final report

Project code: P.PSH.0204

Prepared by: Dr Patrick Kluver, Dr John Webb Ware, Dr John Larsen

Mackinnon Project, University of Melbourne Veterinary School

Date published: August 2008

ISBN: 9781741912654

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

The epidemiology of bovine Johne's disease (BJD) in beef herds

This is an MLA Donor Company funded project.
Meat & Livestock Australia and the MLA Donor Company acknowledge the matching funds provided by the Australian Government to support the research and development detailed in this publication.

Abstract

This project's objective was to describe the epidemiology and economics of BJD, which will help control the disease in future and guide future policy direction.

The study found that association with dairy breeds was the most important risk factor for the introduction of BJD. This has important implications for ongoing control and eradication programs with continued exposure of beef herds to dairy cattle. Index cases were most likely detected by veterinarians investigating clinical cases emphasising their important role for disease monitoring. Of the herds reporting clinical cases, 80% had a single case with only one high prevalence herd, indicating that BJD is self limiting in many beef herds with management strategies to control the disease and environmental conditions limiting spread.

Test and cull programs to eradicate BJD were not successful. Programs that removed high risk cattle by partial or total de-stocking were generally successful. No state program has assessed the success of control and eradication. This should be investigated in more detail.

The financial impact of BJD is not associated with production losses, but rather with the potential loss of income due to lower sale value of livestock. This impact is highly variable depending on the production system. The cost of eradication is highly variable; depending on the strategy adopted so must be planned carefully on an individual basis. There are significant financial risks involved with de-stocking and eradication is only likely to be more profitable (in the long term) than living with the disease when the discount on sale stock is great.

The current state programs that are designed to provide assistance to affected producers and reduce the prevalence of BJD, will not eradicate BJD from the beef herd. Consequently, de-stocking and eradication programs will continue on an ad-hoc basis, as further BJD infected beef herds are identified. This creates a potentially significant and ongoing financial demand for the industry, without any end point to the program. Other options for managing BJD should be considered including vaccination and risk based trading to limit the financial impact on individual producers and the potential regulatory cost on the industry.

Executive Summary

This study aimed to identify risk factors for the introduction and establishment of Bovine Johne's disease infection (BJD) into beef herds.

Dairy breeds, or an association with dairy breeds, appeared to be the most important risk factor for the introduction of infection. An important implication of this is that beef herds will be constantly exposed to the risk of introducing infection whilst the prevalence of BJD remains high in dairy herds. Consequently, programs that aim to control and eradicate BJD in beef herds will need to be undertaken on a continuing and long-term basis, creating a potentially large and ongoing financial demand on the industry.

In addition, some beef breeds were over represented in herds known to be infected with BJD. Consequently, these breeds should be considered an important secondary risk for the introduction of the disease.

A large proportion of infected herds were first identified through veterinary investigation of clinically sick animals. This emphasises an important role for the beef industry in funding disease monitoring programs aimed at detecting changes in the pattern of endemic diseases and the emergence of new diseases.

In general, the control programs that were implemented were successful in progressing infected herds back to the equivalent of a 'non-assessed' (NA) herd status in each state. The exceptions were 'test and cull' programs, which were less successful unless they were combined with the culling of known high risk animals. However, no state has an ongoing program to assess the success of control and eradication programs currently being implemented in infected herds. This is an obvious deficiency, and so the apparent success of eradication programs within previously infected herds should be investigated in more detail.

The major factors that motivated producers to eradicate BJD were the high probability that the program would be successful, and that this would then lead to the removal of restrictions on the sale of animals and land. The social stigma of being the owner or manager of an infected herd was of less importance, but was still rated as very important by 51% of respondents. Access to financial assistance, the possibility of increased mortality rates in infected herds and the potential impact of BJD on the quality of products produced by a beef herd were all rated as unimportant when producers were making a decision about whether to eradicate BJD.

Modelling of the financial impact of BJD in infected herds showed that the impact of BJD within commercial herds will vary with the management and marketing strategies adopted. In general, the financial impact of BJD is associated with attempts to eradicate the disease and restrictions on stock sales, rather than production losses. For commercial producers, those relying on store markets will be most affected, whereas the impact within herds selling cattle direct to feedlots or finished cattle for slaughter will be insignificant, in terms of discounts on the value of sale stock and decreased farm income. However, for some producers the reduced flexibility of their sale options, through having to sell stock only for slaughter, may be more significant.

Results of financial modelling demonstrated that the impact of BJD within commercial beef herds can be reduced if affected producers change enterprises to target

finishing systems. However, not all properties have suitable land class and pasture quality to successfully implement profitable finishing systems.

Further, based on the assumptions made in the financial spreadsheet model it was found that if there was no price discount on sale stock, BJD would need to cause death rates in excess of 5% before either partial or total de-stocking was warranted,. Alternatively, if sale cattle attracted a 10% price discount, then the death rates from BJD would need to exceed 1% before partial or total de-stocking was justifiable. Based on the data collected in this survey, mortality rates were negligible and these levels were never exceeded. However, in some circumstances price discounts may exceed 10%, and so the cost of living with BJD will be more severe.

In scenarios where BJD was not eradicated, using test and cull combined with partial de-stocking, trading restrictions were removed after 5 years, or after 2 years with total de-stocking. In these circumstances, the net present value (NPV) with total or partial de-stocking was still worse over 10 years, and significantly worse if the cost of restocking was increased by 10%. In addition, there are significant risks associated with de-stocking. These include the value received for sale stock, decreased profitability of any intermediate enterprise, increased costs of restocking, failure to eradicate BJD and, ultimately, ending up with less profitable replacement stock and/or enterprises.

Whilst initially doing nothing in a commercial herd was more attractive from a cash flow perspective, the bigger the discount on sale prices, the more important it was to eradicate BJD (assuming that BJD was effectively eradicated by the chosen program).

In stud herds, BJD will usually result in the total failure of the business. Without massive subsidies, BJD infection in a stud herd will inevitably result in an unviable business.

With current industry policy it is important to point out that, without any financial assistance from industry, owners of BJD affected herds who opt for herd dispersal are clearly severely affected if sale cattle are sold at discounted prices, the subsequent enterprise is less profitable and restocking is more expensive. However, the impact on individual herds is likely to be highly variable and this needs to be quantified on a case-by-case basis, as the losses are highly dependant on existing productivity and sale strategies in each herd.

Vaccination programs were not considered in this analysis, but if they become available they may be a realistic option to help improve trading options and limit the financial impact of BJD in the future, especially if attempts to regulate the disease continue.

Finally, it is important to clearly understand that the current programs and industry strategy, designed to provide assistance to affected producers and reduce the prevalence of BJD, will not eradicate BJD from the beef industry due to the constant potential for reinfection from introduced dairy or dairy cross-breed cattle, or when beef cattle are closely associated with dairy herds.

Contents

1 Project Objectives

1. To identify likely risk factors for the introduction and establishment of BJD infection.
2. To describe the occurrence of clustering of BJD infection, in either age or family cohorts, and likely risk factors for the establishment of infection.
3. Describe methods used to control and eradicate BJD and the factors that influence the decision to eradicate the disease from a beef herd
4. Identify factors contributing to the success or failure of eradication programs
5. Assess the cost-effectiveness of different programs

2 Methodology

Initially, a 2-day meeting was held near Melbourne at which State Department of Primary Industry (DPI) staff from the four states in which BJD is endemic identified the type and extent of data that existed for beef herds infected with BJD. Following this meeting, new and existing data was collected from affected herds using a 3-step process, and financial modelling of the impact of BJD for a typical beef herd in south-eastern Australia.

2.1 Collection of data from affected herds

This survey was conducted with the assistance of the DPI in three states, New South Wales, Victoria and South Australia. A 'beef herd' was defined as one which did not produce milk for sale, although it could contain cattle of dairy origin.

There were 49 herds from Victoria, 59 from NSW and one from South Australia included in the analysis. Herds were excluded if they contained less than 30 breeding cows or if they operated as a dairy farm. The final form of the survey is shown in Appendix 1.

A draft survey questionnaire was initially distributed to State DPI staff for their comment. A modified draft was then piloted on up to 4 farms in each State to check its utility and the clarity of the questions. A final draft was then developed from this feedback, with responses from the pilot survey excluded from the final analysis.

The first section of questionnaire was completed by State DPI animal health staff using existing records from known affected herds (Section 1). More detailed information was then gathered from eligible herds through a personal interview of affected producers (Section 2). Finally, information on the clustering of cases by age or familial lines was completed by DPI staff, if records permitted, in herds with 3 or more confirmed cases (Section 3). All herds included in the survey had their BJD status allocated after 1991.

2.2 Financial Analysis

The assumptions and methodology of the financial analysis is discussed more fully in Section 4.1. Briefly, this analysis evaluated the financial impact of the main options used for the control and eradication of BJD, comparing them with an infected beef herd in a 'steady state'.

To evaluate these options a spreadsheet simulation model was developed with a specialist self-replacing beef enterprise as the main enterprise. This spreadsheet model used average income and expenses derived from a number of the most recent data sets for beef enterprises in south-eastern Australia. These included the ABARE survey of beef producers and Victorian Farm Monitor Project results for 2005-06, farm analysis results from clients of the Mackinnon Project in 2006, and results from the Holmes, Sackett and Associates (HAS) publication ‘AgInsights 2006’.

The model was based on a typical self replacing beef herd in south-eastern Australia. Obviously, production and physical performance will vary between this and other regions, but the general outcomes of the analysis will be similar.

For each run, the model calculated the monthly cash flow for the beef herd over a period of 10 years. Four main options were evaluated:

- Base run; living with BJD (ie. no action taken to eradicate)
- Test and cull
- Partial de-stocking
- Total de-stocking

In addition, the net present value (NPV) of annual cash flow, assuming 100% equity, was calculated over 10 years.

3 Results and Discussion – Survey of infected herds

3.1 Physical characteristics of the herds

The average herd size was 127 (n = 98), with a range from 30 to 800 head. The average and median herd size in NSW was 127 and 80, respectively (n=55), compared with Victoria with an average of 111 and median of 73 (n=43).

The farms had an average size of 318 ha (range 20 -1550 ha), with an average stocking rate of 13.8 DSE/ha.

3.2 Testing and the detection of the Index case

The majority of herds (67%, 95% Confidence interval (CI) 57 to 77%) imported the first identified case of BJD, termed the ‘index’ case, with the remaining 33% (95% CI, 24 to 43%) having an animal bred on the farm as the initial case.

The method of identifying the index case was classified into 6 categories, plus a catch all ‘Other’ category (Table 1). Routine testing, where there was no previous suspicion of disease, was further divided into 3 categories; routine Market Assurance Program (MAP) testing, testing required before the movement of cattle, or testing as part of an industry survey.

Herds investigated because an animal they sold or disposed of was subsequently found to be infected were classified as identified by ‘traceback’, whilst herds investigated following the purchase of an animal from a farm subsequently confirmed to be infected were classified as identified by ‘trace forward’. ‘Veterinary investigation’ was where cattle were investigated by a veterinarian because they were clinically ill or showing signs of BJD, including scouring.

The majority of herds 75 (68.8%) were detected due to a veterinary investigation of a sick or scouring animal. Although not specifically asked, this would normally be reliant on notification by the herd owner or manager. This has important implications for ongoing control of BJD in beef herds, with a heavy reliance on owner notification to identify a disease that can have serious financial penalties for the farm business. Veterinary investigations of imported animals accounted for 50% of all index cases.

Fifteen of 109 index cases (14%, 95% CI 7.9-22%) were identified through routine testing by veterinarians or the DPI. Of these, more than half (8 of 109 cases, or 7.3% of the total, 95% CI 3.2-14%) were detected in herds thought to have a low risk of BJD infection when undergoing MAP testing.

Three infected herds (2.8%, 95% CI 0.6-7.8%) were detected due to participation in industry surveys of the prevalence of BJD, and four (3.7%, 95% CI 1.0-9.1%) were detected following testing for interstate movement of livestock.

Despite the fact that 67% (95% CI, 57 to 77) of index cases were found to be an animal imported into the herd, epidemiological investigations (trace forward and trace back) accounted for only 12.8% (95% CI 7.2-21%) of the means of identifying these cases. Of these, trace back identified 7.3% of the index cases (95% CI, 3.2-14%). It is not clear why there is such a discrepancy in this ratio. Potential explanations include difficulties in identifying the herd of origin of an imported animal, the herd of origin may have been investigated but was cleared by subsequent testing, or the herd of origin may have been disbanded. Of significance is that 5% of imported index cases originated from dispersal sales. In this case, a single infected herd would obviously be capable of infecting more than one herd.

Table 1 Detection of the index case

Method identified	No.	%
MAP testing	8	7.3%
Interstate movement	4	3.7%
Industry survey	3	2.8%
Trace back	8	7.3%
Trace forward	6	5.5%
Vet investigation	75	68.8%
Other	5	4.6%
Total	109	

3.3 Characteristics of index cases

The month and year of detection, breed, sex, source and age of the index case was recorded and analysed. The statistical significance reported is Students t-test unless otherwise specified.

3.3.1 Class and age of index cases

Bulls were over represented as index cases, with 27 of 109 (25%, 95% CI 17-35%) index cases being bulls compared with the average herd having 4.5 bulls per 100 cows (ABARE data).

This may be due to a number of factors. Bulls are often the only stock imported onto farms, but 13 of 84 herds (15%, 95% CI 8.5-25%) reported that home bred bulls were their main source of bulls, whilst 85% (95% CI 73-91%) said that the main source of bulls was from outside the farm. Of the index cases that were classified as bulls, 7 of 27 (26%, 95% CI 11-46%) were home bred. This was not statistically different from the overall proportion of farms that used mainly home bred bulls (Fisher's exact P = 0.25). It should be noted that the exact proportion of imported versus homebred bulls was not recorded in the questionnaire.

The average age of index cases when first detected was 5.7 years (95% CI 5.2-6.2), the youngest being 1.5 years and the oldest 13.5. There was a trend for index cases detected by veterinary investigation (this includes clinical cases) to be older than animals diagnosed for other reasons (5.4 vs. 6.4 years), but this was not significant (P=0.081).

There was no difference between the average overall age of homebred and imported index cases (5.6 vs. 5.8 years, P=0.58), nor imported and homebred cows that were index cases (6.4 vs. 6.1 years, P =0.67). However, bulls were identified at a significantly younger age than cows (4.3 vs. 6.3 years, P<0.001), even when corrected for being imported or homebred (P<0.01). In addition, bulls tended to break down or were investigated at a younger age than cows, although this was not statistically significant (mean 4.5 vs. 5.8 years, P=0.054).

When index cases were identified by routine movement testing, trace back or trace forward investigations, or 'Other' methods, bulls were detected at a significantly younger age than cows (4.0 years vs. 8.0 years, P=0.001).

There are several possible explanations for the finding that bulls are significantly younger than cows when detected as an index case, and why bulls tend to be over represented as index cases compared to cows. First, bulls are more likely to be tested at a younger age than cows because of testing for interstate livestock movement. Secondly, bulls may actually be more susceptible to infection, exposed to a greater infective dose when grazed as calves, or subjected to greater social stress, and so more likely to break down with BJD infection at an earlier age. It may also be simply a reflection of herd structure, with the average age of bulls tending to be younger than the average age of cows.

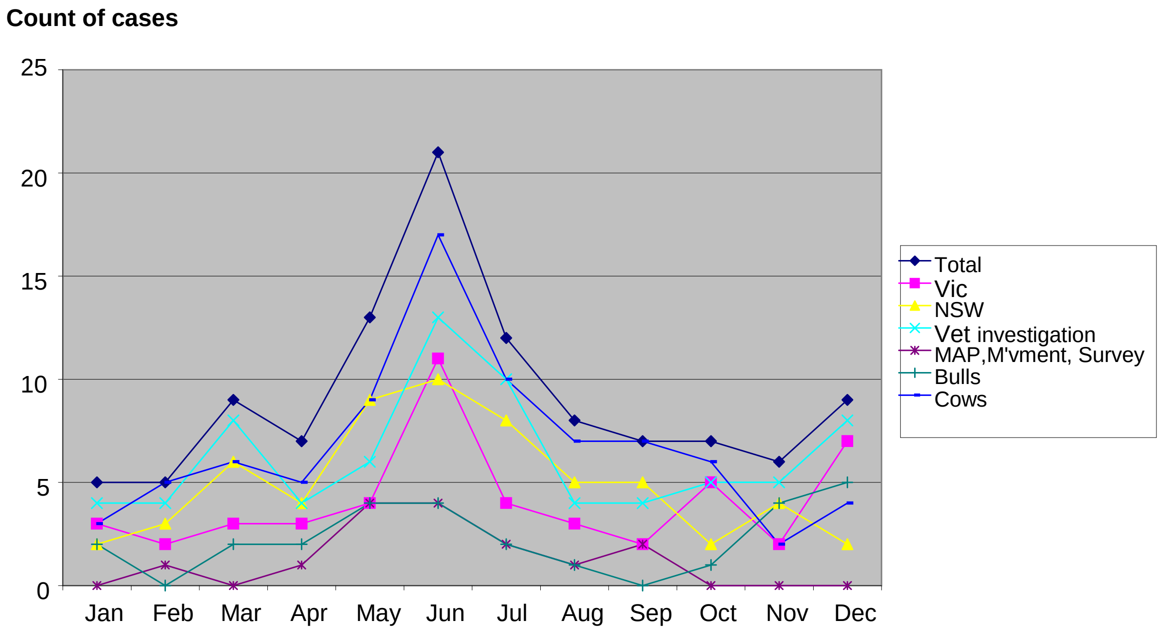
3.3.2 Month when index case detected

The survey identified what time of year the first confirmed case was diagnosed on the affected farm (Figure 1). This shows a significant trend for cases to be detected in May, June and July (Pearson Chi squared goodness of fit 24.5, P=0.011).

This was an unexpected result, but was independent of state, and is correlated with the veterinary investigation of sick or scouring animals and cows in the autumn-winter months. This may be explained by the nutritional stress experienced by many beef cattle at this time, with late pregnancy and lactation superimposed on poor quality pasture in northern NSW, and lack of pasture quantity in south-eastern Australia. It may also be an artefact of the data, due to respondents defaulting to June when the month of first diagnosis was not recorded or able to be recalled. However, this effect appears real, because May and July are also over represented compared to other months.

