



Developments in the Danish control program on paratuberculosis 2006-2014

Nielsen, Søren Saxmose; Krogh, Kaspar

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21 June 2014
Parma, Italy

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Preface

The Paratuberculosis Forum (ParaTB Forum) has been initiated by the International Dairy Federation (IDF) with the first event held in Shanghai, China, in 2006. The second ParaTB Forum took place in Minneapolis, USA, in 2009 and the third ParaTB Forum in Sydney, Australia, in 2012. The fourth ParaTB Forum was convened in conjunction with the 12th International Colloquium on Paratuberculosis. It was kindly hosted by the European Food Safety Authority (EFSA) in Parma, Italy, on 21 June 2014.

The ParaTB Forum provided an opportunity for people involved in the coordination and management of national and regional Johne's disease programs to engage in a frank and open discussion about methods used, progress towards program objectives, and lessons learnt.

This publication contains 17 papers from 15 different countries, all of which are being presented by program representatives on the day.

Acknowledgements go to Norma Arrigoni from the Istituto Zooprofilattico Lombardia Emilia Romagna in Gariga di Podenzano, Italy, and Nicola Pozzato from the Istituto Zooprofilattico Sperimentale delle Venezie in Verona, Italy, as the ParaTB Forum organizers and to the EFSA for sponsoring and hosting the meeting. Special thanks are expressed to Giancarlo Belluzzi from the Italian Ministry of Health and to Joerg Seifert of the International Dairy Federation for promoting the event and for facilitating expert participation. Finally, sincere gratitude is expressed to Animal Health Australia for their assistance which enabled Kelly Wall to compile the proceedings.

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4th PARATUBERCULOSIS FORUM**9.00am to 5.30pm Saturday, 21 June 2014***The Board Room (ground floor), European Food Safety Authority, Via Carlo Magno 1A, Parma, Italy***Program**

| TIME | COUNTRY | TOPIC | SPEAKERS | AFFILIATION |
|---------|----------------------------------|--|----------------------------------|---|
| 9.00am | Welcome and introductions | | Per Have | European Food Safety Authority |
| 9.10am | Austria | 8 years of Compulsory Measures Against Clinical Paratuberculosis in Austria – a Success? | Johannes Lorenz Khol | University of Veterinary Medicine Vienna |
| 9.35am | Belgium | The Perspective on Paratuberculosis Control in Belgium | Koen Mintiens | Boerenbond Research Department |
| 9.55am | Czech Republic | Control of Paratuberculosis in the Czech Republic | Petr Kralik | Veterinary Research Institute |
| 10.15am | Denmark | Developments in the Danish Control Program on Paratuberculosis 2006-2014 | Søren Saxmose Nielsen | University of Copenhagen |
| 10.40am | France | Existing Regional Control Programs on Paratuberculosis in Cattle Herds and National Standards for Certification of Freedom in France: Principles, Implementation and Results | Christine Fourichon | Oniris & INRA |
| 11.00am | Break | | | |
| 11.15am | Germany | Approaches to Controlling Paratuberculosis in Germany – Conditioned by Voluntariness and Federalism | Amely Campe and Karsten Donat | University of Veterinary Medicine, Hannover, Germany Animal Health Service, Thuringian Animal Diseases Fund, Jena |

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| TIME | COUNTRY | TOPIC | SPEAKERS | AFFILIATION |
|----------------|-----------------|---|-------------------------------|---|
| 11.40am | Ireland | Johne's Disease Control in Ireland - Past, Present and Future | Peter Mullaney and Sam Strain | Dept. Agriculture Food and the Marine Animal Health & Welfare N. Ireland |
| 12.05pm | Italy | Bovine Paratuberculosis In Italy: Building Infrastructures and Defining the Guidelines for Control and for Ranking of Herds | Norma Arrigoni | Istituto Zooprofilattico Lombardia Emilia Romagna |
| 12.30pm | Norway | Is the Norwegian Cattle Population Free for Johne's Disease? How to Prove? | Olav Østerås | TINE SA, Advisory Services, Ås, Norway |
| | | The Norwegian Healthier Goat Project | Dag Lindheim | TINE Dairies Norway |
| 12.55pm | Lunch | | | |
| 13.55pm | The Netherlands | Milk Quality Assurance for Paratuberculosis: Progress Obtained in the Cohort of Dairy Herds that Entered the Program in 2006-2007 | Marteen Weber | GD Animal Health |
| 14.20pm | Slovenia | Importance and Control of Paratuberculosis in Dairy Cattle Herds | Matjaz Ocepek | Veterinary faculty/National Veterinary Institute |
| 14.40pm | Spain | Regional Programs in Spain (no paper) | Joseba Garrido | Animal Health Department. Neiker |

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| TIME | COUNTRY | TOPIC | SPEAKERS | AFFILIATION |
|----------------|----------------------------|--|---------------------------------|---|
| 15.00pm | UK | A Review on Progress with Johne's Engagement Program in UK Dairy Herds | Peter Orpin | Myhealthyherd/ Park Vet Group |
| 15.20pm | Break | | | |
| 15.35pm | Australia | JD Control in Australia: Keeping Pace with National Animal Health Policies, the Challenges and Lessons Learned | Lorna Citer and Evan Sergeant | Animal Health Australia |
| | | Application of BJD Management Strategies in the Australian Dairy Industry | Robin Condron | Animal Health Australia |
| 16.00pm | New Zealand | Developing Intervention Options for New Zealand Dairy Herds to Mitigate the Impact of Johne's Disease | Hinrich Voges | Johne's Disease Research Consortium |
| 16:25pm | Canada | Johne's Disease Control in Canada - 2010-2013 - Successes and Challenges | David Kelton and Herman Barkema | University of Guelph Faculty of Veterinary Medicine, University of Calgary |
| 16.50pm | All | Discussion Intro "Which tools are available for accurate herd classification, and for what purpose?" | Nicola Pozzato | Istituto Zooprofilattico Sperimentale delle Venezie |
| 17.00pm | Discussion Cont.... | | | |
| 5.30pm | Close | | | |

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8 Years of Compulsory Measures against Clinical Paratuberculosis in Austria – A Success?

Johannes Lorenz Khol and Walter Baumgartner

Clinical Unit of Ruminant Medicine, University Clinic for Ruminants, Department for Farm Animals and Veterinary Public Health, University of Veterinary Medicine, Vienna, Austria

INTRODUCTION

The Austrian cattle population consists of about two million animals (Eurostat, <http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home>) kept in small farms with an average size of 12 cows and very few farms with more than 100 cows. In the past, two nationwide studies investigating the *Mycobacterium avium* subsp. *paratuberculosis* (MAP) prevalence in Austrian cattle were performed. From 1995 to 1997 Gasteiner et al. (1999) tested 2,757 Austrian cattle for MAP. Statistically balanced serum samples from the four oldest cows per farm were collected and analyzed using the Allied-ELISA (Allied Monitor, Fayette, USA). Positive and questionable samples were subjected to further testing with the more specific H-ELISA (Institute of Microbiology, University of Veterinary Science Hannover, Germany).

In a second study, performed in 2002 and 2003, cattle from 756 farms were tested serologically for the presence of antibodies against MAP (Dreier et al., 2006) at slaughter. Animals included in the study had to be at least two years old and were chosen in accordance to a sampling plan to achieve statistically balanced samples from all parts of the country. Blood samples were analyzed using the Svanovir™ ELISA (Svanova Biotech, Uppsala, Sweden) in this study.

In 1995-97 antibodies against MAP were found in 6.96 % of the farms, 14.54 % had a questionable result in at least one cow, and 78.49 % of the farms were tested negative for MAP (Gasteiner et al., 1999). The second study (2002/2003) revealed 19.05 % positive farms, 10.05 % were questionable and 70.90 % showed no evidence of antibodies against MAP (Dreier, 2003).

Although due to the diverse study design comparison of these two studies is restricted, the significant increase in serological positive animals from 1999 to 2003 is evident (Baumgartner et al., 2005). Based on these findings, the regulation of the Austrian Federal Ministry of Health on monitoring and abatement of clinical paratuberculosis in ruminants (Paratuberculosis-Regulation) came in force on April 3rd, 2006.

LEGAL REGULATIONS

Cattle, sheep, goats and farmed deer are affected by the regulation. Animals showing clinical signs of JD (Johne's disease) according to the major symptoms of the disease listed in the regulation, have to be notified to the district veterinarian. The animal under suspect has to be separated from the herd, slaughtering and the delivery of milk is prohibited. Blood and faecal samples of the suspicious animal is collected by the district veterinarian and sent to the National Reference Laboratory for Paratuberculosis of the Austrian Agency for Health and Food Safety.

If severe emaciation, possibly caused by MAP, is noticed at slaughter or necropsy, samples including liver and intestinal lymph nodes (ileoocaecal) as well as parts of the small intestine have to be sent to the national reference laboratory.

Blood and faecal samples are tested and adjudged by ELISA and PCR by the national reference laboratory for paratuberculosis following the scheme shown in Table one. Lymph node and intestine samples collected at slaughter or necropsy are tested for MAP by PCR. A positive result leads to the result “positive” and a negative PCR result to a negative animal respectively.

Animals with suspected JD proven to be MAP positive have to be culled within three days and need to be disposed. Additionally, hygienic precautions listed in the regulation are directed by the state veterinarian and the farm is checked for further animals with signs of clinical JD. After culling, compensation for culled animals depending on age and value of the animal is paid by the government.

Due to the difficulties in the diagnosis of subclinically infected animals, ruminants with a positive ELISA or PCR result for MAP but not showing any clinical signs of JD are not affected by the regulation.

IMPLEMENTATION AND ACCEPTANCE OF LEGAL REGULATIONS

During 2006 and 2011 samples from 759 cattle with symptoms of JD originating from 325 farms were sent to the national reference laboratory based on the Paratuberculosis-Regulation. Of these animals, 254 (33.5%) were tested positive for MAP resulting in 125 (38.5%) MAP positive farms. Samples from 29 sheep from seven different farms resulting in two (6.9%) positive animals and two (28.6%) positive farms were analyzed during the same time period. Additionally, 14 goats from eight farms and eight deer all originating from one farm were sent to the national laboratory between 2006 and 2011. Of the goats sampled, eight (57.1%) from two (28.6%) different farms were MAP positive as well as five (62.5%) of the sampled deer (Personal communication, Dr. Michael Dünser, National Reference Laboratory for Paratuberculosis).

Samples sent to the national reference laboratory were not geographical equally distributed but showed high variation between different federal states and districts. These differences were not related to differences in the livestock density and were much more distinct than geographic variations of the MAP prevalence seen in the national surveys. The most likely explanation for this finding is that the Paratuberculosis-Regulation is not implemented and supported in all districts and acceptance of the regulation highly depends on the veterinarians and state veterinarians involved.

DISCUSSION AND LESSONS LEARNED

The regulation of the Austrian Federal Ministry of Health and Women on monitoring and abatement of clinical paratuberculosis in ruminants (Paratuberculosis-Regulation) can be an important tool to decrease the incidence of JD in ruminant livestock. Due to insufficient diagnostics for subclinically infected animals, only ruminants showing clinical JD are affected by the regulation (Khol et al., 2007). It is well known that animals with clinical JD are only the tip of the iceberg and that there is always a significant higher number of animals subclinically infected with MAP (Whitlock, 1996). But, as animals in advanced stages of JD frequently shed high

amounts of MAP to the environment the elimination of these animals in livestock can cause a significant decrease of the bacterium in farms and the environment. This may lead to a reduction of MAP intake to the food chain and might help to prevent further spreading of the disease (Khol et al., 2013).

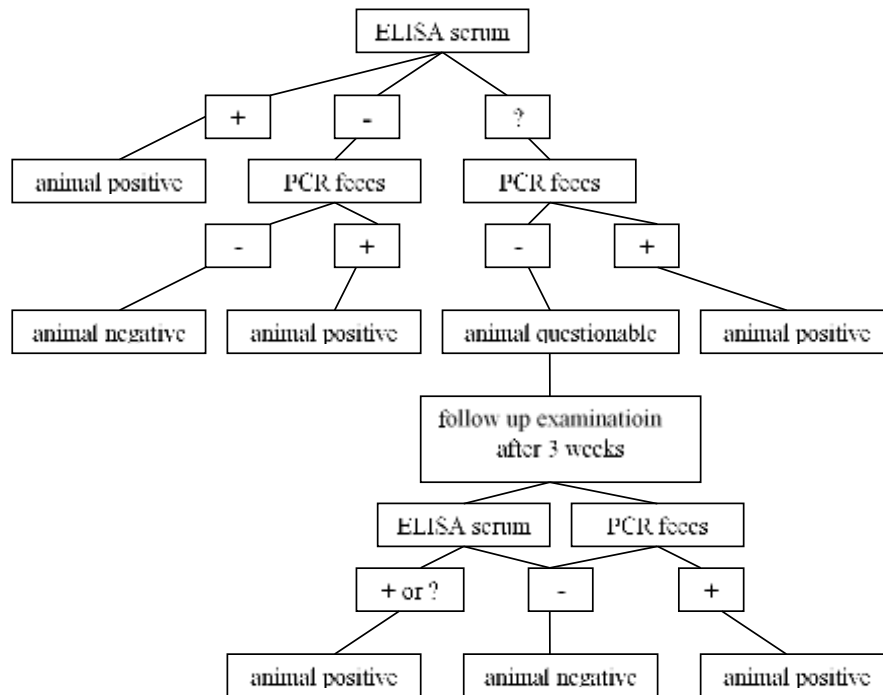
The reported 254 cattle with symptoms of JD actually tested positive for MAP based on the regulation from 2006 to 2011 is actually lower than expected. A possible cause can be an overestimation of the MAP prevalence by the two ELISA-based nationwide studies mentioned above. It is also known, that animals infected with MAP are often culled for reasons not directly related to JD such as decreased milk yield, mastitis, fertility problems or poor development, before showing clinical signs of the disease (Hasanova and Pavlik, 2006).

Legal regulation of an animal disease introduces social and economic disincentives for farmers and veterinarians to notify the authorities, making the acceptance of such regulations by veterinarians and farmers crucial for a successful implementation. One incentive, beside the fact that it is an offence not to comply with the regulation, for farmers to contribute to the regulation could be the compensation paid for culled animals. Industrial and public pressure as well as economic impact of the disease could work as an additional force and overbalance possible disadvantages for the farmer by being known to have MAP positive animals.

An important additional effect of declaring clinical JD a notifiable disease with compulsory culling of affected animals is that consequently the disease is recognized as important by farmers, veterinarians and consumers. The introduction of the Paratuberculosis-Regulation in April 2006 caused many discussions about the disease, control strategies of MAP in livestock and the usability of the regulation in Austria.

The future will show if the Paratuberculosis-Regulation can fulfil the expectations of the lawmakers and is a suitable tool for the reduction of JD. For sure a lot of information and awareness training still is necessary to persuade those who are keeping and working with ruminants to follow the guidelines of the regulation and contribute to prevent further spreading of the disease.

Table One: Test scheme for the detection of MAP in clinical affected ruminants according to the Austrian regulation for paratuberculosis.



MAP: *Mycobacterium avium* spp. *paratuberculosis*

ELISA: Enzyme Linked Immuno Sorbant Assay

+ : positive result

- : negative result

? : questionable result

From: KHOL, J.L., DAMOSER, J., DÜNSER, M., BAUMGARTNER, W. (2007): Paratuberculosis, a notifiable disease in Austria- current status, compulsory measures and first experiences. Short Communication, Prev. Vet. Med. 82, 302-307.

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Paratuberculosis in Belgium

Koen Mintiens

Boerenbond – Research Department, Diestsevest Belgium

The Belgian dairy industry can rely on a voluntary paratuberculosis control program which is supported by all the stakeholders in the milk production chain. The objectives of the program are to reduce the economic impact of ParaTB on dairy farms and to support the high-quality of milk for consumption. The program started in winter 2006-07 and the number of participating herds has constantly been increasing. At the end of its 7th campaign (2012-13) 35% of the targeted dairy farms participated to the program and 79% of the tested herds obtained the low-risk A-status.

INTRODUCTION

A large cross-sectional serological survey revealed in 1997-98 that approximately 6% of the Belgian cattle herds were infected with paratuberculosis. The prevalence was estimated to be higher (10%) in dairy and mixed herds compared to beef herds (3%). The study also showed that 2% of all cattle were infected with *Mycobacterium avium* subsp. *paratuberculosis* (MAP). A cross-sectional study, which was directed to dairy farms with on-farm delivery of milk, resulted in 2004-05 in a 30% herd-prevalence and 1% animal-prevalence. The ParaTB situation was not dramatic but still the dairy farmers decided to roll out a control program to reduce the economic consequences and to promote the image that milk is healthy. The first campaign started during the winter of 2006-07 and the program has been repeated during the consecutive winters since then.

CHARACTERISTICS OF THE PROGRAM

Dairy farms with an economic considerable milk production (based on milk quota) can participate to the Belgian ParaTB control program on a voluntary bases. The program involves all stakeholders: farmers, dairy industry, milk quality control organisations, animal health organisations and is coordinated by the regional animal-health organisations (DGZ and ARSIA). Participation is voluntary but requires a number of compulsory actions to be taken by farmers when they commit to step into the program. The program is financially supported by the Belgian milk production chain.

The program is restricted to specific annual campaigns which run from December 1st to April 30th and during which all participating herds are sampled. They will undergo a complete serological screening on individual blood or milk samples from all lactating cows of at least 30 months of age. All samples are taken by the veterinarian and the farmer may request to sample addition non-lactating animals of more than 30 months where all test results will be considered in the program. From a limited number of seropositive animals resulting from the screening, additional faeces samples are taken for detecting MAP through PCR-analysis, which is required for obtaining the low-risk A-status (see below). In case the result of the additional PCR analysis is positive, the animal needs to be removed from the herd as soon as possible and directed to slaughterhouse or rendering plant.

Every participating herd receives a status based on the apparent MAP prevalence in the herd and the speed on which positive or excreting animals are removed from the herd to slaughterhouse

or rendering plant. The details of the different risk levels are described in Table one. The individual herd status levels are assigned in July after the campaign is closed.

Table One: Levels of ParaTB herd status in the Belgian control program.

| Level | Definition | Criteria | Actions | Financial support |
|-------|-------------|--|---|-------------------|
| A | Low risk | All lactating animals > 30 months and additional examined animals tested negative, or Max. 2 seropositive animals (small herds) or max. 2% apparent sero-prevalence, but all animals are PCR-negative, or positive animals are removed within 2 months after test result. | Bi-annual sampling of lactating animals Immediate removal of positive animals (within 2 months after test result) | Yes |
| B | Medium risk | More than 2 seropositive animals (small herds) or 2% apparent sero-prevalence Positive animals are removed before the removal deadline of the campaign (30 June) | Annual sampling of lactating animals Removal of positive animals before the removal deadline of the campaign (30 June) | Yes |
| C | High risk | Positive animals are not (directly) removed to the slaughterhouse or rendering plant | Annual sampling of lactating animals | No |

RESULTS

The number of participating herds has constantly been increasing throughout the consecutive campaigns, as shown in Figure one below. At the end of the 7th campaign (2012-13), 35% of the targeted dairy farms participated to the program. Seropositive animals were found on 22% of the participating farms and the overall apparent animal seroprevalence was estimated at 1.7%. In total 79% of the tested herds obtained the A-status. Of the remaining herds, 9% obtained a B-status and 12% a C-status.

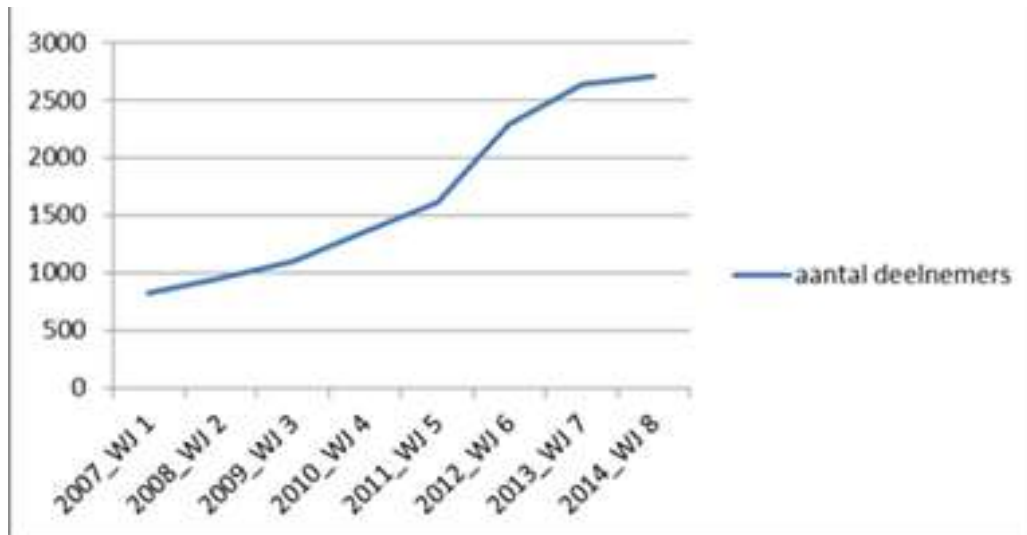


Figure One: Participating farms throughout the different campaigns (Flanders only).

CHALLENGES FOR THE FUTURE

The dairy industry wishes to promote the image of healthy milk as a quality label for the milk products they produce. More and more dairy companies oblige the farmers to participate to the program as a condition for supplying their milk. Therefore many more farmers will have to invest in ParaTB testing through the program, where they will not receive an incentive from the dairy, which leads to a debate about responsibilities. Another issue which rises here is of course the poor sensitivity of the serological tests which are used to detect infected animals. This will result in a false confidence in the quality of the milk that is supplied.

For the next campaign, the financial support by the milk production chain will be reduced by about 40%. At the same time, more farmers will subscribe to the program because of the pressure placed by the dairy industry. This means that the financial support to the individual farmers will reduce with 50%, which may hamper the sustainability of the program. In order to reduce the diagnostic costs, detection of MAP in environmental samples obtained on the farms is currently investigated.

Control of Paratuberculosis in the Czech Republic

Petr Kralik and Iva Slana

Veterinary Research Institute, Brno, Czech Republic

INTRODUCTION

The control of paratuberculosis in the Czech Republic is covered by the Veterinary Law. Historically, there was a Paratuberculosis control program based on culture in the Czech Republic and was supported by the government (payments for the laboratory examinations and compensation for the farmers for the culled animals). The basis of the Paratuberculosis control program was that all animals found to be positive by culture in faeces (i.e. not only animals in clinical state of the infection) had to be removed immediately. ELISA was employed only partially. There were very strict rules for farmers dealing with the restrictions of the trade and movement, separated calving, separation of the calves, etc. However, despite of the financial compensation for removed animals and culture examination of the herd, there were no significant results. Moreover, the time needed for the control was long and farmers violated the recommendations.

Nowadays the control strategy is described in the Methodical Manual of the State Veterinary Administration No.5/2008. The Methodological Manual recommends to perform ELISA examination as the preferred method (and to confirm positive cases by culture or PCR). All positive findings must be reported and State Veterinarian must visit herd. If there are no clinical signs of paratuberculosis in the herd, no precautions are taken. Clinical cases must be confirmed by direct detection method. Subsequently, restrictions in trade and movements of the animals are applied and the precautions are controlled in defined time intervals. After the clinical signs of paratuberculosis in the herd are eliminated, the restrictions are cancelled.

Because the Paratuberculosis control program is no longer supported neither by the state compensation or insurance companies, the will of the farmers and owners of the cattle to control paratuberculosis is rather low. These issues led reduction of numbers of the herds with some control programs. Currently, there are only several official outbreaks of paratuberculosis in the Czech Republic.

AIMS AND OBJECTIVES

The objective is to turn the attention of farmers back to control of paratuberculosis.

LESSONS LEARNED

Current approaches relying solely on a single method either failed or do not have any measurable effect.

IMPROVEMENTS TO BE MADE

We propose to involve farmers more deeply in the control of paratuberculosis. The main motivation for them to keep the recommendations is via their partial or full financial contribution. Therefore, it is important to propose the farmers a complete solution for paratuberculosis. This package should include the cost effective, fast and reliable methods and clear recommendations for different scenarios. Specifically, it should consist from the recommendations how which approach should be used to determine the presence of infection of the level of herd, which methods should be used for the control of young animals entering the

herd and in which time intervals, how to effectively remove infected animals from the herd at low cost, how to keep the herd at very low serological and bacteriological prevalence of paratuberculosis and no clinical signs, etc.

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Developments in the Danish Control Program on Paratuberculosis 2006-2014

Søren Saxmose Nielsen¹ and Kaspar Krogh²

¹*Department of Large Animal Sciences, University of Copenhagen, Frederiksberg C, Denmark*

²*Knowledge Centre for Agriculture, Aarhus N, Denmark*

INTRODUCTION

Mycobacterium avium subsp. *paratuberculosis* (MAP) has been present in cattle herds in Denmark for 100-150 years. The pathogen and associated disease have received variable attention during that period of time, probably due to variable effects across farms and over time within farms, lack of specific tools to deal with the infection, variable prevalence, lack of political attention and stigmatisation of infected herds.

A prevalence study carried out in the 1960's showed that 2.3% of adult cattle at slaughter had lymph nodes which cultured positive for MAP (Jørgensen, 1965). The herd-level prevalence was not established, but slurry samples from a random sample of 125 cattle herds collected in 1979-80 were positive by culture in 12% of the farms (unpublished data by JB Jørgensen, c.f. Larsen and Munch, 1981). However, the diagnostic accuracy of the tests mentioned above was never reported, and no reliable data on the true prevalence exist.

MAP was by the end of the 1970's guesstimated to incur losses of 0.1% of the national production from cattle, and therefore considered insignificant on a national level (Flensburg and Munch, 1980). It was acknowledged that some herds would experience significant losses, but these herds should use vaccination combined with hygienic measures to reduce transmission and ultimately the problem. In 1980 it was noted from the Danish Veterinary Directorate that the concentration of cattle on fewer and fewer premises combined with the "peaceful co-existence of MAP and cattle", it would not be possible to avoid MAP in practically all herds within a certain period of time.

In 1999, a study including 2,709 of the approximately 12,000 dairy cattle herds in Denmark, estimated the true between-herd prevalence to approximately 83% based on bulk tank milk testing (unpublished data by SS Nielsen). Two other unpublished studies, one based on cow-level antibody recording (from 2000) and one based on environmental sampling (from 2006), subsequently suggested that the true prevalence was around 85% (unpublished data by SS Nielsen). The conclusion was that MAP was widespread in the Danish dairy cattle population, as predicted in 1980. However, it is not possible to determine if MAP was already widespread much earlier.

Simultaneously with prevalence studies in the 1998, 1999, 2000 and 2006, a number of projects were on-going focusing on: a) research on use and interpretation of diagnostic information; b) pathogenetic and infection dynamics studies; c) epidemiology and control measures; d) economic impact of the infection; and e) communication regarding the prevalence, diagnostics and options for control. Communication was identified as central to alleviate the stigma associated with the infection, and a key message in that regard was that because of a high prevalence, most farms were likely infected, and that the few farmers would be able to make probable that they were not infected. Interest in communicating about the infection increased, and farmers started demanding that tools used in the research projects, most notably diagnostic tests and risk

assessment tools, were made available in a voluntary national program. This program was launched in February/March 2006 (Nielsen et al., 2007).

AIMS AND OBJECTIVES

The objectives of the program were to provide farmers and advisors with tools to control the infection, and to reduce the prevalence on national level. The program includes dairy herds only, because the beef industry is fairly small and with a more fragmented structure, and the prevalence is much lower (Okura et al., 2010). The objective of this paper is to summarise the efforts made in the voluntary Danish paratuberculosis program from March 2006 to March 2014, to describe the development in the prevalence in the same period, and to summarise the lessons learned.

PROGRAM ELEMENTS AND DEVELOPEMENTS

The program is a risk-based control program based on international and Danish research (Nielsen, 2009a; 2009b). This means that individual cows in all enrolled herds are tested four times per year using an indirect milk ELISA for detection of MAP specific antibodies. The cumulated results from each animal are used to make a risk-profile for that animal, and a certain set of recommendations adhere to each risk profile. The crudest interpretation of the test results leads to a model including three groups of cows: Red, Yellow and Green, where the Red are recommended culled prior to next calving, the Yellow cows should adhere to specific management practices e.g. to improve hygiene around calving, whereas no specific MAP related hygienic measures are associated with Green cows.

Testing is done via two models: i) full-scheme, where all lactating animals are tested at each of the four herd tests; or ii) reduced scheme, where cows > 180 days from the next calving are skipped if they have previously tested negative. Thereby, all cows that are dried off and enter the calving area still have “valid test results” (individual results are only deemed valid if < 4 months old). If a herd is enrolled in the program, testing is done automatically on milk samples from the routine milk recording scheme. Thus, when the milk samples enter the laboratory for assessment of somatic cell count, fat and protein, they are also tested for MAP specific antibodies if the herd is up for testing. The farmer can therefore not avoid testing, if he/she is enrolled.

Test-results are transferred to the Danish Cattle Database, and the farmer and his advisor can “extract” the results in a variety of management reports. They are presented in different interpreted forms, e.g. split into High-Risk (Red and Yellow) and Low-Risk (Green) for management in relation to milk and colostrum feeding, and management at calving, a list with “risk calves” e.g. calves born to Red or Yellow dams etc. Examples are given in Nielsen (2009c).

