JOHNE'S DISEASE RESEARCH CONSORTIUM

ANNUAL REPORT **2014**

JOHNE'S DISEASE
RESEARCH CONSORTIUM

Contents

Definitions

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
LIC	Livestock Improvement Corporation
MAP	*Mycobacterium avium paratuberculosis* —the bacterium that causes Johne's disease
MIA	Meat Industry Association
MBIE	Ministry of Business, Innovation and Employment (formerly Ministry of Science and Innovation, MSI)
Paratuberculosis	Another name for Johne's disease
PTB	Paratuberculosis
UJV	Unincorporated Joint Venture

The disease

Johne's disease (JD) 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, increasing the risk of infection passing amongst herds and flocks. Once infected, an animal can remain unaffected and show no signs of the disease throughout their lifetime, however a small number of animals progress to clinical disease. The bacteria cause an autoimmune reaction in the gut, thickening the intestinal wall and reducing the ability of an animal to absorb nutrients from the diet. Clinically affected animals suffer from wasting and eventually die from malnutrition. There is no recognised treatment for the disease. In New Zealand there are vaccines registered for sheep and deer which while not preventing infection will, in most cases, reduce the signs of clinical disease.

Impacts of the disease on farm

While results from research studies vary, evidence suggests that clinical Johne's disease affects animal production by reducing life expectancy, meat and milk yields and the value of cull animals. Sub-clinical disease may also affect production, but this impact is more difficult to measure. While the financial cost of Johne's disease is thought to be minimal on farms without clinical disease, the cost on the worst affected properties can be substantial and not limited to economic impact alone.

In 2013-14 JDRC information suggests that the cost of Johne's disease to the sheep sector is of the order of $75-92 million annually. Information regarding the cost of Johne's disease to other sectors is still in development.

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. The Ministry of Business, Innovation and Employment (MBIE) provides funding to the Consortium via the Research Partnership funding scheme[1]. Landcorp Farming Limited, Johne's Management Limited (JML) and The New Zealand Merino Company Limited (NZM) are also collaborators. JDRC has a total budget of $10.4M over its lifetime.

The Consortium's research programme focusses on issues "behind the farm gate" and it's goal is to develop practical and cost effective tools which can be used to reduce the prevalence of Johne's disease in herds or flocks in New Zealand.

JDRC contracts research services from some of New Zealand's leading science providers and maintains an industry focused research programme through interaction with its industry participants. Johne's is a complex disease and combining the resources of major industry associations with research partners has been a significant step for ensuring that research investment has been coordinated and focussed on achieving the greatest benefit for the New Zealand livestock industry. We also recognise the value of other research being carried out in New Zealand and internationally, and we encourage collaboration with these groups. Where possible, we contribute to and draw from these efforts to combat Johne's disease in order to secure the latest developments for practical application in New Zealand.

JDRC in 2013-14

In 2013-14 the focus of the JDRC research programme has been our three on-farm projects which are generating solutions to improve the control and management of Johne's disease. These projects were developed in conjunction with industry experts to address priority research targets identified by the Dairy, Beef and Sheep and Deer sectors

