Where’s a MAP when you need one?

THE DEVELOPMENT OF PRACTICAL MANAGEMENT PLANS TO ACHIEVE COST-EFFECTIVE CONTROL OF JOHNE’S DISEASE FOR YOUR DAIRY CLIENTS

Hi everyone,

Welcome to the first topic! We will be discussing the basics of Johne’s disease (JD) in dairy cattle, including diagnosis, focusing particularly on NZ dairying, and will outline some options when attempting to minimize MAP transmission around the calving period.

JD develops after infection with the bacterium *Mycobacterium avium* subspecies *paratuberculosis* (also known as MAP). There are two major strains of MAP: ovine (Type I) and bovine (Type II). The clinical signs of JD vary and can include weight loss (generally over weeks), watery diarrhoea, submandibular oedema (“bottle-jaw”) and/or decreased milk production. Although the observation of clinical signs alone is commonly used by farmers to diagnose JD, the differential diagnosis list for weight loss and/or diarrhoea in NZ dairy cattle is extensive, including BVD/mucosal disease, *Salmonella* spp. and *Ostertagia ostertagi*, and should be considered prior to making a diagnosis of JD based only on clinical signs. The typical gross pathology of MAP infection in cattle is a chronic, granulomatous enterocolitis and a regional lymphadenitis and lymphangitis. Tissue infiltration with lymphocytes and macrophages results in the production of a thickened, corrugated intestinal wall.

In a MAP-infected herd, each animal can be classified into one of four stages:

**The four stages of infection and clinical disease in a MAP-infected herd**

<table>
<thead>
<tr>
<th>STATUS</th>
<th>NON-INFECTED</th>
<th>INFECTED - Non-infectious</th>
<th>INFECTED – Subclinical/Pre-clinical</th>
<th>INFECTED – Clinical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Healthy cow</td>
<td>Infected with MAP</td>
<td>Infected with MAP. The disease is progressing.</td>
<td>Visible clinical signs of disease</td>
</tr>
<tr>
<td>MAP shedding</td>
<td>No</td>
<td>No. Not infectious.</td>
<td>Yes. Ranging from intermittent to heavy.</td>
<td>Yes. Generally consistent and large amounts</td>
</tr>
<tr>
<td>Symptoms</td>
<td>None</td>
<td>None evident. Generally productive. Small percentage progress to clinical disease, particularly if immune-stressed.</td>
<td>May suffer from lower milk production, increased calving intervals and susceptibility to other infectious diseases. No diarrhoea, weight loss and/or bottle-jaw.</td>
<td>Weight loss, drop in milk production, continuous or intermittent diarrhoea and progressive weakness and/or bottle-jaw. All clinical animals eventually die from malnutrition/dehydration</td>
</tr>
<tr>
<td>Diagnostic testing</td>
<td>No diagnostic test can accurately confirm that an animal/herd is free from disease. Use additional information to increase confidence in a likely negative status.</td>
<td>Very difficult to differentiate from a non-infected animal. Blood and milk testing suitable. Faecal testing accurate if animal shedding.</td>
<td>Blood, milk and faecal tests suitable for detecting clinical disease</td>
<td></td>
</tr>
</tbody>
</table>
Cattle can remain subclinical for months to years (or their lifetime) until periods of stress or other factors cause MAP to emerge, replicate and create disease. MAP infection within a dairy herd can resemble an **iceberg**, where the clinical signs of disease may be visible, but the bulk of infection consists of cows in the pre-clinical and subclinical stages. As a rule of thumb, after clinical JD has been present in a herd for several generations, the prevalence of subclinical cases within that herd is likely to exceed the incidence of clinical cases by 10 to 20 times.

Although JD can be a complex disease, the “Six Key Facts” include the most pertinent information and may be a useful starting point when discussing JD with your dairying clients.

**Johne’s disease in cattle: The Six Key Facts**

- Cattle are infected with MAP as calves and replacement heifers, up to 12-18 months, with the highest transmission rate to calves <30 days of age. Heifers and cows >18 months of age are generally not considered to be at high risk of MAP infection.
- Although clinical JD typically occurs in adult cattle 3+ years of age (i.e. the disease is latent for months to years), clinical signs in rising 2-year-old heifers have been reported in NZ.
- Cows with visible clinical signs of JD shed enormous amounts of MAP in their faeces. These animals are the highest risk of MAP transmission to calves and heifers.
- Due to a thick cell wall, MAP can remain viable in the right environmental conditions (i.e. moist; shaded) for months.
- Although clinical disease due to MAP infection can be managed out of a dairy herd, it is impossible to eradicate the bacteria due to its longevity and the low accuracy of currently available diagnostic tests.
- There is no effective treatment for MAP infection or clinical JD.

The first reported clinical case of JD in NZ dairy cattle was in 1912 in a cow imported from Jersey (Stephens and Gill, 1937). A 2012-2013 national survey found 54.3% of NZ dairy farmers (n=457) had suspected or diagnosed at least one cow in their herd with clinical JD. However, the mean *within-herd* incidence of clinical JD (i.e. average percentage of cows affected per herd) was only 0.47% (S.D. 0.76%) (minimum: 0.0%; maximum: 6.2%).

**Bar-chart of the within-herd incidence of farmer-diagnosed JD in 457 New Zealand dairy herds**
So, although over half of NZ dairy herds appear to be affected with JD, the number of cows affected per herd is typically <0.5%. This pattern is generally typical of JD in dairy industries worldwide. In the 2012-2013 survey, the mean herd-level presence and within-herd incidence of clinical JD was higher in South relative to North Island herds.

### Herd-level and within-herd incidence of farmer-diagnosed Johne’s Disease, by regional herd location (n=457)

<table>
<thead>
<tr>
<th>Study herd regional location</th>
<th>Herds n</th>
<th>Clinical JD incidence (%)</th>
<th>Herd-level</th>
<th>Within-herd</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>µ</td>
<td>S.D.</td>
</tr>
<tr>
<td>Northland/Auckland</td>
<td>18</td>
<td>55.5</td>
<td>0.55</td>
<td>0.74</td>
</tr>
<tr>
<td>Waikato</td>
<td>67</td>
<td>31.3</td>
<td>0.39</td>
<td>0.97</td>
</tr>
<tr>
<td>Bay of Plenty</td>
<td>31</td>
<td>25.8</td>
<td>0.17</td>
<td>0.38</td>
</tr>
<tr>
<td>Taranaki</td>
<td>116</td>
<td>52.6</td>
<td>0.40</td>
<td>0.64</td>
</tr>
<tr>
<td>Manawatu/Wellington</td>
<td>23</td>
<td>47.8</td>
<td>0.28</td>
<td>0.52</td>
</tr>
<tr>
<td>NORTH ISLAND</td>
<td>255</td>
<td>43.5</td>
<td>0.37</td>
<td>0.72</td>
</tr>
<tr>
<td>Nelson-Marlborough</td>
<td>27</td>
<td>59.3</td>
<td>0.83</td>
<td>1.29</td>
</tr>
<tr>
<td>Westland</td>
<td>41</td>
<td>78.0</td>
<td>0.86</td>
<td>0.86</td>
</tr>
<tr>
<td>Canterbury</td>
<td>52</td>
<td>69.2</td>
<td>0.57</td>
<td>0.66</td>
</tr>
<tr>
<td>Otago</td>
<td>29</td>
<td>58.6</td>
<td>0.36</td>
<td>0.49</td>
</tr>
<tr>
<td>Southland</td>
<td>53</td>
<td>67.9</td>
<td>0.40</td>
<td>0.59</td>
</tr>
<tr>
<td>SOUTH ISLAND</td>
<td>202</td>
<td>67.8</td>
<td>0.61</td>
<td>0.79</td>
</tr>
<tr>
<td>NEW ZEALAND</td>
<td>457</td>
<td>54.3</td>
<td>0.47</td>
<td>0.76</td>
</tr>
</tbody>
</table>

### Management of Johne’s disease in New Zealand dairy herds

A herd-specific management plan for JD should be developed to minimize the risk of MAP transmission to calves and heifers, rather than attempting to eradicate the bacteria, which is considered unachievable and uneconomic. Available information on the control of JD in dairy cattle have been summarized into 5 key Objectives. Information on Johne’s control, under these Objectives, will be provided as a “toolbox” to your dairy clients in the near future by DairyNZ and the Johne’s Research Consortium.

**OBJECTIVE 1:** To eliminate a major source of MAP before calving and reduce losses due to clinical Johne’s disease

**OBJECTIVE 2:** To minimize calf exposure to MAP before birth and at calving via dam’s faeces and colostrum

**OBJECTIVE 3:** To avoid calf contact with adults and prevent exposure to MAP-contaminated environment

**OBJECTIVE 4:** To prevent heifer contact with cows, their faeces or effluent until they join the herd

**OBJECTIVE 5:** To avoid importing MAP into the herd from “high risk” sources
Within each Objective, recommended management practices are provided as options (i.e. without being prescriptive) so you can tailor a Johne’s disease management plan to each client’s varying needs and objectives. Management practices are presented in one of three categories:

**Best Practice:** Management practices that aim to minimize MAP transmission to the calf. They are intended to be practical, but individuals may consider them too costly or difficult to implement.

**Alternative Options:** If implementing best practice is not practical, alternatives can mitigate risk and are a reasonable alternative.

**High-Risk Behaviour:** In order to develop a successful Johne’s disease management plan, it is highly recommended that these “high risk” practices are eliminated.

