JOHNE'S DISEASE RESEARCH CONSORTIUM

ANNUAL REPORT 2012

JOHNE'S DISEASE
RESEARCH CONSORTIUM

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DEFINITIONS

AFO	Acid Fast Organism
AgR	AgResearch Limited
B+LNZ	Beef + Lamb New Zealand Limited
DCANZ	Dairy Companies Association of New Zealand
DNZ	DairyNZ Limited
ELISA	Enzyme Linked Immunosorbent Assay
JDRC	Johne's Disease Research Consortium
JML	Johne's Management Limited
JRG	Johne's Research Group
LIC	Livestock Improvement Corporation
MAP	Mycobacterium avium paratuberculosis – the bacterium that causes Johne's disease
MIA	Meat Industry Association
MSI	Ministry of Science and Innovation
Paratuberculosis	Another name for Johne's disease
PTB	Paratuberculosis
UJV	Unincorporated Joint Venture

JOHNE'S DISEASE
RESEARCH CONSORTIUM

THE CONSORTIUM

The Johne's Disease Research Consortium (JDRC) was established in 2008 as a joint venture between Industry and the Science community to coordinate Johne's disease research in New Zealand. The participants in the Unincorporated Joint Venture are Beef + Lamb New Zealand Limited (B+LNZ), DairyNZ Limited (DNZ), DEEResearch Limited, AgResearch Limited (AgR), Livestock Improvement Corporation (LIC), Massey University and the University of Otago. The Meat Industry Association (MIA) and Dairy Companies Association of New Zealand (DCANZ) are associate participants in the Consortium and the Science and Innovation Group of the Ministry of Business, Innovation and Employment (MBIE) provides funding to the Consortium via the Research Consortia funding scheme. Landcorp Farming Limited is a research partner. JDRC has a total budget of $9.8M.

The Consortium focuses on research "behind the farm gate", with the goal of developing practical tools which can be applied to produce a cost effective reduction of herd/flock and within herd/flock prevalence of Johne's disease on farm in New Zealand. JDRC contracts research services from New Zealand's leading science providers and maintains an industry focused research programme through interaction with its industry participants.

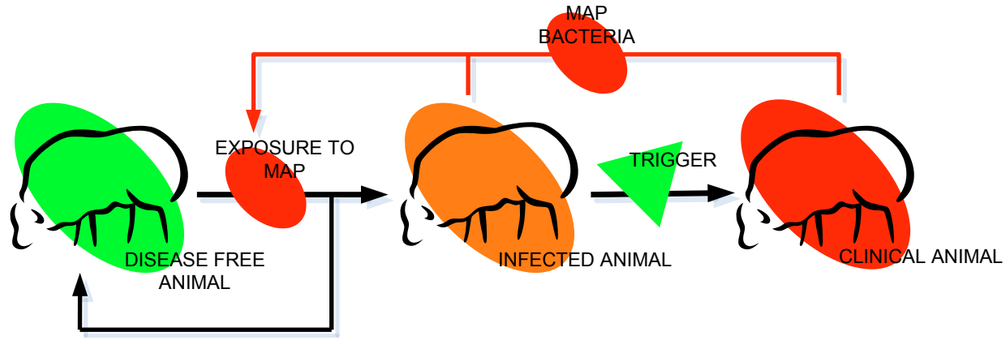
THE DISEASE

Johne's disease (or Paratuberculosis) is a chronic, progressive, contagious and generally fatal infection of cattle, sheep, deer, goats and wildlife caused by the bacterium Mycobacterium avium subspecies paratuberculosis (or MAP). Infected animals contaminate the environment by shedding large numbers of MAP in their faeces and this results in an increased risk of infection amongst a herd. Once infected an animal can remain unaffected and show no signs of the disease through out their life time, however a small number of animals progress to clinical disease, where the bacteria causes an autoimmune reaction in the gut, thickening the intestinal wall and reducing the ability to absorb nutrients from the diet. Clinical animals suffer from wasting and will eventually die from malnutrition. There is currently no recognised treatment for the disease. There are vaccines available for sheep and deer, which do not prevent infection but will, in most cases, reduce clinical disease.

The Impact of the Disease

While results from research studies vary, evidence suggests that clinical Johne's disease has the potential to affect animal production by reducing life expectancy, meat and milk yields and the price of cull animals. Subclinical disease may also affect production, but this impact is more difficult to measure.

On least affected properties, the financial costs of Johne's disease are minimal, but on those worst affected the costs can be substantial.