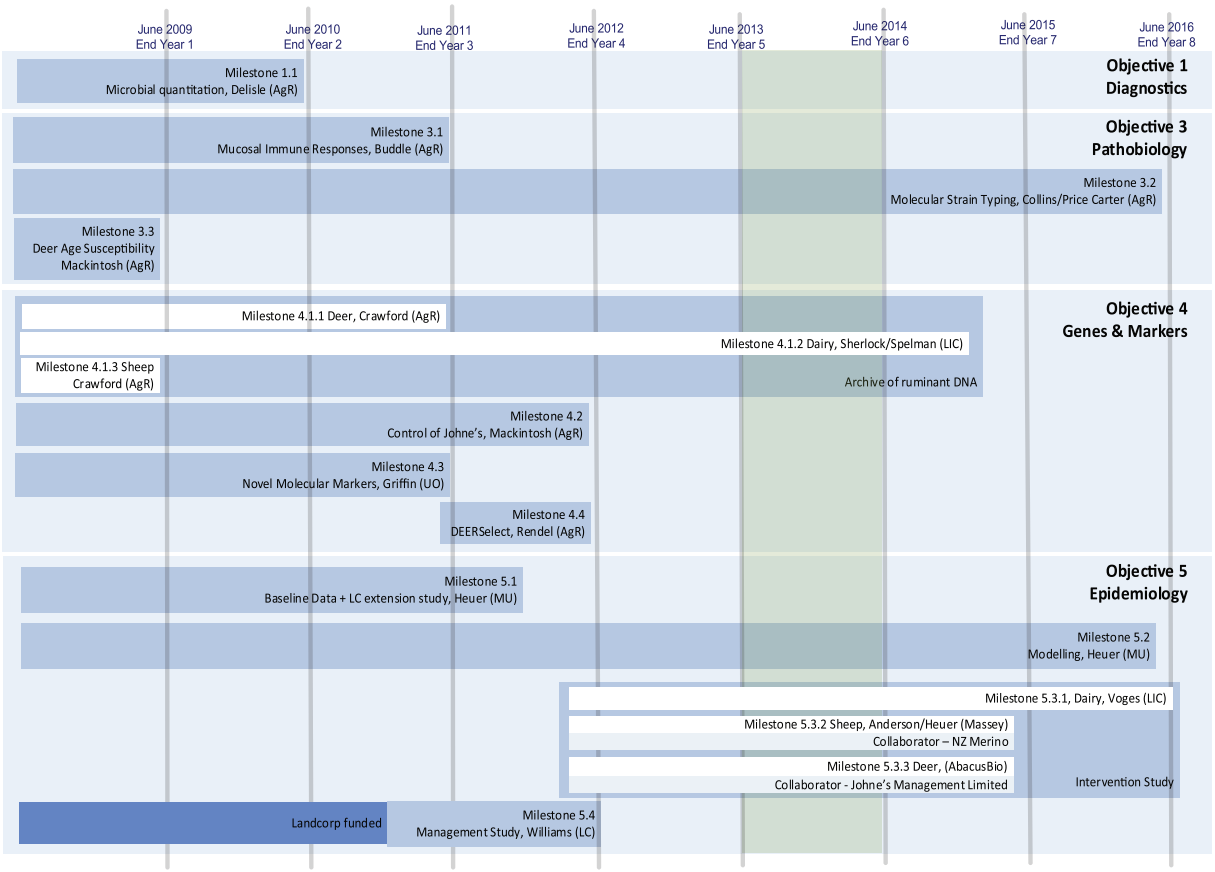
In the Sheep sector, a project team from the Vet Centre Marlborough and Massey University have been monitoring the cause of ewe death on farms with a high suspected incidence rate of Johne's disease. Data is being collected on twenty properties located around New Zealand. This work is being carried out in collaboration with The New Zealand Merino Company Limited.

In the Dairy Sector JDRC is working with Livestock Improvement Corporation to develop guidelines for the management of Johne's disease in dairy cattle, particularly for farms most affected by the disease. Twenty properties are enrolled in a 3 year programme to test the practicality and effectiveness of management techniques to reduce the impact of the disease in the New Zealand farming environment.

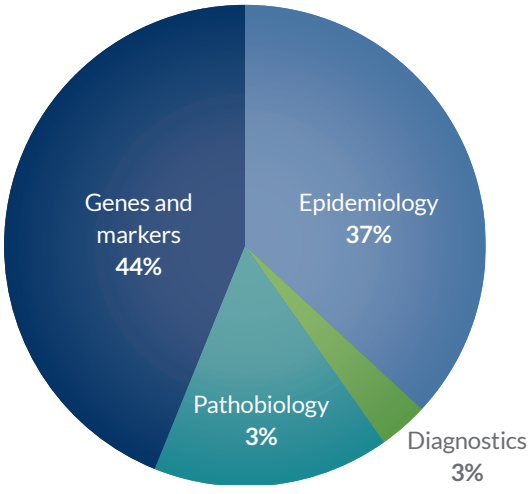
In the Deer sector AbacusBio Limited and Johne's Management Limited are working together to assess the impact of Johne's disease on farm and the utility of diagnostic testing. The study involves the sampling and testing of approximately 3000 animals and aligning farmer observation and test results to better understand disease management tools for Johnes Disease in deer.