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### Diagnostic Testing for MAP

1. **Milk ELISA**

Milk sampling (at herd-testing) provides a convenient opportunity to screen the whole herd and cull high-risk cows before calving. Test costs are reduced by using an intermediate pooling step with a lowered cut-off. Results are ranked into ‘Suspect’, ‘Positive’ and ‘High positive’ categories. Overall, MAP shedding is heaviest amongst ‘High positive’ cows.

**Note:** Negative test results are reported as “Not detected” because test sensitivity is insufficient to detect all infected cattle, particularly in the early stages of infection. Contact the lab for more information/test costs.

2. **Serum ELISA**

Suspect MAP-infected cows or bulls may be confirmed via a serum ELISA. Re-test cows with a “suspect” result through the milk ELISA or faecal PCR to rule out cross-contamination. The sensitivity of any ELISA for MAP is significantly higher in animals shedding high levels of the bacteria and/or showing clinical signs (“Clinical”) relative to pre/subclinical cattle.

Herds that experience severe clinical JD losses and/or clinical disease amongst first-calf heifers should consider bleeding rising 2-year-olds before they calve. Heifers should only be tested at >14 months of age.

3. **Faecal MAP PCR (polymerase chain reaction)**

Real-time PCR tests can give a more accurate estimate of the amount of faecal shedding of MAP by an individual cow. This requires quantitative interpretation and will allow heavy shedders to be identified. PCR is an expensive test relative to milk and serum ELISA.

Clients who are unable to cull all ELISA-positive cows, may find this confirmation test useful to prioritise culling and management of high-risk/high-value animals.
Traditionally, faecal culture was used as a diagnostic test for MAP but a slow turn-around time of 6-12 weeks and the availability of milk and serum ELISA makes this test now impractical.

**OBJECTIVE 1: To eliminate a major source of MAP before calving and reduce losses due to clinical Johne’s disease**

**BEST PRACTICE**
- Immediately cull any cows with clinical signs typical of Johne’s disease; and
- Screen all cows in the milking herd annually for MAP using a milk ELISA at herd-testing; and
- Cull all cows ‘suspicious’, ‘positive’ or ‘high positive’ for MAP on the milk ELISA

**ALTERNATIVE OPTIONS**
- Tag all test-positive cows and cull at the end of the lactation season (i.e. prior to next calving); or
- Tag all test-positive cows and manage separately at calving

**HIGH RISK PRACTICES**
- Maintenance of cows with clinical Johne’s disease on the property

The basis of any successful management program for JD is the identification and immediate cull of animals or other livestock infected with MAP, particularly those affected with clinical disease. MAP can be transmitted to calves and replacement heifers by a number of different routes:

- faecal-oral/horizontal
- in utero/vertical
- via milk or colostrum/transmammary

**Faecal-oral transmission of MAP**
Based on a recent systematic review, contact with adult cow faeces appears to be the most important risk factor for MAP transmission in dairy cattle (Doré et al, 2012). However, multiple factors contribute to the likelihood that the natural transfer of MAP via the faecal-oral route will result in clinical disease, including genetic factors, history, level and frequency of exposure and the age of the animal. In cattle, susceptibility to infection with MAP and the development of clinical JD appears to follow an age-based pattern, with the likelihood of infection highest in calves <30 days of age. Signs of clinical JD are not typically observed until the animal is at least 24 months of age. However, the earlier in life that a calf is exposed to MAP, as well as with higher and more frequent doses, the faster the disease process can be accelerated such that they begin shedding bacteria and exhibiting clinical signs at an earlier age.
Identification and culling of cows with clinical Johne’s disease

The identification of MAP-infected animals with or without clinical signs is essential to minimize the on-farm transmission of MAP. Cattle affected with clinical JD can excrete up to $10^6$ to $10^8$ Colony Forming Units (CFU) of MAP per gram of faeces, generally more than cattle with subclinical JD. However, subclinically affected cattle can also shed significant levels of MAP in their faeces. Two feedings of $10^6$ MAP organisms can successfully infect a calf. Therefore, cattle with clinical JD are considered the most significant source of environmental contamination with MAP. An essential first step of any effective control program for JD in dairy cattle is the rapid identification of all animals with clinical signs of JD.

**Note:** typical clinical signs, such as chronic weight loss and diarrhoea, can be difficult to distinguish from those observed in adult cattle with other conditions and appropriate diagnostic testing should be undertaken to confirm MAP infection is the cause of the observed clinical signs.

It is highly recommended that any heifer or cow that is demonstrating clinical signs of JD, regardless of the stage of pregnancy, is identified, tested and culled immediately. However, the decision to cull a wasting animal may be difficult if it appears bright, alert and has a good appetite. Therefore, in the initial stages of a management program, your client may feel more comfortable in treating animals with diarrhoea and weight loss with an anthelmintic drench or antibiotic and monitoring them for up to two weeks. MAP-infected animals will not show a long-term improvement once treatment ends and should be culled. Optimally, your client will change their policy to the immediate cull of any animal with clinical signs of wasting or scouring after limited success with treatment. The most appropriate diagnostic test for a small number of cows with suspect clinical signs of Johne’s disease is likely to be a serum ELISA.

Identification and culling/management of cows with subclinical/pre-clinical Johne’s disease

The recent modification of a milk ELISA that utilizes existing herd-test samples has made the testing of all cows within a milking herd for MAP reasonably cost-effective. However, the decision to cull a MAP-infected animal can be difficult if it appears healthy and your client may choose to maintain a MAP-infected cow in the milking herd to maximize milk production prior to the development of clinical signs and her forced culling/death. You should make your clients aware that test-positive animals with subclinical JD can shed MAP in their faeces for up to 18 months before clinical signs become apparent so maintenance of test-positive cows should only be undertaken if there are management practices in place to minimize MAP transfer from the milking herd to naïve calves and replacement heifers.

MAP-infected cows with subclinical JD also have lower milk-fat and milk-protein yields, increased calving interval length and increased susceptibility to other infectious diseases (Smith et al, 2010; Ansari-Lari et al, 2012). Therefore, farmers should consider the cost-effectiveness of maintaining these animals in the herd considering their productivity will decrease within 1-2 seasons and there is a high likelihood of the eventual development of clinical signs of JD. If the farmer is unwilling or unable to immediately cull cattle that are test-positive for MAP, it is recommended that these animals are tagged with a ‘JD-suspect’ tag so they can be easily recognized and preferentially culled (e.g. if they develop chronic mastitis). It is also recommended that MAP-infected cows are only naturally mated so any heifer calves are not maintained as replacements.
Identification and culling/management of heifers with subclinical/pre-clinical Johne’s disease

A lower cost option than the “blanket” testing of all cows in a milking herd is to only test the replacement heifers to maintain these animals as the basis of a test-negative milking herd. Additional testing of a proportion of the mature cows, such as the 3 and 4-year-olds, will increase the proportion of the milking herd that is test-negative. As adult cattle of unknown test status are culled, the test-negative milking herd will become predominant. However, this process will take considerably longer than testing all adult cattle from the outset of a control program and a test-negative 2-year-old does not guarantee that this animal will remain test-negative throughout its life.

The low sensitivity of current individual-animal tests for MAP (both serum and milk) in subclinical cattle means that a proportion of truly MAP-infected animals will not be diagnosed as test-positive after one round of testing. Therefore, a single test of the replacement heifer mob does not guarantee that all test-negative animals are non-infected and it is strongly recommended that this mob is re-tested annually. Replacement heifers can be tested using a serum ELISA prior to calving or selectively tested using a milk ELISA once in the milking herd.

Prior to testing replacement heifers only (versus ‘blanket’ testing of the milking herd), it is recommended that a cost-benefit analysis is completed, taking into account the costs of clinical JD (i.e. deaths) and likely costs of subclinical JD (i.e. decreased milk production; reduced pregnancy rates). These costs will depend on the prevalence of MAP in the herd with a higher prevalence of MAP likely resulting in higher costs.

Employing animal husbandry practices to limit opportunities for MAP transmission to calves, while simultaneously testing adult cattle to identify heavy shedders of MAP, was shown to be successful in the reduction of test-positive cows when introduced into nine US dairy herds over a 6-year period, particularly among first-lactation cows (Collins et al, 2010). Moreover, mathematical simulation models have indicated that improving calf management is more efficient to decrease MAP prevalence in a herd than a test-and-cull strategy alone. Therefore, any effective control program for JD must emphasize the prevention of MAP transmission, especially to calves and replacement heifers <12 months of age.

Faecal-oral transmission to cattle from other livestock species

In NZ, multi-species pastoral systems are common, where dairy cattle (particularly replacement heifers and dry/carry-over cows), beef cattle, sheep and deer are grazed either concurrently or successively. Therefore, the effective management of JD on extensive New Zealand pastoral systems requires consideration of multiple species. JD has been reported in all New Zealand farmed ruminant species, with the exception of alpacas and llamas.

Beef cattle: The first investigation of the presence and prevalence of MAP infection in beef cattle was undertaken recently in 102 beef herds, with an infection rate of 27% reported (Verdugo et al, 2010).

Sheep: After a first diagnosis in 1952, MAP is now endemic in the NZ sheep population, with an estimated 60%-70% of sheep flocks infected (Morris et al, 2006; Verdugo et al, 2010). Despite this, the within-flock incidence of clinical disease is generally <1% (Morris et al, 2006).
**Deer:** In the past, outbreaks of clinical JD in weaner and yearling farmed deer had been reported, with the disease considered one of the main animal health concerns of the deer industry. Although recent surveys of NZ deer herds have found 32%-43% to be MAP-positive (Glossop et al, 2006; Verdugo et al, 2010), the mean within-herd incidence of clinical disease is ≤1% (Glossop et al, 2008).

