National Action Group on Johne’s

Technical Manual for Vets

British Cattle Veterinary Association

Action Johne’s

JOHNE'S ACTION

Contents

Introduction

- The British Cattle Veterinary Association (BCVA), in conjunction with the National Johne's Action Group, has developed an online training course to ensure that as many vets as possible are fully up to speed with the details of Johne's disease management, the control strategies and the national Action Johne's initiative. Vets who pass the test will gain the status of "BCVA Accredited Johne's Veterinary Adviser" - BAJVA for short. Only BAJVA's may complete and sign the National Johne's Management Plan declarations annually.
- This training manual is based on the online course materials and is intended to be used as supplementary material for BAJVA vets to refer to when advising their dairy clients on control of Johne's disease. It has been updated in 2019 to reflect latest research and thinking on Johne's disease.

Johne's disease

Clinical signs

- Johne's disease is a chronic, progressive wasting disease caused by infection with the bacteria *Mycobacterium avium* subspecies *paratuberculosis* (MAP). Cattle are usually infected early in life but do not develop clinical disease for several years.
- Cattle that develop clinical Johne's disease have thickening of the gut wall and profuse diarrhoea meaning that the animal is unable to absorb nutrients. There is no cure and animals that show these signs of the disease will waste away, often quite quickly, and will eventually die.

Figure 1: Cow with clinical Johne's disease

- Clinically affected animals usually have minimal value as cull animals, and some would not be suitable. Retaining such cows would mean substantial economic loss to the farm. There is also the issue of credibility of submitting such cows to the food chain.
- Clinical Johne's disease is the tip of the iceberg. If cows in a herd have developed clinical Johne's disease, then homebred replacements are likely to have been exposed to MAP so there may be many more infected cows within the herd.

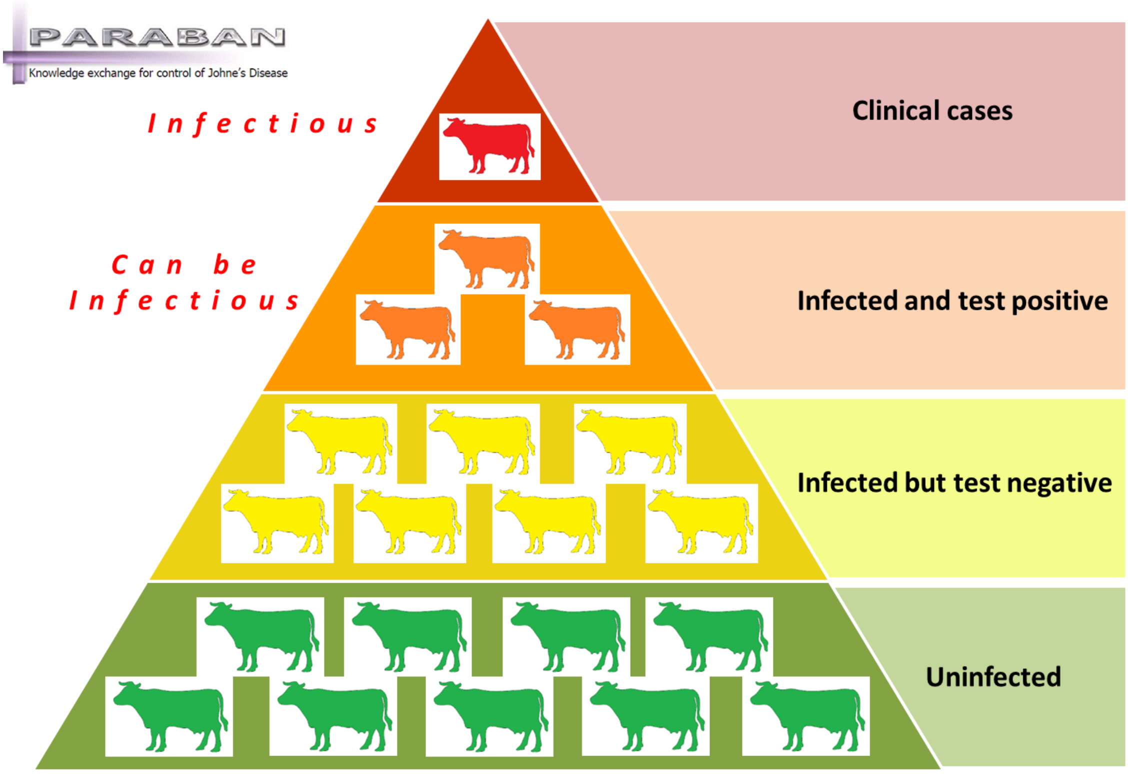


Figure 2: Clinical cases of Johne's disease indicate that there is a much more widespread problem in the herd

Why do we need a national management plan?

- Johne's disease is of welfare and economic concern to farmers as it doesn't just cause disease and death in cattle but also results in production losses. However, clinical signs take a long time to develop and "silently infected" cows can spread the infection before they begin to show obvious signs of clinical disease.
- Detection and segregation of infected animals as early as possible, whilst taking management steps on the farm to reduce the spread of infection, are the keys to successful control.
- International experience has shown that if a rigorous control program is instituted and applied robustly Johne's disease can be brought under control. In Denmark, the within herd Johne's test prevalence for herds adopting the national control program reduced from 10% to 2% over 6 years.
- A recently published review of 48 countries showed that formal control programs are underway in 22 of those countries. Participation is voluntary in 60% of programs but often supported by incentives or penalties. The control programs were reported to be successful in 73% of countries[1].
- The National Johne's Management Plan (NJMP) is now recognised as a strong and credible national disease program across the globe.

Module 1: Latest thinking on Johne's disease

Module 1 presents an overview of the pathology of Johne's disease and summarises some of the latest research relating to Johne's disease and its control.

Pathology

- *Mycobacterium avium* subspecies *paratuberculosis* (MAP) is an obligate intracellular pathogen that thrives inside macrophages
- After ingestion, it enters the macrophages via the M cells in the Peyer's patches
- This infection of macrophages can persist for years without any response from the host's immune system
- MAP controls the host cell to create the right environment for further growth and to hide itself from the infected animal's immune system. It does this via two main mechanisms:
    - Regulating phagosome
        - Sustaining pH for optimum growth
        - Selectively allowing delivery of molecules like transferrin to phagosome by fusion with vesicles in early endosomal network
    - Suppressing immune response
        - Sequestering itself away from antigen-processing machinery of host cell
        - Suppressing ability of infected macrophage to stimulate cell mediated immunity (CMI)
        - Over-production of cell wall lipids that leave infected cell by exocytosis to suppress neighbouring macrophages