The above-mentioned program elements primarily focused on within-herd transmission, and although trade of livestock from non-tested herds was generally discouraged, this was the primary recommendation to reduce between-herd spread of MAP. In 2011, a certification component was added to the program to provide a tool for risk-based management of between-herd spread (Krogh and Nielsen, 2012). This certification scheme is two-dimensional, taking into account the herds own prevalence and the prevalence of the herds from which livestock is purchased. No purchase of livestock combined with a high probability that the true (calculated) prevalence is 0%, can result in the best category, whereas purchase of animals from untested herds and a high prevalence in own herd results in the worst category. Less than 200 herds are signed up for this part, despite that the costs are the same as for the rest of the program, i.e. a flat 350 DKK yearly (~50 EUR/year), covering costs for management, reports and system

administration (costs for testing not included). The certification component are by many farmers perceived as complicated and have also for practical reasons not reached the acceptance level that were anticipated.

Three months after the start of the risk-based control program, 600 dairy herds (12%) were enrolled. This had increased to 25% the following year, peaking in 2009 with 29% of herds and almost 36% of the cows (Figure one). By April 2014, 946 (27%) of the 3503 dairy herds in the country were still enrolled in the program, but only few new ones signed up in 2013 and 2014. Approximately 30% of those leaving the program in 2013 did so because they ceased milk production. The reason for the remaining 70% leaving the program was not known.

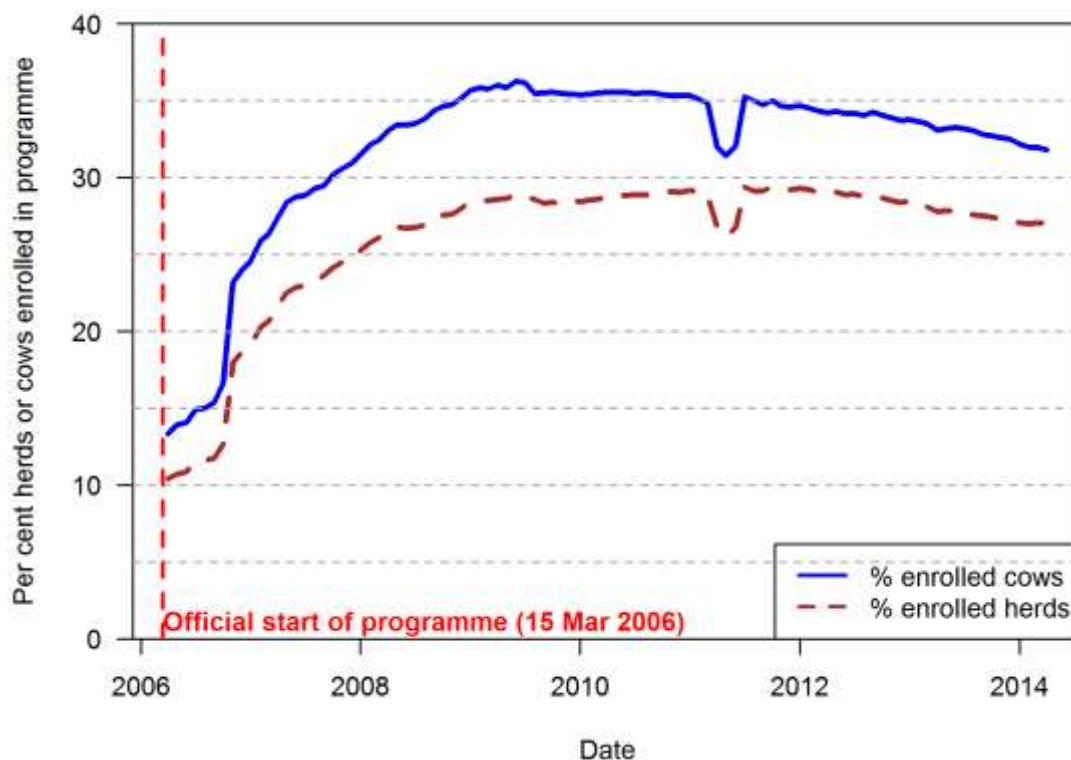


Figure One: Development in the prevalence herds of enrolled in the Danish paratuberculosis control program. The apparent decrease and increase in 2011 is a technical artefact caused by changes in the Danish Cattle Database, not by actual resignation from the program.

LESSONS LEARNED

The test prevalence on cow-level has decreased significantly from 2006 to 2014. An in-house ELISA was replaced by the commercial ID-Screen test (ID-Vet, Montpellier, France) in 2008. The two tests were not immediately comparable, and therefore the results were not either. However, the median within-herd test-prevalence at program start, using the 'scale' of the commercial test, was estimated to >10% for herds enrolled in 2006-2007. The median test-prevalence after one year in the program was 8% in these herds. And after seven years, the median test-prevalence was approximately 2%. The test-prevalence had thus decreased significantly.

A comparison of the median test-prevalence of 3.1% in the cohort of herds starting in 2006-07 to a median within-herd test-prevalence of 5.5% in 99 non-participating herds in 2011 indicated a significant difference. These data sources thus suggest that the prevalence has decreased and

that an effect of the program exist. However, an effect of specific management practices, except from culling of test-positive and keeping the herds closed or purchase of livestock at a low level, has not been demonstrable (Nielsen and Toft, 2011).

A possible explanation is that it is not possible to record what the farmers actually change, when they participate in a control program. The act of enrolment may have sparked transmission reducing initiatives that are non-recordable in some herds, whereas other farmers stating that they have made some transmission-reducing management changes have done so without effectively reducing transmission. Another explanation is that culling of animals that are repeatedly positive in milk antibody ELISA may have a long-term effect on reduction in the transmission. This possibility is indeed something that could require further investigation, because it could have a great impact on future recommendations for management of MAP transmission. However, it also relates to another lesson learned: the meaning of “test-positive” needs to be carefully communicated, because it can have devastating implications on several levels. Firstly, ELISA results may be false-positive.

The specificity of the test in the program has been estimated to 98.7% (Nielsen et al., 2013), so farmers should expect that a positive test can be followed by a negative. It should be clearly communicated. The way to do this has been to recommend never making decisions based on single results: A positive result can easily be followed by a negative. This can be the case for non-infected cows, but also infected cows: of cows deemed to have antibodies based on positivity of their last two samples tested, only 79% were repeatedly positive from first to last tested sample. So a large proportion of cows could have variable antibody reactions before they ultimately have a permanent high antibody level (Nielsen et al., 2013). Dealing with variable results is indeed a challenge, but it has also been feasible. In the beginning of the program, this aspect was explained over and over again. The outcome was in many instances interested farmers and advisors rather than grudging participants.

Another lesson learned has been that funding options have been few after the initiation of the program. A general impression left from funders has been: “A program exists so there is no need for further research”. However, the program aims to reduce the with-in herd prevalence as well as the prevalence of infected herds, not certify herds free or to keep them free. Simultaneously, few herds have seen the need to be certified when this cannot be done with 100% certainty. There is a great need to 1) develop methods to reliably certify herds free of infection once they have been infected; and 2) retain farmers in the program on a cost-effective test-scheme once they have eradicated MAP from their herd. High test costs due to four annual test rounds as with the current system is not seen as beneficial. This means that farms with low prevalence or near completion of their efforts simply leaves the program, without any monitoring taking place, and with focus on the infection disappears.

The majority of herds enrolled in the program have successfully reduced the test prevalence. However, a large proportion of herds are not enrolled, and their average prevalence seems higher than those who previously enrolled with a higher prevalence. Nothing has been done in these herds, and they may constitute a major source of MAP in the future. Should they experience problems, then the tools should still be available. The prediction from 1980 may have come true, but it also appears that reversion of the situation is possible given the right approach and attitude.

IMPROVEMENTS MADE

A number of improvements have been made over the years. These have mainly been suggested through an advisory board including herd health advisors. This board has ensured that comments from practice have been addressed continuously. For example, a major focus on on-farm heat-treatment of milk was made at some point in time. This led to a review of literature, resulting in recommendations on heat treatment of milk and colostrum if this was chosen by some farmers.

A continuous focus on communication of practicalities and result interpretation has been instrumental in keeping contact to farmers and keeping the focus of the program. Specific technical improvements have also been made, e.g. a) identification of herds to be sampled is currently completely automatic to reduce the risk of human errors and farmers wishing to establish own test-schemes; b) development of new test-reports and features for better use of test-results; c) an option for reduced test-costs through reduced sampling; and d) a feature where a farmer can compare his prevalence to the prevalence in other herds at the same time. However, the main framework of the program and recommendations has not really changed, and the decrease in the test-prevalence suggests that the framework has been useful. Renewed focus to keep the trend and keep farmers who might have eradicated MAP from their herds is needed, along with focus on non-participating herds.

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Control of Paratuberculosis in Cattle in France: Components of National and Regional Voluntary Programs and their Application

Christine Fourichon and Raphaël Guatteo

Oniris, INRA, UMR1300 Biology epidemiology and risk analysis in animal health, Nantes, France

INTRODUCTION

Paratuberculosis control in France is based on voluntary programs. These programs are based on different components defined either at the national level, or regionally to account for local specificities and priorities in disease management.

At the national level, a program to certify cattle herds free from MAP infection has been defined in 2002 by ACERSA (Association pour la certification en santé animale). ACERSA is a non-for-profit organisation agreed by the Ministry of Agriculture, where representatives of the farmers' organisations involved in management of livestock health, trade, and genetic resources and representatives of the veterinary practitioners' organisations work together to define certification plans for non-regulated diseases. Recommendations on the content of control plans in MAP-infected herds have also been defined jointly by farmers and veterinarians' organisations (FNGDS and SNGTV).

The implementation of the plans, their precise content, the support and incentives provided to farmers are decided at a regional level, by the GDS (Groupements de Défense Sanitaire). GDS group farmers on a voluntary basis in each "département" (a département is the smallest administrative territory level with governmental institutions). In areas with cattle farming, there are 1000 to 9000 cattle farms in a département. Depending on the local situation, implementation of control plans for non-regulated diseases can vary widely between départements. Indeed, local priorities and resources available to manage control plans depend on the size and type of cattle production, and on the progress of other control plans for endemic infectious diseases such as IBR or BVD for example. Therefore, it is very complex to provide a national picture on MAP control in France.

This paper aims at describing how regional control programs are implemented in Western France.

DATA SOURCES AND METHODS TO DESCRIBE REGIONAL IMPLEMENTATION OF CONTROL PROGRAMS

All GDS of 16 départements in Western France were visited in 2009. Overall, 74 492 cattle farms were registered in the area (national registration and identification statistics).

In each GDS, documents describing the MAP control programs were obtained: general description, contract with farmers who enrol, questionnaires for risk assessment, and annual reports on results... Moreover, a veterinarian or another person in charge of MAP control in the GDS was interviewed.

CERTIFICATION OF FREEDOM FROM MAP INFECTION

The ACERSA certification program has been proposed in 15 out of 16 départements. It started from 2004 to 2008. It relies on systematic testing of animals >24 months of age by either

ELISA, or faecal culture or PCR. In practice, ELISA is the method used for testing animals. In five départements, farmers can receive a financial incentive from the GDS (representing 25% to 100 % of the cost of testing).

Overall only 1% of the herds were enrolled in a certification for freedom plan (from 0.1% to 4.5%). Uptake remains very low. The main reason of this low uptake is that costs are high compared to benefits, except for a few farmers who trade animals of high genetic merit. Some GDS also state that management and follow-up of the plan is complex. There are some cases of farms certified free who face reoccurrence of positive animals at follow-up herd testing (either because of purchase of latently infected animals, or because some infected animals haven't been detected and removed from the herd due to lack of sensitivity of the tests). This contributes to a low attractiveness of the certification plans for farmers.

As a result, the number of cattle on the market issued from certified herds is very low and cannot cover the demand for replacement heifers.

Because of this low uptake, farmers' organisations in Western France (GDS Grand Ouest) have decided to develop a new regional system to classify herds into three categories: herd with a high probability to have MAP-shedding animals (sales of replacement animals should not occur), herd with a low to moderate probability to have MAP-shedding animals (sales of replacement animals should either not occur or be restricted to herds of similar situation), herd likely to be free or with a very low prevalence of MAP infection (sales of replacement animals to any herd). The main objective is to provide possibilities for farmers who want to increase safety of trade when they buy replacement heifers to find enough animals on the market. The criteria to classify herds are under development and evaluation. They rely mainly on combinations of pool samples and environmental samples, to keep costs at an acceptable level.

CONTROL IN MAP-INFECTED HERDS

All GDS propose a control plan for MAP-infected herds. Their implementation started from 1975 to 2000 (1975 to 1990 in the 12 départements with the highest density of cattle). Their content was periodically revised to account for new knowledge and new diagnostic methods available. All plans rely on test-and-cull measures, risk assessment and improved hygiene management to prevent new infections, with a variety of precise measures. Farmers get support and some financial incentives if they cull positive animals, and subject to follow-up of their prevention plan.

Objectives of the control programs in Western France vary between the départements and can include:

- Reduction of the incidence of clinical cases
- Reduction of economic losses
- Reduction of the prevalence
- Limitation of the risk of trade of infected animals
- Reduction of the environmental contamination by MAP
- Protection of replacement young stock

Control plans are systematically proposed to farmers where clinical cases have been confirmed by a diagnostic test (which varies between départements), and in four départements when a positive result was found after a herd screening.

Overall, 4% of the herds were enrolled in a MAP-control plan (0.5% to 11% of the total herds, between-herd prevalence being unknown).

Test-and-cull is based on ELISA only in half of the départements, the other half combining ELISA and PCR. Positive animals must be culled within an interval defined by the GDS in 14 départements. This interval varies widely (from 1 month to 12 month, with a majority of GDS setting it at 6 months).

Besides, all clinical case must be culled. Again, the interval for culling varies from eight days after test result to one year (3 GDS give no maximum, 9 require culling within one month or less).

A visit by a veterinarian and/or a technician to assess risks and propose recommendations is systematically carried out in 13 GDS. Risk assessment relies either on a systematic questionnaire which differs between GDS (7 with scoring, 3 without scoring) or on a discussion with the farmer (with or without supporting documents). Follow-up visits on implementation of risk mitigation measures are done systematically every year in nine GDS, either by a technician or by a vet.

Incentives are provided to farmers for herd testing from 50% to 100% of the laboratory test costs, and in four GDS for sampling costs by the vet (50% to 100% of the costs). Compensation for culling of clinical cases is provided in 13 GDS (from 150€ to 600€ per culled animal), whereas ten GDS compensate culling of positive non clinical animals (from 50€ to 450€ per culled animal). Initial and follow-up visits for risk assessment are free of charge for the farmer in eight GDS and partially subsidised otherwise.

According to the GDS staff, the different reasons given by farmers for refusing to enter the plans when MAP has been detected are: control plan is too complex and puts too many constraints on the farm, trade of animals for live is restricted while in a plan, farmers don't want to cull positive animals with no clinical signs, farmers consider that paratuberculosis is not a problem in their herd, costs of the plans (especially culling) are too high.

OTHER COMPONENTS TO SUPPORT MAP CONTROL

A few other actions are proposed in some GDS to enhance MAP control, with large variations between départements.

Incentives to test animals at purchase are provided in eight GDS.

Incentives to detect MAP infection when merging separate herds or at settling of a new farmer are available in ten GDS.

Herd screening to detect MAP in absence of clinical cases or in case of suspicion can be partially subsidised (two GDS).

Besides, communication on control of MAP is systematically organised by the GDS.

ACKNOWLEDGMENTS

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Approaches to Controlling Paratuberculosis in Germany – Conditioned by Voluntariness and Federalism

Campe, Amely¹; Köhler, Heike²; Donat, Karsten³

¹*Department of Biometry, Epidemiology and Information Processing, University of Veterinary Medicine and WHO Centre for Research and Training in Veterinary Public Health, Hannover, Germany*

²*Institute of Molecular Pathogenesis, Friedrich-Loeffler-Institut, Jena, Germany*

³*Animal Health Service, Thuringian Animal Diseases Fund, Jena, Germany*

PRESENT SITUATION

Paratuberculosis was described first scientifically in 1895 by Heinrich A. Johne, a German bacteriologist, pathologist and veterinarian born in Dresden (Johne and Frothingham, 1895). The first activities to control paratuberculosis in endemic regions were initiated in the 1920's. The disease was endemic at that time predominantly in parts of Mecklenburg-Western Pomerania, north-western parts of Lower-Saxony, at the western borders of Westphalia and in Baden-Wuerttemberg (Huber, 1941).

Today paratuberculosis is a reportable animal disease (Anonymous, 2013). In 2005 the federal government published guidelines recommending hygienic measures, diagnostic approaches and status definitions of paratuberculosis in ruminant farms (Anonymous, 2005). These guidelines intended to harmonize measures taken in the German federal states with the overall aim to reduce clinical cases and economic losses for the farms. Prevention of a further spread of paratuberculosis and prevalence reduction were additional intentions. The guidelines include recommendations for:

- Hygiene measures (especially for the handling of young stock, colostrum management, restocking and purchase of cattle),
- Monitoring measures (clinical symptoms, serological as well as bacteriological testing),
- Measures to prepare an extensive, nationwide monitoring program to assess the prevalence of paratuberculosis.

Several of the listed hygienic measures are well-established in paratuberculosis control, i.e. rearing of calves separated from adult cattle, no cross-usage of materials (e.g. forks, wheelbarrows) and clothing between age groups, colostrum only from test-negative mothers. Moreover, some of the suggested measures go even further, i.e. washing cows prior to calving or testing every animal having diarrhoea lasting more than five days by faecal culture or PCR for *Mycobacterium avium subsp. paratuberculosis* (MAP). Since these guidelines have been published, producers consider most of the recommended measures expensive and difficult to be implemented and maintained.

Several federal states have taken first steps to assess paratuberculosis prevalence in (mostly dairy) cattle during the past ten years. Most of the federal states conducted baseline cross-sectional studies to get an impression of the current situation (see Table one). Results are difficult to compare because of the not harmonized study design, the sampling strategy, the tests used and the interpretation of test results. As concerns sampling strategies different study populations

were addressed (random selection, acquisition by vet, parallel testing of Bovine herpes virus 1 (BoHV1) surveillance samples, clinically suspicious or post-abortion animals). The age of the tested animals differed between the studies as well (all; >20 mth; >24mths). Different herd sizes were handled differently between the studies for sample size calculations. Most of the studies used serum samples applying commercial ELISA-tests, whereas some studies also included testing of individual milk samples or faecal culture. Some studies did not correct the apparent prevalence for test accuracy, whereas others corrected the apparent prevalence according to Rogan and Gladen (1978) based on the manufacturers specifications and on the manufacturers cut-off. Denzin et al. (2011) calculated 6.7% (3.0%-10.4%) as true prevalence for Saxony-Anhalt.

Therefore, a consideration of test accuracy estimates and a calculation would have been preferable over the apparent here as well (see Table one). However, it has to be questioned, if these calculations of the true prevalence can be meaningfully interpreted, although test evaluation studies are available even for Germany. It can be assumed that the study populations of the federal states of Germany do not resemble the study population of the test evaluation studies enough to allow for applying test accuracy estimates. Up to now only one study for Thuringia measured test accuracy based on the specific study population they intended to investigate (Donat et al., 2012).

Table One: Apparent Prevalence of paratuberculosis – based on published data of several federal states in Germany.

| Federal State | Apparent Prevalence | Test | Medium | Study Population (Animal Subgroup) |
|---|---------------------|------------|-------------|---|
| Animal Level | | | | |
| Bavaria (Köhler et al., 2011) | 0.012 | culture | faeces | n=10,013 / 431 farms (all) |
| Bavaria (Böttcher & Gangl, 2004) | 0.980 | Svanovir | Serum | n=2,748 / 119 farms (all) |
| Bavaria (Böttcher & Gangl, 2004) | 0.450 | Herd Check | Serum | n=2,748 / 119 farms (all) |
| Bavaria (Böttcher & Gangl, 2004) | 0.180 | Pourquier | Serum | n=2,748 / 119 farms (all) |
| Saxony and Thuringia (Köhler et al., 2011) | 0.287 | culture | faeces | -- (cattle for slaughter) |
| Hesse (Köhler et al., 2011) | 0.140 | culture | faeces | n=278 / [unknown number] farms (all) |
| Lower Saxony (Köhler et al., 2011) | 0.105 | culture | faeces | n=9,962 / 368 farms (all) |
| Mecklenburg-Westpomerania (Hacker et al., 2004) | 0.122 | Svanovir | milk/ Serum | milk samples (n=2,766); blood serum samples (n=231; all >20 months) |
| Rheinland-Palatinate (Köhler et al., 2011) | 0.089 | culture | faeces | n=1,927 / 233 farms (all) |
| Saxony-Anhalt (Denzin et al., 2011) | 0.042 | Pourquier | Serum | n=896 (all: female >24 mth) |

| Federal State | Apparent Prevalence | Test | Medium | Study Population (Animal Subgroup) |
|--|---------------------|------------|----------------|---|
| Thuringia (2006-2010) (Köhler et al., 2011) | 0.048 | culture | faeces | n=101,006 / 73-128 farms (all) |
| Saxony (pos=+ and inconclusive) (Donat et al., 2005) | 0.096 | Herd Check | Serum | n=55,394 / 493 farms (all) |
| Herd level | | | | |
| Bavaria (Köhler et al., 2011) | 0.107 | culture | faeces | n=10,013 / 431 farms (all) |
| Bavaria (Böttcher & Gangl, 2004) | 0.240 | Svanovir | Serum | n=2,748 / 119 farms (all) |
| Bavaria (Böttcher & Gangl, 2004) | 0.015 | Herd Check | Serum | n=2,748 / 119 farms (all) |
| Bavaria (Böttcher & Gangl, 2004) | 0.090 | Pourquier | Serum | n=2,748 / 119 farms (all) |
| Lower Saxony (Köhler et al., 2011) | 0.538 | culture | faeces | n=9,962 / 368 farms (all) |
| Mecklenburg-Westpomerania (Hacker et al., 2004) | 0.847 | Svanovir | milk/ Serum | milk samples (n=2,766); blood serum samples (n=231; all: >20 months) |
| Rheinland-Palatinate (Köhler et al., 2011) | 0.399 | culture | faeces | n=1,927 / 233 farms (all) |
| Saxony (pos=+ and inconclusive) (Donat et al., 2005) | 0.420 | Herd Check | Serum | n=55,394 / 493 farms |
| Thuringia (2006-2010) (Köhler et al., 2011) | 0.486 | culture | faeces | n=101,006 / 73-128 farms (all) |

Further investigations concerning the suitability of alternative, pooling methods have been performed in Germany, as well (e.g. bulk milk, milk filters, environmental sampling). Furthermore, MAP was cultured from 28.7 % of cattle without macroscopic lesions indicative for paratuberculosis in a slaughterhouse-study covering mainly animals from East German regions (Elze et al., 2013). Apart from dairy cattle paratuberculosis is also prevalent in sheep and dairy goats.

Based on these data it can be assumed, that there are considerable differences regarding the prevalence of paratuberculosis in the federal states of Germany. However, it cannot be deduced, if these differences yield from the different sampling strategies, the tests used and the different test performances or if they can be attributed to structural or regional differences. A systematic investigation of disease prevalence on herd and individual level is still due.

Apart from assessing the current situation in concerted studies more than 6,600 confirmed cases have been reported to the Animal Disease Information System (ISN) hosted by the Friedrich-Loeffler-Institut (FLI) between 1995 and April 2014. However, it has to be taken into account, that reports are biased by the disease awareness, triggered by regional control or compensation programs, and willingness of the farmer and the reporter to investigate cattle for this disease.

This is especially important, because positive results might hamper animal trade and export for several subsequent years.

Although a nationwide program has not been set up by now, several attempts have been made at regional level to monitor and control paratuberculosis. Most important to be mentioned is a control program with financial grants in Lower Saxony which was in place since 1998 (after conceding financial aids since 1973). The principle of the program, which lasts for five years per farm, is to screen cattle elder than two years with an ELISA test and to follow them up six months later with a faecal culture and skip between tests every six month further on. Mandatory measures to be taken by the farmer are the culling of positive animals, special treatment of calves (guideline available) as well as avoidance of introduction (purchase of free animals) and spread (no manure fertilization on pastures).

Farmers taking part in that program could ask back financial aids of the animal diseases fund for their slaughtered/culled animals. Costs for diagnostic testing and extinction of positive animals amounted to about 1.74 Mio. Euro in ten years. Therefore, financial grants were skipped in 2013 due to ineffectiveness as regards sanitation of paratuberculosis on any participating farm. The involved farmers reported their willingness and awareness of necessity to control paratuberculosis; however, they do not trust in the (long-term) effectiveness of their efforts at present.

At present, voluntary regional control programs exist in some federal states (North Rhine-Westphalia, Saxony, and Thuringia). They established own guidelines for testing, status definition and trade control. According to the statutes of the regional animal diseases funds, some federal states (Baden-Wuerttemberg, Bavaria, Brandenburg, North Rhine-Westphalia, Mecklenburg-Western Pomerania, Saxony, and Thuringia) provide aid to compensate for animals eliminated due to clinical signs or positive test results, or cover diagnostic costs, if farmers follow all terms and conditions of the statute and, if existent, the regional control program.

PARATUBERCULOSIS CONTROL IN THURINGIA

Thuringia has a 15 years history in paratuberculosis control. For decades the “Iron Curtain” prevented the introduction of paratuberculosis. About five years after the heavy purchase of Holstein Friesian dairy cows from the western part of Europe the first clinical cases appeared. During the first years attempts were made to control this reemerging infectious disease by culling of clinical cases, later on including the test positives, combined with compensation by the Animal Disease Fund. After very few years this approach was abandoned because of excessive increase of costs.

The first control program came into effect in 2003. It focused on improvement of the hygienic standard of calving, colostrum management, calf hygiene, food hygiene, and the elimination or pasteurization of waste milk for calf feeding purposes. The program included a bi-annual serological herd screening for MAP-antibodies by ELISA (test sensitivity 70.0%, specificity 76.6 %) and retesting of all MAP-antibody-positives by faecal culture. Faecal culture positive animals had to be culled within one month. Colostrum from antibody-positives was excluded from feeding. After five years the effect of the program was evaluated. There were no herds without ELISA-positive cows, and farmers complained about the increasing number of ELISA-positives

in their herds and problems to find cows for colostrum supply. The limited specificity of the ELISA test was considered to be the main cause for this effect.

Meanwhile a study of the national reference laboratory at the FLI had been published revealing a sensitivity of the test used in the control program of <20%, ranging from 15.1% for cows once positive in faecal culture to 40.2% for cows that were repeatedly culture positive (Gierke, 2010). Not surprisingly, the first whole-herd screenings by faecal culture in the control program herds identified a high number of MAP-shedders that had not been detected by the ELISA test. This higher within-herd prevalence resulted in a fading compliance of farmers to the control program which demanded large efforts without perceptible improvements. Analyzing our control program herds, it was recognized that the survival of MAP shedders within the herd after receiving the test result correlated to incidence reduction: If shedders were not removed from the herd or culled only after a long period, incidence did not decrease. Furthermore, the effect of control was related to management measures and hygiene status: Separate calving pens for MAP shedders and staff hygiene were significantly correlated to incidence reduction.

From these years the following was learned:

- Use a test you can trust, i.e. a highly specific test.
- Keep general management recommendations simple.
- Recommend herd-specific measures to improve the hygienic standard after on-farm status analysis.
- Do not make farmers afraid of killing their farms by culling their cattle.
- Ask the farmers about their goals and potentials and give realistic future prospects.
- Use the limited public money to support diagnostic tests rather than pay compensation and do not cover costs completely.

As a part of the re-evaluation of the control program in 2013, 116 Thuringian cattle farmers (82% dairy farmers, 27% already enrolled in the control program) responded in an anonymous survey (Table two). The results clearly indicate, that a danger to the milk and beef industries image by paratuberculosis is realized by a high percentage of cattle farmers and that the expected economic impact of paratuberculosis on milk production is another main stimulus to control the disease. Purchasing animals, nearly all cattle farmers are interested in the paratuberculosis status of the herd of origin. This leads to the conclusion, that the designated paratuberculosis status of a herd should guarantee a high level of security that an animal purchased from this herd will not introduce MAP into another herd.

Table Two: Results of an anonymous survey among Thuringian cattle farmers concerning their opinion about paratuberculosis control in 2013.

| Question | Responders | Yes | | No | |
|--|------------|-----|-------|----|-------|
| | | n | % | n | % |
| Do you consider paratuberculosis as a dangerous infectious disease? | 116 | 85 | 73.28 | 31 | 26.72 |
| Do you consider paratuberculosis a threat for the economy of milk production? | 116 | 90 | 77.59 | 26 | 22.41 |
| Do you expect a danger to the milk and beef industries image by paratuberculosis? | 114 | 106 | 92.98 | 8 | 7.02 |
| Do you expect that your herd is affected by paratuberculosis? | 115 | 37 | 32.17 | 78 | 67.83 |
| Are you already enrolled in the voluntary control program? | 113 | 31 | 27.43 | 82 | 72.57 |
| Would you take part in the paratuberculosis control, if MAP was detected in your herd? | 111 | 100 | 90.09 | 11 | 9.91 |
| Are you interested in the paratuberculosis status of the herd of origin, if you purchase cattle? | 116 | 115 | 99.14 | 1 | 0.86 |
| Would you favor a mandatory control program in Germany? | 115 | 89 | 77.39 | 26 | 22.61 |

Environmental sampling was applied within the control program herds to evaluate, if it was a cost-saving and easy-to-use approach to diagnose paratuberculosis at herd level, concerning the most efficient sampling strategies and its reliability in herds with low prevalence. A threshold level was calculated of the apparent Within Herd Prevalence (WHP), determined by individual faecal culture of all cows, thus allowing for the detection of a herd as MAP-positive at certain probability levels. The combination of three samples (milking area, main cow alleyways, holding pen) performed best with a WHP threshold of 2.9% for 50% probability of detection to 6.2% for 90% probability of detection when tested simultaneously both by faecal culture and qPCR (own data, submitted for publication). Similar thresholds were demonstrated for a combination of one boot swab and one slurry sample applying faecal culture and qPCR simultaneously (own data, not yet published).

