0.7
	Cows – home	1	11	106	27	0	145	99.3	76	2	78	2.6
	Calves (04) - heifers	9*	2	11	8	12	42	78.6	40	2	42	4.8
2006	Weaners (05) 2/06	176**	7	35	17	1	236	25.4				
	Yearlings (05) 8/06	1	8	39	18	0	66	98.5				

* All persistently infected with BVDV

** 1 persistently infected weaner

2.7 Evidence of infections with BVDV and *N. caninum* during the reproductive cycle of interest

This herd was recruited when a significant problem was encountered in late December 2004 with deaths in weaners. These deaths were confirmed as the outcome of *in utero* BVDV infection that had occurred about 14-15 months previously when the dams of these weaners were in the early stages of pregnancy – probably about September-October 2003. It was apparent from the scale of the problem that there had been extensive BVDV transmission in the herd in the recent past. As a result, the reproductive records and management of the herd was reviewed during this period and the preceding 2 years. Reproductive performance of the herd was also monitored during the subsequent breeding periods, especially in 2005 & 2006 because it was known that some persistently infected animals were present.

Serological monitoring confirmed that there had been widespread virus transmission throughout all breeding groups prior to sampling in early 2005. Although several groups of cows had been agisted in 2002 and 2003 due to severe drought, there was a high prevalence in both agisted cows and cows that had remained at 'home'. The results suggested that there had perhaps been more recent infection in some of the agisted cows and also in a group of pregnant heifers. As a result, the progeny of the heifers and all calves from cows that may have been recently infected were sampled as weaners.

There was a very low prevalence of *N.caninum* infections in the breeding herd, with an overall prevalence of 1.8%.

2.8 Impact of BVDV and *N. caninum* on reproductive outcome

Although there was probably an impact of drought on conception rates, especially in 2002 and perhaps 2003, the calving and marking percentages are 10-20% lower in both cows and heifers for the 2003 joining. There is also a reduction in the heifer conception and marking rates following the 2004 joining. It cannot be proven that these reductions are due to BVDV infection but there is convincing evidence that these animals were undergoing active infection with BVDV during the early stages of the reproductive cycle. The reduction in marking percentage is not a reliable indication of the final impact of BVDV on this herd because a large number of calves were lost after marking. Deaths of weaners and yearlings have rightfully been described as a delayed form of reproductive loss because the infection was initiated in early pregnancy, even though the progeny may not succumb until some considerable time later. In this instance about 30 calves were lost in the period just before and soon after weaning. A further 15 weaners died soon after the diagnostic investigation. As a result, the owners made a decision to sell the entire year's calf crop for slaughter as a salvage operation before blood sampling could be undertaken. About 12 weaners were showing signs of illness at the time of sale and several died during transport to the abattoir. There are considered to be about 55-60 of the 2004 calves lost as a result of this outbreak. It is possible that there may also have been additional persistently infected animals in the group that were sold for slaughter. Additionally, a full year's replacement breeding stock was lost.

Although it was not possible to confirm that all calf deaths were due to BVDV, from a diagnostic perspective there is little doubt that most if not all of the calf losses were due to BVDV infection *in utero* and these losses were persistently infected animals that were probably dying as the result of the emergence or introduction of a cytopathic strain of BVDV. This conclusion is based on the sudden and extensive nature of the mortality problem. The deaths were sufficiently acute that testing was undertaken to exclude anthrax as a possible cause.

Some of the cows that were pregnant at the time the project commenced were thought to potentially be carrying infected foetuses, based on the BVDV serology results. Testing of 42 heifer calves that were born in 2005 revealed 9 that were PI. Although the steer portion of this breeding group was not available for the collection of blood samples, there were 2 ill-thrifty calves noticed. These were sampled and both were persistently infected with BVDV, giving a total of at least 11 infected calves in 2005. In 2006 there were 5 stillborn calves born to heifers. Two were shown to be infected with BVDV (1 was positive for antigen, the other had antibodies in pericardial fluid) while the other 3 died as a result of dystocia. All surviving calves were tested at weaning and one was shown to be persistently infected.

Collectively, there were at least 69 calves lost, presumptively due to BVDV infection between 2004 and 2006, without taking into consideration reduced marking rates and the possibility that a number of calves that were sent for salvage slaughter may also have been infected.

During the course of the investigations in 2005, blood samples were collected from all cattle on the property. No persistently infected adult cattle were identified. The only PI animals identified were calves that were born in 2004 or later. The possibility cannot be completely excluded that the source of BVDV for this outbreak may have been an unidentified PI animal that had been sold before the herd was tested. An alternative possibility was infection of females while on agistment and introduction of virus to the home property following the delivery of a PI foetus or calf. However, after discussion with the owners, the most likely source of the virus was identified as an introduced calf. This animal was poorly grown and was an unwanted addition to a small group of animals that had

been purchased from a neighbour. It was subsequently held with a small group of pregnant breeders and presumably led to the birth of another PI calf. The subsequent presumptively PI calf that was born was held in a paddock but showed abnormal behaviour and could not be mustered for removal at weaning. Over time, all groups of breeders had contact with this animal at various times during early pregnancy as they were moved through and held in this paddock.

There was no evidence that *Neospora* infection had any impact in this herd.

2.9 Other factors causing reduced reproductive efficiency

Apart from the impact of drought and suboptimal nutrition in lowering conception rates, no other causes of reduced reproductive performance were identified. In this herd, although there were reduced calving rates, the main losses were prior to marking and especially around weaning, at times when other causes of loss are more readily identifiable if they are to contribute to the problem.

2.10 Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

While this herd had a high level of immunity at the end of the outbreak, immunity in new groups of replacement heifers depends on ongoing transmission from PI animals. The owners have reported that while they had intended to retain known PI animals, survival has been an issue and it is likely that they will vaccinate replacements. It is unlikely that *Neospora* will play a role in losses in this herd.

Herd Summary N3
South West Slopes

This is a commercial Shorthorn beef breeding herd located at Harden in Southern NSW. The cattle graze improved pastures based on phalaris, ryegrass, clover and lucerne.

3.1 Herd Selection Criteria

This herd was selected on the basis of an apparently emerging pestivirus problem following the delivery of 3 stillborn calves and 3 calves with congenital defects. There was concern that a number of mature cows (3 or more calves) that had been pregnant had lost calves. This was confirmed by rectal palpation where 10 of 43 cows were not pregnant. Diagnostic investigations were undertaken on a blind calf that was unable to suckle and had a flaccid paralysis. At post-mortem examination it was shown to be affected by hydranencephaly, due to BVDV, on the basis of BVDV-specific antibodies in the AGID (>3) undertaken on pre-colostral serum. The farm is in an area that is south of the Akabane virus zone and the calf was shown to be free of Akabane virus-specific antibodies.

3.2 Monitoring methods for this herd

Blood samples were collected from all animals in the herd for BVDV and neospora serology and, where appropriate, for the detection of persistent BVDV infections by antigen ELISA. Breeding records were collected for the subsequent year for comparison.

3.3 Herd Management

The herd was run as 3 separate breeding groups, consisting of maiden heifers, first calf cows and mature cows. All females were vaccinated with a combination clostridial and leptospiral vaccine. Steers were sold at approximately 500kg.

- Duration of joining and number of females joined

Bulls were run at a rate of 3% and were left with the females for 12 weeks. In 2004, 85 females were joined.

3.4 Reproductive performance

- Pregnancy rate

Pregnancy diagnosis was undertaken at 7 months after the start of joining. Of the 85 females joined, 70 were pregnant. The breakdown by joining group was:

Group	Number	Pregnant	Pregnancy rate
Heifers	24	19	79%
1st Calf cows	19	18	95%
Mature cows	42	33	79%

- Calving rate

Of the 70 females that were still pregnant, 61 produced full term calves. One abortion was observed between pregnancy testing and calving, there were 2 calves with congenital defects, 2 stillborn and 5 perinatal deaths. Three more calves died at 2 months of age. No samples were submitted for diagnostic investigations but 1 calf had pneumonia and the others were described as ‘wasting’. One more calf died at 8 months after a period of ill-thrift.

3.5 Prevalence of BVDV and *N. caninum* at commencement

Investigations in this herd commenced with the diagnosis of a congenital BVDV infection. The whole herd was sampled as soon as practical after this investigation. The results are summarised in the following section.

3.6 Evidence of transmission of BVDV and *N. caninum* during the study period

The whole herd sampling indicated that there had been widespread recent infection in the breeding herd, especially apparent in the animals that were on the point of calving or had recently calved. There was a very high proportion of strong reactors (3 & ≥3) in the BVDV AGID (see table). Two BVDV persistently infected animals were identified, both unjoined yearling heifers. There was little evidence of *Neospora* infection in the herd.

Age/ Group	BVDV AGID							*Neospora* ELISA			
	Neg	1	2	3	≥3	Total	%+ve	Neg	+ve	Total	%+ve
Unjoined heifers	-	-	12	7	-	19	100	14	5	19	36
Heifers	2	1	5	11	13	32	94	31	1	32	3
1st calf cows	-	2	8	5	1	16	100	16	0	16	0
Mature cows*	-	5	16	3	10	34	100	34	0	34	0
TOTAL	**2**	**8**	**42**	**27**	**25**	**104**	**98**	**98**	**6**	**104**	**6**

* Problem mob at time of initial investigation

Due to the very high prevalence of BVDV infection found at the first sampling, follow-up sampling of the cows for serology was not undertaken. However, the calf crop was tested at about 8-9 months of age. Three of these calves were shown to be persistently infected with BVDV.

3.7 Evidence of infections with BVDV and *N. caninum* during the reproductive cycle of interest

At sampling that was undertaken around the time of, or soon after the 2005 calving, it was apparent that there had been widespread transmission of BVDV throughout the breeding herd and that a large number of animals had been infected during pregnancy. It is likely that a high proportion of animals had been infected during the current breeding season. Based on the proportion of strong (3 & ≥3) reactors in the BVDV AGID, it is estimated that at least 50% of breeders had been infected while pregnant. There was minimal evidence of infection of the breeding cattle with *Neospora*, with a single seropositive heifer.

3.8 Impact of BVDV and *N. caninum* on reproductive outcome

In this herd, although it was not possible to investigate every case, BVDV infection has probably resulted in the loss of up to 22 calves (26%) (32% if the 5 surviving PI animals are included) and has had an impact through:

- Abortion - 9 animals that were confirmed as pregnant failed to calve;
- Congenital defects – 2 cases;
- Perinatal deaths - 2 stillborn, 5 deaths;
- Preweaning deaths – 3 calves between 2-8 months of age;

- Post-weaning illthrift and deaths – 1 unconfirmed case;
- Persistently infected animals – 5 surviving.

All of these are typical clinical presentations of BVDV infection although it is uncommon to encounter such a wide array in one herd. Based on the detection of PI animals and the birth of calves with congenital defects and taking into account probable virus transmission rates, it is likely that these animals were infected from early to mid-gestation (approximately 60-150 days). If infection had occurred at an earlier period it is likely that there would have been no congenital defects and more PI animals. Conversely, following infection at a later time, there would have been few PI animals and perhaps less impact on reproduction overall.

There is evidence that this virus may have also caused indirect reproductive loss in this herd, even among the cows that produced viable (& non-PI) calves. A number of these calved a long period after joining commenced, suggesting that either there were very poor conception rates initially OR they lost a foetus and were re-joined by the bulls that were left with them. Of the cows that calved, there were 15 (22%) that calved between 350-408 after joining. This long interval would clearly impact on the subsequent breeding season as many of these females had only recently calved and were in early lactation.

The original source of virus for this herd could not be identified but there were 2 PI yearling heifers born in the previous calf drop. It is possible that they were the product of infection acquired when the cattle were moved along a road between two properties. Apart from this movement, the herd was closed and there were no cattle on neighbouring properties at that time. These PI heifers would have been present in some of the breeding groups at critical stages (perhaps up to 6 months) of pregnancy and provided a source of virus to a high proportion of the herd. It is interesting to note that there was evidence of recent BVDV transmission in all breeding groups. The owners did advise that at least one of these animals did move around on the farm and probably between mobs. It is possible that 2 yearling deaths from the previous year were also pestivirus-related but these were not confirmed. If these were indeed due to BVDV infection, it is likely that they must have been separated from the breeding females at an early stage because the results of the serology and the outcome of the 2005 calving clearly indicate widespread virus transmission in late 2004/early 2005.

3.9 Other factors causing reduced reproductive efficiency

Although there were a number of abortions that were not specifically investigated, the still births, congenital defects and pre-weaning deaths associated with persistent BVDV infection would suggest that most if not all of the reproductive loss in this herd was due to BVDV. There no other cause of abortion identified and *N. caninum* did not contribute to reproductive loss.

3.10 Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

In the short term there is little or no scope for further losses due to BVDV because there are only a few susceptible animals remaining after the extensive virus transmission that occurred in 2004/05. However, because most of the PI animals have already died and some were sold for slaughter, it is likely that the current high level of herd immunity will quickly decline as it is likely that subsequent generations of breeders will not become infected and naturally immunised. In the absence of rigorous biosecurity, vaccination of replacement females would be recommended to prevent future outbreaks of the magnitude seen in 2005.

Herd Summary N4
Central Tablelands

This is a medium-large size stud and commercial Angus herd, located at Bathurst in Central Western NSW. The herd contained about 500 commercial cattle and 300 stud cattle. The stud herd had been larger until the retirement of a family member 3 years ago when all of the breeding age stud females held at that time were sold.

Cattle graze a mixture of native and improved pastures as well as oats in winter. During the drought in 2002 and 2003, another property was leased at Oberon and 100 commercial breeders were agisted there to allow normal production to continue. These animals returned to the home property towards the end of 2003. The herd utilises natural breeding, artificial insemination and embryo transfer.

4.1 Herd Selection Criteria

This herd was selected in 2005 for detailed investigation following the submission of 33 blood samples that had been collected because the owner was concerned that reproductive loss and enteric disease observed in the herd may have been due to BVDV infection. These samples gave clear evidence of active virus transmission as well as the presence of PI animals.

4.2 Monitoring methods for this herd

As the presenting problem was the occurrence of a recognised reproductive problem that had already occurred in the herd, the initial activity involved the collect of blood samples from all breeders and replacement heifers. These samples were tested for BVDV and *Neospora* antibodies and where appropriate, BVDV antigen. As pregnancy diagnosis was routinely performed, a comprehensive review of reproductive data was undertaken for several preceding years. Reproductive records for the following year (2006) were also reviewed.

4.3 Herd Management

Generally, animals were joined in age-related breeding groups of 30-40 females with single sires in separate paddocks. Joining extended for a period of 9 weeks. Heifers were routinely joined at 14-16 months of age (approximately 300Kg bodyweight). All animals were vaccinated for clostridial diseases using a 5 in 1 vaccine. Calves were usually weaned at about 4-5 months of age.

For the embryo transfer program commercial and culled stud cows were used as the recipients. Normal herd management plans had been severely compromised by 2 years of severe drought and the need to agist 100 animals on another property.

4.4 Reproductive performance

The results of pregnancy testing and marking for the period that lead up to the detection of the BVDV problem are summarised as follows:

Table 4.1:

Joining Year & Group	Number joined	Number pregnant	Pregnancy rate	Calves branded	Branding rate
ET recipients 2003*	76	29	38%	25	33%
Stud Heifers AI 2003*	84	70	83%	67	80%
Commercial cows 2003			93%		
Stud cows 2004	80	78	97%	75	94%
Stud heifers 2004	0	0		0	
Commercial cows 2004	270	249	92%	239	89%
Commercial heifers 2004	85	83	98%	77	91%

*Problem year:

4.5 Prevalence of BVDV and *N. caninum* at commencement

The owner of this herd was concerned that a reproductive problem that had occurred in 2003/4 may have been due to BVDV following the return of animals from agistment. However, the herd investigation did not commence until July 2005. At that stage, there had been re-structuring of the herd following the dispersal of the original stud herd (with only a proportion of animals retained by the current owner). Consequently, blood samples were collected from all stud and commercial heifers, cows and bulls on the property and were tested for antibodies to BVDV and *Neospora*. The results, which are summarised in the following section, must be interpreted against a background of a problem that may have occurred perhaps 18 months to 2 years earlier.

4.6 Evidence of transmission of BVDV and *N. caninum* during the study period

The serology results for the stud and commercial cattle are listed by ages in Tables 4.2 & 4.3 respectively.

Table 4.2: Stud females

Year	Age/ Group	BVDV AGID							*Neospora* ELISA			
		PI*/Neg	1	2	3	≥3	Total	%+ve	Neg	+ve	Total	%+ve
1998/9			5	6			11	100	9	2	11	18.2
2000			2				2	100	2		2	0
2001			1				1	100	1		1	0
2002				2	1		3	100	3		3	0
2003		1	5	30	35	3	74	98.6	72	2	74	2.7
2004		7	4	18	14	1	44	84.1	39	5	44	11.4
2005		3/15	0	9	24	38	86	82.6	86		86	0
Total		**3/23**	**17**	**65**	**74**	**42**	**221**	**89.6**	**212**	**9**	**221**	**4.1**

* No persistently infected with BVDV & No seronegative

Table 4.3: Commercial females

Year	Age/ Group	BVDV AGID							*Neospora* ELISA			
		PI/Neg	1	2	3	≥3	Total	%+ve	Neg	+ve	Total	%+ve
1998/9		1/1	11	30			42	97.6	42		42	0
2000		¼	18	16	11	1	50	92.0	50		50	0
2001		2/2	38	59	6		105	98.1	105		105	0
2002		½	31	27	10		70	97.1	70		70	0
2003		2/2	14	62	10		88	97.7	88		88	0
2004		4/4	4	65	59		132	97.0	132		132	0
2005												
Total		**11*/15**	**116**	**259**	**96**	**1**	**487**	**96.9**	**487**		**487**	**0**

* No. of persistently infected with BVDV & no. seronegative

4.7 Evidence of infections with BVDV and *N. caninum* during the reproductive cycle of interest

This herd was recruited after a problem had been suspected by the owner and sometime after the transmission that lead to the main losses had occurred. As a result, the reproductive records and management of the herd was reviewed during this period and the preceding 2 years. Reproductive performance of the herd was also monitored during the subsequent breeding period in 2005/6 because it was known that some persistently infected animals were still present on the property.

Serological monitoring confirmed that there had been widespread BVDV transmission throughout most breeding groups of both the commercial and stud herds prior to the sampling that occurred between July and September 2005. The owner suspected that the recognised problem arose after several groups of animals had been segregated from the main source of infection while cattle were on agistment. There is little doubt that the herd had been endemically infected because there were PI commercial breeders that were born each year from 1998/99. However, the serology results would suggest that the situation is more complex because all age groups had a significant proportion of animals that appear to have been infected in the last year. For this to occur, there had to be many susceptible animals recently come in contact with one or more of the PI animals.

There was a very low prevalence of *N.caninum* infections in the breeding herd, with an overall prevalence of 4.1% in the stud herd and no infection detected in the commercial herd. Although there are limited numbers of older animals in the stud herd, it is plausible and tempting to suggest, that some of the peaks of higher prevalence may have arisen during the BVDV transmission in these groups.

4.8 Impact of BVDV and *N. caninum* on reproductive outcome

The full extent of losses in this herd is difficult to assess due to a combination of the retrospective nature of the investigation and the fact that many animals were sold at the time the investigation commenced. Testing was largely limited to animals that remained on the property at the end of the annual sales. There was a high probability that there were a number of persistently infected calves born in 2004 and perhaps also in 2005 that were not detected prior to sale. Nevertheless, estimates of the extent of the impact of BVDV on the herd have been provided by the owner and do provide an

indication of the scale of the problem. There are also other implications from the infection of cattle in this herd that warrant its inclusion in the study.

The owner had expected, based on previous performance, a pregnancy rate of at least 60% (45 calves) from the embryo transfer program, instead of the 38% pregnancy rate (29 calves), giving a minimum loss of 16 calves. In a similar manner, a pregnancy rate of about 93% (78 calves) should have been delivered by the heifers rather than the 83% (70 calves) that were born. Further, 2 of the male calves from the heifers were also PI, effectively another loss. Collectively, the losses were estimated by the owner to have cost more than $50,000. As the most of the heifer calves born in 2004 were sold prior to being tested, it is possible that there were PI animals that were transferred to other owners. It is suspected that there were also at least 12 PI animals born in 2000 following transmission in 1999 with low level losses in most other years. Finally, in 2005 at the start of the investigation, due to an owner error in sample identification, 2 recently identified PI bulls were sold and the mistake was not recognised for 2 weeks. This caused considerable distress for the owner who had to explain the situation to the purchasers and refund the cost of purchase and delivery. Fortunately, both the new owners had managed the new bulls in a manner that had no impact on the herd. Had they been on the new properties for any longer there was a potential for spread of BVDV in other herds.

