

A photograph of a herd of black and white dairy cows, likely Friesians, standing in a dirt field. The cows are the central focus, with several in the foreground looking towards the camera. They have distinctive black spots on white fur. Some cows have yellow ear tags, and one in the foreground has a red tag. The background shows a line of green trees and a cloudy sky. The overall scene is a typical farm setting.

A Practical Approach to the Prevention and Control of Johnes Disease

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Key messages

- Key elements of Johnes Management
- Principles of infectious disease prevention and control
- Testing for the presence of infection
- Testing for the control of infection
- Current management strategies in UK dairy herds

A National Johnes management programme for dairy herds

1

- **Education**

- Vets, farmers, processors, industry

2

- **Engagement**

- Vets and farmers, incentives and benefits

3

- **Define herd risks and status**

- Risk analysis and surveillance tests to determine herd status

4

- **Strategy and tasks**

- Prevention in the low prevalence, test negative herds
- Control in the test positive herds

The four pillars supporting the health status of a herd

Health status of the herd

Biosecurity
Risk of entry

Surveillance

**Resilience &
immunity**

Bio-containment
Risk of Spread

“Making herds healthier”

The four pillars supporting the health status of a herd

Health status of the herd

Surveillance

Biosecurity
Risk of entry

Resilience &
immunity

**Bio-
containment**
Risk of Spread

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Define the Disease Status of the herd

- Risks
 - Biosecurity
 - Biocontainment
- Presence of infection – test
- Immune status and resilience
 - Vaccine status
 - Susceptibility

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Creating a risk profile for the herd

- **Biosecurity risks** = risks of disease **entry** into the herd
 - Cattle
 - People
 - Environment
- General and disease specific risks
- Specific to herd type: beef and dairy