Therefore, the control program was revised and the main pillars of the control measures were modified as follows:

- **Farm hygiene:** Herd-specific recommendations that can be realized 365 days a year with particular focus on measures with evidence to reduce the incidence:
 - Separate caving pens for MAP-positive cows (own data, not yet published).
 - Prevent contact of neonates to other cows after calving (Pillars et al. 2011).
 - Withdraw waste milk for calf feeding purposes or pasteurize (Pillars et al. 2011).
 - Ensure a high level of personal hygiene in calve rearing (own data, not yet published).
- **Diagnosis:** Annual testing of first lactation cows and all to date negatively tested cows by faecal culture.
- **Culling:** Is organized in accordance with the farmers objectives and potentials:

- High prevalent herds: do not rebreed shedders, cull if other problems occur.
 - Low prevalent herds: cull shedders immediately, if open; otherwise do not rebreed (there are serious ethical concerns to cull pregnant cows in Germany).
- **Status definition:** “Paratuberculosis-unsuspicious” cattle herds have:
- No positive results in the annual herd checks by faecal culture over three years (similar to level 6 of the national program standard of the USDA).
 - Purchased cattle only from herds in the same status (i.e. verification of status).
 - Maintenance of the status: herd check with no positive results every two years (from 2015: every three years and environmental sampling in the years in between).
- **Trade control:** Purchase cattle only from herds having the same status (i.e. control or verification or unsuspecting).

At present 115 herds (92 dairy, 23 beef cattle) with about 38.000 cows are enrolled in the program which represents about 25% of the Thuringian population (115.000 dairy cows, 40.000 beef cows). Out of these herds, 34 acquired the status “paratuberculosis-unsuspicious” during the last five years, and none of those herds had a reintroduction of MAP until now. Certainly, most of these herds are “historically free”, i.e. MAP was never introduced. Because these are nearly 30% of all involved herds, it can be concluded, that a relevant proportion of the Thuringian cattle herds is still free from paratuberculosis. Therefore, these herds are to be identified and protected by effective control of animal trade. Purchasing cattle, farmers of these herds are strongly recommended to ask for the paratuberculosis status of the herd of origin.

Previous experience indicate that without doubt, stamping out paratuberculosis in affected herds is a challenge. Fortunately, a few Thuringian herds had very few shedders and after immediate culling of these cows positive test results never occurred. These herds are now certified as “paratuberculosis-unsuspicious”. Analyzing the cumulative incidence of MAP-shedders in a subset of 25 control program herds, a reduction of the median of MAP incidence from 11.05% (n = 25) in 2008 to 4.04% (n = 25) in 2012 was observed (Figure one). Therefore, five years of control are a realistic period of time to halve paratuberculosis incidence.

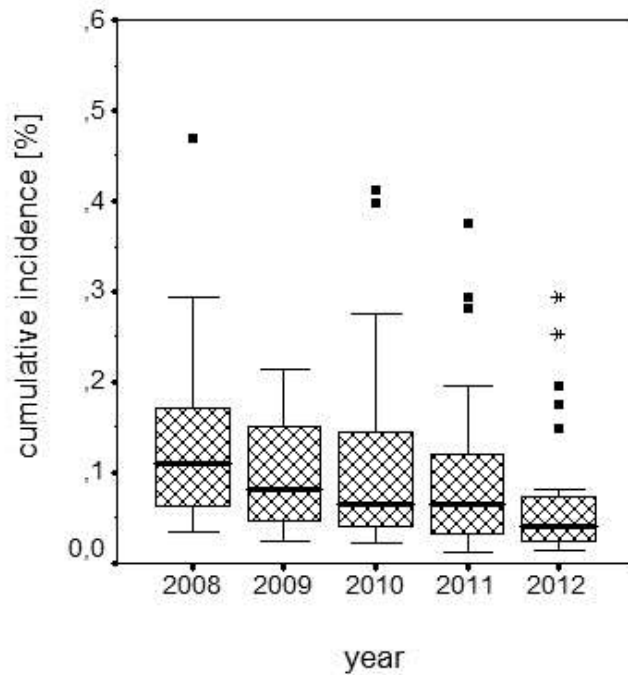


Figure One: Median and inter-quartile range of the cumulative incidence of cows shedding *Mycobacterium avium* spp. *paratuberculosis* (MAP) in five consecutive years in 25 dairy herds enrolled in the Thuringian paratuberculosis control program. ■ Statistical outliers, *Extreme values.

Considering the experiences from the Thuringian control program, a double tracked and partly risk based approach to control paratuberculosis can be suggested (Figure two) taking into account that stamping out the disease within some years is not a realistic objective for highly prevalent herds:

- Track A: Cattle breeders and probably paratuberculosis-free herds should aim to be certified as a “paratuberculosis-unsuspicious” herd in accordance with the rules described above.
- Track B: Dairy farmers should at least control paratuberculosis in their herds to a level that ensures a reduction or elimination of economic losses.

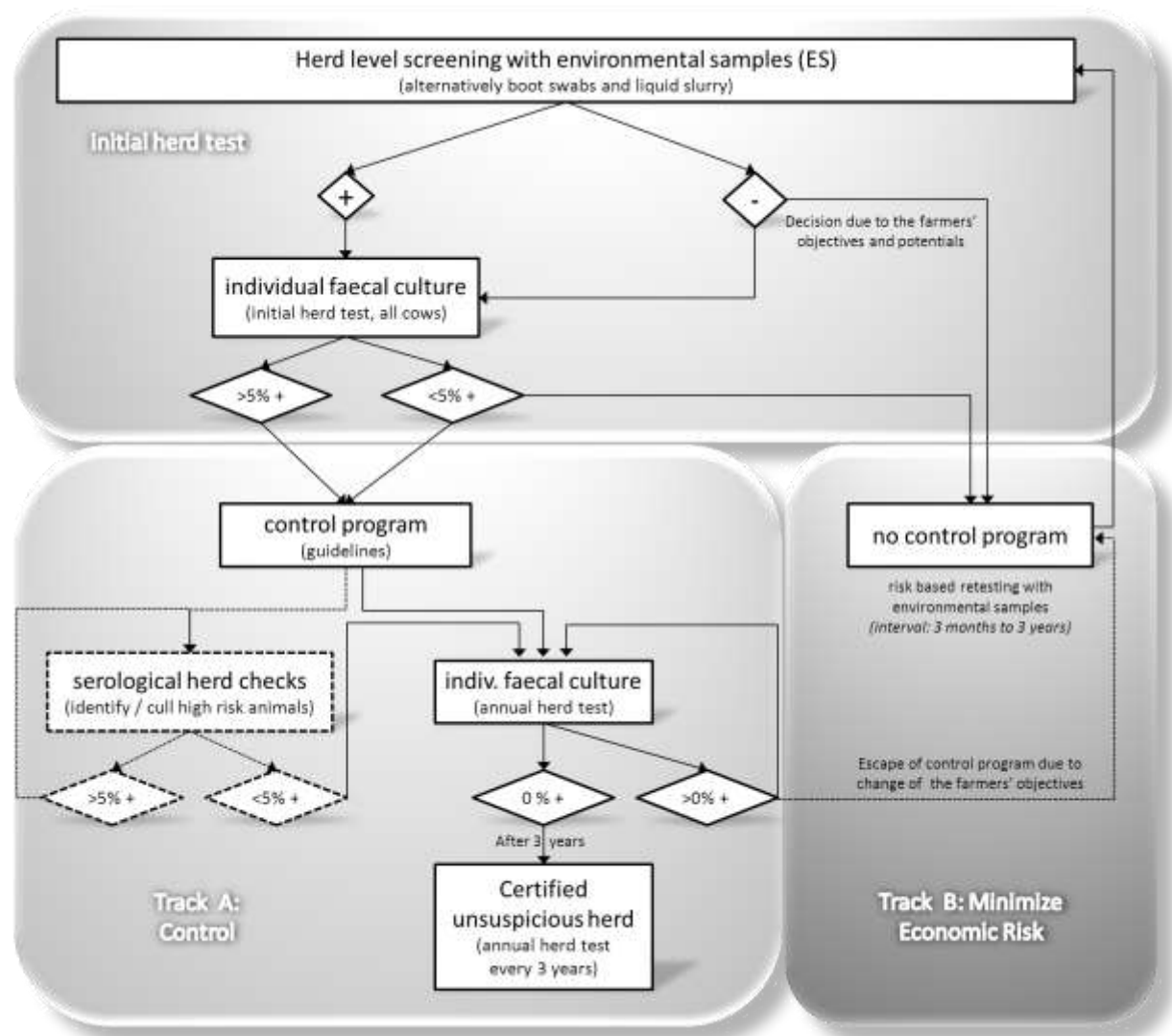


Figure Two: Proposed strategy for paratuberculosis control considering the experiences from the Thuringian control program.

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Johne's Disease Control in Ireland - Past, Present and Future

Peter Mullooney¹ and Sam Strain²

¹Department of Agriculture, Food and the Marine, Kildare Street, Dublin 2, Ireland

²Animal Health and Welfare NI, 97 Moy Road, Dungannon, Co. Tyrone, BT71 7DX, Northern Ireland

INTRODUCTION

At the end of December 2009, the bovine population in Ireland was distributed between 123,500 herds of which 19,700 were dairy farms. In total, there were 6.5m bovine animals in the country including 3.4m females and 300,000 bulls aged 12-months-of-age or over. (AIM 2009). Just over one million of these were dairy cows. The milk from these cows was supplied to thirty-two cooperatives. Exports of Irish dairy products and ingredients were valued in the order of €2.29 billion. In 2010, total Irish milk output amounted to 5,582 million litres with an estimated value of €1,536 million. Three of the key players internationally in the infant milk formula sector are located in Ireland supplying 15% of the global requirement with a combined turnover of €667m in 2008.

The prevalence in Ireland of Johne's disease has been shown by two prevalence surveys. The first of these estimated herd prevalence in dairy herds to be approximately twenty per cent (Good et al., 2009). A second prevalence survey will be reported in an oral presentation at the 12th International Colloquium on Paratuberculosis. Briefly, a prevalence survey based on detection of serum antibodies was carried out on 1654 Irish herds picked randomly from all the herds in the country which were subjected to an annual brucellosis test in 2009. All 78,123 females and breeding bulls over 24 months-of-age in these herds were tested using the ID vet ELISA test. There were 286 positive herds of which 91 herds had two or more positives. The overall prevalence of infected herds, based on the presence of at least one ELISA-positive animal, was 17.41%. The herd prevalence level amongst dairy herds (27.76%) was higher than among beef herds (12.7%). The animal level prevalence for all breeds was 0.60%. The corrected overall herd seroprevalence excluding those with only one positive result was 5.50%, representing 9.7% of dairy herds and 3.3% of beef herds. These figures compare favourably with those reported for other countries.

JD has been increasing in incidence in Ireland in recent years (Figure one). There were ninety-two positive faecal samples detected between 1932 and 1982, but there were one hundred and fifty in 2003 alone. Much of this increase in incidence has been attributed to the large number of cattle that were imported in the intervening years (Richardson et al. 2009, Barrett et al. 2011).

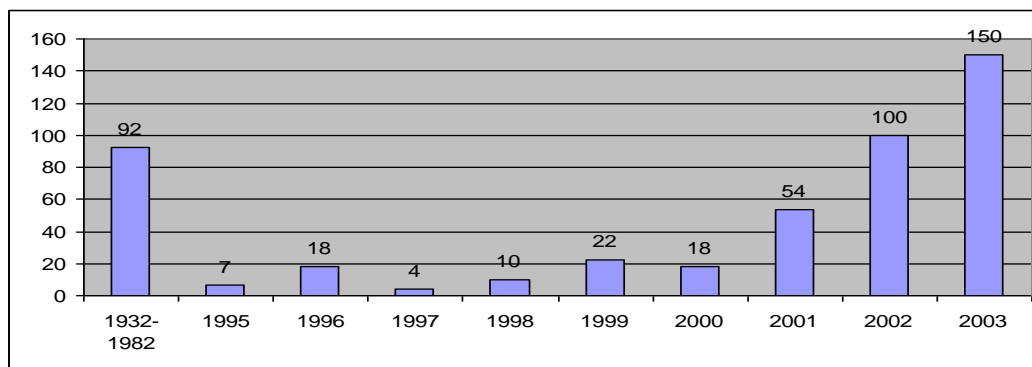


Figure One: Faecal positive samples in Ireland (1932 – 2003).

There were a total of fifty-two thousand cattle imported between 1992 and 1996, sixteen thousand from each of France Germany and Netherlands, almost three thousand from Denmark and smaller numbers from Belgium, UK and Italy. A survey of sixteen herds with imported animals by O'Doherty et al. in 2000 showed that of 226 animals tested eight were positive by ELISA and nine positive on faecal culture. 25% of herds were ELISA positive and 37.5% faecal positive.

AIMS AND OBJECTIVES

To present a summary of past, present and future Johne's disease control in Ireland.

Because of the increasing prevalence of Johne's disease in Ireland a Pilot Herd Health Project was set up in 2004. Details of this have been reported in full previously (Muldowney et al. 2009). This Pilot project was subsidised by the Department of Agriculture Food and the Marine. Johne's Disease (JD) was included in the pilot herd health program because of its increasing incidence worldwide and the possibility that it might be a zoonosis. This was of major concern to the dairy industry in Ireland. The industry and farm organisations agreed there was need for action to address the increasing prevalence of infection and to mitigate potential consumer concerns. However diagnostic tests for Johne's were poor and control programs that had been established in Holland, USA and Australia had met with varying degrees of success. One of the concerns of the stakeholders was who would pay for the scheme. The key drivers in the Herd Health Pilot Program were veterinary practitioners. The Department of Agriculture gave initial financial support. Other diseases of concern to participants included in the pilot program were Bovine Viral Diarrhoea (BVD) and Infectious Bovine Rhinotracheitis (IBR).

The initial communication in setting up the pilot project was with farmers, vets, and industry and farming organisations.

A Johne's disease-specific booklet was distributed to all dairy and beef farmers and made available on the Department's website. Seminars were held to highlight the need for herd health in the changing EU farming environment. The economic impact of the disease was stressed and a herd, which showed marked reduction in milk yield and profit per cow during the period of infection, was used as a case study.

The initial communication with vets consisted of a specific Johne's disease booklet distributed to all vets, regional Scientific Seminars and regional training courses for all interested veterinary practitioners. At the training courses lectures were given on Johne's, IBR, BVD and

Epidemiology and Risk Analysis. Four different workshops on risk analysis for Johne's disease in dairy herds, Johne's disease in suckler herds, IBR and BVD were held. The lectures were recorded on video and distributed to the participants on a CD. Relevant articles on the three diseases were also given to participants. The risk assessment templates, which were based on those published by Rossiter et al., were designed in text and spreadsheet format and follow up workshops were held twelve months after commencement of the scheme to review progress.

The Herd Health Program was subsidised by the Department of Agriculture who paid a fee to practitioners for the risk assessment on three to four chosen herds each. Laboratory testing was free to farmer participants. Thirty-five vets attended the course and twenty-two enrolled clients. Sixty-eight risk analyses were carried out on herds. Sixty-three of these herds decided to participate in a Johne's disease control program, nineteen in BVD and six in IBR. Following the initial farm visit and risk assessment, a sampling strategy and disease control plan was put in place. Most participants found that the Risk Analysis Template took longer to complete than they expected but found it useful in comparing with the next year's results and that the farmer client had agreed targets. The scheme aimed to establish pilot herds in each participating practice, which could then be used to extend a similar scheme to other herds in the practice, and the disease control procedures could be used as examples for other diseases.

The industry and farming organisations were given regular updates on progress of the pilot project and reports were submitted to the Irish Farmers Journal.

A daylong seminar on Johne's disease was held in August 2005. All participating vets and farmers and other interested parties were invited and about 120 attended. The main speakers were Drs Mike Collins and Jeannette McDonald of the University of Wisconsin and Dr Bob Whitlock of the University of Pennsylvania.

A further daylong seminar on Johne's disease and BVD for participating vets and farmers was held in December 2007. This was followed by a daylong workshop where individual problems on each herd were addressed by the main speakers Prof. Joe Brownlie of the Royal Veterinary College, London and Prof. Soren Nielsen of the University of Copenhagen.

Sixty-three of the sixty-eight herds participating in the pilot project tested for Johne's disease. Some herds wanted to establish that they did not have a Johne's problem and therefore only took faecal samples for fear of false positives on the ELISA test. Of the twenty herds that carried out faecal sampling fourteen herds had all animals negative but further sampling was not carried out in these herds. Six herds had positive animals on the faecal test. Because of the relocation of the diagnostic laboratory shortly after the start of the scheme there was a delay in reporting faecal culture findings. This resulted in most practitioners using the ELISA test afterwards and of the fourteen herds with negative faecal herd tests, seven subsequently had positive animals on ELISA tests. Twenty of the twenty-nine herds that had only one ELISA test done had positive animals. Twelve of these herds were in 2005, of which seven were positive and these herds may have dropped out of the program. Of the sixteen herds, that have only had one test in subsequent years, twelve were positive. Of the thirty-four herds that had more than one ELISA herd test carried out all except four herds had positive animals. Some herd owners may have been of the mistaken opinion that one test would have indicated freedom from the disease. Some were looking for a certification program of freedom. Of the forty six dairy herds participating in the Johne's program, only thirteen had not bought in any cattle in the previous twelve months and eight had only bought in a bull and of these twenty one herds, fifteen had a

positive test result. A herd would need to be closed in order to have meaningful certification. If a suitable number of closed herds were interested in participating in a certified freedom program, the Danish milk ELISA test, taken four times a year, might have been a more convenient way of monitoring. We had hoped to set up an on line training system for participating farmers and veterinarians but this was not finalised. With the setting up of Animal Health Ireland, more publicity was given to Johne's disease and some of the herds that not tested for several years began retesting again as shown in Figure two.

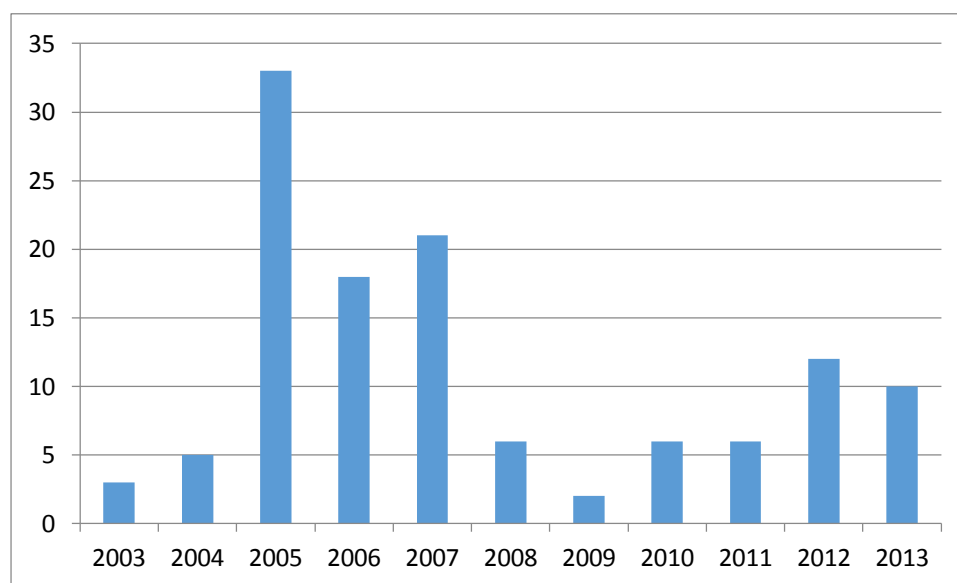


Figure Two: Number of herds testing per year of 65 herds participating in a Johne's disease pilot control program.

Within herd prevalence varied from 0% to 13.33%.

LESSONS LEARNED

The pilot program demonstrated that it was possible, with sufficient knowledge and commitment, to implement successful Johne's disease control at farm level. A number of further lessons also emerged from the pilot program. These included the importance of education of farmers and veterinary surgeons; a clear understanding of the limitations and uses of diagnostic tests; the need to clearly communicate achievable goals and the timelines associated with these; the challenge of motivating farmers to stick with a program and the challenge of scaling up this type of approach to a national level. It is likely that if more effort was put in to engaging more frequently with the farmers and vets involved in the scheme some herds would have participated for a longer period of time.

CURRENT APPROACHES TO THE CONTROL OF JOHNE'S DISEASE IN IRELAND

Two organisations, Animal Health Ireland (AHI) and Animal Health and Welfare Northern Ireland (AHWNI), have been established within the island of Ireland to progress the control of some of the most significant endemic non-regulated infectious diseases. Operating in the two jurisdictions they work under a formal cooperation agreement sharing resources and technical knowledge. A technical working group was formed to develop the framework for a Johne's Disease Control Program (JDCCP) building on previous experiences as detailed above. Their conclusions have been presented to implementation groups in each of the jurisdictions which comprise representatives from across the agri-food industry. Within the Republic of Ireland this group agreed to launch a voluntary pilot control program for dairy herds in October 2013. Within Northern Ireland it is anticipated that a control program will be launched using the same technical framework later in 2014.

PILOT PROGRAM OBJECTIVES

Details of the program can be found at www.johnes.ie. The long term objectives of the program are;

1. To identify those herds that test negative for Johne's disease and provide these farmers with the knowledge and professional support to allow them to increase their confidence of being free of infection over time and to protect their herds from the on-going risk of introduction of this disease (bio- exclusion).
2. To provide herds known or suspected of being infected, with the knowledge and professional support to allow them to control and reduce the disease over time and ultimately to achieve a high confidence of disease freedom (bio-containment).
3. To further underpin the quality of Irish dairy and beef produce in the international marketplace.

The program has been launched as a pilot which will be evaluated in detail during the second half of 2014. Therefore the short term objective of the program is to evaluate and refine the various program components, including data handling, diagnostic and on-farm advisory elements and cost benefit analyses that would be required to support a future, extended Johne's disease control program in Ireland.

PROGRAM OUTLINE

The Pilot Program consists of three principal components;

1. Enrolment

The Dairy Herd Pilot Johne's Disease Control Program is voluntary. To facilitate enrolment AHI developed an on-line enrolment process. This allows farmers to nominate their chosen trained veterinary practitioner to carry out their on-farm risk assessment (see point 3 below) and who will assist them in the interpretation of all test results.

2. Herd Screening

All animals in the herd over two years of age at the date of enrolment must be included in a herd screen which must be completed within 12 months of enrolment. Each eligible animal is tested by an AHI designated laboratory using the sample types and frequencies set out below.

- Two Individual cow milk samples taken at least 3 months apart avoiding the three months following a TB skin test and the first week of lactation or;
- One blood sample avoiding the three months following a TB skin test or;
- One faecal sample.

3. Veterinary Risk Assessment and Management Plan (V-RAMP)

This is a detailed on-farm review carried out by an approved veterinary practitioner in partnership with the farmer to identify aspects of management that could predispose to the introduction and spread of infection within the farm and to provide recommendations for the reduction of these risks.

Herd Screening

All samples for testing are collected by or under the supervision of an independent third party. Although the majority of infected cattle acquire infection as calves, they rarely test positive in the first two years of life. Even in older animals the available tests will miss a substantial proportion of infected cattle. For this reason, negative test results are not regarded as conclusive evidence that an animal (or herd) is uninfected. For this reason the program will require repeated testing over several years to help build confidence in the true status of the herd. All test samples must be sent to any of the several laboratories which have undergone a designation process defining various parameters of laboratory practices such as sample test turnaround times, database upload formats for test results and laboratory quality standards.

Sample Timing & Result Interpretation

An ELISA test on blood or milk is classified as positive using the test cut-off recommendations of the manufacturer of the test kit that is being used. A faecal sample culture result will be classified as positive following molecular confirmation of any suspect bacterial growth. Where possible, cattle are not sampled within three months following a TB skin test as this can lead to false positive Johne's test results. Where this has happened and to avoid as far as possible false positive results being used for future categorisation, all animals testing positive for the first time should be tested again, using either a dung sample (which may be taken immediately) or a further blood or milk test (taken more than three months following the TB skin test). If this further test is negative, the animal is considered to be negative. Similarly, milk samples from the first 7 days of lactation should not be tested as milk taken during this period can lead to false positive results. Where a sample has been taken during this period, any animals testing positive should be subjected to a further screen using one of the recommended tests. If this further test is negative the animal is considered to be negative.

Where cattle are tested using two milk samples, the samples must be taken at least 90 days apart. A positive test result defines an animal as infected. However where an animal tests positive to either the blood or milk test there is the facility to further investigate the animal's infection status by ancillary testing of a dung sample by culture or PCR performed at a reference laboratory. If

this ancillary test is negative, the animal will be defined as having an indeterminate disease status and will be classified as inconclusive except where:

- The original test was performed within three months of a skin test, or
- Where a milk sample was taken during the first seven days of lactation.

In which cases the animal will be considered to be negative.

Only herds with positive ancillary test results are classified as infected. Where an animal has an initial positive test result but no ancillary test is performed the animal is considered infected. In some cases the ELISA test result may be inconclusive. Where an animal has an inconclusive ELISA test result on either milk or blood samples the animal's infection status is classified as inconclusive.

Inconclusive animals

Where an animal tests positive using either a blood or a milk sample but negative using an ancillary test, or tests inconclusive using blood or milk, it is classified as inconclusive. An animal will remain inconclusive for a minimum of one year from the date it first had a positive test result. If after one year it has a negative test result or results from a subsequent annual cycle of testing the animal will be classified as negative. If the animal continues to test positive it will be treated in the same way as any other animal with a positive test result, i.e. classified as infected unless subjected to a subsequent ancillary test. If this ancillary test is again negative the animal will continue to be classified as inconclusive. Similarly where an animal has an inconclusive ELISA test result its infection status will be classified as inconclusive.

Sale of JD positive animals

Herd owners participating in the program are not permitted to sell any animal that is deemed to have provided a positive or inconclusive result, in accordance with the definitions provided above except to a licensed slaughter premises.

Veterinary Risk Assessment and Management Plan (V-RAMP)

This is a detailed on-farm review carried out by an approved veterinary practitioner in partnership with the farmer to identify aspects of management that could predispose to the introduction (bio-exclusion) and spread of infection within the farm (bio-containment) and provide recommendations for the reduction of these risks. Only veterinary practitioners who have undergone specific training provided by AHI are approved to undertake the assessments.

The V-RAMP uses a scoring system which assists the identification of high-risk practices and areas within the farm on which control should be focussed. The assessment leads to a small number of agreed farm-specific practical recommendations to be implemented on the farm. In conducting the risk assessment, the approved veterinary practitioner has access to outputs from the program database, including previous animal movements. This data is reviewed with the herd owner to identify the impact of such movements on the risk of introduction of infection, the confidence that a negative screening test indicates that the herd is truly free from infection and the importance of implementing the agreed recommendations. Where individual animal movements are deemed to have constituted a low risk of introduction of infection, these movements can be discounted by the veterinary practitioner within the database so that they are not used for the herd categorisation.

Herd Categorisation

A categorisation system to quantify the level of confidence that any given herd participating in the program with negative test results is truly free of infection will be developed during the pilot phase of the program. This information, once developed, will be made available to those individual program participants who request it in respect of their own herds. Aggregate, anonymised information on all participants in the program will also be used to assist with the on-going evaluation and refinement of the program. No other parties will have access to this information.

The system, which is based on a number of risk categories, provides a measure of the degree of confidence that any given herd is truly free of infection at a particular point in time and a framework by which to evaluate progress in controlling the disease at individual herd and aggregate level.

The herd category is based on two streams of data:

- 1) Herd test results
- 2) Animal movement data.

Animal movement data will be captured from DAFM Animal Identification and Movements System (AIMS) and the risk of introduction of JD attaching to these movements will be calculated automatically by the database based upon work previously carried out (More et al., 2013). Initial and subsequent categorisations for all herds will be calculated following the completion of herd screen test results, any ancillary test results and the risk assessment and disease management advisory visit. Where herd results or the advisory visit are incomplete the herd will have an 'undetermined category'.

Program Support

Only veterinary practitioners who have undergone specific training provided by AHI are approved to undertake the assessments. The objectives of the training is to provide veterinary practitioners with a thorough training in Johne's disease in terms of:

- The causal agent
- The pathogenesis of infection
- The importance of the infection within Ireland
- The diagnosis of infection and the principles of test result interpretation
- The principles of disease control in terms of both bio-exclusion and bio-containment
- The details of the Animal Health Ireland Johne's Control Program
- The principle of 'risk' as it relates to the introduction and dissemination of Johne's disease on farms
- The concept of 'confidence' as it relates to freedom from Johne's disease at the farm and animal levels
- The AHI developed Veterinary Risk Assessment and Management Plan (V-RAMP) documentation using examples to illustrate each of the sections within the document together with a practical 'on-farm' session to allow practitioners to perform a VRAMP alongside facilitators

- Developing skills for teaching and facilitating herd-owners in the principles of infection control
- The interpretation of various test result, herd history and animal movement scenarios as they relate to the most likely infection status of farms.

The training follows a full day schedule involving formal lectures, on-farm practical's and informal tutorials. To date 319 Veterinary Practitioners have undergone the training with the expectation that there will be approximately 400 trained by June 2014. This represents virtually all veterinary practices with substantial farm workloads across the Republic of Ireland. (See Figure three for a map illustrating the geographical spread of trained vets up to the end of April 2014).