An unusual feature of the infections in this herd were the number of breeding cows that were PI and had survived, some the product of spread in the herd in 1998, and were up to 6 years of age when detected. There was a total of 11 surviving PI breeders, 1 or 2 in each year from 1999 to 2003 (see Table 4.3). A further 5 mature cows that were dams of some of these PI animals had died unexpectedly over the previous 2-3 years, suggesting that there was a very high probability that they too were PI animals. All of these animals died in the 12 months after the start of the investigation. While some produced more than one PI calf, their breeding potential was not fully realised and represented a further BVDV related loss. The owner has estimated that including follow-on effects BVDV has cost at least $200-250,000 in lost production since 1999.

4.9 Other factors causing reduced reproductive efficiency

As this herd was recruited towards the end of the field investigation phase of the project, there was neither scope, nor indications, to investigate the potential for other agents to have an impact in this herd.

4.10 Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

While this herd had a high level of immunity at the end of the outbreak, immunity in new groups of replacement heifers depends on ongoing transmission from PI animals. The owners have reported that while they had intended to retain known PI animals, survival has been an issue and replacement heifers are now vaccinated. It is highly unlikely that *Neospora* will play a role in losses in this herd.

Herd Summary N5
South West Slopes

This was a large commercial beef breeding herd located at Coolac in southern NSW. The herd consisted of 1250 Angus/Hereford cross-bred females.

5.1 Herd Selection Criteria
This herd was selected on the basis of being a well-managed large commercial beef breeding herd in which a diagnostic investigation incriminated BVDV as the probable cause of an active abortion problem.

5.2 Monitoring methods for this herd
As there was an identified abortion problem that was observed when pregnancy testing was being undertaken in April 2005, the attending veterinarian was asked to provide data for the reproductive performance for the herd for the current year and for the following year. A request was made for blood samples to be collected from a proportion of animals in each of the different management/age groups and from the calves from the affected mob at about weaning.

5.3 Herd Management
Heifers were joined in spring at 14-15 months of age at 320-370Kg by natural mating in groups of approximately 120-150 head with 3% bulls included for 9 weeks. Mature cows were mated in mixed age groups of about 150 head with 2.5% bulls. All females were vaccinated for leptospirosis while bulls were vaccinated for *Campylobacter* infection and had been serving capacity tested. Calves were weaned at 6-7 months of age in March-April. The herd had recently increased in size due to the addition of several purchased lots of heifers. The problem groups of heifers had been weaned, reared and joined in isolation then additional animals were added to the mob.

5.4 Reproductive performance
The results of pregnancy testing for the 2004 & 2005 breeding seasons are summarised as follows:

Table 5.1:

Joining Year & Group	Number joined	Number pregnant	Pregnancy rate
Heifers '04*	328	279	85.0%
Cows '04	922	871	94.5%
Heifers '05	217	183	84.3%
1st Calf cows '05	234	188	80.3%
Cows '05	1049	939	89.5%

*Problem group in 2005

5.5 Prevalence of BVDV and *N. caninum* at commencement

Blood samples were collected from a cross section of the herd in August 2005 just prior to calving. The results presented in Table 5.2 below should therefore reliably reflect the likelihood of infection in many animals during the current pregnancy but can only be used as a guide to determining the prevalence of BVDV infection and hence herd immunity at the start of the joining period. *Neospora* infection in the herd was rare and hence not considered to be of any significance to the current problem.

5.6 Evidence of transmission of BVDV and *N. caninum* during the study period

The prevalence of BVDV and Neospora in the herd at the point of calving in August 2005 is summarised in Table 5.2. These results indicate that a high proportion of heifers were probably infected with BVDV during the current joining period and/or while pregnant.

Table 5.2:

Year	Age/ Group	BVDV AGID							*Neospora* ELISA			
		Neg	1	2	3	≥3	Total	% +ve	Neg	+ve	Total	% +ve
8'2005	Unjoined Heifers	15	0	1	8	1	25	40	25	0	25	0
	Heifers A, B*	23	20	20	16	12	91	75	90	1	91	1
	Heifers C	17	0	10	5	1	33	48	31	2	33	6
	1st calf cows	1	2	20	3	0	26	96	26	0	26	0
	Cows	0	4	18	3	0	25	100	25	0	25	0
3'2006	Weaners*	92	1	5	15	67	180	51				
	1st Calvers (A,B)	12	7	25	6	0	50	76	50	0	50	0

* Problem groups
[a] Progeny of problem group

5.7 Evidence of infections with BVDV and *N. caninum* during the reproductive cycle of interest

The serology results for the samples collected in August 2005 are consistent with active BVD virus transmission the heifer group, especially the A & B mobs. There is also limited evidence of recent infection in all other age groups but it is possible, perhaps even likely, that these infections did not occur in the current breeding period. There is minimal evidence of past infection with *Neospora* in some age groups (just 1 or 2 animals from the groups sampled).

5.8 Impact of BVDV and *N. caninum* on reproductive outcome

The full impact of BVDV on this herd will remain undetermined because, despite repeated requests from the owner, insufficient data was provided to support a detailed analysis. Pregnancy testing in 2005 identified a reduced pregnancy rate in the heifers and multiple abortions were observed. It was estimated that there was a further 15% reduction in calving rate, though the actual calving and marking rates are not available. When there were strong indications that there could be a large number of weaner deaths associated with PI animals, the owner sold the mobs that were under suspicion before testing could be undertaken. It is also possible that there may have been reduced pregnancy rates associated with BVDV infection in several mobs but that cannot be proven.

Although more likely in 2005, when BVDV was associated with abortions, perinatal deaths and pre-weaning calf losses, in 2006 the pregnancy rates observed in the mature cows were lower than expected. There were also low rates observed in the first calf cows that had been involved in the BVDV problem the previous season. Whether this was solely due to the stresses associated with a first lactation or whether there was an infectious cause cannot be determined. While there as a lower than expected pregnancy rate in the maiden heifers, these animals had been vaccinated with a BVDV vaccine prior to joining. The attending veterinarian suggested that the reduced pregnancy rate in these heifers was probably due to inferior performance of the bulls.

5.9 Other factors causing reduced reproductive efficiency

Other than the residual effects of a prolonged drought, no other causes of reduced reproductive efficiency were identified.

5.10 Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

Despite widespread BVDV transmission in 2004/5, there were still some groups of animals, mainly heifers and first calf cows that had less than optimal immunity to BVDV. The owner had already implemented a vaccination program in the maiden heifers prior to joining, and with continued vaccination of young stock, losses should be minimised.

Herd Summary N6
South Coast

This is a well managed 1200 acre mixed commercial beef and sheep breeding herd located north of Braidwood on the eastern slopes of the southern tablelands of coastal NSW. The cattle are Hereford and Hereford Angus cross.

6.1 Herd Selection Criteria

This herd was selected on the basis of illthrift with chronic pneumonia and scouring in weaners in late summer (March) 2005. There was no response to treatment with electrolytes and antibiotics. Diagnostic investigations of 3 affected weaners confirmed that each was persistently infected with BVDV.

6.2 Monitoring methods for this herd

Blood samples were collected from all animals in the herd in May 2005 for BVDV serology and, where appropriate, for the detection of persistent BVDV infections by antigen ELISA. Breeding records were collected for the previous 4 years and the subsequent year for comparison.

6.3 Herd Management

The herd is run as 2 separate breeding groups, consisting of maiden heifers and cows. All cattle are vaccinated with a 5 in 1 clostridial vaccine as calves and then given an annual booster. Vaccination for leptospirosis is not practised as the prevalence of leptospiral infection in the district is considered to be low.

Bulls are purchased from local studs. Females are first joined at 2 years of age for 6-8 weeks and are pregnancy tested 8 -12 weeks after the bulls are removed.

6.4 Reproductive performance

The breakdown of reproductive performance between 2001 and 2006 was as follows:

Table 6.1:

Year	Females joined	Pregnant	Calved	Calves weaned	Calves sold	Heifers retained
2001	141	127	124	123	80	43
2002	98	90	86	86	52	32
2003	62	58	56	51	28	22
2004	80	76	75	73	46	27
2005	84	78	75	74	43	31
2006	79	74	74	74	48	26

Table 6.2:

Year	Females joined	Pregnancy rate	Calving Rate*	Weaning rate*	Calves sold/retained*
2001	141	90%	97.6%	99.2%	100.0%
2002	98	92%	95.6%	100.0%	97.7%
2003	62	94%	96.6%	91.1%	98.0%
2004	80	95%	98.7%	97.3%	100.0%
2005	84	93%	96.2%	98.7%	100.0%
2006	79	94%	100.0%	100.0%	100.0%

* proportions of:

pregnant females that calved;
calves born that were weaned;
weaned calves sold or retained.

Over the 6 years for which data was provided, there was good reproductive performance in each year. There was an increase in pre-weaning deaths of unknown aetiology from the 2003 joining (calves born spring 2004). It is possible that this was due to the introduction of BVDV into the herd (see later).

6.5 Prevalence of BVDV at commencement

Investigations in this herd commenced with the diagnosis of a BVDV infection as a cause of weaner illthrift with pneumonia and scouring. Blood samples submitted from three 6 month old weaners confirmed persistent BVDV infection in each calf. The whole herd was sampled in May 2005 as soon as practical after this investigation. The results are summarised in the following section.

6.6 Evidence of transmission of BVDV during the study period

The whole herd sampling indicated that there had been widespread recent BVDV infection in the breeding herd. There was a very high proportion of strong reactors (3 & ≥3) in the BVDV AGID (see Table 6.3).

Table 6.3:

Herd	Age/ Group	BVDV AGID						
		Neg	1	2	3	≥3	%+ve	Total
Weaners	9mths	8*	0	2	9	5	75	24
Unjoined heifers	18 mth	14	1	11	5	0	45	31
First Calf cows	3 YO	0	8	15	4	0	100	27
Mature Cows	4-7 YO	0	9	46	4	1	100	60
Bulls			1	2	2		100	4

* All seronegative calves are persistently infected with BVDV

6.7 Evidence of infections with BVDV during the reproductive cycle of interest

The detection of PI calves in March 2005 indicates that there was virus transmission in late 2003 when the dams of these calves were joined. There was then potential for ongoing transmission in the herd, as a minimum, from the birth of these calves in August-September 2004. At the time of the investigation, joined had ended, so there was potential for infection of the next generation of calves. This is supported by the serology for the cows (mature and first calvers) where there are a number of strong (3, >3) reactors. It is possible (though not highly likely) that these high antibody levels could be the result of these cows carrying PI calves in the previous breeding year.

6.8 Impact of BVDV on reproductive outcome

The herd data and serology suggest that BVDV was probably spreading in the breeding cattle during the 2003/4 and 2004/5 breeding years. However, BVDV appeared to have no apparent impact on pregnancy rates. If there was any early embryonic loss, the affected cows must have conceived quickly because there was no extended calving. There were 6 persistently infected calves detected when the 2003/4 calf drop was tested. It is also possible that the pre-weaning losses of calves may have also been due to BVDV. Based on the serology results for the cows when tested in May 2005, when they would have been 5-6 months in calf, it is likely that further PI calves may have been born in the 2004/5 breeding season. However, it was not possible to sample these calves at or around weaning in autumn 2006.

6.9 Other factors causing reduced reproductive efficiency

In this herd, there were good pregnancy, calving and weaning rates. The main impact of BVDV in this herd was the result of premature deaths and reduced productivity as a result of illthrift in weaners and yearling age cattle. There were no other agents identified as contributors to losses at this age.

6.10 Likelihood of future impact of BVDV on reproductive efficiency

The results of the whole herd serology indicate that more than half of the heifers that were approaching joining were still susceptible to BVDV. As these are joined as a separate group, it is likely that they would remain susceptible until pregnant. While they remained in isolation, it would be unlikely that they would be infected with BVDV. However, the progeny of the main herd remained a threat in 2006. Further, the original source of virus for this herd could not be identified. Careful management of these animals during pregnancy is important to prevent further losses.

In the short term there is little or no scope for further losses due to BVDV in the adult herd because there are no susceptible animals remaining after the extensive virus transmission that occurred in 2003-5. However, because most of the PI animals are likely to die or be sold for slaughter, it is likely that the current high level of herd immunity will quickly decline as it is likely that subsequent generations of breeders will not become infected and naturally immunised. In the absence of rigorous biosecurity, vaccination of replacement females would be recommended to prevent future outbreaks.

Herd Summary V1
Western Districts

This was a small beef research herd located at Hamilton in Victoria. The herd consisted of 157 British crossbred females.

7.1 Herd Selection Criteria

This herd was selected on the basis of being a well-managed small breeding research herd in which a diagnostic investigation confirmed BVDV infection as the cause of sudden deaths in 18 month old steers. This herd was one of the herds involved in the Beef CRC in southern Australia.

7.2 Monitoring methods for this herd

As the presenting problem in March 2005 was deaths in 18 month old steers that were persistently infected with BVDV, it was apparent that the virus had been active in this herd at least 2 years previously. It was likely that current reproductive records would be of less relevance than those from 2-3 years ago, especially for the spring/summer 2002 joining season and perhaps 2001. Consequently, an attempt was made to examine records from 2001 to 2003 and the current (2004) joining was monitored as pregnancy testing was imminent. Blood samples were collected from all animals in the herd and tested for BVDV antibodies, BVDV antigen were appropriate and for *Neospora* antibodies.

7.3 Herd Management

Heifers were joined at about 14 months of age. Both heifers and cows were bred by AI following oestrus synchronisation and at observed oestrus. After 2 rounds of AI, non-pregnant animals were run with a bull. All females were vaccinated for leptospirosis while bulls were vaccinated for Campylobacter infection and had been serving capacity tested. The commercial target for the herd was the sale of steers at approximately 550 Kg.

7.4 Reproductive performance

Comprehensive reproductive records could not be provided for this herd for the key years 2001-2003 but the limited data available indicated low conception rates following AI with a large number of animals calving late following joining to bulls. Pregnancy testing after the 2004 joining showed that 90% of cows were in calf.

7.5 Prevalence of BVDV and *N. caninum* at commencement

As this was an investigation of a mortality problem in 18 Month old steers, the results for blood samples collected at the commencement of the investigation only reflect the current status on the farm and not the status when the problem occurred. Blood samples were collected from the surviving steers in the problem mob and all cows and calves at pregnancy testing in April 2005. The results presented in Table 7.1 below reflect the potential for future infection in this herd. *Neospora* infection in the herd was rare and hence not considered to be of any relevance to the current problem.

7.6 Evidence of transmission of BVDV and *N. caninum* during the study period

The prevalence of BVDV and Neospora in the herd at pregnancy testing in April 2005 is summarised in Table 7.1.

Table 7.1:

Year	Age/ Group	BVDV AGID							*Neospora* ELISA			
		Neg	1	2	3	≥3	Total	% +ve	Neg	+ve	Total	% +ve
4'2005	5-7 mth calves	103	2	0	0	1	106	3	100	6	106	6
	Steers 18 mths*	11**	8	51	8	9	87	87				
	Cows	3	32	87	2	0	124	98	122	2	124	2

* Problem group; ** All seronegatives are PI

7.7 Evidence of infections with BVDV and *N. caninum* during the reproductive cycle of interest

Due to the retrospective nature of this investigation, it was not possible to determine how many breeding females may have been infected in spring/summer of 2002-3, leading to the birth of many PI calves. However, it is obvious that a high proportion of cows must have been infected during this time. Almost all breeders are now immune (perhaps all would be shown to be immune if a more sensitive assay such as the VNT was employed). No PI animals were detected in the breeding herd. Consequently, the original source of infection in this herd will remain unknown, but there is little doubt that there must have been one or more PI animals running in the breeding herd for some time.

There is minimal evidence of infection with *Neospora* in this herd. The slightly higher presence of positive calves may be the result of residual maternal antibodies.

7.8 Impact of BVDV and *N. caninum* on reproductive outcome

While it is not possible to assess whether BVDV had any impact on conception, calving or weaning rates in this herd, it is, however, apparent that a high proportion of the breeding herd was susceptible to BVDV prior to the 2003 spring calving. Infection of these breeding cows occurred during early pregnancy, resulting in the birth of many PI calves. The possibility that they may have infected cows during breeding and contributed to further losses from the 2003 joining cannot be excluded. This may be an explanation for the suboptimal marking rate from this joining. Many or perhaps most of these PI animals had survived to approximately 18 months of age and, until the first appearance of disease, had apparently grown well. The death of these steers was acute and initially enterotoxaemia was thought to be the cause. The loss of each of the PI animals represents a delayed reproductive loss because these animals failed to reach their market target of 500Kg. The exact number of PI calves that was born is not known. However, there were 13 PI steers that died around the time of the investigation and a further 11 surviving PI steers were detected when the whole herd was sampled. These all died soon after they were sampled, resulting in the proven loss of 24 18 month old steers and perhaps other unconfirmed losses that had occurred at a younger age. There was no evidence that *Neospora* caused losses in this herd.

7.9 Other factors causing reduced reproductive efficiency

Other than the effects of a prolonged drought, no other causes of reduced reproductive efficiency were identified in this herd. However, the management of animals prior to and during artificial insemination, and perhaps oestrus detection, may have contributed to lower conception rates to AI

7.10 Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

Despite the continuing presence of a large number of PI steers on the property, almost all of the current batch of weaners remained seronegative. There was a single animal that had been recently infected, most likely 'over the fence' because the weaners and steers were being held in adjacent paddocks. This is a powerful demonstration of the influence of management on the transmission of BVDV in a herd and the development of immunity in individual mobs. As the weaner heifers were susceptible and there were no known sources of infection other than the 18 month old steers (that died soon after this sampling), it is highly probable that within several years of a major problem, a naive herd was again developing.

Herd Summary V2
Western Districts

This was a large stud herd located in southern Victoria. The herd contained approximately 1500 stud females.

8.1 Herd Selection Criteria

Although the extensive testing in this herd was predominantly a follow-up to a diagnostic investigation, data have been included in the project to highlight the capacity for BVDV infection to have an extreme impact on a herd if circumstances are appropriate for large scale transmission in susceptible groups of animals. It also highlights the influence that management of stock can have on virus transmission patterns and impact in a herd where BVDV is probably endemic.

8.2 Monitoring methods for this herd

The presenting problem in late 2006 was abortions in maiden heifers. Serology suggested that there had been recent infection with BVDV and this was a likely cause of the problem.

8.3 Herd Management

Full details of the management of the breeding herd are not available but it is known that due to drought conditions, the heifers were sent from the home farm to another property where they were raised and joined. At the end of joining, the pregnant heifers were brought back to the home farm where they were run with other cattle.

8.4 Reproductive performance

Reproductive records are not available for the herd but it is known that there was a reduced pregnancy rate with abortions in the heifers.

8.5 Prevalence of BVDV at commencement

As this was an investigation to determine the number of persistently infected calves born to the heifers there was no serology undertaken on the breeding herd. However, following the detection of PI calves, the owners tested all bulls to confirm that there were no PI animals being sold. None of the 387 bulls tested was shown to persistently infected with BVDV, indicating that either most of the breeding cows were immune or that there had been no BVDV transmission in the adult cattle. The results for blood samples collected from the calves are presented in the following section.

8.6 Evidence of transmission of BVDV during the study period

The prevalence of BVDV antibodies in the 3-4 month old calves in February 2007 is summarised in Table 8.1.

Table 8.1:

Year	Age/Group	BVDV AGID						
		Neg	1	2	3	≥3	Total	% +ve
2'2007	4-5 mth calves	212	8	6	11	10	247	14

Of the 212 seronegative calves, 172 initially gave positive results in the PACE test, suggesting that they were actively infected with BVDV. When re-sampled 4-8 weeks later, 138 of the 172 calves gave positive results in the PACE, confirming that they were persistently infected – a prevalence of

56% of PI calves. Each of the animals that gave negative results in the PACE were also shown to be seropositive, indicating that they had been acutely infected when first sampled.