**Goats:** Although NZ farmed goats were first reported with JD in the early 1980s (West, 2002), there have been no published estimates of the animal or flock-level prevalence of JD in this species.

**OBJECTIVE 2: To minimize calf exposure to MAP before birth and at calving via dam’s faeces and colostrum**

**BEST PRACTICE**
- Only calve cows that are test-negative for MAP and are not demonstrating clinical signs typical of Johne’s disease
- Cull the current season’s calf from cows that developed clinical Johne’s disease and/or were ‘high positive’ on the milk ELISA, regardless of genetic worth
- Move the springer mob regularly to maximize clean pastures
- Remove newborn calves from the springer mob at least twice daily
- Feed replacement heifer calves fresh colostrum from test-negative cows only

**ALTERNATIVE OPTIONS**
- Tag all test-positive cows and manage separately at calving; and
- Tag calves from test-positive cows and manage as heifers/adults
- Feed replacement heifer calves colostrum from lower risk cows (i.e. heifers and 3 years old)
- Test-bucket newly calved cows suspected of Johne’s disease and do not feed to replacement heifer calves

**HIGH RISK PRACTICES**
- Maintenance of cows with clinical Johne’s disease on the property; and
- Excessive fouling of the calving environment; and
- Sourcing pooled colostrum from untested, older cows; and
- Calving of test-positive cows with the rest of the milking herd

Studies have shown that MAP can be transferred from the dam to the foetus/calf both ante-partum (*in utero*) and post-partum (transmammary). However, whether a foetus infected with MAP at or soon after birth will remain a subclinical carrier throughout life or will invariably progress to clinical JD has not been investigated. MAP has been isolated from the cotyledons, foetal membranes and uteri of pregnant cattle (Hole 1953; Lawrence 1956; Doyle 1958; Seitz et al 1989; Sweeney et al 1992a). Twenty to 40% of pregnant cows with advanced clinical JD will infect their foetus through *in utero* transmission of MAP. In contrast, less than 10% of pregnant cows with subclinical JD infect their foetus prior to birth (Sweeney et al 1992a). MAP has also been detected in the udder, supramammary lymph nodes and milk of sheep, goats and cattle (McDonald et al 2005; Nebbia et al 2006; Salgado et al 2007). Up to 35% of cows affected with clinical JD and 12% of subclinically affected cattle shed detectable levels of MAP in their milk (Sweeney et al 1992b).
**Maintenance of a clean calving area**

Research investigating potential risk factors for MAP infection within the environment of calving cows has predominately been undertaken overseas, focusing on cows that are housed and calved indoors in designated pens or stalls. However, in New Zealand, cows are most commonly calved outdoors in “springer” or calving paddocks, where multiple cows within 1-2 weeks of calving are grazed and managed separately from the dry mob and the milking/colostrum mobs. Although a 2005 Australian study found an increased risk of MAP infection when calving occurred in a shed or calving pad compared to a paddock (Ridge et al, 2005), a more recent study found the opposite association, with a lower risk for cows calved on a pad, relative to a shed or calving paddock (Ridge et al, 2010). It has been hypothesized that calving cows in a shed environment, such as a ‘herd home’, may increase the risk of MAP transmission due to greater organism survival in the sheltered shed environment (Chiodini et al, 1984).

**Snatching of calves pre-suckle**

Faecal contamination of teat surfaces is believed to facilitate MAP transmission to those calves that are permitted to suckle naturally (Merkal, 1985). A recent study confirmed that there is a 1.87 times higher odds of MAP contamination of the teat surface of freshly calved cows if the dam is shedding MAP in her faeces (Pithua et al, 2011). Moreover, dams with “very high” faecal shedding of MAP (i.e. those with clinical disease) had a 4.06 times higher likelihood of teat contamination with MAP relative to test-negative dams. Goodger et al (1996) found a significant association between the removal of calves from their dams soon after birth and a reduced herd-level risk of MAP. However, the removal of calves from their dam pre-suckle, requiring consistent observation and multiple ‘pick-ups’ per day, may be challenging on most commercial New Zealand dairy farms, possibly requiring the employment of additional labor. Australian farmers nominated the required removal of calves from their dams within 12 hours of birth as the most difficult element of a recommended JD control program (Ridge et al, 2010).

**Culling of calves from cows affected with clinical signs typical of JD at calving or within one month of calving**

Numerous studies have demonstrated a possible familial predisposition to MAP infection in dairy cattle (Gonda et al 2006; Osterstock et al 2008; Shook et al 2012). Koets et al (2000) estimated the heritability of MAP susceptibility in dairy cattle at 0.06 which was comparable to other conditions in cattle, such as mastitis (0.07) and teat injury (0.14) (Philipsson et al 1980), while Shook et al (2012) recently confirmed a heritability of 0.15 for JD in Israeli dairy cattle. Moreover, cows shedding high levels of MAP in their faeces are also more likely to shed the bacteria in theircolostrum relative to light faecal shedders (Pithua et al, 2011). Therefore, it is recommended that any calves born to cows affected with clinical signs of JD at calving or within or month or calving are culled.

**Selective culling of heifer calves from test-positive cows**

A calf born to a MAP-infected cow is at higher risk of MAP infection at birth relative to a test-negative cow due to the *in utero* transmission of MAP and shared genotypes associated with a
susceptibility to infection. As an alternative to early culling, these calves could be tagged, proactively tested as adults and naturally mated so the value of any production is maintained, but their genetics are managed out of the herd over time.

**Feeding of “low risk” Day 1 colostrum or an approved colostrum replacement product**

Calves are fed colostrum during the first days of life to obtain the IgG antibodies that are essential for healthy immune function. Colostrum is a macrophage-rich environment and, as MAP is an intracellular bacterium within macrophages, colostrum is considered of particularly high risk to suckling calves. Although the mechanisms by which MAP may contaminate colostrum are still poorly understood, infected faeces may contaminate teat skin and/or freely circulating MAP-infected macrophages may pass into the mammary gland via the hematogenous route (Pithua et al, 2011). Hygenic udder washing prior to colostrum collection has been shown to be significantly correlated with a reduced risk of MAP infection in calves.

Stabel (2008) demonstrated that calves born from subclinically affected cows naturally infected with MAP were more likely to be test-positive via tissue culture at 12 months of age if fed colostrum from their dam versus similar calves fed pooled colostrum from healthy, test-negative cows. In a recent national study of New Zealand dairy farmers, approximately half of the 552 farmers surveyed allowed newborn calves to feed colostrum directly from their dam, while the remainder fed colostrum pooled from multiple cows. Only 2.7% of farmers fed pooled colostrum sourced from cows considered to be at “low risk” for JD.

If the colostrum mob is not tested pre-calving, a “low risk” colostrum mob may be developed consisting predominately of heifers, which are of lower risk of MAP transmission relative to older cattle within the same milking herd. Alternatively, colostrum may be derived from the last rows milked in the colostrum mob if those rows consist predominately of heifers. However, if clinical disease is present in the heifers, a “low risk” mob should be developed from test-negative animals. As a minimum, the colostrum from cows with clinical signs typical of JD should be disposed of prior to feeding to the calves.

In a US study, calves fed raw bovine colostrum had a higher risk of infection with MAP than calves fed a commercial colostrum replacement product (Pithua et al, 2009). Colostrum replacement products, made from whey protein concentrate and containing bovine globulin protein, are available to feed replacement calves as a low-risk alternative to fresh Day 1 colostrum from on-farm cows. A recent US study found there was no significant difference between cows fed a commercial colostrum replacer at the time of birth from cows fed raw bovine maternal colostrum as calves with respect to overall risk of death, culling, lifetime milk yield or breeding performance (Pithua et al, 2010). Despite this, currently, these products do not appear to have been commonly used under New Zealand conditions.

**Note:** A recent systematic review has encouraged a focus on minimizing the faecal transmission of MAP from adult cattle to calves <6-12 months of age rather than colostrum management (Doré et al, 2012).
Identification of familial lines and culling of direct offspring of a MAP-infected/clinically affected cows and/or natural mating of cows within a susceptible familial line

The offspring of MAP-infected dams may be at higher risk of infection due to:

- *in utero* and transmammary transmission;
- an increased risk of exposure to teat ends and pasture contaminated with faeces containing MAP; and
- shared genotypes associated with susceptibility to infection

It has been common practice in some international dairy herds for offspring of a test-positive cow to be culled along with its dam, often irrespective of the offspring’s test status. Culling the offspring of a test-positive dam has been supported by recent studies of a possible familial predisposition to MAP infection in dairy cattle (Koets et al 2000; Osterstock et al 2008; Shook et al 2012). Recent Dutch and German studies have found that the level of heritability increases in herds with a MAP prevalence of ≥10% (van Hulzen et al, 2011; Küpper et al, 2012), indicating that culling based on familial lines may be a particularly effective management tool in those herds with a significant MAP prevalence.

It is recommended that a comprehensive cost-benefit analysis is completed prior to recommending culling along familial lines in NZ dairy herds. This culling practice may involve substantial initial economic loss as any financial investment made into production of the offspring will be lost. Alternatively, test-positive cows or cows within an apparently susceptible familial line may be naturally mated only to ensure their genetics are excluded from the replacement heifer mob, while maintaining the production value of the dams.
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THE DEVELOPMENT OF PRACTICAL MANAGEMENT PLANS TO ACHIEVE COST-EFFECTIVE CONTROL OF JOHNE’S DISEASE FOR YOUR DAIRY CLIENTS

Hi everyone,

Welcome to the second topic! We will be discussing recommended management practices to minimize the risk of MAP transmission in the pre-weaning and post-weaning periods. As outlined in Topic 1, a test-and-cull or test-and-manage strategy on its own is insufficient to effectively manage JD in dairy cattle and minimizing the transfer of MAP to calves and replacement heifers is essential in any successful control program. After Objectives 1 and 2 were outlined in Topic 1, Topic 2 continues directly into Objectives 3, 4 and 5.