Approximately 1800 herd owners are currently enrolled into the program. Financial support is available to all enrolled herds from the Department of Agriculture and the Marine (DAFM) to cover the costs of the V-RAMP (€200 per herd). In addition participating dairy co-operatives are contributing €100 towards the costs of animal testing for each of their suppliers who is participating in the program.

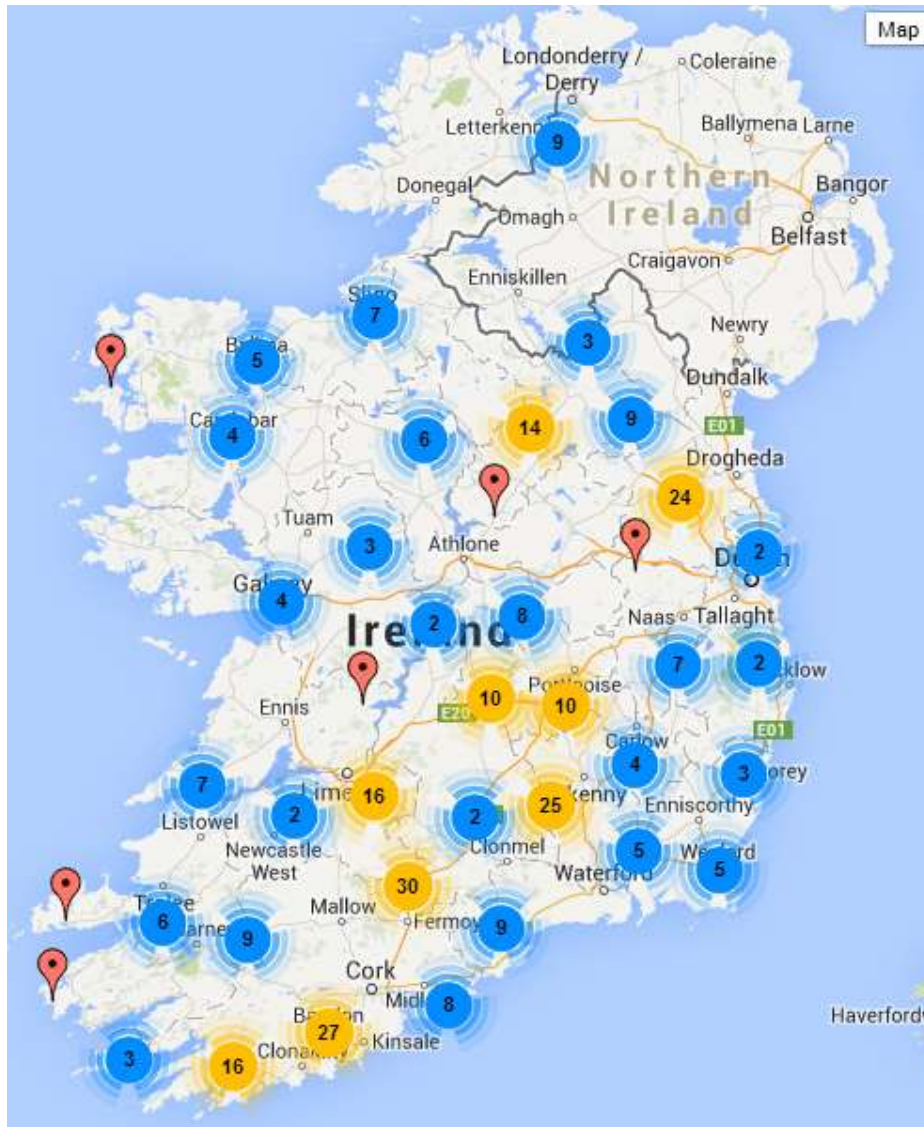


Figure Three: Geographical Distribution of Trained Veterinary Practitioners.

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Bovine Paratuberculosis in Italy: Building Infrastructures and Defining the Guidelines for Control and for Ranking of Herds

Norma Arrigoni¹, Luigi Ruocco³, Giulia Paternoster², Marco Tamba²

¹*Istituto Zooprofilattico Sperimentale Lombardia and Emilia-Romagna, National Reference Centre for Paratuberculosis, Piacenza, Italy*

²*Istituto Zooprofilattico Sperimentale Lombardia and Emilia-Romagna, Epidemiology Unit of Emilia-Romagna, Bologna, Italy*

³*Ministry of Health, Italy*

INTRODUCTION

Bovine Paratuberculosis (bPT) is a chronic enteritis caused by *Mycobacterium avium* subsp. *paratuberculosis* (MAP), and it is recognized as one of the most important infectious diseases in the dairy industry causing important economic losses in infected herds. The disease is *widespread* worldwide in cattle herds (6); in Europe, apparent herd-level prevalence of MAP infection in farmed animals ranges between seven and 60% (7). In Italy, where about 1.5 million dairy cows are reared in more than 40,000 herds, bPT occurrence is essentially unknown at the national level. However, serological surveys, based on ELISA testing, have been carried out in several regions of Northern and Central Italy (Table one) and results show apparent herd-level prevalence between 42% and 65%. Prevalence of seropositive animals is lower, ranging from 2.4% to 4.6%.

In Italy bPT was not a notifiable disease until 2013. Despite the wide distribution throughout the nation, no structured control program had existed, but a voluntary herd certification program was implemented in two neighboring provinces (Lodi and Milano) of the Lombardy region in northern Italy. In recent years, however, concerns over MAP being a potential foodborne zoonotic agent and hence over the possible contamination of foods of animal origin, in particular dairy products (2), has led China and India to require specific bPT warranties for trading (no clinical cases in the last 12 months and application of technical treatment of milk that is effective in killing MAP, respectively). Even if the association between MAP and Crohn's disease is proven, the etiological role of this microorganism remains a controversial subject in the scientific community (1, 3, and 4) and a major concern of consumers, the dairy industry and public health professionals.

Italy exports different dairy products, such as Parmesan cheese, mozzarella and gorgonzola, to China and India with a current value of cheese exports of about 13 million Euro per year. This export trend is rapidly increasing as both countries are among the fastest growing emerging markets. In order to protect the export market, in 2013 the Italian Ministry of Health issued the "National guidelines for the control of bovine paratuberculosis and for assigning the health ranking of the herds" as a way to define a transparent process for the certification of dairy products destined for export. The National guidelines had been adopted by a majority of the regions in Italy by the end of 2013. This represents the first control and certification program against bPT in Italy. In this paper we describe the principles on which the guidelines are based.

Table One: Results of serological surveys carried out in Italy, 2000-2010.

| Region | Year of survey | Diagnostic test | Apparent herd-level prevalence | Apparent animal-level prevalence | References |
|-------------------|----------------|-----------------|--------------------------------|----------------------------------|------------|
| Veneto | 2000-2001 | Indiv. ELISA | 65% | 4.0%* | (9) |
| Lombardia | 2003-2005 | Indiv. ELISA | 48% | 2.6%* | (9) |
| Lazio | 2005 | Indiv. ELISA | 42% | 2.4%* | (5) |
| Umbria and Marche | 2009-2010 | Indiv. ELISA | 53% | 4.6%** | (8) |

(* = cattle over 12 months-of-age; ** = cattle over 24 months-of-age)

AIMS AND OBJECTIVES

The main aims of the national guidelines are:

- To collect data on the occurrence of clinical cases of bovine paratuberculosis,
- To provide a herd ranking system based on the bPT status of herds, describing the risk of selling MAP infected cattle,
- To define a transparent procedure for the certification of dairy products exported to countries requiring specific warranties concerning bPT,
- To improve awareness and knowledge of bPT among farmers, and provide tools to avoid the introduction of MAP in the herd, and
- To promote the implementation of voluntary herd control programs in infected herds.

The main components of the national guidelines are:

1. A **passive surveillance system** with mandatory reporting of bPT cases to the Veterinary Services. A case of bPT is defined as an adult bovine (>24 months-of-age) presenting with emaciation and chronic diarrhea and testing positive by PCR on feces.

All bPT confirmed cases are registered in the National Informative System for Animal Diseases (SIMAN). A herd with a bPT case acquires the PTC level and, for a pre-defined period, its milk cannot be used for dairy products exported to countries requiring specific bPT warranties. When a clinical case is reported, the first serological screening of the herd by the national veterinary health services is free of charges for the farmer.

2. A **classification of bovine herds** based on the risk of MAP infection in the herd (**Table two**). There are seven MAP risk levels, the first two (PTC, PT0) are assigned by the national veterinary health services on the basis of presence (PTC) or absence (PT0) of bPT cases. The PTC level identifies those herds that, having had a clinical case, are not allowed to sell milk destined for dairy product exports. The accreditation for the other levels (PT1 to PT5) is obtained upon specific request of the farmer. The health status of the herd is based on results of standardized serological testing schemes voluntarily applied (S1 and S2 protocols; **Table three**). Serological testing has to be repeated annually; herds are awarded a higher certification level with each subsequent negative annual test. PT1 and PT2 herds are probably MAP infected but with a low within-herd prevalence while the higher levels are considered MAP free, with increasing probability from PT3 up to PT5. These levels assist buyers in assessing the risk of

purchasing MAP infected animals, thereby protecting themselves from the risk of introducing the disease.

Table Two: Risk-based classification of bovine herds and specific requirements for obtaining and maintaining the bPT rank.

| Rank | Health Status Description | Requirements for obtaining the rank | Requirements for maintaining the rank |
|---|------------------------------------|---|--|
| Compulsory Herd Classification in the national cattle database: | | | |
| PTC | Herd with clinical cases | Clinical bPT cases reported in the last 12 month | |
| PT0 | Herd without clinical cases | No clinical bPT cases reported in the last 12 month | |
| Voluntary Herd Classification in the national cattle database: | | | |
| PT1 | LOW RISK HERD | No clinical cases reported in the last 12 months, and seroprevalence \leq 5% (S1 protocol) | No clinical cases reported in the last 12 months, and seroprevalence \leq 5% (S1 protocol) |
| PT2 | NEGATIVE HERD | No clinical cases reported in the last 12 months, and all animals testing negative (S1 protocol) | No clinical cases reported in the last 12 months, and all animals testing negative (S1 protocol) |
| PT3 | FREE HERD, LEVEL 3 | At least 24 months with PT2 level No clinical cases and all animals testing negative (S2 protocol) | |
| PT4 | FREE HERD, LEVEL 4 | At least 12 months with PT3 level No clinical cases and all animals testing negative (S2 protocol) | |
| PT5 | FREE HERD, LEVEL 5 | At least 12 months with PT4 level No clinical cases and all animals testing negative (S2 protocol) | |

Table Three: Sampling schemes for serological monitoring of the herds (individual serum or milk).

| Protocol | Aims | Sampling Scheme |
|----------|--|--|
| S1 | To acquire PT1 and PT2 levels; To maintain all the levels | <ul style="list-style-type: none"> • All bulls older than 24 months • All cows older than 24 months purchased in the last 12 mos. • A sample* of cows older than 36 months born on the farm |
| S2 | To acquire PT3, PT4 and PT5 levels | <ul style="list-style-type: none"> • All bulls older than 24 months • All cows older than 24 months purchased in the last 12 mos. • All cows older than 36 months born on the farm |

*# of cows older than 36 months in the herd / # of cows older than 36 months to test

1-41/all; 42-50/41; 51-60/49; 61-100/55; 101-300/62; 301-500/63; >501/65

3. **Voluntary adoption of herd control programs.** Farmers with infected herds can voluntarily apply a control program to gradually reduce within-herd prevalence by adopting biosecurity (preventing the introduction of MAP infection into the herd) and bio containment measures (preventing the spread of MAP among animals within the herd) and an appropriate testing scheme as outlined in Figure one.

Farmers, advised by their practitioners, can manage to reduce the risk of MAP infection thereby lowering the prevalence in order to meet the requirements to export dairy products with a low risk of MAP contamination. The national guidelines include two manuals (one for beef and one for dairy herds) to conduct a standard risk assessment and design a herd-specific MAP control program. The risk analysis helps to identify those practices that allow MAP infection to spread in the herd and suggests specific herd management practices to control the risk factors identified.

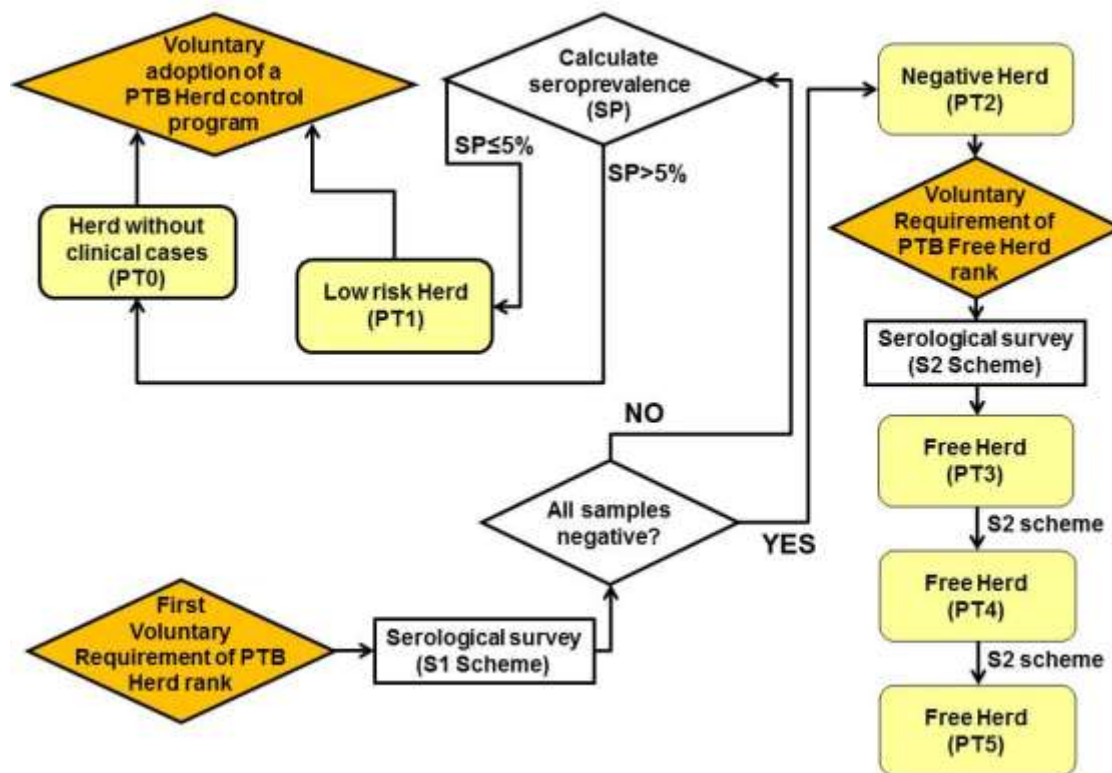
It is important to define the farmer's goals, because they represent what is important to the owner and influence the future commitment to the control plan. Together with the farmer, the practitioner will develop a herd management plan including measures to:

- Manage (separate calving and elimination of colostrum) or cull infected cows and their offspring. This measure requires the application of a testing scheme. The manuals contain a recommended outline, but the individual diagnostic protocol depends on the prevalence of infection and on the objectives of the farmer (control/eradication, expected schedule, economical resources, etc.);
- Avoid calf infections by preventing direct or indirect contact with potentially infected feces of adults (prompt calf removal from the cow, feeding with colostrum from a single test-negative cow, feeding pasteurized milk until weaning, rearing homogeneous age groups, and adopting hygienic measures to prevent feed and water manure contamination).

The manuals for the control of paratuberculosis in dairy and beef herds, including the risk assessment scheme as well as a brief explanatory brochure for the farmers, are available online on the website of the National Reference Centre for Paratuberculosis (PTNRC;

http://www.izsler.it/izs_bs/s2magazine/index1.jsp?idPagina=441). Practitioners should reinforce the need for controlling paratuberculosis over time, defining periodically the health status of the herd and redesigning the management measures to control MAP transmission within the herd.

Figure One: Flowchart of the Guidelines for accreditation of herds against bovine paratuberculosis.



DISCUSSION

The National Guidelines for the control of bovine paratuberculosis and for the herd ranking represent the first nationally coordinated control program against bovine paratuberculosis in Italy. Since the national guidelines were adopted by the majority of the Italian regions at the end of 2013 they are not yet fully implemented and it seems premature to define lessons learned and improvements made. However, in our opinion the main strengths of the program are:

- Serological testing on individual milk or serum as a diagnostic strategy to rank herds. Despite the complexity of the disease, the ranking of herds is based on a quite simple and economic testing method.
- Voluntary ranking of low-risk herds. As a result, highly motivated farmers will be encouraged to enroll in the program. They can promote their health status and get a higher price for their low risk replacement heifers and products.
- Herds with clinical cases get one free screening by the national veterinary health services to assess the initial health status of the herd.
- All paratuberculosis tests are performed by the laboratories at the 10 national veterinary public health institutes (Istituto Zooprofilattico Sperimentale) making data collection easier, thereby facilitating the monitoring of the control program. The National

Reference Center conducts regular proficiency tests of the national laboratories evaluating the accuracy and standardization of all MAP analytical procedures (ISO/IEC 17043:2010).

The main critical points are as follows:

- Communication, education and awareness of the stakeholders are essential elements for the success of a bPT control program, requiring long-term commitment and efforts. Collaboration between practitioner and farmer is the key to success of the program. Veterinarians need to be well trained and educated in order to provide the farmer a wide range of approaches to control the disease through time, allowing the owner to choose a control strategy depending on his own goals and resources. The guidelines delegate the education for veterinarians and farmers to the regions. To support and broaden the education program, the Italian PTNRC has developed several information resources:
 - A free online course for veterinarians on paratuberculosis running on an e-learning platform (<http://www.formazioneveterinaria.it>);
 - A brief explanatory brochure for farmers, summarizing the characteristics of bPT and of the national guidelines (http://www.izsler.it/izs_bs/s2magazine/index1.jsp?idPagina=441);
 - A risk assessment application for tablets, a very useful and innovative tool for practitioners, to evaluate the health status of the herd and perform a MAP transmission risk analysis. Considering the critical procedures threatening the health status of the herd, the application elaborates an outline of appropriate recommendations useful to design a herd-specific control program;
 - Free online courses for beef and dairy farmers on paratuberculosis pathology, diagnosis, management and control; and
 - Yearly national conferences for veterinarians, regulatory agencies, dairy industry, and other stakeholders.

- It is very important to collect data on herd profitability in order to motivate and support the adoption of biosafety and bio containment measures throughout time. A well designed control plan against MAP infection also enhances the overall biosecurity of the herd, reducing the risk for other faecal-oral transmitted pathogens (enteritis of calves) and the incidence of environmental mastitis and puerperal infections, with immediate and long-term economic benefits (lower use of treatments, decreased pre-weaning mortality, better production performances). Communication of the financial benefits resulting from the application of a paratuberculosis control plan is very important since they are strong incentives for farmers to adopt management practices aimed at reducing the risk of paratuberculosis infection in the herd and the risk of contamination of dairy and beef products. These measures will ensure the future of the export market for the Italian cattle industries.

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Is the Norwegian Cattle Population Free of Johne's Disease?

How to Prove this?

Olav Østerås

TINE SA, Advisory Services, Section Animal health and Welfare, Ås, Norway

INTRODUCTION

John's disease was first diagnosed in Norway in 1907 in cattle and 1934 in goats (National Veterinary Institute, 2005). John's disease is a notifiable disease in Norway (group B). Some farms in the pre-war period were found to be positive, and restrictions were put on sales of animals to control the disease. In the post-war period there were few new cases with four infected herds detected in 1997 (all beef cattle and imported from abroad). These herds were slaughtered with compensation. In 1988/99 there was a new herd infected, possibly infected from goat herds. In 2001 there were two new infected herds (one imported from abroad and slaughtered, and one other which was a neighbour to the previous herd with imported infection.

In 2002 there was also two herds infected (one most possible infected from goat herds and one imported from abroad). Both these farms slaughtered their cattle and finished production. The last herd which was infected was detected in 2010 and possible infected from goat herds. This herd has been put under restrictions for sale and sampled several times each year now and is so far negative. The herd is planning to finish production within a few years. According to this Norway cattle production should be free from *Mycobacterium avium paratuberculosis* (MAP), and as the goat population recently also have eradicated MAP the complete milk production and beef production in Norway should be free.

AIMS AND OBJECTIVES

The aim of this presentation is to visualize the problems of declaring a population free for MAP after eradication and to discuss the control strategy to keep this population free for MAP. For the eradication program in goats see presentation from Lindheim (this conference, 2014). The control should be risk based, and at present the highest risk for introduction of MAP should be through importation of animals from countries with endemic MAP, contact with goat herds, contacts with imported animals or transfer of manure from infected herds, through sale of used equipment like automatic milking machines (AMS), manure equipment or feed etc., During the year 2013 30 cattle, 12 sheep were imported from other countries into Norway. So the question is - how can we prevent a potential import of infected animals and/or equipment into Norway? The other problem is to secure and prove that there is no infected herd within the country. To do this we want to sample bulk tank milk using ELISA for MAP antibodies. A new serological multiplex test under development by MV Diagnostics Ltd. and Enfer Scientific (Scotland/Ireland) was run for 1839 bulk tank samples.

The preliminary results are illustrated in Figure one.

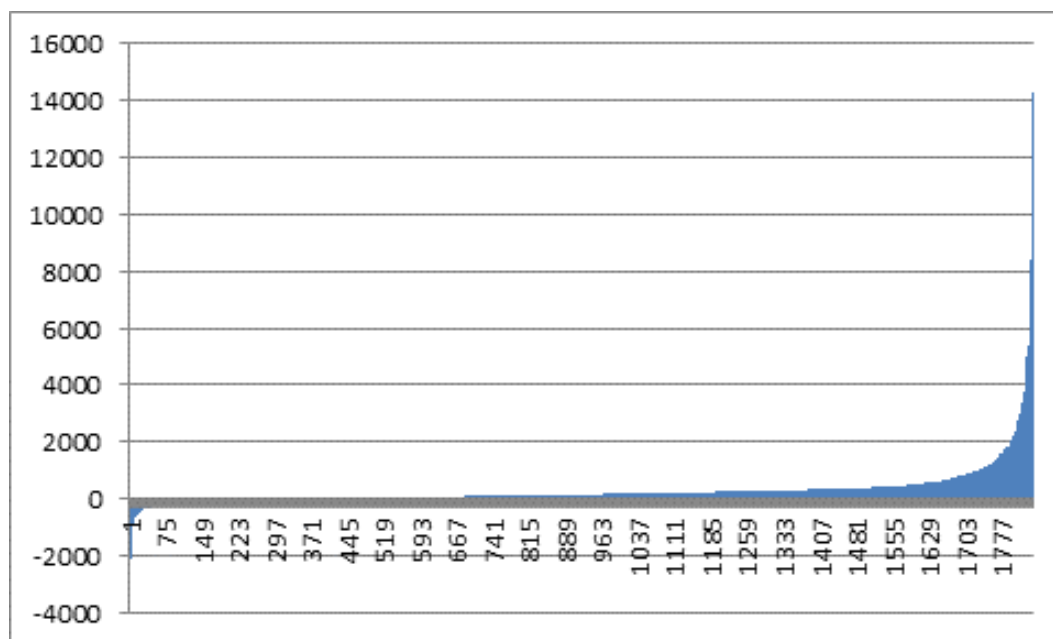


Figure One: Reading from the new diagnostic test from MV Diagnostics/Enfer Scientific.

The MVD-Enferplex Bovine Multidisease test is a multiplex chemiluminescent ELISA designed to screen for antibodies to eight diseases (BRSV, BCV, Neospora, Strep. Ag, BVD, ParaTB (MAP), Anaplasma and Mycoplasma bovis). The assay was designed for use with milk and serum.

In this diagnostic test reading values above 3000 is preliminary set to be positive, there would be 25 positive or 1.36 %. Supposing that the population is truly negative this will confirm a specificity of the test at 0.986 % (95% CI: 0.981 to 0.992). There was a jump in the reading values from 8,300 to 11,800. If the cut off was set to 10,000 in reading value there would be 4 positive samples, making a specificity at 0.998 (95 % CI: 0.996 to 0.992). A number of 134 samples were tested by IDEXX in parallel reading. One of these was positive, which was negative on the new test, on one which was positive on the new test was negative on IDEXX, making a specificity of 0.992 (95 % CI: 0.978 to 1.00).

LESSONS LEARNED

It is always difficult to prove that a country is free from MAP as a diagnostic test never has 1.00 specificity. As an example if the population consist of 9000 herd and all bulk tank are sampled once with a test of specificity of 0.998 (which is extremely good) we will end up with from 1 to 39 false positives if the population is true negative. If we use a lower cut-off value and a test with specificity of 0.986 we will end up with from 75 to 170 false positive. The question is then how do we deal with these possibly false positives? We could run another test, we could do bacteriology, or pathology in old animals at slaughtering process.

IMPROVEMENTS MADE

The principle with the development of the new MVD-Enferplex Bovine Multidisease test was to design a multiplex assay tailored around Norway's requirements for disease control in cattle.

This would make a reliable easy handling and relatively cheap and effective diagnostic system. The challenge would always be how to handle false positive and false negative and how to identify those. This problem would be quite different in an endemic population under control or eradication compared to a population like the Norwegian which is expected to be negative or close to negative.

The Norwegian Healthier Goat Project

Dag Lindheim¹ and Liv Sølverød^{1,2}

¹*Department of Goat Health Services, TINE Norwegian Dairies, Ås, Norway*

²*Department of Mastitis Laboratory, TINE Norwegian Dairies, Molde, Norway*

INTRODUCTION

A goat health survey in 2000 showed high prevalence of Caprine Arthritis Encephalitis (CAE), and Caseous Lymphadenitis (CLA). Johne's disease was enzootic in parts of southern Norway, and vaccination has been compulsory in these areas to avoid clinical outbreaks. Johne's disease and CAE are notifiable diseases. In 2001 the Veterinary Authorities had restrictions on 43 goat herds due to diagnosed Johne's Disease. "Healthier Goat" was started in 2001.

AIMS

The aim is to eradicate CAE, CLA and Johne's disease from the Norwegian goat populations.

Educational Programs on Biosecurity

A variety of educational efforts for farmers, advisors and veterinarians are carried out to motivate participants and build knowledge in "every day biosecurity". Receiving this knowledge is for free, and this part of the project is an important success factor.

Without these educational efforts the whole project would be a total waste of money.

The Eradication Principles - "Snatching" kids

Kids are taken from the birth channel and moved away from the infected barn immediately. They are then housed in a clean barn, given cow colostrum and raised on milk replacer, water, concentrate and hay. Adult goats are slaughtered at the end of the lactating period. Thereafter, the barn and near surroundings are cleaned and disinfected. Healthy goats are then moved back to the barn to start their first lactation.

There are no vaccination against Johne's disease in sanitized herds. The sanitized herds are monitored for five years by clinical observation and antibody detection in serum and bulk tank milk.

From the year 2013 the chosen ELISA test is Multiplex from Enfer, giving results for all three agents by using one drop from the sampled serum or milk. In areas where Johne's disease has been diagnosed in animals earlier, the pastures are kept free from manure and grazing animals for at least 18 months.

RESULTS

Test results verify that farmers manage to do the sanitation process (snatching) and follow the projects procedures very accurately. Test positive animals in sanitized herds are slaughtered.

Out of 602 sanitized herds the following numbers of herds were recorded as reinfected; three with CAE, one with Johne's Disease, and eight with CLA. Re-infected herds are carefully monitored and test positive animals are slaughtered. During the years 2012 and 2013 there were no new outbreaks of those diseases in sanitized herds.

By the end of 2014 all goat milk processed by TINE Norwegian Dairies will come from sanitized flocks.

Milk Quality Assurance for Paratuberculosis: Progress Obtained in the Cohort of Dairy Herds that Entered the Program in 2006-2007

Maarten F. Weber, Gerdien van Schaik, Marian Aalberts, Annet G.J. Velthuis

GD Animal Health, Deventer, The Netherlands

INTRODUCTION

In 2006, a Milk Quality Assurance Program (MQAP) for paratuberculosis in Dutch dairy herds was initiated. The aim of this MQAP is to reduce the concentration of *Mycobacterium avium* subsp. *paratuberculosis* (MAP) in bulk milk (van Roermund et al., 2005; Weber et al., 2008). The MQAP is run alongside the pre-existing 'Intensive Paratuberculosis Program' (IPP; aiming at elimination of MAP and low-risk trade of cattle (Benedictus et al., 2000; Weber et al., 2006)).

The MQAP promotes preventive management measures and culling of test-positive cattle to reduce the spread of MAP. On the herd-level, these measures increase the probability to obtain and maintain the preferred herd status (status A). On the national level, these measures taken by individual farmers increase the quality of bulk milk at the National level.

Herds participating in the MQAP are assigned a herd status (A, B or C) based on the results of herd examinations. Each herd examination consists of testing either individual milk samples of all lactating cattle or serum-samples of all cattle \geq three years of age by ELISA. Milk samples regularly collected for Milk Production Registration are used for testing. All samples are tested with the IDEXX Paratuberculosis Screening Ab Test (previously marketed as ELISA Paratuberculosis Antibody Screening, Institut Pourquier)¹. Farmers are entitled to confirm positive ELISA results by individual faecal PCR-assay or culture. If the result of the confirmatory test is negative, the animal is considered test-negative. However, confirmatory testing of faecal samples is only recommended in herds unknown to be infected.

The initial assessment consists of a single herd examination. Test-negative herds enter a surveillance procedure and are assigned status A. The surveillance of herds with status A consists of biennial herd examinations. Test-positive herds at the initial assessment or surveillance procedures enter a control procedure and are assigned status B (if all test-positive cattle have been removed from the herd) or status C (if any test-positive cattle are retained in the herd). The control procedure aims to control the infection in the herds, such that the milk quality can be guaranteed. The control procedure consists of annual herd examinations. If an annual herd examination in a herd with status B yields negative results only, then the herd progresses to status A.