[1] Formerly the Research Consortia Funding Scheme

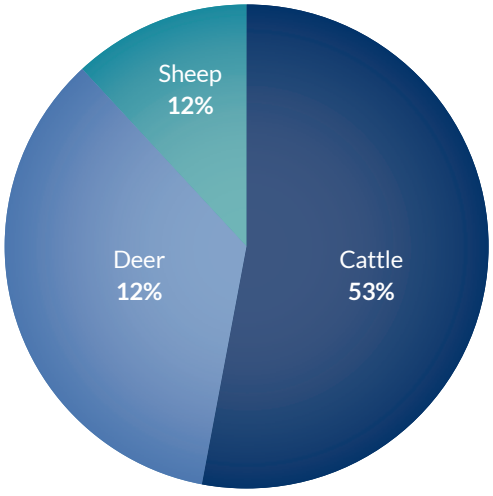
Science programme



Science funding by objective



Species funding allocation



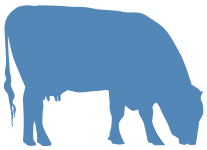
Sheep and beef sector

Data from the 2013-14 JDRC on-farm study indicates that sheep affected with Ovine Johne's disease (OJD) die approximately 6 months earlier than their counterparts, contributing to losses in flocks with a high incidence of Johne's disease.

The study, which is being completed in collaboration with The New Zealand Merino Company, began in 2012 and aims to investigate the true cause of ewe death on properties suspected to have high rates of Johne's disease[2]. To date researchers have found that while JD morality rates are high on these properties, there are also a number of other conditions that cause ewe death. Final data from the trial is expected in 2015.

Alongside the on-farm study JDRC has also been investing in the development of a simulation model to assess the effectiveness and economics of interventions for controlling OJD in sheep flocks. Data collected on-farm is being used to populate models and strengthen the predictions that are generated. From this work researcher's estimate, based on a population of 38 million adult sheep and 75% of farms being affected with disease, that the cost of OJD to the national economy is between $75-92 million annually. The model also predicts that vaccination to control OJD would be cost effective when OJD mortality on farm is >1.8%, but will not be economic if mortality is <1%. This data will be used to provide guidance to farmers and provide confidence for making decisions about when it is both practical and economic to actively manage OJD in New Zealand sheep flocks.

[2] Peter Anderson, Marlborough Veterinary Centre, Cord Heuer, Massey University



Dairy sector

The primary goal of the on-farm dairy intervention study is to develop practical guidelines for the management of Johne's disease in dairy cattle. In 2013-14 Livestock Improvement Corporation[3] completed drafting a toolbox which provides options for control of JD. The toolbox is largely focussed on calf health and minimising the transmission of infection to the most vulnerable animals in the herd. It describes both best practice for minimising the disease and also high risk practices that should be avoided to protect herds. The resource presents farmers and practitioners with a number of choices for controlling the disease so that tailored solutions can be developed to suit the needs of individual herds. The toolbox is due for publication in early 2015.