JDRC REPORT

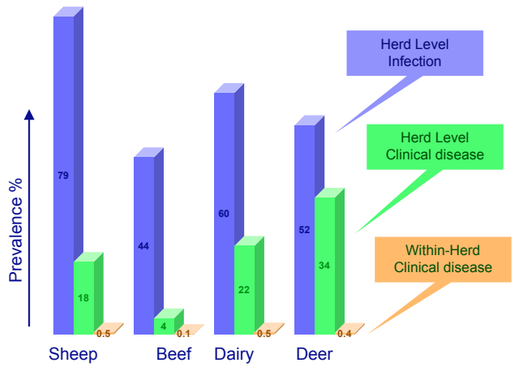
Most of the fundamental aspects of the JDRC science programme were completed in 2012 and the on-farm aspects of the programme strengthened with the development of on-farm trials, to extend understanding of the control of Johne's disease in the field. The three on-farm studies in deer, sheep and dairy cattle are the final step in the JDRC science program and will be complete by 2015-2016.

Alongside this work the Consortium has been consulting with its partners to consider future priorities for Johne's disease research in New Zealand.

Collectively JDRC's industry participants have supported the goal that Johne's disease should not affect on farm productivity and performance in New Zealand. Discussions have focussed on what industry needs to achieve this goal and therefore what support JDRC can provide.

The Bryan report[1], commissioned by the Consortium in 2011, reviews the prevalence and impact of Johne's disease in New Zealand. While providing an accurate estimate of prevalence of disease is a difficult task due to the nature of the disease and limitations surrounding its diagnosis, best estimates would suggest that infection with MAP is widespread, with >50% of all herds/flocks infected, but the rate of clinical Johne's disease is at fairly low levels in all species. In all species there is a significant tail of the population where within herd prevalence (and incidence) is particularly high and within these tails there is likely to be significant economic loss and also the greatest risk of transmission of MAP in and between herds and across into the food chain.

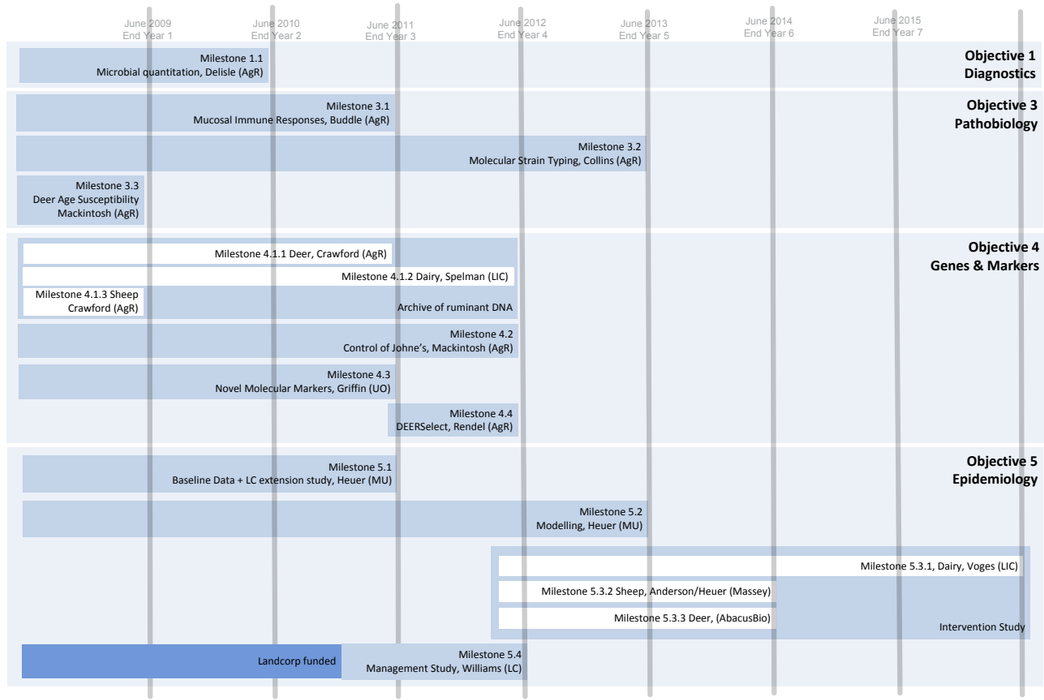
Therefore, to manage the disease in New Zealand successfully it is considered that as a first priority we need to be able to identify those farms most affected by the disease and provide cost-effective tools to minimise its impact, while ensuring that controls are in place to prevent the disease becoming an issue in those lesser or unaffected herds. JDRC's on-farm trials are aimed at supporting industry in this task and remain the priority for the Consortium's research focus in the next 4 years.