Biosecurity in the beef herd

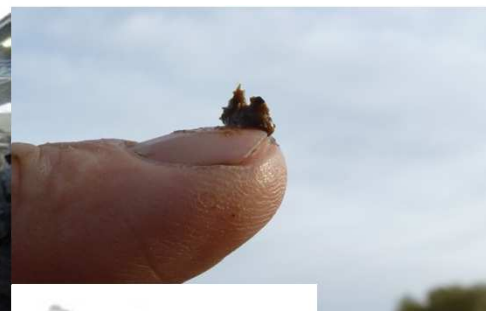
Sibley

In Practice 2014;**36**:5 238-248 doi:10.1136/inp.g2829

Biosecurity in the dairy herd

Sibley

In Practice 2010;**32**:7 274-280 doi:10.1136/inp.c3913



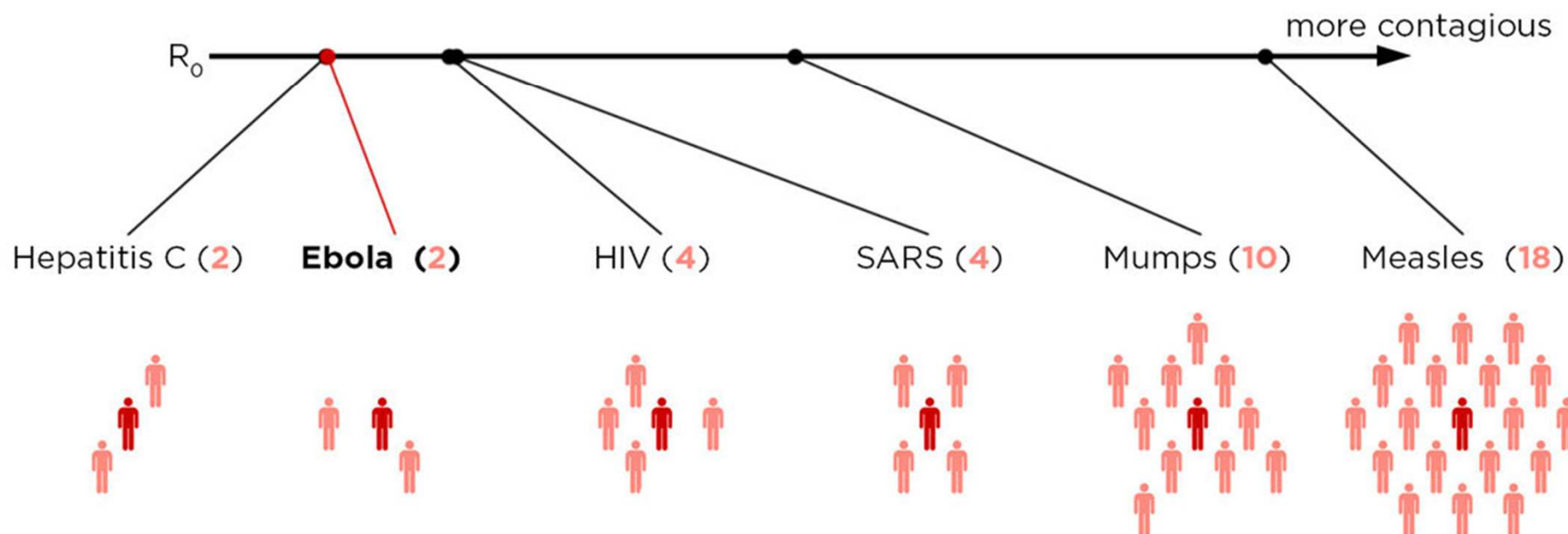
Creating a risk profile for the herd



- **Bio-containment risks**
= the risk of disease **spread** within the herd
- General and disease specific risks
- The **multiplier** of disease within the herd
- (and may influence persistence)

R_0 = the ability to infect

The number of **people** that **one sick person** will infect (on average) is called R_0 .
Here are the maximum R_0 values for a few viruses.



Identifying the high risk herd

- Beware of the Red – Red herd
- This herd is at high risk of entry and high risk of spread
- The herd may not yet be infected, or may not be detected as infected!
- Infection in this herd is likely, and will spread rapidly



The screenshot displays the 'John's questionnaires' section with five risk assessment cards: 'Disease entry risks from cattle' (Red - high risks), 'Disease entry risks from people' (Green - low risks), 'Disease entry risks from objects' (Amber - moderate risks), 'Disease entry risks from John's' (Red - high risks), and 'Disease spread risks from John's' (Red - high risks). Below these are 'John's plans' for Biosecurity, Surveillance, Disease control, and Disease prevalence (labeled 'Much higher'). The 'John's recorded history' section shows 1 surveillance entry and 0 vaccination entries. Navigation links for 'More John's' and 'Return to home page' are at the bottom.

These herds will become high prevalence herds and will be a problem to vet and farmer

The biggest risk of Johnes entering a herd is through the purchase of infected cattle that then become infectious and spread the disease within the herd



- Beware the stock bull
- The original animal may be long gone by the time infection is discovered.
- Manage the risks – by buying **down** the risk gradient

There can be a time lag of 4 – 8 years before infection is discovered!

Define the current infection status of the herd: Testing for the presence of infection

- Is the herd infected?
- If so, what is the current prevalence of infection?
- The risk data will provide information about:
 - The likelihood of infection being present
 - The prediction of future prevalence



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Available surveillance tests to indicate the presence of infection