8.7 Evidence of infections with BVDV during the reproductive cycle of interest

The results of sampling of the calves born to the heifers are conclusive evidence that there was widespread transmission of BVDV in the heifer mob. The absence of PI animals in the 387 bulls sampled also indicate that there was little transmission in the adult herd – either due to the absence of PI animals or due to a high level of herd immunity.

8.8 Impact of BVDV on reproductive outcome

While it is not possible to assess whether BVDV had any impact on conception or calving rates in this herd, it is, however, apparent that a high proportion, if not all, of the heifers was susceptible to BVDV prior to the 2006 joining. Infection of a very high proportion of these heifers occurred during early pregnancy, resulting in the birth of a very high incidence (56%) of PI calves. As there were also abortions, the impact of BVDV in this heifer mob has been substantial. No estimate of the economic loss is available, but as this is a leading stud herd, the costs would have been extremely high.

8.9 Other factors causing reduced reproductive efficiency

Investigations were not undertaken to identify other causes of reduced reproductive efficiency in this herd.

8.10 Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

The detection of such a large number of PI animals on this property has prompted the owners to test all stock to identify and remove any PI animals. A vaccination program has been implemented for all breeding stock.

Appendix 2: Detailed records and observations for herds in Queensland

Herd summary Q1
Capricornia

1.1 Herd selection criteria

- The herd was at risk to introduction of pestivirus as it was free from pestivirus
- In the absence of pestivirus, it provided an opportunity to investigate the impact of *N. caninum* as the prevalence was at least 33%
- The property was adjacent to a national park with a high dog population
- The owners were interested in causes of reproductive wastage
- The property had good facilities with a high level of cattle control
- Its relatively close proximity to 2 other sites would allow limited comparative herd performance as well as a potential site for discussions with producer groups.

1.2 Monitoring methods

Cows were ultrasound scanned with rectal examination 6 times from March 05 to June 06.

Data recorded was age, body condition, lactation status, P8 fat, pregnancy and ovarian activity of empty cows.

The same random sample of cows (20 per paddock) in each paddock was bled for serological status at each muster for *pestivirus* (pestivirus), *N. caninum*, *Leptospira hardjo* and *L. pomona.* In addition any cow that experienced reproductive failure, if not part of the random sample, was also bled twice.

Calving data was recorded by the owner through paddock observation.

1.3 Herd management

The cattle involved were all home bred. Two mobs were involved, Booreeco paddock of 75, 3 yo wet Santa Gertrudis cows and Grass paddock of 60, 4-9 yo wet Santa Gertrudis cows. Both mobs had been mated for 4 months from 20 Nov 04 to 22 Mar 05 and again from mid-Nov 05 to 22 Mar 06. Calves were weaned at about 5 months of age. Cattle were vaccinated with 7 in 1 vaccine in May 05 and again in June 06. Bulls were subjected to a BBSE in Aug 05 and were vaccinated against campylobacteriosis.

1.4 Reproductive performance

Table Q1.1 Reproductive performance of cows in Booreeco and Grass mobs

Mob	No cows mated	Age (years)	Pregnancy rate (%)	Calving rate (%)	Weaning rate (%)
Booreeco	75 wet	3	93	91	84
Grass	60 wet	4-9	88	84	75

1.5 Prevalence of BVDV and *N. caninum* at commencement

Table Q1.2 Prevalence of BVDV and *N. caninum* at commencement of study

Mob	BVDV (%)	*N. caninum* (%)
Booreeco	0	55
Grass	0	33

1.6 Evidence of transmission of BVDV and *N. caninum* during study period

There was no evidence of transmission with *pestivirus* throughout study period in either mob.

The incidence of *N. caninum* remained relatively static throughout study period (Table Q1.3).

Table QM1.3 Prevalence (%) of BVDV and *N. caninum* in cows initially selected at random for serial bleeding

Mob	n		22/03/2005	25/05/2005	25/07/2005	21/11/2005	7/04/2006	13/06/2006
Booreeco	19-20	BVDV	0	0	0	0	0	0
	19-20	*N. caninum*	55.0	55.0	60.0	57.9	52.6	57.9
Grass	15-21	BVDV	0	0	0	0	0	0
	15-21	*N. caninum*	33.3	30.0	35.0	36.4	20.0	33.3

1.7 Evidence of infections with BVDV and *N. caninum* during the reproductive period

There was no evidence of infection with *pestivirus* during the study period

One cow in the Booreeco mob experienced a lactation failure. It was positive to *N. caninum* but there was no serological information on this cow prior to the loss. In the Grass mob, there was no seroconversion in cows that had a pre-, peri- or postnatal loss.

1.8 Impact of BVDV and *N. caninum* on reproductive outcome

pestivirus had no impact on reproductive outcome. For *N. caninum*, a chi-square test was used to test for significant differences in mating outcomes by serological status. There was no significant difference of serological status on weaning percentage of pregnant cows resulting from the 2004-05 mating or the pregnancy rate resulting from the 2005-06 mating.

Table Q1.4 Weaning percentage of pregnant cows by *N. caninum* serological status

Mob	Seropositive		Seronegative		
	n	%	n	%	Chi-square
Booreeco	12	100	7	100	
Grass	8[a]	63	14	79	P = 0.42 ns

[a]2 of the 3 losses due to other recognised causes

Table Q1.5 Pregnancy rate by *N. caninum* serological status from 2005-06 mating

Mob	Seropositive		Seronegative		
	n	%	n	%	Chi-square
Booreeco	12	1 (92)	7	7 (100)	P = 0.43 ns
Grass	7	1 (86)	8	2 (75)	P = 0.61 ns

1.9 Other factors causing reproductive efficiency

The prevalence rates for *L. hardjo* and *L. pomona* in both mobs were quite high, particularly in the early part of the year (Figures Q1.1 and Q1.2). The antibody titres were as high as 1/1600 for *L. hardjo* and 1/3200 for *L. pomona* particularly at the first 2 observations, perhaps reflecting recent vaccination.

1.10. Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

For *pestivirus*, this is considered to be low. Only bulls are purchased and the owners will now ensure that these bulls are not PIs. There is good control of cattle with minimal incursions of neighbours cattle.

For *N. caninum*, the future impact would be minimal based on the results from this study even though the seroprevalence is greater than 30%.

Herd summary Q2
Capricornia

2.1 Herd selection criteria

- The herd had a history of sub-optimal reproductive performance. Sixteen cows were bled in Aug 04 with 1 cow giving a reaction of 2 and another of 3 in the BVDV AGID.
- There were good facilities, good animal control and the owners were interested in causes of reproductive wastage.
- Its close proximity to 2 other sites would allow limited comparative information on herd performance and could also serve as a site for discussion for producer groups

2.2 Monitoring methods

There were 2 mobs involved: Corlee paddock consisted of 55 mixed-age Brahman cows and Top Gap paddock of 46 mixed-age dry Brahman cows. Both mobs were kept as discrete groups.

Data recorded was age, body condition and lactation status with ultrasound scanning used to determine P8 fat, pregnancy status and ovarian activity of empty cows. Corlee paddock was mustered 6 times from Apr 05 to Jun 06. Top Gap paddock was mustered 3 times from Dec 05 to Jun 06.

A random sample of 25 pregnant cows in Corlee paddock and 10 pregnant cows in Top Gap were selected at the initial observation for bleeding to assess serological status of BVDV, *N. caninum*, *L. hardjo* and *L. pomona*. These same cows were then bled at subsequent musters. Cows that had a prenatal, perinatal or postnatal loss were also bled. Calving data was recorded by the owner through paddock observation.

2.3 Herd management

The cattle involved were all home bred except for the bulls which had been on the property for several years. Corlee paddock was single-sire mated for 5 months commencing in Oct 05 and again in Oct 06. Top Gap paddock had been involved in a synchronised AI programme in Oct 05 then single-sire mated to a backup bull for 2 months. Calves were weaned at 5-7 months of age.

The Corlee mob was vaccinated against leptospirosis in Sep 04 with no subsequent vaccinations. The vaccination history of Top Gap paddock was not recorded. Both bulls passed a BBSE.

2.4 Reproductive performance

Table Q2.1 Pregnancy and weaning rates

Mob	Year	No Cows mated	Age (years)	Pregnancy rate (%)	Weaning rate (%)
Corlee	04/05	55 (13 wet)	2-10	75	67
	05/06	56 (42 wet)	3-10	89	
Top Gap	05/06	46 (all dry)	2-9	73	

2.5 Prevalence of BVDV and N. caninum at commencement

Table Q2.2 Prevalence of BVDV and *N. caninum* at commencement of study

Mob	Date	BVDV (%)	*N. caninum (%)*
Corlee	1 Apr 05	16	4
Top Gap	9 Dec 05	30	10

2.6 Evidence of transmission of BVDV and *N. caninum* during study period

For pestivirus, there was no evidence of active transmission throughout the study. In the Corlee mob, the prevalence gradually declined (Table Q2.3). In the Top Gap mob, the prevalence remained static at 20%.

For *N. caninum*, there was seroconversion of 4 animals between Jul 05 and Dec 05 with 2 of these reverting to negative by Feb 06. The change in status of these 2 animals could be due to fluctuating antibody levels or they may have been false positives.

Table QM2.3 Serological status of cows initially selected at random then repeatedly bled

	Mob	Serological status	01-Apr-05		07-Jun-05		26-Jul-05		09-Dec-05		28-Feb-06		09-Jun-06	
			n	%	n	%	n	%	n	%	n	%	n	%
BVDV	Corlee	N	21	84	21	84	22	88	23	88	25	93	24	96
		1		0	1	4		0	1	4		0		0
		2	4	16	3	12	3	12	2	8	2	7	1	4
	Corlee Total		25		25		25		26		27		25	
	Top Gap	N							7	70	7	70	7	70
		1							1	10	1	10		0
		2							2	20	2	20	3	30
	Top Gap Total								10		10		10	
Neospora	Corlee	N	24	96	23	92	24	96	21	81	24	89	22	88
		P	1	4	2	8	1	4	5	19	3	11	3	12
	Corlee Total		25		25		25		26		27		25	
	Top Gap	N							9	90	10	100	9	90
		P							1	10	0	0	1	10
	Top Gap Total								10		10		10	

2.7 Evidence of infections with BVDV and *N. caninum* during the reproductive period

There was no evidence of *pestivirus* infection. All of the 4 cows in the Corlee mob that had a perinatal loss were seronegative to BVDV. One of these 4 cows seroconverted to *N. caninum*.

2.8 Impact of BVDV and *N. caninum* on reproductive outcome

In the Corlee mob, there was no significant difference in weaning percentage of pregnant cows based on serological status of either BVDV or *N. caninum* (Table Q2.3).

Table Q2.4. Weaning percentage of pregnant cows based on serological status to either BVDV or *N. caninum* in Corlee paddock resulting from 2004/05 mating

	Serological status	N	Weaning percentage [a]	Chi square
BVDV	Positive	5	100	P = 0.17
	Negative	21	81	
N. caninum	Positive	7	86	P = 0.92
	Negative	19	84	

[a] 4 calves lost, all from unknown causes

For the 2005/06 mating, there was no significant difference in pregnancy rates by serological status to either BVDV or *N. caninum* in the Corlee mob (Table Q2.5). In the Top Gap mob, there was no significant difference in pregnancy rates by serological status to BVDV (Table Q2.5). However with *N. caninum* there was a significant difference with the only seropositive cow not pregnant whilst all 9 seronegative cows being pregnant but this result should be treated with caution because of the small number of animals involved.

Table Q2.5 2006 Pregnancy rates by serological status for Corlee and Top Gap paddocks

Disease	Status	Paddock	n	Pregnancy rate (%)	Chi-square
BVDV	Positive	Corlee	5	60	P = 0.10
	Negative		23	91	
	Positive	Top Gap	3	100	P = 0.21
	Negative		7	71	
N. caninum	Positive	Corlee	8	88	P = 0.86
	Negative		20	85	
	Positive	Top Gap	1	0	P = 0.05
	Negative		9	89	

2.9 Other factors causing reproductive efficiency

Leptospirosis may have contributed to the 4 prenatal losses in the Corlee mob although these cows weren't sampled for confirmation. The prevalence of *L. hardjo* and *L. pomona* prior to the losses in the random samples of cows in 2005 ranged from 0-28% and 4-28% respectively (Figure Q2.1). The herd was previously vaccinated against leptospirosis infection in 2004.

2.10. Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

For *pestivirus* there appears to be a medium level risk of future impact. Vaccination against pestivirus is not practised. However, the owners show cattle and purchase stud stock as well as sharing bulls with other properties. These present possible risks for the introduction of this virus. The boundaries are reasonably secure.

For *N. caninum*, the impact would appear to be minor. There was only 1 of 4 prenatal losses that seroconverted to *N. caninum* and no foetus was found so cause of loss could not be determined. There was no significant effect of *N. caninum* serological status on mating outcome.

Herd Summary Q3
Capricornia

3.1 Herd selection criteria

- There was a history of suboptimal reproductive performance in previous years;
- It was at risk to pestivirus introduction;
- In the absence of pestivirus, it provided an opportunity to investigate the impact of *N. caninum* on reproductive performance;
- There were good facilities and the owner had the interest to be involved in the project;
- Its relatively close proximity to 2 other potential sites allowed limited comparative herd performance as well as a potential site for discussions with producer groups.

3.2 Monitoring methods

Cows were ultrasound scanned with rectal examination 4 times from April 05 to March 06. Data were recorded for breed, age, body condition, lactation status, P8 fat, pregnancy and ovarian activity of empty cows.

A random sample of 37 pregnant cows in Breeder paddock and 43 pregnant cows in Hut paddock were selected at the initial observation for bleeding to assess serological status of BVDV, *N. caninum*, *L. hardjo* and *L. pomona*. These same cows were then bled at subsequent musters. As well, cows that had a prenatal, perinatal or postnatal loss were bled.
There was a twice weekly observation of cows during the calving period but calves were not mothered up or tagged. There were no post-mortems performed on dead calves.

3.3 Herd management

The cattle were all home bred. There were 2 mobs involved; Breeder paddock of 194 Brahman and Brahman cross breeders aged from 3 to 11 years and Hut paddock of 188 mainly Brahman and some Brahman cross breeders aged from 2 to 10 years.

Both mobs were multiple-sire mated for 4 months starting late October each year. Older calves were branded at the Dec 05 muster. Cows were vaccinated against leptospirosis and bulls were subjected to a BBSE in Oct 05 and vaccinated against campylobacteriosis.

3.4 Reproductive performance

Table Q3.1 Reproductive performance of cows in Breeder and Hut paddocks

Year	Mob	Age (years)	No Cows mated	Pregnancy rate (%)	Weaning rate (%)
2004/05	Breeder	3-5	102	89	80
		6+	92	85	76
		All	194	87	78
	Hut	2	4	100	75
		3-5	99	48	43
		6+	86	69	58
		All	189	58	51
2005/06	Breeder	3-5	67	73	
		6+	96	67	
		All	163	69	
	Hut	3-5	66	73	
		6+	42	57	
		All	108	66	

3.5 Prevalence of BVDV and *N. caninum* at commencement

Table Q3.2 Prevalence of BVDV and *N. caninum* at commencement of study

Mob	BVDV (%)	*N. caninum* (%)
Breeder	0	20
Hut	0	20

3.6 Evidence of transmission of BVDV and *N. caninum* during study period

There was no evidence of infection with *pestivirus* in either mob throughout study period.

For *N. caninum*, there was only one cow in the Breeder mob that seroconverted during the observation period and it subsequently weaned a calf. In Breeder mob, the incidence remained relatively static whilst in Hut mob, the incidence gradually declined.

Table Q3.3 Prevalence of BVDV and *N. caninum* in cows initially selected at random for serial bleeding

Mob	n		Apr-05	Jul-05	Dec-05	Mar-06
Breeder	34-40	BVDV	0	0	0	0
		N. caninum	20	18	21	21
Hut	41-45	BVDV	0	0	0	0
		N. caninum	20	14	17	14

3.7 Evidence of infections with BVDV and *N. caninum* during the reproductive period

There was no evidence of infection with *pestivirus* during the study period.

There was only one cow where there was an association between being serologically positive to *N. caninum* and reproductive loss. This cow was pregnant in July 2005 and empty and dry in December 2005. The foetus/calf was never found. The cow was seropositive at the commencement of the study.

3.8 Impact of BVDV and *N. caninum* on reproductive outcome

There was no impact of *pestivirus* on reproductive outcome. There was a significant effect of *N. caninum* serological status on weaning rate in Hut mob but not Breeder mob (Table Q3.4)

Table Q3.4 Weaning percentage of pregnant cows by *N. caninum* serological status from 2004-05 mating

Mob	Seropositive		Seronegative		Chi-square
	n	%	N	%	
Breeder	8	100	29	90[a]	P = 0.22 ns
Hut	6	50[a]	37	89[a]	P = 0.03

[a]There were no other recognised causes of these losses

There was no significant effect of *N. caninum* serological status on 2005-06 pregnancy rates in either mob (Table Q3.5)

Table Q3.5 Weaning percentage of pregnant cows by *N. caninum* serological status from 2005-06 mating

Mob	Seropositive		Seronegative		Chi-square
	n	%	N	%	
Breeder	8	88	32	75	P = 0.43 ns
Hut	7	57	51	67	P = 0.62 ns

3.9 Other factors causing reproductive efficiency

The herd was vaccinated against leptospirosis but the prevalence fluctuated with time. In Dec 05, prevalence to both *L. hardjo* and *L. pomona* was in the range of 41 to 53% in both mobs with most titres being 200 – 1600.

No cause has been identified for the difference in overall performance in the Hut mob compared to the Breeder mob in 04-5

Mean body condition scores of < 3 would be the major contributing cause of the low pregnancy rates in both mobs in 2006.

3.10. Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

For *pestivirus* this is medium. Cattle have been sent off the property for agistment in the past because of seasonal conditions. Young cattle are also bought for finishing although these tend to be on a separate portion of the property. The boundaries are reasonably secure.

For *N. caninum*, the future impact is medium based on the results of this study. The seroconversions seem to occur prior to 2-3 years of age, prior to entry into the breeding herd.

Herd summary Q4
Northern Goldfields

4.1 Herd selection criteria

Project participation: A desire to understand impacts of endemic reproductive disease in a large herd with minimal previous monitoring
Property size: 40,000 ha
Pasture type: Spear grass forest; a mix of low–fertility granite-derived soils and fertile basalt-derived soils.
Herd size: >2,000 cows
Property business: Beef production

4.2 Monitoring methods

Measurements taken are shown in Table Q4.1. NLIS tags were used to monitor animals and lactation status was recorded for 86% of cows during the April-May 2006 muster. No further data was collected.

Table Q4.1 Measurements taken at Q4

	Growth		Female reproduction		Serology - females (n)		Bulls		
Date	Wt	CS	Foetal age	Lactation	BVDV AGID	*Neospora*	CS	BBSE	VD
30Nov04	Est	Est					Yes	Yes	Yes
21Jun05	Est	Est	Yes	Yes	Pregnants	Pregnants	Yes	Yes	Yes
Apr-May06				Yes					

4.3 Herd management

Genotype: Brahman
Mob size: 650, of which 211 pregnant cows were tagged for monitoring; a further 19 non-pregnant heifers were sampled in June 05.
Bulls: 33 3- and 4-year-old Brahmans bulls. All had a BBSE conducted on them.
Female age and parity: Maiden 2003 heifers
Selected animals' description: See Table Q4.2
Management: The study animals were within a larger group up to June 2005. From this time, low cattle control resulted in tagged animals being dispersed across the station. Only botulism vaccination was current. Only 86% of animals were recovered for reproductive assessment in mid-2006.

Table Q4.2 Description of selected animals at Q4

Trait	Start of mating: 30-Nov-04	End of mating: 21-Jun-05
Visual estimate of weight	~310 (~240-380)	~420 (~370-470)
Condition score (1-5)	2-3	3-4
Lactating	0%	

4.4 Reproductive performance

Reproductive history of the herd was unknown.