From 2010 onwards, the Dutch dairy processing industries require all dairy herds delivering milk to their factories to participate in either the MQAP or the IPP. From 2011 onwards, all dairy herds delivering milk are required to have at least status B, meaning that all test-positive cattle have to be removed from the herd (Weber and Franken, 2008).

The aim of this paper is to present results obtained over an eight-year period (2006 - 2013) in the first cohort of 718 herds that voluntarily entered the MQAP in 2006 – 2007.

¹ Individual milk samples are tested using a cut-off S/P ratio = 1.00. Initially, a cut-off S/P ratio = 0.25 was used. In August 2007, this cut-off was raised to 1.00 to increase the specificity of the test. Individual serum samples are tested using cut-off S/P ratios of 0.90 and 1.10, with samples with an S/P ratio between 0.90 and 1.10 being reported as inconclusive.

MATERIALS AND METHODS

Results of the initial assessment, surveillance and control procedures of the MQAP obtained between January 2006 and December 2013 by all Dutch dairy herds that entered the MQAP in 2006 and 2007 without prior participation in the IPP were retrieved from the certification-operating-system of GD Animal Health. Herds with prior participation in the IPP were excluded, because upon entering the MQAP these herds generally did not take part in the initial assessment and were assigned a herd status based on test results obtained in the IPP.

To analyse the results of the surveillance and control procedures, non-parametric survival analyses was performed. In the analysis of the results of the surveillance procedure, loss of status A due to positive test results in the surveillance procedure was considered an event. In the analysis of the results of the control procedure, progression of a herd from status B or C to status A was considered an event. In the analysis of the results of the surveillance procedure, only the first period that a herd was assigned status A was included. Similarly, in the analysis of the results of the control procedure in herds with status B or C, only the first continuous period that a herd was assigned status B and/or C was included. Thus, repeated measurements of individual herds were excluded. In both survival analyses, loss to follow-up (i.e., at the end of the study period, cessation of participation in the MQAP, herds changing production-type to non-dairy or herds ceasing to exist) was taken into account as right censoring. Loss of status A due to non-adherence to the regulations of the MQAP (such as the requirement to test cattle introduced from a herd with a lower status) was also considered as right censoring.

To analyse the proportion of herds with status A, B or C over time after the first herd examination, the status of each herd was retrieved at one-month intervals.

RESULTS

Initial assessment

A total of 718 dairy herds entered the initial assessment of the MQAP in 2006 and 2007 without prior participation in the IPP. In 629 of the 718 herds (88%) the first herd examination was done by individual milk-ELISA, whereas in the remaining 89 herds (12%) this was done by serum-ELISA. In 322 herds (45%), all cattle were ELISA-negative. These herds were assigned status A. In the remaining 396 herds (55%), at least one individual was ELISA-positive. In 98 of those 396 herds, confirmatory faecal culture of all ELISA-positive cattle yielded negative results only. After the first herd examination, these herds were temporarily assigned status B, but this was changed to A when the negative results of faecal culture became available. Thus, in total 420 herds (58%) were assigned status A at the completion of the initial assessment, and 298 herds (42%) were assigned status B or C.

Surveillance of herds with status A

At completion of the initial assessment, 420 herds achieved status A. These herds had a probability of 69% to retain status A for at least 6 years (Figure. one).

Of the 298 herds that were assigned to status B or C at the completion of the initial assessment, 217 herds (73%) progressed to status A at a later stage. These herds had a probability of 24% to retain status A for at least 6 years (Figure. one).

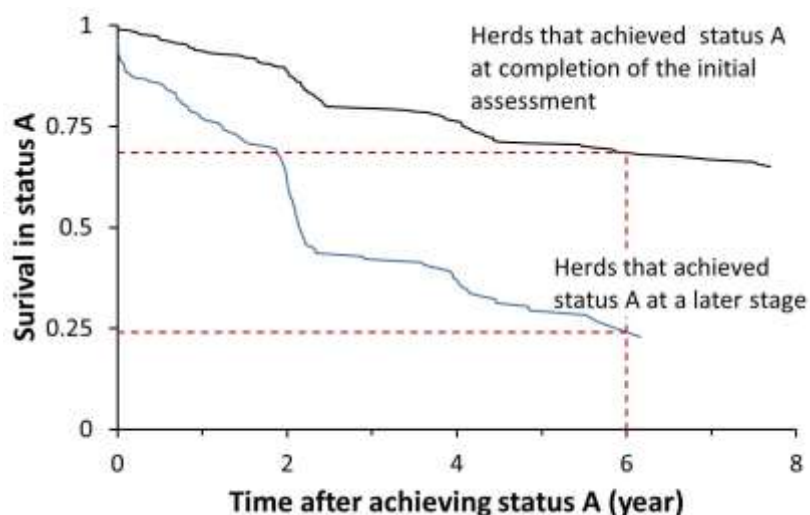


Figure One: Survival curve for Dutch dairy herds in status A. Loss of status A due to positive test results in the surveillance procedure was considered as an event; loss of status A due to other reasons and loss to follow-up were considered as censoring. The survival curves are based on data of 420 herds that achieved status A at the completion of the initial assessment, and 217 that achieved status A at a later stage.

Control in herds with status B or C

At completion of the initial assessment, 298 herds were assigned status B or C. These herds had a cumulative probability of 52% to progress to status A within four years after completion of the initial assessment (Figure two).

Of the 420 herds that were assigned status A at completion of the initial assessment, 95 herds shifted to status B or C at a later stage. These herds had a cumulative probability of 95% to regain status A within four years after shifting to status B or C (Figure two).

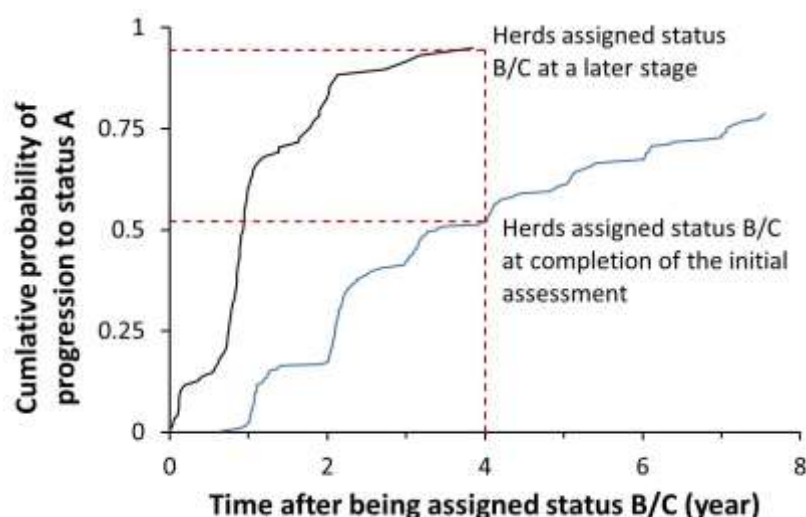


Figure Two: Cumulative probability of progression to status A overtime after a herd is assigned either status B or C. The curves are based on data of 298 Dutch dairy herds that were assigned status B or C at completion of the initial assessment, and 95 Dutch dairy herds that were assigned status B or C at a later stage.

Proportion of herds with status A, B or C over time

The assignment of the 718 dairy herds to status A, B or C over time after the first herd examination of the initial assessment is shown in Figure three. The number of dairy herds for which data were available decreased over time (Figure three A) because herds entered the program at varying time points in 2006 and 2007 (meaning that at the end of 2013, herds could participate up to 6 - 8 years) and because 117 of the 718 study herds ceased to produce milk or ceased to exist during the study period.

Over time, the proportion of herds with status A increased from 45% immediately after the first herd examination (i.e., prior to any confirmatory testing of faecal samples of ELISA-positive cattle) to 75% at seven years after the first herd examination (Figure three B). In part, this increase may be explained by an increase of the cut-off of the individual milk-ELISA from 0.25 to 1.00 in August 2007, i.e. up to 19 months after the first herd examination of participating herds. However, even after this increase of the cut-off, the proportion of herds with status A consistently increased from 65% at two years after the first herd examination, to 75% at seven years after the first herd examination (proportions test, $p < 0.001$).

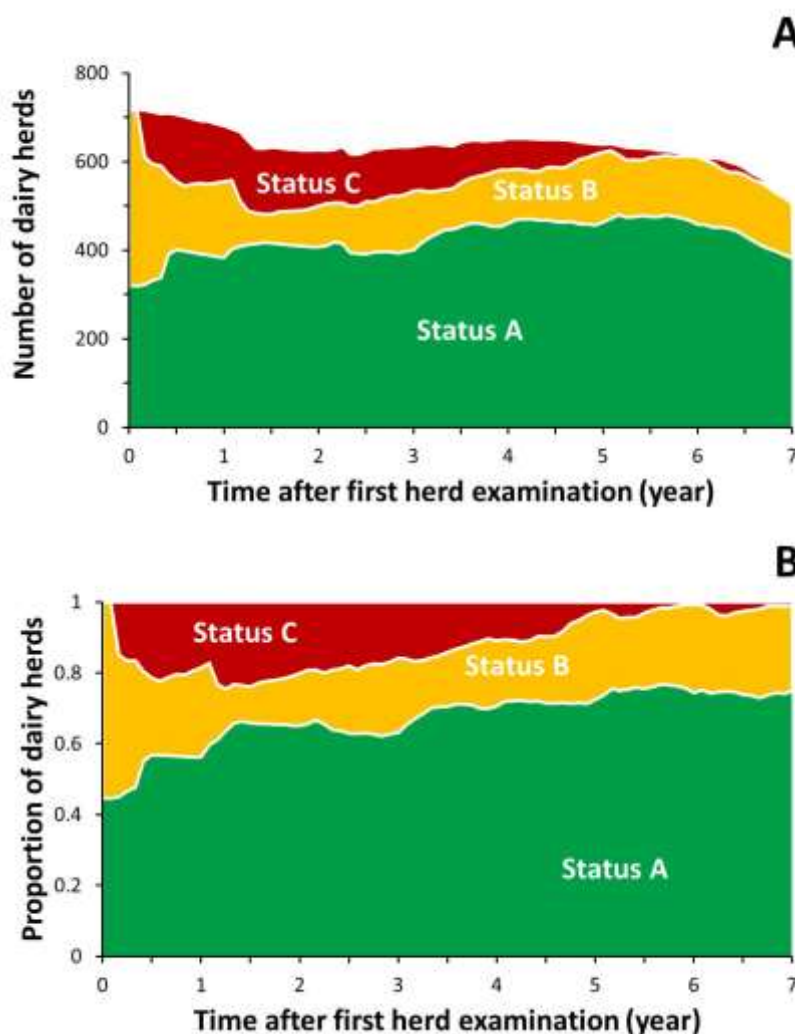


Figure Three: Assignment of 718 Dutch dairy herds that entered the Milk Quality Assurance Program in 2006 or 2007 to status A, B or C over time after the first herd examination of the initial assessment. (A) Number of herds per status (B) Proportion of herds.

Importantly, the proportion of herds that had either status A or B increased over time as well, and at any point in time beyond year five, at least 95% of the participating herds had status A or B.

In the subset of 420 herds that were assigned status A at the completion of the initial assessment (i.e., after any confirmatory faecal testing of ELISA-positive cattle), the proportion of herds with status A was always higher than 76% (Figure four). At the first herd examination by ELISA, 98 of these 420 herds (24%) herds had one or more ELISA-positive cattle. In these 98 herds, confirmatory testing of faecal samples did not yield any positive results. These 98 herds were temporarily assigned status B, until the negative results of confirmatory faecal cultures had become available at the completion of the initial assessment. Therefore, at $t = 0$ in Figure four, 76% of the 420 herds were assigned status A.

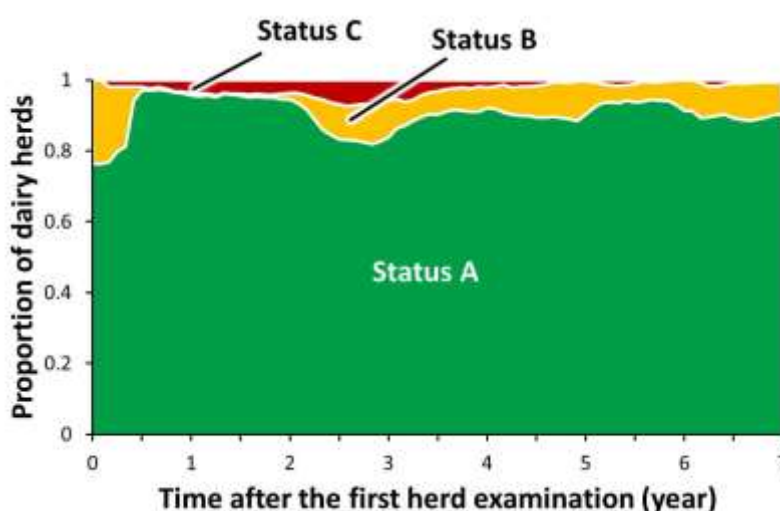


Figure Four: Herd status over time after the first herd examination in 420 Dutch dairy herds that were assigned status A after completion of the initial assessment (i.e., after any confirmatory testing of faecal samples).

In the subset of 298 herds that were assigned status B or C at the completion of the initial assessment, the proportion of herds with status A increased to 50% in year 6 (Figure five).

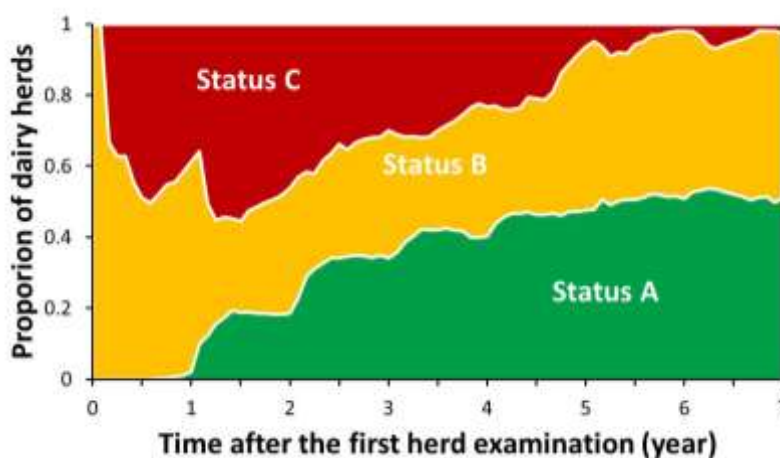


Figure Five: Herd status over time after the first herd examination in 298 Dutch dairy herds that were assigned status B or C after completion of the initial assessment (i.e., after any confirmatory testing of faecal samples).

DISCUSSION

The aim of this paper was to evaluate the progress obtained over an eight-year period (2006 - 2013) in the first cohort of herds that voluntarily entered the MQAP in 2006 – 2007 without prior participation in the IPP. It is important to note that this cohort was a non-random selection of Dutch dairy herds, predominantly owned by farmers with an interest in the control of paratuberculosis.

The results show that, at present, almost all study herds have at least status B (i.e., any test-positive cattle are removed from the herd). Moreover, the results show a steady and consistent increase over time of the proportion of herds with status A. Although this increase may be partially explained by a change of the cut-off of the individual milk-ELISA in August 2007, the proportion of herds with status A has continued to increase in later years (Figure three B).

At completion of the initial assessment, 58% of the herds were assigned status A. These herds had a probability of 69% to retain status A for at least 6 years (Figure one). Herds that were assigned status B or C after completion of the initial assessment had a probability of 52% to progress to status A within four years after the initial assessment (Figure two). However, these herds were at a considerable risk of shifting again to status B or C: only 24% of these herds retained status A for at least six years.

An important advantage of the observed high rate of herds progressing from status B or C to status A is that farmers with known infected herds are encouraged that it is feasible to obtain the preferred herd status A. This has beneficial effects on the support of the program by farmers, and their willingness to take preventive management measures and cull test-positive cattle to control the infection in their herds. However, a potential disadvantage is that upon reaching status A some farmers are no longer encouraged to implement further improvements to their herd management. Preventive management measures such as a closed herd management and separation of young stock and adult cattle increase the likelihood of successful control of the infection (Garry, 2011; Lombard, 2011). This was confirmed by modelling studies, which indicated that preventive herd management had a major impact on the likelihood of obtaining and retaining the preferred herd status in a milk quality assurance program (van Roermund et al., 2005; Weber et al., 2008). Thus, in advising farmers it is important to stress that status A should not be considered as 'MAP -free' and that obtaining status A does not take away the need for preventive herd management measures. This was indeed exemplified by the high hazard of losing status A in herds that progressed from status B or C to status A previously.

It is concluded that in this first cohort of herds that voluntarily entered the MQAP in 2006 – 2007, the proportion of herds with status A has steadily and consistently increased over time. This indicates that the program positively contributes to the control of MAP in the Dutch dairy population.

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Importance and Control of Paratuberculosis in Dairy Cattle Herds

Mateja Pate, Katarina Logar, Petra Bandelj, Urška Zajc, Jože Starič, Jožica Ježek, Darja Kušar, Jana Avberšek, Brane Krt, Tina Pirš, Matjaž Ocepek

University of Ljubljana, Veterinary Faculty, Ljubljana, Slovenia

INTRODUCTION

Slovenia is a small Central European country in which approximately 460.000 cattle of about 15 breeds are bred. Among them, the Simmental cattle are the predominant (37%), followed by the Black and white (16%) and Brown (9%). Average cattle farm in Slovenia encompasses 6 ha of landscape and 12 heads of cattle with 5.7 animals older than two years. Paratuberculosis is a common disease of ruminants in Slovenia. The first case was detected in 1961 in imported Jersey cows. No other cases were reported until 1993, when paratuberculosis was found in a sheep flock; since then, several outbreaks of the disease in cattle, goats and sheep have been documented. Systematic screening of paratuberculosis was going on between 1995 and 2001, using various serological tests and including different categories and numbers of cattle (Ocepek et al., 1999, 2002). Between 2002 and 2007, no data on paratuberculosis prevalence were available.

In 2008, a seroprevalence study was conducted in which animals older than two years were screened for *Mycobacterium avium* subsp. *paratuberculosis* (MAP) in randomly selected cattle herds. The study showed that the true prevalence at the herd level was almost the same as in 1999 and that it was fairly low (18.49%) compared too many European countries (Kušar et al., 2011). However, later studies indicated that a lot more dairy cattle herds are infected. Investigation of randomly selected animals from eight big dairy cattle herds (average herd size 184 heads) showed the presence of antibodies against MAP in every herd with 50% of herds being culture-positive (Starič et al., 2011).

In addition, a PCR-based investigation of subclinically infected animals of different age groups from a herd with a history of paratuberculosis revealed that a vast majority (up to 89%) of the animals within a herd may be infected with MAP (Logar et al., 2012). These facts, which revealed that the situation regarding paratuberculosis is not that favourable in Slovenia, call for immediate implementation of measures necessary to control the disease.

AIMS AND OBJECTIVES

The results of our previous work on paratuberculosis suggested two main conclusions. Firstly, the specificity of the ELISA kits used is questionable. Namely, in the majority of cattle herds with no evident clinical signs of infection and with no history or epidemiological link with paratuberculosis, there were no culture- or PCR-positive animals despite about one tenth of seropositive animals. This can be attributed to cross-reactions with other subspecies of *M. avium* which are evidently widespread in the environment in Slovenia, concluding from our previous studies. Secondly, there is a need for a highly sensitive and specific method to detect subclinically infected animals. Lack of sufficiently sensitive, specific and reliable laboratory tests can lead to underestimation of the proportions of MAP shedders in herds. The main objective of our research in the past few years was therefore to provide useful diagnostic tools which would constitute a base for a much needed disease control program.

IMPROVEMENTS MADE

Therefore, we introduced a high-yield DNA extraction method coupled with quantitative real-time PCR to detect MAP in cattle faeces (Logar et al., 2012). The study, which included faecal culture, milk ELISA, milk qPCR and faecal qPCR, was performed on the samples of 141 subclinically infected dairy cattle of all age categories from a farm with a history of paratuberculosis. The results suggested that the proportion of low-level MAP shedders in cattle populations tested in the past was most likely underestimated. In addition to detecting a surprisingly high proportion of MAP shedders within a herd (89%), we demonstrated a negative influence of MAP infection to milk production already in the first lactation heifers. Due to its relatively high sensitivity and specificity, the developed qPCR can be applied to test for MAP at the herd or individual level, regardless of animal age or production stage.

This tool enabled us to conduct two pilot studies on paratuberculosis control employing vaccination in two heavily infected cattle herds. In both herds, an almost 50% prevalence of MAP infection was established by faecal culture of all cattle older than two years. Milk and faecal samples of cattle of different age groups were investigated by culture and qPCR for the presence of MAP six to twelve months before and six to twelve months after vaccination. In one herd, the proportions of culture-positive faecal samples, qPCR-positive milk samples, qPCR-positive faecal samples and the average number of MAP in positive samples decreased up to 57% while in another herd, only the proportion of qPCR-positive milk samples and the average number of MAP in positive samples were reduced. However, in both herds the average milk yield increased for about 600 kg per cow after vaccination. Concluding from these two experiments, vaccination apparently reduces economic losses and MAP shedding in milk, but is not entirely effective for controlling the disease.

LESSONS LEARNED

Effective disease control should include estimation of paratuberculosis prevalence in large dairy cattle herds, using a reliable, sensitive and specific diagnostic method. In addition, we believe that introduction of herd certification would be crucial to stop the spread of the infection; it would enable the farmers to purchase healthy animals from MAP-negative herds and to increase the value of animals in trading. In the infected herds, control measures should be proposed on individual basis, taking into account the infection rate and type of breeding.

Vaccination should be considered for controlling the disease, but only as a last option. Without the measures to prevent the spread of the disease, it can be expected that the majority of large dairy cattle herds in Slovenia will become affected by paratuberculosis. To protect the public and animal health, and the competitive position of Slovene cattle breeding, the measures to control the disease should be prepared immediately. However, this goal cannot be successfully pursued without participation of the government, veterinarians, cattle breeding associations and the cattle breeders themselves.

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A Review on Progress with Johne's Engagement Program in UK Dairy Herds

Peter Orpin¹ and Richard Sibley²

¹*Park Veterinary Group, United Kingdom*

²*West Ridge Veterinary Practice, United Kingdom*

INTRODUCTION

A voluntary Johne's Engagement program was initiated in 2008 in the United Kingdom (UK) facilitated by Dairy UK (representative body of UK milk processors). The program has engaged approximately one third of the larger dairy herds through activity driven by the private veterinarian, milk processor/retailer or via funded regional disease control schemes. The engagement process involved farmer and veterinary education, structured risk assessment, standardised surveillance and control planning using trained vets as described in the Third Paratuberculosis Dairy Forum. (Orpin 2011). The experiences over the last five years have helped shape a change in the way diseases are approached and managed in the UK with a greater emphasis on predicting and preventing diseases rather than waiting for infection to appear and testing and managing the disease at this stage (Orpin 2014) This paper will build on the lessons learned and recent developments within the UK engagement program since the last IAP conference in Sydney, 2011.

AIMS AND OBJECTIVES

The original objective of the milk processor organisations was to engage a wide range of dairy producers in Johne's management through a broad collaboration between all parties involved which was instrumental in the success of the engagement program.

The methodology of the program is described in the previous Dairy Forum proceedings (Orpin 2011). The essence of the approach was based on education, risk assessments, 30 cow targeted screens and herd specific control of the disease at farm level.

The risk data gathered and stored within the web based database (www.myhealthyherd.com) rapidly revealed the extent of the problem within UK Dairy herds. Widespread consolidation of dairy herds in the last ten years had reduced the producer numbers from over 18,000 to 10,500 and the average herd size has increased from 85 to 123 dairy cows over the same time period.

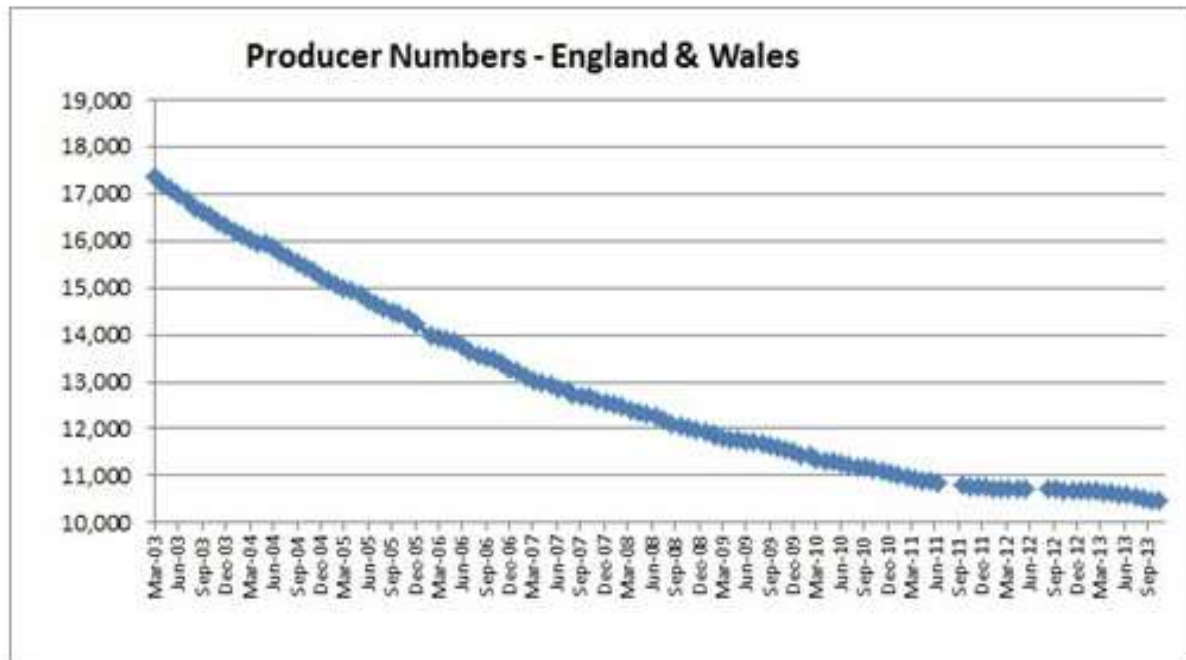


Figure One: Dairy Producers in England and Wales 2003-2013 (Dairy Co).

Mycobacterium avium subsp. paratuberculosis (MAP) infection was unwittingly introduced into herds through the purchase of latently infected cattle from the herds selling up their milk quota and ceasing dairy production. This was further exacerbated by enforced restocking due to Foot and Mouth Disease and bTB which prompted emergency restocking of herds primarily from markets and dispersal sales to ensure the producers could maintain their contracted level supply of milk. The risks of within herd spread were high with over 75% of herds assessed having a high risk of MAP transmission from cow to calf. (See Figure two). Only 24% of herds did not purchase cattle onto their holdings. Animal movement has been the norm within UK dairy herds and as such these risks must be managed more effectively if diseases are to be controlled effectively.

Solutions had to be found which would help control the spread of MAP within a wide range of dairy farms with differing resources and aspirations. It was quickly recognised that a single control scheme would not be practical due to the wider range of different farming systems within the UK.

Persistent promotion of the Johne's Engagement program was undertaken during the first three years of the program through the milk processors, vets and other stakeholders. This helped dispel the stigma surrounding the disease as it rapidly became apparent that the majority of the larger progressive dairy processors were already infected. Once this barrier was overcome producers were able to talk freely amongst each other about their experiences with the disease. This was crucial in terms of expanding the engagement over a wider base of producers.

In the last two years however the Johne's Engagement Program has reached a level of penetration whereupon most sizeable producers are aware of the disease and have taken steps to assess risks, undertaken preliminary surveillance and taken appropriate action to reduce introduction and spread of the disease. The disease has become "owned" by the farmers and supported by the vets. This is a crucial point to achieve with a disease such as Johne's which is only effectively controlled by steps that the farmer takes to optimise husbandry. Testing alone will not control the disease.

Surveillance strategies have been improved. The popular targeted 30 cow screen has been further researched by a retrospective analysis of 385 herds (Hanks 2013). The odds ratios for test positive animals were compared to a range of factors recorded by the milk recording company. The Probability of being test positive increased x1.5 for cows in parity 3+; x2 for cows with a SCC >200,000 cells/ml; x1.8 for cows with >2 SCC >200,000 cells/ml; and x2 for cows with milk yields more than 25% below their adjusted herd average. The construction of a scoring system to automatically identify these high risk cows from the milk records has helped increase the sensitivity of the 30 cow screen in correctly identifying infection from 54% to 83% in herd with prevalence less than 4%. This has helped deliver a new surveillance system from National Milk Records suitable for lower aspiration farmers using automatic 30 cow screens repeated every three months.

| General biosecurity risks relevant to Jones Disease n = 2993 dairy herds | Frequently | Occasionally | Never |
|---|-------------------|---------------------|--------------|
| The herd introduces cattle on to the farm | 13.7% | 62.1% | 24.2% |
| Cattle share grazing or buildings with cattle of unknown disease status | 2.9% | 8.2% | 88.9% |
| Slurry or farm yard manure is from another farm is spread on land | 0.6% | 4.9% | 94.5% |
| Cattle have access to waterways that have passed through another livestock farm | 14.5% | 38.7% | 46.8% |
| Cattle are fed with feeds that could have had contact with other animals | 1.8% | 16.1% | 82.2% |
| Johnes Disease specific biosecurity risks n=2296 dairy herds | | | |
| The herd has introduced groups of animals of unknown Johnes status in last ten years | 13.4% | 39.6% | 47.0% |
| The herd has introduced individual animals of unknown Johnes status over last ten years | 11.0% | 57.8% | 31.2% |
| Slurry of farm yard manure from another farm is spread onto young stock pastures | 0.4% | 4.2% | 95.4% |
| Calves have access to streams or watercourses that have passed through another livestock farm | 6.6% | 28.2% | 65.2% |
| Young stock graze pastures that are heavily infected with rabbits | 13.8% | 48.9% | 37.3% |
| Young stock co-graze pastures with sheep of unknown disease status | 8.0% | 21.9% | 72.1% |
| Calves are fed on colostrum from other herds that may be high risk of carrying MAP | 2.0% | 4.0% | 94% |

Figure Two: Biosecurity Risk assessment profiles for 2296 dairy herds captured by the Myhealthyherd database during the Johnes Engagement program 2008-2014.