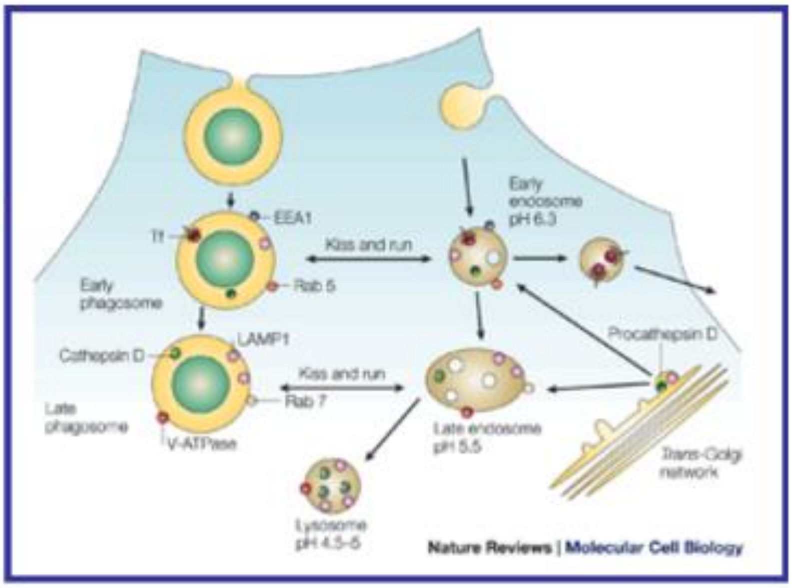


Figure 3: MAP cell control mechanisms (Professor Mike Collins for National Milk Laboratories)

Infection

- Johne's disease has a long period from infection to immune response and clinical signs; typically 3-5 years but can be shorter in cases with a heavy infection load.
- This makes it difficult to detect infected animals early in the course of disease due to MAP evading the immune system and preventing triggering of the humoral immune response.

- Diagnostic tests rely on failure of cellular immunity and triggering of humoral immunity (antibody production) or faecal shedding of MAP. Both of which are not present, low or intermittent in early stages of infection.

Age susceptibility

- Calves under 6 months of age are most susceptible to infection with MAP, with a considerable difference in susceptibility noted between adults and calves less than 6 months, and between adults and calves between 6-12 months[2]. The rate of decline of susceptibility with age has a large impact on transmission[3].
- Calves infected at more than 6 months of age are less likely than younger calves to go on to develop Johne's disease but still have a significantly higher rate of infection than adults. Calves up to 12 months of age can be experimentally infected with both high and low doses of MAP[4].
- Adults can be infected if exposed to high levels of MAP, such as from a heavily contaminated environment. From the point of view of epidemiology and onward transmission, this is less significant due to the incubation period as cows infected as adults will likely be culled from the herd before they begin to shed[5].

MAP Shedding

- Faecal shedding levels in MAP infected cows vary widely. In multiple cultures taken from a single sample up to one quarter (25%) of samples may show colonies in only one culture, demonstrating considerable sample variation[6].
- There has been recent interest in the role of super-shedders (defined as cows shedding > 10^7 cfu MAP/g faeces)[7]. It has been shown that around 10% of PCR positive cows will be super-shedders[8]. This is especially relevant in large herds where several super-shedders could be present at any one time.
- The level of MAP shedding in individual animals is one of the most important factors in the spread of infection and research supports the observation of clusters of infection occurring. It is possible that these factors are due to the presence of super-shedders[3,9.]
- Two distinct shedding patterns have been observed[10]
  - Progressors: continuous and progressive shedding
  - Non-progressors: intermittent and low shedding; usually in the absence of a humoral immune response
- In naturally infected animals it is thought less than 10% will become progressors or heavy shedders, with most being intermittent and low shedders[11].

Testing

- Milk, blood and faecal samples can all be used to test for MAP infection.
- The diagnostic tests available for Johne's disease receive a lot of bad press. In fact, the tests themselves are good at detecting their target, whether that is antibody or bacteria. However, due to the long course of disease and the ability of MAP to lie dormant in infected animals for a long period of time, detecting infection in the early stages can be challenging.
- No test is 100% sensitive or specific (i.e. a gold standard). Post mortem examination is generally used as the gold standard and other tests are compared to this, but post mortem results are still not perfect.

- It is very difficult to attribute sensitivity and specificity values to current diagnostic tests as the sensitivity of the gold standard test is not 100%.
- Faecal culture and PCR are compared against post mortem then blood and milk ELISA are compared against faecal culture and PCR to determine sensitivity and specificity values for the tests.

Choosing a test

- The choice of testing method depends on whether we are testing for clinical disease, establishing a herd status or testing as part of a control programme.
- Choose the right test for the right objective to provide clients with a cost-effective testing strategy.
- ELISA tests are cheaper and often used to make management decisions as part of a control programme. Faecal culture and PCR are generally used as a diagnostic tool or to establish shedding.
- Approaches to testing within the National Johne's Management Plan are reviewed further in Module 2.

Figure 4 is a graphic from Soren Nielsen's work in 2009 showing the relationship between Antibody ELISA results and faecal shedding[12]. This shows:

- Antibody levels may increase 1-2 years before heavy shedding
- The majority of high and intermittent shedders will be identified by ELISA testing pre shedding
- Repeated ELISA testing allows shedders to be identified earlier; a single annual test could lead to over half of shedders not being identified pre-shedding.