Approximately 75% of 2003 heifers were pregnant at foetal ageing in June 05. Most pregnancies occurred in the Dec-Feb period. About 16% of non-pregnant heifers were lactating. Only 2 of 211 selected pregnant heifers (1%) were lactating. The overall estimate of heifers pregnant at or prior to 01Oct04 was 5%. Condition did not appear related to pregnancy status.

4.5 Prevalence of BVDV and *N. caninum* at commencement

In a preliminary assessment at a post-mating bleed, there was a relatively-high seroprevalence of *Neospora caninum* in heifers, but slightly lower in older cattle. The prevalence of *pestivirus* was very high and moderate in young and mature cattle, respectively (Table Q4.).

Table Q4.2 Sero-prevalence of BVDV and *Neospora caninum* at Q4 in August 2004

Year group	Class	Total	BVDV	*Neospora*
Mature	Cow	13	6 (46%	4 (31%)
2001	First-lactation cow	14	5 (36%)	3 (21%)
2002	Empty and early-pregnant maiden heifers	8	8 (100%)	2 (25%)
2002	Mid-late pregnant maiden heifers	18	18 (100%)	8 (44%)

4.6 Evidence of transmission of BVDV and *N. caninum* during study period

Serology results from the group that was monitored (Table Q4.3) showed that all but one was *pestivirus* positive. The reaction levels suggested that some animals had probably been infected during the previous 6 months.

Table Q4.3 Serology of Q4 heifers at the end of the 04-05 mating in June 2005

Year	Age/ group	BVDV AGID							*Neospora* ELISA			
		Neg	1	2	3	>3	Total	% +ve	Neg	+ve	Total	% +ve
2005	Heifers 2.5 years	1	9	166	54		230	100	180	50	230	22%

4.7 Evidence of infections with BVDV and *N. caninum* during the reproductive period

Samples were not collected at appropriate intervals to determine if sero-conversions to *N. caninum* occurred during the pregnancy period.

4.8 Impact of BVDV and *N. caninum* on reproductive outcome

There was no apparent relationship between stage of pregnancy and either post-mating pestivirus titre or *Neospora caninum* titre.

The prevalence of *Neospora* was moderate in this herd (22%). There was no significant difference in calf loss between sero-negative (9% loss) and sero-positive (13% loss) animals, respectively (P>0.05).

Table Q4.4 Impact of *Neospora caninum* on reproductive outcome

Year	Age/	Seronegative					Seropositive				
2005	Group Heifers 2.5 years	Mate >143	Preg 143	Wean 130	Loss 13	9%	Mate >39	Preg 39	Wean 34	Loss 5	13%

4.9 Other factors affecting reproductive efficiency

From preputial mucus samples taken from the bulls prior to mating it was found that 4 bulls harboured *Campylobacter fetus* subspecies *venerealis* (vibriosis) and all were *Tritrichmononas foetus*-free. Four months after mating, access was gained to 22 of the bulls used. Six were infected with *Campylobacter*; 3 persistent cases, and 3 new cases. This may have reduced pregnancy rates per cycle. If it is assumed that 50% of heifers were cycling when bulls were allocated to mating (based on estimated weight and condition at the time), that 90% were cycling by mid-May 2005, and that the rate of commencement of cycling was constant between these times, then the pregnancy rate per cycle for the Q4 heifers is estimated to be 50-70%. This suggests a relatively low impact of disease on establishment of pregnancy.

4.10. Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

Almost all heifers that were joined in 2005 had been infected with pestivirus by the end of joining. A similar pattern was detected in the heifers sampled at the commencement of the project. These results would suggest that pestivirus is probably endemic in young stock on the property. It was not possible to establish when infections were occurring but it is possible that, in a herd of this size, some heifers have been infected during early pregnancy and producing persistently infected calves. These would contribute to the maintenance of the virus in the herd, the ongoing transmission observed in heifers and probably low level, chronic loss. Significantly, there was a much lower prevalence of antibody in the mature cow herd, suggesting that perhaps the virus had been introduced in recent years but confined to younger stock. As cattle control was relatively low in this herd, there must remain the potential for the virus to spread to the older cattle, which could result in a much higher level of loss.

Though calf loss was slightly higher in animals that were sero-positive to *Neospora caninum,* this was non-significant, and there was no expectation that future losses due to this parasite would be higher over the whole herd.

Herd summary Q5
Northern Goldfields

5.1 Herd selection criteria
Property size: 40,000 ha
Pasture type: Spear grass forest with a predominance of low–fertility granite-derived soils on hilly country.
Herd size: >2,000 cows
Property business: Beef production
Project participation: A desire to understand impacts of endemic reproductive disease in a large herd with minimal previous monitoring.

5.2 Monitoring methods
Sampling and measurements taken are summarised in Table Q5.1. Using available data for animals assessed on 05-Jul-06, a determination was made of whether or not cows reared a calf in 2004/05 and 2005/06, and whether or not they were pregnant in 2006/07. The sum of calves reared and pregnancies for each cow was its estimated calf output for the study period.

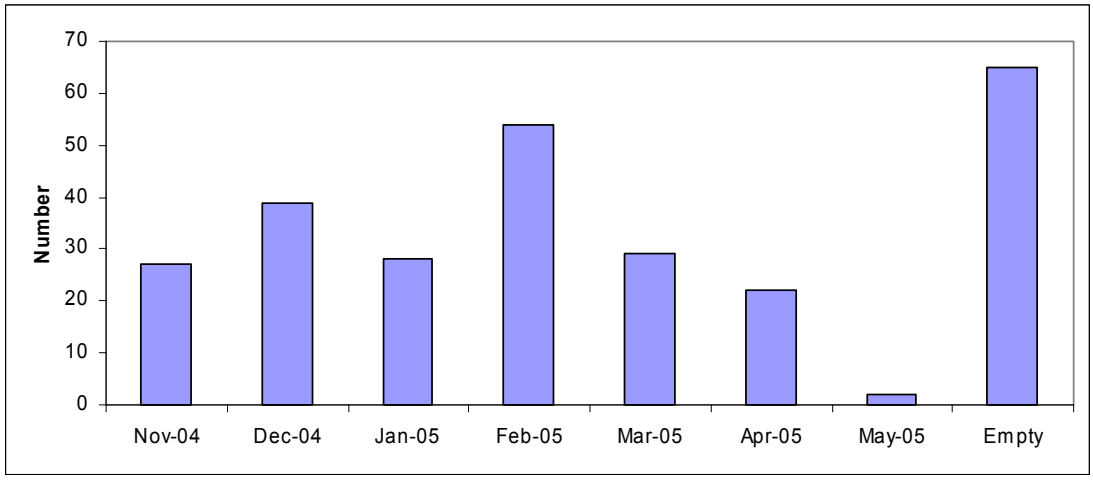
Table Q5.1 Measurements taken at Q5 sites

	Growth	Female reproduction		Serology - females (n)		Bulls		
Date	**CS**	**Foetal age**	**Lactation**	**BVDV AGID**	**Neospora**	**CS**	**BBSE**	**VD**
06Dec04 - 04Feb05	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
05Jul06	Est	Yes	Yes	Yes	Yes	Yes	Yes	Yes

5.3 Herd management
Genotype: Brahman
Mob size: 327 cows were inducted into the study.
Bulls: 13 mixed-age Brahmans bulls. All had a BBSE conducted on them.
Female age and parity: 4 to 14 year-old multiple-parity cows
Management: The study group was managed as one group from December 2004. In March 2005, the herd was transferred from NW of Charters Towers to another station west of Charters Towers. Low infrastructure development at Goldsborough meant that these cattle were mixed with other cattle across the station and mating was continuous. In July 2006, 147 of the 327 cows were recovered for assessment. Only botulism vaccination was current. Bulls infected with *Campylobacter* were treated with erythromycin prior to joining.

5.4 Reproductive performance
Reproductive history prior to the project was unknown. The expected calving around the time of herd enrolment was widely distributed (Figure Q5.1).

Figure Q5.1 Calving distribution of Q5 cows in 2004/05



5.5 Prevalence of BVDV and *N. caninum* at commencement

In a preliminary assessment at Q5, prevalence of both BVDV and *Neospora* was low at a post-mating bleed (Table Q5.2).

Table Q5.2 Sero-prevalence of BVDV and *Neospora caninum* at Q5 in August 2004

Year group	Class	n	BVDV	*Neospora*
2000	Cow	14	2 (14%)	0
2001	First-lactation cow	13	4 (31%)	1 (8%)
Total	ALL	27	6 (22%)	1 (4%)

5.6 Evidence of transmission of BVDV and *N. caninum* during study period

Between Feb 05 and Jul 06 there was no transmission of pestivirus within the herd; 8 of the 9 cows positive in Feb 09 and present in Jul 06 remained positive (Table Q5.3). At allocation, only 5% of the Q5 cows were sero-positive to BVDV, and 17% were sero-positive to Neospora.

Table Q5.3 Serology of Q5 cows bled in Dec04 - Feb05

Year	Age/group	BVDV AGID							Neospora ELISA			
		Neg	1	2	3	>3	Total	%+ve	Neg	+ve	Total	% +ve
2004-05	Cows	308	4	9	3		324	5%	274	50	324	17%

5.7 Evidence of infections with BVDV and *N. caninum* during the reproductive period

There was no evidence of sero-conversion to either BVDV or *N. caninum* during the reproductive period between December 2004 and July 2006.

5.8 Impact of BVDV and *N. caninum* on reproductive outcome

As no pestivirus transmission occurred, no impacts of pestivirus transmission on reproduction were measurable in this herd. This was despite what appeared to be a high chance of *pestivirus* challenge:

- low seroprevalence
- titres on project onset indicating recent transmission in some animals, thus presence of a carrier within the herd
- poor infrastructure reducing animal control after transfer to Goldsborough

Calf output (2005 and 2006 calves) and pregnancy (2007 calf) for three years was determined using data collected over the study period. There was no apparent relationship between *Neospora* status and cow fertility (Table Q5.4).

Table Q5.4 Female performance at the Q5 sites

Year	Group	*Neospora* negative						*Neospora* positive					
		Bred	Calves					Bred	Calves				
		#	0	1	2	3	Av	#	0	1	2	3	Av
2005 -07	Cows	120	1%	23%	59%	17%	64%	27	0%	15%	70%	15%	67%

Cows recovered in 2006

5.9 Other factors affecting reproductive efficiency

Prior to mating, qPCR of preputial mucus samples indicated no evidence of infections in bulls (after treatment for previously-identified infections) with either *Campylobacter fetus* subspecies *venerealis* (vibriosis) or *Tritrichmononas foetus*.

5.10. Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

This herd has risk factors indicating a high susceptibility to losses in the future to pestivirus. There appears to be intermittent low level transmission of the virus across all ages groups in the herd. This could be explained by the occasional birth of persistently infected animals which do not survive, or perhaps contact with infected animals from other sources. There is known to be regular mixing between groups on the property and movement of cattle between properties. If a persistently infected animal is introduced, or is produced in the herd and survives, it has the potential to significantly lower already-low weaning rates. These were most probably due to the prevailing poor seasonal conditions during the project; this was reflected in average cow body condition of 2.3 (1-5 scale) at allocation to the project, rising to 3.2 at the conclusion of the study.

The non-significant effect of *Neospora caninum* on calf loss suggests there is no expectation that significant future losses due to this parasite would occur in this herd.

Herd Summary Q6
Northern Goldfields

6.1 Herd selection criteria

The owners of Q6 indicated they were experiencing substantial pregnancy to weaning losses with no reasons apparent. Data for two paddocks to be used in the study were typical for the station (Table Q6.1).

Table Q6.1 Reproductive wastage at Q6 in 2004-05

Paddock	Cows pregnant	Calves branded	Weaned	Total losses	Losses branding to weaning
A	81	71	68	16%	4%
R	206	188	175	15%	7%

Property size: 40,000 ha
Pasture type: Spear grass forest with primarily low–fertility granite-derived soils.
Herd size: >2,000 cows
Property business: Beef production

6.2 Monitoring methods

The observations were conducted over two breeding seasons. Measurements taken are shown in Table Q6.2.

Table Q6.2 Measurements taken at Q6

	Growth	Female reproduction		Serology - females			VD
Date	**CS5**	**Foetal age**	**Lact**	***Neospora* ELISA**	**BVDV AGID**	**Lepto SA**	**Campylo. PCR**
19Jan-11Feb05	Yes	Yes	Yes	Yes			Bulls
17Mar05	Yes	Yes	Yes	Yes			Bulls;40 cows
28Apr05	Yes	Yes	Yes	Yes			
28Jul05	Yes	Yes	Yes	Yes			
23Feb-27Mar06			Yes#				
18May06	Yes	Yes	Yes	Yes	15 cows/pdk	A pdk	

A data collection problem resulted in loss of lactation status data for 43 cows at this time

6.3 Herd management

Genotype: Brahman
Mob size: There were 106 cows in A paddock (~2,000 acres), and 175 cows mated in R paddock (~4,000 acres).

Bulls: Four and 7 Brahman bulls were mated in R and A paddocks, respectively. All had a preputial mucus sample taken prior to mating, and had previously passed a BBSE conducted by a local veterinary practice using Australian Cattle Veterinarians' standards.
Female age: At allocation, cows in A and R paddocks were aged 4-8 and 4 years, respectively.
Management: Mating for 4 months commences each year in mid-late November. Calves are branded at musters prior to weaning. Weaning commenced at the Feb-Mar muster each year. These individually-identified (NLIS) cattle remained within their management groups till final measurements in May 06. Cows culled in 2005 were primarily those that did not conceive. Only botulism vaccination was current.

6.4 Reproductive performance

The owners indicated that previous pregnancy rates were high (specific data not provided), but reproductive wastage often exceeds 15%. Overall reproductive performance of the two study groups during the project is shown in Table Q6.3.

Table Q6.3 Reproductive performance of the study herds

Year	Paddock	Cows	Pregnant		Mating outcome for pregnant cows			
					Wean	Calf lost	Unknown	Loss
2005	A	106	94	89%	56	9	28	16%
2005	R	175	166	95%	146	5	15	3%
2006	A	69	62	90%				
2006	R	155	136	88%				

6.5 Prevalence of BVDV and *N. caninum* at commencement

In a preliminary assessment, the prevalence of *Neospora* at a post-mating bleed was low, and there was no evidence of *pestivirus* (Table Q6.4).

Table Q6.2 Sero-prevalence of BVDV and *Neospora caninum* at Q6 in August 2004

Year group	Class	n	BVDV	Neospora
2001	First-lactation cows	13	0%	0%
2002	Maiden heifers	13	0%	1 (8%)

6.6 Evidence of transmission of BVDV and *N. caninum* during study period

The herd remained free of pestivirus, but 14-17% of the cattle were *Neospora*-positive at allocation. A low level of horizontal *Neospora* transmission occurred with 1.8% (5/280) and 2.2% (4/178) becoming infected between Jan-Apr 05 and between Apr 05 and May 06, respectively (Table Q6.3).

Table Q6.3 Prevalence of cows sero-positive for BVDV and *Neospora caninum* at Q6

Year	Paddock	BVDV AGID							Neospora ELISA			
		Neg	1	2	3	>3	Total	%+ve	Neg	+ve	Total	% +ve
Jan-05	A	106					106	0	91	15	106	14
Apr-05	A	106					106	0	86	20	106	19
May-06	A	69					69	0	50	19	69	28
Jan-05	R	175					175	0	146	29	175	17
Apr-05	R	175					175	0	146	29	175	17
May-06	R	153					153	0	125	28	153	18

6.7 Evidence of infections with BVDV and *N. caninum* during the reproductive period

No evidence of *pestivirus* was found on the property during the study period.

Five A paddock cows became sero-positive to Neospora over mating in 2005, but all five established pregnancies within the period that most animals conceived in their respective reproductive classes, with no subsequent evidence of reproductive wastage. Four of these remained in the herd in 2006 and all re-conceived. Two further cows from each paddock became sero-positive between Apr 05 and May 06. All were pregnant in both 2005 and 2006, but one lost its 2006 calf between Apr 06 and May 06.

6.8 Impact of BVDV and *N. caninum* on reproductive outcome

There was no significant difference in any reproductive parameters between cows that were infected with *Neospora* or remained uninfected (Table Q6.4).

Table Q6.4 Cow fertility in relation to sero-conversion to *Neospora caninum* at Q6

		Neospora negative							*Neospora* positive						
Mate	Pdk	Mate	Pregnant		Retained pregnant cows				Mate	Pregnant		Retained pregnant cows			
Year					All	Wean	Loss					All	Wean	Loss	
2005	A	85	73	86%	49	43	6	12%	20	20	100%	16	13	3	19%
2006	A	50	44	88%					19	18	95%				
2005	R	146	139	95%	125	121	4	3%	29	27	93%	26	25	1	4%
2006	R	127	112	88%					28	24	86%				

Six A paddock cows and two R paddock cows aborted (6% and 1%, respectively). The reason for this difference is not known. There were two abortions of 3-5 month pregnancies in each paddock. The other 4 abortions in A paddock were 1-2 month pregnancies. Two of these reconceived.

6.9 Other factors affecting reproductive efficiency

Cows remained in good body condition throughout the study which is reflected in high pregnancy rates.

There was a large difference between paddocks in overall foetal and calf loss (3% *v* 16%; $P<0.05$). The reason for this is unclear. In A paddock, no cows had any antibodies against *L. pomona*. Tests for *L. hardjo* Ab found no significant difference between those that reared a weaner and those that experienced foetal or calf loss

Pre-trial data provided by the owners (Table Q6.1) suggested losses prior to branding are in the vicinity of 10%, which is within expectations. Branding may also contribute to losses at this site, e.g., due to diseases such as tetanus or to branding-related trauma.

One bull in R paddock was positive for *Campylobacter fetus* subspecies *venerealis* (vibriosis) in both Feb and March 2005. No cows were diagnosed as carrying *Campylobacter*. The positive bulls were different bulls. The bull infected at the February assessment was cleared of infection using antibiotic therapy. All bulls were tested free of *Tritrichmononas foetus*.

If all dry cows were cycling at allocation (as would be expected – only one of 139 dry cows was not either pregnant or cycling in March 05) in both years in both paddocks, pregnancy patterns suggest

that pregnancy rates per cycle are 50% or lower, which is below the benchmark level of 70%. This effect of delayed conceptions perhaps reflects the presence of *Campylobacter*.

6.10. Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

The complete absence of any evidence of pestivirus in this herd indicates its high susceptibility to infection which could come through mixing with foreign cattle that are introduced or move between neighbouring properties unintentionally. The status of neighbours' cattle is unknown.

The non-significant effect of *Neospora caninum* on calf loss suggests there is no expectation that significant future losses due to this parasite would occur in this herd.

Herd Summary Q7
Upper Flinders

7.1 Herd selection criteria
Property size: 32,000 ha
Pasture type: Mitchell and Flinders grass pastures on black soil downs.
Herd size: 2,000 cows
Property business: Beef production

Previous research in this herd demonstrated that conception rates per cycle in heifers appeared to be 30-50% which is well below the benchmark level of 70% pregnant per cycle. In 2004, no abortions from 135 pregnancies (3-10 weeks) were recorded between March and September. The owners independently have concerns about losses well in excess of 10% between confirmed pregnancy and weaning. pestivirus, *Neospora*, *Campylobacter fetus* subsp. *venerealis*, *Tritrichomonas foetus*, and pathogenic *Leptospira spp*. were all recently diagnosed on the station. This study was conducted concurrently with a study that developed PCR methods for diagnosis of *Campylobacter fetus* subsp. *venerealis*, *Tritrichomonas foetus*, and pathogenic *Leptospira spp*.

7.2 Monitoring methods
Substantial monitoring of ~800 young breeding females and ~200 mature cows and associated bulls (see next section) was conducted as indicated in Table Q7.1.