An integral part of the on-farm dairy intervention study has been a case control study, completed in 2014. Telephone and postal surveys were used to collect information about Johne's disease from approximately 1750 herds, with the aim of identifying risk factors for the disease in New Zealand dairy herds. Of those herds surveyed 23% noted JD as a serious or moderate concern, 48% had suspected or diagnosed JD on their farms in the past 5 years and 39% had a management plan in place for JD. Herds were more likely to be Johne's positive if they were large, if replacement heifers were transported off-farm at ≥5 months of age or if calves were raised on the property of birth for at least one month post-weaning. Herds were more likely to be Johne's negative if the predominant breed was Friesian or Kiwi-cross (Friesian-Jersey cross) or if they were located in the Bay of Plenty, Gisborne or Waikato regions rather than in the West Coast of the South Island. This information has been incorporated into the toolbox to improve advice to farmers.

Deer sector

The aims of the on-farm deer study are to provide a better understanding of the application of diagnostics to the management of Johne's disease in deer, to understand how JML's database of JD-suspect lesions (JDSLN) relates to the on-farm impact of disease and to provide case studies for the industry which demonstrate how Johne's disease has been successfully managed using the tools currently available to deer farmers.

In 2014 AbacusBio Limited[4] and Johne's Management Limited (JML)[5] have completed a survey of 151 deer herds to investigate the link between JD-suspect lesion rate and the on-farm impact of Johne's disease. Preliminary results show that there is a strong link between JD-suspect lesion rate, the impact of JD on-farm, and farmer concern about the disease. This is a positive result that provides support for the methodologies that JML uses to prioritise resources for controlling JD in New Zealand deer herds.

Final results from the deer study are expected in 2015 and the results will be used to formulate best-practice guidelines for the use of diagnostic tests for JD in deer. A series of workshops will be also be held in 2015 by JML to communicate the results of the study to the sector.

[3] Geoff Corbett, Anna Lowe; Livestock Improvement Corporation,Project Manager: Hinrich Voges. Contractor: Jaimie Hunnam, Cognosco

[4] Peter Fennessy, Neville Jopson; AbacusBio Limited

[5] Solis Norton; Johne's Management Limited

Sector wide developments

Reducing the impact of Johne's disease on farm is a multifaceted goal for the Consortium. The disease is complex and MAP remains a difficult organism to study. The bacteria grow slowly in culture systems, are difficult to detect and their effect on ruminant animals is usually long-term. The disease also manifests itself differently in different species which leads to a need for tailored management practices across the sectors. There are, however, many common factors between the species and much to learn about how the disease behaves in New Zealand's multispecies, pastoral grazing environments, which culd improve our overall ability to manage the disease long-term.

Strain typing

JDRC continues to invest in typing of MAP strains to better understand the epidemiology of Johne's disease and to determine if there are any distinctive characteristics in our MAP strains that would assist in management of the disease in New Zealand. Strain typing studies have helped identify a number of different sub-strains of MAP in New Zealand and has provided strong evidence that MAP is being transmitted from species to species in New Zealand livestock, most likely via co-grazing. In 2013-14, studies to distinguish MAP strains in samples collected in the deer, dairy and sheep on-farm studies have failed to find significant differences in MAP sub-types within species. While this could indicate that there are no differences to be found, it seems more likely to be that the typing methodology is not powerful enough to investigate the questions researchers are asking. Future studies will investigate the usefulness of Gene Sequencing for this research, a newer, more powerful tool for investigating bacterial strains.

Diagnostics

While the suite of diagnostic tests available for Johne's disease is not perfect, it is now understood that when applied correctly the tests can help control and minimise the spread of JD in livestock. In order to be most effective it is important that users understand the limits of a diagnostic test's capability and where and when it should be applied. Existing methods (including ELISAs, PCR and pathology based assays) are most robust for the diagnosis of clinical stages of disease. A test for reliably diagnosing sub-clinical or infected animals remains to be found.

As noted in previous reports the work of the Consortium has added support and understanding to New Zealand's ability to diagnose the disease using traditional diagnostic methods. A particular focus of the on-farm deer study is to provide guidance to farmers and practioners on the application and understanding of diagnostic testing in deer herds.