This trend could be further investigated and confirmed by examining records of submissions to veterinary laboratories in these regions over a number of years.

Figure 1 Detection of index cases by month



3.3.3 Breed of index case

In Section 1 of the survey, DPI representatives were asked to nominate the breed of the index case, which is summarised in Tables 2 and 3. These are divided into pure beef breeds, where the breed was given, a beef cross-breed where the cross was nominated as a 'beef breed x', 'cross', or 'dairy cross'. Cross-breeds were usually only one nominated breed, for example 'Angus cross', so some beef crosses may contain dairy blood.

Pure bred beef cattle comprised 67 of the 108 index cases, with the major breeds represented being Murray Grey (31%, 95% CI 21-44%), Angus (22%, 95% CI 13-34%), Shorthorn (10%, 95% CI 4.3 -20%) and Limousin (7.5%, 95% CI 2.5-17%).

There are no reliable records of breeds kept on farms in Australia, but the annual sale of registered bulls is a convenient and relevant guide to the popularity and prevalence of breeds. When comparing the major British and European breeds, it is interesting to note the differences between bulls sold and cattle breeds of BJD cattle identified (Table 4). The Angus and Hereford breeds are under-represented as index cases compared to bull sales, whereas Murray Grey, Shorthorns and Limousins are over represented. No Charolais or Simmental cattle were nominated as index cases on the farms in this study.

Whilst the breed prevalence is an interesting observation, the comparison group is only registered bull sales in 2006, so may not truly reflect the overall population. It is also only representative of the previous year, whereas the survey collected data from affected beef herds over the previous 30 years.

The over representation of Murray Grey and Shorthorns, compared with other traditional breeds, is of interest. This may imply an increased susceptibility to infection for these breeds, with Murray Greys being originally developed from a Shorthorn Angus cross. However, it is more likely to simply reflect more widespread dissemination of BJD within a breed due to the dominance of a few infected herds.

This may have occurred early in the development of the breed, or reflect more intimate contact with dairy cattle by these dominant herds. This difference may also have been influenced by changing trends in the popularity of breeds over the last 20 years.

Whatever the explanation, the Murray Grey and Shorthorn breeds appear to pose a higher risk of introducing BJD into non-affected or non-assessed beef herds compared with other British or European breeds.

Beef cross-breds are treated separately and it is unclear from the responses whether these animals are beef-cross-beef or beef-cross-dairy, except for the 3 Hereford-Shorthorn crosses. Beef crosses made up 16% (95% 9.5-24) of index cases.

Dairy or dairy cross-breds made up 22% of cases (95%CI 15-31%), and obviously pose a high risk for the introduction of BJD into beef herds. However, reliable figures on what proportion of beef herds have dairy or dairy cross-breeds, and what proportion of the herd that they comprise, are not readily available.

Table 2 Index case by breed (n=108)

Beef pure-bred		Beef cross-bred		Dairy pure-bred		Dairy cross-bred	
Angus	**15**	**Angus x**	**9**	**AIS**	**3**	**AIS x**	**1**
Brahman	**3**	**British x**	**1**	**Jersey**	**2**	**Jersey x**	**3**
Brangus	**3**	**Hereford x**	**1**	**Friesian**	**2**	**Friesian x**	**11**
Gelbvieh	**3**	**Hereford x S'horn**	**3**	**Guernsey**	**1**	**Guernsey x S'horn**	**1**
Grey man	**1**	**Limousin x**	**1**				
Hereford	**3**	**Mixed**	**1**				
Limousin	**5**	**Saler x**	**1**				
Maine Anjou	**3**						
Murray Grey	**21**						
Santa Gertrudis	**2**						
Shorthorn	**7**						
Wagyu	**1**						
Total	67	Total	17	Total	8	Total	16

Table 3 Breed of imported Index cases (n=73)

Beef pure-bred		Beef cross-bred		Dairy pure-bred		Dairy cross-bred	
Angus	**10**	**Angus x**	**6**	**AIS**	**2**	**AIS x**	**0**
Brahman	**2**	**British x**	**0**	**Jersey**	**1**	**Jersey x**	**2**
Brangus	**2**	**Hereford x**	**1**	**Friesian**	**2**	**Friesian x**	**8**
Gelbvieh	**3**	**Hereford x S'horn**	**1**	**Guernsey**	**0**	**Guernseyx S'horn**	**0**
Grey Man	**1**	**Limousin x**	**0**				
Hereford	**3**	**Mixed**	**1**				
Limousin	**4**	**Saler x**	**1**				
Maine Anjou	**3**						
Murray Grey	**13**						
Santa	**1**						
Shorthorn	**5**						

Wagyu	**1**						
Total	48	Total	10	Total	5	Total	10

Table 4 Bull sales in 2006 compared to the breed of the index case (British and European breeds only)

Breed	Bull sales in 2006		Index cases	
	Number sold	% of sales	Breed	% of pure beef breeds
Angus	7,544	48	15	29
Charolais	2,048	13	0	0
Hereford	3,547	22	3	5.8
Limousin	578	4	5	9.8
Murray grey	502	3	21	41.2
Shorthorn	839	5	7	13.7
Simmental	623	4	0	0
Total	**15,681**	**100**	**51**	**100**

3.3.4 Origin of index case and likely source of infection

3.3.4.1 Homebred animals

Homebred animals made up 36 of the 109 index cases (33%, 95% CI 24-43%). There was no indication that these cases may have become infected off the farm during their first year of life, with all 29 responses received indicating that no time was spent off farm by these index cases.

When asked whether the dam of the index case was an import, only 26 responses were received. Of these, 10 (38%, 95% CI 20-59%) were imported and 16 (62%, 95% CI 40-80%) were homebred.

Collaborating DPI staff were also asked to suggest the most likely source of infection (Table 5). It is difficult to assess the reliability of this information, and so it should be interpreted with some caution. Nevertheless, this section was filled out by experienced veterinarians or animal health officers who had a good working knowledge of the affected farm.

Table 5 Likely source of infection if the index case was homebred

Source of infection	Count	%
Introduced beef bull	2	6%
Introduced beef cow	8	22%
Introduced dairy cow	5	14%
Introduced dairy bull	0	0%
Dairy association	9	25%
Neighbour	0	0%
Not known	8	22%

Other	4	11%
Total	**36**	**100%**

Beef cattle of either sex were associated with 28% of homebred index cases (95% CI 14-45%), dairy cattle 39% whilst 33% were not known or attributed to another source.

Several affected herds had been dairy herds from 10-20 years before the index case. This suggests that, at least in some beef herds, the expression and translation of BJD infection occurs very slowly. Thus, the overall prevalence remains low and the progression of sub-clinically infected animals to clinical cases occurs very slowly.

Of the 39% of homebred index cases being associated with dairy cattle (95% CI 23-57%), an introduced dairy or dairy cross cow accounted for 14% of cases (95% CI 4.6-30), whilst an association with a dairy herd, or a past history of being a dairy herd, accounted for 25% (95% CI 12-42%).

Introduction of BJD from neighbouring farms was not thought to be associated with any of the homebred index cases. This differs from the case of BJD in dairy farms, where the flow of effluent or mixing of animals from neighbouring farms can often occur.

In one case the disease was thought to have been introduced by goats which ran with poddy calves. The goats were confirmed as being infected with BJD after an index case occurred in a cow.

There were 8 homebred cases where the source of infection was not known. Three of these herds had a previous history of cattle with signs consistent with BJD but were never investigated.

3.3.4.2 Imported index cases

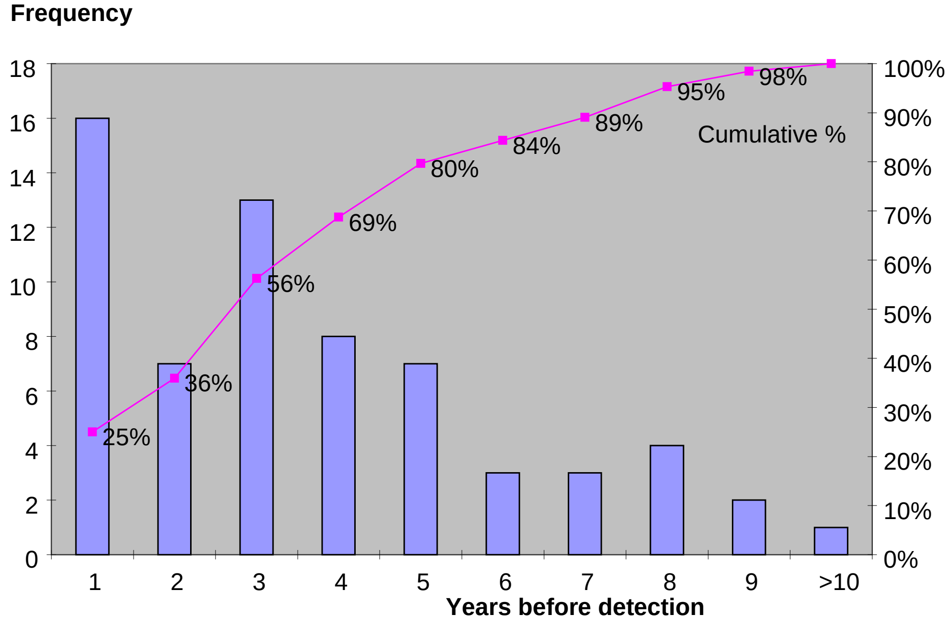
Figure 2 shows how long imported cases were resident on a farm before they broke down with BJD. This is an estimate, as only the year of arrival was nominated and so it was assumed that all animals arrived on 30 June when calculating this interval.

To more effectively control this disease, it is important that infected animals are detected as soon as possible. This limits the number of susceptible animals that are exposed to infection, which in turn reduces the number of at risk animals that have to be culled. About 25% of imported index cases were detected within one year of arrival, and 56% of animals spent less than 3 years on farm before detection. However, 44% of imported index cases were on the farm for more than 3 years, with 20% present for 5 or more years, potentially exposing a large proportion of susceptible animals within these herds to BJD infection.

It must also be remembered that 33% of the index cases on farms were in homebred animals. Presumably infection on these farms originated at some stage from animals that were previously imported, but which were then either culled before showing clinical signs of BJD or died on the farm without any further investigation.

Early identification of BJD is important in order to limit spread of the disease within the herd. This makes eradication more economic and achievable, without the need to de-stock or cull large numbers of at risk animals. Thus, the identification or investigation of animals with signs consistent with BJD as soon as possible is very important, but only 56% of imported cases were identified within 3 years of being introduced.

Figure 2 Time (years) imported cases spent on farm before detection



3.3.4.3 State of origin of imported index case

The state of origin was an important feature investigated because many states, including NSW, have had restrictions on the importation of cattle from higher prevalence states, such as Victoria and Tasmania, in an attempt to limit the introduction and spread of BJD.

All 32 Victorian herds imported their index case from within that state (Table 6). In NSW, 8 of 38 cases were imported from Victoria (22%, 95% CI 9.5-37%) and one was imported from Queensland (2.6%, 95% CI 0.07-13). However, the majority of imported index cases originated from within NSW (29 of 38 or 76%, 95% CI 60-89%).

Thus, although interstate importation does pose a risk for the introduction of BJD into NSW, most introductions actually came from within the state.

Due to the low numbers of cases, no attempt was made to compare the proportion of interstate or imported index cases with the overall proportion of imported animals in the general farm population.

Table 6 State of origin of imported index cases

State	Source state	
Vic	Vic	32
NSW	Vic	8
	NSW	29
	QLD	1

3.3.4.4 Herd of origin of imported index cases

Studs were the source of an imported index case in 30% of herds, saleyards in 36% and purchases from on farm or dispersal sales in 28% of cases (Table 7).

There were no cases attributed to agistment cattle, although one homebred index case was the calf of an agisted cow that calved on the affected property.

Although saleyards are often thought of as high risk they appear to pose no higher risk than stud sales or on-farm sales.

Table 7 Source of animal

Source	**Count**	**%**
Stud	22	30%
Saleyard	26	36%
Dispersal sale	4	5%
On farm sale	17	23%
Agistment	0	0%
Other	4	5%
Total	**73**	**100%**

3.3.4.5 Association of imported index cases with dairy cattle
Only 32% of respondents (23 of 73) knew whether the source farm of an imported index case was associated with dairy farms (Table 8). Of these, 57% (13 of 23) were from a dairy farm or a former dairy farm. On 9% (2 of 23) of source farms, dairy cows were known to have been used as recipients in embryo transfer programs.

The herd of origin was not known to have any association with dairy cattle in 35% of cases (8 of 23).

Table 8 Source farm's direct association with dairy

Association with dairy	**No.**	**%**
Existing dairy farm	**5**	**7%**
Former dairy farm	**8**	**11%**
Dairy cattle as recipients	**2**	**3%**
No association	**8**	**11%**
Don't know	**46**	**64%**
6 other	**3**	**4%**
Total	**72**	**100%**

Table 9 Association of the area of the source farm with dairy

Type of association	No.	%
A dairy area	**32**	**44%**
A former dairy area	**7**	**10%**
No association	**8**	**11%**
Don't know	**26**	**36%**
Total	73	100%

Only 64% of respondents knew if the area of origin of the index case was associated with dairy cattle (Table 9). The index case was imported from a dairy area or former dairy area in 83% of cases (39 of 47), but there was no association with a dairy area in 17%.

There are two related explanations for this high association with dairy areas or former dairy areas. These are the association between dairy cattle and higher rainfall areas, both of which have a higher prevalence of BJD infection.

3.4 Herd testing & clinical cases

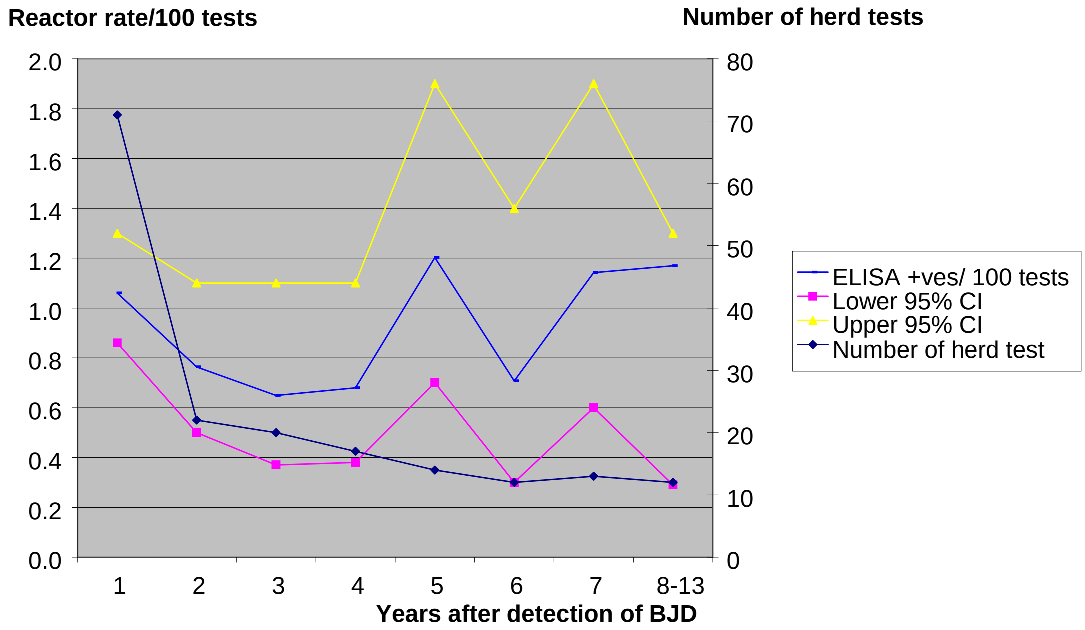
The investigation asked for all serological reactors or clinical cases to be recorded, and nominate if the animal was a clinical case or an ELISA reactor. Sixty-four herds identified at least one case as being a 'clinical case', compared with 75 which nominated the index case being identified by veterinary investigation of a sick or scouring animal.

There could be a number of reasons why the veterinary investigation may not have been a clinical case. For example, when asked to nominate how the case was identified, a clinical case may have been first identified as being an ELISA reactor.

Due to the format of the survey and the type of data available, it was not possible to define the 'at risk' period for the herds. This period would be truncated by a number of events, particularly the beginning of a control program and associated removal of at risk animals or ELISA reactors, or partial or complete de-stocking. In nearly all cases, the date for the beginning of the control program was the same as that nominated for when the index case was identified.

Of the 64 herds that indicated at least one clinical case, 51 (80%) had only a single case, 8 had two cases, 4 herds each had 3, 4, 5 and 7 cases each, and one high prevalence herd had 28 cases.

Figure 3 Rate of ELISA reactors after detection of BJD



3.5 Control programs

Most herds included in this study undertook some form of control program. The collaborating DPI staff member was asked to classify the control program according to one of the following criteria:

a) test and cull
b) test and cull, plus culling of high risk animals
c) partial de-stocking
d) full de-stocking.

The study did not take into account how control programs may have changed over time, but some herds had undertaken ELISA testing for a number of years before partially or completely de-stocking more recently due to the availability of compensation.

Of the 7 herds not undertaking any control program, 3 remained classified as 'Suspect', 3 were 'Infected' and one was 'Restricted'. In all these herds the index case was an imported animal.

Herds classified as Restricted are an infected herd that has culled all known infected animals and then undergone one whole herd negative ELISA test. This was not able to be explained although the index case was a recent introduction with little or no exposure to infected animals.

3.5.1 Control programs instituted

The characteristics of the BJD infection in an affected herd was summarised as being in one of the following four categories:

1. The disease was endemic, with evidence of disease in home bred animals or a large proportion of the herd had been exposed.
2. The index case was a recent introduction with limited opportunity for exposure to susceptible animals (no more than 1 or 2 calf cohorts or a well defined part of the herd)
3. The index case was a recent introduction with little or no exposure to susceptible cattle.
4. The index case was an introduced animal but herd records did not enable accurate assessment of the likely exposure to susceptible animals.