OBJECTIVE 3: To avoid calf contact with adults and prevent exposure to MAP-contaminated environment

BEST PRACTICE

- Feed milk replacer to replacement heifer calves
- Prevent faecal contamination of calf pens by adult cattle or effluent run-off
- Provide clean “low risk” drinking water at all times and prevent access to ponds
- Only feed milk from test-negative cows
- Use dedicated calf runs with no grazing access by adult cattle, including the milking herd

ALTERNATIVE OPTIONS

- Only feed milk from young cows at lower risk of MAP shedding relative to herdmates; or
- Consistently monitor the milking herd for early signs of clinical JD and test-bucket suspect cows to remove colostrum/milk from calf supply

HIGH RISK PRACTICES

- Grazing calves in the “hospital” paddock or with cull cows
- Feeding milk from the “penicillin” or sick mob to calves
- Allowing access by calves or heifers to the effluent pond
- Spraying of effluent in the vicinity of the calf shed (wind drift) or on the weaned calf paddocks

NZ dairy calves are typically transported once or twice daily from the calving paddock to a calf rearing facility, which generally consists of a converted or purpose-built, open-sided shed divided into pens in which each of 5-10 calves can be raised. Adjacent to the calf rearing facility may be small paddocks which the calves can access either immediately and without restriction or only post-weaning/in fine weather. Calves may remain in the calf rearing facility for between 1 day to 10 weeks before being transported either directly off-farm (to the “run-off” or “dry block”), onto larger, dedicated calf paddocks or onto the milking platform. Therefore, pre-weaned calves may be
maintained either in a calf rearing facility with milk delivered to the pens or in calf paddocks, the milking platform or at a run-off, with milk delivered via a multi-calf 'calfeteria'.

Numerous studies have confirmed that there is an increased risk of MAP transmission in larger herds (Collins et al, 1994; Muskens et al, 2003; Tavornpanich et al, 2008; Ridge et al, 2010), which has been assumed to predominately be due to a relatively lower quality in calving management and calf rearing due to the larger number of animals to be cared for per unit time (particularly in seasonal calving herds) and possible staff training and retention issues leading to imperfect application of the management practices.

Calf pen contamination through exposure to faeces from infected cattle within 3-10 days of birth has been found to be associated with a positive MAP status in calves born from infected dams (Benedictus et al, 2008). Drinking water contaminated with MAP from the on-farm milking herd could also represent a source of bacterial transmission to naïve calves and replacement heifers. An example of a lower risk water source to pre-weaned calves is bore water.

From approximately 2-4 days of age, calves may either continue to be fed Day 2-4 colostrum and/or be fed whole vat milk pooled from multiple cows and/or the “penicillin”, “red” or “waste” milk from cows that are within the milk withholding period (WHP) of an administered antibiotic or other treatment.

**Feeding of Milk replacers**

Approximately 4% of New Zealand dairy farmers feed milk replacer, either with or without whole vat milk and/or colostrum to their replacement calves. This compares to an estimated 59% of US dairy farmers, with reduced cost, consistency of product and ease and flexibility of storage reported as the main reasons for milk replacer use (Heinrichs et al, 1994).

**Pasteurization of milk**

Pasteurization effectively reduces the MAP load in milk by four to five logs, but the efficacy depends on the initial MAP concentration, which depends on the prevalence among the contributing cattle (Grant et al, 1996; Gao et al, 2002; Okura et al, 2012). Two basic pasteurizer designs are commonly marketed to dairy producers in the US: a batch pasteurization system and a continuous flow system (Godden et al, 2006).

A 2006 US study found that calves fed a conventional milk replacer had significant lower weight gains and weaning weights and a higher risk of treatment and death than did calves fed pasteurized non-saleable milk, where “non-saleable” milk was the equivalent of Day 2-4 colostrum and/or “penicillin” milk (Godden et al, 2006). The estimated savings of feeding pasteurized non-saleable milk, compared to milk replacer, was US$0.69/calf per day. However, it was not cost-effective to pasteurize “saleable” milk (i.e. whole vat milk derived from the milking herd) relative to using milk replacer. Moreover, the estimated average number of calves needed to be introduced daily to economically justify the non-saleable milk pasteurization system was 23 calves.

Therefore, in the NZ system, approximately 1,850 calves would need to be born in the first 8 weeks of calving to justify the cost of use of a commercial pasteuriser and, to-date this system has not been introduced into commercial dairy units in NZ, likely due to a lack of apparent cost-effectiveness.
Feeding of “penicillin” / “red” milk to pre-weaned replacement heifer calves

The true significance of feeding calves the “penicillin”, “red” or “waste” milk on the risk of MAP transmission remains equivocal. However, commonly the “sick” or “penicillin” mob consists predominately of cows treated for clinical mastitis with an increased individual somatic cell count (ISCC), particularly early in the lactation season and cows with antibodies to MAP often have a concurrent, high ISCC (Baptista et al, 2008). Moreover, it is likely that cows milked in the “penicillin” mob are under increased stress relative to the rest of the milking herd due to a concurrent infectious disease, such as clinical mastitis or lameness. Stress has a major negative impact on the cell-mediated immune pathways that are vital to protect animals against chronic infection, such as JD. Therefore, there may be an increased risk of faecal shedding of MAP from infected, subclinical animals within the “penicillin” mob, particularly if there is a relatively high within-herd prevalence of MAP infection.

Farmers may inadvertently include cows with clinical signs suspicious of JD in the “penicillin” or “sick” mob while waiting for confirmation of diagnostic testing or response to treatment. This milk may preferentially be fed as “waste” milk to pre-weaned calves. Herds in which calves are fed colostrum collected from known MAP-infected cows are 87 times more likely to be infected with MAP than herds in which such colostrum feeding practices are not typical (Dieguez et al, 2008). The excretion of MAP in colostrum and milk appears to be correlated with the stage of infection with pre-clinical and clinical cows more likely to be shedding significant levels of MAP (Sweeney et al, 1992). As a minimum calves should not be fed milk from cows with suspected or confirmed clinical JD. Milk from these cows should be routinely removed prior to the vat using a test-bucket and disposed of. Clear identification of these cows (e.g. using coloured udder spray) is essential to ensure milking staff do not inadvertently include these animals in the “waste” milk collection for calves.

OBJECTIVE 4: To prevent heifer contact with cows, their faeces or effluent until they join the herd

BEST PRACTICE

- Provide dedicated grazing areas for weaned calves and replacement heifers (i.e. do not graze on the milking platform)
- Do not spray effluent on calf paddocks and beware of wind drift
- Transfer replacement heifer calves to the off-farm rearing unit as soon as possible
- Consistently provide clean, “low risk” drinking water and fence off open, flowing water sources

ALTERNATIVE OPTIONS

- If grazing weaned calves on the milking platform, allow as much time as possible between grazing of the milking herd
- If grazing adult cattle at heifer run-off, allow as much time as possible between grazing of the replacement heifers

HIGH RISK PRACTICES

- Set stocking calves on the milking platform or share-grazing with the milking herd
- Co-grazing of replacement heifers at the run-off with adult cattle, including beef cattle
- Spraying of effluent on any pastures to be grazed by weaned calves or replacement heifers

**Grazing of replacement heifer calves on the milking platform**

In New Zealand, it is common practice for pre-weaned and/or weaned dairy calves and/or replacement heifers to spend some days to months grazing on the pastures supporting the milking herd during the lactation season (i.e. the “milking platform”). Calves may be grazed either before or after the herd on a 20-40 day rotation. The thick capsule of MAP confers significant resistance to environmental effects, enabling it to survive for up to 11 months in soil (Gay and Sherman, 1992), though these levels will decrease over time. Therefore, it is strongly recommended that either these susceptible age classes are not grazed on the milking platform or the time spent grazing the milking platform is minimized. This may be achieved by:

- Maintaining the calves in the calf rearing facilities (“calf shed”) for longer;
- Transporting calves to an off-farm grazing facility (“run-off”) earlier; and/or
- Quarantining a section of the existing farm from grazing by adult cattle for a minimum of three months prior to calving. These pastures would then be grazed solely by the calves until they are transported to a run-off.

Any existing calf paddocks should not be included in the milking herd rotation until all calves have been transported to the run-off.

**Effluent sprayed pastures**

In a typical New Zealand pastoral, spring-calving dairy herd, the milking herd will excrete between 5% and 15% of their total daily faecal output on the dairy yard. Following milking, the yards will generally be washed down with a high-pressure hose creating a diluted mix of water, faeces and urine (“effluent”). Historically, effluent treatment involved a two-pond system which combined an anaerobic and facultative pond. Although this system effectively removes sediment, high concentrations of nutrients remain and, in the past, began to have visible impacts on surface-water and ground-water quality (Houlbrooke et al, 2004). In response to the introduction of the Resource Management Act in 1991, the spraying of liquid effluent and spreading of solid dairy waste onto dairy pastures has gained popularity, with an estimated 90% of 4,600 Waikato dairy farmers now applying this practice. The two-pond treatment system, with discharge to a nearby running water source, has been phased out by local regulatory authorities and is now regarded as a discretionary activity by regional councils.