[1]*The Prevalence of Johne's disease in New Zealand: A review of our current understanding. Mark Bryan and Keryn Cresswell. VetSouth Ltd. August 2012 (Commissioned by JDRC).*

JDRC'S SCIENCE PROGRAMME

The science programme, originally scheduled to deliver its objectives by June 2013, has been granted an extension to June 2016 to allow the completion of on-farm intervention studies in dairy cattle, deer and sheep.



PROVIDING INFORMATION TO INDUSTRY ABOUT JOHNE'S DISEASE

In 2012 JDRC partners DairyNZ and Beef + Lamb New Zealand, in collaboration with the Consortium, have published guidelines for the management of Johne's disease in dairy cattle and sheep which are intended to provide farmers with the most up to date information about controlling disease. The recommendations are based on research and best practice, both from within New Zealand and overseas, and represent our best understanding at this time.

The dairy guidelines were published in DairyNZ's April 2012 Technical series and the sheep guidelines published in June 2012 as a Beef + Lamb New Zealand Fact sheet. Copies can be obtained from DairyNZ or Beef + Lamb NZ and www.jdrc.co.nz

Information regarding the management of Johne's disease in deer are available from Johne's Management Limited www.johnes.co.nz or freephone 0800 456 453

STRAIN TYPING

The ability to distinguish between different strains of bacteria is a useful tool for answering questions about sources of infection and the spread of disease. In the past 4 years JDRC has invested in the development of a sub-typing system for Mycobacterium avium subspecies paratuberculosis (MAP). While there are two major strains of MAP, Type C and Type S, typing of MAP isolates from dairy cattle, beef cattle, sheep and deer have indicated that there is up to 20 sub strains of Type C and 8 sub strains of Type S in New Zealand, with 4 of these sub-strains responsible for ~89% of all infections.

The sub-typing system, developed at AgResearch, is based on genetic sequences, known as VNTRs (Variable Number Tandem Repeats) and SSRs (Short Sequence Repeats). In 2012 researchers have investigated adding more VNTRs and SSRs to the system in an attempt to further subdivide the strain types seen. While some improvement was made the changes were moderate and only useful if the typing system was looking at complex research questions. With this limited success, researchers have concluded that New Zealand likely has a less genetically diverse range of MAP sub-types than other countries.

In 2012, JDRC, in collaboration with Johne's Management Limited (JML), has also considered the question of the role of strain type in disease virulence. JML is an Industry funded company that promotes the control of Johne's disease in farmed deer in New Zealand and maintains a national database of JD-like lesions detected in deer at processing.

In this study, the sub-typing system was applied to MAP isolates collected from deer identified by JML at slaughter as having JD-like lesions. Researchers compared the strain type of the deer samples with severity of disease in the deer measured by acid fast organism (AFO) status. The results of the study were inconclusive, however it was found that both the common Type C sub-strains of MAP which affect deer frequently caused clinical disease and were also frequently seen in animals in the early stages of infection.

MODELLING JOHNE'S DISEASE

Computer models which simulate how MAP affects animals are a low cost means of looking at how the spread and impact of Johne's disease might be controlled. Most of the models currently available for Johne's disease have been developed for dairy cows in intensive farming systems where the Johne's bacteria are transmitted by direct contact with infected animals. Researchers at Massey University have been developing Johne's disease models for New Zealand's pastoral grazing systems, which allow for bacteria to be transmitted indirectly from the environment as well as by contact between animals. Two models have been developed to date, one for deer and the other for sheep.

Modelling JD in Deer

Field and experimental work shows that MAP infections develop differently in deer than in other species, the most obvious difference being the early onset of clinical disease in deer when compared to sheep and cattle. The computer model developed considers these factors and then simulates the effectiveness of different control measures for the disease in deer. The model predicts that the most effective means of reducing the prevalence and incidence of disease on farm is the early detection and removal of high shedding and clinical animals. It also suggests that rotational grazing is better for disease control than permanent grazing as rotation minimises bacterial loads on pasture, which in turn will help reduce the prevalence of the disease.

Modelling JD in Sheep

While a significant number of sheep have been shown to be infected with MAP in New Zealand, only a small portion of animals progress to clinical stages of the disease, when they shed large amounts of bacteria. Most sheep do not succumb to the disease in their productive lifespan and have only intermittent periods when they are shedding bacteria. The computer model has been developed to accommodate this shedding profile and has been tuned to account for the impact of seasonal lambing and age related management of animals on New Zealand farms. Similar to deer, the model again suggests that early detection and removal of high shedders will be the most effective means of reducing the prevalence and impact of JD in a flock.

As in the case of all computer simulated results, these findings must be confirmed in field trials in order to provide robust recommendations for application on farm.