The results of this analysis are summarised in Table 10 and discussed below.

3.5.1.1 Endemic herds

These categories would be expected to strongly influence the control program instituted in each herd, although other influences or constraints, such as economic or aspirational goals, would also be important.

Thirteen of 30 herds in which the disease was described as 'endemic' had undertaken a test and cull program, with or without some removal of high risk animals. Of these herds, only one small herd of 40 cows had achieved a 'non-assessed' (NA) status by a test and cull program alone. There were no records of the herd testing in the 2 herds classified as 'RD2', but they had between 160-180 breeders.

Of the 5 endemic herds using test and cull, combined with the culling of high risk animals, 2 still had an infected (IN) status and 3 had progressed to NA. Within the 2 infected herds, one was first detected in 2006, whereas the other had stopped the test and cull program after 2 herd tests before 2000. The 3 NA herds which had successfully undertaken test and cull combined with removal of high risk animals had either removed a large portion of the herd (90%), or had removed a whole breed of cattle in which the disease seemed to be confined (Maine Anjou).

There were only 2 herds in which the disease was described as endemic and partial de-stocking occurred without testing. Of these, one remained IN and the other was classified as NA after undergoing 2 negative whole herd tests and removing all breeding stock.

Of the herds where the disease was endemic, 15 were described as having undertaken full de-stocking. Of these, 12 had a NA status and 3 were IN. The 3 with infected herds had only recently de-stocked, and so were due to qualify for NA status within the next 12 months. All 3 had undertaken some whole herd ELISA testing.

One herd, described as 'other', was a herd in which the source of infection was goats.

3.5.1.2 Recent introduction of the index case

In cases where the index case was a recent introduction, there was limited opportunity for spread of BJD. On these occasions, herd records generally allowed the identification and culling of any well defined high risk groups.

Consistent with the definition of this group, no herd had used test and cull without removal of high risk groups. A total of 6 herds had used test and cull combined with removal of high risk animals. Of these, 3 were NA, 2 were SU and 1 was RD1.

Twenty four herds had undertaken a partial de-stock with removal of high risk animals. Of these, 21 of 24 had a NA status, 1 was SU and 2 remained infected. Of the 2 infected herds, one had an interim status and the other had been de-stocked but the owner had failed to notify the DPI. One herd had completely de-stocked to achieve NA status.

Only 9 herds were classified as where the index case was a recent introduction with little or no exposure to susceptible cattle. Of these, 7 were classified as NA, 1 was RD1 and one was still classified as infected.

Eighteen herds were categorised as having an introduced index case, but the existing records did not enable an accurate assessment of the likely exposure of susceptible animals. Of these, 11 were classified as NA, 6 were still infected and 1 was classified as RD2.

Of these 18 herds, 4 had undertaken a test and cull program, with 3 remaining infected and 1 RD2. Another 4 herds had undertaken a combination of test and cull and removal of high risk groups. Of these, 3 were NA and one remained infected. Two of the 18 herds in this disease category had culled high risk groups, of which 1 remained with an IN status and the other was NA. The remaining 8 herds had de-stocked, with 7 being classified as NA, whilst one remained IN because it had only recently de-stocked at the time of the survey.

One herd was currently classified as NA after a single animal was detected at a MAP test, with no other animal subsequently detected. This is an unusual case in that only one animal was detected and BJD was confirmed at slaughter. This was a homebred animal and the herd had been a dairy in the early 1970's. However, only a limited amount of testing was conducted after the initial index case, and this level of testing could not provide an assurance that the herd was truly free of infection.

Table 10 Summary of progression of infected herds' status according to the clinical category of BJD infection

Disease category	STATUS	Control program*					Total
		TC	TCR	PD	FD	Oth	
Disease was endemic	IN	3	2	1	3		9
	NA	1	3	1	12	1	18
	RD2	2	1				3
	Total	6	6	2	15	1	30
Recent introduction with limited opportunity for exposure	IN			2			2
	NA		3	21	1		25
	RD1		1				1
	Suspect		2	1			3
	Total		6	24	1		31
The index case was a recent introduction with little or no exposure	IN					1	1
	NA		2	2	2	1	7
	RD1		1				1
	Total		3	2	2	2	9
The index case was an introduced animal but herd records were poor	IN	3	1	1	1		6
	NA		3	1	7		11
	RD2	1					1
	Total	4	4	2	8		18
Other	NA	1					1
	Total	1					1
Total		11	19	30	26	3	89

*Control Program; TC = Test and cull; TCR = Test and cull with removal of high risk animals; PD = Partial de-stock with removal of high risk animals; FD = Full de-stock; Oth = Other

3.5.2 Control Methods

For the purpose of the survey, 'eradication' was defined as achieving a classification of NA status from the State DPI. This could be achieved through several means, but the control programs reported were summarised as belonging to one of 5 different categories:

1. Test and cull
2. Test and cull with removal of high risk animals
3. Partial de-stock with removal of high risk animals
4. Full de-stock
5. Other

3.5.2.1 Herd testing

For the test and control program, all animals over 24 months of age were tested annually on 25 of 29 farms (86%) and 14% of herds were tested every second year. Another 43 herds undertook a one-off whole herd ELISA test.

Thirty owners indicated that they had undergone a test and cull program. Of these, 11 herds were described as test and cull and 19 were test and cull with removal of high risk animals.

The testing regime varied between herds and is summarised in Table 11. Year 1 is the first herd test conducted, with each subsequent herd test given by year, although these were often not tested in consecutive years. Herds with split tests within a year had these tests combined and were classified as one herd test.

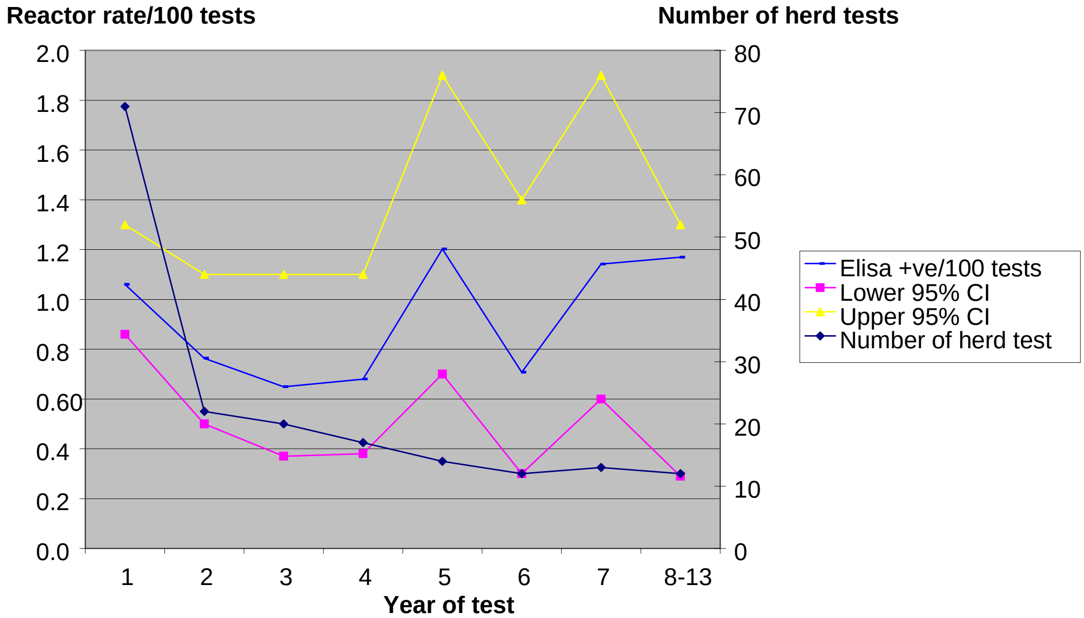
Reactors were removed at the earliest possible time from known infected herds. Follow up of reactors at slaughter varied between herds. Of the 22,612 tests undertaken, 205 (0.91%) were ELISA positive. Of these, 62 were confirmed with either faecal culture or necropsy results, 32 of these 205 (15.6%) were classified as false positives and the remaining 111 were either not reported in the survey or were unresolved.

There was a slightly higher rate of false positives reported from the NSW herds. This may be a function of the disease prevalence, with a slightly higher prevalence in Victoria, based on confirmed positives. Alternatively, there may be a difference in the ELISA kits used between these states.

Table 11 Summary of herd testing

Year of test	Number of herds	Number of tests	ELISA +ve	ELISA +ve confirmed	ELISA false +ve	FC Positives	Total both FC & ELISA +ve
1	71	9431	100	31	6	6	1
2	22	3536	27	5	8	10	2
3	20	2464	16	9	1	14	3
4	17	2207	15	6	8	1	2
5	14	1414	17	3	0	3	3
6	12	1131	8	1	1	0	0
7	13	1226	14	4	7	0	0
8	4	342	4	2	2	1	1
9	3	297	3	1	0	1	1
10	1	76	0	0	0	0	0
11	1	25	0	0	0	0	0
12	2	275	0	0	0	0	0
13	1	188	1	0	0	0	0
Total for all herds		22,612	205	62	33	36	13
Victorian herds		11,366	94	38	5	28	8
NSW herds		11,246	111	24	28	8	5

Figure 4 ELISA reactor rate by year



The ELISA reactor rate appears to decrease for 3 years following the initial herd testing, but then stays relatively constant. However, many herds undertook only one herd test.

3.5.2.2 Test and cull alone

Test and cull was usually only used alone where it was not possible to identify well defined high risk groups. This can occur where the disease is endemic, where the index case is in a homebred animal or if an introduced animal has been in the herd for some time and herd records do not permit the identification of high risk groups. In these situations, the whole herd is often potentially exposed and either de-stocking or test and cull, with or without removal of high risk animals, are the only viable control options.

Table 12 Classification of herd status by disease picture in herds using 'test and cull' program alone

Disease picture	Herd Status	No. herds
Disease endemic	IN	3
	NA	1
	RD2	2
Total		6
Introduced not able to define high risk group	IN	3
	RD2	1
Total		4
Other	NA	1
Total		1
Grand Total		**11**

The test and cull herds had undergone up to 7 herd tests, with an average of 3.7 herd tests. The 6 herds that still had an IN status had tested for up to 7 years, with an average of 1.7 herd tests.

Overall, only 2 of 11 herds had achieved an NA status from using Test and Cull alone. One of these was a small herd of 40 and the other was a large herd that only ever had 1 infected animal detected at a routine interstate movement test.

3.5.2.3 Test and cull with removal of high risk animals

Test and cull alone, where the test has limited sensitivity and there is no reliable means of preventing disease spread, other than removing mostly late stage diseased animals, has inherent disadvantages in a disease control program. For example, in dairy herds early removal of calves from adult cattle is practised in an attempt to break disease transmission.

If possible, high risk groups should be preferentially culled. These are animals that have been exposed to an infected animal and considered susceptible at the time of exposure. This may be a calf cohort exposed to an infected animal, or a calf cohort of an infected animal, meaning these animals are likely to share a common exposure. Other high risk groups usually include calves, siblings or dams of infected animals, or other animals from the same source.

A total of 19 herds were described as having used a program which was test and cull with removal of high risk animals. Of the 19 herds, 3 remained classified as infected with a further 2 suspect herds. Of these, 2 had only commenced the program in 2006 and 1 had not tested since 2000. Of the suspect herds, only one had undertaken herd testing, with 2 negative tests of animals over 4years old in 2004 and 2006, but it will de-stock in 2007.

Eleven of the 19 herds had achieved a status of NA, with an average of 55% of the herd being culled because they were high risk animals. These herds performed an average of 2.7 herd tests.

Three herds had a status of RD1 or RD2. All 3 herds had been in the program since 2004 and had undertaken from 4 to 5 herd tests.

3.5.2.4 Partial de-stock with removal of high risk groups

Twenty-six of 30 herds that had undergone a partial de-stock with removal of high risk groups had a disease picture described as the index case being an introduced animal with limited (24 of 26) or little or no exposure to susceptible cattle. There were 2 herds in both the first (endemic) and fourth categories (where the indexed case was an introduced animal but herd records did not allow accurate assessment of likely exposure to susceptible animals).

Table 13 Classification of herd status by disease picture in herds using 'partial de-stock with removal of high risk groups'

Disease picture	**No. herds**
Endemic	2
Recent introductions	24
Recent introduction little exposure	2
Introduced but poor records	2
Total	**30**

Of the herds that had undergone partial de-stocking and were described as endemic or a large proportion of the herd had been exposed, 1 herd had achieved NA status and 1 was still infected. The herd that had a NA status had not kept any calves over a period of 6 years, and so effectively had removed most stock, buying in replacement breeders.

Of the 24 herds that were described as recent introductions with limited exposure to susceptible stock, 22 (92%) had achieved NA, with 2 classified as infected and one as SU. The herd with an infected status will move to NA later in 2008 based on further assessment of cull animals, whilst the suspect herd is awaiting a whole herd ELISA to clarify its status.

Herds in which partial de-stocking had occurred and had progressed to NA status had de-stocked an average of 62 animals (range 7 to 159). As a proportion of the herd size nominated by the owner (including bulls, cows, steers, heifers, calves before the diagnosis of BJD was made), this averaged 41% (range 11-124%).

3.5.2.5 De-stocking

Full de-stocking was used in a 28 herds, of which 26 had an assigned status and 2 were of unknown status. De-stocking usually constitutes removal of all animals off the farm with restocking of animals when an approved decontamination period has elapsed, provided it remains de-stocked of all susceptible species for 12 months. During de-stocking, young animals can be run on the property for a limited period, up to 12-18 months, and then consigned to slaughter without jeopardising the decontamination period.

Susceptible animals include cattle, deer, goats and camelids. The SDRs consider that cattle over one year of age are at very low risk of becoming infected.

The SDRs are open to interpretation with regard to de-stocking. In some jurisdictions, the 12 month de-stocking period only commences when all cattle, including calves, are removed and adult cattle from ’Beef only’ herds or higher status can only be introduced when the 12 month period has elapsed. In other areas, young cattle born on the farm can be kept until 18 months, adult cattle can be introduced almost immediately, but calves from these animals born within 12 months or within the decontamination period must be sold for slaughter before they are 18 months.

Of the herds that had de-stocked and had a status, 22 of 26 (85%) were NA and 4 (15%) were classified IN. These 4 herds were either just within the 12 month decontamination period, or were only just about to commence de-stocking.

Within the 28 herds, an average of 224 animals were de-stocked (range 26-700) after an average of 1.5 whole herd tests (maximum of 5). Six herds had conducted no herd testing, 13 had conducted one whole herd test and 9 had conducted 2 or more whole herd tests before undergoing de-stocking.

Although some herds may have entered into the MAP after the de-stocking, no herds appeared to have had an ongoing monitoring program to assess whether they had successfully ‘eradicated’ the disease. This is not surprising, considering the negative consequences of a diagnosis of BJD.

3.5.3 Motivation for controlling BJD

The motivation for using de-stocking to control BJD was sought using Q.27 in Section 2 of the survey (see Appendix 1).

The owners or managers were asked to indicate the importance of the following 8 factors for their decision to eradicate or control JD, on a 1-6 scale, with 1 being not important, 3 of minor importance and 6 very important::

1. Ability to sell cattle unrestricted.
2. Ability to sell land unrestricted.
3. The social stigma associated with the disease.
4. The death rate or stock losses due to Johne's disease.
5. Access to a financial assistance and counselling package.
6. A good chance of success.
7. Having JD affects the quality aspects of my products.
8. The financial advantage of eradicating.

The average scores and the breakdown of the scores are summarised in Figures 5 and 6, respectively.

3.5.3.1 Ability to sell cattle or land without restrictions

The ability to sell cattle without restrictions was rated as very important (5 or 6) by 93% of respondents, with only 6 % rating it is as either minor or not important (Table 14). The respondents who rated it as of minor importance also rated selling vealers as of major importance, and so were not selling stores before trade restrictions were imposed due to the detection of BJD.

The ability to sell land without restrictions was rated as very important (5 or 6) by 72%, of minor importance (3 or 4) by 14% and 15% rated it as not important (1 or 2). There appeared to be no relationship between how long respondents intended to farm and how they rated the importance of selling land.

Table 14 Summary of responses rating importance of selling cattle and land

Rating	Sell cattle	Sell land
1 Not important	0%	12%
2	5%	3%
3 Minor importance	1%	3%
4	0%	11%
5	9%	7%
6 Very important	84%	65%
Average score	**5.7**	**4.9**

The ability to sell land without restrictions may have been rated as less important than the ability to sell cattle without restrictions for several reasons. The impact of restrictions on cattle sales is immediate, and is something that all the affected owners are likely to have experienced to some extent. Conversely, sale of land occurs less commonly and it is also unclear what effect BJD restrictions have on land values. In addition, the impact of selling land would be less important for owners not intending to sell land in the immediate future.