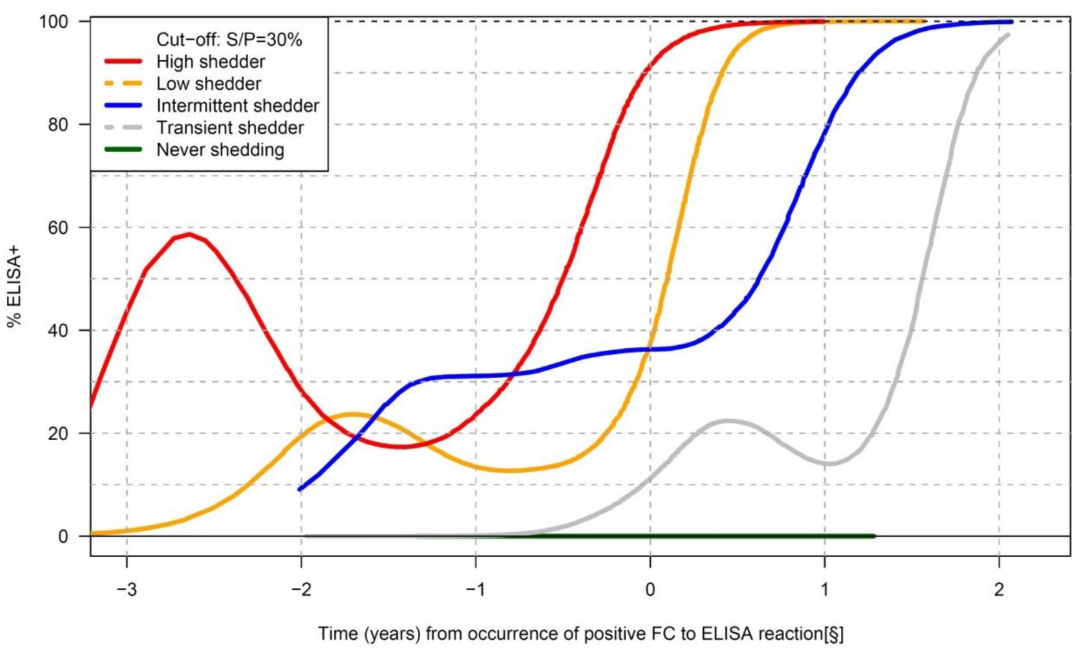


Figure 4: The relationship between Antibody ELISA results and faecal shedding

ELISA tests for antibody: Blood and milk samples

- Blood and milk tests (ELISA tests):
  - detect antibodies to MAP, indicating that an animal is infected
  - are most useful for making management decisions
  - are relatively simple and inexpensive
- The same test is used on blood and milk with a different cut-off value optimised to fit each type of sample.
- Bulk milk tests are sometimes used as an indicator of disease status at herd level but sensitivity is very low for Johne's disease. Bulk milk ELISA tests are cheap and easy, and if positive, do show evidence of Johne's disease on farm. However, poor sensitivity means that a low or negative result can be very misleading for the farmer – they can then think they don't have a problem when actually due to the poor sensitivity of the test, it hasn't been picked up. **Bulk milk tests are not permitted for use as part of the National Johne's Management Plan.**
- Test sensitivity depends on stage of disease with very low sensitivity in the early stages of infection increasing as the animal gets closer to clinical disease.

ELISA test performance

Test type	Sample	Reliability	Pros	Cons
ELISA	Blood	Se 40-80% Sp > 99%	Simple and relatively cheap test.	Need to take blood sample so may be reluctant to sample frequently
	Bulk Milk	Se 20-30%?? Sp 99%	Cheap and easy. Positive shows evidence of Johne's infection on farm	Poor sensitivity leads to 'negative' result being misleading to farmers
	Individual Milk	Se 40-80% Sp > 99%	Easier to obtain than blood samples so ability to test more frequently	Need for accurate id of samples Lactation stage effect?

PCR and culture tests for bacteria

- Faecal samples can be tested by culture (growing MAP in the laboratory) or PCR (detecting MAP DNA).
- Faecal tests:
  - detect shedding of MAP in faeces, indicating that an animal is infectious
  - are more expensive than ELISA tests
  - take longer to produce results (culture)
  - are most useful as diagnostic tools
- A positive result is usually diagnostic.

- Passive shedding accounts for the less than perfect specificity of faecal culture and PCR – false positives can occur if a cow ingests MAP and passes it out in faeces but is not actually infected.
- The main down side of faecal culture is the length of time taken to obtain results. If it is used as a confirmatory test, and especially if the animal is showing clinical signs, the animal should be isolated and/or culled quickly to prevent further spread of infection. A delay while waiting for results could allow the animal to infect others.
- PCR tests have also been trialled on bulk milk samples, but as with bulk milk ELISA tests, the sensitivity was found to be poor.

Culture and PCR test performance

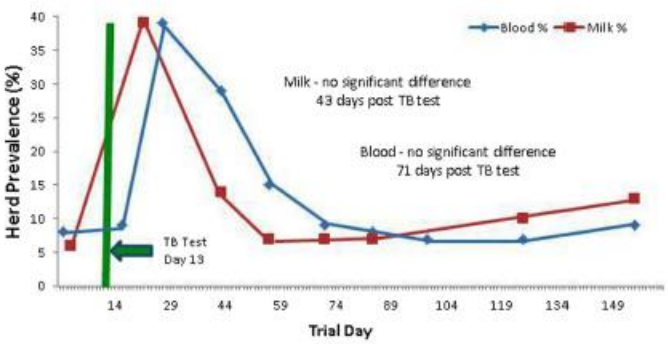
Test type	Sample	Reliability	Pros	Cons
Culture	Faeces	Se 30-50% Sp ≤ 100%	A positive result is diagnostic. No false positives(?) Good confirmatory test	Up to 14 weeks for a result Poor sensitivity especially in young/ subclinical animals or light/intermittent shedders.
PCR	Faeces	Se 30-50% Sp ≤ 100%	Rapid turnaround. No false positives(?) Positive result is diagnostic.	Poor sensitivity in young/subclinical animals or in light/intermittent shedders
	Bulk Milk	?	Good indicator of presence of *Map* in milk.	Poor sensitivity due to number of animals contributing to tank and nature of shedding. No information about disease prevalence. Contamination vs direct shedding into milk?

Repeated testing

- ELISA tests are simple and cheap and can therefore be used more frequently than faecal culture or PCR. Repeated ELISA testing allows earlier detection, which in turn enables farmers to manage high risk cows appropriately to prevent them from infecting calves.
- Quarterly milk ELISA testing is a common and useful strategy. Repeated milk ELISA testing detected 95% of "low" shedders and 98% of "high" shedders, whereas repeated faecal culture tests only detected 72% of ELISA positive cows[13].
- Peaks and troughs are seen in antibody levels when the cell-mediated immunity is losing control of the disease and humoral immunity is being triggered. Repeated ELISA testing increases the chances of detecting an early antibody peak. Antibody levels also dip, so it's not uncommon for an animal to give variable ELISA results at this stage of disease. This can be very frustrating for farmers looking at quarterly testing results and seeing an animal's results change.

Considerations when testing

- ELISA detects humoral immune response; faecal culture or PCR detects shedding. An animal will not necessarily be positive on both tests at the same time.
- None of these methods will pick up infection in early stages of disease as antibodies are not yet produced for detection by ELISA tests and MAP is not yet shed in the faeces.
- Youngstock testing is not generally recommended. It is unlikely to pick up infected animals so is not usually cost effective.
- TB testing can affect the results of Johne's (MAP) antibody ELISA tests.



Research from Ireland in 2014 showed ELISA values remained significantly higher for 43 days post TB testing in milk samples and until 71 days in blood samples[14]. Check with laboratory for recommended intervals between TB testing and Johne's screening. **Leave at least six weeks as an absolute minimum between TB testing and Johne's (MAP) ELISA testing.**

- **Milk from cows less than 7 days calved should NOT be used for Johne's ELISA (MAP) testing**. The nature of colostrum/early milk makes defatting of these samples extremely difficult and this will interfere with ELISA testing.