The aim of the land application of effluent is to utilise the soil/plant system to absorb, filter and break-down all waste components within the effluent. Moreover, dairy effluent contains nitrogen, phosphorus, potassium, magnesium, sulphur and trace elements and acts as a form of natural fertiliser and there can be marked increases in the yield of pastures that have below optimum fertility (Hawke and Summers, 2003). Commonly, small, self-propelled irrigators are used to spread the effluent at varying speeds across selected dairy pastures. However, the application of raw effluent to dairy pastures is also an efficient method of spreading concentrated faeces contaminated with MAP, which is of considerable concern if applied prior to grazing of susceptible animals (i.e.
calves post-weaning). MAP remains in the uppermost soil layers and on grass, indicating the spraying of effluent on dairy pastures represents a clear hazard to susceptible livestock (Salgado et al, 2011). Moreover, MAP was found to be more likely to be detected in the run-off from pastures with a higher slope, indicating contaminated water/effluent runoff could affect down-slope pastures, particularly after heavy rainfall (Salgado et al, 2013). Therefore, it is recommended that replacement heifer calves are not grazed on effluent sprayed pastures at any time and possible run-off and wind drift from these pastures is also monitored.

**Grazing of other livestock on calf or heifer paddocks**

As beef cattle, deer and goats can also be infected with and shed Type II (bovine) MAP in their faeces, the grazing of dairy calves and replacement heifers with beef or dairy cattle >24 months of age or goats or deer of any age should be considered a “high risk” management practice if the infection status of these animals is unknown. If replacement heifers are grazed off-farm, a discussion with the heifer “grazier” concerning the co- or alternate grazing of these species with replacement heifers should be part of a JD management plan.

**Grazing and drinking above soil level**

It takes up to two months for MAP to leach through soils, indicating a preference to remain on grass and in the uppermost soil layers (Salgado et al, 2011). Therefore, providing drinking water and supplementary feed above ground level to reduce feeding/drinking where MAP is most concentrated is preferable.

Once weaned, replacement heifer calves may be maintained on the milking platform on the home-farm until they are either transported to grazing off-farm or until they calve as rising 2-year-olds. Off-farm grazing may be owned and managed by the farmer or by a “heifer grazier” who, for a set weekly per heifer payment, manages the heifers until they are transported back to the home-farm for calving.

A recent systematic review concluded that >73% of calves exposed to MAP before the age of 6 months eventually developed clinical JD, whereas 19% of cattle exposed after 12 months of age will eventually develop clinical signs of disease (Windsor and Whittington, 2010). Therefore, although the focus of any JD management plan should be on calves <6 months of age, the management of replacement heifers both on the home-farm and at off-farm grazing should also be considered, including water sources and grazing of other species.

**OBJECTIVE 5: To avoid importing MAP into the herd from “high risk” sources**

**BEST PRACTICE**

- Maintain a “closed” herd with good boundary fencing
- Only purchase and/or lease adult stock that are test-negative for MAP
- Verify the herd-of-origin and establish the Johne’s disease history of the sale herd
• Use artificial insemination and only buy bulls that have been tested for MAP

ALTERNATIVE OPTIONS

• Only purchase heifers or young cows
• Test newly purchased or lease cattle on arrival and quarantine until a result is available
• Do not graze carry-over and purchased cows on the heifer run-off
• Ensure boundary fences at the heifer run-off are well maintained

HIGH RISK PRACTICES

• Purchase of empty/cull cows that have not been tested for MAP
• Purchase of cows that have clinical signs typical of Johne’s disease and/or their untested herdmates

The primary method by which MAP is spread between dairy herds is via animal movements. A “closed” herd is defined as one where there is no introduction of dairy cattle onto the property at any time, regardless of the number, age, sex and likely time they would spend on-farm. However, there are few New Zealand dairy herds that can truly be classified as “closed” because, as a minimum, many farmers will purchase or lease bulls for the natural mating period.

It is strongly recommended that, prior to purchase/lease, all dairy animals >18 months of age are visually examined for clinical signs typical of JD by an experienced individual. The presence of even one animal with clinical JD in a sale mob indicates the likely presence of multiple MAP-infected animals that may go on to develop clinical disease. Therefore, even if a clinical animal is removed prior to purchase, a proportion of the remaining cattle will be infected with MAP and may develop clinical JD in the future.

Diagnostic testing, for example with a serum ELISA, and removal of test-positive sale animals may reduce the proportion of infected animals in the group. However, as all tests for MAP are <100% sensitive, this is unlikely to remove all infected animals from a sale mob containing one or more clinically affected animals. The purchase of test-negative animals from a mob with no clinical signs of JD is highly preferable to the purchase of test-negative animals from a mob with one or more animals with clinical disease. The seller may remove cattle affected with clinical signs of JD from a mob prior to sale. Therefore, it is recommended that the buyer evaluate the likelihood of MAP infection in the seller’s herd.

There are two main methods to assess the risk of JD in a herd or origin:

Test results for MAP: Although the results of any testing for MAP are informative, negative test results from only a small proportion of the herd (such as a few cull animals) is not sufficient to have confidence that the entire dairy herd is at “low risk” of infection, particularly as there is no test for MAP that has a sensitivity of 100%.

Presence of other indicators for JD: The buyer may also ask the seller for information on other indicators of the presence of absence of JD in their herd. Indicators for JD can include:

• Presence/prevalence of dairy cattle with poor body condition score (relative to the season) that were non-response to treatment, including improved nutrition; and/or
• Presence of non-specific cross-reactivity to routine Tb testing.
The buyer can also assess the farmer’s interest in Johne’s disease and the presence of an active Johne’s disease management plan in the dairy herd. Dairy herd owners with knowledge of Johne’s disease, in particular the typical clinical signs, are more likely to have investigated the MAP status of their own herd. It is always preferable to purchase cattle from a herd of origin with an active Johne’s disease management plan. Moreover, purchase of cattle from herds with confirmed MAP infection but an adequate management plan is more favorable than the purchase of animals from properties with an unconfirmed status and/or with no control program. Although cattle from the former herds have some probability of MAP infection, the buyer can have some confidence in their knowledge of the MAP status of purchased cattle and can manage them accordingly. In contrast, the MAP status of purchased cattle from herds with an unconfirmed status will be relatively unknown and may require additional management, such as long-term quarantine, to minimize the risk of MAP transmission to the buyer’s dairy herd.

A national herd classification system for Johne’s disease is not currently available in the New Zealand dairy industry. This means that the buyer is wholly responsible for assessing the risk of Johne’s disease when purchasing from a particular herd of origin (i.e. “Buyer beware”).

Purchase of animals where the herd of origin is unknown (e.g. saleyards), prevents the buyer from assessing the risk of Johne’s disease in that herd. This means the buyer is entirely dependent on visual inspection to determine the likely infection status of sale cattle/calves. In this situation, it is recommended that the buyer should always assume that purchased animals are infected with MAP if the herd of origin is unknown and manage them accordingly.

If purchased animals are not tested for MAP pre-sale, all animals over 18 months of age can be tested post-arrival using an appropriate diagnostic test, such as a serum ELISA. Cattle tested with an ELISA prior to 14 months of age are unlikely to have developed a sufficient immune response to be detected using this method.

To minimize environmental contamination with MAP, testing should be completed as soon as possible after arrival. Until test results are available, all purchased animals should be treated as if they are potentially infected with MAP and grazed on pastures that can be easily quarantined for a minimum of six months from on-farm cattle, particularly calves and replacement heifers. Purchased animals should be examined consistently for visible weight loss and/or diarrhoea post-arrival. If any purchased animals develop clinical signs of JD and/or are test-positive, it is recommended that the seller and stock agent (if applicable) are informed. It is strongly recommended that the individual NAIT tag number of each clinical and/or test-positive animal is recorded. After aggregation of the herd(s) of origin of MAP-infected cattle through cross-referencing of NAIT numbers, it is recommended the buyer considers purchasing animals from alternative herd(s) in the future.

If the on-farm dairy herd is at “low risk” of JD, the farmer may consider immediate slaughter and/or long-term quarantine of all purchased cattle to reduce the likelihood of MAP transmission to on-farm calves and replacement heifers. However, if MAP infection has been previously confirmed in the on-farm dairy herd, the farmer may choose to only minimize (rather than prevent) the entry of MAP-infected cattle into the on-farm herd through culling of test-positive animals only.
**Risk of MAP entry via semen:** Although MAP has been cultured from the seminal fluid, sperm and testes of bulls and from cryopreserved semen intended for artificial insemination (AI) (Ayele et al, 2004; Buergelt et al, 2004; Glawischnig et al, 2004; Khol et al, 2007), MAP transfer by AI or natural insemination has not been confirmed. A formal risk analysis by the European Food Safety Authority (EFSA) Scientific Panel on Animal Health and Welfare (2004) concluded the likely risk of MAP transmission via semen was low. However, that report also highlighted the need for research into the potential effect of processing on MAP viability in semen and the biology of transmission post-insemination in order to develop a more robust assessment.

**Risk of MAP entry via embryos:** MAP has been isolated from the uterine flush fluid and embryos of cattle with clinical Johne’s disease (Rohde and Shulaw, 1990; Bielanski et al, 2006). However, the standard sequential embryo washing procedure developed by the International Embryo Transfer Society completed prior to embryo transfer has been found to effectively reduce MAP levels to below the minimum effective dose (EFSA, 2004; Bielanski et al, 2006).

Purchase of semen or embryos from animals that are test-negative for MAP will increase the likelihood that the buyer has purchased non-infected product. However, as there is no diagnostic test for MAP that is 100% sensitive, it is not possible to definitively prove that an animal is free of infection. If a herd of origin appears to be at “low risk” of MAP infection, this should increase buyer confidence that purchased semen and embryos are truly non-infected.