1. The organism

- Direct smear
- Culture
- PCR
- Phage

2. Response to exposure and infection

- Clinical signs
- Post mortem examination
- **Serology**

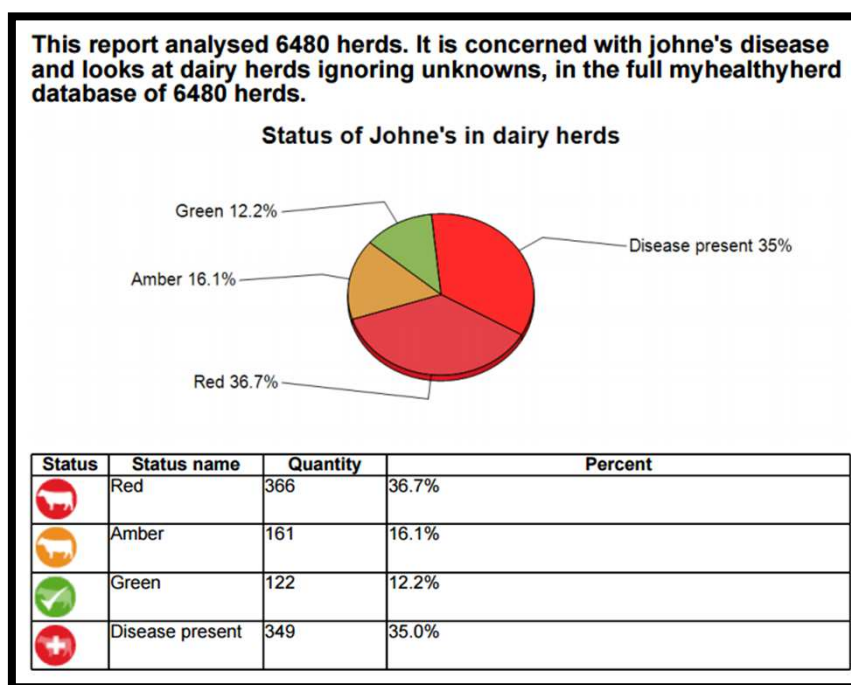


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Herd tests for the presence of infection using serology

1. Bulk milk antibody
 - Poor sensitivity
 - Low price
2. Whole herd screens
 - Good sensitivity
 - Expensive
3. 30 Cow targeted screen
 - **Good sensitivity**
 - **Low price**



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Selection of cows for the 30 cow screen

- If infection is present in the herd, select those most likely to test positive
 - Age
 - Cell count
 - Production
 - Stage of lactation
 - Other health issues



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The 30 cow targeted screen

Hanks et Al Cattle Practice

Table 5. Percentage of the known positive herds detected by a 30 cow screening based on targeted and random selection, compared in different within-herd prevalence categories.

within-herd prevalence of JD milk ELISA positive cows	n herds	Cumulative % of all herds	% herds where positive cow(s) were detected using:	
			Targeted selection of 30 cows	Random selection of 30 cows*
<1%	5	1%	40%	23%
1% to <2%	24	8%	79%	43%
2% to <3%	31	16%	77%	57%
3% to <4%	32	24%	97%	70%
4% to <5%	39	34%	97%	79%
5% to <6%	28	41%	93%	85%
6% to <7%	33	50%	100%	90%
7% to <8%	25	56%	100%	93%
8% to <9%	24	63%	100%	95%
9% to <10%	33	71%	100%	97%
>=10%	111	100%	99%	99%
ALL herds	385		95%	84%

* median outcome of 100 Monte-Carlo simulations

Is targeted milk sampling an effective means of detecting Johne's disease in dairy herds?

J D Hanks, N M Taylor, M A Kossaibati

Blood or Milk?

- Same antibody, same test
- Milk antibody is a direct correlation with blood, but can vary
- Milk antibody affected by
 - Stage of lactation
 - Yield



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MAP Antibody: variations

- Antibody is produced when cellular immunity fails
- Immuno-stimulation may precipitate production of antibody
 - Other infections
- Release of MAP from the macrophages may stimulate ab = predict **infectious** animals

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Risks and status: next steps

- Prevent infection in the test negative herds
 - Manage biosecurity
 - Monitor closely
- Control infection in the known infected herds
 - Select an appropriate control strategy
 - Monitor progress