Figure 5 Average scores showing motivation for controlling BJD

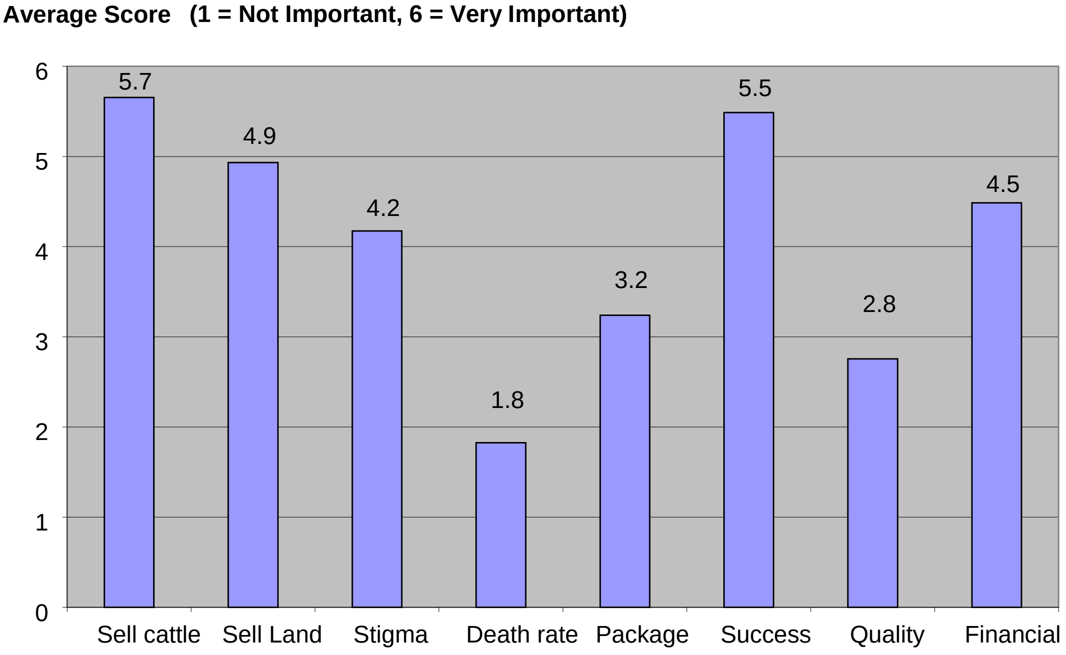
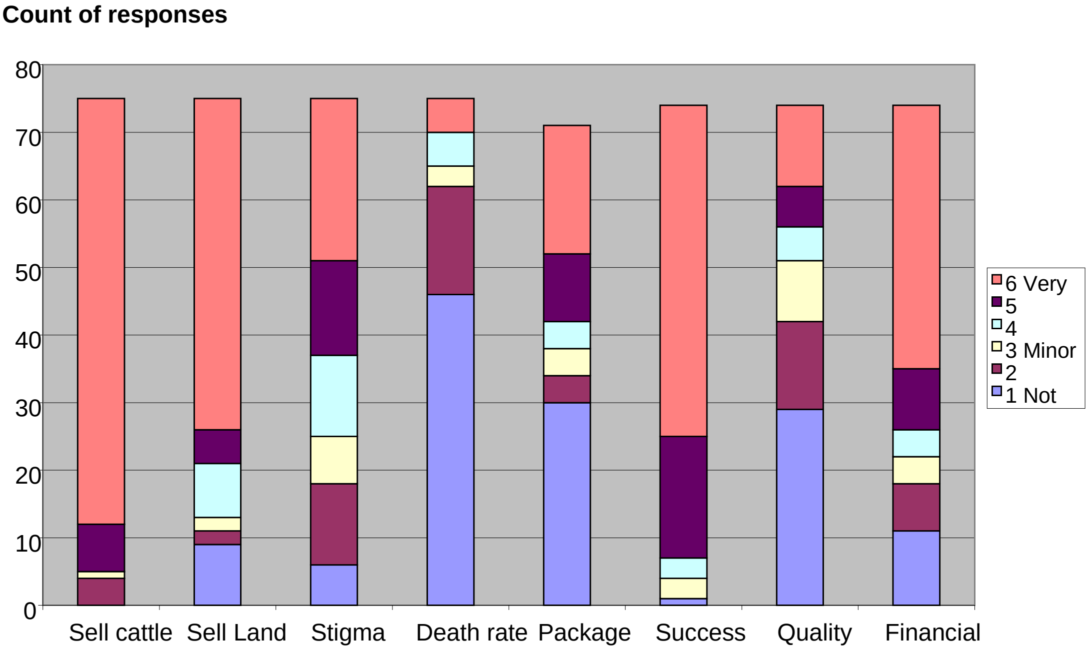


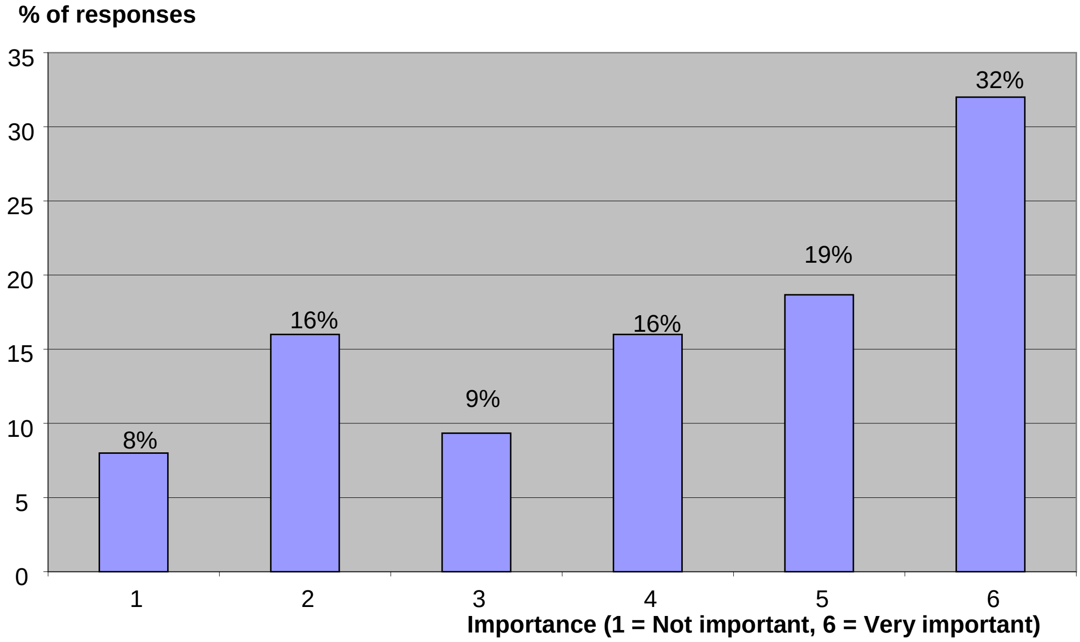
Figure 6 Breakdown of scores summarising the motivation for controlling BJD



3.5.3.2 The stigma associated with the disease.

The social stigma associated with the disease as a motivation for controlling BJD was rated as very important by 51%, with 25% rating it as minor importance and 24% as unimportant (Figure 7). Thus, social stigma does appear to be a strong motivation for controlling or eradicating BJD despite efforts to reduce this stigma.

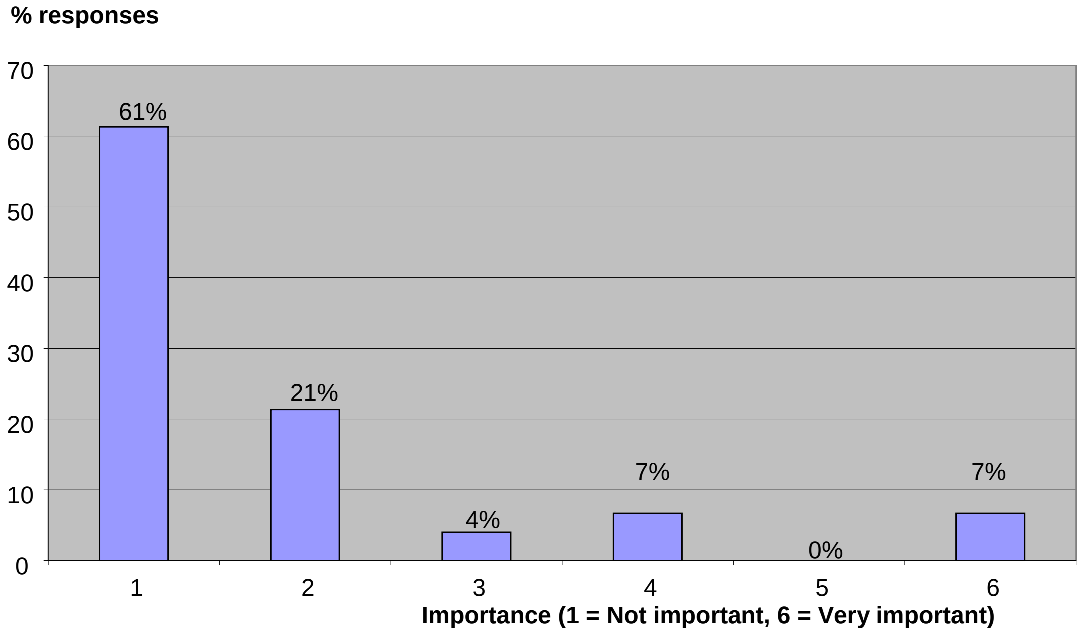
Figure 7 Importance of social stigma as a motivation to control BJD



3.5.3.3 Death rate

As would be expected with a disease that normally causes very few losses, death rate was not a major motivating factor in controlling BJD for most of the survey participants. Only 7% of respondents thought that it was of major importance, with 11% indicating that it was of minor importance and 82% rating this as unimportant (Figure 8).

Figure 8 Importance of death rate as a motivation to control BJD



3.5.3.4 Access to financial assistance

These results are summarised in Figure 9. They indicate a bimodal response, with 48% of respondents rating access to financial assistance to help control the disease as not important, but 41% rating it as very important. This distribution may possibly reflect whether or not producers have accessed financial assistance, but this was not assessed in the study.

Figure 9 Importance of access to financial assistance as a motivation to control BJD

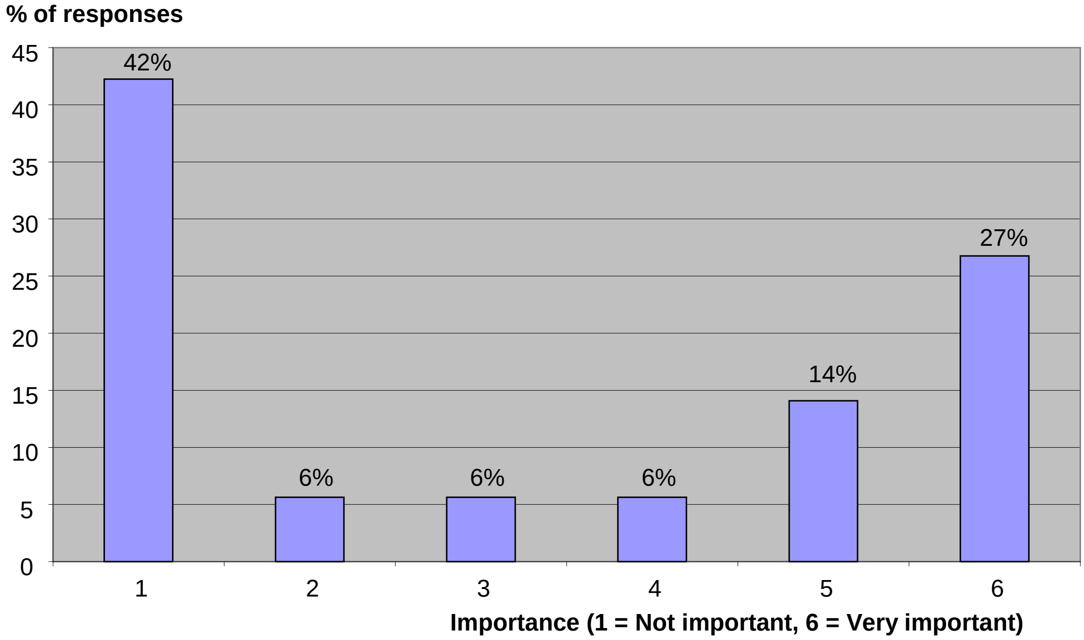
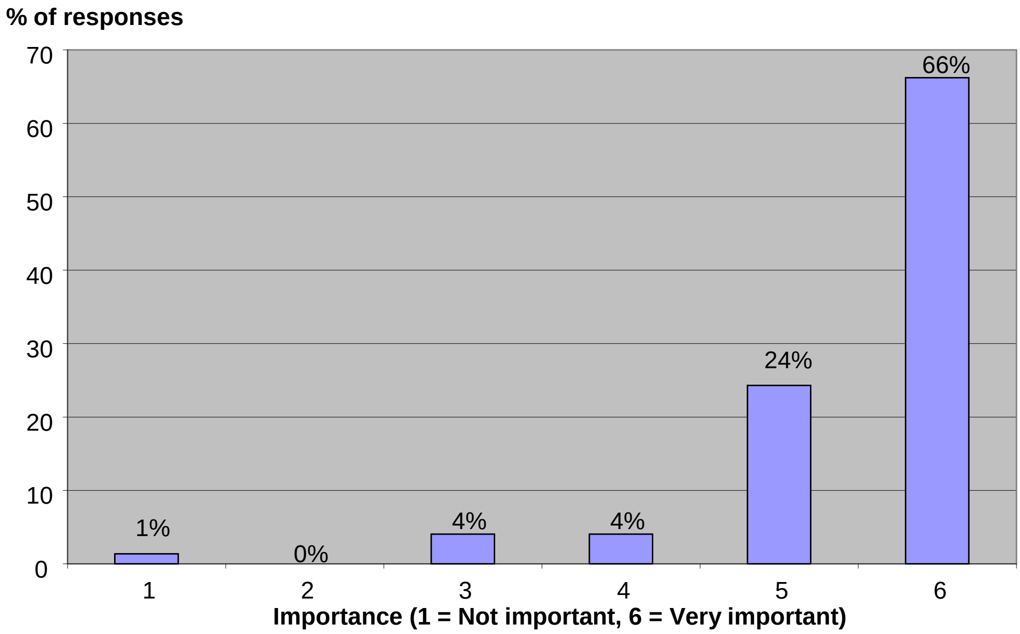


Figure 10 Importance of a good chance of success as a motivation to control BJD



3.5.3.5 Chance of success

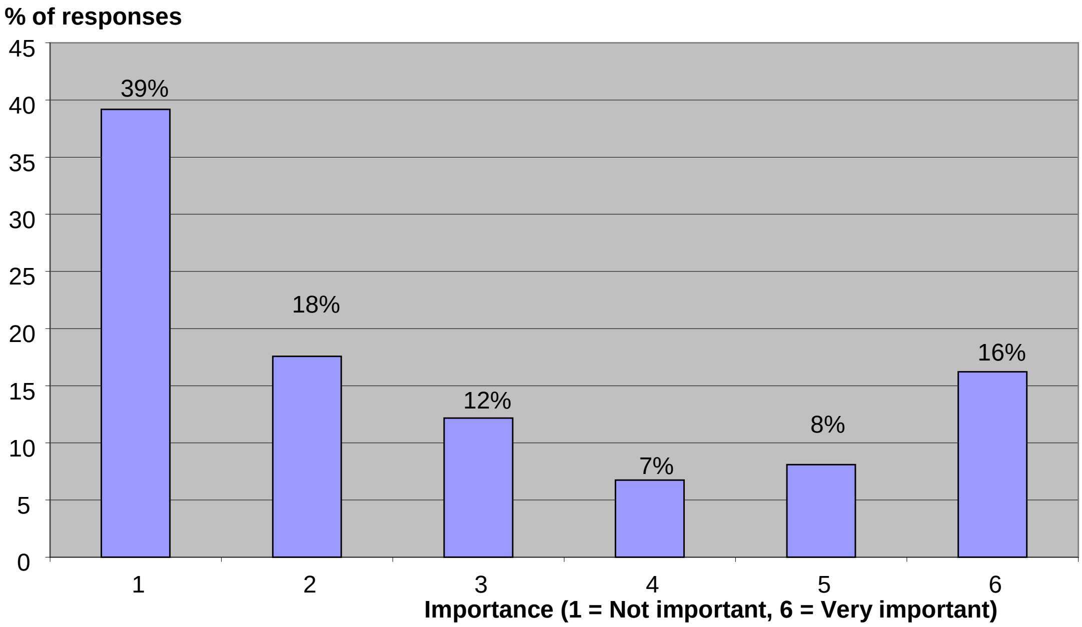
It would seem logical that most people would be unlikely to enter a program if there was a poor chance of success. Accordingly, over 90% of respondents said that a good chance of success was very important, with only 1% suggesting that this was not important to them (Figure 10.).

3.5.3.6 The effect on quality of farm products

Any negative effect that BJD may have on product quality was of lesser importance, with more than half of the respondents (57%) rating this as not important when deciding whether to eradicate the disease (Figure 11). However, 24% thought it was important and 19% thought it was of minor importance.

Not surprisingly, of the 11 producers who indicated that stud breeding was an important enterprise, 5 (45%) rated the quality aspects of products that they sell as being very important for controlling BJD, whereas 3 of 11 (27%) rated it as not important. Thus, quality aspects are of greater importance if stud breeding is an important enterprise, but otherwise this is generally considered unimportant.

Figure 11 Importance of the effect of BJD on product quality as a motivation to control the disease



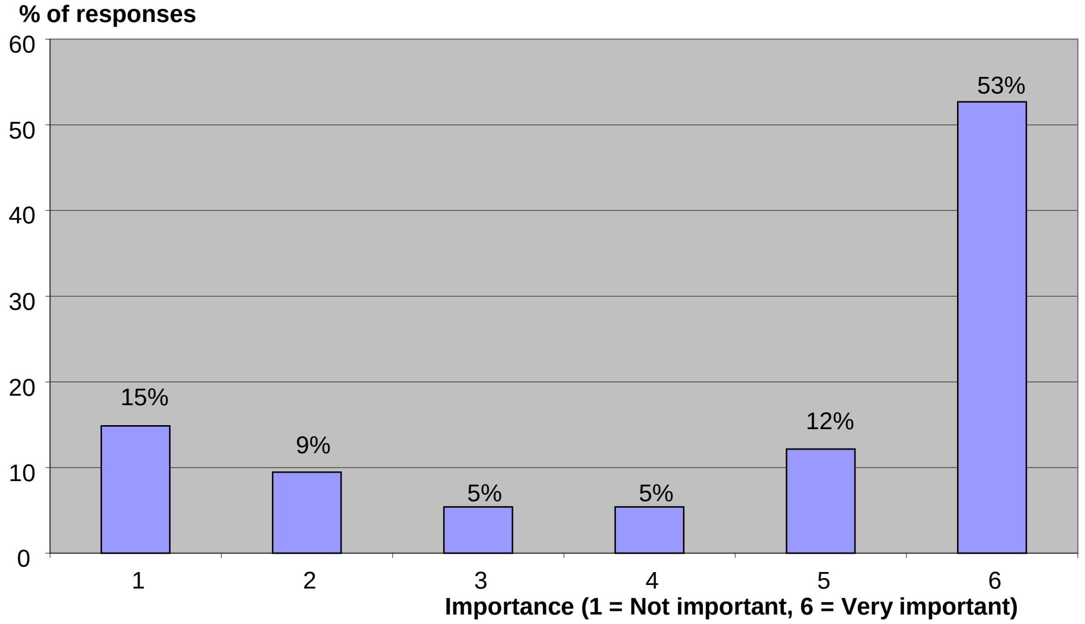
3.5.3.7 Financial advantage of eradicating

The majority (65%) of farmers thought that the financial advantage of eradicating BJD was very important, with only 24% rating this as not important (Figure 12).