**Risk of MAP transmission via drinking water**

Although MAP, as an obligate pathogenic parasite cannot multiply in freshwater, a thick, complex mycobacterial cell wall means the bacteria can remain viable for up to 20 months in this environment. However, numbers appear to drop markedly over time, with a marked reduction over succeeding months. The duration of MAP longevity may be influenced by the initial level of contamination and by seasonal factors, such as sunlight, freezing, rainfall and evaporation (Larsen et al, 1956).

It is recommended that drinking water for calves and replacement heifers and irrigation water for calf/heifer paddocks is sourced from on-farm only where the risk of MAP is more likely to be known. If this is not possible, assess the likelihood that water sourced from off-farm is contaminated with MAP (e.g. are there adult cows with clinical signs of JD upstream?).

This may be difficult for many farmers to achieve if they have no choice for the source of irrigation water. It may be more practical to manage pastures as potentially contaminated once irrigated. However, if the farmer has a choice of supplies from which to source irrigation water for calf and heifer paddocks, a supply that is not downstream of areas grazed by off-farm livestock may be preferable.

**Risk of MAP transmission from wildlife**

MAP has been isolated from tissue samples of a number of non-ruminant wildlife species in New Zealand, including possums, hedgehogs, rabbits, hares, ferrets and feral cats (Nugent et al, 2011).
Rabbits and hedgehogs were found to shed detectable levels of MAP in their faeces. Only three animals were observed with grossly visible abnormalities at post-mortem (two hedgehogs and one rabbit), with all three culture-positive for MAP. Wildlife control as a concept to reduce the likelihood of MAP introduction onto a dairy property may only be useful if the population of wildlife species on and around that property is relative large and there is evidence of a significant source of MAP on neighbouring properties.

**Determining a herd’s MAP status**

Effective management of Johne’s disease may require a significant, long-term financial commitment from the farmer. Therefore, it is strongly recommended that the presence of MAP in the dairy herd is confirmed prior to implementation of any management plan. Currently, there is no national herd-level classification scheme for MAP and the below categories are suggestions only.

**Herd with an “Unconfirmed” MAP infection status:** A herd can be defined as having an “unconfirmed” MAP status if there has been nil/insufficient diagnostic testing to confirm the presence or likely absence of infection. This means a herd is classified as “unconfirmed” even if there have been no livestock with clinical signs typical of Johne’s disease on the property.

**Herd at “low risk” of MAP infection:** As there is no diagnostic test for MAP that is 100% sensitive, it is not possible to definitively prove that a dairy herd is free of infection. However, herds in which appropriate diagnostic testing for MAP has been carried out on a suitable number of animals, with negative results, can be defined as “low risk” (rather than “clear” or “free”).

**Herd “infected” with MAP:** Herds can be classified as “infected” if MAP is detected in one or more dairy cattle by an appropriate diagnostic test. An alternative to whole-herd testing may be the “targeted” sampling of a small number of cows with clinical signs suspicious for JD. This can rapidly confirm MAP in a herd as the sensitivity of detection in cattle with clinical JD is markedly higher relative to cattle with subclinical JD. However, a negative test result only from animals suspected of clinical JD will not be sufficient to prove that a herd is at “low risk” of MAP infection. Further testing of an appropriate number of apparently healthy animals (e.g. through milk testing at herd-test) will be required to confirm the MAP status of the herd (see figure below).

Furthermore, testing of a small number of JD-suspect animals only will not provide any information on the prevalence of MAP infection in the herd. Therefore, prior to testing only JD-suspect animals, the relative worth of information gained should first be considered. Although the initial financial cost may be greater, testing of the entire milking herd using an appropriate test, such as the milk ELISA, to confirm the presence of MAP is likely to provide more information relative to targeted sampling.
ELISA testing on milk is becoming more commonly used as a diagnostic test for antibodies to MAP, with a test recently modified within the New Zealand setting due to the ease of sample collection through vat collection (herd-level) or the existing herd-testing scheme (individual cow-level). Although, currently, the sensitivity of the ELISA appears to be higher when used in serum relative to milk, the per cow cost of the milk ELISA is substantially less.

**PLEASE NOTE:** Numerous published reports have confirmed that developing a control program for Johne’s disease based only on test-and-cull or test-and-manage will not reduce MAP prevalence and is not cost-effective relative to a plan including calf and heifer management (Collins and Morgan, 1992; Groenendaal and Galligan, 2003; Dufour et al, 2004; Kudahl et al, 2008; Weber et al, 2008). Therefore, although diagnostic testing is useful to confirm a MAP diagnosis in clinically affected cows and to identify a proportion of subclinically affected cows, additional measures to minimize the transmission of MAP to replacement heifer calves, as outlined in previous Objectives, is essential for the successful control of Johne’s disease.
Where’s a MAP when you need one?

THE DEVELOPMENT OF PRACTICAL MANAGEMENT PLANS TO ACHIEVE COST-EFFECTIVE CONTROL OF JOHNE’S DISEASE FOR YOUR DAIRY CLIENTS

Hi everyone,

Welcome to the third and final topic! We will be discussing some additional areas that have not been covered in the 5 Objectives discussed in Topics 1 and 2. Also provided is a suggested questionnaire that you may use with your clients to gain important information during your initial JD consult and some real-life examples of NZ dairy herds affected with clinical JD, including suggested formatting for reporting of agreed, herd-specific management actions.

I hope you’ve enjoyed learning more about the management of JD in the NZ dairy industry. Please continue to use the discussion forums to ask questions.

Some additional FAQs

1. Is destocking a viable option to control MAP in dairy herds?
Destocking, or the removal of all ruminant stock, generally for two consecutive summers, was recommended initially to Australian sheep producers with high mortality rates due to JD in an attempt to eradicate the disease. However, this was complicated by the difficulty in sourcing replacement stock after the two year period which could be guaranteed to be free of JD. Destocking is only likely to be economically viable in herds where the monetary loss due to JD outweighs the difficulty in sourcing uninfected replacement stock and monetary losses inherent in destocking.

2. Why have farmers applied lime in the past as part of a Johne’s disease control program?
To scavenge iron in limiting environments, most mycobacterial species will produce the lipid-soluble siderophore mycobactin and the water-soluble siderophore exochelin (Harris and Barletta 2001). However, MAP is a mycobactin auxotroph, synthesizing exochelin only, and so appears to be susceptible to a lack of iron. The solubility of iron increases as pH decreases, so iron is more readily available to all microorganisms, including MAP, in an acidic environment (Johnson-Ifearulundu and Kaneene 1997). As soils are ingested with pasture, it was hypothesized that the dietary intake of iron could promote the survival of MAP in the environment and so improves the likelihood of bacterial transmission.

New Zealand soils tend to be acidic (i.e. pH <7). Lime is applied to soils to increase pH to optimum levels of between 5.8 and 6.2, by supplying calcium to the soil. An increase in pH should decrease the solubility of iron and, therefore, the survival of MAP. Although evidence of a positive relationship between acidic soils and the herd-level presence of MAP has subsequently been published by researchers investigating JD in cattle, sheep and goat herds in the United States, Australia and Spain (Johnson-Ifearulundu and Kaneene 1999; Reviriego et al 2000; Whittington et al 2004), this relationship could not be replicated in a later Australian study and has been largely discredited (Johnson-Ifearulundu and Kaneene 1998; Whittington et al 2004).
3. Can cows/calves be vaccinated for Johne’s disease in New Zealand?

Vaccination has been used to control clinical JD in cattle and sheep worldwide for the past 80 years. Modern JD vaccines typically consist of either whole killed or attenuated MAP organism, mixed with an oil adjuvant and administered to calves within 35 days of birth either subcutaneously or intramuscularly (Emery, 2004; Begg, 2005; Dupont, 2005; Knust et al, 2013). The basic premise of development of a Johne’s disease vaccine is the generation of protective immunity while eliminating those elements within the bacteria which stimulate an undesirable response, such as injection-site lesions (see below). It is generally accepted that, while vaccination may reduce clinical cases, it does not prevent infection – rather it stimulates the host immune response to control infection, thus preventing or delaying the progression to clinical disease and shedding of the organism (Rosseels, 2008).

There are two vaccines currently registered for JD control in New Zealand: Silirum™ (Zoetis NZ) and Gudair® (Zoetis NZ). Guidair® is currently registered for use in sheep and goats only, while Silirum™ is registered for use in cattle and deer only (Clough et al, 2010). A previous vaccine, Neoparasect® is no longer available in New Zealand. There are a number of possible side effects associated with vaccination for JD in dairy cattle in New Zealand:

- Injection site lesions
- Cross-reactivity to a primary intradermal test for *Mycobacterium bovis* (*M. bovis*)
- Operator safety

**Injection site lesions**

Following vaccination for JD, cattle may develop a permanent granuloma at the injection site, although this has not been reported to cause any long-lasting effects. However, the number and severity of tissue granulomas and colonization of tissues with MAP has been found to be significantly lower in young calves vaccinated with Silirum™ relative to controls in experimental challenge models (Munoz, 2005; Sweeney, 2007).

**Cross-reactivity to primary intradermal test for *M. bovis***

Vaccination for Johne’s disease can sensitize dairy cattle to mycobacterial antigens, causing a cross-reactive response to the primary intradermal diagnostic tests for bovine tuberculosis (*Mycobacterium bovis*) within the National Tuberculosis Pest Management Strategy, including the positive caudal fold and comparative cervical tests (MacDiarmid, 1987; Kohler, 2001). Although preliminary company data indicated that Silirum™ demonstrated a reduced rate of Tb test interference than that observed with other, killed, oil adjuvant vaccines for JD, this result could not be replicated in subsequent NZ studies (Clough et al, 2010). For this reason, Silirum™ is not actively marketed to the NZ dairy industry and the use of this vaccine in a New Zealand dairy herd requires special dispensation from OSPRI New Zealand (formerly the Animal Health Board).