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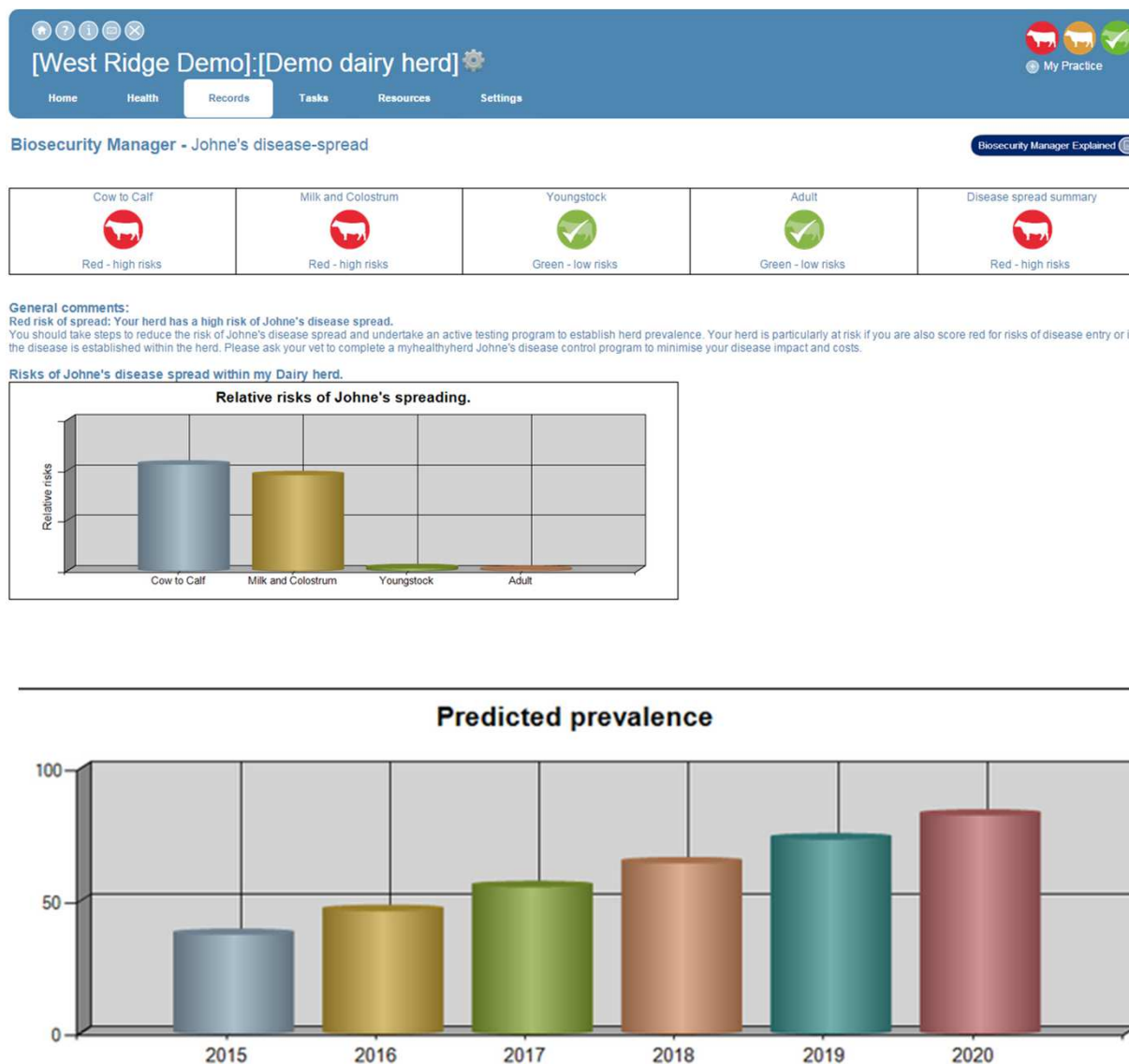