In the early days the vets became disillusioned with the control of Johne’s disease in dairy herds due to their mixed experiences with often inappropriately delivered “test and cull” programs. The dairy herds commonly have sustained high risks of transmission combined with significant within herd prevalence which can overwhelm the impact of an annual test and cull program. The program seldom delivered good results as the risks were difficult to manage (e.g. “snatch calving” in communal maternity pens was seldom applied efficiently) and the annual testing frequency led to a drift of enthusiasm within three months of the test date.

These challenges were largely overcome by the development and agreement of the 7 main control strategies for controlling the disease (Figure three). A technical group was set up within the Dairy UK Johne's action group to formally agree the main strategies and most importantly which types of herds would be most appropriately managed by each strategy. Johne's Vaccination for instance is allowed within the UK and decisions were made that this was still appropriate but would be usefully employed in very few herds and then only as a “firebreak” to help reduce the overall prevalence prior to introduction of a more appropriate strategy.









| Strategies | | | |
|---|--|---|--|
| Title | Description | Suitable for | Use |
| Improved Farm Management (IFM) | Improve farm management (IFM) to reduce the spread of infection from adult cows to calves. | Herds planning to reduce Johne's disease spread and incidence over a 5 year + horizon or any herd wishing to reduce the risk of Johne's. Optimal for moderate to low prevalence herds aiming for green status. |  <input type="checkbox"/> |
| Improved Farm Management and Single Test | Improved farm management (IFM) combined with testing to help reduce identify infectious cows for management and reduce risk of calf infection. | Herds planning to reduce Johne's disease spread and incidence over a 5 year + with the additional ability to identify infected cows earlier for proactive management. Ideal for moderate prevalence herds wishing to improve the success of IFM |  <input type="checkbox"/> |
| Improved Farm Management, Test and Cull | Test and cull in addition to improved farm management (IFM) to reduce the spread of infection from adult cows to calves. | For low prevalence herds with high aspirations for control. Aiming for green or accredited status over 5 year+ period. An aggressive strategy not economic for high prevalence herds. |  <input type="checkbox"/> |
| "Firebreak" vaccination and Improved Farm Management | "Firebreak" vaccination to reduce the spread of infection from adult cows to calves for 3-5 years progressing to improved farm management (IFM). | For high prevalence herds where IFM control measures are difficult to apply and desire to reduce the impact of clinical disease within the herd only. NOT suitable for herds wishing to demonstrate low prevalence in the future or trade with non vaccinating herds as vaccinated cattle can still spread disease and interfere with JD tests. Vaccination used as short term measure to damp down prevalence and then progress to fully implemented IFM in 3-5 years. |  <input type="checkbox"/> |
| Biosecurity Protect and Monitor | Johne's disease entry risks are green and whole herd screens show the disease is absent | Herds with green entry risks and zero prevalence. Not recommended for herds of unknown Johne's prevalence or any herd where infection is present and this route should only be adapted after seeking veterinary advice and preliminary surveillance and risk assessments. |  <input type="checkbox"/> |
| Risk Based Control (Quarterly Milk Testing) | Risk based 'test and manage' program using quarterly milk testing of all cows to most reliably identify high risk cows for separation at drying off to reduce the risk of spread to calves intended for breeding | Herds wishing to use a proactive regular testing for every cow in the herd allowing for cost effective management of high risk cows with minimal changes to the management of the majority of test negative cows. Suitable for milk recording herds of any prevalence. |  <input type="checkbox"/> |
| Purchase replacements and breed herd to terminal sire | Breed all cattle to terminal sire with objective to fatten offspring. Source replacements from known low prevalence herds. | High/ Moderate prevalence herds willing to purchase replacements in preference to rearing their own. Only suitable if replacements can be sourced from herds of known low prevalence. |  <input type="checkbox"/> |
| Vet specified Custom Strategy | | |  <input type="checkbox"/> |

Figure Three: The seven control strategies for Johne's disease control in Dairy herds (Source www.myhealthyherd.com)

The control strategies adopted for beef and dairy herds can easily be extracted from the Myhealthyherd database and a small subset of those chosen through the funded Healthy Livestock Scheme clearly shows the range of strategies adopted. In this particular example the vets were paid to deliver a structured program of education, risk assessment, surveillance and control planning on participating farms. Test and cull and vaccination strategies were not popular control programs constituting less than 12% of farms whereas improved farm management or in combination with testing accounted for more than 46% of farms. Quarterly testing using the Danish Risk Based Control system described by Soren Nielsen was the most popular program with over 36% of farms adopting this program. (Nielsen 2007, 2009).

| Strategy option | Number of dairy farms | Percent |
|--|-----------------------|---------|
| Improved farm management (IFM) of whole herd to limit spread | 221 | 26.3 |
| Single annual test of all adults, targeted risk management and IFM | 163 | 19.4 |
| Test and cull with IFM | 93 | 11.1 |
| Firebreak vaccination with IFM | 8 | 1.0 |
| Biosecurity, protect and monitor | 49 | 8.5 |
| Quarterly testing and targeted risk based control | 274 | 32.7 |
| Purchase all replacements and breed to terminal sire | 7 | 0.8 |
| Vet specified custom strategy | 24 | 2.9 |

Figure Four: Control Strategies chosen within 839 UK Dairy farms in the Healthy Livestock Program.

This clearly illustrates the importance of providing choice for vets and farmers in terms of control. For a cost effective and practical solution to be adapted it must satisfy the resources and aspirations of the farmer rather than those of the scheme provider. 26% of herds adopted improved farm management without supplementary testing. On many small dairy farms where husbandry levels are high this is wholly appropriate and is seldom officially recognised by laboratory based schemes which are dependent on testing for acknowledgement of engagement.

The adoption curve for the Danish Control program as provided by one of the milk recording companies NMR (Herdwise) within the UK illustrates the rate of engagement. The rise in numbers in 2011 was driven by the compulsion by a major retailer (Tesco) enforcing adoption of quarterly milk testing for Johne's within its supplier group of 850 farmers in 2011. (Figure five).

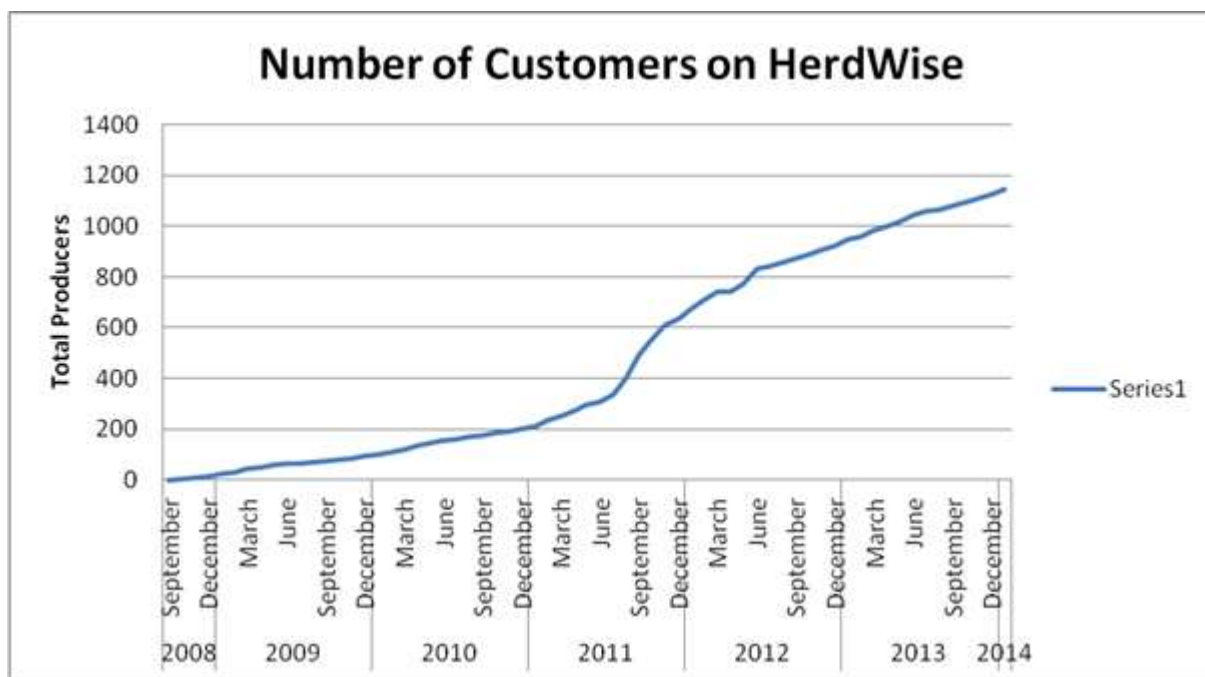


Figure Five: Number of producers using HerdWise control (National Milk Records 2008 to 2014).

The within herd prevalence within the HerdWise herds can readily be tracked. The mean % of cows’ repeat testing positive (red) is 3.4% with 41% of herds with less than 2% red cows.

As the program has progressed the uptake of the Danish Control program within milk recorded herds has allowed for the development of more knowledge of the impact of disease on both health and productivity.

Comparisons of average lifetime yield compared to the prevalence of repeat test positive (red) cows within a herd revealed that herds with less than a 3-4 % prevalence level delivered typically 10-15% higher lifetime yields than herds with prevalence’s greater than 6%. (Figure six).

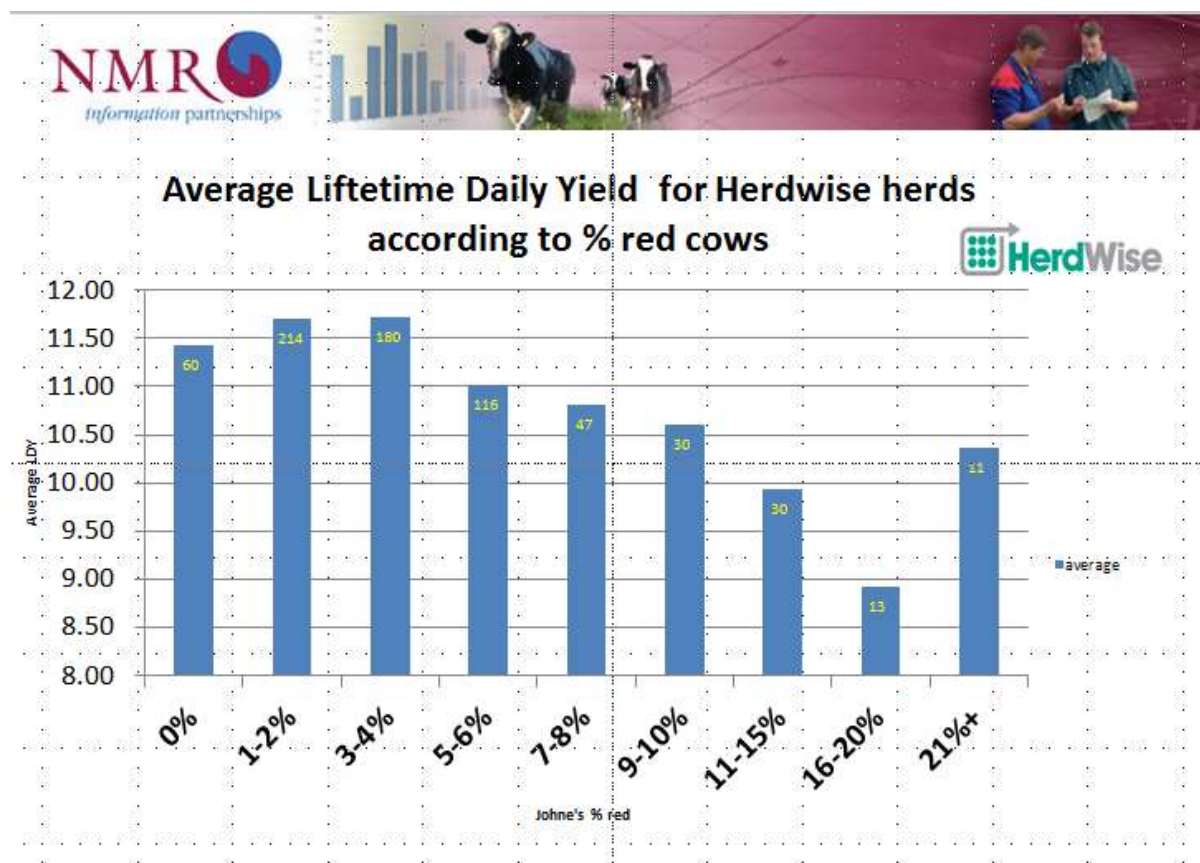


Figure Six: Graph illustrating average daily yield from HerdWise herds compared to the within herd prevalence of repeat test (red) cows.

Sharing this simple information with farmers helps ensure that the farmers kept engaged with the program.

A variety of graphs have been developed within the Myhealthyherd and NMR databases which now allow the farmer and vet to track the prevalence of test positive cattle and notably the year of birth of any infected cows. This allows progress to be monitored and explains how prevalence levels typically rise before they fall within infected herds.

The official accredited Johne's scheme as operated by CHcCs has recently modified their standards to allow a grading of herd status based on the % test prevalence and years without a test positive result. The herds are categorised on a scale of 1-5. All participating farmers are requested to submit a control plan with their samples. The definition of an accredited herd has also been extended to three consecutive annual herds tests of all breeding cattle over the age of two years with no test positive result. Johne's accreditation remains problematic with issues of cross reactivity with TB, test sensitivity and biosecurity and bio containment challenges all proving to make this a difficult area to manage. Certainly for any countries wishing to engage farmers with Johne's disease it may be more productive to avoid disease assignment until the engagement program is well underway.

| Status | Definition |
|----------------------|--|
| Risk Level 1: | This is directly equivalent to the previous CHeCS Accredited status. Level 1 status is associated with the lowest risk when buying in stock. Health plan required. |
| Risk Level 2: | Herds with Level 2 status have had one or two clear consecutive herd tests. Health plan required. |
| Risk Level 3: | Herds with Level 3 status have reactors identified at the annual herd test, but these are no more than 3% of the animals tested. Health plan required. |
| Risk Level 4: | Herds with Level 4 status have reactors identified at the annual herd test, and these amount to more than 3% of the animals tested. Health plan required. |
| Risk Level 5: | Any herd that is not carrying out the required testing or does not have a suitable health plan in place automatically falls into this category. Level 5 status is considered to be the greatest risk with respect to Johne's Disease when buying in stock. |

Figure Seven: The CHeCS categorisation of Johne's Herds (revised January 2013).

LESSONS LEARNED

As the program developed it became increasingly clear that consistent education and awareness for vets, farmers and the wider industry is essential for the program to succeed. Both farmers and veterinarians need to be fully aware of the issues that surround Johne's disease; traditional views that the disease is a sporadic clinical condition of adult cows were the initial challenge. Indeed, the lack of understanding of many veterinarians had led to some obstruction in the adoption of the program by some farmers and veterinary practices in the early days. This has now been overcome through sustained and consistent communications.

The use of various databases has been instrumental in the success of the program. Measuring test positive rate in a central database is not enough to retain engagement. Systems must be in place to allow the vet and farmer to revisit risk profiles, create disease predictions and store lab results locally in an accessible manner. This helps firmly drive the "ownership" of the disease back to the farmer which is vital. Risk management is the crucial part of Johne's control. The focus can easily be shifted to the test result and culling rather than the more arduous and more relevant reduction of the risk of disease transmission. Avoiding indiscriminate culling of cows without concomitant control of transmission is essential. The Myhealthyherd program has been redesigned to allow free farmer access to discuss and record their control strategy for Johne's and other diseases as part of their annual health plan. This will hopefully generate a wider discussion and progression with control on a regular basis.

TB testing and the cross reaction with the Johne's ELISA test has provided continued challenges. In restricted herds where cows are tested every 60 days the % positive cows increases and apparent specificity of the tests reduces. Until such a point where a more specific test is created the only option available is more selective culling and management of test positive cattle under close veterinary guidance.

The challenge still remains as to how best to provide effective drivers for low prevalence herds to take part in the program as early indications are that high risk, infected herds are volunteering whilst those that consider themselves as unlikely to be infected are not engaging. The majority of

replacement dairy cows have been sourced from herd dispersals and whole herd sales rather than planned sales of lower disease risk stock.

The development of quarterly, automated targeted quarterly 30 cow screens based on the work by Hanks (Herd Tracker) delivered via National Milk Records is an interesting development. Cows are selected based on cell count, milk yield and age for testing. This allows herds of lower aspiration or prevalence to monitor for infection in a reasonably robust and effective way.

The discussions at the annual health plan may trigger wider involvement and surveillance for the disease in low prevalence herds through the introduction of the free disease manager module within Myhealthyherd. Asking the question “how do you plan to control and test for Johne's disease” will help trigger initial involvement.

There has been little market demand from the farmers or milk processors for extension of the current JD engagement program to a widely adopted official program with standardised surveillance as adopted in the Netherlands. The current emphasis is to reduce the prevalence within herds to an acceptably low prevalence based on the aspirations of the farmer rather than drive farmers into a centralised scheme with no purpose or advantage to the producer.

The Dairy UK group are now reconsidering the next steps. A rational approach would be to ensure that every dairy producer has a robust control and protection plan installed by a trained veterinarian. This is more likely to deliver success and widespread engagement and the tracking of progress. Currently this is not a compulsory element of dairy production in the UK and as such Johne's disease will remain a significant albeit declining problem for UK dairy producers.

SUMMARY

Improvements made

The key improvements and developments over the last 2 years have been:

- The continued support by Dairy UK and Dairy Co (extension service) for the Johne's program.
- The agreement of the key control strategies for the disease.
- The demand from farmers and industry for the incorporation of Johne's disease control programs within regionally funded health programs.
- The continued development of databases and programs to help illustrate the impact of JD on dairy cows to facilitate improved control approaches.
- The development of simpler automated surveillance strategies such as repeated targeted 30 cow screens (Herd Tracker).
- The incorporation of disease control within the annual farm assurance health plan.
- The improvements to the CHeCS categorisation of herds providing a more graded approach to the disease.
- The continued education of vets, academics and farmers in the concepts of practical “predict and prevent” approaches based on farmer aspiration and resources rather than didactic “test and treat” approaches with low levels of adoption and application.

- Achieving the goal of farmer “ownership” of Johne's disease rather than leaving this in the hands of the vets or labs.

The complexity of the UK dairy industry and the competitive nature of the retailers and processors have created complications that many other countries may not have to overcome. However with persistence progress to reducing the prevalence of MAP within the UK Dairy Herd is achievable using a commercially driven farmer initiated program and is well underway.

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Useful websites

Proceedings Dairy UK Johne's meeting www.dairyuk.org

Myhealthyherd www.myhealthyherd.com

Johne's information www.johnes.org

Herdwise www.nmr.co.uk/herdwise

CHeCS_ www.checs.co.uk

Dairy Co www.dairyco.org.uk

JD Control in Australia: Keeping Pace with National Animal Health Policies, the Challenges and Lessons Learned

Lorna Citer¹ and Evan Sergeant²

¹*Animal Health Australia*

²*AusVet Animal Health Services, Australia*

INTRODUCTION

The National Johne's Disease Control Program (NJDCP) has been in place for nearly two decades and has a coordinating function which enables the individual industries, and states to develop projects which achieve outcomes consistent with the objectives of the respective projects for the control of bovine and ovine Johne's disease (BJD and OJD). Through each of these sub programs for the sheep and cattle industries the NJDCP continues to deliver on objectives which ensure the Australian livestock industries can demonstrate effective control measures to prevent the spread of disease into regions where it is rare or unknown. The background and rationale for the program has been fully detailed previously (4th ParaTb Forum, Sydney 2012) and this paper will focus on changes that have occurred within the program since 2012, in particular identifying the drivers for the changes that have occurred and challenges which have been experienced.

As the only national endemic disease control programs in Australia (programs for other endemic diseases are state based) the BJD and OJD programs are subjected to ongoing review to ensure the program continues to align with national animal health policy directions. During this time Johne's disease control has evolved from a strongly regulated program to an industry driven partnership with state governments, while still retaining a technically strong basis to control activities. The programs are underpinned by Standard Definitions, Rules and Guidelines (SDR&G's), some of which, such as tracing and the allocation of herd statuses, depend on government support for implementation. The programs also ensure the availability of tools for producers to be able to protect individual businesses from the introduction of Johne's disease and to contain the disease in the event it inadvertently enters a flock or herd.

Johne's disease continues to occur in some regions of Australia, principally along the south eastern seaboard where stocking density is higher and the climate more temperate. Other regions have little or no recorded disease and, overall, Australia continues to report low herd and flock prevalence for Johne's disease in beef, alpaca, goat and dairy herds relative to many other countries. (Table 1).

| State | Cattle | Goat | Alpaca | Deer | Total |
|-----------------|-------------|-----------|----------|----------|-------------|
| New South Wales | 124 | 3 | 0 | 0 | 127 |
| Queensland | 6 | 1 | 0 | 0 | 7 |
| South Australia | 56 | 1 | 0 | 0 | 57 |
| Tasmania | 39 | 4 | 0 | 0 | 43 |
| Victoria | 887 | 9 | 0 | 0 | 896 |
| Total | 1112 | 18 | 0 | 0 | 1130 |

Table 1: Number of herds or flocks infected with Johne's disease as at December 2013. (Source National Animal Health Information System)

The national sheep flock is monitored through abattoir monitoring and with over 10% of the flock monitored annually the percentage of monitored flocks detected with lesions is 1.3% (2013). There is significant regional variation in disease prevalence, from <1% to >30% of flocks, which in itself presents challenges for determining how best to provide appropriate outcomes for producers with very different expectations and needs.

Historically Johne's disease cases in Australia have been caused by one of two strains, Sheep (S) and Cattle (C), with little crossover between cattle and sheep. This has enabled the disease control programs for the dairy, beef and sheep sectors to develop independently of each other. This approach remains in place, although in recent times there have been an increasing number of beef herds identified with clinical disease caused by S strain in areas where ovine Johne's disease is endemic. This situation is being monitored.

Since 2012 the cattle and sheep programs have been revised to reflect a changing focus in national animal health policy development towards whole of farm biosecurity, and to incorporate additional technical knowledge arising from a comprehensive Johne's disease research program funded by the livestock industries and matched by Australian government funding. However the objectives of each program have remained essentially the same and the program continues to be underpinned by nationally agreed SDR&Gs, and Australian and New Zealand Standard Diagnostic Procedures (ANZSDPs). The ANZSDPs provide a basis for consistent diagnostic protocols, interpretation of approved diagnostic tests, and allocation and resolution of disease status.

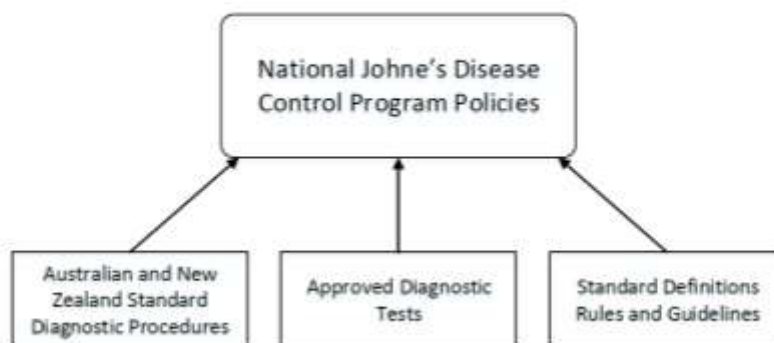


Figure 1: Pillars of the National Johne's Disease Control Program.

HOW HAS THE PROGRAM CHANGED SINCE 2012?

Johne's disease occurs in all the ruminant livestock industries in Australia. The variation in disease prevalence between industry sectors and the tendency for industries to farm independently of each other has meant that a single approach or program across all species is unlikely to suit the livestock industries. Each industry sector has undertaken an environmental analysis to place Johne's disease in an industry risk matrix. This analysis has demonstrated differing sources and levels of risk and specific mitigations for each industry. The outcome has been an increased emphasis on an industry-by-industry approach in developing control programs.

THE CATTLE INDUSTRIES

Prior to 2012 BJD was regulated in all states except Tasmania and zones were in place as a disease control measure. The dairy and beef industries operated under a common set of policy statements that did not fully acknowledge the different structures of the respective industries or different sources of risk that each industry managed. Since mid-2012 the dairy and beef industries have adopted a more enterprise based approach to disease control activities, implemented control strategies based on 'compartmentalisation,' and improved biosecurity practices. Producers are encouraged to trade stock based on the demonstration of herd assurance for BJD.

The two distinctive approaches to Johne's disease management and control in the dairy and beef sectors has now been recognised in the SDR&G, Edition Eight, published in mid-2012. Relevant factors for the two approaches include, national herd prevalence for each sector, the trade and production risks each sector could face, and the capacity to implement certain on-farm practices such as calf hygiene. In the majority of states (excluding those where the disease is rare or unknown) BJD in dairy herds has been de-regulated and the focus has moved to providing extension messages and support groups, which emphasise herd biosecurity, hygienic calf rearing and rearing young stock on low risk pastures, in isolation from the main milking herd, not just for Johne's disease control but to improve calf health generally.

The National Dairy Assurance Score was developed some years ago to support an approach which recognised farmers who undertook a range of disease risk mitigations at the farm level.

Dairy farmers are actively encouraged to provide their herd's score on a cattle health statement at the point of sale, as indication of the level of assurance provided by the management practices in that enterprise. In some states the use of a Dairy Score at point of sale is mandatory.

The beef sector continues to take a population based assurance approach which recognises that beef herds that have not co-mingled with dairy cattle or grazed dairy pastures are at low risk of having Johne's disease. The National Cattle Health Statement is promoted as the means of identifying the level of assurance associated with cattle offered for sale. Extension messages target beef producers and agents in regions where the dairy and beef sectors interface to warn of the risks associated with purchasing dairy cross cattle, or beef cattle without a cattle health statement. Beef herds which are identified as infected or suspect herds are offered assistance through the Financial and Non-Financial Assistance Package to resolve the herd status and return to unrestricted trading.

THE SHEEP INDUSTRIES

The sheep industries have steadily been moving towards a less regulated approach for a number of years. The most recent review of the National OJD Management Plan was completed in 2012. The review clearly demonstrated a producer preference for an industry driven management plan based on a risk management approach including placing much greater responsibility for disease control on producers, either individually or collectively. The revised plan commenced in 2013 with greater emphasis on farm biosecurity practices, vaccination, the use of a national Sheep Health Statement to certify the risk management practices that are in place on the property and the development of regional biosecurity plans to reduce the risk of inadvertent disease introductions into regions where the disease is rare or unknown.

In developing this revised approach the sheep industries are moving from 'single disease' control plans to the concept of controlling several significant endemic diseases simultaneously through a biosecurity risk assessment approach. The revised plan encourages producers to take a broader approach to animal health and demonstrate a level of animal health assurance in their sheep flocks for a number of significant production diseases such as virulent footrot, and lice.

THE ALPACAS AND GOAT INDUSTRIES

Relative to the cattle and sheep industries, the goat and alpaca industries in Australia are small. There are currently no known infected alpaca in Australia and this has been the situation for a number of years. The industry organisation promotes a general biosecurity message.

The goat industry has a very low prevalence of disease, which occurs mainly in dairy goat herds. For a number of years the goat industries have promoted on-farm biosecurity practices as a means of reducing the spread of Johne's disease in the dairy and farmed goat sectors². Like the dairy cattle industry, the dairy goat sector has focussed on hygienic kid rearing but more recently has sought to broaden the disease control base to include caprine arthritis encephalitis.

² Farmed goats are animals that are raised for meat under farming conditions in comparison to wild goats which are allowed to free range and are harvested from the rangelands.

THE CHALLENGES OF MAINTAINING A RELEVANT AND SOUND NATIONAL CONTROL PROGRAM

Perhaps the greatest challenge to any long term disease control program arises from the stakeholders' capacity to sustain the approach. A disease control program such as the NJDCP which has been maintained for a lengthy period faces challenges arising from a number of quarters, and not necessarily relating to the disease itself. These organisational and political challenges relate to the capacity of program managers to continue to have policy makers (government and industry) engage and continually evaluate the program in the light of changing disease risk profiles and technical capabilities, and to also retain the technical expertise to make sound objective judgements. For the purposes of this paper the challenges faced in recent times are considered under the headings of corporate and political challenges, technical challenges, and communications/extension.

CORPORATE AND POLITICAL CHALLENGES

At times producers, and policy makers in Australia have appeared reluctant to adopt a program that takes a purely 'evidence based' approach to the control of Johne's disease because of the difficulty in justifying the allocation of resources and funds to the management of a single disease that contributes a seemingly low risk to on-farm productivity (even though this is not the basis of the program) and a much greater political risk to governments. This has led governments to further reduce their inputs to the program, particularly in regulation.

Organisations representing livestock producers must necessarily adopt a national perspective. In supporting an animal disease program they must assess risks to the national industry, principally arising from market access and public health. However these livestock organisations have also recognised the value of managing several significant endemic diseases through a biosecurity focus using individual and regional risk assessments and the Johne's disease programs are steadily aligning with this preference.