WHOLE HERD TEST AND CULL FOR REDUCING THE IMPACT OF JOHNE'S DISEASE

In 2008 Landcorp Farming Limited began investigating the effectiveness of a whole-herd test and cull policy for controlling Johne's disease in their stag breeding programme. While successful in reducing the incidence of Paralisa® positive animals, Landcorp have noted that they do not necessarily advocate implementation of a test and cull programme as described in this study as the control of Johne's disease can often be multifaceted and should be tailored to specific farm circumstances. This was an experiment designed to determine the result of using test and cull alone to control disease in a herd.

Over three years, approximately 7,400 hinds and 3,500 stags were tested using the Paralisa® test method developed by Disease Research Laboratory (DRL) at Otago University. All animals that tested positive or suspect for Johne's disease were removed from the herds by culling. Over the course of the study the number of test positive or suspect positive animals declined in all tested herds, in Red deer from 22.5% to 3.4% and in Wapiti from 5.4% to 0.7%. Whole herd test and cull therefore proved effective for reducing the incidence of test positive animals.

The test and cull strategy was costly to implement in the early stages as large numbers of animals were identified and removed from the herds. In order to determine the actual cost benefit of the policy however, an economic evaluation of trial data was undertaken by AgResearch Limited, using a computer model to compare the performance of a herd with no Johne's disease to that of herd with the disease and where the disease was said to be affecting growth and weaning rates. The model assumed that any animals culled were replaced with unaffected animals, returning the herd to its base level of performance. It did not take account of the sensitivity or specificity of the Paralisa® test.

The results indicated that culling and replacement of animals under these conditions could be economic over a 10-year period, across a wide range of Johne's disease incidence rates, as long as the disease was significantly impacting on production (e.g. weaning and/or growth rates). The greatest response was seen when weaning rates were depressed.

The results from this study showed that the test and cull programme undertaken over 3 years effectively reduced the incidence of deer testing Paralisa® positive for Johne's disease. It is recommended that farmers talk with their veterinarian or an advisor with expertise in the control and management of Johne's disease to tailor a specific plan that is aimed at both reducing the incidence of disease and continuing to maintain long term disease control on their farm.

JDRC FINDINGS AND ACHIEVEMENTS 2008-2012

	Herd Prevalence		Within Herd Prevalence	
	Clinical	Subclinical	Clinical	Subclinical
Beef cattle	~4%	~31%	<0.1%*	-
Dairy cattle	~10%	~60%	~0.45%	~2%
Deer	~30%	~60%	~0.4%	-
Sheep	~20%	~68%	0.5-1.0%*	-

There is strong evidence that MAP is transmitted between species as co-grazed animals can share the same strain of bacteria

Both dairy cattle and deer are usually infected with Type C strains of MAP, however there is a clearly different Type C sub-strain found in dairy cattle than that found in deer

Studies in dairy cattle have indicated that there is limited value in testing for JD infection in young cattle as both culture and serology can fail to detect infected animals

In dairy cattle with severe JD, MAP bacteria survive in the gut because the immune system fails to recognise that MAP is a threat and does not respond as it should

On some farms animals can be infected with more than one strain type of MAP, indicating the animals have been infected on more than one occasion

Over 1800 Johne's affected dairy cows have been identified, DNA sampled and genotyped to find genes that may be related to resistance and susceptibility to Johne's disease

Trials have proven that young deer are more likely to develop clinical disease on exposure to challenge with MAP than older animals

JDRC FINDINGS AND ACHIEVEMENTS 2008-2012

Over 5000 dairy herds have been screened for Paratuberculosis by bulk vat milk ELISA; 1% herds were test positive and 5% herds classified as suspect

A list of genes which may potentially be markers for signalling resistance or susceptibility to JD in cattle and deer has been identified

Genetic parameters for measures of Johne's susceptibility in deer have been estimated. They are moderate (0.16 to 0.26) and highly genetically correlated (0.85 to 0.94) in red deer. Heritability's are low in Wapiti.

A reliable challenge model for inducing MAP infection in dairy cattle has been developed, traditionally an area of difficulty for researchers worldwide

Resistant and susceptible phenotypes in deer may be distinguished by the nature of their gene expression response to MAP challenge in vitro

On-farm trials suggest that a proportion of deer with histopathological symptoms (lesions) caused by Johne's disease can self cure

Jersey cows are three times more susceptible to Johne's disease than Holstein-Friesians

Co-grazing of livestock species effects the incidence of disease; e.g. clinical disease in one species on farm increases the likelihood of disease occurring in another species on farm

The incidence of Johne's disease shows regional variations in New Zealand, effecting deer and cattle most severely in the South Island and sheep in the North

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