Industry resources

Three major factors have been identified as important in reducing the impact of MAP on farm; controlling on-farm transmission, preventing entry of the disease into the herd and maximising herd/flock health. Guidelines for the management of livestock, based on these three principles, are available for cattle, sheep and deer.

Johne's Advisory Group

The JDRC established the Johne's Advisory Group (JAG) in 2013 to provide advice to the JDRC Board regarding the science and management of Johne's disease both within New Zealand and internationally. The JAG is appointed by the JDRC Board and currently has 12 members, selected from across the dairy, beef and sheep and deer sectors, with expertise in farming, science, veterinary practice, extension activities, food safety and regulatory control.

In 2013-14 the JAG has bedded in a number of processes that will be used to support the monitoring and oversight of control and management processes. Specific JAG tasks included;

- A review of media and scientific publications (from January 2013 to April 2014) which identified developments both in New Zealand and internationally which are of significance for New Zealand
- A review of existing management guidelines for sheep, cattle and deer making recommendations for updating the documents
- A review of research priorities for New Zealand based on an analysis of on-farm risk of the transmission of MAP.

As a result of these reviews the JDRC has considered issues around the management of MAP contaminated effluent, vaccination in cattle and deer and the influences of changes to post mortem inspection requirements for OJD vaccinated sheep.

The establishment of the JAG is a key outcome for the JDRC that will ensure that gains from the JDRC collaboration are built on in the future for the benefit of the livestock industry.

2008–2014 findings and achievements

Across the species	Population based estimates of prevalence indicate 60% of dairy cattle, 52% of deer, 79% of sheep and 44% of beef cattle in New Zealand are infected with MAP. Levels of clinical disease are much lower, and within herd incidence of clinical disease is very low (<1%)		The incidence of Johne's disease shows regional variations in New Zealand, affecting deer and cattle most severely in the South Island and sheep in the North Island
	There is strong evidence that MAP is transmitted between species when animals are co-grazed, increasing the likelihood of infection on multi-species farms.		While increasing the risk of disease transmission, co-grazing appears to have potential beneficial effects on deer herds by reducing the incidence of clinical JD when jointly farmed with sheep
	There are at least 20 sub strains of Type C and 8 sub strains of Type S MAP found in New Zealand dairy cattle, beef cattle, sheep and deer however four of these sub-strains are responsible for ~89% of all infections.		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 to that found in deer
	On some farms animals can be infected with more than one strain type of MAP, suggesting the animals have been infected on more than one occasion		Computer models predict that early detection and removal of high shedders will be the most effective means of reducing the impact of Johne's disease in a herd of deer or flock of sheep
	The performance of faecal culture, pooled faecal culture, serological tests and combinations of these tests for herd level diagnosis of MAP infection has been investigated and knowledge applied to monitoring the status of sheep flocks, beef cattle and deer herds	2013-14	Surveys of deer, cattle and sheep have indicated that both infection with MAP and clinical disease affect productivity; lower pregnancy rates were seen in JD positive beef and deer herds, lower culling rates in JD positive beef herds, and higher culling rates in JD positive deer herds
Sheep and Beef	Computer modelling shows that co-grazing beef and sheep increases the prevalence of disease in both species. The longer the co-grazing period the higher the prevalence becomes		Computer modelling suggests JD is more difficult to control in sheep than beef cattle as interventions, such as test and cull, reduce prevalence faster and to lower levels in beef than sheep.
	Surveys and anecdotal evidence suggest that in most sheep flocks JD is a low level threat to animal health. Further information is needed about the true cause of ewe deaths on farm to understand the value of controlling the disease on farm		Clinical Johne's disease is rare in beef cattle in New Zealand. Most herds are infected with Type S strains of MAP, likely due to direct contact between sheep flocks.
	The annual cost of Ovine Johne's disease has been estimated at $2.2-3.2 per adult ewe. With 75% of the 38 million adult sheep estimated to be affected with OJD, the costs at a national level are in the order of $75-92 million	2013-14	Data collected on farm suggests that ewes with Johne's disease die at least 6 months earlier than their flock mates
	Modelling data suggests vaccination could be expected to reduce ewe mortality in a flock from 2.75% to zero over 9 years by continuous vaccination	2013-14	
	Modelling data predicts that vaccination would be cost effective in flocks where OJD mortality is ≥1.8%, but is not cost effective below 1% mortality		Guidelines have been published for the management of Johne's disease in sheep flocks