This has produced challenges of a different kind, as Cook, (2013) has identified, producers engagement with biosecurity practices are influenced by their perceptions and attitudes towards animal health and whether they perceive that the 'benefits are perceived to accrue to a wider society but direct costs are borne by producers.' In the case of Johne's disease, in the absence of significant production losses the benefit of individual farm biosecurity planning is to manage trade risk for the national livestock industry as a whole.

One particular challenge arising since the last forum has been the loss of corporate memory about the conditions under which the Johne's disease program was initiated, in particular the rationale for the program and the constraints under which it was established. An understanding of the background and threats which were the catalyst for the original program helps to determine the relevance of the current program and to inform future direction. Policy advisers for governments and industries have regularly changed and new officers have joined the policy discussions. Each generation of new policy makers usually includes a number of newly appointed committee members unfamiliar with the epidemiology of the disease and the particular characteristics of mycobacteria. Organisations experience the constraints of lost corporate memory yet need to constantly re-assess the value of a program against a background of political pressure arising from changing animal health priorities.

Considerable effort and resources has needed to be applied to ensure that new personnel (industry and government) are familiar with the latest technology and the details of previous program activities and policies.

The role of private practitioner veterinarians in the NJDCP has proven equivocal. Some are very supportive of national approaches and work actively on committees to provide the views of their colleagues and to also support the dissemination of information about national programs to their peers. However it would be naive to consider all private practitioner veterinarians as supporters of national control programs particularly if their local client base is heavily infected. Strongly held local opinions can reduce the effectiveness of national messages and undermine agreed policy positions, creating political disruption at both the local producer and organisational level. This issue may be further compounded when practitioners have not maintained currency on technical developments relating to the epidemiology and control methods for Johne's disease, including in regions where they are unfamiliar with the agricultural systems.

Increasingly policy makers have come to recognise that the level of desired support from private practitioners for programs such as the NJDCP may not always be forthcoming, particularly when the policies are not seen as a 'good fit' with the business models used in private practice. While maintaining a dialogue with private practitioner veterinarians and continuing to have them engage actively with the national program, program managers do not assume unanimous wide-spread support from the veterinary profession.

TECHNICAL CHALLENGES

The Australian position has been that a national control program with a technically sound base establishes a defensible and sustainable position; one which has the best chance of delivering program objectives and withstanding political pressure.

To compare a related disease area, Australia is in the desirable position of being one of the few countries recognised as being free of bovine Tuberculosis, a status which has been enjoyed since 1997. Over time this has led to a general reduction in the number of people with a high level expertise in *Mycobacterium bovis* in jurisdictions and the focus of expertise is now located within academic institutions. A similar trend is occurring with *Mycobacterium paratuberculosis* as departments of agriculture face ongoing resource constraints and loss of staff.

Industries and governments continue to support a reference laboratory for Johne's disease to pursue excellence in Johne's disease testing matters and to be able to support other laboratories and research efforts. Currently negotiations are underway for the next three year phase of this operation to make best use of the available expertise.

The Australia government and industry continues to support a significant Research and development program to address important questions for JD around epidemiology, vaccination and tests development – the details of which will be provided by other papers. The continuation of a coordinated research approach has been seen as a valuable adjunct to the national program, and a demonstration of the livestock industries commitment to delivering the best possible policies to producers.

The regional nature and relatively low levels of disease experienced nationally, give rise to a number of challenges which are specific to Australia. These include the over reliance on vaccine as an alternative to biosecurity and biocontainment by some sheep producers. Though very

important for clinical disease control in endemic areas and central to national control policy, the Australian experience has been that even after five years of continuous use on all eligible animals, the majority of flocks in a research trial (Windsor, 2009) continue to shed bacteria.

Another concern arising from the use of vaccine relates to the possible impact on ELISA test results of animals destined for certain export markets. The dairy and beef industries and the Australian government had been cautious in their response to the registration of Silirum^(R) as an adjunct to the management of bovine Johne's disease because of the potential to confuse test results in export cattle.

It is unfortunate that the challenges of imperfect tests for Johne's disease and the absence of a DIVA test for Johne's disease can make it difficult to resolve the disease status of herds, which is necessary to protect some export markets.

COMMUNICATION CHALLENGES

The media in Australia operates in an environment where scientific fact is used opportunistically alongside 'pseudo-science' to justify often extreme views. In the case of Johne's disease this approach discredits soundly based animal health activities creating confusion and mistrust within producer groups and devaluing the efforts of their nominated representatives. This conundrum has occurred from time to time in the policy debates about Johne's disease and led to a reluctance of agri-political leaders and bureaucrats to make decisions in the face of a potentially hostile rural media. Livestock industry councils and government officials are increasingly reluctant to engage in public debate as it can result in protracted and difficult policy negotiations which come at a financial and personal cost to all involved.

The role of social media continues to be considerable and is increasing. Disaffected producers who have been previously quarantined have been quick to recognise the reluctance on the part of decision makers to engage in social media. The former have then garnered media support at very little cost to support their positions. At times, small but strident campaigns opposing any proposed program changes, have caused a distraction for national industry bodies, drawing resources away from the main focus.

Even when changes have been the result of comprehensive industry consultations, media criticism may continue, through the persistence of a disaffected minority. It is a difficult situation to reverse.

A comprehensive communication effort, through revised and accessible webpages and targeted extension messages to livestock agents and producers is underway to ensure producers received consistent technical messages on the most effective means of avoiding, and controlling Johne's disease. Advice on biosecurity and on-farm Johne's disease control methods is being delivered in part through a recently formed Livestock Biosecurity Network which has a brief to address biosecurity practices on-farm generally and to assist producers obtain expert assistance to develop individual farm biosecurity plans. The Livestock Biosecurity Network is funded by the livestock councils from levies raised on producers whenever livestock is sold. It has field officers in each state who are responsible for working directly with producers to engage farmers in implementing biosecurity practices.

In line with this emphasis on producer-initiated biosecurity, messages about Johne's disease control are being linked to more general messaging about the importance of farm biosecurity,

and in particular the need for producers demonstrate animal health assurance through the use of animal health statements. There is a resurgence of interest at the policy level in audited biosecurity plans for Johne’s disease but with a future option of including other endemic diseases as well. The three pillars of the national program (Fig 1), continue to be recognised by each industry and state and ensure a consistent and robust technical approach to diagnosis and the official allocation of a herd or flock status.

FUTURE CONTROL OF JOHNE’S DISEASE

The livestock industries remain committed to the control of Johne’s disease but are seeking to place the responsibility for this control more firmly on individuals or groups of producers. Over the past twenty years there have been extensive research and surveillance programs in Australia. These have led to a much clearer understanding about the behaviour of the disease under Australia conditions and provided producers with the tools to manage the disease on a local and regional basis.

The focus is now very much on communicating the ways in which Johne’s disease can be controlled and engaging with producers in achieving behavioural change. The benefits of practicing sound farm biosecurity at the individual farm level and through the formation of biosecurity regions will continue to be promoted not only for Johne’s disease but also for other significant endemic diseases.

The use of animal health statements as a demonstration of farm assurance by vendors and as a risk assessment tool by purchasers is starting to gain traction and is gradually gaining support from stock agents, who see this practice as a means of mitigating their own business risk, in the event they are caught in litigation for the sale of diseased animals.

The extensive surveillance program undertaken in sheep abattoirs has been the catalyst for pharmaceutical companies to partner with livestock industry councils, meat processors and producer groups to actively promote best practice disease prevention and containment and effect changes in producer behaviour. Since 2008 over eleven million mutton sheep have been inspected for a number of significant endemic diseases including Johne’s disease and the data recorded on a national database, (Table 2). The data is available to state departmental officers who use the information to inform extension messages and determine research priorities. Some of the data is being returned to individuals directly, supported by producer extension meetings jointly delivered by processors, state departmental officers and the processing sector. In this way producers come to understand the impact and consequences of specific disease on the red-meat value chain. As well as developing an understanding of biosecurity and bio-containment, producers are also provided with information on current treatment and vaccines.

Table 2: Number of sheep and lines inspected per financial year for the period 2008-13. (Source Animal Health Australia)

| | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-2013 |
|------------------------|-----------|-----------|-----------|-----------|-----------|
| Number of lines | 12,895 | 12,511 | 7,925 | 13,852 | 16,027 |
| Number of sheep | 3,054,498 | 2,452,652 | 1,268,282 | 2,543,201 | 3,098,872 |

Despite these considerable challenges, the livestock councils and state governments have been able to review the sub programs of the NJDCP and incorporate a number of changes into each which have made the BJD and OJD programs more ‘socially acceptable’ while still retaining sufficient risk management to ensure a robust disease control program. Most importantly though, the programs and policies have become very much ‘industry driven’. This has led to growing ‘grass roots’ support and adoption of national health statements as a risk assessment tool and the formation of regional biosecurity areas which are administered by producer committees. Each regional biosecurity area sets a minimum level of assurance for producers bringing in stock from endemic areas, and although the requirement is not mandated through government regulation, the level of compliance can be monitored through the National Livestock Identification System.

Industry and government resources are likely to remain constrained for the foreseeable future. Regulatory control programs have become more difficult to deliver unless the consequences from the disease are considered major. In this environment the Australian Johne’s disease programs are evolving to take include other significant endemic diseases with a focus on communication and the adoption of best practice disease risk mitigation and containment activities. This approach is collectively supported by the industries and governments.

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Application of BJD Management Strategies in the Australian Dairy Industry

Robin Condron and Jamie McNeil

Dairy Australia, Melbourne, Australia

The Australia dairy industry has a high priority for the management of BJD in Australia. This follows an assessment of the potential risks and is integral to the National Strategic Plan to Manage BJD in Australia.

After decades of regulatory controls for BJD Australia has established a favourable situation in comparison with other countries, as endemic Johne's disease is restricted to south-eastern Australia and in affected dairy herds BJD occurs at a low prevalence. A national BJD control plan was established in 1996 and a new approach was introduced in 2003 to manage BJD in Australia by the industry peak bodies and animal health authorities. The new National Strategic Plan involved more emphasis on industry-led voluntary measures and less regulated approach through cooperation of farmers, animal health authorities, dairy processors and government agencies.

The goals of the national approach are to reduce contamination of farms and farm products by *Mycobacterium paratuberculosis* to protect the status of non-infected herds and regions and to reduce social, economic and trade impact of BJD. These goals were reconfirmed in a review of the national BJD strategy in 2012.

The dairy industry risk analysis found that the likelihood of *M. paratuberculosis* in dairy products was very small and that the most significant factors to reduce the risk were effective heat treatment of milk and continued reduction in the prevalence of *M. paratuberculosis* infection in dairy cattle. To achieve uptake and improve voluntary management of BJD the industry has promoted practices for hygienic calf rearing and BJD assurance measures. Key initiatives of this approach were communication and support for the '3-Step Calf Plan', the JD Calf Accreditation Program (JDCAP) and the National Dairy BJD Assurance Score (Dairy Score). This approach has focused on strategies to limit the transmission of *M. paratuberculosis* on-farm and between farms, while creating awareness of the disease and providing science-based information to farmers, veterinarians and dairy industry advisers.

When the Dairy Score was established in 2004 the dairy industry committed to a review of the contribution of the 3-Step Calf Plan to BJD assurances. A review of the scientific literature relating to BJD and its control was undertaken to assess whether current scientific knowledge still supports the underlying principles of the Plan. The integration of the 3-Step Calf Plan into the Australian industry has also been investigated from the perspective of both farmers and the milk processors. The goal was to assess farmer awareness and compliance with the Plan and determine the role the Plan plays in BJD assurance for the Australian dairy industry.

The review found that current scientific knowledge and epidemiological modelling provides support for the scientific principles that underpin hygienic calf rearing programs such as the 3-Step Calf Plan and JDCAP. The widespread adoption of the Plan and its integration with other dairy industry on-farm change management programs increases its value.

3-STEP CALF PLAN AND JD CALF ACCREDITATION PROGRAM

The 3-Step Calf Plan is a voluntary scheme focusing on hygiene to minimise the risk of BJD transmission within a herd by protecting young cattle from exposure. It was implemented by the Australia dairy industry to provide a pathway for dairy producers to rear calves with reduced risk of infection and thereby control the spread of BJD in their herds

The 3-Step Calf Plan which has been incorporated in dairy on-farm quality assurance programs involves: 1) Calves should be taken off the cow within 12 hours of birth. 2) Management of the calf rearing area should ensure no effluent from susceptible species comes into contact with calves. 3) Calves up to 12 months old should not be reared on pastures that have had adult stock or stock are known to carry BJD on them during the past 12 months. The JDCAP which is a requirement of the Victorian Test and Control Program has more rigorous specifications and guidance. Neither strategy guarantee the production of BJD-free calves but they aim to reduce the risk of new infections and hence the prevalence of infection in the herd. The differences between these two approaches to calf management are reflected in the different weightings assigned in the Dairy Score. The 3-Step Calf Plan appeals to many farmers, who perceive it as a less regulated strategy for BJD control with minimal negative impact on their farm business. It provides a low cost and “safe” path to reduce the risk of BJD on their farm without the necessity for blood testing of adult cattle or determination of BJD presence or prevalence in the herd.

The hygienic calf rearing principles upon which the 3-Step Calf Plan is based are synergistic with other dairy industry extension programs. In 2011 Dairy Australia published “*Rearing Healthy Calves - how to raise calves that thrive*” a practical guide to all aspects of calf management. This publication has been supported by the delivery of calf management workshops throughout the major dairy regions to improve farmers’ knowledge and skills in calf rearing. One of the key messages of this extension program is that by implementing the 3-Step Calf Plan, farmers will not only limit the spread of BJD but also reduce the prevalence of neonatal calf diarrhoea. Linkage and consistent advice is also maintained with other extension activities. For example, Countdown 2020, Dairy Australia’s national mastitis control and milk quality program is also promoting the rapid removal of both cows and calves from the calving environment. Providing a clean calving environment and early removal of freshly calved cows from the calving environment reduces the prevalence of mastitis at the time of calving and also limits the risk of transmission of *M. paratuberculosis* and the pathogens that cause calf diarrhoea.

Dairy Australia is also active in promoting the benefits of on-farm biosecurity. The principles of the 3-Step Calf Plan complement these biosecurity messages by highlighting a risk management approach to disease control. Presenting multiple benefits of the 3-Step Calf Plan improves its acceptance amongst farmers by enhancing the perceived return on investment i.e. less calf disease, less cases of mastitis at calving and better control of BJD. These messages have also been integrated into the training curriculum of the National Centre of Dairy Education Australia the major provider of vocational education to dairy farmers and their employees. Using this integrated approach the principles of hygienic calf rearing have now reached a wide audience who understand their value in protecting dairy calves from disease.

BJD ASSURANCE FOR RISK-BASED TRADING

The National Dairy BJD Assurance Score was developed to rank the status of cattle based on available information from BJD control measures. The Dairy Score provides guidance about how BJD assurance can be improved and it underpins voluntary risk-based trading systems for

farmers to better manage the risk of BJD with herd introductions. The Dairy Score provides incentives for the adoption of recommended control measures; testing to a lower prevalence and implementation of hygienic calf rearing. In the Dairy Score cattle that have been reared under recommended calf hygiene plans are awarded additional assurance points reflecting less risk of being infected.

SCIENTIFIC SUPPORT FOR HYGIENIC CALF REARING APPROACHES

Studies of the efficacy of BJD control programs in dairy herds in the United States have shown that test and cull programs alone were not able to decrease the prevalence of BJD (Groenendaal and Galligan 2003). However improving management strategies to reduce transmission had a positive impact and delivered significant economic benefits. A subsequent herd simulation model produced similar results (Kudahl et al. 2008). Disease modelling has shown that improved calf hygiene is an essential aspect of any control program when all possible approaches to BJD management are investigated (Groenendaal & Galligan 2003; Cho et al. 2012).

- Kennedy and Benedictus (2001) described risk management strategies to limit the transmission of BJD in dairy herds, identifying that the following management practices can reduce the likelihood of exposing calves to *M. paratuberculosis* infection:
- Provision of a clean environment for birth;
- Ensuring only colostrum from its mother or from animals that are tested negative is feed to the newborn calf;
- Separation of the calf and mother within 12-24 hours of birth;
- Rearing the young calf in a clean environment (shed or pasture), free from adult faecal contamination, and
- Feeding calf milk replacer or pasteurized milk and supplying uncontaminated water.

Two significant principles underpin this risk-based approach. Firstly, calves are most susceptible to infection with *M. paratuberculosis* at birth and this susceptibility gradually decreases, becoming negligible by 12 months of age. Secondly, environmental contamination with the faeces of adult cattle is a major risk factor for the transmission of *M. paratuberculosis*, so certain hygienic calf management practices can reduce this risk by limiting the exposure of young, susceptible calves to faecally-derived *M. paratuberculosis* organisms. The calf rearing practices recommended under the 3-Step Calf Plan are founded on these two principles.

Increasing resistance of cattle to infection with age has been commonly accepted. A meta-analysis of BJD transmission studies by Windsor & Whittington (2010) investigated evidence for age resistance and although there was difficulty with confounding and gaps in information they noted significant differences between age groups and concluded there is strong support for the principle of age-related susceptibility to infection with *M. paratuberculosis* in cattle. Between 4 months and one year of age it becomes more difficult to infect a calf and by one year of age susceptibility is equivalent to that of an adult animal (Sweeney 2011).

M. paratuberculosis is shed in the faeces of infected cows and ingestion of faeces by susceptible calves is widely accepted as the major route for establishment of infection (USDA 1997; Fecteau & Whitlock 2010). A systematic review of studies investigating the risk factors associated with *M. paratuberculosis* transmission to dairy calves has recently been undertaken (Dore et al. 2012). He concluded that the contact of calves with faeces from adult cows was the most important risk factor in BJD transmission. Although this review looked at five possible risk areas (calving

environment, colostrum and milk ingestion, housing and direct contact with adult faeces) all relate directly to contact of calves with *M. paratuberculosis*-infected faecal material. The review found that contact of calves with faeces from adult cows was a risk factor for *M. paratuberculosis* transmission with an odds ratio in the range of 4.59-30.5.

A cross sectional study of 121 herds in USA found a three-fold increase in the risk of a herd being positive for BJD if they had an exercise or stand-off area for cows (Johnson-Ifeorunlu and Kaneene 1998). Such a practice is likely to provide a reservoir of *M. paratuberculosis* organisms and potentiate spread to high risk sites such as calf rearing areas, most likely through staff movements and cross-contamination of fomites. The role of environmental contamination in spreading BJD was supported by the finding that cleaning of maternity pens after each use reduced the risk of a herd being BJD-positive by three-fold. A larger cross sectional study of 1004 USA dairy herds where 21.6% were infected with *M. paratuberculosis* also provided strong evidence of the role of environmental contamination in BJD transmission (Wells & Wagner 2000). It found that factors such as group housing of peri-parturient cows and group housing of preweaned calves was associated with higher likelihood of a herd being BJD-positive. Similarly a Spanish survey concluded that feeding colostrum from *M. paratuberculosis*-infected cows and housing replacement calves with adult cattle before they were six months old were management practices associated with *M. paratuberculosis* infection (Dieguez et al. 2008).

A wide review of Canadian research concluded that control programs for reducing the transmission of BJD in dairy herds should not only include strategies to reduce the number of infected stock shedding *M. paratuberculosis* (i.e. a test and cull approach) but also focus on protecting young stock from environments, feed and water contaminated with faeces of mature cows (McKenna et al. 2006). A subsequent Canadian study supported this approach, finding that increased faecal contamination of calving pens contributed to an increase in seropositive cows (Tiwari et al. 2009). Calf-to-calf transmission and an open herd policy also contributed to the risk in this study. It was proposed that any national Canadian BJD control program should offer two distinct pathways for participation in BJD control: a “testing” versus a “no testing” approach with the latter approach to improve participation (McKenna et al. 2006). The “no testing” pathway would have its focus on risk management and disease avoidance. This mirrors the current approach adopted by the Australian dairy industry with the National Dairy BJD Assurance Score giving extra assurance to calves reared under the 3-Step Calf Plan and JDCAP protocols.

Groenendaal et al. (2002) examined the economic and epidemiological consequences of BJD control programs in the Netherlands and Pennsylvania (USA), using a dynamic stochastic simulation model. Hygienic calf management and various on-farm hygiene management practices were identified as the key determinants in reducing the prevalence of BJD. Another recent Canadian modelling study found that basic calf hygiene measures, which included harvesting colostrum from cows with cleaned udders, no feeding of pooled colostrum and preventing contact of young calves with adult cow manure, featured prominently amongst the most cost-effective control options (Cho et al. 2012).

Dorshorst et al. (2006) examined the cost-effectiveness of various combinations of hygiene practices and test and cull strategies using a static simulation model. A small improvement in calf hygiene together with test and cull was identified as the most favourable control option for the model simulation with a base herd of 100 cows and a 10% within-herd true prevalence of BJD. More intensive hygiene management was more attractive as within-herd prevalence and herd size

increased. These results all support the recommendation that dairy farmers provide a clean environment for young calves and prevent contact of calves with adult cow manure.

Most BJD transmission studies provide only a snapshot of current practices and may not reflect previous practices that may have contributed to the establishment or propagation of the disease. A 20 year study of transmission parameters in a single herd enrolled in a BJD control program found that the most significant sources of infection for calves were their mothers or infected animals that had recently calved (Benedictus et al. 2008). The herd successfully reduced its disease prevalence from 60% to around 10%. They concluded that in regards to infection risk, exposure to environmental contamination or contaminated animals was the greatest threat, though a calf is most likely to derive infection from its dam.

Another five year observational study on the effectiveness of implementing management practices to control the spread of BJD determined that exposure to adult cows other than dam and feeding colostrum from one cow to multiple calves were associated with the highest odds ratios (Pillars et al. 2011). It was concluded that programs to control the spread of BJD in dairy herds should prioritise minimising the exposure of newborn calves to *M. paratuberculosis* being shed from adult infected cows. Other possible routes of infection include *in-utero* transmission and via ingestion of colostrum containing *M. paratuberculosis* passaged directly into the udder from an infected dam (Sweeney 2011).

The role of *in-utero* transmission of *M. paratuberculosis* was recently reviewed (Whittington and Windsor 2009). A meta-analysis estimated an *in-utero* transmission rate of 0.44-1.2 infected calves per 100 cows per annum in herds with low within-herd prevalence (5%). This estimate increased to 3.5-9.3 calves per 100 cows per annum if herd prevalence increased to 40%. It was concluded that *in-utero* transmission may have a significant impact on BJD transmission but only if all other routes of infection were controlled and the infection prevalence in the herd was high. In the context of the Australian BJD control program the significance of *in-utero* transmission is considered minor relative to the role played by environmental contamination.

An initial investigation of the role of colostrum and milk in BJD transmission in infected herds concluded that both can be risk factors but only at a minor level (Nielsen et al. 2008). Various alternate sources and practices of liquid feeding were examined and although all had odds ratios greater than one, the researchers expected a more significant result if colostrum and milk were indeed major risk factors, given the number of cattle in the study. The highest risk was associated with calves kept on foster mothers and it was concluded that this reflected the effect of exposure to environmental contamination rather than the feeding method. The authors acknowledged that environmental contamination of the liquid feeds could be a confounding variable in this study.

Control of feeding is not directly incorporated in the 3-Step Calf Plan but early calf separation and recommendations to feed good quality colostrum has been a feature calf rearing advice. This results in reduced suckling of the dam and risk of ingesting faecal contaminated milk.

A review modelling within-herd transmission in dairy cattle concluded that assumptions about routes of transmission and their contributions vary greatly and knowledge gaps exist (Marce et al. 2010). For example little is known of the maximum age at which cattle can become infected, or the relationship between infective dose and disease particularly in relation to the recently described 'supershedder' phenomena (Fecteau & Whitlock 2010). It is suggested that existing models could be improved by considering the contribution of indirect transmission from contamination of milk and colostrum and the role of calf-to-calf transmission. It has recently

been reported that the age of the animal at the time of first exposure and the dose of *M. paratuberculosis* it is exposed to will influence its age of shedding and the occurrence of clinical disease (Mitchell et al. 2012).

While reaffirming the importance of the separation of young stock from adult cattle Weber & Groenendaal (2012) found that calf-to-calf transmission had a significant impact on prevalence of infection and decreased some of the benefit gained from separation of adult cattle from young stock. Another model which addressed both calf-to-calf transmission and indirect contamination through the environment concluded that the degree of exposure of calves to adult faeces and the age at which this exposure first occurred significantly influenced transmission rates, with calf-to-calf transmission playing only a minor role in disease transmission (Marce et al. 2011). A large study of 18,979 cows over a six year period found the proportion of cattle which began shedding *M. paratuberculosis* prior to two years of age increased as the prevalence in the herd increased (Weber et al. 2010). Heifers were found more likely to be shedding *M. paratuberculosis* in herds with BJD disease prevalence >10% (Bolton et al. 2011). A recent meta-analysis of the effect of dose and age at exposure on shedding of *M. paratuberculosis* postulated that the increased susceptibility of calves, the constant contact with *M. paratuberculosis* and the likelihood that early-infected animals will shed *M. paratuberculosis* earlier in life could be a self-propagating scenario that may make disease reduction difficult in high prevalence herds (Mitchell et al. 2012). The significance of calf-to-calf transmission in maintaining BJD within a herd is still unclear but possibly less significant in herds with low prevalence.

Scientific evidence continues to grow in support of the significant impact of environmental contamination with *M. paratuberculosis* on herd prevalence. It can be concluded that hygienic calf rearing programs such as JDCAP and the 3-Step Calf Plan reduce the transmission of *M. paratuberculosis* and decrease the prevalence of BJD in dairy herds. The challenge in interpreting research in this area arises from variations in study design and limitations on data collection. Epidemiological modelling has provided some answers but the optimal model design is still being debated (Marce et al. 2010). Unfortunately it is not currently possible to quantify the individual components of calf management and their contribution to risk factors. Programs should initially focus on broad principles of BJD management and risk analysis be applied to each individual herd. It is acknowledged that the relative importance of each step in the management 3-Step Plan may vary from farm to farm and system to system.

ADOPTION OF THE 3-STEP CALF PLAN WITHIN THE AUSTRALIAN DAIRY INDUSTRY

An appreciation of farmer attitudes to BJD control is necessary when reviewing the impact of the 3-Step Calf Plan within the Australian dairy industry. Implementation of the 3-Step Calf Plan, JDCAP or any other hygienic calf management program to limit the transmission of *M. paratuberculosis* within a herd requires changes in farm management and possible additional costs in labour and infrastructure. It is logical for farmers to divert their available resources to manage those areas which they believe incur the greatest losses or present the greatest risks to their business. For most farmers BJD control is a risk management activity that has a lower priority than other ongoing animal husbandry and health issues such as infertility, lameness and milk quality. The success of any disease control program is generally dependent on the farmers' willingness to initiate a control program and the effectiveness of those measures in reducing transmission of disease.

Surveys commissioned by Dairy Australia report a high level of awareness (63%) amongst Australian dairy farmers of the 3-Step Calf Plan (Watson 2012). Over 44% of all farmers surveyed reported that they consistently implement all three steps of the 3-Step Calf Plan (Watson 2012) with the majority implementing at least one step. Currently 52% farmers always remove calves from their dams within 12 hours of birth, 88% always manage calf rearing areas to ensure calves do not come in contact with effluent from adult cattle, and 74% always graze calves in a separate paddock until 12 months of age (Watson 2012). These data illustrate the challenge faced by farmers to consistently remove calves within 12 hours of birth. Watson (2009) found that almost 80% of calves were removed within 24 hours. It is probable that the ability to remove calves from their dams will vary with the time of day the calf is born, but most farmers are attempting to achieve early calf removal, even if this is not always achieved by 12 hours of age.

When questioned about the disease risk associated with exposing newborn calves to faeces, 70% of dairy farmers surveyed expressed concern about this occurring (Watson 2009) indicating a good understanding of the need to rear calves in clean environments to limit calf diseases, including BJD. These farmer survey results consistently show that the majority of Australian dairy farmers continue to implement the 3-Step Calf Plan or at least one step of the Plan to the best of their ability and that there is a high level of awareness of the 3-Step Calf Plan within the dairy industry.

The requirements of the 3-Step Calf Plan have now been incorporated into all major dairy on-farm quality assurance programs. Discussions with dairy company field officers and on-farm quality program auditors revealed a high level of understanding of the 3-Step Calf Plan within the milk processing companies and an appreciation of its role in the control and management of BJD in the Australian dairy industry. Feedback on the observed levels of farm compliance with the 3-Step Calf Plan was encouraging.

Implementation of any BJD control program requires additional cost and a significant effort for the dairy farmer. Most recent Dairy Australia farmer survey data shows that removing calves within the first 12 hours (step one) is the most difficult step for farmers to consistently implement, whilst providing a designated calf grazing area for the first 12 months of life (step three) was the next most difficult (Watson 2012). Farmers with extra-large herds (> 500 cows) had the highest rate of implementation of the 3-Step Calf Plan, with 77% of those surveyed consistently undertaking all three steps.

CONCLUSIONS

BJD continues to present ongoing issues for dairy industries around the world. Dairy producers have to contend with an insidious disease which may not rank as high in their management priorities as more visible problems such as milk quality, infertility and lameness. It is a challenge for the dairy industry to balance requirements to support the reputation of dairy products and maintain commitment to cost of effective disease control measures when there are limited direct impacts on farm productivity.