Myhealthyherd Risk of spread report

Key document that will determine the future Johnes management of the herd

Identifies and quantifies the “multiplier” of disease in the herd

Used to **predict** future prevalence



Control strategy options

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



Choice of control strategies

A choice of seven control strategy options were offered to participating farmers, with advice from trained veterinary surgeons being used to help with the selection of an appropriate strategy for the particular herd. The choice of control strategy was based on:

- Current Johnes status and estimated prevalence from screening tests
- The future predicted prevalence using a mathematical algorithm within myhealthyherd.com including current estimated prevalence, and current risks within the herd
- The aspiration of the farmer, with plans for future control or eradication
- The resources of the farmer and the ability to comply with any selected control strategy

Some infected animals will never be infectious: they will leave the herd without ever transmitting disease

Infected



Infectious



Testing programmes will help identify infectious animals, but infected animals are difficult to detect because of the insensitivity of the tests

Working the R_0

$$R_0 > 1$$

- The disease gets worse
- More and more animals become infected
- With long incubation periods, it may take several years to find out what the R_0 is in a herd!

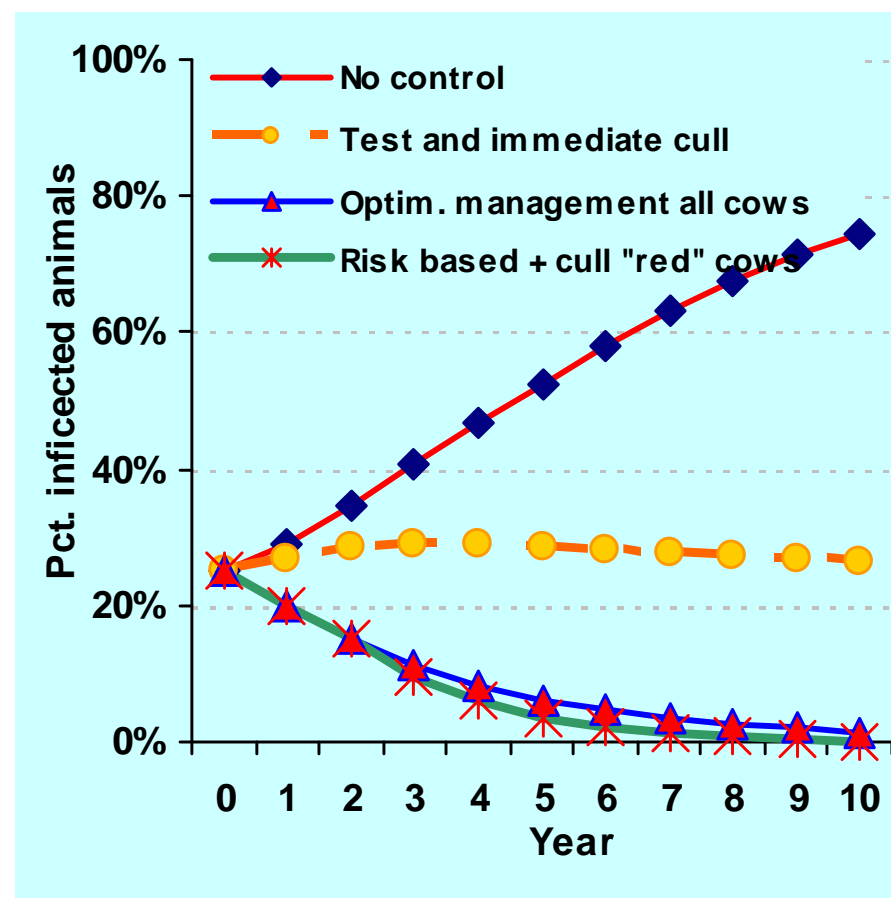
$$R_0 < 1$$

- The disease dies out
- Speed of decline dependent on size of R_0
- Disease control dependent on keeping R_0 below 1
 - Between herds
 - Within herds

