Using Artificial Intelligence and Machine Learning

A Revolutionary New Approach to
Interpreting Johne's Test Data

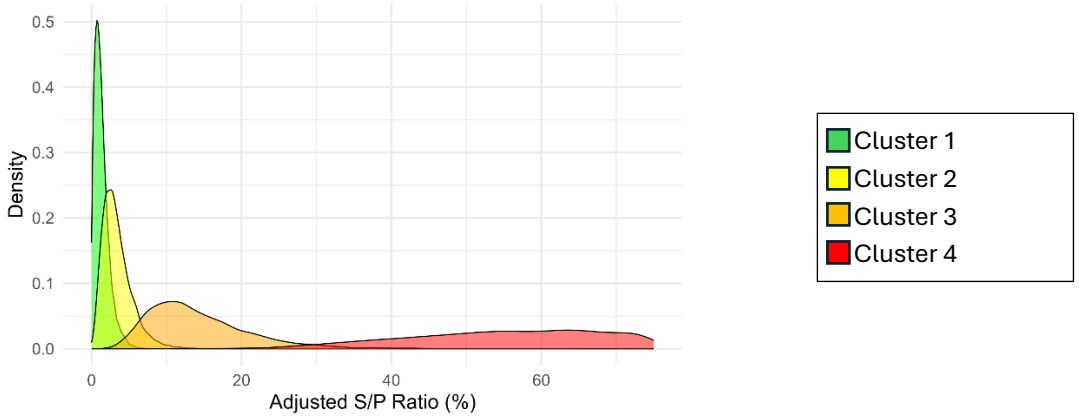
Interpreting the Johne's Pattern Analysis Report

A New Approach to Analysing Johne's Test Data

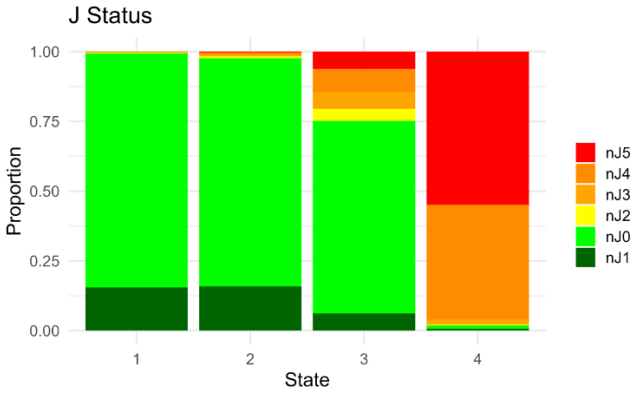
The REMEDY Platform utilises a totally new approach to analysing existing Johne's Disease test data. More specifically, unsupervised clustering and machine learning have been used to explore existing Johne's ELISA test data.

Initially, Johne's milk ELISA test results were 'corrected' for factors that can influence the test result such as days in milk, milk yield, SCC and milk constituents. This data was then used in an 'unsupervised' approach which identified four different 'clusters' in the data without the model having any prior knowledge of how to interpret the Johne's test results. How these clusters map to existing test titres and existing "J" States are illustrated below.

An illustration of mapping of clusters to ELISA test titres



An illustration of mapping of clusters to existing J States



Most cows in Cluster 4 are J4 or J5 cows i.e. already flagged as high risk. Based on further research we were able to demonstrate that cows in Clusters 1 and 2 were at very low risk to progressing to the higher risk Clusters (3 and 4). Furthermore, based on a cow's history and that of her dam, her siblings and the status of the dams of herd mates born around the time of her birth we are able to calculate the probability of an individual animal progressing to a higher risk state over time. More specifically we are able to predict the probability of a cow being in cluster 4 at calving (within the next four months) and in