**Operator safety**

Injection site reactions can be very severe in accidental self-inoculation by the vaccinator and particular care is advised when administering a vaccine for JD. Medical attention should be sought immediately after any incident.
EXAMPLE 1: Real-life clinical Johne’s disease

The following outlines a real-life example of clinical Johne’s disease in a New Zealand dairy herd, with suggested formatting for reporting of herd-specific information and agreed management practices/action points. Some information has been removed to ensure the herd remains confidential. Other than occasional confirmation of clinical cases of JD through positive serum ELISA, there had been no whole-herd testing for MAP completed in this herd.

In the discussion forum, give your recommendations for this herd based on the information below. Please list any answers in the discussion forum under “Example 1”:

Herd name: ______________________
Herd Location: _____________________
Visit date: _________________________

Herd summary:
Herd is predominately a Jersey herd of ~220 cows of superior genetics, just south of __________. Cows are milked twice daily during the calving season and once daily once all calves are weaned. The herdowners have the use of an off-farm run-off (owned by the herdowner’s brother).

Herd management: ______________________
Herd owners/managers (primary contact): ______________________
Home phone: _________________________
Mobile: ______________________________
Fax: _________________________________
Email: ______________________________

Breed(s): Jersey with small percentage of cross-breds.

Herd Johne’s disease status:
MAP has been confirmed on the property (based on test-positive cows with clinical signs) with approximately 3-4 cows culled annually due to clinical Johne’s disease. Two seasons ago, an estimated 12 cows (~5%) were culled. Cows are predominately >4 years of age when observed with clinical signs. Owners are now adept at diagnosing Johne’s disease based on clinical signs and will cull animals ASAP once diagnosed. To the owner’s knowledge, clinical JD has not been observed in beef cattle grazed on the run-off.

Herd calf/replacement heifer rearing:
Due to on-going losses due to clinical Johne’s disease, all heifer calves conceived through artificial insemination are currently maintained as replacements. Calves are removed twice daily from their dams, preferentially pre-suckle. Due to the temperate climate, the calving areas are generally dry and clean (season-dependent). The colostrum mob is maintained adjacent to the milking shed on clean shavings so udder cleanliness is maintained. Any remaining contamination is cleaned from udders prior to milking.

Currently, 80 replacement heifer calves are reared on the property to approximately 6 weeks of age.
in an open-sided (front-facing) calf-rearing shed with consistent application of fresh wood shavings and Virkon® disinfection (approximately fortnightly). There is excellent drainage due to a sloping concrete floor and an outside pen accessible by the calves on fine days that can be hosed out. There is little to no illness/scours in the calf mob as a result of the high quality of calf management. There is sufficient distance to prevent the inadvertent passage of effluent/run-off from the dairy to the calf shed. The calf pens are reasonably large, with an easy carrying capacity of 8-10 calves per pen. The shed is well ventilated, but positioned to minimize drafts. The main water source to the shed is a natural stream, the only species upstream of which is the neighbour’s beef cattle. Calves are fed pooled colostrum and whole milk from multiple adult cattle.

At approximately 6 weeks of age, calves are moved from the calf rearing shed to the milking platform on the same property. Calves are rotationally grazed ahead of the milking herd until approximately 4 months of age (transported ~October). Milk and calf meal is carted to the calves. Effluent is sprayed on some low-lying paddocks once yearly, but these paddocks are not accessible by the calves or replacement heifers. The main water source to the milking platform is river water, with beef cattle the predominate species upstream.

At approximately 4 months of age, calves are moved to a run-off owned by the owner’s brother which is grazed by beef steers and, possibly, older dairy stock. Calves are maintained on the run-off until approximately 18 months of age, when they are returned as in-calf heifers. Replacement heifers are not exposed to effluent spraying on the run-off and the main water source is dam water.

Recommended management practices?

EXAMPLE 2: Real-life clinical Johne’s disease
The following outlines a second, real-life example of clinical Johne’s disease in a New Zealand dairy herd which is potentially more complex than the first example. In the discussion forum, give your recommendations for this herd based on the information below and list any answers under “Example 2”:

Herd name: _______________________
Herd Location/Address: ___________________
Visit date: _______________________

Herd summary:
The complex consists of two herds, physically located alongside each other on ________. Herd 1, a higher BW herd, milks ~260 cows, while Herd 2 milks ~180 cows. The herds are milked and managed separately through the season, but there is some transfer of low production cows from Herd 1 to Herd 2 and transfer of some high producing cows from Herd 2 to Herd 1 to maintain numbers. The property grazed by Herd 1 and a nearby run-off are owned by_______, while the property grazed by Herd 2 is leased in a 50:50 sharemilker arrangement. _______ also leases a small block across the road to be included in the milking herd rotation as required.

Both properties are narrow, with one or two paddocks only located on either side of a central race.
The run-off is reasonably ‘rough’ country, suitable only for stock >12 months of age and beef stock.

**Herd management:**
Complex owner: _______________
Home phone: _______________

Herd 1 contract milker: ____________
Herd 2 contract milker: ____________

**Breed:** Predominately Friesian with some cross-bred genetics.

**Complex calf/replacement heifer rearing:**
Due to the culling of an increasing number of cows due to clinical Johne’s disease (2012: Herd 1 – 13/180 (7.2%); Herd 2 – 5/260 (1.9%) all calves conceived through artificial insemination are currently preferentially maintained. Calves are removed once daily and fed colostrum for 3-4 days post-birth. Calves preferentially receive their first dose of colostrum from their dam. Currently, calves are maintained on the property from birth to 3-4 weeks of age in an open-faced (front-facing) calf-rearing shed. There is sufficient distance to prevent the inadvertent passage of effluent/run-off from the dairy to the calf shed. Calf pens are large, with an easy carrying capacity of 10-15 calves per pen. Sheds are well ventilated, but positioned to minimize drafts. The main water source to the calf rearing shed and the milking platform is bore water.

At approximately 3-4 weeks of age, calves are moved from the calf rearing shed to the milking platform on the same property. Calves are rotationally grazed until approximately 12 months of age. Milk is carted in feeders to the calves. The milking herd is grazed on the milking platform, passing through the paddocks grazed by the calves on an approximate 20 day rotation. At approximately 12 months of age, calves are moved to a dry block which is grazed intermittently by the milking herd between October and February, and consistently by replacement dairy heifers between 12 and 24 months and a mob of ~150 beef steers.

Approximately 10% of the milking platform may be sprayed with effluent, but grazing calves/replacement heifers do not graze this pasture. A small mob of sheep (killers) are grazed on the rougher country (not grazed by the milking herd) and pigs are run in a small paddock near the shed.

**Complex Johne’s disease status:**
Johne’s disease has been confirmed on the property, with cases appearing to increase steadily over the last 10 years, particularly in Herd 2.

<table>
<thead>
<tr>
<th>Year</th>
<th>Herd 1 (n = ~260 cows)</th>
<th>Herd 2 (n = ~180 cows)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1 (0.4%)</td>
<td>2 (1.1%)</td>
</tr>
<tr>
<td>2011</td>
<td>2 (0.8%)</td>
<td>4 (2.2%)</td>
</tr>
<tr>
<td>2012</td>
<td>5 (1.9%)</td>
<td>13 (7.2%)</td>
</tr>
</tbody>
</table>

It was hypothesized that the increase in clinical Johne’s disease prevalence in 2012 may have been as
a result of a particularly wet winter in the 2011/2012 season.

**Recommended management practices?**

### SUGGESTED CLIENT QUESTIONNAIRE

The following is a series of questions you may ask your clients to give an overall initial impression of calf and heifer management on the property, the herd’s current and previous Johne’s disease history and may provide insight into likely “high risk” areas of possible entry of MAP into the herd and/or MAP transmission within the herd. Please note this questionnaire is not exhaustive and merely provides a starting point for a comprehensive discussion with your clients. If you think of some more useful questions, please feel free to share them on the discussion forum.

#### 1: General farm information

1.1 Primary contact name/details: ____________________________________________

1.2 What area on the property has been grazed by dairy cattle, including dairy calves, in the current season? (i.e. the “dairy grazing” area) ______ acres/hectares

#### 2: Most recent calving period

2.1 In the most recent calving period, when did the herd calve?

- Autumn
- Spring
- Mixed/year-round
- Non-seasonal town supply

2.2 Were cows calved in the same paddocks as the previous year?

- Yes
- Somewhat – some fresh calving paddocks were used
- No – all calving paddocks were fresh
- Unknown

2.3 On average, how many times a day were calves removed from their dams?

- 1
- 2
- Greater than 2

#### 3: Pre-weaning calf rearing facilities/”calf pens” (this season)

3.1 Were calves raised between birth and weaning on this property in this season?

- Yes
- No – calves were transported to a separate property soon after birth
- Other (______________________________)

3.2 How many calves were raised from birth to weaning this season? __________________
3.3 Did effluent (including water used to hose down the milking parlour/yards after milking) pass through any calf rearing facility/calf pen?
   - Yes, consistently
   - Yes, but only intermittently/accidently (e.g. overflowing drain)
   - No, never
   - Calf rearing facility not located on same property as milking parlour
   - Unknown

3.4 Where did calves receive their colostrum from?
   - Their dam
   - Colostrum pooled from multiple adult cattle
   - Colostrum pooled from cows at ‘low risk’ of Johne’s disease (e.g. heifers)
   - Other (__________________________________________________________)
   - Unknown

3.5 What was the predominant source of milk fed to calves this season?
   - Whole milk/waste milk
   - “Penicillin” or “red” milk from the sick mob
   - Milk replacer
   - Other (__________________________________________________________)

3.6 This season, what were the source(s) of water provided to pre-weaned calves in the calf rearing facility?
   - Natural stream
   - Bore water
   - Town water
   - No water was provided to the pre-weaned calves
   - Other (__________________________________________________________)
   - Unknown

4: Weaned calf rearing/“calf paddocks” (this season)
This section refers to the time period from calf weaning until calves were approximately six months of age or until they were sent away from the home-farm for grazing (whichever came first).