Table Q7.1 Measurements taken at Q7

	Production			Serology & PCR – females				VD
Date	**Cond score**	**Foetal age**	**Lact status**	**Neosp ELISA**	**Pesti AGID**	**Lepto SA Ab**	**Lepto PCR**	**Camp & Trich PCRs**	**Camp ELISA**
13Dec04							B		
22Jun05	F#	F	F	F	F		134 Y & Z; 91 C; B		
09Sep05	W	W	W		EW	EW			
03Oct05	Y Z	Y Z	Y Z					Y & Z	
03May06	W Y Z	W Y Z	W Y Z	W Y Z	W Y Z	DY DZ			
23Sep06	W-Z	W-Z	W-Z		X				EW

# W=Commercial 2002 cows; X=Bull-breeding 2002 cows;
Y=Commercial 2003 heifers; Z=Bull-breeding 2003 heifers;
C=Cows; F=All females; E=Non-pregnant animals; D=Pregnancy to weaning loss;
B=Bulls Reproductive tract mucus for *Campylobacter* and *Tritrichomonas* PCR; urine for *Leptospira* PCR

7.3 Herd management
Genotype: Beefmaster

Mob size: Two age groups of young breeding females were monitored in detail: 188 2002 females and 286 2003 females. Each age group was managed as two groups, either separately or within larger herds of breeding cows (Table Q7.2). Multiparous cows (n=190) from two paddocks were sampled once earlier in the study to find indicators of the prevalence of reproductive diseases in older animals on the station.

Bulls: Most of the 67 bulls (excluding 7 in WS paddock) allocated to the study paddocks (Table Q7.2) had a preputial mucus sample taken prior to mating, and had passed a basic BBSE using Australian Cattle Veterinarians' standards. All were vaccinated against *Campylobacter* prior to mating.

Female age and parity: The 2003 females were maiden two-year-olds at the commencement of the study which was the 2005 mating. The 2002 females were rearing their first calf.

Table Q7.2 Cattle groups included in observations at Q7 in 2005

Group Code	Paddock	Females			Bulls		
		Description	Year group	No.	Status	Year	No
C	WS	Cows	2001 and older	519	Camp Trich#	1998 1999 2001	1 11 3
	WD	Cows	2001 and older	634	Clean*	2000 2001 2002	1 5 11
X	DW	First-lactation select	2002	108	Clean	2003	5
W	FR	First-lactation average	2002	332	Clean	1998 1999 2000 2001 2002	1 1 1 1 5
Z	ST	Maiden select	2003	157	Clean	2003	4
Y	SB	Maiden average	2003	197	Camp	2002 2003	1 6

Some bulls in the group were known to be infected with the nominated diseases; some bulls were not tested, and for these, venereal disease status is unknown
* Diagnosed as free of both *Campylobacter* and trichomoniasis, or if diagnosed with *Campylobacter*, treated with erythromycin to clear the disease prior to mating
= Select = Visual selection as superior "types" for bull breeding
Θ Average = Balance of a cohort after "Select" group drafted off

Management: Mating commences in late January and continues for up to 7 months. Calves are branded at musters prior to weaning. Weaning commences in May-June each year. Females allocated to detailed monitoring were individually identified and remained within their management groups till final measurements in May 06. Cows culled in 2005 were primarily those that did not rear a 2005 calf or did not conceive in 2005. Only botulism vaccination was current. As part of drought mitigation, most of the station's bull-breeding herd including group X (see Table Q7.2) was transferred to another nearby family station for the period Aug 05 to May 06 inclusive. Group Z (see Table Q7.2) was also boxed with this group when they returned. Group W cows were transferred to WS paddock with cows in March 2005.

7.4 Reproductive performance

Pregnancy rates for this station are historically high mainly because of pastures which achieve high annual growth; e.g., steers gain an average of 190 kg/year. Despite very poor seasonal conditions prevailing, the cattle remained in good condition throughout the study, reflecting good management

and good quality country. Though pregnancies can be high, reproductive wastage can exceed 15% as indicated by management group performance during the study (Table Q7.3). A persistent feature at Q7 is low pregnancy rate per cycle which causes delayed conception patterns (See Section 7.1).

Table Q7.3 Reproductive performance of the study herds

Year	Group	Mated	Pregnant		Pregnant & mating outcome known			
					All	Wean	Loss	Loss
2005	X:First lactation	90	79	88%	33	33	0	0%
2005	W:First lactation	88	86	98%	83	76	7	8%
2005	Z:Maiden	93	93	100%	91	77	14	15%
2005	Y:Maiden	189	173	92%	166	137	28	17%
2006	X:2nd lactation	82	70	85%				
2006	Z:First lactation	91	80	88%				
2006	Y:First lactation	165	146	88%				

7.5 Prevalence of BVDV and *N. caninum* at commencement

In a preliminary assessment at Q7, there was a variable prevalence of *pestivirus* with the maiden heifers fully susceptible and a moderate seroprevalence in both weaners and the cow groups. There was a moderate prevalence of antibody to *Neospora* at a post-mating bleed (Table Q7.4), but, interestingly, the prevalence declined consistently with increasing age of stock.

Table Q7.4 Sero-prevalence of BVDV and *Neospora* at Q7 in August 2004

Year group	Class	n	BVDV	*Neospora*
2000	Mature cows	15	7 (47%)	0%
2001	First-lactation cows	15	4 (27%)	2 (13%)
2002	Empty and early-pregnant maiden heifers	12	0%	2 (17%)
2002	Mid- to late-pregnant maiden heifers	8	0%	2 (25%)
2004	Weaners	15	5 (33%)	1 (7%)

7.6 Evidence of transmission of BVDV and N. *caninum* during study period

Sero-prevalence of both BVDV and *Neospora caninum* in 2005 was very low in the study groups, which consisted of young animals (Table Q7.5). Sero-conversion to BVDV occurred in two Y (2003) group heifers during the study period. Only two of the 2003 heifers had positive AGID Ab titres to BVDV; all 2002 cows remained negative. There was no transmission of *pestivirus* within these groups over the study period. In contrast almost half the mature cows were sero-positive for *pestivirus* indicating that the virus is either endemic within the herd or there has been extensive transmission in the recent past and the source of virus is no longer present.

Table Q7.5 Sero-prevalence of BVDV and *Neospora* at Q7 in mid-2005

Year	Age/ Group	BVDV AGID							Neospora ELISA			
		Neg	1	2	3	>3	Total	%+ve	Neg	+ve	Total	%+ve
2005	WS:Cows	26	2	10	8		46	43	43	3	46	7
2005	WD:Cows	24	1	12	9		46	48	42	4	46	9
2005	X:First	82					82	0	84	5	89	6

Year	Age/ Group	BVDV AGID							Neospora ELISA			
		Neg	1	2	3	>3	Total	%+ve	Neg	+ve	Total	%+ve
2005	lactation W:First lactation	94					94	0	93	5	98	5
2005	Z:Maiden	92			1		93	1	91	2	93	2
2005	Y:Maiden	178		1			179	1	171	8	179	4

7.7 Evidence of infections with BVDV and *N. caninum* during the reproductive period

There was no evidence of infections associated with disease in any of the cattle over the period of observation.

7.8 Impact of BVDV and *N. caninum* on reproductive outcome

There was no evidence that BVDV AGID antibody levels were related to pregnancy rates in cows, which were in moderate to forward condition, during 2005 (Table Q7.6).

Table Q7.6 Cow fertility in relation to sero-conversion to BVDV at Q7

Year	Group	BVDV positive			BVDV negative		
		Mated	Pregnant		Mated	Pregnant	
2005	Cows:West	26	11	42%	20	12	60%
2005	Cows:Woods	24	10	42%	22	12	55%

The prevalence rate of *Neospora* Ab was relatively low at 6% of 554 animals tested. There was no significant difference in reproductive performance between females sero-positive and sero-negative to *Neospora caninum* (Table Q7.7). Interestingly, the levels of loss were lower in cows that had been infected with *N. caninum*.

Table Q7.7 Cow fertility in relation to *Neospora caninum* status at Q7

		Neospora negative							*Neospora* positive						
Mate	Pdk	Mate	Pregnant		Retained pregnant cows				Mate	Pregnant		Retained pregnant cows			
Year	#				All	Wean	Loss					All	Wean	Loss	
2005	C	85	44	52%					7	1	14%				
2005	X&W	166	154	93%	108	100	8	7%	12	11	92%	9	9	0	0%
2005	Z&Y	270	254	94%	245	203	41	17%	12	12	100%	12	11	1	8%
2006	X&W	165	136	82%					11	11	100%				
2006	Z&Y	244	215	88%					12	11	92%				

C=Cows; X&W=First & second lactations in 2005 & 2006; Z&Y=Maiden in 2005 and First lactation in 2006

7.9 Other factors affecting reproductive efficiency

The prevalence of leptospirosis was quite low, and there was no evidence of relationships between infection and reproductive wastage (Table Q7.8).

Table Q7.8 Reproductive wastage in relation to SA Ab and urine PCR for *Leptospira* at Q7

Year	Group	Serology	Empty	Abort	Calf loss	Preg Cull	Wean
2005	X&W:First lactation	Positive *L.hardjo*	0/6				
		Suspect *L.pomona*	1/6				
2005	Z&Y:Maiden	Negative PCR n=80	5%	1%	13%	3%	79%
		Suspect PCR n=6			17%		83%
		Positive PCR n=6					100%
2006	Z&Y:First lactation	Positive *L.hardjo*			1/42		
		Positive *L.pomona*			0/42		

Bulls mated to both groups of 2002 heifers tested positive to *Campylobacter* by PCR either prior to or at the end of mating. Those mated to the group X heifers were negative prior to mating, but these heifers were mixed with mature cows, and transmission from the cows appears to have occurred. There was no apparent difference in cumulative pregnancies between these groups in either 2005 or 2006. Seven vaginal mucus samples from late conceiving and non-pregnant 2002 heifers in September 2006 were all negative in a *Campylobacter* ELISA. However, pregnancy rates per cycle did not exceed 50%, even in non-lactating cows.

Vaginal mucus from 134 2003 heifers at the end of mating in May 2005 all tested negative when submitted for a *Campylobacter* PCR. Bulls mated to Group Y, but not group Z, tested positive to the *Campylobacter* PCR. Pregnancy rate per cycle appeared 20% higher in group Z than group Y in 2005 (Figure Q7.3), but no group exceeded 50% in 2006.

A total of eight (6%) 2003 heifers from both management groups were positive for *Tritrichomonas* (9,000-1.1M organisms/mL). All but one was pregnant at the time of sampling, and all seven pregnant animals raised a calf to weaning. There was no apparent relationship between *Tritrichomonas* infection and time of conception (Figure Q7.5).

Vaginal mucus samples taken from five 2003 heifers in September 2006 were tested using the *Campylobacter* ELISA:

- Two heifers that aborted had positive titres (28-32).
- Two of three non-pregnant heifers had titres classed as Suspect (34), and the other was negative.

With this evidence of *Campylobacter* exposure related to pregnancy failure and foetal loss, it suggests that during the study, *Campylobacter* was the primary infectious agent having a significant impact on fertility.

There was a high rate of foetal and calf loss in 2003 cows. This is consistent with industry anecdotes; i.e., losses in first-lactation females under extensive management are usually closer to 20% than 10%. The reason for this loss was not apparent during this study.

7.10. Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

This study showed that *pestivirus* is probably endemic on this property and that two age groups were not exposed to the virus up to the completion of the study. This indicates that there is a very high risk that *pestivirus* may cause reproductive wastage in the future, especially when heifers join breeding groups that contain older stock.

Though there was low prevalence of *Neospora caninum,* it appeared to have no significant impact on pregnancies or foetal and calf wastage.

Herd Summary Q8
Lower Burdekin

8.1 Herd selection criteria
Property size: 40,000 ha
Pasture type: Spear grass forest with a mixture of low–fertility granite-derived soils and basalt-derived soils.
Herd size: >4,000 cows
Property business: Beef production
Project participation: A desire to understand impacts of endemic reproductive disease in a large herd with minimal previous monitoring

8.2 Monitoring methods
Measurements and samples of Q8 cattle were as described in Table Q8.1. Due to a change of ownership, observations at this site were discontinued in May 2005.

Table Q8.1 Measurements taken at Q8

Date	Growth		Female reproduction		Serology – females		Bulls
	Wt	CS	Foetal age	Lactation	Pesti AGID	*Neospora*	Vibrio PCR
15Dec04	Est	Yes	Yes		Yes		Yes
26May05		Yes	Yes	Yes	Yes	Yes	Yes

8.3 Herd management
Genotype: Brahman
Mob size: A sub-sample of 230 heifers was monitored within a group of 1,700.
Bulls: Six Brahman bulls were found in this group prior to official commencement of mating. Brahmans (n=22) and Charbray bulls (n=37) aged from 2 to 7 years were allocated to mating.
Female age and parity: Maiden 2003 heifers
Management: Q8 was a station within a group across Queensland, and many classes of cattle were moved regularly between properties. Official mating was from mid-December 2004. The mating group remained as one until pregnancy diagnosis in May 2005. Botulism vaccination was current. The heifers were supplemented with *ad lib.* fortified molasses for several months prior to the start of mating.

8.4 Reproductive performance
Reproductive history of the herd was unknown. Many of the subset of 230 2-year-old heifers that were monitored were small and reproductively immature at allocation in December 2004. A visual estimate of weight was 210-310 kg (average ~260 kg) at a body condition of 2.5 (backward – moderate) and average P8 fat depth of 2mm.

As heifers essentially had continuous access to bulls from birth, pregnancies essentially reflected the proportion that had recently reached puberty. In May 05, no animals that had conceived prior to Sep 04 and a quarter of those that conceived in Sep 04 were mustered as they had calved and were left behind. Sixteen further cows were also not recovered. At allocation, 44% of heifers were pregnant, with almost all non-pregnant heifers acyclic. As there had only been 6 bulls were found in this group of 1,700 heifers, this provided an interesting measurement of the serving capacity of bulls if given the opportunity.

8.5 Prevalence of BVDV and *N. caninum* at commencement

In a preliminary assessment at Q8, a low prevalence of *pestivirus* and moderate prevalence of *Neospora* was found at a post-mating bleed (Table Q8.2).

Table Q8.2 Sero-prevalence of BVDV and *Neospora caninum* at Q8 in August 2004

Year group	Class	Total	BVDV	*Neospora*
Mature	Cow	14	5 (36%)	5 (36%)
2001	First-lactation cows	7	2 (29%)	1 (14%)
2002	Maiden heifers	14	2 (14%)	4 (29%)
2004	Weaners	15	1 (7%)	2 (13%)

8.6 Evidence of transmission of BVDV and *N. caninum* during study period

BVDV sero-conversion occurred in 9 heifers (5%) by May 2005 and only 4 of these (3%) between Dec 04 and May 05 (Table Q8.4), which is a transmission rate of ~0.5% of naïve cattle per month.

The prevalence of antibody to *Neospora caninum* in the heifers was 22% (Table Q8.4).

Table Q8.3 Serology in Q8 heifers in May 2005

Year	Age/group	BVDV AGID							*Neospora* ELISA			
		Neg	1	2	3	>3	Total	%+ve	Neg	+ve	Total	% +ve
2005	2yo heifers	182		6	3		191	5%	149	42	191	22%

8.7 Evidence of infections with BVDV and *N. caninum* during the reproductive period

There was no evidence of any clinical effects of pestivirus during this observation at Q8.

Within the *Neospora*-positive group of 13 non-pregnant heifers, two had a CL and two had a follicle of 13 mm which suggested they were also cycling. One of those with a 13 mm follicle had palpable evidence of a recent abortion.

Within the *Neospora*-negative group of 25 non-pregnant heifers, only 4 had a CL; no others had large follicles. Two of the 4 cycling heifers had been diagnosed pregnant in Dec04 and had lost the pregnancy.

The pregnancy rates of heifers that had evidence of cycling during the observation were 97% and 90% for *Neospora*-negative and positive heifers, respectively ($P>0.05$).

8.8 Impact of BVDV and *N. caninum* on reproductive outcome

Sero-conversion to BVDV (4 heifers) appeared unrelated to immediate reproductive performance but detailed observations and testing of calves was not conducted.

Final pregnancy rates in heifers sero-positive for *Neospora caninum* in ~7 months since heifers had presumably commenced cycling was significantly lower than in sero-negative heifers (85% v 69%; $P<0.05$; table Q8.4).

Table Q8.4 Heifer fertility as a function of *Neospora caninum* sero-conversion at Q8

Year	Age/group	*Neospora* negative			*Neospora* positive		
		Mated	Pregnant		Mated	Pregnant	
2005	Maiden (2yo) heifers	149	126	85%	42	29	69%

8.9 Other factors affecting reproductive efficiency

From preputial mucus samples taken from the bulls prior to mating it was found that 2 bulls harboured *Campylobacter fetus* subspecies *venerealis* (vibriosis). The impact of this was not investigated.

8.10. Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

The opportunity for substantial impacts from pestivirus infection appeared high in this herd as the virus appeared to be endemic, there were continual between-property movements of cattle, there was evidence of pestivirus transmission during this observation, the level of cattle control was not high, and the prevailing prevalence of sero-negative animals was moderate to high, with more than 60% of cows susceptible. When the wide range of stages of pregnancy is also considered, a herd such as this provides an ideal environment for pestivirus to cycle and continuously produce chronic losses. There was no discernible effect of pestivirus on herd fertility as transmission rate was very low, i.e., ~0.5% per month. With a period of prolonged exposure to bulls, early conception failure or abortion is likely to be less apparent without intensive observations. The low transmission rate observed may have been because of a very low number of PI animals in a very large group grazed over a large area with many watering points. Any changes to management that result in more regular or closer contact between animals could accelerate virus transmission and increase losses in the herd.

There was a significant effect of *Neospora* on overall pregnancy rate which was 16% lower in infected heifers ($P<0.05$). The difference in pregnancy rate between infected and uninfected animals was smaller (10%; $P<0.05$) in heifers that appeared to have reached puberty. This suggests that *Neospora* infection may be a significant contributor to reproductive wastage in this herd. There was no apparent interaction with pestivirus infection.

Herd Summary Q9
Lower Burdekin

9.1 Herd selection criteria

Property size: 40,000 ha
Pasture type: Spear grass forest with primarily low–fertility duplex soils.
Herd size: 1,500 cows
Property business: Beef production and research

Q9 was the site of an intensively-monitored herd of young cows. To avoid disease confounding the research, all cattle are vaccinated against a range of diseases: botulism, vibriosis, leptospirosis, clostridial diseases (5-in1), and pestivirus.

This herd represented an ideal situation for the study of the impact of *Neospora caninum*.

9.2 Monitoring methods

Full growth and mating outcome measures were taken for all females. Data from a total of 1,820 matings was available. From first mating in 2003, the animals were mustered each 4 to 8 weeks for weighing and reproductive tract assessment, including foetal age and ovarian function. Calving dates and survival to weaning were recorded for each cow, as was date and reason (if known) of any foetal or calf loss between confirmed pregnancy and weaning. Blood samples were taken annually from all females (Table Q9.1).

Table Q9.1 BVDV vaccination, reproductive histories and bleeding of Q9 cows

Date	*2001 cows*	*2002 cows*	*2003 cows*	*Pestigard*	*Bleeding*
Jan03-Apr 03	1st mating				
Nov03-Jan04	1st calving				
16Dec03				Priming	
13Jan04				Secondary	Bleed
Jan04-Apr04	2nd mating	1st mating			
08Sep04				1st booster	
Nov04-Jan05	2nd calving	1st calving			
11 Jan 05					Bleed
Jan05-Apr05	3rd mating	2nd mating	First mating		
30May05					Bleed
Sep05				2nd booster	
Nov05-Jan06	3rd calving	2nd calving	1st calving		
Jan06-Apr06	4th mating	3rd mating	2nd mating		
26Apr06					Bleed
Sep06				3rd booster	
Nov06-Jan 07	4th calving	3rd calving	2nd calving		

The *Neospora* status of each animal was established each year. Once positive, this status was presumed to be maintained. The BVDV serological status of all animals was assessed using the BVDV AGID at the first sampling in Jan 03. Animals negative at this test were assessed using the

BVDV antigen ELISA (PACE) to detect persistently infected animals. The PACE assay was conducted on a further sub-group of animals in January 04.

9.3 Herd management

Genotype: Brahman

Mob size: Two management groups comprising approximately half each of 440 breeding females grazed in 100-200 ha paddocks within an area of 2,400 ha.

Bulls: Bulls were joined with the herd at a rate of ~3 per 100 females for three months annually between early January and early April. All had passed a BBSE using Australian Cattle Veterinarians' standards.

Female age: The Q9 herd is made up of 3 age groups that arrived in mid-2001, mid-2002 and mid-2003 as weaners.