For Johnes disease, R_0 can be between 0 and 50+

Control of Johnes Disease

- The disease can be controlled by husbandry and management alone
 - Stop the spread
 - Reduce R_0 to below 1
 - The disease will decline
- New infections are minimised: old infections die out



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Practical control

- Identify the infected animals that will become infectious
- Prevent them creating new infections
 - Cull them before they become infectious
 - Prevent transmission to susceptible cattle



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Identification of infected animals that may become **infectious**

- Use serology
- Milk or blood
- Detectable antibodies are raised before infected cattle shed significantly
- Regular testing essential to identify animals prior to shedding



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Sample selection

- Young animals unlikely to shed significantly
- Antibody easily detected, if present, in both blood and milk
- IDEXX Paratuberculosis Ab Test reasonably sensitive
- Defining the cut-off

Performance Evaluated on ~1800 European and US samples

	Sensitivity	Specificity
Serum vs. Culture:	64.7% ¹ (n=68)	99.2% (n=717)
Plasma vs. Culture:	59.8% ² (n=82)	100% (n=174)
Milk vs. Culture:	80.7% (n=124)	99.7% (634)

1. Serum sensitivity = 69.9%, if suspect results are considered positive

2. Plasma sensitivity = 62.2%, if suspect results are considered positive

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In practice

- All adult cattle tested every 3 months for MAP antibody in milk
- Automated, using milk recording samples
- Reported to farmer and vet
- Positive animals are classified according to test history

Line No.	Ear Tag	ELISA 1 29/01/2014	ELISA 2 28/04/2014	ELISA 3 27/07/2014	ELISA 4 30/11/2014	ELISA 5 23/02/2015	ELISA 6 31/03/2015	Infection Group on 31/03/2015	
664	370379300664	50.93	45.65	--	38.39	56.86	53.62	J5	!
10	370379201510	--	--	--	--	--	37.93	J4	?
193	370379100011	4.84	15.83	--	17.53	11.87	34.16	J4	?
615	370379300615	--	4.61	14.30	30.14	--	--	J4	?
660	370379600660	4.17	10.49	6.00	1.03	16.76	42.43	J4	?
666	370379500666	4.68	10.49	--	16.68	19.49	34.89	J4	?
1040	370379101040	--	0.49	3.24	5.36	47.67	--	J4	?
1268	370379501268	--	12.97	1.12	5.85	25.78	31.52	J4	?
1492	370379501492	--	--	--	--	--	42.35	J4	?
1509	370379101509	--	--	--	--	--	112.91	J4	?
1024	370379601024	8.15	7.06	6.19	71.13	--	17.40	J3	?
1085	370379401085	6.18	7.06	--	31.30	22.47	54.84	J3	?
1088	370379701088	9.79	15.51	23.19	17.66	31.66	26.73	J3	?
1391	370379201391	--	--	--	30.45	6.33	1.02	J3	?
556	370379700556	7.54	2.63	35.72	11.70	7.82	13.01	J2	✓
960	370379500960	3.09	27.80	39.59	12.79	18.25	18.36	J2	✓
485	370379600485	--	1.49	5.66	--	--	--	J1	✓
1508	370379701508	--	--	--	--	--	13.09	J1	✓
1	370379301245	--	0.86	1.51	0.00	2.92	--	J0	✓
2	370379700605	4.51	3.10	10.41	--	12.94	7.78	J0	✓

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Control tasks

- Animals at risk of shedding MAP and infecting others are identified from the tests
- They are marked, and managed to prevent spread of infection
 - Culled
 - Managed



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Summary

- Eradication of Johnes Disease may be impossible
- Those herds without infection need protection and monitoring
- Infected herds need management and control
- Johnes management needs to be economically justified
 - Costs and benefits
- Serological testing can be used to define infection status of a herd and to identify infected animals that may become infectious as part of a Johnes management programme
- Testing alone will not solve Johnes: management changes are essential for successful control

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