Dairy cattle

More than 5000 dairy herds have been screened for Paratuberculosis by bulk vat milk ELISA; 1% herds tested positive and 5% herds were classified as suspect		Bulk milk vat ELISA testing can be used to screen dairy herds for Johne's disease, but screening should not be attempted in late lactation as raised antibody levels in milk interfere with test performance
Dairy cattle are most likely to test positive to Johne's disease between lactations 3-6		Jersey cows are three times more susceptible to Johne's disease than Holstein-Friesians
A reliable challenge model for inducing MAP infection in dairy cattle has been developed, traditionally an area of difficulty for researchers worldwide		There is limited value in testing for JD infection in young cattle as both culture and serology can fail to detect infected animals
A DNA bank from ~2000 Johne's affected dairy cows has been established and DNA genotyped to find genes that may be related to resistance and susceptibility to Johne's disease		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
Guidelines have been published for the management of Johne's disease in Dairy herds		Johne's disease reduces the productivity of dairy cattle both seasonally and across the lifetime of a cow. Milk, fat and protein yields can be significantly lower in JD positive cows
A survey of 1750 dairy herds has indicated that 23% of herds rank their concern about JD as serious or moderate, 48% had suspected or diagnosed JD on farm in the past 5 years and 39% had a management plan in place for JD	2013-14	Survey data indicates that herds are more likely to be JD positive with increasing herd size and if replacement heifers are transported off farm at ≥5 months of age or calves are raised on the property of birth for at least one month post-weaning

Deer

Trials have proven that young deer are more likely to develop clinical disease on exposure to challenge with MAP than older animals		On-farm trials suggest that a proportion of deer with histopathological signs (lesions) caused by Johne's disease can self-cure (i.e. lose visible signs of the infection)
Whole herd test and cull, applied over 3 years can effectively reduce the incidence of deer testing Paralisa® positive for Johne's disease		Typing of MAP strains found in lymph node lesions of deer at slaughter show that all of the common MAP strains frequently cause clinical disease
Genetic parameters for measure of Johne's susceptibility in deer 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 module has been created for DEERSelect, to aid in the selection of JD resistant stock for breeding; however the module has not been implemented as the expected genetic gains do not currently merit removing selection pressure from other valuable traits
A bank of DNA from Johne's affected deer has been created and is available for future genetic studies		A list of genes which potentially may be markers for signalling resistance or susceptibility to JD in deer has been identified
Resistant and susceptible phenotypes in deer may be distinguished by the nature of their gene expression response to MAP challenge in vitro		Several key genes have been found related to MAP infection in deer. Their function suggests that susceptible animals develop severe disease due to uncontrolled inflammation and cell death processes. Resistant animals appear to be able to control cell death
Analysis suggests that pooled faecal culture and serology may not be suitable tests for determining "freedom from disease" in deer herds due to a high rate of false-positive diagnoses.		Computer models in deer predict that rotational grazing is preferred for disease control in deer over permanent grazing to minimise bacterial loads on pasture
Survey data suggests farmers rate losses due to JD culling as having more impact on farm than weaning losses	2013-14	Farmers that use consultants and participate in discussion groups are more likely to recognise the true impact of JD than others
Survey data indicates a strong link between lesion rate and on-farm impact of JD. 70-80% of farms with a low or zero lesion rate had a JD suspect death rate of less than 1%.		Survey data indicates that 77% of farmers feel JD is either declining or already at low levels in their deer, while only 23% rank the disease as a serious production limiting issue.

JDRC Board

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