Management: Mating for 3 months commenced in early January (Table Q9.1). Weaning occurred at the May-Jun muster each year. All progeny were transferred to other stations after weaning each year. All females were managed as age groups till October 2004 when they were re-allocated to management groups: group A included 2001 and 2002 females; group B included the balance of the 2001 and 2002 females and all 2003 females. These individually-identified cattle from then on remained within their management groups. Cows were culled if they failed to rear a calf in consecutive years. Nutrition of the animals was well managed such that average condition of all cows was moderate to forward at weaning each year.

9.4 Reproductive performance

Pregnancy rates are high within mating period and nutritional constraints, and reproductive wastage between confirmed pregnancy and weaning historically is within previously-reported acceptable levels (Table Q9.2).

Table Q9.2 Reproductive performance of Q9 herd: 2003-2008

Mating age (yrs)	Into mating lactation	Mate	Pregnant		Retained pregnant animals					
							Foetal and calf losses			
		n	n	%	n	Wean	Pre-natal	Neo-natal	Post-natal	Total
2	Dry	445	288	65%	288	251	13	13	11	15%
3	Wet & Dry	440	244	55%	244	217	13	9	5	11%
4+	Wet & Dry	936	725	77%	719	641	22	20	36	12%

9.5 Prevalence of BVDV and *N. caninum* at commencement

In 2002, ten heifers were sampled to test whether BVDV was being actively transmitted in the herd. Nine animals were negative, but one had an AGID reaction of 3 which at the time was attributed to infection prior to relocation to Q9 as a weaner. BVDV vaccination commenced in 2003 and has been maintained since (Table Q9.1). Prior to commencement of the observation at this site, the prevalence of animals sero-positive to *Neospora caninum* was unknown.

9.6 Evidence of transmission of BVDV and *N. caninum* during study period

Despite all animals being vaccinated, and given previous research that showed that the vaccine does not produce usually significant AGID antibody titres, BVDV transmission appeared to continue through the study period (Table Q9.3). In April 06, within 30 of 413 cows randomly tested for BVDV AGID antibodies, the proportions negative, with titres of 1-2, and with 3+ titres were 23%, 70% and 7%, respectively. This is strongly suggestive of the presence of a PI animal. As there was only minimal sero-conversion by January 04 in the 2001 females, it is extremely unlikely that this group had contact with a PI animal. Antibody levels are almost certainly due to exposure prior to weaning 2.5 years earlier at their source properties. By January 05 substantial sero-conversion had occurred in both management groups, thus indicating at least one PI animal was present in each group for some time prior to Jan 05.

All but one animal within the 2002 and 2003 cohorts was identified as either sero-converting (positive in the AGID) or not a PI (negative on PACE). The unchecked animal was 021028 that calved (more likely experienced late abortion) on 14 Nov 04. Comments made by the calving team were: cow found freshly dead 17 Nov 04, bleeding from nose; foetus found 5m from body, not fully formed, no hair on body. Less than two months earlier this cow appeared fit and healthy. Though highly suggestive that she was the source of infection, a PCR analysis of a frozen blood sample collected from this animal at weaning showed that it was negative for BVDV, thus excluding it as a PI animal.

Table Q9.3 Prevalence of antibody to BVDV and *N. caninum* by age and management group

Date	Year group	BVDV AGID							*Neospora* ELISA			
		Neg	1	2	3	>3	Total	%+ve	Neg	+ve	Total	%+ve
Jan-04	2001	159	1	1	4		165	4%	159	15	174	9%
Jan-05	2001; BVDV neg 04	95	35	25	1		156	39%	151	23	174	13%
May-05	2001	95?							136	38	174	22%
Apr-06	2001; BVDV neg 05	3	3				6	50%	128	39	167	23%
Jan-04	2002	116	18	20	35		189	39%	199	18	217	8%
Jan-05	2002; BVDV neg 04	78	29	9			116	33%	199	18	217	8%
May-05	2002								195	22	217	10%
Apr-06	2002; BVDV neg 05	3	1				4	25%	184	22	206	11%
Jan-04	2003								40	1	41	2%
Jan-05	2003								40	1	41	2%
May-05	2003								40	1	41	2%
Apr-06	2003	0	4				4	100%	38	3	41	7%
Jan-04#	GrpA	144	14	14	27		199	28%	204	16	220	7%
Jan-05	GrpA; BVDV neg 04	103	32	6	1		142	27%	201	19	220	9%
May-05	GrpA								188	32	220	15%
Apr-06	GrpA; BVDV neg 05	3	2				5	40%	177	32	209	15%
Jan-04#	GrpB	130	5	7	11		153	15%	193	18	211	9%
Jan-05	GrpB; BVDV neg 04	70	32	28			130	46%	188	23	211	11%

Date	Year group	BVDV AGID							*Neospora* ELISA			
		Neg	1	2	3	>3	Total	%+ve	Neg	+ve	Total	%+ve
May-05	GrpB								182	29	211	14%
Apr-06	GrpB; BVDV neg 05	3	2				5	40%	173	32	205	16%

Animals were still within their year cohorts at this stage.

The best available hypothesis for the seropositive animals is that one or more PI animals entered the 2002 cohort before and during maiden mating in early 2004. Vaccination against BVDV commenced at the same time, but it is quite possible that animals may have been infected prior to the onset of immunity from vaccination. The resultant PI calves would then achieve infection of in-contact animals during suckling in late 2004. This would include both 2001 and 2003 cohorts, which by this time were mixed with the 2002 cohort to form two management groups.

The possibility of this occurring has not been discounted as heifers grazed paddocks adjacent to a neighbour whose pestivirus status is unknown. Further, there are approximately 3,000 other cattle on Q9 and the pestivirus status of these has not been checked in recent times. Some support for this hypothesis is demonstrated by the low pregnancy rate per cycle (Table Q9.4) which is a typical effect of pestivirus; however, to counter this, there was no evidence of a difference in conception patterns between those that did or did not sero-convert as well as low subsequent foetal and calf wastage (Table Q9.4).

Table Q9.4 Mating outcome of maiden 2-year-old Brahmans at Q9 in 2004

Average start of mating weight			299
Average start of mating condition (1-5)			3.5
% cycling at start of mating			54%
% cycled at least once by end of mating			79%
% pregnant at end of mating			67%
Estimated established pregnancy rate per cycle			40-50%
Foetal and calf wastage			
Stage	***Numbers***	***Percentages***	
Mated	218	Pre-natal loss (of confirmed pregnancies)	0%
Pregnant	147	Neo-natal loss (of calving cows)	5%
Pre-natal loss	0	Post-natal loss (of surviving neo-nates)	1%
Neo-natal loss	7	Total loss (of confirmed pregnancies)	6%
Post-natal loss	1	Weaning rate	64% (139/218)

If the hypothesis for transmission is true, then within 2002 females, the incidence cannot be determined as the period of exposure is unknown. The calculated average monthly incidence of pestivirus infection in the 2001 females in late 2004 appeared to be at approximately 15-20%.

Neospora transmission

Horizontal transmission of *Neospora caninum* occurred over the course of the observation (Table Q9.3). The calculated average monthly incidence was 0.35% of previously-naïve cows. This is quite possible as dingo populations fluctuate seasonally and are controlled annually at this site.

9.7 Evidence of infections with BVDV and *N. caninum* during the reproductive period

During the study period, 20 monitored cows that were cycling during mating conceived and experienced sero-conversion to *Neospora caninum* before weaning. Fifteen of these completed gestation normally. One cow experienced neo-natal calf loss which was associated with sero-conversion. Two cows (10%) aborted at the time of sero-conversion when foetal age was an estimated 2-3 months. This is not significantly higher than the pre-natal loss rate of 4% in this herd.

9.8 Impact of BVDV and *N. caninum* on reproductive outcome

Within maiden heifers but not first lactation cows, there was significantly higher reproductive wastage in those that did *v* those that did not sero-convert to BVDV between the start of mating in Jan 2004 and the end of calving in Jan 2005 (Table Q9.5). These cows were re-allocated to management groups from age groups just prior to calving. Within group A, reproductive wastage was significantly higher in animals that sero-converted between Jan 04 and Jan 05. Most losses were in the neo-natal period. All animals had received their secondary Pestigard vaccination in Jan 04, with a booster in Sep 04. That there were significant differences within first-calvers and group A is most likely to have been chance as the losses in animals that remained either sero-negative or sero-positive were much lower than usually occurs; i.e., 4% v ~12%. Given this, the conclusion is that the vaccine effectively protected the cows from a significant increase in reproductive wastage above normal.

Table Q9.5 Effect of sero-conversion to BVDV in 2004-05 at Q9

Mate age (yr)	Class#	No sero-conversion						Sero-conversion					
		Mate	Pregnant		Wean	Loss		Mate	Pregnant		Wean	Loss	
3	First lactation	100	63	63%	59	4	7%	61	42	69%	40	2	5%
2	Maiden	151	114	75%	110	4	4%	38	31	82%	26	5	16%
2-3	Group A	158	107	68%	103	4	4%	39	26	67%	22	4	15%
2-3	Group B	93	70	75%	66	4	6%	60	47	78%	44	3	6%

Animals were allocated from age groups to management groups in October 2004

There was no significant effect of *Neospora* status on pregnancies either within year or management group or across all matings (Table Q9.6). Analyses of reproductive wastage at various stages between early pregnancy and weaning also showed no significant difference between sero-positive and sero-negative animals.

Table Q9.6 Effect of *Neospora caninum* infection on mating outcomes

Mate	Calf	Sero-negative							Sero-positive at or during mating						
		Mate	Pregnant		Retained pregnants n	Wean	Loss		Mate	Pregnant		Retained pregnants n	Wean	Loss	
Group A															
2003	2004	67	34	51%	34	31	3	9%	7	3	43%	3	1	2	67%
2004	2005	204	130	64%	130	117	13	10%	16	12	75%	12	11	1	8%
2005	2006	185	109	59%	109	99	10	9%	32	21	66%	21	17	4	19%
2006	2007	176	145	82%	144	132	12	8%	32	24	75%	24	21	3	13%
2007	2008	165	114	69%	113	96	17	15%	29	23	79%	22	21	1	5%
Group B															
2003	2004	91	52	57%	52	46	6	12%	8	3	38%	3	3	0	0%

2004	2005	153	111	73%	111	103	8	7%	17	14	82%	14	11	3	21%
2005	2006	181	119	66%	119	105	14	12%	29	18	62%	18	15	3	17%
2006	2007	173	151	87%	151	137	14	9%	32	27	84%	27	25	2	7%
2007	2008	169	120	71%	117	99	18	15%	30	21	70%	21	19	2	10%

9.9 Other factors affecting reproductive efficiency

The effects of nutrition, management and genetics on reproduction in these cattle were not confounded with the effects of either BVDV or *Neospora caninum* at Q9. No other infectious agents known to affect cattle fertility were diagnosed in this herd.

9.10. Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

There was evidence of pestivirus transmission within the Q9 herd. All evidence indicated the source of the virus to be neighbouring cattle, either on Q9 or a neighbouring station. There appeared to be no impact of pestivirus on reproduction in this herd, presumably because of protection afforded by vaccination with Pestigard. Until the sources of infection and mode of transmission are identified in this herd, maintenance of vaccination to control *pestivirus* is recommended.

Although there was evidence of infection with *Neospora* there was no significant effect on reproductive performance, consistent with findings at other sites. Therefore there is no anticipation that *Neospora* will have effect in the future in this herd despite moderate infection levels and an average monthly incidence of 0.35% in the presence of a fluctuating dingo population.

Herd Summary Q10
Upper Flinders and Capricornia

10.1. Herd selection criteria

This Beef CRC herd was developed from the introductions of Brahman and Composite weaner heifers from 8 different properties. In August 2003, a number of poor performing heifers and first calf cows were bled and 3 were positive by PCR to pestivirus. All infected animals came from the same property of origin. A vaccination program against pestivirus was then instigated in November 2003. Prior to this, the reproductive performance in this herd was of concern. Perinatal losses in the 2003/04 calving season were 9% followed by perinatal losses in the 2004/05 calving of 41% with hypovitaminosis A considered the major contributor. A random sample of cows bled in December 2004 found 100% of cows positive to BVDV but only about 6% positive to *N. caninum.*

The property had good facilities and good cattle control. The herd was handled 4-6 weekly for weighing, ovarian scanning and pregnancy diagnosis as part of the Beef CRC experiment. Cows and calves were mustered at birth to collect calf birth date and weight.

10.2 Herd management

The cows were run in 3 mobs; B1 comprising 150, 3-4 yo Brahman cows, C1 comprising 154, 3-4 yo Composite cows and C2 comprising 169, 3-4 yo Composite cows. Mating commenced December 2004 and was completed in March 2005. The mobs were managed similarly and were processed through the yards on 3 consecutive days. Because of drought conditions, C1 mob was trucked (1100 km) to Brigalow Research Station at Moura in Central Queensland and remained as a mob until the following year with the same management as that at Toorak

All cows were vaccinated against leptospirosis in mid-pregnancy (June), and BVDV and campylobacteriosis in August–September each year. All bulls were vaccinated against campylobacteriosis prior to mating and all bulls were tested negative for trichomoniasis both on culture and PCR.

10.3. Monitoring methods

The reproductive performance of cows was monitored for one mating cycle from start of mating in December 2004 until weaning in May 2006. Eighteen, 16 and 14 cows were selected at random in B1, C1 and C2 mobs in December 2004 and were repeatedly bled in March, June and December 2005. As well in all mobs, as many cows as possible that had a prenatal, perinatal or early postnatal loss were bled twice subsequent to this loss.

10.4. Reproductive performance

Table 10.1 Mating outcome of cows in the 3 mobs

Mob	No Cows mated	Age (yrs)	Pregnancy rate (%)	Calving rate (%)	Weaning rate (%)	Loss from pregnancy to weaning (% unit)
B1	150	3-4	82	77	65	17
C1	154	3-4	94	86	81	13
C2	169	3-4	94	88	72	22

10.5. Prevalence of BVDV and *N. caninum* at commencement of study

Table 10.2 Prevalence of BVDV and *N. caninum* at commencement of study

Mob	Date	N	BVDV (%)	*N. caninum* (%)
B1	Dec 04	18	18 (100%)	1 (6%)
C1	Dec 04	16	16 (100%)	1 (6%)
C2	Dec 04	14	14 (100%)	1 (7%)

10.6 Evidence of transmission of BVDV and *N. caninum* during study period

Transmission occurred prior to the commencement of the study as there was a 100% infection rate of cows that were randomly bled at the initial observation. This level was maintained throughout apart from one cow in Mob 1 which had a fluctuating antibody level (seronegative in July 05 and positive [1+] in December 2005).

The seroprevalence of *N. caninum* remained low (8-12%) until June 2005 which was followed by a sharp increase in seroprevalence in all 3 mobs (33 – 43%) at December 2005.

10.7 Evidence of infections with BVDV and *N. caninum* during the reproductive period

Most cows that had a prenatal, perinatal or postnatal loss were not bled prior to the loss but were bled 4-8 weeks after the loss (Table 10.3). There was no evidence of active infection with *pestivirus* as most reaction levels were static. It was not possible to tell in most cases of pre-, peri- or postnatal loss whether there was any seroconversion to *N. caninum* because of no sample prior to the loss. However, of the 70 cows involved, only 21 had antibody to Neospora at the post-loss sample. Of the 5 animals from which a pre-loss sample was collected, there was only one seroconversion (Cow # 011054).

Table10.3. Serological status of BVDV and *N. caninum* in cows prior to and after a prenatal, perinatal or postnatal loss.

Mob	Category of loss	Cow ID	Calf ID	Estimated age of loss days	Cause of loss	BVDV			*N. caninum*		
						Date 1[a]	Date 2[b]	Date 3[c]	Date 1[a]	Date 2[b]	Date 3[c]
B1	Prenatal	024003		60	Unknown	#	3	3		N	N
		026004		88	Unknown		3			N	
		014058		117	Unknown		3	2		N	P
		026052		125	Unknown		3	3		N	N
		014140		133	Unknown		3	3		N	N
		024032		140	Unknown		3	3		N	N
		014031		194	Unknown		3	3		P	P
	Perinatal	024100	06T014	1	Poor mothering		3			P	
		024127	06T001	1	Premature		3			N	
		026169	06T213	1	Haemaloytic anaemia		3			P	
		027031	06T102	1	Haemaloytic anaemia		3			P	
		027233	06T123	1	Premature		3			N	
		024146	06T147	2	Unknown		3			N	
		026031	06T144	2	Haemaloytic anaemia		3			P	
		027093	06T015	2	Unknown		2		N	N	
	Lact. failure	011126		Around birth	Unknown		3			N	
	Postnatal	011054	06T107	3	Poor mothering	3	3		N	P	
		014122	06T077	3	Haemolytic anaemia		3			N	
		021006	06T087	3	Unknown		3			N	
		027224	06T115	3	Unknown		3			N	
		026001	06T239	4	Unknown		3			P	
		026029	06T185	5	Haemolytic anaemia		2			N	
		021066	06T165	8	Haemolytic anaemia		3			P	
C1	Prenatal	012303		37	Unknown	3	3	3	N	N	N
		012043		43	Unknown		2	2		N	N
		022116		58	Unknown		3	3		N	N
		025134		86	Unknown		3			N	
		022254		88	Unknown		3			N	
		012017		96	Unknown		3			N	
		012362		96	Unknown		2			N	
		012375		133	Unknown		2	2		N	N
		025270		133	Unknown		3	2		P	P
		022352		207	Unknown		1			N	
	Perinatal	012064	06H022	1	Premature		3			N	
		022047	06H032	1	Stillbirth		3			P	
		025228	06H067	1	Predator		3			P	
C2	Prenatal	013063		39	Unknown		3	3		N	N
		012377		40	Unknown		2	2		N	N
		013154		40	Unknown	2	2		N	N	
		022401		40	Unknown		3	3		N	N
		022272		42	Unknown	3	2	3	P	N	N
		022266		51	Unknown		3			P	
		022203		58	Unknown		2	3		N	N
		013128		61	Unknown		3	3		N	N
		013021		91	Unknown		3	3		N	N
		012201		118	Unknown		2	2		N	N
		022005		147	Unknown		2	2		N	N
		022391		147	Unknown		3	2		N	N
		012164		208	Unknown		2	2		P	P
	Perinatal	013120	06T250	1	Unknown		3			P	
		022062	06T028	1	Unknown		3			P	
		022295	06T020	1	Unknown		3			N	
		022376	06T119	1	Unknown		3			N	
		023109	06T175	1	Unknown		3			N	
		023123	06T174	1	Unknown		3			P	
		023293	023293	1	Haemolytic anaemia		3			N	
		023298	06T082	1	Unknown		3			N	
		012184	06T238	2	Haemolytic anaemia		3			P	
		022069	06T232	2	Unknown		3			N	
		022379	06T148	2	Haemolytic anaemia		3			P	
		023128	06T157	2	Unknown		2			N	
	Lact. failure	023255		Around birth			3			N	
	Postnatal	022178	06T234	3	Unknown		3			N	
		023099	06T017	3	Unknown		2			P	
		023167	06T194	3	Unknown		3			N	
		023190	06T192	3	Haemolytic anaemia		3			P	
		023084	06T066	4	Accident		3			N	
		023234	06T091	7	Haemolytic anaemia		2			N	
		022029	06T005	8	Unknown		3			P	
		013024	06T142	14	Accident		3			N	

Date 1[a] Serological result 4-8 weeks prior to loss

Date 2[b] Serological result 4-8 weeks post loss

Date 3[c] Second serological result 4-8 weeks after previous bleed

[#] Cell blank because no blood sample taken

10.8 Impact of BVDV and *N. caninum* on reproductive outcome

Table 10.4 shows the mating outcome of pregnant cows bled at random at the end of mating. It was not possible to determine the impact of *pestivirus* because all cows were seropositive. There was no significant effect of *N. caninum* serological status on mating outcome.

Table 10.4. Weaning percentage of pregnant cows based on serological status to either BVDV or *N. caninum* resulting from 2004/05 mating

Disease	Mob	Serological status	n	Weaning % of pregnant cows	Chi square
BVDV	B1	Positive	13	85	
		Negative	0		
	C1	Positive	13	92	
		Negative	0		
	C2	Positive	13	69	
		Negative	0		
N. caninum	B1	Positive	1	100	P = 0.56
		Negative	12	83	
	C1	Positive	0		
		Negative	13	92	
	C2	Positive	2	50	P = 0.36
		Negative	11	82	

10.9 Other factors causing reproductive efficiency

There were no other apparent infectious factors contributing to reproductive inefficiency. There appeared to be continuing impact of hypovitaminosis A (Hill *et al.* 2009, AVJ 87:94-98) in that a number of perinatal losses were due to haemolytic anaemia. The hypothesis for this is that there is possibly residual damage to the uterine caruncles with foetal circulatory leakage during gestation.