Recent developments in MAP control

- **Phage Testing:** Technology originally developed for rapid detection of TB in humans and now available for the detection of MAP. A mycobacteria specific bacteriophage is used to infect live MAP cells and burst open the cell walls to expose the MAP DNA, the DNA can then be extracted and used for standard PCR. Only viable MAP will be detected, and trial work shows enhanced sensitivity over standard PCR. This can be carried out on milk and blood samples and is now commercially available; it cannot be used on faecal samples and is not currently recognised as a confirmatory test by CHeCS.
- **Milking hygiene**: the potential of bulk milk PCR tests is being investigated and it has been shown that herds can be ELISA positive but PCR negative if good milking hygiene is practised in an infected herd. The positive ELISA results in these herds indicate that the infection is present and animals in the herd are producing antibodies against MAP, as detected by the ELISA test, but that good hygiene has prevented MAP from entering the bulk tank via faecal contamination, as demonstrated by the negative PCR result.[15]
- **Pasteurisation of colostrum** can be used as part of an improved farm management strategy to prevent transmission of MAP to calves via colostrum. Pasteurisation at 60ºC for 60 minutes should be sufficient to eliminate MAP from colostrum. Mean IgG levels in calves fed colostrum treated this way were higher and morbidity was significantly lower[16].

Module 2: Assessing risk and testing methods

Module 2 covers:

- Farm risk assessment
- Appropriate testing to establish status
- Testing for disease management

Risk assessment

- Farmers need to know their risk status for Johne's disease. Assessment of the risks of entry and spread in a herd should be carried out by a vet as part of a farm visit.
- It's important for the vet to get a good feel for what happens on the farm on a day to day basis in terms of biosecurity (to prevent disease entry) and biocontainment (to prevent disease spread) in order to perform an effective risk assessment.

Risks of entry

Major	Minor
Introduction of Cattle	Waterways
Slurry	Sheep
Imported colostrum	Wildlife

Introduction of cattle

- Purchased cattle are the main route of introduction of Johne's disease onto farms.
- When considering risk from purchased animals, consider:
  - **Source**: Sourcing cattle from low risk herds with a history of testing and control or CHeCS accreditation reduces the risk of entry of Johne's disease. The risk is increased if cattle are from multiple sources or purchased through a market where no history is available.
  - **Number**: the more animals that are brought onto the farm, the higher the risk. For example, a farm that replaces 5% of the herd every year is at much higher risk than a herd buying a breeding bull every two years.
  - **Frequency**: more frequent replacements from multiple sources represent a higher risk than one purchase from a single source.
- Is the herd truly closed? Farmers often say yes… apart from the odd heifer that they buy or the bull that they bring in every other year! Further investigation may be required to determine whether the herd is truly closed.
- Consider purchased calves and bulls as risk for disease entry as well as adult cows.

Slurry/manure

- Highest risk if spread on land that will be used for grazing youngstock.
- Using contractors or shared slurry spreading equipment increases the risk of introducing MAP. Slurry 'trading/ shifting' poses a high risk if the farm of origin has Johne's disease.
- Minimising leaf contamination through use of slurry injection rather than broadcast spreading can reduce the risk to grazing animals.
- Although MAP is an intracellular bacterium there is evidence it can survive outside its host for up to a year. Bear in mind that MAP can live on pasture for up to 55 weeks and tends to

remain on grass and in the upper levels of pasture soil. It can also survive for 48 weeks in water and sediments and at least 6 months in slurry[17,18,19,20].

Milk/colostrum from other farms

- Smaller farms are more likely to bring in colostrum from neighbours if required e.g. a cow has calved and no colostrum is available. This is risky if the neighbour's Johne's disease status is unknown or if they have Johne's disease. Encourage clients to have a colostrum bank from known low risk animals to avoid buying in colostrum from high risk sources in an emergency.

Waterways

- Waterways may be a source of infection if they flow through fields of livestock or land that is fertilised with manure or slurry.
- Youngstock are at highest risk of infection – it may be worth fencing off waterways or otherwise restricting access for this group in particular.

Other animals

- The risk of disease transmission from other species is lower than from cattle, but should still be considered. Recent work from New Zealand has demonstrated greater evidence of sheep to cattle transmission with Type I MAP (sheep strain) more commonly isolated from New Zealand beef cattle than Type II (cattle strain)[21].
- Overwintering sheep on cattle grazing is a common scenario. If that happens, what animals are then going to have access to that grazing? Avoid putting youngstock onto potentially contaminated pasture.
- Wildlife such as rabbits and deer can be infected with MAP[22], with both known to be potential reservoirs of infection. Increased prevalence of MAP in rabbits has been found on farms struggling to control Johne's disease[23].

Risks of spread

Risk Category	One to Many Risks	One to One
MAJOR	Cow to calf (Maternity Area) Milk and colostrum Cow to post weaned calf Cow to heifer	Clinical cow to foetus/calf Infectious cow to foetus/calf
MINOR	Cow to cow Calf to calf	Infected cow to foetus/calf

The relative importance of these risks will vary from farm to farm and will change over time. In herds just starting with Johne's disease control the major, one to many risks are the ones to tackle first as this is where the biggest gains can be made. As these risks are addressed, the minor risks, and one to one risks will become relatively more important and the plan will need to evolve to manage this.

Cow to calf

- A shedding cow in the maternity area can contaminate the pen to such a level that every calf born into that area could be infected until the pen is completely cleaned out. This is a major one to many risk and should be managed as a priority. This can be done by the use of individual calving pens which are completely cleaned after every calving; or by identification of high-risk cows and their exclusion from the dry cow and maternity areas producing a 'green calving line'.

Milk/colostrum from within the farm

- Ensure that milk and colostrum for calves is harvested hygienically and that teats and feeding equipment are kept free of faecal contamination.
- If calves are left with their dams and allowed to stand and suckle, the risk of MAP transmission is increased, particularly if udders are not clean and calves can ingest faecal material from the teats.
- Cows producing waste milk such as those with high cell counts, mastitis or receiving antibiotic treatment are more likely to have Johne's disease. Waste milk comes from a higher risk population of cows and calves fed waste milk are therefore at higher risk of infection. **Milk from positive cows should be discarded and not fed to replacement heifers.**
- If milk from multiple cows is pooled and fed to calves and one cow is infectious, there is a risk of infecting multiple calves.

Youngstock

- Don't just focus on calving and calf rearing. Remember that youngstock are more susceptible to MAP infection than adults.
- Prevent contact between the adult herd and youngstock of less than 12 months old; this includes both direct contact between cattle and indirect contact with faeces.
- Check slurry management to avoid faecal contamination of calf shed or youngstock accommodation.
- Grazing is especially important on farms where young calves are grazed, and this is particularly common on organic farms. Calves on pasture while still milk fed are highly susceptible to Johne's disease. When were adult cows last grazed on that land? When was slurry last spread on it? Remember MAP can survive for up to a year on pasture.
- Keep troughs used for youngstock free from faecal contamination from adult cows.