It is unclear from the survey whether BJD was actually of minor importance for those who responded this way. This response may have been because they did not believe that it was important or, alternatively, they may have thought that there was no financial advantage to eradicating BJD. The latter may be the case in many circumstances for non-stud producers.

Both stud breeders and respondents for whom vealer production was a significant enterprise thought that financial advantage of eradication was important, in similar proportions to both the overall sample population and those to whom stud or vealer production was of no importance.

Figure 12 Importance of the financial advantage of eradicating BJD as a motivation to control the disease



Respondents were given the opportunity to specify any other reasons for their decision to eradicate BJD. Responses included an inability to show cattle and effects on cattle feedlot and store markets, which is similar to the ability to sell cattle without restrictions.

One respondent said he *"had no choice in the matter, had to clean out and that was that"*, whilst one respondent said that *"stress on the family and friends was of major importance in deciding to control the disease"*.

3.5.4 Reasons for not undertaking eradication or control programs

Six of 7 survey participants who indicated that they did not attempt control of BJD responded to questions relating to their motivation for doing this (Figure 13). Because of these low numbers, these results should be interpreted with some caution. However, the major drivers appear to be that there was no obvious financial advantage to control or eradicate (mean score = 5.0), they philosophically disagreed with the current programs (4.7), or thought eradication was too difficult (4.5).

Of those who thought that there was no economic advantage to eradication or control, 3 of 4 respondents were vealer producers, showing that this was a major driver. This is not surprising, as vealer production is not affected to the same degree as other beef production systems are by the current restrictions on trade.

The average age of the 4 respondents who thought that it was not worth undertaking control or eradication due to their age was 66 (50, 55, 77 & 81), compared to the average for all respondents of 60.4 (n=79). Two respondents, who thought that their age was not important, were aged 57 and 80.

Figure 13 Reasons for not undertaking eradication or control of BJD (n=6)

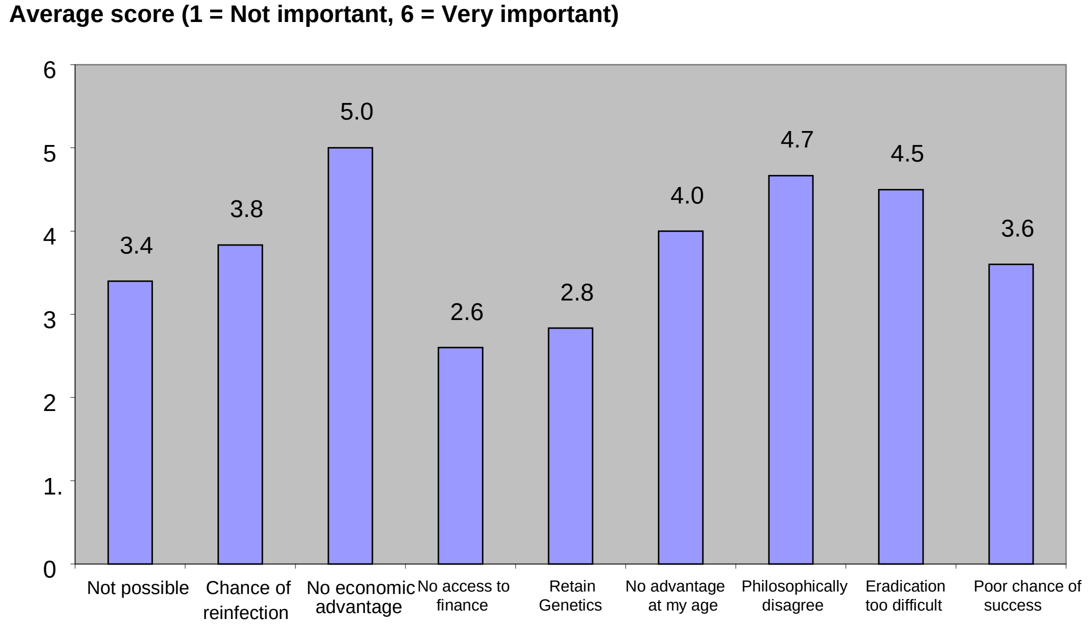
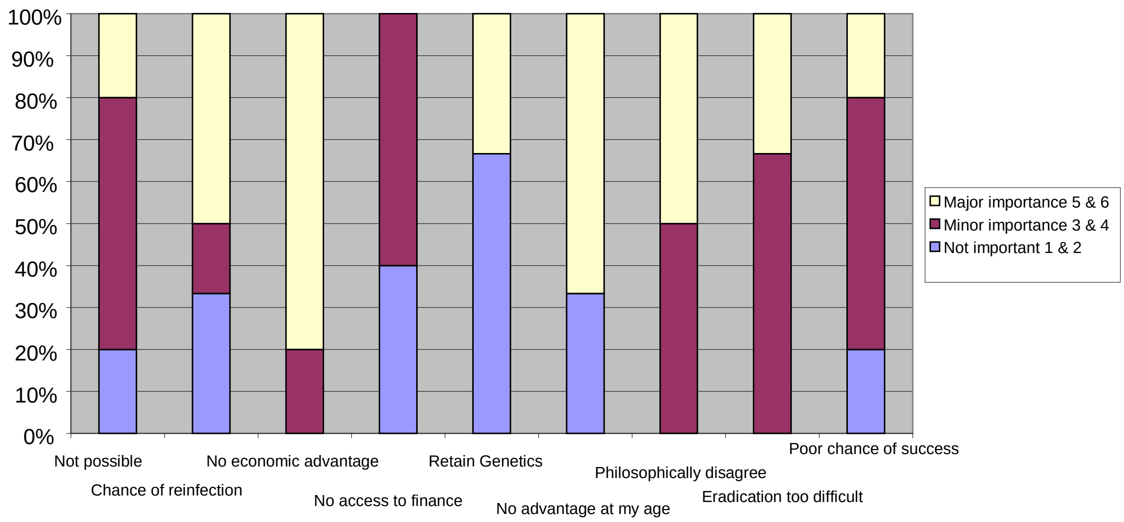


Figure 14 Reasons for not undertaking eradication or control of BJD - proportion of responses for each score



All 6 respondents appeared to have some philosophical disagreement with State Government sponsored control programs, but half rated BJD as of minor importance whereas half rated it as very important.

All 6 respondents also thought that control and eradication was too difficult, with 4 stating that it was of minor importance and 2 stating that it was of major importance.

Although the chance of reinfection averaged only 3.8, and was rated as of minor importance, 50% said that it was of major importance, 1 rated it as of minor importance and 2 rated it as of no importance.

Retaining genetics was rated as not important to 4 of the 6 respondents, but 2 rated it as of major importance.

3.6 Evidence of clustering by age and familial lines

Survey respondents were asked to provide information on year of birth and familial relationships where there had been 3 or more confirmed cases and they had reliable records.

This resulted in the reporting of an additional 141 cases from 16 herds. Seventy four cases had been confirmed by faecal culture, histology or tissue culture. Of these confirmed cases, 67 were home bred with 36 having a nominated year of birth.

The data was analysed to test if the number of herds with cases born in a given year was uniformly distributed over the birth years 1981-2001. However, it could not be demonstrated that the data did not come from either a uniform or a Poisson distribution (P=0.27 and 0.55, respectively, likelihood ratio test).

In conclusion, there was no evidence of clustering by year in the home bred cases. Although we were unable to demonstrate that clustering by year occurred in these herds, it is important to remember that this data set was limited. In addition, any data of this nature will be censored to some degree by the limited sensitivity of the diagnostic tests applied, the culling of high risk animals, the inability to follow up all animals and the limited expression of BJD in beef herds.

There was insufficient data submitted to allow an analysis of cases by their family lines.

3.7 Association between farm characteristics & establishment of BJD

One of the aims of the project was to establish whether there were factors associated with the disease becoming established within a herd. For this purpose, herds which had a homebred case were compared with herds which only had cases in imported animals.

This is not an ideal comparison because of the nature of the disease, especially factors that affect early expression of BJD. Thus, factors promoting the identification of imported animals may also be the same ones that enable the disease to become established within a herd. The other difficulty with this comparison is that the disease does not progress in an uncontrolled manner in herds where the index case is an imported animal. In these cases there will always be some form of disease control directed at preventing the transmission of BJD to resident animals.

A univariable analysis was performed with Stata using either the Fisher's exact, Mann-Whitney or Kruskal-Wallis tests, or a one way analysis of variance.

The only factor which was significant in this analysis (P=0.05) was the number of cow breeds on the farm, where farms with 2 or more main breeds were more likely to have only an imported animal infected. This is very likely to be a proxy for the number of animals traded, which increases the chance of importing the disease. Thus, it is unlikely that having more than one breed of cow is protective for the establishment of BJD infection within a herd.

Herd factors were also analysed in reference to the ELISA reactor rate, but no factors were significant (all $P > 0.05$).

4 Evaluation of cost effectiveness of different control programs for BJD

4.1 Background to financial analysis

The financial impact of the main options used for the control and eradication of BJD were compared with a steady state beef herd infected with BJD. To evaluate these options, a spreadsheet model of a beef herd was established using average income and expenses. These were based on the 2005-2006 ABARE survey of beef producers and Victorian Farm Monitor Project, Mackinnon Project farm analysis data, and Holmes Sackett and Associates (HAS) AgInsights 2006.

The model beef herd was based on a representative self-replacing beef herd in southern Australia. Production and physical performance will obviously vary between regions, although the general outcomes of the analysis will be similar.

A spreadsheet simulation model was developed, with a specialist beef enterprise as the main enterprise. Scenarios were undertaken for both commercial and seed-stock producers. For each run the model calculated the monthly cash flow for a period of 10 years with four main options evaluated:

- Base run with no action ('living with BJD')
- Test and cull
- Partial De-stocking
- Total De-stocking

In addition, the net present value (NPV) of annual cash flow was calculated, assuming 100% equity over 10 years.

4.1.1 Assumptions

4.1.1.1 Physical property

The farm was based on a specialist beef enterprise of about 511 ha with an average stocking rate of 10.8 dse/ha (ABARE's southern Victoria and Gippsland farm survey, 2005-2006; www.abareconomics.com). The primary enterprise was a beef breeding herd producing 400 kg steers for sale at 15 months of age.

In addition to the primary beef breeding enterprise, the impact of BJD was also analysed with a stud enterprise and a vealer herd.

In this analysis no cropping was conducted and 97% of farm area was allocated to cattle. The remaining area was used for a small sheep enterprise, consistent with the average ABARE specialist southern beef farm. The base herd is a British breed with the herd structure of the property outlined below:

Table 15 Herd structure in base commercial beef herd

	Mature cows	First calf heifers	Yearling steer	Yearling heifers	Bulls
Number	200	72	122	122	9
Average dse/hd	13	13	7	7	15
Annual sales in steady state herd	56	11	120	48	3

The base mortality rate was assumed to be 2% across the herd. The calf marking percentage was assumed to be 85% for first calf heifers and 92% for mature cows, about the industry average. The average stocking rate was about 10.8 dse/ha and it was assumed that this remained constant over all years for all runs. About 5,520 dse were run, comprising 5,390 dse of cattle and 130 dse of sheep.

4.1.1.2 Cost structure

The costs in the model were based on ABARE performance or, when data was not available, the Victorian South West Farm Monitor group, Mackinnon Project farm analysis data or Holmes Sackett and Associates AgInsights 2006. The cost structure is listed in Table 16.

Table 16 Cost structure of base commercial herd

Item	$/dse	$/ha	total
Variable costs cattle (include animal health, freight, sundry, selling costs)	$3.76	$40.60	$20,230
Fertiliser	$2.36	$25.44	$13,000
Other pastures costs sprays etc	$0.53	$5.68	$2,900
Feed and hay costs	$1.81	$29.57	$10,000
Casual labour	$0.24	$2.54	$1,300
Overheads	$5.98	$64.58	$33,000
Family labour costs	$7.97	$86.11	$44,000
Capital expenditure	$2.17	$23.48	$12,000
Interest	$2.28	$24.62	$12,580
Sheep variable costs	$10.00	$2.54	$1,300

4.1.1.3 Income

The base income generated was based on the $/head values shown in Table 17. Based on these values, the average sale price was $1.45/kg for all stock, including cull for age (CFA) cows. This is the 9 year average price listed in HAS AgInsights, with premiums and discounts based on age and sex,

Table 17 Average sale price $/head in base commercial herd

Class of animal	$/head sale value
Cows	$640
First calvers	$560
Yearling heifers	$550
Yearling steers	$650
Bulls	$1,400

The likely impact of BJD on cattle prices is highly variable and dependent to some extent on the producers original target markets. For example, a producer who targets the store markets, particularly for breeder cattle, may be highly exposed to the impact of BJD restrictions. In contrast, a producer who sells all cattle over the hooks or to feedlots will have virtually no penalties from BJD on the sale price of surplus cattle. Thus, the impact of BJD is quite variable on a farm by farm basis. For this reason, rather than second guess the impact of BJD on individual prices of sale cattle, a sensitivity analysis of different prices was conducted.

With the base scenario, the farm business cash flow was -$3,300. This did not include off farm income that was about $37,000/annum for the average farm recorded by ABARE in southern Victoria.

All costs and income were indexed at 2.8% per annum over the 10 year analysis.

4.1.1.4 Capital structure

The values for the capital structure of a commercial herd, shown in Table 18, were based on ABARE's average southern Victorian specialist beef farm in 2005-2006.

Table 18 Capital structure of base commercial herd

Current assets		
Stock		
Cattle	$369,493	
Sheep	$5,200	
Hay	$5,000	
Farm Management Deposits and liquid assets	$61,000	
Total current assets		$440,693
Non-current assets		
Plant (clearing sale value)	$91,000	
Land	$2,665,000	
Total non-current assets		$2,756,000
Total Assets		**$3,196,693**
Liabilities		
Farm loan	$148,000	
Total		$148,000
Total Liabilities		**$148,000**
Net Worth		**$3,048,693**
Equity		**95.4%**

4.1.1.5 Sensitivity analysis

Cash flow, including interest costs but before tax, and the net present value of annual cash flow (assuming full equity) were analysed over a period of 10 years.

Note that the base scenario could be a normal herd or an infected herd, with no price discount. The strategies modelled and compared with the base scenario were:

- *Scenario 2* - Base scenario with net cattle prices 10% higher (infected herd with no control cost, but receiving 10% discount for cattle price).
- *Scenario 3* - Base scenario with net cattle prices 10% lower.
- *Scenario 4* - Test and cull with base cattle prices. In this case all adult cattle were tested for BJD on an annual basis, at a cost of $11/head, and sero-positive animals were culled. Given that cull rates were low, based on the responses to the survey, no alteration to herd structure was required.
- *Scenario 5* - Test and cull with 10% lower cattle prices.
- *Scenario 6* - Test and cull with 20% lower cattle prices.
- *Scenario 7* - Partial de-stocking with base cattle prices. In this scenario three age groups of females were sold, with all age groups assumed to have been in contact with the recently introduced index case of BJD. This included all yearling cattle, 2 year old heifers and calves. To maintain stock numbers, trade cattle were purchased in years 1-3. Replacement cows were purchased in year 3 to enable stock numbers to return to their original structure.
- *Scenario 8* - Partial de-stocking, with sale prices 10% lower than base until BJD eradicated in year 5, then reverting to equivalent base scenario price.

The purchase plan to retain stock numbers after partial de-stocking for scenarios 7 and 8 is outlined in Table 19. Trade steers were purchased at $600 and replacement pregnant cows for $800 (year 1 price), both adjusted according to the Consumer Price Index (CPI) in each year.

The genetic base of purchased cows, especially their growth and fertility, was assumed to be similar to the cows sold. In reality, this may not be the case and the productivity of the partial replacement herd may be inferior. Cost of testing all cattle over 2 years of age for BJD were included in years 1, 3 & 5.

Table 19 Stock purchase plan required to maintain stock numbers after partial de-stocking (scenarios 7 & 8)

	Year 1	Year 2	Year 3
Cows			120
Trade steers	210	340	120

- *Scenario 9* - Total de-stocking with base sale price of stock. In this case all cattle were sold except weaned calves, which were sold in year 2. To maintain stock numbers, trade cattle were purchased in year 1 and complete herd replacements were purchased in year 2, enabling stock numbers to return to the original structure by year 3.

The purchase plan to retain stock numbers after total de-stocking in scenario 9 is summarised in Table 20. Trade steers were purchased at $600 and replacement pregnant cows for $800 (year 1 price), both adjusted by CPI each year. Two year old pregnant cows were purchased for $700 and replacement heifers for $550.

The genetic base of purchased cows, especially their growth and fertility, was assumed to be similar to the cows being sold. Again, in practice this may not be the case and the productivity of the partial replacement herd may be inferior.

Testing costs for BJD of all cattle over 2 years of age were included in year 1.

Table 20 Stock purchase plan required to maintain stock numbers after total de-stocking (scenario 9)

	Year 1	Year 2
Cows		200
2 year old cows		70
15 mo heifer		120
Trade steers	440	120
Bulls		9

- *Scenario 10* - Total de-stocking with sale prices 10% lower than base until BJD was eradicated in year 3, then reverting to equivalent base scenario price.
- *Scenario 11* – The same as for scenario 10 but, in addition, replacement stock price was assumed to be 10% higher after the de-stocking program was completed.
- *Scenario 12* - Base scenario with base stock price, except a 5% death rate due to BJD, in addition to background death rate of 2%. No action taken to eradicate BJD.
- *Scenario 13* - Base scenario 10% lower sale price for stock and 1% death rate due to BJD, in addition to the background death rate of 2%. No action taken to eradicate BJD.