12.10. Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

For *pestivirus*, the future impact is low as all mobs will be vaccinated annually against *pestivirus*. There are negligible incursions from neighbouring properties because of secure boundary fences. The only introductions into the mobs will be new bulls and as a policy, all are tested for PI status, campylobacteriosis and trichomoniasis.

The impact of *N. caninum* is unknown. These results would suggest that the impact will be minimal.

Herd Summary Q11
Burnett

11.1 Herd selection criteria

The Beef CRC herd at Brian Pastures was developed from introductions of Composite weaner heifers from 4 different properties. Introductions were made in mid-2001, mid 2002 and mid-2003. In August 2003 there was a death in a 3-y-o cow from pestivirus. Subsequent bleeding of 5 poor performing 2-y-o heifers found that 3 of these were positive on PCR to BVDV. All infected animals came from one property of origin. The level of reproductive wastage from calving to weaning prior to the monitoring was 11.5% in heifers and 8.7% in first calf cows.

A random sample of cows were bled in each mob in November 2004 with 91% and 100% of cows seropositive to BVDV and 74% and 94% seropositive to *N. caninum* respectively in Mobs C1 and C2. Cows had been vaccinated against *pestivirus* with Pestigard vaccine in October 2003 but despite this 28% and 24% of the random samples of cows respectively in Mobs C1 and C2 had a serological level of 3

The property had good facilities and good cattle control. The herd was handled at a 4-6 weekly interval for weighing, ovarian scanning and pregnancy diagnosis as part of the Beef CRC experiment. Cows and calves were mothered at birth to collect calf birth date and weight.

11.2 Herd management

There were 3 cohorts (No 1 - 3) which were bred on 4 properties and were delivered to Brian Pastures as weaners. From weaning the animals were run as a cohort mob and were weighed and ovarian scanned at 4-6 weekly intervals. After the second mating the cohorts were boxed into 2 mobs. At mating in November 2004, C1 mob comprising 238, 3 – 4 yo cows and C2 mob 240, 2 – 4 yo cows. Mating was for 3 months. Animals were vaccinated against leptospirosis and the clostridial diseases in May-June each year. Bulls were vaccinated against campylobacteriosis. Vaccination against bovine ephemeral fever was done in November 2002 with a follow-up booster in July-August of each year. Vaccination against pestivirus was instigated in October-November 2003 with the secondary dose in November 2003 -January 2004. Heifers (No 3's) were vaccinated against pestivirus in August 2004 with the older cows receiving their annual vaccination in November 2004.

11.3 Monitoring methods

Cows were selected at random for serial bleeding with bleeding occurring in November 2004, February, June and November 2005. Initially 43 cows were bled in C1 and 17 in C2 but this latter number in C2 was increased to 31 in February 2005. As well in both mobs, cows that had a prenatal, perinatal or early postnatal loss were bled twice subsequent to this loss.

11.4. Reproductive performance

Table 11.1 Mating outcome of cows in the 2 mobs

Mob	No Cows mated	Age (years)	Pregnancy rate (%)	Calving rate (%)	Weaning rate (%)	Loss from pregnancy to weaning (% unit)
C1	240	3-4	73.5	67.6	66.4	7.1
C2	238	2-4	51.7	50.8	47.9	3.8

11.5 Prevalence of BVDV and *N. caninum* at commencement of study

Table 11.2 Prevalence of BVDV and *N. caninum* at commencement of study

Mob	Date	N	BVDV (%)	*N. caninum* (%)
B1	Nov 04	43	39 (91)	32 (74)
B2	Nov 04	17	17 (100)	16 (94)

11.6 Evidence of transmission of BVDV and *N. caninum* during study period

There was no active transmission of BVDV in C2 mob as all randomly selected animals were seropositive. Seroprevalence in C1 mob declined but then increased but the overall trend would not suggest active transmission. There was a sharp increase in seroprevalence of *N caninum* in C1 mob from June (66.7%) to November 2006 (97.2%) suggestive of transmission whilst there was a gradual increase in seroprevalence of C2 mob from 94.1% in November 2004 to 100% in November 2005.

11.7 Evidence of infections with BVDV and *N. caninum* during the reproductive period

Most cows that had a prenatal or perinatal loss were not bled prior to the loss but were bled 4-8 weeks after the loss (Table 11.3). Most cows that experienced a postnatal loss were not bled. There was no evidence of active infection with *pestivirus* as most reaction levels were static with some shift of these levels either up or down. All cows that experienced a prenatal loss were seropositive to *N. caninum.* (Table 11.3)

Table 11.3. Changes in serological status of BVDV and *N. caninum* prior to and after a prenatal, perinatal or postnatal loss.

Mob	Category of loss	Cow ID	Estimated age of loss days	Cause of loss	BVDV			*N. caninum*		
					Date 1[a]	Date 2[b]	Date 3[c]	Date 1[a]	Date 2[b]	*Date 3*[c]
C1	Prenatal	012009	122	Unknown	#	2	2		P	P
		012288	41	Unknown		2	2		P	P
		012349	35	Unknown		2	3		P	P
		022031	181	Unknown	3	2	2	P	P	P
		022209	153	Unknown		2	1		P	P
		025194	176	Unknown		1	2		P	P
		025202	145	Unknown		2	2		P	P
		025230	91	Unknown		2	2		P	P
		030044	171	Unknown		3	1		P	P
		030140	178	Unknown	0	3	2	P	P	P
		030353	181	Unknown		2	2		P	P
		030415	74	Unknown		2	2		P	P
		030427	124	Unknown	2	2	2	P	P	P
		030476	67	Unknown	2	2	3	P	P	P
	Perinatal	012079	0	Stillborn		2			P	
	Postnatal	022022	146	Accident	2			P		
C2	Prenatal	013140	172	Unknown		2	2		P	P
		023130	64	Unknown		2	2		P	P
		023160	49	Unknown		2	2		P	P
	Postnatal	022121	4	Unknown			3			P

Date 1[a] Serological result 4-8 weeks prior to loss
Date 2[b] Serological result 4-8 weeks post loss
Date 3[c] Second serological result 4-8 weeks after previous bleed
[#] Cell blank because no blood sample taken

11.8 Impact of BVDV and *N. caninum* on reproductive outcome

Table 11.4 shows the mating outcome of pregnant cows bled at random at the end of mating in February 2005. There was no significant difference in weaning percentage of cows that were initially serologically positive to either BVDV or to *N. caninum*

Table 11.4. Weaning percentage of pregnant cows based on serological status to either BVDV or *N. caninum* resulting from 2004/05 mating

Disease	Mob	Serological status	n	Weaning percentage of pregnant cows	Chi square
BVDV	C1	Positive	27	96%	P = 0.48
		Negative	10	90%	
	C2	Positive	13	100%	
		Negative	0		
N. caninum	C1	Positive	24	92%	P = 0.18
		Negative	13	100%	
	C2	Positive	13	100%	
		Negative	0		

11.9 Other factors causing reproductive efficiency

There were no other apparent infectious factors that could have been contributing to reproductive inefficiency. All cows were vaccinated against leptospirosis and all bulls were vaccinated against campylobacteriosis and trichomoniasis.

11.10 Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

In June 2006 after the study was completed, 226 cows from the property that the original PIs came from were tested using PACE but all were negative.

For pestivirus the future impact is low as both mobs will vaccinated annually against pestivirus. There are negligible incursions from neighbouring properties because of secure boundary fences. The only introductions into the mobs will be new bulls and as a policy, all are tested for PI status, campylobacteriosis and trichomoniasis.

The impact of *N. caninum* is unknown. These results would suggest that the impact will be low even though most animals on the property are seropositive.

Herd Summary Q12
Capricornia

12.1. Herd selection criteria

This Beef CRC herd had been experiencing 12.8 % loss from pregnancy to weaning. The property was infected with both pestivirus and *N. caninum.* A random sample of cows were bled in Mobs B1, B2 and C1 in December 2004 with 33%, 0% and 30% being serologically positive to BVDV and 0%, 16.7% and 23.3% being serologically positive to *N. caninum* respectively. Even though the herds were vaccinated against pestivirus with Pestigard vaccine, 8.3% and 20% of cows in B1 and C1 mobs respectively had serological levels of 2, probably as a result of infection prior to vaccination.

The property had good facilities and good cattle control. The herd was handled at a 4-6 weekly interval for weighing, ovarian scanning and pregnancy diagnosis as part of the Beef CRC experiment. Cows and calves were mothered at birth to collect calf birth date and weight.

12.2 Herd management

The cows were run in 3 mobs; B1 comprising 200 Brahman cows, 2- 5 yo; B2 comprising 206 Brahman cows, 2-4 yo and C1 comprising 307 Composite cows, 2-4 yo. Mating was for 3 months from Dec 04 to Feb 05. The mobs were managed similarly from Dec 04 until Aug 05 and were processed through the yards on 3 consecutive days. From Aug to Dec 05, cows from all mobs were mixed into 4 small paddocks based on pregnancy status to collect birth data and then post calving were drafted into several other paddocks until cows were put back into their mob for mating in Dec 05.

All cows were vaccinated against leptospirosis in mid-pregnancy (May) each year and bulls were vaccinated against campylobacteriosis prior to mating and all bulls have been tested and found negative to trichomoniasis both on culture and PCR. All 3–5 yo cows were vaccinated initially on 3 Dec 03 with a booster on15 Jan 04 whilst the 2 yo cows were initially vaccinated on23 Sep 04. All cows received a booster on 23 Nov 04 with annual vaccinating against *pestivirus* then continued.

12.3. Monitoring methods

24 and 30 cows were selected at random in B1 and C1 mobs in Dec 04 and were repeatedly bled in March, July and Dec 05. 20 cows in B2 mob were selected at random in Mar 05 and repeatedly bled in July and Dec 05. As well in all mobs, cows that had a prenatal, perinatal or early postnatal loss were bled twice subsequent to this loss.

12.4. Reproductive performance

Table 12.1 Mating outcome of cows in the 3 mobs

Mob	No Cows mated	Age (years)	Pregnancy rate (%)	Calving rate (%)	Weaning rate (%)	Loss from pregnancy to weaning (% unit)
B1	200	2-5	84.4	80.9	68.8	15.6
B2	206	2-4	72.9	69.0	63.1	9.8
C1	307	2-4	88.2	85.4	80.1	8.1

12.5. Prevalence of BVDV and *N. caninum* at commencement of study

Table 12.2 Prevalence of BVDV and *N. caninum* at commencement of study

Mob	Date	n	BVDV (%)	*N. caninum* (%)
B1	Dec 04	24	8 (33)	0
B2	Mar 05	20	14 (70)	5 (25)
C1	Dec 04	30	10 (30)	7 (23)

12.6 Evidence of transmission of BVDV and *N. caninum* during study period

There would appear not to be any evidence of active transmission of *pestivirus* even though the seroprevalence of positive animals fluctuated. In the 3 mobs there was an increase in the seroprevalence of N. caninum between July and Dec 05.

12.7 Evidence of infections with BVDV and *N. caninum* during the reproductive period

Most cows that had a prenatal and perinatal loss were not bled prior to the loss but were bled 4-8 weeks apart after the loss (Table 12.3). Most cows that experienced a postnatal loss were not bled. There was no evidence of active infection with *pestivirus* as most reaction levels were either static or declined. There was little evidence to incriminate *N. caninum* as 30 of the 39 animals from which samples were collected post loss remained seronegative (Table 12.3).

Table 12.3. Serological status of cows that had a prenatal, perinatal or postnatal loss

Mob	Category of loss	Cow ID	Calf ID	Estimated age of loss (days)	Cause of loss	BVDV reactions			*N. caninum* status		
						Date 1[a]	Date 2[b]	Date 3[c]	Date 1[a]	Date 2[b]	Date 3[c]
B1	Prenatal	010024		45	Unknown	#	2	2		Neg	Neg
		001133		51	Unknown		2	2		Neg	Neg
		010247		81	Unknown		1	0		Neg	Neg
		010281		82	Unknown		1	0		Neg	Neg
		031059		108	Unknown		2	2		Pos	Pos
		031045		127	Unknown		0	0		Neg	Neg
	Perinatal	001114		2	Not sucking		0			Neg	
	Lactation failure	001032		Around birth	Unknown		2			Neg	
		010346		Around birth	Unknown		3			Pos	
		020359		Around birth	Unknown		1			Pos	
		030086		Around birth	Unknown		0			Neg	
	Postnatal	001092	060510	3	Bottle teats						
		001025	060483	4	Bottle teats		1			Neg	
		010018	060271	4	Bottle teats						
		031030	060129	11	Dead - unknown						
		020060	060133	17	Poor mothering						
		031011	060146	17	Missing - unknown						
		001069	060432	31	Not sucking						
		010006	060426	74	Dead - unknown						
		001014	060352	101	Post branding						
		020291	060165	132	Dead - unknown						
		001127	060168	142	Missing - unknown						
		010470	060149	142	Missing - unknown						
B2	Prenatal	031043		43	Unknown		1	0		Neg	Neg
		020449		64	Unknown		1	2		Neg	Neg
		020054		87	Unknown		1	0		Neg	Neg
		010290		90	Unknown		1	1		Neg	Pos
		010328		90	Unknown		0	1		Neg	Neg
		020201		99	Unknown		0	0		Neg	Neg
		030370		101	Unknown		1	1		Neg	Neg
		020098		122	Unknown		3	2		Neg	Neg
	Perinatal	020549		2 days	Abandoned		3			Neg	
	Lactation failure	020250		Around birth	Unknown		1			Neg	
		020380		Around birth	Unknown		1			Neg	
		030029		Around birth	Unknown		2			Neg	
		030079		Around birth	Unknown		1			Pos	
		030464		Around birth	Unknown						
	Postnatal	030012	060112	6	Leg injury						
		020289	060321	17	Missing - unknown						
		030513	060436	77	Missing - unknown						
		030081	060291	161	Dead- unknown						
C1	Prenatal	030064		58	Unknown		0	0		Neg	Neg
		030276		58	Unknown		2	2		Neg	Neg
		030453		73	Unknown	2	2	2	Pos	Pos	Pos
		030304		73	Unknown		2	3		Neg	Neg
		030403		100	Unknown		2	3		Pos	Pos
		010097		120	Unknown		2	2		Pos	Pos
		020355		206	Unknown		0	0		Neg	Neg
	Perinatal	020273		At birth	Stillborn		0			Neg	
	Lactation failure	010250		Around birth	Unknown		0			Pos	
		020071		Around birth	Unknown		0			Neg	
		020094		Around birth	Unknown		0			Neg	
		020254		Around birth	Unknown		0			Pos	
		030449		Around birth	Unknown		2			Neg	
	Postnatal	020371	060462	15	Dingo		0			Neg	
		020320	060410	57	Missing - unknown						
		030123	060252	78	Missing - unknown						
		020545	060503	87	Missing - unknown						
		021218	060343	93	Unknown	0			Neg		
		020395	060368	118	Missing - unknown						

Date 1[a] Serological result 4-8 weeks prior to loss
Date 2[b] Serological result 4-8 weeks post loss
Date 3[c] Second serological result 4-8 weeks after previous bleed
Blank cells indicate that animal not bled

12.8 Impact of BVDV and *N. caninum* on reproductive outcome

Table 12.4 shows the mating outcome of pregnant cows bled at random at the start of mating. There was no significant difference in weaning percentage of cows that were initially serologically positive to either BVDV or to *N. caninum*

Table 12.4. Weaning percentage of pregnant cows based on serological status to either BVDV or *N. caninum* resulting from 2004/05 mating

Disease	Mob	Serological status	n	Weaning percentage of pregnant cows	Chi square
BVDV	B1	Positive	5	100	P = 0.55
		Negative	15	93	
	B2	Positive	14	93	P = 0.52
		Negative	6	83	
	C1	Positive	6	100	
		Negative	20	100	
N. caninum	B1	Positive	5	100	P = 0.55
		Negative	15	93	
	B2	Positive	8	88	P = 0.43
		Negative	12	92	
	C1	Positive	11	100	
		Negative	15	100	

12.9 Other factors causing reproductive efficiency

There were no other apparent infectious factors that could have been contributing to reproductive inefficiency. All cows were vaccinated against leptospirosis and all bulls were vaccinated against campylobacteriosis and were tested free from trichomoniasis

12.10. Likelihood of future impact of BVDV and *N. caninum* on reproductive efficiency

For both diseases the future impact is low. The station will continue to vaccinate the 3 mobs against *pestivirus* but other mobs on the station are not vaccinated. There are negligible incursions from neighbouring properties as Belmont is in a U-bend of the Fitzroy River and the river is permanently wide and deep resulting from backup water from a downstream barrage. The only introductions are new bulls and the station has a policy of testing all bulls for PI status, campylobacteriosis and trichomoniasis. For neosporosis, the impact seems low based on these results.

Herd Summary Q13
Maranoa

13.1 Herd Selection Criteria

In January 2005 the local stock inspector was asked to investigate the cause of a poorer than expected calving percentage in a beef herd at 'Bonarby'. Blood samples were collected from 3 cows with calves at foot, and 9 heifers and cows which had either failed to calve or the calf had died after birth. None of the cattle tested positive for either *L. hardjo* or *pomona.* All tested positive for bovine pestivirus, with two of the three cows with calves at foot having an AGID reaction of 3, and three of the nine breeders experiencing losses also having an AGID reaction of 3. One cow with a calf at foot and one which had experienced loss also tested positive for *Neospora caninum*. The findings indicated that it was very likely that there had been recent (within last 6 months) infection with pestivirus in this herd, and based on their joining time, cows could have been pregnant between 3 to 9 months during the outbreak. On the basis of the history of the herd it was decided to enrol the Bonarby herd into the project and monitor the outcomes of the '04 –'05 and '05 -'06 joining.

13.2 Monitoring methods for this herd

The property was visited on 24th August, 2005 and all breeding females mustered were pregnancy tested and blood samples collected. Swabs of vaginal mucus were collected from five home bred heifers which had failed to conceive. Each of the 3 breeding bulls underwent a physical examination and blood samples were collected. The owner decided to retain all the pregnant heifers (n=46) and 38 of the pregnant cows. On 30th March, 2006, blood samples were collected from 29 weaner steers (mainly 5 to 6 months of age) and on 13th May samples were collected from 43 weaner heifers (mainly 6.5 to 7.5 months of age). On 13th May the breeding herd (n=102) was pregnancy tested.

13.3 Herd Management

The herd was established in 2000 with Red Poll cross cattle from a nearby property. In August 2005 the herd consisted of 120 breeders, mainly Red Poll/Santa Gertrudis cross cows with some recently introduced mated Brahman heifers (n=30). The herd was routinely vaccinated with 7-in-1 vaccine. The property has 4 working dogs and dingoes are regularly seen on the property.

- Duration of joining and number of females joined

The herd was joined between November and February using a bull percentage of 3-4%. Bulls did not routinely undergo a breeding soundness examination and had not been vaccinated against campylobacter infection.