Calf to calf

- Work done in 2014 demonstrated that calf to calf transmission is possible. Calves infected with high doses of MAP at 2 weeks and 12 weeks continued to shed MAP for several weeks; with older calves proving to be more resistent[4].
- Work on 17 herds in Canada in 2017 detected MAP in calf pens in 9/17 herds and 3% of the calves were found to be shedding. Further work using experimentally infected calves and contact exposed calves showed shedding in all calves and that one shedding calf can infect 3 other calves[24].
- This may be one cause of low-grade persistence of Johne's disease in some herds and highlights the need for replacement calves to be reared away from any high-risk calves, creating not just a 'green calving line' but also a 'green calf line'.

Dam to calf

- It has been demonstrated that cows born to seropositive dams are 6 times more likely to become seropositive themselves either through in utero transmission or via exposure to dam faeces or colostrum shortly after birth; with the seropositive status in 34% of seropositive cows is attributable to being born to a seropositive dam[25].

- Recent UK work has also shown an increased risk in cows born to dams that were seronegative at their time of birth but were subsequently disclosed as positive. This adds weight to the advice that when a cow becomes seropositive you should look not only at her most recent calf but also back to her previous calf as it has an increased risk of being infected[26].

Other

- Remember the potential for adult to adult transmission.
- Identify positive animals and remove heavy shedders to minimise spread within the herd.
- Get rid of infectious cows as soon as possible to minimise environmental contamination.
- Use test results to inform culling decisions about which cows to cull and when to cull.
- Don't forget bulls in testing or control programmes. As with adult cows, keep bulls away from youngstock.

Risk assessment protocols

- Risk assessments should be carried out by the vet during a farm visit.
- There are several ways for vets to do this:
    - If confident about which questions to ask, you can go out and assess the risk independently.
    - If not, there are various methods available to help. Several risk assessment protocols for Johne's disease on dairy farms have been developed and are available to use. These are a useful check to make sure all appropriate questions have been asked. Also, providing written evidence of your findings and a point of reference at your next review.

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Biosecurity Risk Assessment for Johne's disease in dairy herds

Farm address:	**Herd:**
Farmer's name:	**Date:**

Johne's specific disease entry / biosecurity risks for Dairy herds with calving animals.				
Q1	I have introduced groups of cattle (more than two at a time) of unknown Johne's health status into my herd in the last **10 years**	Never	Less than 5% herd/ year	More than 5% herd/year
Q2	I have **only** introduced single animals (including breeding bulls) of unknown Johne's health status into my herd within the last 10 years	Never	Occasionally	Frequently
Q3	I spread slurry or manure from **another farm** on ground that is grazed, or will be grazed, by **calves or youngstock** less than 12 months old intended for breeding.	Never	Occasionally	Frequently
Q4	My calves or youngstock (less than 12 months old) that are intended for breeding have access to streams or waterways that have passed through another cattle farm, and have within the past 5 years.	Never	Occasionally	Often
Q5	My calves or youngstock (less than 12 months old) that are intended for breeding graze pastures which are heavily infested with rabbits.	Never	Occasionally	Frequently
Q6	My calves or youngstock (less than 12 months old) that are intended for breeding graze pastures with sheep of unknown Johne's status, or that have been grazed with sheep in the last 12 months, and have done so within the past 5 years.	Never	Occasionally	Frequently
Q7	I feed calves that are intended for breeding colostrum or milk derived from other herds that are not of known low Johne's risk,	Never	Occasionally	Frequently

Figure 5: Example of risk assessment framework from My Healthy Herd

- The protocol in the example from My Healthy Herd here is for assessing biosecurity for risk of entry. A biocontainment risk assessment for risk of spread is also available. The answers are put into an algorithm to assess risk and produce a traffic light score to grade farms on certain areas.
- Other risk assessment frameworks for Johne's disease are available from the UK and overseas.

Testing to establish status

- Farmers are expected to know their risks of entry and spread of Johne's disease from the on-farm risk assessment with their vet.
- They also need to know their herd status (i.e. whether there is evidence of Johne's disease on farm or not) to comply with the National Johne's Management Plan (NJMP).
- Testing to establish herd status involves actively seeking out disease if it is there to give as much confidence as possible in assigning the herd status.
- There are several testing options available to establish herd status; they are shown in order of reliability in assigning herd status from low to high:
    - **Cull cow screening**: cull cows with issues such as high cell count, low yields, lameness and poor fertility are most likely to have Johne's disease. The next time that a cull batch

is identified on the farm, take blood and/or milk samples on a routine visit for ELISA testing.
    - **Targeted 30 cow screen**: identify 30 cows most likely to have Johne's disease (high cell counts, low yields, and poor doers). Blood or milk can be used – herds that are milk recording can be tested automatically, using their milk records to select the 30 target cows. The 30 cow screen shows a 95% chance of correctly categorising the herd as infected or non-infected.
    - **Whole herd screen** – when a 30 cow screen is not enough, this is useful for confirmation if the herd is known to have Johne's disease and also for identification of infected cows within the herd.
- Selecting the correct test is based on clinical judgement to decide which is most appropriate to establish herd status. A cull cow screen should be considered to be the minimum acceptable level of testing.
- **Bulk milk testing is not acceptable under the NJMP and is not enough to establish farm status.** The sensitivity of individual ELISA tests is low at around 30-50% and bulk milk sensitivity with samples from hundreds of cows is very poor. Positive bulk milk ELISA shows that Johne's disease is present but a negative result provides very little information about herd status. We don't want farmers to assume that all is well based on a negative bulk milk result, resulting in complacency about Johne's disease management.
- The level of risk of entry in a herd also affects the level of confidence that we can have in a negative herd test result.
- The results from a study carried out over 5 years of testing demonstrated that confidence in freedom decreases with increasing numbers of introduced animals[27]. Obtaining animals from higher risk sources also decreases confidence in freedom as time goes on.
- The farmer's buying habits are very important in establishing herd status and confidence in freedom from Johne's disease.
- The minimum testing requirement to demonstrate that a herd is free from Johne's disease is a biannual screening test (i.e. one of the three options above every six months). This is sufficient for low risk, closed herds but for a herd sourcing replacements, additional testing will be required, such as a quarterly targeted 30 cow milk ELISA screen. Testing introduced stock is also recommended.
- CHeCS risk level schemes are an excellent option for herds seeking to demonstrate that their herd is 'low risk' for Johne's disease.