4.1 Were calves raised for at least one month after weaning on this property?
   - Yes
   - No – calves were transported to a separate property soon after weaning – skip to Section 5
   - Other (__________________________________________________________)
4.2 Could effluent or slurry get onto the paddocks grazed by the calves at any time until calves were moved off-farm or until they were 6 months of age (if still on-farm)?

- Yes – effluent/slurry was deliberately spread/sprayed over the calf paddock(s)
- Yes – run-off from hosing down the dairy/milking parlour could spread over the calf paddock(s)
- Yes – other method (______________________________)
- No – Skip to Question 4.4
- Unknown

4.3 If effluent/slurry had been spread over the calf paddocks, what was the average length of time between application and when calves were grazed on those paddocks?

- <1 month
- 1-3 months
- 3-6 months
- >6 months
- Unknown
- Effluent slurry was not spread over the calf paddocks

4.4 What were the source(s) of water to weaned calves in the calf paddocks?

- Natural spring/stream/river
- Bore water
- Irrigation ditches
- Dam
- Town water
- Other (______________________________)

4.5 Please indicate if any livestock were grazed on the calf paddocks during the 6 months prior to the weaned calves.

- No livestock were grazed on the calf paddocks in the 6 months prior to weaned calves

<table>
<thead>
<tr>
<th>Grazed on calf paddocks in 6 months prior to weaned calves</th>
<th>Age and sex</th>
<th>Grazed (tick)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Livestock species</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy cattle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milking herd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carry-over cows/dry cows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lame/sick mob</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yearlings/steers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lambing ewes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry ewes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rams</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weaners/hoggets/lambs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef cattle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cows and calves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry cows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yearlings/steers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.6 Please indicate if any livestock were grazed on the calf paddocks at the same time or in rotation with the weaned calves

☐ No livestock were grazed on calf paddocks at the same time/in rotation with weaned calves

☐ Grazed on calf paddocks at same time as weaned calves

<table>
<thead>
<tr>
<th>Livestock species</th>
<th>Age and sex</th>
<th>Grazed (tick)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy cattle</td>
<td>Milking herd</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carry-over cows/dry cows</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lame/sick mob</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bulls</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yearlings/steers</td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>Lambing ewes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry ewes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rams</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weaners/hoggets</td>
<td></td>
</tr>
<tr>
<td>Beef cattle</td>
<td>Cows and calves</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry cows</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bulls</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yearlings/steers</td>
<td></td>
</tr>
<tr>
<td>Deer</td>
<td>Any</td>
<td></td>
</tr>
</tbody>
</table>

5: Replacement heifer rearing/“heifer paddocks” (this season)
This section refers to the grazing patterns, management and environment of replacement heifers from six months of age or from the date of movement away from the home-farm (whichever comes first) until visit/consultation date.

5.1 How many home-bred heifer calves will be/were raised as replacements? ________________
(If none/zero, skip to Section 6)

5.2 How have home-bred replacement heifers predominately been grazed?
☐ On the home farm only – skip to Question 5.4
☐ Off-farm and managed by the herd owner/manager/sharemilker
☐ Off-farm and managed by a heifer grazer
☐ Other (____________________________________________________)

5.3 When did or when do you intend on sending replacement heifers away for grazing from the home-farm?
(e.g. March) ____________________________

5.4 Has effluent/slurry been spread or sprayed on the heifer paddocks?
☐ Yes
☐ No
☐ Unknown
5.5 What have been the source(s) of water to the heifer paddocks?
(Please tick all that apply)
- Natural spring
- Stream/river
- Bore water
- Irrigation ditches
- Dam
- Town water
- Other (______________________________________)
- Unknown

5.6 Please indicate which livestock have been grazed either at the same time or in rotation (if applicable) with the replacement heifers (i.e. on the same paddocks)
- No other livestock grazed pastures at the same time or in rotation with replacement heifers
- Unknown if all or some of the grazier(s) have livestock grazing with replacement heifers

<table>
<thead>
<tr>
<th>Livestock</th>
<th>Age and sex</th>
<th>Grazed WITH (tick)</th>
<th>Grazed IN ROTATION (tick)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy cattle</td>
<td>Milking herd</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carry-over cows/dry cows</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other heifers (different source)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sick/lame cows</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bulls/steers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calves/Yearlings (6-24 months)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheep</td>
<td>Lambing ewes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry ewes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rams</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weaners/hoggets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef cattle</td>
<td>Calving cows</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry cows</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bulls/steers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yearlings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deer</td>
<td>Yearlings (12-24 months)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adult hinds (2+ years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adult stags (2+ years)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6: Neighbors
6.1 How often does stock from neighboring properties enter the dairy grazing area on your property?
- Never
- Very rarely (less than once per year)
- Occasionally (at least once every 6 months)
- Often (at least once every 2 months)
7: Johne's disease in the dairy herd

History of Johne's disease in the dairy herd:

7.1 What was the total number of dairy cattle that had been suspected or diagnosed with Johne’s disease on this property prior to this lactation season? ______________

☐ Unknown

If zero (0) or Unknown, skip to Question 7.3

7.2 Describe details of any dairy cattle with suspected or diagnosed Johne’s disease prior to this lactation season:

<table>
<thead>
<tr>
<th>Month</th>
<th>Year</th>
<th>Number of animals</th>
<th>Age (years)</th>
<th>Sex (M/F)</th>
<th>Diagnostic test used</th>
<th>Purchased or home-bred</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. June</td>
<td>2009</td>
<td>1</td>
<td>3</td>
<td>F</td>
<td>Blood test</td>
<td>Purchased</td>
</tr>
</tbody>
</table>

Johne's disease in dairy herd during the current lactation:

7.3 What is the total number of dairy cattle that have been suspected or diagnosed with Johne’s disease on this property in this lactation season? ______________

☐ Unknown

If zero (0) or Unknown, skip to Question 7.8

7.4 Describe details of Johne’s disease suspicion or diagnosis in your dairy herd in this lactation season.

<table>
<thead>
<tr>
<th>Month</th>
<th>Age (years)</th>
<th>Sex (M/F)</th>
<th>Number of animals</th>
<th>Diagnostic test used</th>
<th>Purchased or home-bred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: July</td>
<td>5-7</td>
<td>F</td>
<td>3</td>
<td>Clinical signs</td>
<td>Home-bred</td>
</tr>
</tbody>
</table>

7.5 Indicate the movement of dairy cattle suspected or diagnosed with Johne’s disease in this season

☐ Left in the milking herd
☐ Moved into a separate, scouring or wasting mob
☐ Placed into a random paddock separate from healthy animals
☐ Placed into a paddock specifically isolated as a “hospital” paddock
☐ Grazed with replacement heifer calves or yearlings
7.6 What number of dairy cattle suspected or diagnosed with Johne’s disease in this season experienced the following fates?

<table>
<thead>
<tr>
<th>Fate</th>
<th>Number of animals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dairy heifers</td>
</tr>
<tr>
<td>Euthanized on-farm</td>
<td></td>
</tr>
<tr>
<td>Slaughter plant/Abattoir</td>
<td></td>
</tr>
<tr>
<td>Found dead</td>
<td></td>
</tr>
<tr>
<td>Left in the milking herd</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

7.7 In this season, once an animal was suspected or diagnosed with Johne’s disease, how long, on average, before the affected animal(s) was/were euthanized or sent to a slaughter plant?

Animal(s) were neither euthanized nor sent to the works

- Less than one week
- Between one week and one month
- Between one month and 6 months
- Over 6 months
- Unknown

7.8 Describe the management program used to keep the dairy herd free of Johne's disease and/or decrease the number of clinical cases:

- No management program in place in the dairy herd – Please skip to Question 7.11

7.9 When did this management program commence? ________________

7.10 Do you consider this management program to be:

- Highly successful
- Moderately successful
- Fairly successful
- Completely unsuccessful

7.11 What is your level of confidence when diagnosing Johne’s disease in dairy cattle based on clinical signs alone?

- Totally confident
- Very confident
- Confident
- Not really confident/doubtful
- Not at all confident
- Other (______________________________)
- Unknown
8: Dairy herd replacement policy

8.1 Describe the number and region(s) of origin of dairy cattle, including calves, heifers and bulls, purchased for this season.

☐ No dairy cattle purchased this season

<table>
<thead>
<tr>
<th>Dairy cattle class</th>
<th>Age</th>
<th>Number</th>
<th>Region(s) of origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example</td>
<td>4</td>
<td></td>
<td>Canterbury (x2); Otago (x2)</td>
</tr>
<tr>
<td>Calves</td>
<td>&lt;6 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replacement heifers</td>
<td>12-24 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult cows</td>
<td>&gt;2 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult bulls</td>
<td>&gt;2 years</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8.2 Did you actively ask for the Johne’s status/history of source properties of replacement dairy stock purchased for this season? (One answer only)

☐ Yes
☐ Sometimes
☐ No
☐ Unknown

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* RECOMMENDED READING: Full papers provided