Taxation implications and subsidies to assist with the control and eradication of BJD were not considered for any of the scenarios.

4.1.2 Seed stock (stud) scenario

The cost and income assumptions for the analysis of the impact of BJD within a stud herd are shown below.

4.1.2.1 Cost assumptions for seed stock

The marginal costs of operating the stud operation were estimated at $1,500/ bull sold. This included all additional feeding, recording, direct stud expenses and marketing costs.

These costs were based on discussion with several seed stock producers, although there were a wide range of stud costs, ranging from less than $1,000 to over $2,000/ bull sold. Other costs were assumed to be similar to commercial herds.

Stud costs were reduced by 50% during partial de-stocking as bulls and surplus females were unlikely to be of high value during this period.

4.1.2.2 Income assumptions for seed stock

Seed stock producers not only receive income from bulls but also benefit from the sale of breeding stock at higher prices. Sale values for surplus females were assumed to be between 45-85% above similar commercial values. The sale price assumptions for the herd are listed in Table 21 below.

Table 21 Average sale price in the base seed stock herd ($/head)

	number	$/head
Cows	56	$1200
First calf heifers	11	$1100
Heifer weaners	48	$800
Steers	60	$650
Young bulls	60	$3000

In the stud herd, 50% of bulls were sold as sires, the remaining male calves castrated and sold as commercial steers. The value of semen sales or embryos has not been included in this analysis, although this is an important income stream in some studs. However, when the stud was infected with BJD, the value of all stock reverted to commercial values.

With the partial and total de-stocking scenarios, the stock sales and purchase strategies were similar to the base scenarios, except bulls were only bred from the cow herd. The value of replacement stud stock will be extremely variable, but in this analysis it was assumed that they have a value 50% above the standard sale values listed above.

It was also assumed that replacement seed stock had similar genetic merit to stock sold due to BJD. As for the commercial herds, this may be difficult to achieve, especially where whole herd replacement is required. Another option, to replace the herd but maintaining existing genetic merit, would be to use embryo transfer. The cost of such a program is likely to be very high, but has been undertaken in similar circumstances.

After BJD was eradicated, the sale value for seed stock reverted to uninfected herd values after year 5 with partial de-stocking (once clearance is gained with testing), and year 4 with total de-stocking.

There are significant downside risks after restocking, as a stud may lose a significant number of clients due to the stigma of BJD infection. It may also take considerably more time to build the sale value of bulls up to their original value.

4.2 Results and discussion - Commercial producers

Table 22 and Figure 15 show the projected cumulative cash flow with different scenarios over 10 years, while the scenarios tested are summarised in Table 23.

Table 22 Cumulative cash flow with different scenarios over 10 years

	year 0	year 1	year 2	year 3	year 4	year 5
Scenario 1	$ (10,023)	$ (4,615)	$ (8,385)	$ (11,298)	$ (13,981)	$ (16,410)
Scenario 2	$ (10,023)	$ (20,468)	$ (41,819)	$ (64,434)	$ (89,036)	$ (115,794)
Scenario 3	$ (10,023)	$ 11,134	$ 24,467	$ 39,965	$ 56,766	$ 74,899
Scenario 4	$ (10,309)	$ (7,867)	$ (15,182)	$ (21,972)	$ (28,903)	$ (36,032)
Scenario 5	$ (10,309)	$ (23,744)	$ (48,781)	$ (75,492)	$ (104,635)	$ (136,423)
Scenario 6	$ (10,309)	$ (39,741)	$ (82,827)	$ (129,677)	$ (181,168)	$ (237,714)
Scenario 7	$ (10,309)	$ (44,253)	$ (83,885)	$ (114,435)	$ (115,315)	$ (132,855)
Scenario 8	$ (10,309)	$ (68,663)	$ (126,848)	$ (167,349)	$ (180,776)	$ (203,926)
Scenario 9	$ (10,309)	$ (76,064)	$ (108,876)	$ (123,614)	$ (137,878)	$ (152,234)
Scenario 10	$ (10,309)	$ (111,486)	$ (160,989)	$ (180,192)	$ (199,305)	$ (218,925)
Scenario 11	$ (10,309)	$ (111,486)	$ (198,495)	$ (220,913)	$ (243,515)	$ (266,923)
Scenario 12	$ (10,023)	$ (13,180)	$ (27,936)	$ (45,035)	$ (65,051)	$ (86,750)
Scenario 13	$ (10,023)	$ (21,756)	$ (45,688)	$ (72,432)	$ (101,622)	$ (133,471)

	year 6	year 7	year 8	year 9	year 10
Scenario 1	$ (18,626)	$ (20,657)	$ (22,481)	$ (24,076)	$ (25,419)
Scenario 2	$ (144,896)	$ (176,544)	$ (210,957)	$ (248,374)	$ (289,145)
Scenario 3	$ 94,242	$ 114,841	$ 136,745	$ 160,007	$ 184,680
Scenario 4	$ (43,384)	$ (51,107)	$ (59,240)	$ (67,812)	$ (76,854)
Scenario 5	$ (171,087)	$ (208,877)	$ (250,065)	$ (294,948)	$ (343,853)
Scenario 6	$ (299,766)	$ (367,816)	$ (442,396)	$ (524,085)	$ (613,512)
Scenario 7	$ (145,638)	$ (158,905)	$ (173,103)	$ (188,031)	$ (204,022)
Scenario 8	$ (222,799)	$ (242,678)	$ (264,055)	$ (286,777)	$ (311,229)
Scenario 9	$ (166,688)	$ (181,256)	$ (196,793)	$ (213,296)	$ (230,835)
Scenario 10	$ (239,094)	$ (259,866)	$ (282,140)	$ (305,956)	$ (331,436)
Scenario 11	$ (291,206)	$ (316,443)	$ (343,566)	$ (372,645)	$ (403,840)
Scenario 12	$ (110,275)	$ (135,782)	$ (163,440)	$ (193,431)	$ (225,956)
Scenario 13	$ (168,213)	$ (206,100)	$ (247,405)	$ (292,427)	$ (341,488)

Figure 15 Cumulative cash flow with different scenarios over 10 years

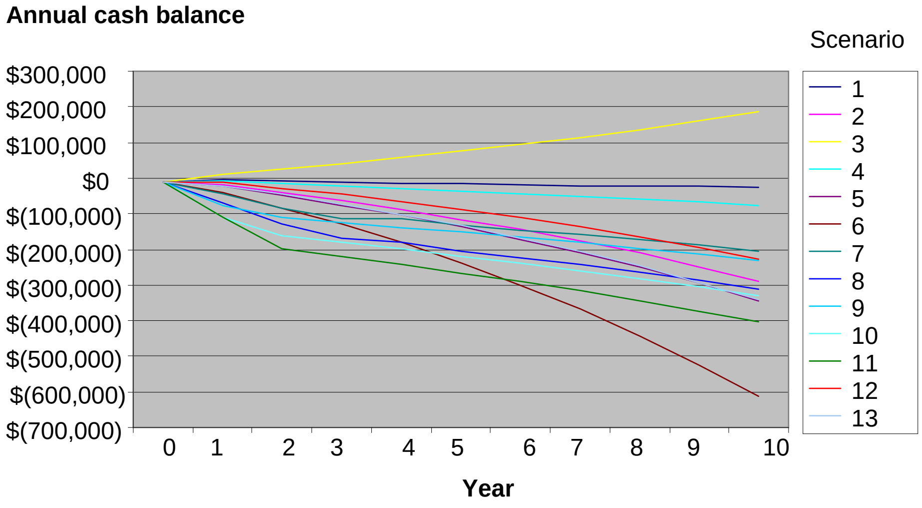


Table 23 Summary of scenarios tested

Scenario	Description
1	Base herd
2	Base with sale price 10% lower
3	Base with sale prices 10% higher
4	Test and cull base sale prices
5	Test and cull sale prices 10% lower
6	Test and cull sale prices 20% lower
7	Partial de-stocking base sale prices
8	Partial de-stocking sale prices 10% lower
9	Total de-stocking base sale prices
10	Total de-stocking sale prices 10% lower
11	Total de-stocking sale prices 10% lower purchase prices 10% higher
12	5% mortality rate due to BJD base sale prices
13	1% mortality rate due to BJD sale prices 10% lower

The analysis of long term cash flow shows all strategies were worse off compared with the base herd, either BJD free, or infected with no discount on sale prices.

The scenarios are very sensitive to the sale prices received. Quantifying the impact of BJD between herds is very difficult, as all herds have different marketing strategies depending on their production systems, target markets and specifications of cattle produced. However, the impact of BJD on a beef herd will be greater where the producer targets store sales for surplus stock. With trading restrictions, opportunities to target the market will be negligible. Thus, the impact of BJD will be far greater for producers who achieve large premiums for their breeder cattle.

The impact of BJD on the price of cattle in herds that produce finished or feedlot cattle should be negligible, although flexibility of their marketing options could be greatly reduced, especially for producers who traditionally sell finished stock through saleyards.

This analysis did not attempt to evaluate the likely drop in value of sale stock, but rather analysed the impact of selling cattle for a set price or discount compared with the standard herd.

Compared with the base herd, three broad options have been analysed; test and cull, partial de-stocking with testing to retain NA status, and total de-stocking. The outcome of each option will depend on the time taken to eradicate BJD or remove restrictions on trade.

In this analysis, it was assumed that eradication was not achieved with the test and cull strategy, as this was the case with most producers who adopted this strategy in the survey. The time taken to eradicate BJD was 5 years with partial de-stocking, or 3 years with total de-stocking. Trading discounts were removed after these times.

The cost of de-stocking is dependent on three important factors:

- The sale price of de-stocked cattle
- The profitability of the intermediate enterprise
- The cost of stock to restock after the 12 month decontamination period has ended.

For the analysis, a short term cattle trading enterprise was used as the intermediate enterprise. This is the most likely enterprise that will be adopted by specialist cattle producers in this situation, whereas mixed farming enterprises are likely to have more flexibility, such as expanding their sheep or cropping enterprises. However, cropping for one year is unlikely to be profitable, given that pastures will need to be re-sown after the cropping phase.

The cost and impact of partial de-stocking will depend on the number of animals that need to be sold to eradicate BJD. In this analysis, the three youngest age groups were sold, although this will vary enormously between farms, depending on the time infected cattle were on the farm and the potential exposure of resident cattle to them.

With the options analysed, compared to the base herd where no cost of BJD control was expended, all options had a significant impact on long term cash flow. The initial impact was greatest with full de-stocking, but once BJD was eradicated cash flow was improved, relative to the scenario of test and culling where BJD is not eradicated, and by year 10 the difference in net position was not great. However, the impact of larger discounts in stock price (scenario 6), or where replacement cattle cost 10% more (scenario 11), was particularly severe.

The difference between partial and total de-stocking by year 10 was not great, even though in year 2 the total de-stock scenarios were worse. The total de-stocking scenarios improved after this, as no further discount in stock price was assumed to occur.

An interesting observation is that scenario 5 (test and cull with 10% stock sale discount) was worse off by year 10 compared to the partial and total de-stock scenarios with 10% discount in stock prices, even though it was better initially. This is because the test and cull strategy assumes that BJD is not eradicated, and so discounts in stock prices remain for the whole ten year period.

The impact of mortalities must be severe before the cash flow becomes worse than the de-stocking scenarios. For example, in scenario 12 (5% death rate attributed to BJD, but no discount for stock sales), the 10 year cash flow is similar to the scenario with de-stocking with no stock discount. Likewise, scenario 13 (1% death rate attributed to BJD, with an ongoing 10% discount for stock price) has a similar cash flow by year 10 to the de-stocking scenarios, which have a 10% discount for stock prices. In other words, death rates must be extremely high to justify the eradication of BJD on direct losses alone.

The monthly cash flow of options with a 10% discount on stock prices are shown in Figure 16. To fully compare each of these scenarios, their net present value, assuming a discount rate of 8.5%, is shown in Table 24.

From the analysis of cash flow, it is apparent that the de-stocking strategies have major implications for cash flow. If de-stocking strategies are to be adopted it is important to consider their effects on cash flow, and these must be budgeted for accordingly. In addition, for the scenarios analysed it was assumed that when cattle were de-stocked, the intermediate enterprise was acted on immediately. However, in reality, this is often not the case. If a producer does not restock immediately, then income and cash flow will be even lower in the short term, and this will have serious flow on effects for the following year(s).

It is interesting to note that the difference between scenarios 5, 8 and 10, for which the major effect of BJD were 10% lower stock prices, was not great. However, in the scenario where BJD was not eradicated, continuing losses through decreased value of sale stock would result in this option being the worst in the longer term.

The NPV of scenario 13, which assumed a 1% death rate due to BJD with no other control costs, plus the 10% discount in sale price, is similar to those modelled by scenarios 5, 8 &10.

Figure 16 Monthly cash flow of options with a 10% discount on stock prices

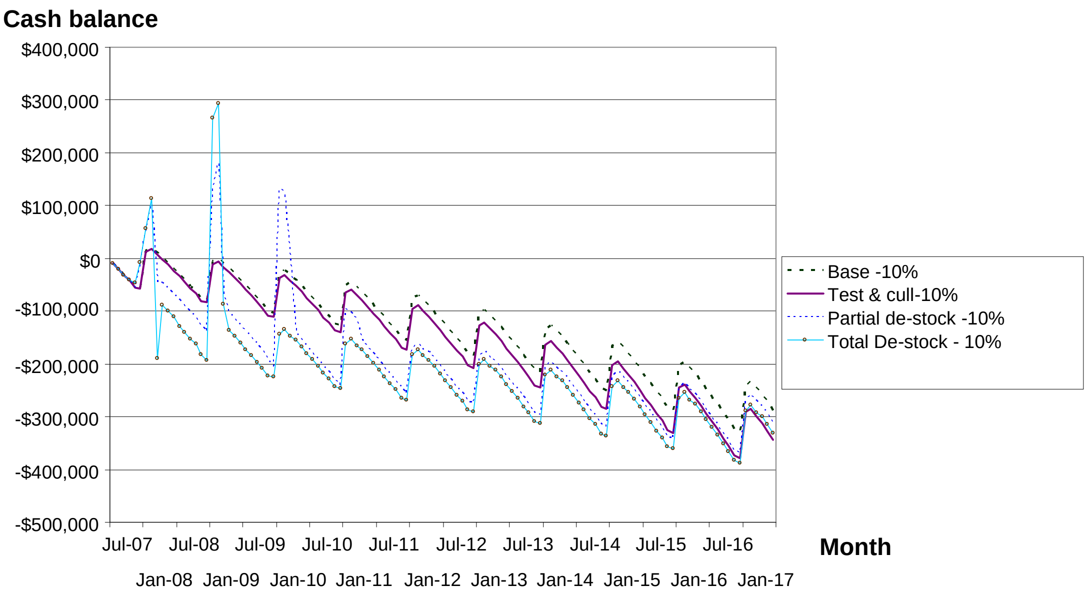


Table 24 Net present value (NPV) of commercial herd scenarios over 10 years

Scenario	Description	NPV after 10years
1	Base	$78,280
2	Base with sale prices 10% lower	-$35,769
3	Base with sale prices 10% higher	$191,465
4	Test cull – base	$55,345
5	Test cull - 10% lower sale prices	-$58,863
6	Test cull - 20%	-$173,602
7	partial de-stock – base	-$3,396
8	partial de-stock -10% lower sale prices	-$49,877
9	Total De-stock-base	-$12,791
10	Total De-stock-base with 10% lower sale prices	-$56,137
11	Total De-stock-base +/ - 10% lower sale prices & 10% higher purchase prices	-$87,111
12	5% death rate base stock price	-$9,384
13	1% death rate -10% lower stock price	-$58,251

If no discount on sale price occurs, as will be the case where herds sell finished stock or stock to feedlots, BJD must cause a 5% death rate for the NPV to be similar to the de-stocking options (scenario 7 & 12). This is not likely to occur in normal commercial farming situations. However, if BJD does not cause any discount on stock prices and mortality rates are very low, all scenarios will be worse off than doing nothing and living with BJD.

4.2.1 Risks with each strategy

There are significant risks associated with each of the strategies modelled.

First, there is the risk that de-stocking will fail to eradicate BJD. This is highly likely for specialist vealer producing herds, where replacement breeders are often purchased with a dairy herd background (eg. Friesian-cross cows). With partial de-stocking, infected cattle may be overlooked during the de-stocking program. As an example, for sheep flocks infected with Ovine Johne's disease (OJD), re-infection through purchase of infected sheep is a major cause of failed eradication attempts. To date, this risk has not been investigated in beef herds that have undergone eradication programs by de-stocking.

Major financial risks are associated with de-stocking strategies. In particular, the price received when stock are sold may be low, and the cost of replacement stock may be considerably higher than expected, thus increasing debt levels. In addition, if the land is not fully utilised during the period of decontamination, or if the intermediate enterprise is less profitable than the original, farm income will decrease. It has been assumed that the land is fully utilised in the scenarios evaluated.

BJD is unlikely to be a major problem for trading herds, given that young stock are usually traded and turnover is very high.

The low death rates caused by BJD in beef herds, as demonstrated by the survey, will have virtually no impact on financial performance. Rather, the major financial penalties associated with BJD are due to loss of earnings from sale stock. Annual death rates would need to reach 5% in herds that have no loss of sale price due to BJD to incur similar losses to de-stocking strategies, a most unlikely scenario.