Testing for control

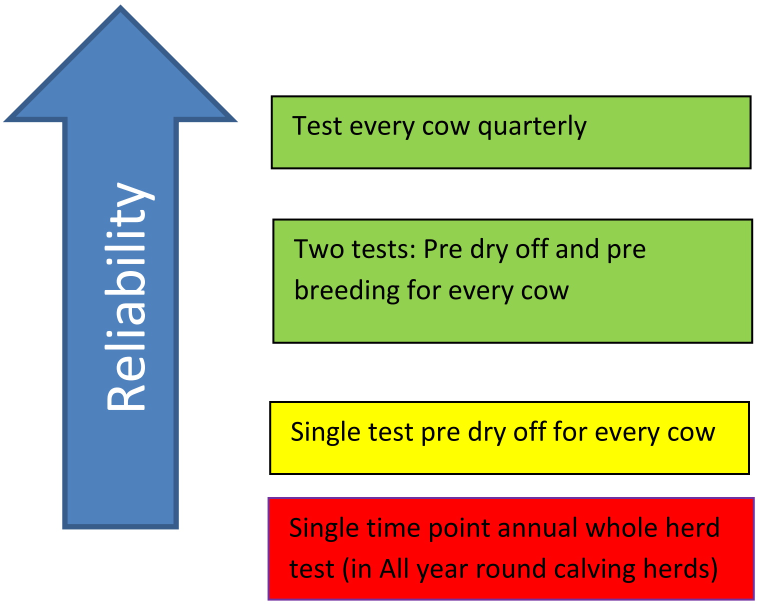
Strategic testing for monitoring and control

- Testing can be continued once herd status has established to monitor any changes and to manage disease.
- Strategic testing should be used for disease management to ensure that the results are available at the time they're going to be used to make management decisions, such as identifying high risk cows to stop them from spreading the disease.
- Testing at dry off:
    - Aim to know during the dry period whether that cow is high risk or not

- Identify positive cows and manage appropriately through dry period, calving and milk and colostrum management to prevent disease spread to other animals.

- Testing before breeding:
  - Identify positive cows and ensure that replacement heifers are not bred from them. Either do not breed positive cows again or breed them to a terminal sire. Offspring from positive cows should be fattened for slaughter, **not** kept as suckler cows.
  - It is often difficult to get farmers to cull infected cows. By making a 'do not serve' decision then those cows will naturally leave the herd as barren at the end of lactation, with no risk of her entering the maternity area again.
- The minimum requirement for effective testing for monitoring and control is a single blood or milk ELISA test pre dry off. This allows decisions about management to be made before calving.
- An annual whole herd test at a single time point is insufficient for strategic testing to allow management decisions to be made in a year round calving herd. We don't want to detect positive cows after calving as we will miss the opportunity to protect calves from infection. However, whole herd tests can be useful for establishing herd status.
- Testing is best used to inform management decisions. In this way we can avoid having pregnant high risk animals, reducing the need for segregation and complex management.

More is better – testing twice per year before dry off and breeding, or quarterly testing, increases the probability of identifying infected animals early in the course of disease. Earlier detection means more effective management to prevent them spreading the disease.



Module 3: Management strategies

Controlling Johne's disease on dairy farms

- A combination of husbandry changes to reduce disease spread and a test-and-cull programme to remove infected animals has been shown to be the most effective way to control Johne's disease on dairy farms.

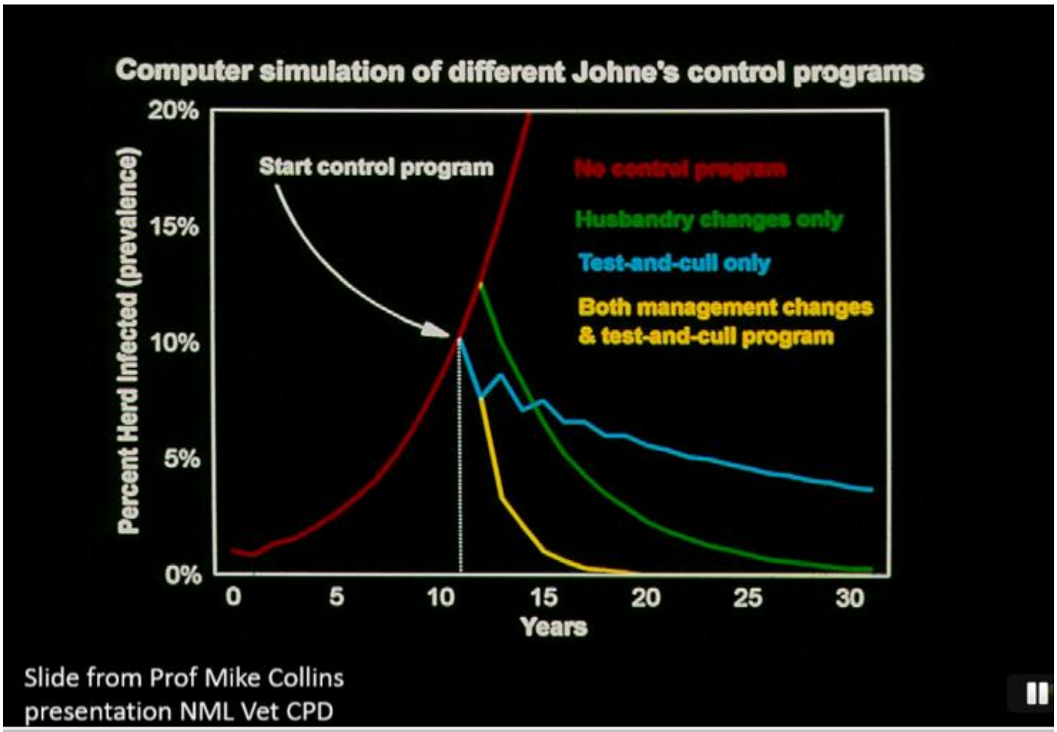


Figure 6: Johne's control programmes

- Figure 6 shows the outputs from a computer simulation by the University of Wisconsin. It assumes that Johne's disease was introduced at year 0 and control measures began in year 12.
- The effect of husbandry changes alone on within-herd prevalence is represented by the green line. It takes around 2 years to observe a reduction in prevalence and takes many years to reach low prevalence again.
- Test-and-cull in the absence of management changes will not reduce the prevalence substantially. It prevents an ongoing increase in prevalence but is not effective to achieve elimination of Johne's disease from a herd.
- The outcome from management changes and test and cull together are represented by the yellow line. Infected cows are identified and removed rapidly. This strategy achieves the quickest progress and produces a rapid reduction in prevalence to below 5% within 5 years. It is also the quickest option to achieve eradication[28].