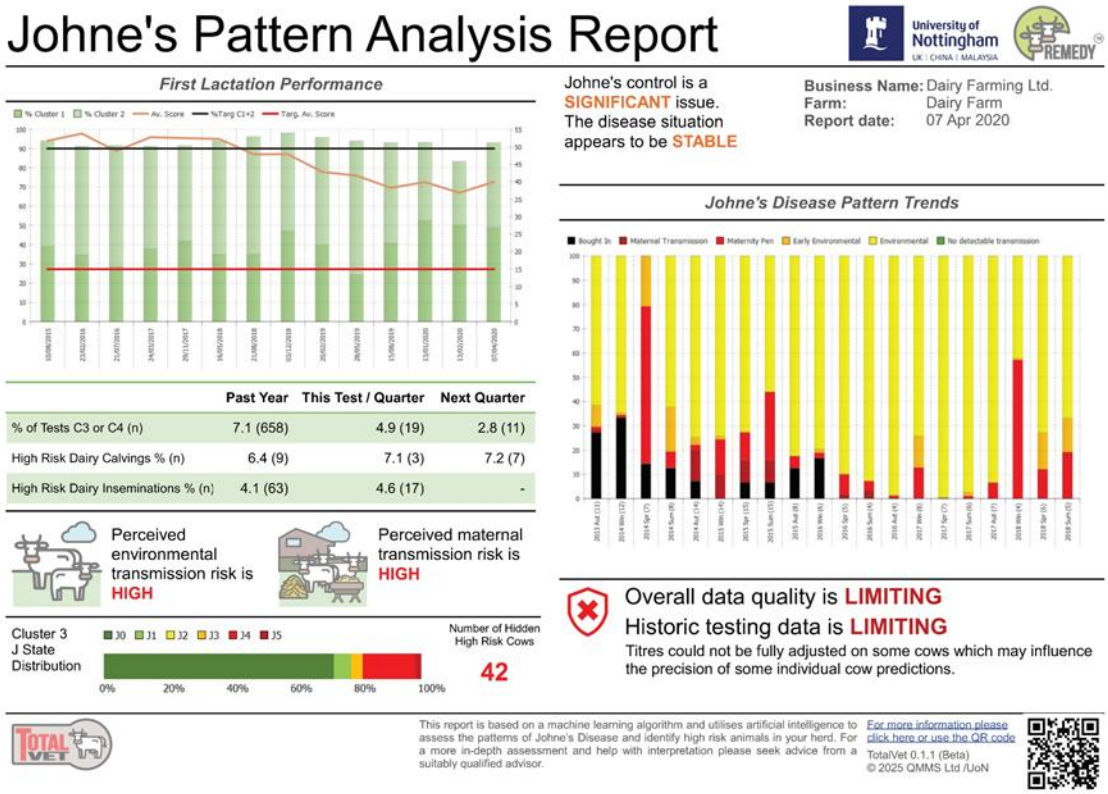
twelve months' time, therefore informing both service and calving management decisions.

The cluster of greatest interest is probably Cluster 3 given that these cows are at much higher risk of progressing to Cluster 4 that cows in Cluster 1 and 2. More specifically, J0 and J1 cows in Cluster 3 are between 150 times and 1,000 times more likely to progress to Cluster 4 than J0 and J1 cows in Cluster 1.

Given that we can predict the most likely probable cluster of a given cow, we can apply a 'cluster score' to an individual animal which reflects her likely future state and therefore we can make earlier assessments of herd management policies.