13.4 Reproductive performance

- Pregnancy rate

Year	'03 – '04	'04 – '05	'05 –'06
Heifers	N/A	79% (n = 24) N.B 30 heifers (90% pregnant) added to herd at pregnancy test	95% n = 20
Cows	83% (n= 69) (includes a small	85% (n = 66) (overall pregnancy	56% (n = 82) (approx. 50% were

	number heifers)	rate was 85%)	1st calf heifers)

- Weaning rate

Year	**'03 – '04**	**'04 – '05**	**'05 – '06**
Weaning rate	74% (n = 69)	71% (n = 120)	N/A

13.5 Prevalence of BVDV and N. caninum at commencement

	Seroprevalence	
	BVDV	*N.caninum*
Cows with calves at foot or had failed to calve or their calf died (n=12)	100%	17%

13.6 Evidence of transmission of BVDV and *N. caninum* during the study period

Year	Age/Group	BVDV AGID							*Neospora* ELISA			
		Neg	1	2	3	≥3	Total	%+ve	Neg	+ve	Total	%+ve
'05	Heifers (homebred)	0	0	20	4	0	100	24	21	3	13	24
'05	Heifers (introduced)	25	1	3	1	0	17	30	25	5	17	30
'05	Cows	1	0	35	30	0	98	66	54	12	18	66

'04 - '05 weaner mob testing

- 5 to 6 month-old weaner steers (n=29) – 45% BVDV seropositive (0 x AGID 3); all seronegative samples yielded negative results in the BVDV antigen capture ELISA test
- 5 to 6 month-old weaner heifers (n=43) – 19% BVDV seropositive (4 x AGID 3); all seronegative samples yielded negative results in the BVDV antigen capture ELISA test

13.7 Evidence of infections with BVDV and *N. caninum* during the reproductive cycle of interest

There was clear evidence of widespread recent infection with pestivirus in the breeding females during the '04 – '05 breeding season and subsequent gestation period. However, the herd was vaccinated with Pestigard at the end of the '04 –'05 breeding season. No PI female was detected amongst the breeding females. The evidence of pestivirus transmission amongst the weaners from the '04-'05 breeding season is equivocal, although it is possible that a PI calf was initially present but subsequently died.

13.8 Impact of BVDV and *N. caninum* on reproductive outcome

The finding of a high proportion of cows with a BVDV AGID reaction of ≥3 in August '05 when many cows were 7 to 8 months pregnant indicates a high risk of birth of some PI calves. However, no PI calves were detected in the weaned calves. The lack of evidence of transplacental infection may have been due to the fact that many cows became infected just prior to joining as evidenced by the finding that the sample of cows tested in the middle of the '05 joining period (January) were all seropositive, and also that the herd was then vaccinated with Pestiguard in February and March'05. The incidence of losses from pregnancy testing to weaning for the '03-'04 and '04-'05 breeding seasons were similar (9% and 14% , respectively). There was a marked improvement in pregnancy

rate of the heifers from the ’04-’05 to the ’05-’06 breeding season (79% and 95%, respectively). The evidence of widespread infection in the heifers in ’05 may indicate that *pestivirus* contributed to the lower pregnancy rate in these heifers, but this was not confirmed. There was no evidence of increased reproductive loss in the *N.caninum* positive cattle compared to the seronegative cattle. A stunted calf bled in August ’05 was *N.caninum* seropositive and BVDV seronegative and antigen capture ELISA negative.

Appendix 3: BVDV transmission studies in large herds in Queensland

Summary
The incidence of BVDV was estimated in three groups of juvenile cattle and two groups of older breeding females in extensively-managed herds in the dry tropics. The calculated monthly incidence of BVDV infection varied from as low as 0.5% to as high as 26%, with the lower rate seen in a very large herd of older heifers. These results show that even in endemically-infected herds, significant proportions of females may still be naïve to BVDV at maiden mating as 2-year-olds, thus being susceptible to financially-significant reproductive wastage when exposed to PI animals.

Background
Globally there has been considerable work understanding the effect and transmission of BVDV. There is limited information available on the transmission of BVDV in the Australian beef cattle industry which is essential to develop a practical understanding of the biological and financial impact of the disease.

Previous studies in temperate areas indicated that as many as 60% of cattle in contact with PI animals may contract BVDV over 24 hours when yarded and regularly mixed (McGowan and Kirkland, 2003). Under average stocking rates on pasture in temperate regions, transmission rates of 30-60% per month (1-2% per day) are often observed (Kirkland and McGowan, unpublished observations). Rates can be considerably greater, or less depending particularly on opportunities for close contact, forced mixing and disturbance of established social groups. There have been very few reports on transmission under conditions similar to those encountered in north Australia other than that of McGowan *et al*. (1993) who reported a study of BVDV transmission during an artificial breeding programme conducted on 2 commercial beef properties in the Arcadia Valley of central Queensland. These authors reported that two days prior to insemination 53% of the cows and 68% of the heifers were sero-negative to BVDV. At Day 51 after AI, 70% and 32% of the sero-negative cows and heifers, respectively, had sero-converted but between Day 51 and Day 210, only 17% and 3% of the sero-negative cows and heifers, respectively, had sero-converted. The rate of transmission during the period associated with frequent handling to synchronise oestrus and AI cattle, ie, up to day 51 was one animal infected every 2 to 3 days, but after this up to the period of late gestation the rate of transmission was significantly lower.

Objective
To measure the incidence of BVDV infection in endemically-infected north Australian cattle herds

Methods
Weaner studies commenced at five sites. Several other sites were abandoned without any animal handling or sampling because the probability of recovery of the animals for a second bleed late in 2006 was not sufficiently high to warrant commencement. At the commencement of the study at each site, results of first bleed were used to determine whether the study should proceed. At a site in NW Queensland, a segregated group of 210 newly-weaned heifers (visual estimate of weight range: 150-400 kg) were transferred to a second property in mid-July 2006. Heifers were tagged and bled but the study was discontinued when it was found that all heifers were sero-negative. A similar outcome occurred within a central Queensland property (Mackay district) when a sub-sample of 27 (of ~800) weaners all tested AGID Ab negative.

Where active transmission did occur, the average incidence per month was calculated. Estimates of incidence were also available from 2 large herd study sites.

Results and Discussion

Detailed reports are presented separately for 3 sites (see reports for Q14, Q15 and Q16 later in this Appendix). A summary of results from the 5 sites where virus transmission was monitored collectively indicated average monthly incidence of 9-26% for BVDV infection in large groups of juvenile cattle, but rates as low as 0.5% in large herds of older cattle (Table Q13.1). These results are unique for the north Australian environment.

Table Q13.1 Summary of BVDV transmission studies.

Location	Mob	Duration	Starting sero-prevalence	Incidence of sero-conversion	Calculated average monthly incidence
Q14	199 Brahman weaners (all tested) Large herd NE Qld Weaned from multiple mobs	5 m	29%	71%	17%
	Dispersed over station PIs unidentified	6m	71%	84%	9%
Q15	306 Brahman weaners (all tested) Large herd NE Qld Weaned from multiple mobs Segregated group, One watering point. One PI.	2 m	21%	63%	22%
Q16	506 Hereford x Simbrah weaners. Data from 223. Large herd west Qld. Weaned from 9 mobs Segregated group, PIs unidentified	5 m	63%	78%	26%
Q8	1700 Brahman heifers. Data from 230. Large herd NE Qld Segregated group, PIs unidentified	5 m	4%	3%	0.5%
Q9	440 Brahman cows (all tested) Large herd NE Qld; 2 management groups, PIs unidentified	3 m	4%	39%	15-20%

The higher transmission rates are similar to those observed under pastoral conditions in temperate Australia. The reason for the low transmission rates in some herds of extensively-managed cattle in the tropics may partially be a function of:

- extended hot dry situations as the virus remains infectious for short periods at temperatures above $10^{O}C$ or when exposed to UV light (McGowan and Kirkland 2003)
- low stocking rates, multiple artificial watering points in large paddocks, and wide dispersion of herds during the wet season when water is readily available which all reduce contact frequency
- cattle family and territorial behaviour being more readily expressed

However, it the possibility that the PI animals in several of these herds may have died or were removed should not be overlooked. PI animals were only identified in one herd and in the herds with the highest transmission rates, observation periods were short compared to the other herds. In the herd with the lowest transmission rate, the possibility that the PI animal(s) was removed from the group prior to the first sampling (and the seroconversions were the result of spread during yarding)

cannot be excluded. In one herd (Q14), the transmission rate in the second half of the observation period was about half of that observed in the first 5 months. This may also reflect removal of a PI or, alternatively, a reduced rate of spread as there is less likelihood of contact between a PI and susceptible animal as the proportion of immune animals rises.

Though incidence of infection is often not high, it is still sufficient to achieve high rates of infection across a group over 6-12 months. This is exploited at Q16 where all weaner heifers from the different breeding herds are brought together and managed as a single mob to encourage the transmission of BVDV to the majority of heifers prior to their first mating. However, there is expected to still be 10-15% of heifers' sero-negative at the commencement of mating as maidens. If a PI animal is introduced to to a group of females that are being joined or are in the early stages of pregnancy, the incidence is high enough to achieve significant reproductive wastage, as well as continue the cycle of endemic infection.

High management levels where cattle are well-segregated into age groups can result in elimination of the virus or at least creation of naïve age groups at first mating as seen at two north Queensland sites in this project. Such herds are highly susceptible to substantial loss if exposed to PI animals at inopportune times and this is highly likely where the overall herd is endemically infected.

These results underscore the scope for significant economic impact of BVDV (see Appendix 4). If BVDV is endemic in large herds, and it often is because of the inability to achieve an optimal level of control of cattle, there is usually chronic low-level reproductive wastage. In these situations, it appears that vaccination of heifer cohorts with a low sero-prevalence prior to first mating may be a financially-viable strategy.

Herd Summary Q14
Northern Goldfields

14.1 Herd selection criteria
Property size: 40,000 ha
Pasture type: Spear grass forest with primarily basalt-derived soils.
Herd size: 2,000 cows
Property business: Beef production

In a preliminary assessment, a high prevalence of BVDV was detected at a post-mating bleed (Table QT14.1) of heifers and cows.

Table Q14.1 Prevalence of BVDV at Q16 in August 2004

Year group	Class	n	BVDV
Mature	Cows	15	93%
2001	Maiden pregnant heifers	14	93%
2002	Maiden empty heifers	15	80%

14.2 Monitoring methods
In May 05, Nov 05 and Apr 06, a selected group of weaners was mustered for routine husbandry when they were bled, weighed and body condition scored.

Sera from all animals were tested for BVDV AGID Ab. At the first bleed, animals negative to this test were assessed using the PACE to identify persistently infected animals. At later bleeds, PACE-positive animals were retested using the AGID and PACE tests to confirm their status.

14.3 Herd management
Genotype: Brahman
Study group: 199 randomly-selected newly-weaned heifers (n=91) and steers (n=108) aged 4-7 months (average (~5.5 months) in May.
Management: It was planned for these individually-identified cattle to remain as one group within a larger management group of 500+ animals throughout the study. The cattle were stocked at approximately one adult equivalent per 8 ha.

From May-September 05 the weaners were supplemented with molasses with 3% urea and 10% protein meal; from October they were offered molasses with 8% urea. Recovery of animals was incomplete in Nov-05 (16 absent) due to a fence being broken four weeks earlier which resulted in some weaners moving to four other adjacent paddocks. The owners were subsequently unable to keep these cattle as one group, and they mixed through other mobs for the duration of the study. Fourteen animals were missing in Apr-06, 2 of which were also missing in Nov-05. The weaners remained in moderate condition and gained >100 kg in 11 months.

14.4 Evidence of transmission of BVDV during study period

Table Q14.2 BVDV serology of cattle at serial bleeds at Q13

		BVDV AGID						
Date	**Group**	**Neg**	**1**	**2**	**3**	**>3**	**%+ve**	**Total**
26-May-05	All	141 #	55	3			29%	199
02-Nov-05	Negative in May 05	54	2	50	26		59%	132
27-Apr-06	Negative in Nov 05	28		20	3		45%	51

Includes animals with maternal antibody when first sampled

At weaning, most animals were negative or had a low reaction in the BVDV AGID (Table Q13.2). There were only 4 animals with reactions of 1 or 2 at weaning in which this antibody level persisted 5 months later; 32 had become negative. Animals with a low titre at weaning that reverted to negative or increased 5 months later (n=80) were considered to have residual maternal antibody. Those that remained positive may have been infected *in utero* or had been infected prior to the first sampling. Those that had maternal antibody were considered as negative at weaning in this study

At the three bleeds in May-05, Nov-05 and Apr-06, the prevalence of BVDV-positive animals was 29%, 71% and 84%.

The calculated average monthly incidence of BVDV in this group was 17% in the first 5 months and 9% in the next 6 months. These transmission rates were comparable to rates observed in grazing cattle in temperate Australia when stocks are not regularly yarded.

14.5 Identification of PI animals

No carrier animals were identified in the surveillance group.

At weaning, 7 animals were either positive in the PACE test. Antibodies were subsequently detected in 2 animals indicating transient infection at the weaning bleed. However, 5 were negative for both BVDV antibody (AGID) and virus (PACE) 5 months later. Three of these 5 were sampled consecutively with the 2 animals that seroconverted; one of the latter 2 was the first sampled in this series. Samples were collected using vacutainers with a change of needle for each animal. Samples were centrifuged and serum frozen for subsequent assay at a local office using methods to prevent cross-contamination. Possibilities for the unconfirmed positive results include sample cross contamination from an unidentified source or poor specificity of the assay. The latter is not considered to be an issue as the PACE has very high sensitivity and specificity. The fact that each of these animals remained seronegative throughout the observation period is of interest when there was such a high seroconversion rate in the general population. The possibility that one or more of these animals was a PI and a false negative result was obtained in the PACE, perhaps related to sample storage, must be considered a possibility.

Herd Summary Q15
Northern Goldfields

15.1 Herd selection criteria
Property size: 20,000 ha
Pasture type: Spear grass forest with low-fertility duplex soils.
Herd size: 1,500 cows
Property business: Beef production

The only evidence of potential reproductive problems of infectious origin in the Q14 herd was a lower-than expected pregnancy rate in maiden heifers. BVDV was suspected as a contributing cause.

15.2 Monitoring methods
In Sep 05 and two months later, the weaners were mustered for routine husbandry when they were bled. Sera were tested for BVDV antibody in the AGID. At the first bleed, sera negative to this test were assessed using the PACE to identify possible carriers. At the subsequent bleed, sera from PACE-positive animals were re-assessed using the AGID and PACE tests.

15.3 Herd management
Genotype: Brahman
Study group: 306 newly-weaned heifers and steers aged 3-8 months (average (~5 months) in Sep-05.
Management: These individually-identified cattle were managed as one group throughout the study. The cattle are stocked at approximately one adult equivalent per 6 ha. Cattle in the group had a common trough for water. Seven animals that were sero-negative in Sep-05 were not recovered for sampling in Nov-05.

15.4 Evidence of transmission of BVDV during study period
Of 14 animals with an AGID reaction of +1 in Sep-05, there were 6, 2, 2, 3, and 1 with reactions of Neg, 1+, 2+, 3+ and 4+ in Nov-05. Animals with a 1+ reaction at weaning that reverted to negative were considered to have residual maternal antibody. Those that remained positive may have been infected *in utero* or had been infected prior to the first sampling. Those that had maternal antibody were considered as negative at weaning in this study.

The incidence of BVDV infection over the 2-month observation was 63% (Table Q14.1). At the bleeds in Sep-05 and Nov-05, the prevalence of BVDV-positive animals was 21% and 71%. The calculated average monthly incidence of BVDV in this group was 22%, an average of about one animal becoming infected daily.

Table Q15.1 BVDV serology of Q14 weaners

		BVDV AGID						
Date	**Group**	**Neg**	**1**	**2**	**3**	**>3**	**%+ve**	**Total**
29-Sep-05		242 #	8	9	43	3	21%	305
29-Nov-05	Neg in Sep-06	87	1	55	86	6	63%	235

Includes animals with maternal antibody when first sampled; excludes PI animal

15.5 Identification of PI animals

One PI was found in this group. The BVDV carrier continues to be used by the business to achieve sero-conversion in other juvenile heifers on the station.

Two animals that were PACE-positive in Sep 05, were both BVDV AGID Ab and PACE negative in Nov 05. When re-tested in Mar-06, they had titres of 2+ and 3+, confirming that they were transiently infected when first sampled.

Herd Summary Q16
Northern Goldfields

16.1 Herd selection criteria
Property size: 20,000 ha
Pasture type: 80% Mitchell grass and 20% Buffel grass
Herd size: 2,000 cows
Property business: Beef production

In February 1999, an outbreak of BVDV infection was diagnosed on Q16 associated with signs of peri-natal and weaner mortality and weaner ill-thrift.

16.2 Monitoring methods
Monitoring of BVDV transmission occurred during musters for routine husbandry. On 6th September 2006, 109 heifers were identified and bled. On 7th February 2007, heifers seronegative in September were re-bled and an additional 114 weaner heifers that had been added to the mob since the initial bleeding were bled. All sera were tested for antibodies using a BVDV AGID test. Samples from weaners that tested antibody negative at both samplings were submitted for PACE testing to identify PI cattle.

16.3 Herd management
Genotype: Hereford and Hereford x Simbrah
Mob details: 506 recently weaned heifers aged 6 to 8months, weighing 250 to 290 kg, of which 109 were monitored.
Management: All heifers were NLIS identified at weaning. The weaners were from 2 properties, one of which was Q16, and from 9 different breeding paddocks. The weaners are managed in the cattle yards at Q16 for 10 to 14 days after weaning before being put into paddocks. Initially 350 weaner heifers were placed in a 2,800 acre paddock with 4 watering points in early September. In late September 125 weaner heifers were added and in November a further 31 heifers were added.

16.4 Evidence of transmission of BVDV during study period
This study demonstrates the herd is endemically infected with BVDV, with clear evidence based on the high prevalence of AGID reactions of ≥3 that there is active infection in weaner heifers (Table Q16.1).

Table Q16.1 BVDV serology of cattle at Q15

		BVDV AGID						
Date	**Group**	**Neg**	**1**	**2**	**3**	**>3**	**%+ve**	**Total**
06-Sep-06		40		29	40		63%	109
07-Feb-07		25	1	48	77		83%	151

Three heifers that were serologically negative at the time of the first bleed were not present at the second visit. The producer reported that no carcasses had been found in the weaner paddock. Nor were the missing weaners found after mustering the only paddock beside the weaner paddock that contained cattle.

Twenty-nine of the 37 initially sero-negative cattle sero-converted over the 5-month period, i.e., an incidence of infection of 78%. The calculated average monthly incidence of BVDV in this group was 26%

The practice of managing all the replacement weaner heifers from the different breeding mobs as a single mob at Q16 is encouraging the transmission of BVDV to the majority of heifers prior to their first mating. However, not all heifers are infected which leaves a small number of susceptible early pregnant heifers to continue the cycle of endemic infection in this herd.

16.5 Identification of PI animals

No PACE-positive animals were identified.

Appendix 4: BVDV National Prevalence

Table A4.1 Location of herds sampled to determine the prevalence of BVDV

	GROUPS SAMPLED - 2007 & 2008				
STATE	Calves	Heifers	Cows	Unknown*	Total
NSW	25	41	58	22	88
NT	10	9	14	3	19
QLD	43	52	53	8	74
SA	3	3	6	1	7
TAS	5	6	8	10	25
VIC	35	48	86	9	114
WA	3	4	6	1	9
ALL	**124**	**163**	**231**	**54**	**336**

* Age structure not specified

Table A4.2 Proportion of herds with evidence of active infection with BVDV

	Active/Recent Infection				All herds			
STATE	Calves	Heifers	Cows	Unknown	Active	Recent	Total	% (A or R)
NSW	13*	22	14	14	48	21	69	78
NT	7	0	4	2	9	3	12	63
QLD	13	15	17	4	25	11	36	49
SA	2	2	2	0	4	2	6	86
TAS	2	3	4	1	5	7	12	48
VIC	19	20	30	6	45	17	62	54
WA	2	1	1	1	2	3	5	56
ALL	**58**	**63**	**72**	**28**	**138**	**64**	**202**	**60**

* Number of herds

Table A4.3 Distribution of prevalence of BVDV in heifers sampled

	Prevalence in Heifers					Extremes			
YEAR	0-25	26-50	51-75	76-100	All	0	% herds	100	% herds
2007	25*	41	58	6	105	26	25	26	25
2008	10	9	14	0	33	10	30	7	21
ALL	**35**	**50**	**72**	**6**	163	**36**	22	**33**	**20**
ALL (%)	**21**	**31**	**44**	**4**					

* Number of herds

Table A4.4 Distribution of prevalence of BVDV in cows sampled

	Prevalence in Cows					Extremes			
YEAR	**0-25**	**26-50**	**51-75**	**76-100**	**All**	**0**	**% herds**	**100**	**% herds**
2007	22*	32	27	78	137	10	7	39	28
2008	11	15	18	19	63	8	13	8	13
ALL	**33**	**47**	**45**	**97**	222	**18**	8	**47**	**21**
ALL (%)	**15**	**21**	**20**	**44**					

* Number of herds