The six strategies

- There are six control strategies within the National Johne's Management Plan.
- The six control strategies are:
    1) Biosecurity Protect and Monitor
    2) Improved Farm Management
    3) Improved Farm Management and Strategic Testing
    4) Improved Farm Management Test and Cull
    5) Breed to Terminal Sire
    6) Firebreak Vaccination
- One of the six strategies will suit every farm.
- Farmers should select the most appropriate control strategy with the help of their vet. This will need to consider farmer aspiration and the reality on farm. A farmer may aspire to be on Strategy 1 but if they currently have a high prevalence of Johne's disease and minimal resource to tackle it, you must choose a strategy they can manage and will work.
- Only **ONE** strategy should be used at any time, but the most appropriate strategy may change over time.
- Within the chosen **strategy** there will then be a list of **tasks** which will need to be undertaken to make that strategy work eg tagging of high-risk cows, cleaning of calving pens or colostrum harvesting protocols.
- Whichever strategy is chosen some tasks will be common across all farms. All farms should have a biosecurity plan; not just those on Strategy 1. Many farms on Strategy 3 will chose to breed their high-risk cows to a terminal sire as part of Johne's disease management; that is a **task** within that strategy, it does not mean they should be on Strategy 5 instead or are on a combination of both.
- Additional information on the control strategies is available on the Action Johne's website

1. Biosecurity Protect and Monitor

- **This strategy is only suitable for herds with no evidence of Johne's disease.**
- The first step is to establish with as much confidence as possible that there is no evidence of Johne's disease on the farm. A targeted 30 cow screen or a cull cow screen is a good starting point but is a minimum requirement. A whole herd screen should be considered, depending on the farm's history or buying policy.
- Once the herd's Low-risk status has been established, the focus of this strategy is ensuring that Johne's cannot enter the farm by having a robust biosecurity plan to prevent disease entry. Buying policy is the most important part of this strategy. Closed herds reduce risk significantly by avoiding the biggest risk factor of bringing Johne's onto the farm - purchasing stock. If replacements do need to be bought in, careful sourcing from low risk herds is very important. Ideally, replacements would come from low risk CHeCS accredited herds but currently there are not that many dairy CHeCS accredited herds to source replacements.
- Other potential routes for introduction should also be considered e.g. slurry management or purchased milk/colostrum from other farms as well as other livestock and wildlife sources.
- Once the plan is in place, constant monitoring with appropriate screening tests is required to detect Johne's disease as quickly as possible if it does enter the herd. The level of monitoring

required depends on the farm's structure – a small herd that has been strictly closed for 40 years is going to require less screening than a large herd that buys in animals every year. **The minimum screening requirement for monitoring under this strategy is bi-annual targeted 30 cow or cull cow screen.**
- Herds using the Biosecurity Protect and Monitor strategy may wish to consider becoming CHeCS accredited to obtain a price premium if selling high value heifers or breeding bulls. Annual whole herd screening is required.

2. Improved Farm Management

- This strategy involves reducing transmission of Johne's disease within the herd, and particularly from cow to calf, using husbandry measures alone.
- **Every cow must be treated as high risk**. There is no testing involved so no way of identifying high risk cows. Every cow is treated as though she is Johne's positive and management changes are put in place to prevent her infecting her calf. This requires a large commitment of labour and resource which not all farms will be able to provide.
- Calving area management is used to prevent transmission at calving. Calves should be snatched (i.e. removed immediately after birth in a clean wheelbarrow) or cows should calve in clean individual pens so each cow can only infect her own calf.
- Calf management is also very important. Feed only dam colostrum and milk to minimise the risk of transmission, or process milk and colostrum to reduce risk by using on-farm pasteurisation. This is very effective when used correctly.
- As there is no testing component to this strategy, it is not possible to track progress to determine whether the strategy is working. If something goes wrong with the management practices and prevalence starts to increase, there is no way to detect this and it can be some time before it is noticed. High risk animals can contaminate the environment when not identified until late in the course of the disease. Without testing, it is also unlikely that infected animals will be detected before clinical disease develops, which will reduce their cull value.
- There is high potential for the strategy to go wrong if not all members of farm staff are fully engaged. It is very important that everyone is on board and understands how important it is to implement improved management for each and every cow. It takes a big commitment in terms of labour and resource e.g. individual calving pens require cleaning between every calving.
- Understanding the farmer's aspiration is important in deciding whether this is a suitable strategy for their herd. If their goal is to prevent disease getting out of control, this is a good strategy. If they are aiming for eradication or CHeCS accreditation, this is not the most efficient way to do it as there is no way to track progress.
- This strategy is most suitable for low risk farms, with low risk of entry, low risk of spread and low prevalence. These are often smaller farms with year-round calving that can provide individual attention to calving cows. At the opposite end of spectrum, it can be used on large farms with dedicated labour resources for calving and calf management.

3. Improved Farm Management and Strategic Testing

- This strategy uses the same improved farm management principles as the previous strategy, but with an additional strategic testing element.
- Testing is used to identify high risk animals by testing at strategic times. The test results are used to make decisions about managing high risk animals while allowing the low risk cows to be managed normally.
- Coming up to **calving** is one of main times to know a cow's status to allow individual management decisions to be made and block transmission to calves.
    - Test at dry off or early in the dry period to identify and segregate high-risk cows to avoid contamination of the calving area and infection of calves.
    - Don't feed calves any milk or colostrum from positive cows.
- Knowing status before **breeding** allows decisions to be made.
    - High-risk cows should not be used to breed replacement heifers. They should either not be bred from again or bred to a terminal sire to produce a beef calf.
- Test results help with **culling** decisions.
    - Immediate culling may be appropriate for cows which are repeatedly or high positive or have other issues (e.g. lameness, high cell count, poor fertility). These cows are more likely to be shedding MAP and infecting other animals.
    - If a cow is first time positive or low positive and is otherwise a good cow, consider keeping her to the end of the lactation.
    - Using test results to make culling decisions permits culling while positive cows still have some value before developing clinical Johne's disease.
- **The minimum testing requirement for this strategy is a single ELISA test pre dry off for all cows.** A single annual whole herd test is not suitable – a more strategic approach is required to provide the information need to make management decisions.
- Testing pre calving (i.e. pre dry-off or early dry period) AND pre-breeding is useful. It avoids the use of expensive straws of sexed semen for replacement heifers on positive cows and multiple tests increase the chances of early detection.
- Quarterly testing of the whole herd can be an easier option as coordinating pre dry off and pre breeding tests in a year round calving herd can get complicated. Building up a picture of results over time increases the chances of early detection and permits early action to prevent transmission.

4. Improved Farm Management Test and Cull

- This strategy is suitable for herds with low levels of disease.
- Strategic testing is used and test positives are culled immediately rather than managed separately as a high risk group.
- Improved farm management is still important to prevent cow to calf transmission, as the evidence shows that test and cull alone is not enough – it will prevent disease exploding but won't reduce prevalence or make progress towards eradication.
- For low prevalence herds - either low prevalence to start or where Johne's disease has been managed for several years and prevalence has been reduced to a low level - this can be a good strategy to adopt. However, this strategy is not suitable for herds with high prevalence as it will not be possible to cull out all positives as soon as they are identified.

- It can be tricky to manage positives separately when there are only a few of them so it is often easier just to cull them immediately.