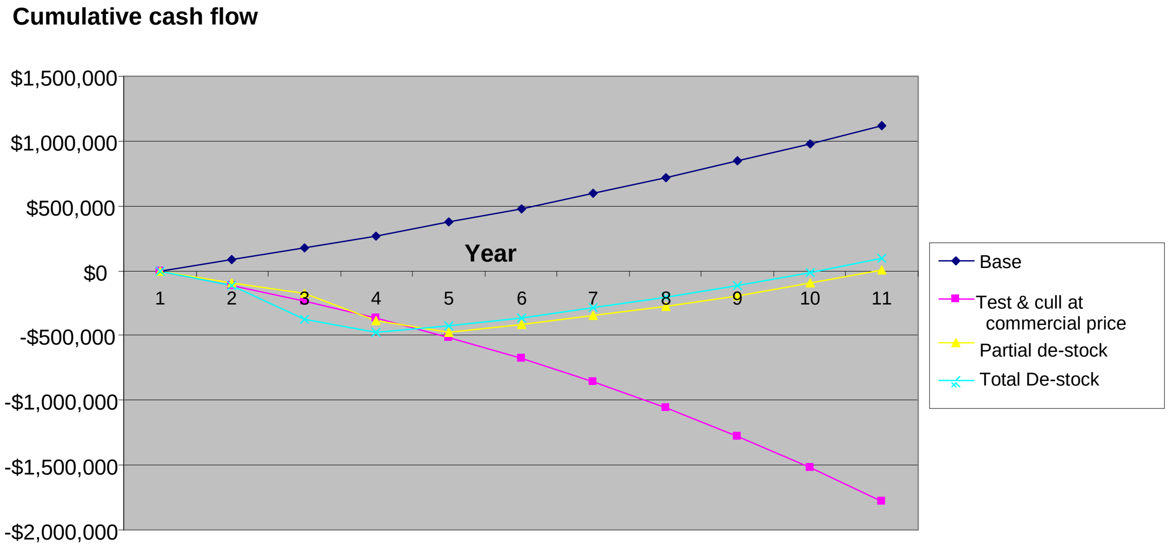
4.3 Results and discussion - Seed stock (stud) herds

Clearly, due to trading restrictions, living with BJD in a stud herd is not an option. In contrast to commercial herds, where the impact of BJD is variable, depending on the discount on sale stock, time of trading restrictions and the strategy adopted to eradicate BJD, the impact of BJD on stud herds is devastating. This occurs because of both a massive loss of income and loss of value of the herd. In addition, there is a major cost of restocking for stud herds.

The cumulative annual cash flow for the stud herd over a 10 year period with different options is shown in Figure 17. The test and cull scenario is clearly not sustainable, on the assumption the BJD is not eradicated, because this means that stud sales cannot recommence.

There is a major impact on cash flow and profitability from both partial and total de-stocking. In addition, the modelling undertaken represents a best case scenario. This is because the assumed replacement costs for the stud stock are reasonably conservative and, once BJD is eradicated, sale prices and volumes are assumed to revert back to pre BJD prices.

Figure 17 Cumulative cash flow with different scenarios over 10 years



As expected, the net present value of the BJD options analysed in the stud herd was financially devastating, further demonstrated by the summary of net present values over a 10 year period shown in Table 25. Without massive financial assistance, BJD infection in a stud herd will result in an unviable business. This impact is driven entirely by loss of sale income and the cost of restocking, not production losses. In addition, this analysis has not considered any potential negative impact on the value of land if BJD is not eradicated.

Table 25 Net present value of scenarios in stud herd over 10 years

	NPV (10 years)
Base stud herd BJD free	$741,377
Test cull commercial price	-$656,666
Partial de-stock	$99,957
Total de-stock-base	$143,835

5 Success in Achieving Objectives

5.1 Success in Achieving Objectives

This report aimed to study the epidemiology of Bovine Johne's Disease in beef herds, including;

1. To identify likely risk factors for the introduction and establishment of BJD infection.
2. To describe the occurrence of clustering of BJD infection, in either age or family cohorts, and likely risk factors for the establishment of infection.
3. Describe methods used to control and eradicate BJD and the factors that influence the decision to eradicate the disease from a beef herd
4. Identify factors contributing to the success or failure of eradication programs
5. Assess the cost-effectiveness of different programs

The report generally achieved the objectives outlined. The study identified important risk factors for the introduction and establishment of BJD infection in beef herds. Dairy breeds or an association with dairy breeds was the most important risk factor for the introduction of BJD into beef herds. In addition some beef breeds including Murray Grey and Shorthorn breeds were over represented in herds known to be infected with BJD. Bulls tended to be over represented in the initial diagnosis of BJD with the average age 5.7 years (4.3 years for bulls and 6.3 years for cows). Infected herds tended to run higher stocking rates than the industry average. This presumably is associated with the fact that more infected herds are run in higher rainfall regions.

The majority of index cases were identified through veterinary investigations of clinically sick animals. The majority of cases occurred in winter months, particularly from May to July.

Of the imported index cases, 44% of cases were not diagnosed for at least 3 years and 20% for more than 5 years, which has significant consequences for subsequent potential spread within the infected herd

We could not demonstrate that clustering by age occurred, though it is important to remember that this data set was limited. In addition, there was insufficient data submitted to allow an analysis of cases by their family lines.

To identify factors that were associated with the disease becoming established within a herd, herds which had a homebred case were compared with herds which only had cases in imported animals. There are a number of limitations of this comparison which are outlined. The only factor that was significant was number of cow breeds on the farm, where farms with 2 or more main breeds were more likely to have only an imported animal infected. This is very likely to be a proxy for the number of animals traded, which increases the chance of importing the disease.

The methods that are used to control and eradicate BJD from infected herds were identified. There are four strategies including test and cull programs test and cull with removal of high risk animals and partial and total de-stocking.

In general, the control programs that were implemented were successful in progressing infected herds back to the equivalent of a 'non-assessed' (NA) herd status in each state. The exceptions were 'test and cull' programs, which were less successful unless they were combined with the culling of known high risk animals.

However, no state has an ongoing program to assess the success of control and eradication programs currently being implemented in infected herds. This is an obvious deficiency, and so the apparent success of eradication programs within previously infected herds should be investigated in more detail.

The major factors that motivated producers to eradicate BJD were the high probability that the program would be successful, and that this would then lead to the removal of restrictions on the sale of animals and land with subsequent financial benefit. The social stigma of being the owner or manager of an infected herd was of less importance, but was still rated as very important by 51% of respondents. Access to financial assistance was considered less important though still rated highly by 41% of respondents. The possibility of increased mortality rates in infected herds and the potential impact of BJD on the quality of products produced by a beef herd were all rated as unimportant when producers were making a decision about whether to eradicate BJD.

The financial impact of BJD is outlined for both commercial and stud herds in this report. The outcome is highly variable dependent on management strategies and price scenarios. The impact of BJD is more related to value of sale stock rather than production losses. Likewise the cost of de-stocking and restocking is highly dependent on the value of stock sold, intermediate enterprise profitability and cost of restocking. The impact on individual herds is likely to be highly variable and this needs to be quantified on a case-by-case basis, as the losses are highly dependent on existing productivity and sale strategies in each herd. Risks of de-stocking are outlined in the report.

Whilst initially doing nothing in a commercial herd was more attractive from a cash flow perspective, the bigger the discount on sale prices, the more important it was to eradicate BJD (assuming that BJD was effectively eradicated by the chosen program).

In stud herds, BJD will usually result in the total failure of the business. Without massive subsidies, BJD infection in a stud herd will inevitably result in an unviable business.

6 Impact on Meat and Livestock Industry

6.1 Impact on Meat and Livestock Industry

This report has identified a number of important factors about BJD that must be considered by industry. This information should help formulate future industry strategies for the management of BJD in the Australian beef herd.

The most important risk factor for introduction of infection appeared to be an association with dairy breeds. The association with dairy cattle is already considered as part of state trading regulations. However, an important implication of exposure of beef cattle to dairy cattle will be the ongoing risk of introducing infection whilst the prevalence of BJD remains high in dairy herds. Consequently, programs that aim to control and eradicate BJD in beef herds will need to be undertaken on a continuing and long-term basis, creating a potentially large and ongoing financial demand on the industry.

Veterinary investigations of clinical cases were the most important method of identifying index cases. This highlights the importance of veterinary investigations for disease monitoring programs aimed at detecting changes in the pattern of endemic diseases and the emergence of new diseases.

In general, the control programs that were implemented were “successful” in progressing infected herds back to the equivalent of a ‘non-assessed’ (NA) herd status in each state. The exception was ‘test and cull’ programs, which were less successful unless they were combined with the culling of known high risk animals. Programs that involve test and culling alone would appear to be of limited value.

It is important to realise, no state has an ongoing program to assess the success of control and eradication programs currently being implemented in infected herds. This is an obvious deficiency, and so the apparent success of eradication programs within previously infected herds should be investigated in more detail to ensure existing eradication program are effective.

Within the framework of current industry policy it is important to point out that, without industry-funded assistance, individual producers are far more severely affected when cattle from affected herds are sold at discounted prices. However, the impact on individual herds is highly variable, depending on existing productivity and sale strategies, and so needs to be quantified on an individual basis.

It is also important to point out that the current state based programs, designed to provide assistance to affected producers and reduce the prevalence of BJD, will not eradicate BJD from the wider beef herd. Consequently, de-stocking and eradication programs will continue on an ad-hoc basis, as further BJD infected beef herds are identified. This creates a potentially significant and ongoing financial demand for the industry, without any end point to the program. In fact, if more detailed investigations are undertaken the potential financial burden on the industry may increase, as more beef herds with BJD are identified.

Vaccination programs and risk based trading, were not considered in this analysis. However, if these options become available they may help improve trading options and limit the financial impact on owners of infected herds if industry regulation of BJD continues.

7 Conclusions and Recommendations

7.1 Risk factors for introduction of BJD

A major objective of this study was to identify risk factors for the introduction and establishment of Bovine Johne’s disease infection (BJD) into beef herds.

A survey of 109 herds, mainly from NSW and Victoria, found that the presence of dairy breeds, or an association with dairy breeds, was the most important risk factor for the introduction of infection. An important implication of this is that beef herds will be constantly exposed to the risk of introducing infection whilst the prevalence of BJD remains high in dairy herds. Consequently, programs that aim to control and eradicate BJD in beef herds will need to be undertaken on a continuing and long-term basis, creating a potentially large and ongoing financial commitment for the industry.

In addition, some beef breeds, notably Murray Grey and Shorthorns, were over represented as index cases within infected herds. This probably reflects the dissemination of BJD infection by a few larger infected herds within these less common breeds, but they should be considered an important secondary risk for the introduction of BJD.

In a large proportion of the herds surveyed (69%), the index case was identified by the veterinary investigation of an animal or animals. This emphasises an important role for disease monitoring programs aimed at detecting changes in the pattern of endemic diseases and the emergence of new diseases. There is likely to be a favourable cost-benefit for any investment the beef industry makes into programs that enhance this monitoring capability.

Animals imported onto farms comprised the majority (67%) of index cases, with only 25% of these being detected within one year of arriving on the farm. Studs, saleyards and dispersal sales were all of similar importance, being 30%, 36% and 28% of imported index cases, respectively.

Whether or not BJD becomes endemic within a beef herd is strongly related to the time that cases spend on the farm before they are detected. Early detection limits the number of susceptible animals that are exposed to infection, but 44% of cases spent 3 or more years within the herds studied in the survey. Programs that encourage veterinary monitoring of sick animals will tend to reduce the time spent on the farm by clinical cases, and so will help limit the establishment of BJD infection.

The average age of index cases was 5.7 years, with most detected in the autumn or winter months (May to July) when cattle, in particular breeding cows, are regularly subjected to nutritional stress during late pregnancy and lactation. Investigation of records from veterinary laboratories would be a useful adjunct to this study, helping confirm this trend and provide a basis for on-farm monitoring programs.

Bulls were overrepresented, being 25% of index cases. This probably reflects the fact that bulls are often the only animals introduced into many herds, but also suggests that application of new diagnostic tests or vaccination strategies should be applied to these animals.

Of the 64 herds reporting a clinical case of BJD, 80% had only a single case. Five herds had 3 or more cases, with most having from 3-7, and only 1 high prevalence herd, which reported 28 cases. This strongly suggests that BJD is a self-limiting infection in most beef herds, with only a very few herds having management strategies and environmental conditions suited to spread of the disease and serious production losses.

7.2 Methods used to control BJD and factors influencing the success of control programs

Success - ‘eradication’ of BJD - was defined as achieving a classification of non-assessed (NA) status from the State DPI. This was achieved through control programs categorised as:

a) Test and cull
b) Test and cull with removal of high risk animals
c) Partial de-stocking with removal of high risk animals
d) Full de-stocking
e) Other

In general, these control programs successfully moved infected herds to the equivalent of NA herd status. The exceptions were ‘test and cull’ programs, which were less successful unless combined with the culling of known high risk animals. Thirty of 109 herds (28%) had undertaken test and cull programs. Of these, 2 of 11 herds using test and cull alone, and 11 of 19 using test and cull with culling of high risk animals, achieved NA status. This lack of success is a reflection of the limited sensitivity of the current ELISA test, highlighting the desirability of cost-effective tests with a much higher sensitivity.

Importantly, no state has an undergone an assessment of the success of the control and eradication programs that are currently being implemented in infected herds. This is an obvious deficiency, and so the apparent success of eradication programs within previously infected herds should be investigated in more detail.

The major factors that motivated producers to eradicate BJD were the high probability that the program would be successful, and that this would then lead to the removal of restrictions on the sale of animals and land. The social stigma of being the owner or manager of an infected herd was of less importance, but was still rated as very important by 51% of respondents.

Access to financial assistance was rated as less important, the possibility of increased mortality rates in affected herds and the potential impact of BJD on the quality of products produced by a beef herd were rated as unimportant in a producer’s decision about whether to eradicate BJD.

7.3 Cost-effectiveness of control programs

The base herd was based on a typical southern Victorian specialist beef farm. With long term costs and income projections, such a herd is a break-even business, and so must rely, to some extent, on off-farm income.

Based on evidence from the survey, direct production losses from BJD are usually very low and have virtually no financial impact. The effect of BJD on commercial herds will vary with the management and marketing strategies adopted, but those relying on store markets will be most affected. The impact on herds that sell cattle direct to feedlots or for slaughter will be insignificant, in terms of discounts on the value of sale stock and reduced farm income. Nevertheless, for some producers selling only for slaughter may reduce the flexibility of their sale options.

For store cattle producers, the impact of BJD will be more significant as this sale option is prevented by the restrictions on trading cattle. If store prices are at a premium to slaughter prices, as is often the case on a price per kg basis, then potential price discounts and the impact on farm income are significant. This impact would be reduced if producers changed enterprises to target finishing systems. However, not all properties have suitable land class and pasture quality to successfully implement profitable finishing systems.

If considering only the production losses from BJD, when there was no price discount on sale stock, BJD would need to cause death rates in excess of 5% before either partial or total de-stocking was warranted, on the basis of the assumptions made, due to the large cost of de-stocking and restocking. If cattle sold incur a 10% price discount, then the death rates attributed to BJD would need to exceed 1% before partial or total de-stocking was warranted. However, in some circumstances price discounts will exceed 10%, and so the cost of living with BJD will be greater.

In this analysis, it was assumed BJD was not eradicated using testing and culling, but trading restriction were removed after 5 years with partial de-stocking, and after 2 years with total de-stocking. In these scenarios the NPV of either form of de-stocking was still worse over 10 years, and significantly worse if the cost of restocking was 10% greater.

There are significant risks associated with de-stocking, including the value received for sale stock, profitability of any intermediate enterprise and the cost of restocking. Other risks include failure to eradicate BJD, purchasing less profitable replacement stock or embarking on a less profitable alternative enterprise. From a cash flow perspective, doing nothing was initially more attractive. However, as the discount on sale prices increased, the desirability of eradicating BJD became far greater.

In stud herds, BJD will result in total failure of the business. Without massive financial assistance, BJD infection will result in an unviable business.

Within the framework of current industry policy it is important to point out that, without industry-funded assistance, individual producers are far more severely affected when cattle from affected herds are sold at discounted prices. However, the impact on individual herds is highly variable, depending on existing productivity and sale strategies, and so needs to be quantified on an individual basis.

It is also important to point out that the current state based programs, designed to provide assistance to affected producers and reduce the prevalence of BJD, will not eradicate BJD from the wider beef herd. Consequently, de-stocking and eradication programs will continue on an ad-hoc basis, as further BJD infected beef herds are identified. This creates a potentially significant and ongoing financial demand for the industry, without any end point to the program. In fact, with if more detailed investigations are undertaken the potential financial burden on the industry may increase, as more beef herds with BJD are identified.

Finally, vaccination programs and risk based trading, as currently adopted for the National Ovine Johne's disease program, were not considered in this analysis. However, if they become available they may help improve trading options and limit the financial impact on owners of infected herds if industry regulation of BJD continues.

8 Appendices

8.1 Appendix 1 – Survey of affected herds

Section 1

To be filled out for all farms by the district veterinarian (DV) or state Animal health officer, (AHO). This is to be filled out for all farms where records exist and were infected in 1991 or since and have an average of at least 20 breeders.

Section 2

To be filled out by all producers who meet the selection criteria and currently still farm, or by a DV or AHO in consultation with the owner.

Section 3

The aim of section 3 is to gain information on the epidemiology of the disease within herds and especially if clustering or within herd risk factors for disease. This is additional information where more than three or more confirmed cases (they can be either clinical sub clinical cases) cases have occurred and have herd records which allow for suitable data collection. This section is to be completed by the District veterinarian or Animal Health Officer.

Confirmed case: Cases confirmed means cases that have been diagnosed as infected with a definitive test; faecal culture, tissue culture, or histology. For the purposes of this exercise, cases which are classified by histopathology as consistent or suggestive of Johne's disease will be classified as 'confirmed with BJD'.

8.1.1 Section 1

The following questions describe the characteristics of the first or index case of BJD on the farm.

Q1 When was the first confirmed case of BJD diagnosed on the farm?________(Month / year)

Q2 What class and breed of animal was the first confirmed case of BJD? Please tick one of the boxes and write the breed in the space provided.

- □ **B**ull (Breed …………………)
- □ **C**ow (Breed…………………)
- □ **S**teer (Breed………………….)

Q3 How was the first case of BJD identified on the farm - please tick one of the following boxes.

1. routine Market Assurance Program testing
2. routine test for movement (eg interstate)
3. routine test as part of an industry survey
4. trace back investigation from another farm that, I sold cattle to
5. trace forward investigation from another farm that I bought cattle from
6. veterinary investigation of a sick or scouring animal
7. other please state________________________________

Q4 The first confirmed case of BJD was in (please tick one of the following boxes.)