There is universal recognition that hygienic calf rearing is an essential component of effective BJD management and control in dairy herds. The 3-Step Calf Plan plays an important role in the control of BJD in the Australian dairy industry and its introduction has improved farmer engagement with the national BJD control program and their attitudes to BJD control. The key messages of the 3-Step Calf Plan are readily integrated with broader extension approaches to

improving animal health and welfare outcomes, providing additional incentives for on-farm implementation. Milk processors have welcomed the integration of the 3-Step Calf Plan into their audited on-farm QA programs and value this less regulated approach to BJD control.

Most importantly, the scientific principles underpinning the management of BJD risk by hygienic calf rearing are still supported. The relationship between age and susceptibility to infection and the importance of the faecal-oral route of infection are undisputed. Despite the scarcity of published reports of outcomes of specific calf hygiene measures for BJD control, there is a wide body of international literature and practice that indicates calf hygiene is most important for the reduction in prevalence and impact of BJD in herds enrolled in control programs. More stringent controls may be required when the objective is to eliminate infection from the herd or when the prevalence of infection is high. Recent epidemiological modelling also indicates that the implementation of hygienic calf rearing is a cost effective strategy for BJD control.

The introduction of the 3-Step Calf Plan has changed farmers' attitudes to BJD control and reinforced the communication of recommended practices. Incorporation of calf rearing measures in the National Dairy BJD Assurance Score provides recognition of the important contribution that hygienic calf rearing makes to BJD risk management.

This review found that the 3-Step Calf Plan is now an integral part of the Australian dairy industry's approach to control of BJD. Farmer awareness and implementation of the 3-Step Calf Plan has improved over the last decade, with the majority of dairy farmers now complying with all or part of the Plan. The recognition of 3-Step Calf Plan with assurance points in the Dairy Score has been an important driver for adoption of recommended BJD control measures. Farmers prefer the less regulated approach to BJD control that the 3-Step Calf Plan offers, which has no negative impact on their farm business. Regardless of the herd's BJD status, farmers value the calf health benefits that are evident when more attention is given to early removal and hygienic rearing of calves.

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Developing Intervention Options for New Zealand Dairy Herds to Mitigate the Impact of Johne's Disease

Hinrich Voges

JDRC, New Zealand

The New Zealand dairy industry encompasses 11891 herds (NZ Dairy Statistics 2012-13) and 4.8 million cows, with an average herd size of 402 cows. The total population has grown by 1 million cows over the previous ten years, primarily driven by rapid expansion of dairying in the South Island where cow number doubled to 1.8 million over the same period (average herd size 614 cows).

Despite increasing use of supplementary feeding and feed pads or barns that provide improved nutrition and respite for both the herd and pasture during inclement weather, rotational grazing throughout the calendar year remains at the core of NZ dairy farming. Calving occurs in distinct 'calving seasons'; over 85% of NZ dairy herds have a single two-month calving period in spring with calves born on pasture in the open. While the remaining herds milk all year round, most calve in two separate short 'calving seasons'.

It has long been accepted that Johne's disease is widespread throughout the national dairy herd although the within-herd incidence of clinical disease is low in most herds. In the 1980s JD incidence appeared to be worsening with annual losses of 5% or more due to Johne's disease reported by some herds (Milestone and de Lisle, 1986), but there was little evidence of this in the 90s and early 2000s with an analysis of dairy herd culling records from 1998 to 2007 showing stable annual loss rates (Voges 2009). This prompted speculation that improved herd and calf rearing management practices may have led to reduced exposure to MAP amongst replacement heifers. Of particular note, off-farm heifer rearing at dedicated young stock rearing units became the norm at this time. Traditionally calves had been set-stocked in pairs or small groups across the dairy platform paddocks grazed by the adult herd. This ensured regular direct contact between calves and the cows.

However anecdotally it appears that JD incidence may be on the rise again with increasing awareness and concern amongst dairy farmers and their veterinarians, especially in the South Island. In part this may be a reflection of the rapid expansion in this region and its relative importance in the national dairy herd. But as herd management practices continue to evolve there is a risk that new pathways may emerge leading to increased transmission within and between herds. It therefore makes sense to constantly reassess these trends in terms of disease risks. For instance in recent years many herds have implemented the practice of dosing all neonates with pooled fresh colostrum to ensure adequate maternal antibody transfer. Does this exacerbate the spread of MAP from super-shedders to the neonatal calves? Also improved environmental and riparian safeguards are now more rigorously enforced, so effluent must be safely disposed without contaminating waterways. Spray irrigation of dairy effluent is the most common and practical solution. Replacement heifer calves are at risk of infection unless measures are in place to ensure that they do not have access to pasture with effluent irrigation but also to prevent contamination of calf housing as a result of wind drift.

New Zealand does not have an organised JD control scheme for cattle and it has been left to individual herd owners and their veterinarians to combat the disease. Instead efforts by the Johne's Disease Research Consortium (JDRC) have been aimed at gaining a better understanding of the risks facing NZ dairy herds and to develop a suite of intervention tools to combat Johne's

disease in herds. To this end, JDRC carried out a case-control survey in 2013 and is in the process of developing a suite of intervention strategies for dairy herds.

CASE-CONTROL SURVEY

The aim of this study is to look at the changing trends in dairy herd management and identify any specific risk factors affecting NZ dairy herds. Analysis is still under way and results will be reported in future. Initial results confirm that South Island herds are more likely to be affected by Johne's disease. Herd size is also directly correlated with JD risk. Rising average herd size (40% increase in over the last 10 years) may fuel Johne's disease incidence overall so that measures targeting MAP transmission are becoming more important especially in the South Island where the average herd is twice the size of North Island herds.

Furthermore, the case-control study data shows a highly significant association between the time that calves remain on the dairy platform / home farm and JD risk. This reinforces the message that we need to focus on protecting the replacement heifers beyond the calving and pre-weaning period.

INTERVENTION TOOLBOX / STRATEGIES

Livestock Improvement Corporation is developing a set of tools for herd owners and veterinarians. These interventions are designed specifically to reduce MAP transmission and are grouped into five overall strategies; a) culling high-risk animals (includes testing), b) calving, c) pre-weaning and d) post-weaning heifer management, as well as e) herd biosecurity. Recognising New Zealand's highly seasonal nature and relatively low cost pasture approach to dairy farming, the focus of intervention tools remains very much on practical measures aimed at reducing the impact of Johne's disease. They are not intended to be proscriptive, but rather give herd owners and their vets choices that allow them to address the risks associated with MAP transmission as needed. To be relevant to herds with a wide range of management practices, variable capacity to implement interventions, and varying incidence of JD in herds, the tools in each strategy are presented in three categories:

Best Practice

This is ideal scenario especially for herds suffering significant JD losses but may prove too costly or unnecessary in herds that do not have Johne's disease problems.

Alternative Options

Sometimes herd owners are not able to comply with best practice, but alternative options will go some way to mitigating the risks.

High-Risk Behaviours

These management practices are likely to favour MAP transmission and should be avoided by all herds.

An initial version of the toolbox is currently being trialled with a group of study herds across New Zealand. These herds range from small to very large herds, both individually owned to large corporate herds. The primary aim is to test the practicality of the strategies and their implementation by herds/vets to ensure they are relevant and so that they may be refined. The toolbox will be delivered to the wider New Zealand dairy farming community by DairyNZ, the representative industry good body.

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Johne's Disease Control in Canada – 2010-2013 – Successes and Challenges

David .F. Kelton¹, Herman .W. Barkema², Greg .P. Keefe³, Gilles Fecteau⁴, Réjean .A. Barker⁵

¹*Dept of Population Medicine, University of Guelph, Guelph, Ontario, Canada*

²*Dept of Production Animal Health, University of Calgary, Calgary, Alberta, Canada*

³*Dept of Health Management, University of Prince Edward Island, PEI, Canada*

⁴*Dept of Clinical Sciences, University of Montreal, St. Hyacinthe, Quebec, Canada*

⁵*Canadian Johne's Disease Initiative, Canadian Animal Health Coalition, Abbotsford, BC, Canada*

INTRODUCTION

Johne's Disease (JD) has long been identified as an important production-limiting disease of dairy cattle. Concern over public scrutiny of *Mycobacterium avium* subspecies *paratuberculosis* (MAP) as a potential zoonotic agent has brought the disease to the forefront among producers groups across Canada. While programs targeted at JD control have been developed and implemented provincially, the coordination of these programs at the national level remains an important issue to ensure some degree of uniformity of practice since cattle frequently move among provinces.

The Canadian Johne's Disease Initiative (CJDI) has served the role of coordinating provincial JD control activities across Canada. Since its inception in July 2009, the CJDI, funded by Dairy Farmers of Canada and the Canadian Cattlemen's Association, has been guided by its Advisory and Technical Committees (each with representation from industry, veterinary schools, and provincial programs). The CJDI priorities were: 1) to increase education about and awareness of JD across Canada among dairy producers, veterinarians and allied industries; 2) to encourage the development and implementation of control programs in all ten Canadian provinces and where possible to support coordination among these programs; and 3) to facilitate the development and funding of research programs in areas that will support the coordinated mission of JD control. The CJDI reached the end of its funded mandate in 2013. The future of a coordinated national JD initiative has not yet been resolved.

AIMS AND OBJECTIVES

Given that JD control is being delivered at the provincial level (Canada has ten provinces – each with an important dairy industry), the aim of this document is to describe the structure, similarities and differences among these dairy programs and to highlight some of the important lessons learned during the early stages of program implementation.

The objectives are:

- 1) - To briefly compare the provincial dairy cattle programs in terms of key components, program administration, program delivery, status programs, testing and penetration.
- 2) - To describe lessons learned through the initial stages of provincial program implementation.

PROVINCIAL PROGRAMS

All ten Canadian provinces currently have, or have had at some point during the last four years, a voluntary JD control program. In most cases, the programs were producer-initiated (in Québec the program was initiated by the provincial government, but with producer support) and are managed by committees that include producer organization, provincial government, university, milk recording and veterinary association representatives. Below is a table (Table one) that includes the start and end year, the funds expended and the relative proportions of public and industry dollars committed to the program. In most cases, the allocated funds have been spent and there is very little ongoing industry or provincial funding. Some provinces have secured funding for another year or two, and there are some funding requests pending, but most of the programs which are ongoing are now 'producer pay' programs.

Table One: Regional – Provincial JD Initiatives (Programs).

| Region-Province | Program | Cash expended | % Public funding | % Industry funding |
|-----------------------|--------------------|-----------------------|-----------------------|-----------------------|
| Atlantic ¹ | 2011 - ongoing | \$ 1 M | 75 | 25 |
| Quebec | 2007 - ongoing | \$ 1.6 M | 80 | 20 |
| Ontario | 2010 - ongoing | \$ 2.44 M | 12 | 88 |
| Manitoba | 2010 - 2011 | \$ 100 K ² | 100 | 0 |
| Saskatchewan | 2012 - 2013 | \$ 125 K | 87 | 13 |
| Alberta | 2010 - ongoing | \$ 1.04 M | 64 | 36 |
| BC | 2009 - 2012 | \$ 250 K | 100 | 0 |
| CANADA | 2007 - 2014 | \$ 6.6 M | 52³ | 48³ |

¹Atlantic Canada includes Nova Scotia, New Brunswick, Prince Edward Island, and Newfoundland and Labrador

²Estimated

³Weighted by number of herds in each province.

All of the programs have four key elements in common: 1) education of producers, veterinarians and the public, 2) an on-farm risk assessment administered by a veterinarian, 3) testing at either the herd and/or the cow level, and 4) applied research to support the development of the program and other JD programs. Details of each provincial program can be found on their respective websites:

Canadian Johne's Disease Initiative:

<http://www.animalhealth.ca/Programs/Detail.aspx?id=24>

Alberta: <http://www.albertamilk.com/johnes/johnesinitiative.aspx>

Atlantic Provinces: <http://www.atlanticjohnes.ca/>

Ontario: <http://www.johnes.ca/>

Québec:

<http://www.mapaq.gouv.qc.ca/fr/Productions/santeanimale/maladiesanimales/paratuberculose/>

Education about MAP, including its spread and control, is central to all of the provincial initiatives. Ranging from traditional forms of delivery (articles in magazines and journals and presentations at conferences and meetings) to novel approaches such as small group facilitated self-directed learning (focus farms), this is a core element that is critical to the success and long term viability of each of these programs.

The Animal Health Risk Assessment and Management Plan (RAMP) is a questionnaire that guides the herd veterinarian and the producer through a step-by-step assessment of calving, calf raising and hygiene practices associated with good calf and cow health, and excellent milk quality. The goal is to identify risk factors that could allow MAP from a shedding cow to infect calves on the farm. After completing the questionnaire (risk assessment), the producer and the veterinarian decide what can and will be done in the next year to mitigate some of the identified risks as part of developing the "management plan". Generally, acceptance of recommendations is good when producers realize that steps taken to reduce new MAP infections will also reduce other calf diseases caused by fecal-orally transmitted pathogens.

The RAMP is the most uniform component of the provincial programs, at least in part because there is a national standard for process that was developed by CJDI technical committee. Each provincial program has adhered to the standard, although the method of delivery does vary. Since private veterinary practitioners are conducting these assessments, training becomes an important component of the overall program. Methods used to train veterinarians ranges from one-on-one training to group training to on-line web-based methods.

All of the Canadian programs have a testing component aimed at identifying high risk herds which should engage in more aggressive control strategies. The approach and test(s) used across the country vary, as do the monetary incentives/subsidies to test. Some programs utilize environmental testing alone or in combination with individual cows testing, while others are based solely on individual cow test results. Cow tests in use include milk ELISA, serum ELISA, fecal culture and fecal PCR. In each case the testing is done through either the provincial or regional diagnostic laboratory or the Dairy Herd Improvement (DHI) milk recording laboratory, all of which are accredited for the tests they are offering. The way these test results are used by the program and the veterinarians/producers varies among provinces, and details can be found

on the respective program websites. Nevertheless, the veterinarian is seen as a key player in each of these programs and in most cases the test results come back to the dairy producer through the attending herd veterinarian, so that they can help the producer interpret the test results appropriately.

Many dairy producers who participate in these voluntary control programs, and have therefore demonstrated a desire to control JD in their herd, wish to have their efforts recognized. They also want to know how other herds in the country compare, particularly if they are in need of purchasing replacement animals for their herd. To meet this demand, most of the provincial programs have either a status or recognition program. In some cases the program simply issues a certificate of completion once a herd has met all of the program requirements, while others have a more complex status system which distinguishes among herds and recognizes herds of different JD risk. Given that cows are frequently bought and sold, and that they move within and between provinces, there is a need to harmonize these status programs.

The other major concern among dairy producers is the disposition of test-positive animals. Again, the programs varied in how they dealt with animals identified as being test-positive with any of the approved test methods. For instance, in Québec all producers who wish to access their program funded individual cow test results must sign an affidavit stipulating that they will not sell any test positive animals. This restricted animal movement is enforced through a provincial animal traceability program that is unique to Québec at this time. On the other hand, Ontario participants who wished to qualify for program funding support had to remove all cows found with high titre (HT) tests (based on the milk ELISA test in use a positive test result is 0.1 or greater, while a High Titre is 1.0 or higher) and NOT sell to another dairy herd or to the food chain, within 90 days of the testing date. Producers who removed these HT cows as required by the program received \$500 per cow to assist with on-farm changes to prevent MAP spread.

All of the provincial programs have associated research activities focused on JD control. Some of the programs fund research directly from their operating budgets, while others make program dollars available to researchers for provincial and federal matching fund applications. The research programs are generally coordinated by faculty at the local/provincial veterinary colleges. These researchers gather annually at a relatively informal research conference where progress is presented and new ideas for collaborative research are developed. Discussions among members of this group have contributed to the harmonization of programs across the country.

Following is a list of some of the research projects that were initiated over the last four years targeting Johne's Disease and MAP:

- Age and dose dependent susceptibility of MAP in calves (U of Calgary; graduate student: Rienske Mortier).
- Evaluation of an alternative environmental sample collection method to detect dairy herds infected with MAP (U of Calgary; graduate student: Robert Wolf).
- Effectiveness of farm pasteurization to control horizontal transmission of MAP (U of Calgary; graduate student: Robert Wolf).
- Integrated analysis of MAP genotype and phenotype: identifying vaccine targets (U of Calgary; graduate student: Amanda Mirto).
- Transmission pattern profiling of MAP between and within Canadian dairy herds by fast and discriminating strain typing (U of Calgary; graduate student: Christina Ahlstrom).
- Inhalation as route of transmission for MAP; comparison of intratracheal and aerosolized challenge (U of Calgary; graduate student: Susanne Eisenberg).

- Prevalence of and risk factors for MAP infection in Alberta dairy herds (U of Calgary; graduate student: Robert Wolf).
- MAP infection in wild ruminants (U of Calgary; graduate student Taya Forde).
- Transmission of infections between elk and beef cattle (U of Calgary; graduate student: Mathieu Pruvot).
- Motivation of farmers to participate in Johne's disease prevention and control programs (U of Calgary; graduate student: Caroline Ritter).
- Calf-to-calf transmission of MAP (U of Calgary; graduate student: Caroline Corbett).
- Gene expression of MAP *in* infected calves (U of Calgary; graduate student: Joel David).
- Early T-cell profile in the peripheral blood of calves experimentally infected with MAP (U of Calgary; graduate student: Yasmeen Khalil).
- Atlantic Johne's Disease Initiative (U of PEI; graduate student: Karen MacDonald-Phillips).
- The use of individual milk, bulk milk and environmental samples in a voluntary Johne's Disease control program (U of PEI; graduate student: Carrie Lavers).
- A study of MAP shedding patterns in feces, milk and colostrum and development of methods to detect the bacteria in colostrum (U of PEI; graduate student: Emilie Laurin).
- Development of a risk assessment based calf management program for the control of Johne's disease (U of Guelph; graduate student: Ulrike Sorge).
- Applying recombinant technologies to define the secretome of MAP for the discovery of potential immunogens and diagnostic reagents (U of Guelph; graduate student: Antonio Facciuolo).
- Integrating milk based cow and bulk tank test data, dairy cattle inventory data and GIS location data for paratuberculosis surveillance (U of Guelph; graduate student: Carolyn Innes).
- Johne's Disease in Ontario small ruminant dairy industries: prevalence, risk factors and diagnostic tests (U of Guelph; graduate student: Cathy Bauman).
- Measuring the impact of a participatory approach to accelerating the adoption of practices and procedures to control Johne's Disease on Ontario dairy farms (U of Guelph; graduate student: Steven Roche).
- Equivalency of strong positive serum and milk ELISA Johne's Disease test results in Ontario dairy herds (U of Guelph; graduate student: Carolyn Innes).
- Interpretation of repeated testing for Johne's Disease in dairy herds (U of Guelph; post-doc: Cindy Todd).
- Johne's Disease prevention and control on Organic dairy farms in Ontario (U of Guelph; graduate student: Laura Pieper).
- Dairy herd health screening using bulk tank, herd pool, group pool and individual milk samples (U of Guelph; post-doc: Cindy Todd).
- Comparison of participants and non-participants in a voluntary Johne's Disease control program in Ontario, Canada (U of Guelph; graduate student: Alex Watters).
- Survival of high test positive cows in herds participating in a voluntary Johne's Disease control program (U of Guelph).
- Quantifying the cost of removing fecal shedders in a voluntary Johne's Disease control program (U of Guelph; student: Taika von Konigslow).
- Identification of MAP infected dairy herds: diagnosis by standardized environmental culture; impact of biosecurity measures on incidence; and evaluation of PCR as a complementary tool in the MAP culture protocol for the classification of contaminated environmental samples (Université de Montréal; graduate student: Juan Carlos Arango Sabogal).

- Study of the immune status of dairy cows with bovine paratuberculosis (Université de Sherbrooke; graduate student: Pier-Luc Dudemaine).
- Development of an early diagnosis of bovine paratuberculosis (Université de Sherbrooke; graduate student: David Foch-Chow-Tho).
- Study of the infection response to MAP to identify associated susceptibility genetic markers (Université de Sherbrooke; graduate student: Olivier Ariel).

JD control programs have reached over 4,700 (>35%) Canadian dairy farms and >60% of the dairy veterinarians across Canada (Table two). Priority on-farm JD risk areas have been identified (calving management, young calf management, and cattle additions) and targeted herd management changes have been implemented on many farms to reduce JD risks.

Table Two: Impact of Regional – Provincial JD Programs.

| Program | Participating Farms # (%) | Trained dairy veterinarians # (%) | Herd risk change over time (RAMP score out of 300) |
|---------------|---------------------------|-----------------------------------|---|
| Atlantic | 459 (69) | 49 (60) | POS Herds improved 19 points NEG Herds improved 6 points |
| Quebec | 1362 (22) | 161 (47*) | NA |
| Ontario | 2339 (58) | 246 (>95) | ALL Herds improved 8 points |
| Manitoba** | ~200 (57) | ~20 | NA |
| Saskatchewan | 20 (12) | ~10 | NA |
| Alberta | 350 (61) | 78 (95) | ALL Herds improved 16 points |
| BC | 30 (6) | 11 (50) | NA |
| CANADA | 4,759 (>35) | 575 (>60) | Reduced risks in herds |

(# number, * 95% if include indirect training, ** estimated, NA not available, ~ approximate)

LESSONS LEARNED

- 1) Program evaluations determined the extreme importance of a national standardised, simplified, prioritised risk assessment and management practices (i.e. RAMP) process to enable the producer and trained herd veterinarian to effectively change management to control JD.
- 2) The involvement and training of veterinarians to deliver the RAMP was critical. Private practitioners were instrumental in recruiting participants/adding credibility. RAMP facilitated discussions between the producer and herd veterinarian focused on areas of the farm (e.g. calf pens and calving area) that are far too frequently ignored. Deficiencies were often easily corrected, representing a strategic control of contagious diseases transmitted fecal-orally, including calf diarrhoea. The JD control programs provided very effective examples of implementation of targeted biosecurity on dairies across Canada. Veterinarians in Atlantic Canada identified communications effectiveness as a key challenge within the RAMP process. Veterinary curricula have historically not addressed this issue sufficiently, particularly for food animal veterinarians.
- 3) Provincial programs used differing on-farm JD sampling/testing techniques. Discussions among researchers, veterinarians and producers have resulted in a better understanding of limitations and fostered further collaborative research evaluating tests/test strategies.

Probably the most important lesson learned by most dairy producers is that exposure risk control is more important than testing and culling test-positive cows.

- 4) The industry must continue to try to eliminate the movement of MAP-infected cows between farms and from one province/region to another. With enforcement of movement restriction now limited to Québec, it is important to continue educating producers who buy replacements to check source herd health status (i.e. buyer beware).
- 5) Canadian JD programs voluntarily attracted up to 70% producer participation. How do we reach the remaining herds, which may include a disproportionate number of JD problem herds? Enrolment was boosted because these programs were producer-initiated and industry led. The support of veterinarians and industry staff (DHI testers in Ontario played a key role in reminding producers about testing opportunities) was very important and effective. However, we need to continuously find new ways to keep the program prominent in the minds of producers and to show program value to not only maintain enrolment but also bring the sceptics and late adopters on board. Extension outreach and farm focus research have been enabled by the JD initiatives.
- 6) There is a need for a national infectious disease herd status program. It is extremely important that a herd status for a certain disease in one province means the same as in another province. The leaders of the provincial JD Initiatives have started discussions to make this happen for JD, but it is important that the same will happen for the other infectious diseases that will be included in a national biosecurity effort. A status program must be national in scope and needs to be developed by farmers for farmers. Leadership from national organizations such as Dairy Farmers of Canada and the national breed associations is needed to move this forward.
- 7) Canada's significant advances related to the control of JD over the past seven years have primarily resulted from the coordination of integral research – education – program development activities by enthusiastic JD control champions from industry, academia, and the provinces. The CJDI Technical Committee has enabled this forum and the national coordination of JD Program components (research, farm, and laboratory) and standardised approaches for JD program planning/delivery at annual MAP Researchers Meetings since 2008.

BUILDING ON JOHNE'S - TRANSITIONING TO CANADIAN BIOSECURITY INITIATIVES

Recently, Dairy Farmers of Canada (DFC) and the Canadian Food Inspection Agency (CFIA) published two documents on dairy farm biosecurity: Biosecurity for Canadian Dairy Farms: National Standard (http://www.inspection.gc.ca/DAM/DAM-animals-animaux/STAGING/text-texte/terr_biosec_dairy_standards_1360169547274_eng.pdf) and Biosecurity for Canadian Dairy Farms: Producer Planning Guide (<http://www.inspection.gc.ca/animals/terrestrial-animals/biosecurity/standards-and-principles/producer-guide-dairy-farms/eng/1374262804030/1374262928209>). Additionally, biosecurity is one of the six programs that will be implemented as part of DFC's proAction Initiative (<http://www.dairyfarmers.ca/what-we-do/programs/the-proaction-initiative-on-farm-excellence>), an initiative that was accepted by the board of Dairy Farmers of Canada in June 2013 and will be implemented in the coming years. It was decided that the proAction Initiative will be the same in all Canadian provinces.

Applying successful methods and leveraging the JD Initiative lessons learned may optimise the launch of Canadian dairy farm biosecurity. The Canadian Johne's Technical Committee enabled the positive integration of current science into practical field application and the resultant delivery of effective, standardized provincial/regional JD control programs. With strong leadership from industry, all veterinary schools, key provincial programs, and the Canadian Food Inspection Agency, significant Canadian JD progress was achieved in a modest timeframe.

Participant List

| Name | Email | Affiliation | Country |
|---------------------|--|--|----------------|
| Alfonso Zecconi | alfonso.zecconi@unimi.it | Dipartimento Patologia Animale, Università degli Studi di Milano | Italy |
| Amely Campe | Amely.Campe@tiho-hannover.de | University of Veterinary Medicine, Hannover, Germany | Germany |
| Carlotta Ferroni | c.ferroni@sanita.it | Italian Ministry of Health | Italy |
| Christine Fourichon | christine.fourichon@oniris-nantes.fr | Oniris & INRA | France |
| Dag Lindheim | dag.lindheim@tine.no | TINE Dairies Norway | Norway |
| David Kelton | dkelton@uoguelph.ca | University of Guelph | Canada |
| Evan Sergeant | evan@ausvet.com.au | c/- Animal Health Australia | Australia |
| Giancarlo Belluzzi | g.belluzzi@sanita.it | Italian Ministry of Health | Italy |
| Giorgio Varisco | giorgio.varisco@izsler.it | Istituto Zooprofilattico Lombardia Emilia Romagna | Italy |
| Heike Koehler | Heike.Koehler@fli.bund.de | Friedrich-Loeffler-Institut, Federal Research Institute of Animal Health | Germany |
| Herman Barkema | barkema@ucalgary.ca | Faculty of Veterinary Medicine, University of Calgary | Canada |
| Hinrich Voges | hinrichnz@gmail.com | Johne's Disease Research Consortium | New Zealand |
| Iva Slana | slana@vri.cz | Veterinary Research Institute | Czech Republic |

Participant List

| Name | Email | Affiliation | Country |
|-----------------|--|--|-----------------|
| Johannes Khol | Johannes.Khol@vetmeduni.ac.at | University of Veterinary Medicine Vienna | Austria |
| Joseba Garrido | jgarrido@neiker.net | Animal Health Department. Neiker | Spain |
| Kamil Kovarcik | kovarcik@vri.cz | Veterinary Research Institute | Czech Republic |
| Karsten Donat | kdonat@thuringertierseuchenkasse.de | Animal Health Service, Thuringian Animal Diseases Fund, Jena | Germany |
| Kelly Wall | kwall@animalhealthaustralia.com.au | Animal Health Australia | Australia |
| Koen Mintiens | koen.mintiens@boerenbond.be | Boerenbond Research Department | Belgium |
| Lorna Citer | LCiter@animalhealthaustralia.com.au | Animal Health Australia | Australia |
| Luigi Ruocco | l.ruocco@sanita.it | Italian Ministry of Health | Italy |
| Marco Tamba | marco.tamba@izsler.it | Istituto Zooprofilattico Lombardia Emilia Romagna | Italy |
| Marian Aalberts | M.Aalberts@gddiergezondheid.nl | GD Animal Health | The Netherlands |
| Marteen Weber | m.weber@gddeventer.com | GD Animal Health | The Netherlands |
| Matjaz Ocepek | Matjaz.Ocepek@vf.uni-lj.si | Veterinary faculty/National Veterinary Institute | Slovenia |

Participant List

| Name | Email | Affiliation | Country |
|------------------|--|---|----------------|
| Nicola Pozzato | npozzato@izsvenezie.it | Istituto Zooprofilattico Sperimentale delle Venezie | Italy |
| Norma Arrigoni | norma.arrigoni@izsler.it | Istituto Zooprofilattico Lombardia Emilia Romagna | Italy |
| Olav Østerås | olav.osteras@tine.no | TINE SA, Advisory Services, Ås, Norway | Norway |
| Peter Mullaney | peter.mullaney@agriculture.gov.ie | Dept. Agriculture Food and the Marine | Ireland |
| Peter Orpin | pete.orpin@parkvetgroup.com | Myhealthyherd/ Park Vet Group | United Kingdom |
| Petr Kralik | kralik@vri.cz | Veterinary Research Institute | Czech Republic |
| Ramón Juste | rjuste@neiker.net | Animal Health Department. Neiker | Spain |
| Réjean Bouchard | rejean.bouchard@dfc-plc.ca | Dairy Farmers of Canada | Canada |
| Robin Condrón | RCondrón@dairyaustralia.com.au | Dairy Australia | Australia |
| Sam Strain | sam.strain@animalhealthni.com | Animal Health & Welfare N. Ireland | Ireland |
| Søren Nielsen | saxmose@sund.ku.dk | University of Copenhagen | Denmark |
| Stefano Marangon | smarangon@izsvenezie.it | Istituto Zooprofilattico Sperimentale delle Venezie | Italy |