5. Breed to Terminal Sire

- In high prevalence herds with high risks of entry and spread, it can be difficult to block cow to calf transmission with management changes alone. On some farms, the time of calving is difficult to control and the farm is not able to apply the management changes required to ensure that next generation of replacement heifers is not infected.
- If farms are purely commercial and not looking to retain genetic lines, they may be able to source replacement heifers from lower risk herds than their own and buy in a lower prevalence of Johne's disease.
- In this strategy, all cows are bred to a terminal sire and the offspring fattened for slaughter. It is important to ensure, as far as possible, that offspring go for slaughter and do NOT end up as suckler cows. Education will be required to ensure that the beef industry is also aware.
- This approach can be a long term option for some farms. They become a flying herd and buy in all replacements for the milking herd.
- Some farms may want to breed their own replacements in the future, even if not in a position to do so at present due to high disease prevalence and inability to implement management changes. By sourcing lower risk replacements, they can reduce the prevalence over the next few years to be able to breed their own replacements.
- Testing can still be useful in this strategy to identify infected cows and cull them before they become clinically affected. This increases cull value and allows for a more planned approach to culling. Testing costs can often be recouped by avoiding deaths and maximising cull values.

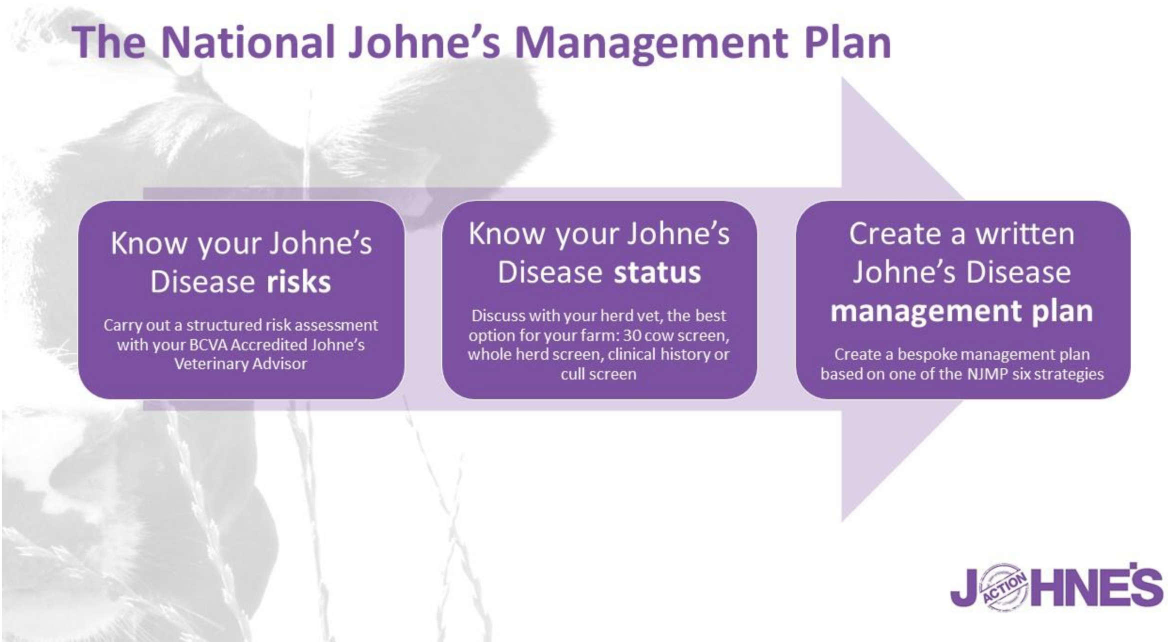
6. Firebreak Vaccination

- **Vaccination should only be used when all of the facts have been considered and it has been demonstrated that none of the other strategies are going to fit.**
- It is advisable to check with the farmers milk purchaser before vaccinating as it is prohibited in some milk contracts.
- For herds unable or unwilling to put management in place to break the transmission cycle from cow to calf, vaccination should be considered as a last resort. This option should be viewed as a temporary strategy to buy enough time to allow the problem to be tackled properly.
- Vaccinated cows produce antibodies which makes interpretation of ELISA tests very difficult. Positive test results in vaccinated cows could be due to vaccination, infection or both. It can be challenging to find a way out from a vaccination programme as testing options are now more limited.
- The follow-on options after vaccinating are to breed all cows to a terminal sire or move on to a purely improved farm management strategy. Vaccination is often adopted if improving farm management is not possible which may make the latter option challenging.
- Vaccination of calves often doesn't prevent infection as calves are frequently infected in the first week of life on dairy farms, so many are already infected before the vaccine confers any protection. Vaccination also does not prevent MAP excretion and vaccinated cows can still be infectious.

- If a farm is seeing clinical disease in first lactation heifers, vaccination may be useful to delay the onset of clinical disease and extend productive life (e.g. may delay disease onset to 2nd or 3rd lactation instead).
- There are questions around vaccination interfering with TB testing as there is potential for false negatives or even false positives on TB tests due to the vaccine. The vaccine is against *Mycobacterium avium* subsp. *paratuberculosis* (MAP) and the top injection in the intradermal tuberculin test is *M. avium* derivative, which is why cross-reactivity can occur.
- This strategy is called "firebreak" vaccination because we do not believe that vaccination offers a long term strategy for Johne's disease control. It will not reduce disease prevalence, but it will delay the onset of clinical disease and may save the farmer some money by reducing losses through culling. It makes identification of positive animals and long term management very difficult.

Selecting a strategy

- Choosing the right strategy for your client relies on your clinical judgement. This section covers some of the questions to ask and factors to consider when advising farmers on the most appropriate strategy for their herd.
-
    - **Is there evidence of Johne's disease in the herd?**
        - If no disease is present, Biosecurity Protect and Monitor should be sufficient. Develop a robust biosecurity plan to prevent disease introduction and implement appropriate ongoing monitoring.
    - **Is improved farm management possible?**
        - Does the farm have the resources and labour available to prevent transmission between cows and calves through careful management at calving and while rearing replacements?
        - Is the farmer willing and able to implement the necessary management strategies?
        - If so, one of the Improved Farm Management strategies should be selected.
    - **Is regular testing possible?**
        - Is the farmer willing to carry out regular testing (at least one annual ELISA test at dry off) and take action to control Johne's disease on the basis of the results?
        - Is the prevalence low enough to cull all test positives immediately?
    - **Can all positive cows be culled straight away?**
        - This will depend largely on the within herd prevalence - if it is high, then immediate removal of test positive animals from the herd is unlikely to be economically viable.
        - If positive cows are retained, careful management is required to ensure that they do not infect others.
    - **Is vaccination appropriate?**
        - Is this a high risk, high prevalence herd that is going to struggle to improve management and is probably also losing a lot of cows to clinical Johne's? If that is the case, consider vaccination. However, it must be entered into with an exit strategy in mind as this is not a long-term solution.



Further information

Additional information and resources are available on the Action Johne's website
www.actionjohnesuk.org

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