HB a home bred animal (If yes go to question 5)
IM an imported animal (If yes go to question 10)

Q5 If the first confirmed case of BJD was a home bred animal in what year was it born?________________

Q6 Was its dam an introduced animal?

- □ Yes
- □ No

Q7 Did this animal spend any time off farm in its first year of life?

- □ Yes How many months did it spend off farm?______months and where (ie agisted, shows etc________________)
- □ No

Q 8 What was the likely source of infection?
(Please tick the most appropriate)

1. Introduced beef bull
2. Introduced beef cow
3. Introduced dairy cow
4. Introduced dairy bull
5. The herd was previously a dairy herd or has bought dairy or dairy cross breeds in to the herd
6. Neighbour
7. Don't know
8. Other source – please specify_____________________________________

Q 9 What is your reason for suspecting this likely source of infection?____
____
____

Go to question 17

Q 10 If the first confirmed case of BJD was an introduced animal, in what year was it introduced? __________

Q 11 Where did the animal come from?

1. Directly from a stud
2. sale yard
3. at a dispersal sale
4. at an on farm sale (non stud)
5. it was on agistment
6. other please specify ____

Q 12 How old was the animal when it was introduced to the property?

_______Years ________Months

Q 13 From what state did the animal come from?

1. Victoria
2. NSW
3. South Australia
4. Tasmania
5. Queensland
6. Western Australia

Q 14 From what district did the animal originate? ____________________

Q 15 Did the source farm have any association with dairy cattle?

1. A dairy farm
2. A former dairy farm
3. It used dairy cattle as recipients in embryo transfer programs
4. No association
5. Don't know
6. Other please specify____

Q 16 Does the area where the animal originate have any association with dairy cattle?

1. It is a dairy area
2. It was a former dairy area
3. No association with dairy
4. Don't know
5. Other please specify………………………………….

Q 17 The following statement best describes the current JD status.

1. There has been no control program on this farm. and the current JD status is ________________
2. Control/eradication commenced in the year ______ and the current JD status is ________________

Q18 Which of the following best describes the disease picture in the herd when JD control was first attempted?

1. The disease was endemic with evidence of disease in home bred animals or a large proportion of the herd had been exposed.
2. The index case was a recent introduction with limited opportunity for exposure to susceptible animals (1 or 2 calf cohorts or a well defined part of the herd)
3. The index case was a recent introduction with little or no exposure to susceptible cattle.
4. The index case was an introduced animal but herd records did not enable accurate assessment of the likely exposure to susceptible animals

Q19 Which best describes the control program on the farm.

1. Test and cull
2. Test and cull with removal of high risk animals
3. Partial de-stock with removal of high risk animals
4. Full de-stock
5. Other____

Q20 If herd testing has been conducted which of the following tests were used (tick each test used).

E ELISA

FC Faecal culture

GI Gamma interferon

J Johnin skin testing

C CFT

Q21 If testing was conducted in a test and cull program how often was it conducted.

0.5 Twice per year

1 Annually

2 Every 2 years

3 Other please state_______________________________________

Q22 If testing has been conducted which animals were tested?

____

____

____

____

Q23 If test and cull is conducted on farm what is the policy on removal of reactors.

Please describe____

____

____

Q24 Describe the high risk groups removed and number of each group removed?

	Describe	Number
A. Calf cohorts of infected animals		
B. Calf groups exposed to infected bull		
C. Calf groups exposed to infected cows		
D. Dam of infected animals		
E. Siblings of infected animals		
F. Calves of infected animals		
G. Discrete group of exposed animals *		
H. Other		

*This may be group of animals exposed on an out block.

Q 25 and 26 are to be filled in if herd doesn't qualify for more detailed history in section 3 of the survey. If the herd qualifies go to Q 27.

Q25. History of reactors or clinical cases.

Date detected	**Age**	**Homebred (Y/N)**	**Reason detected** **(Clinical case, ELISA reactor, faecal culture +ve)**	**Confirmed** **(either culture +ve, histo +ve or not attempted NA)**	**Comments**

Q26 Summary of any herd testing completed.

Date	Number tested	Number ELISA +ve	Number Faecal culture +ve	Number ELISA +ve and FC +ve	Comments

Q27 The individual animal identification and records are best described as appropriate to (Please tick all appropriate)

1. identify reactors
2. identify year cohorts
3. identify imported animals
4. identify dam
5. identify sire
6. none of the above

Q 28 Average herd size during this time? Average __________Range _______________

Q 29 What is the nearest bureau of Meteorology rainfall recording station to the farm and Post code?

____

The following website displays a map with most of the BOM sites on it searchable by region:

http://www.bom.gov.au/climate/map/climate_avgs/clim_avg1.shtml

8.1.2 Section 2

8.1.2.1 Introductory letter

The following survey on Bovine Johne's disease (BJD) in beef cattle has been commissioned by Cattle Council, in cooperation with State Departments of Agriculture and Meat and Livestock Australia, and is being conducted by the University of Melbourne's School of Veterinary Science.

The survey is part of a larger project to describe the epidemiology and the economics of the disease and it is hoped that the results of this survey may help in controlling the disease in the future and guide future policy direction.

We ask you to help us by completing this questionnaire and returning it to your local Department of Agriculture or Rural Lands Protection Board vet in the stamped self addressed envelope provided. All results will remain confidential with your local department or RLPB vet ensuring that no information identifying your property will be passed on to the University without your expressed permission.

The success of this project and this survey in particular depends upon every owner filling in the details of this survey as accurately as possible. Every reply is extremely important to us.

Dr Patrick Kluver
Lecturer Small Ruminant Medicine and Production
Mackinnon Project
School of Veterinary Science
University of Melbourne

8.1.2.2 Approval of Owner or Manager

To be filled out by owner/manger

Name ____

Physical address

____

____

Postal address ____

____

Post code_________________

Phone ___________________

Mobile __________________

Fax ___________________

PIC _____________________

Are you happy for your contact details to be divulged to Dr Patrick Kluver of the University of Melbourne Vet School. (Your contact details will not be used for any other purposes other than this current research project.)

- ☐ Yes
- ☐ No

The following herd number is assigned by the state departmental representative for the purposes of this survey.

State ____________________ Herd Number ______________________________

8.1.2.3 Questionnaire for Owner or Manager

The following questions relate to the management and physical characteristics of your farm. Since BJD may have affected the way that you manage your farm and because we want to determine the risk factors for BJD these next few questions relate to the year that BJD was introduced to your farm, or if that is unknown when the first confirmed home bred animal with JD was born on your farm. We will call this year the first year of known JD infection.

Q 1 Did your farm have any association with dairy cattle?

1. A dairy farm
2. A former dairy farm
3. I used dairy or dairy cross cows
4. I used dairy cattle as recipients in embryo transfer programs
5. No association
6. Don’t know.
7. Other please specify___________________________

Q 2 Please indicate the importance of the following enterprises on your farm before your herd was diagnosed with BJD. (Before trading restrictions were applied).

	Major Importance 2	*Minor importance 1*	*Did not occur 0*
A. Vealer production			
B. Stud breeder			
C. Breeding and fattening			
D. Buying stores to fatten			
E. Selling stores			
F. Feedlot			
G. Agistment of beef cattle			
H. Agistment of dairy cattle			
I. Other Specify			
J. Other specify			

Q 3 What were the major cow breed(s) on your farm in order of importance?

1______________________

2______________________

3______________________

Q 4 What were the major bull breeds on your farm in order of importance?

1_____________________

2_____________________

3_____________________

Q 5 What were the approximate number of the following stock classes on your farm before BJD was diagnosed?

	Bulls (1yrs+)	Breeding cows (2 yrs +)	Steers (1yrs +)	Heifers (1-2 yrs)	Calves (<1 yr)
Cattle					

Q 6 Bulls were normally sourced from: indicate all source/s in order of importance, (1 most common, 2 next most common source etc)

- **A. A stud**
- **B. I breed my own bulls**
- **C. Saleyards**
- **D. Other commercial breeder**
- **E. Hired or borrowed**
- **F. Other please specify____________________**

Q 7 The following questions relate to the <u>normal practice</u> on your farm after BJD was diagnosed while your herd had an infected or restricted status.

	Major Importance 2	*Minor importance 1*	*Did not occur 0*
A. Vealer production			
B. Stud breeder			
C. Breeding and fattening			
D. Buying stores to fatten			
E. Selling stores			
F. Feedlot			
G. Agistment of beef cattle			
H. Agistment of dairy cattle			
I. Other Specify			
J. Other specify			

Q 8 Please indicate the date that you normally join the following animals

	Date bulls in	Date bulls out
Heifers		
Cows 1		
Cows 2 (if split calving)		
Bulls run with cows all year.		

Q 9 On what approximate date are calves normally weaned on your farm?
____________________(ie 20th of November)

Q 10 At what age are <u>bulls</u> normally culled for age on your farm?

1. 5-7 years
2. 7-9 years
3. 10 years or over
4. No particular age

Q 11 What age are <u>cows</u> normally culled for age on your farm?

1. 5-7 years
2. 7-9 years
3. 10 years or over
4. No particular age

Q 12. How many hectares of your farm are used for?

Grazing	[	] Hectares
Cropping	[	] Hectares
Not available for grazing	[	] Hectares
Total area of farm	[	] Hectares

Q 13 How many hectares are irrigated?_________________________ Ha

Q 14 How many Megalitres are used for irrigation?_______________ML

Q 15 What best describes the main grazing management of cattle on your property.

1. Set Stocked
2. Rotational grazing
3. Cell grazing
4. Mix of rotational grazing and set stocking

Q 16 If sheep are grazed please indicate the approximate number of each class that you normally have on your property.

	Rams (1 yr +)	Breeding ewes (1 yr +)	Wethers (1yrs +)	Lambs (<1 yr)
Sheep				

Q 17 If sheep are grazed what best describes the mix of sheep grazing with cattle on your farm?

1. Sheep and cattle are grazed separately on different parts of the property
2. Sheep and cattle are co-grazed on the same pasture at the same time for most of the year
3. Sheep and cattle are rotated and grazed on the same paddocks but usually not at the same time

Q 18. Please indicate in the table what type of supplementation is normally fed on your farm and to what class of stock? (Please tick the appropriate box).

	Cows and calves	Heifers
Pellets		
Grain		
Hay		
Silage		
Blocks		
Other please specify		
Other please specify		

Q 19 How is the supplement fed out? (Please tick the appropriate box).

	Trails or on ground	Self feeders troughs or racks	Feeding Pad
Pellets			
Grain			
Hay			
Silage			

Other please specify

Q 20 The main stock water is supplied from? (Tick all appropriate boxes)

1. Dams
2. Rivers creeks
3. Bore water
4. Town water

Q 21 The dams and creeks on my property are

1. All fenced
2. Mostly fenced
3. Mostly unfenced
4. None are fenced

Q 22 The cows and calves drink water from (Tick all appropriate boxes).

1 Dams

2 Creeks

3 Troughs

4 Other (Please specify)___________________________

Q 23. On how many separate parcels of land does your farm operate?___________

Q 24 What is the average rainfall for your farm? [ ] mm

The following questions relate to the control programs for BJD on your property?

Q 25 Has control/eradication been attempted on your farm?

- ☐ Yes In what year did the control program commence? _________Go to Q28.
- ☐ No

Q 26 Do you intend to attempt control/eradication on your farm?

- ☐ Yes
- ☐ No (If no go to question **Q 29**).

Q 27 If you have implemented or are intending to implement an eradication/control program, please indicate the importance of the following factors for your decision to eradicate or control JD.

Ability to sell cattle unrestricted.

1 2 3 4 5 6
Not important Minor importance Very important

Ability to sell land unrestricted.

1 2 3 4 5 6
Not important Minor importance Very important

The social stigma associated with the disease.

1 2 3 4 5 6
Not important Minor importance Very important

The death rate or stock losses due to Johne's disease.
1 2 3 4 5 6
Not important Minor importance Very important

Access to a financial assistance and counselling package.
1 2 3 4 5 6
Not important Minor importance Very important

The death rate or stock losses due to Johne's disease.
1 2 3 4 5 6
Not important Minor importance Very important

A good chance of success.
1 2 3 4 5 6
Not important Minor importance Very important

Having JD affects the quality aspects of my products.
1 2 3 4 5 6
Not important Minor importance Very important

The financial advantage of eradicating.
1 2 3 4 5 6
Not important Minor importance Very important

Other please specify ____
____.
1 2 3 4 5 6
Not important Minor importance Very important

Q 28 If you have NOT attempted eradication/control strategies and have no intention of doing so, please indicate the importance of the following factors for your choice.

I don't think it is possible.

1 2 3 4 5 6
Not important — Minor importance — Very important

Good chance that I will become reinfected.

1 2 3 4 5 6
Not important — Minor importance — Very important

There was no economic advantage to eradicate.

1 2 3 4 5 6
Not important — Minor importance — Very important

No access to a financial assistance and counselling package.

1 2 3 4 5 6
Not important — Minor importance — Very important

I wanted to keep my genetics.

1 2 3 4 5 6
Not important — Minor importance — Very important

No advantage at my age.

1 2 3 4 5 6
Not important — Minor importance — Very important

I philosophically disagree with the current state policies on JD.

1 2 3 4 5 6
Not important — Minor importance — Very important

Eradication was too difficult.

1 2 3 4 5 6
Not important — Minor importance — Very important

A poor chance of success.

1 2 3 4 5 6
Not important — Minor importance — Very important

Other please specify ____.

1 2 3 4 5 6
Not important — Minor importance — Very important

Q 29 In summary what was the main change to your cattle enterprise due to your BJD infected/restricted or suspect status?

____
____
____
____
____
____

Q 30 If you have conducted an eradication/control program which procedures have been used on your herd (Tick all appropriate boxes).

1. A one off blood test of all animals
2. A one off faecal test of all animals
3. Blood testing all animals annually
4. Faecal testing all animals annually
5. Removal of positive animals
6. Removal of dams from positive animals
7. Removal of daughters from positive animals
8. Removal of all cattle from the same calf crop as positive animals
9. Removal of all cattle exposed as calves to infected or test positive animals
10. De-stocking entire herd
11. I run young cattle on low risk pastures
12. I only buy bulls from MAP accredited herds
13. I only buy females from MAP accredited herds
14. I only buy cattle from "Beef only" herds

Q 31 Who is the <u>main</u> adviser for bovine Johne's disease control on your property?

(***Tick one only)***

1. No-one
2. Local vet
3. Private Veterinary consultant
4. Private Agricultural consultant
5. Agriculture Department officer
6. RLPB veterinarian
7. Cattle Council advisor
8. Other *(Please specify)* ________________

DEMOGRAPHIC QUESTIONS

Q 32 What year were you born? ________

Q 33 How many years have you farmed cattle?_________

Q 34 How many more years do you intend to farm cattle?___________

Q 35 What is the number of full-time labour units on your farm (including yourself, your family and employees)? _____________

Thankyou for participating in our survey - we appreciate your contribution and assistance. If you would like to make any general comments about the survey or about JD control and regulation, or its' effect on your business, please do so in the following space.

8.1.3 Section 3

The following section is to be completed by the government/RLPB vet or animal health advisor familiar with the control program on the farm.

The following section is to be filled out where 3 or more confirmed reactors have occurred and herd records are able to identify the origin and age of the animals (these confirmed cases can be clinical or sub-clinical, or a combination of both).

Q1 The following is a summary of all the herd testing conducted on the farm.

Date	Number tested	Number ELISA +ve	Number Faecal culture +ve	Number ELISA +ve and FC +ve	Comments

Q 2 History of individual reactors or clinical cases on farm.

ID	Month and year of birth	Breed	Date detected	Home bred (Y/N)	Clinical Case (Y/N)	ELISA result (+/-/NA)	Faecal Culture result (+/-/NA)	Histo result (+/-/NA)	Tissue culture result (+/-/NA)

Q 3 The following is a table for additional epidemiological data that may be available for a small number of herds, where extensive records may have been kept or large amounts of epidemiological data were collected. (This will only be available where extensive testing has taken place, U stands for not tested)

ID	JD status of dam (+/- or U)	Positive Siblings	Negative Sibling	Sibling status unknown	Other relevant epidemiological information

Q 4 Please add any further comments on the control of BJD in this herd in the following section.

8.2 Appendix 2 – summary of data analysis

Herd factors associated with establishment of infection (evidence of homebred animals) compared to herds where there was no establishment of infection.

Outcome is the detection of a homebred JD case.

Variable	n	Total Observations	P-value
ELISA reactor rate	24	58	0.9
Importance of vealer production	22	66	0.2
Importance of stud breeding	21	64	0.8
Importance of buying stores	21	64	0.8
Importance of selling stores	21	64	1.0
Importance of feedlotting	20	64	0.23
Importance of agisiting cattle	21	62	0.5
Number of cow breeds	22	67	0.012
Autumn or spring calving	15	44	0.5
Split calving	15	44	0.46
Stocking rate (DSE/Ha)	20	59	0.2
Stocking rate (DSE/Ha/100mm)	20	58	0.34
Ha Irrigated	22	64	0.9
Grazing mix	9	14	1.0
Sheep present	20	59	1.0
Feeding system	13	41	0.60
Water troughs only	22	64	1.0
More than one block of land	22	64	0.9

Average rainfall	22	65	0.8

Herd factors with ELISA reactor rate as the dependent variable in the initial whole herd ELISA test.

Variable	n	Total Observations	P-value
Clinical present		64	0.16
Importance of vealer production		46	1.0
Importance of stud breeding		45	0.39
Importance of buying stores		44	0.86
Importance of selling stores		43	0.94
Importance of feedlotting		44	0.89
Importance of agisiting cattle		41	0.41
Number of cow breeds		46	0.41
Autumn or spring calving		25	0.09
Weaned less than 5mths old		23	0.23
Cows culled for age		46	0.18
Stocking rate (DSE/Ha)		42	0.48
Stocking rate (DSE/Ha/100mm)		42	0.47
Ha Irrigated		44	0.40
Grazing mix		8	0.54
Sheep present		42	0.38
Feeding system		22	0.06
Water troughs only		43	0.14
More than one block of land		46	0.73
Average rainfall		46	0.65