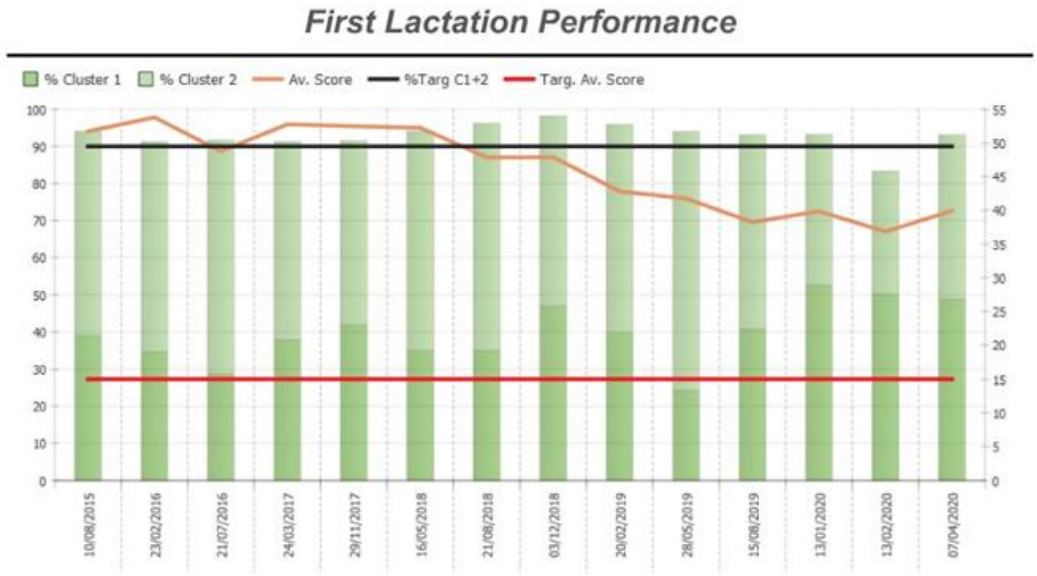
By using Cluster scores, unlike the current J classification system, REMEDY is able to predict those cows that are likely to be high risk in the future.

These findings have been pulled together in a Johne's Disease Pattern Report, an example of which is illustrated below and explained overleaf.

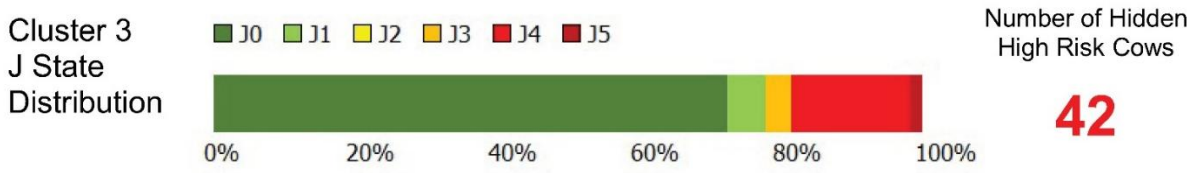


Interpreting The Pattern Report

The individual components of the report are outlined and explained below:



This graph plots heifer performance in the past four years. This gives an insight into current herd performance using the correlation between cluster score in early and later lactations. As a target, > 90% of heifers should remain in Clusters 1 and 2 throughout lactation 1 (see green bars and green target line). The 'cluster score' is based on the instantaneous probability of a heifer being in a given cluster combined with a 4-month projection of her likely status (see black line and dotted target line). This means that likely progress or deterioration at the herd level can be predicted by the direction of travel of this line (ie increasing = deteriorating prospects). A mean cluster score of heifers of < 15 is attainable in herds with a very low prevalence of disease.



This horizontal bar chat shows the distribution of cows currently in Cluster 3 by their current "J" state with the Number of "High-Risk Hidden Cows" reflecting the number of cows in this cluster that are currently classified as J0 or J1. Farmers subscribing to REMEDY will be able to see the probabilities of individual cows, highlighting the Hidden High Risk cows.

	Past Year	This Test / Quarter	Next Quarter
% of Tests C3 or C4 (n)	7.1 (658)	4.9 (19)	2.8 (11)
High Risk Dairy Calvings % (n)	6.4 (9)	7.1 (3)	7.2 (7)
High Risk Dairy Inseminations % (n)	4.1 (63)	4.6 (17)	-

This table summarises the position of the herd over the past 12 months showing the proportion of the herd (and number of animals) in Clusters 3 and 4 in the past 12 months, at the most recent test and projected into the next quarter based on individual cow predictions.

The table also summarises the number and proportion of 'high-risk' inseminations in the past 12 months and past quarter. This is based on insemination (to dairy) of high risk Cluster 3 and 4 cows.

Finally, the number and proportion of calvings, resulting in a dairy heifer, that occurred in Cluster 3 and 4 dams is summarised as a marker of ongoing management control.

Perceived environmental transmission risk is **HIGH**

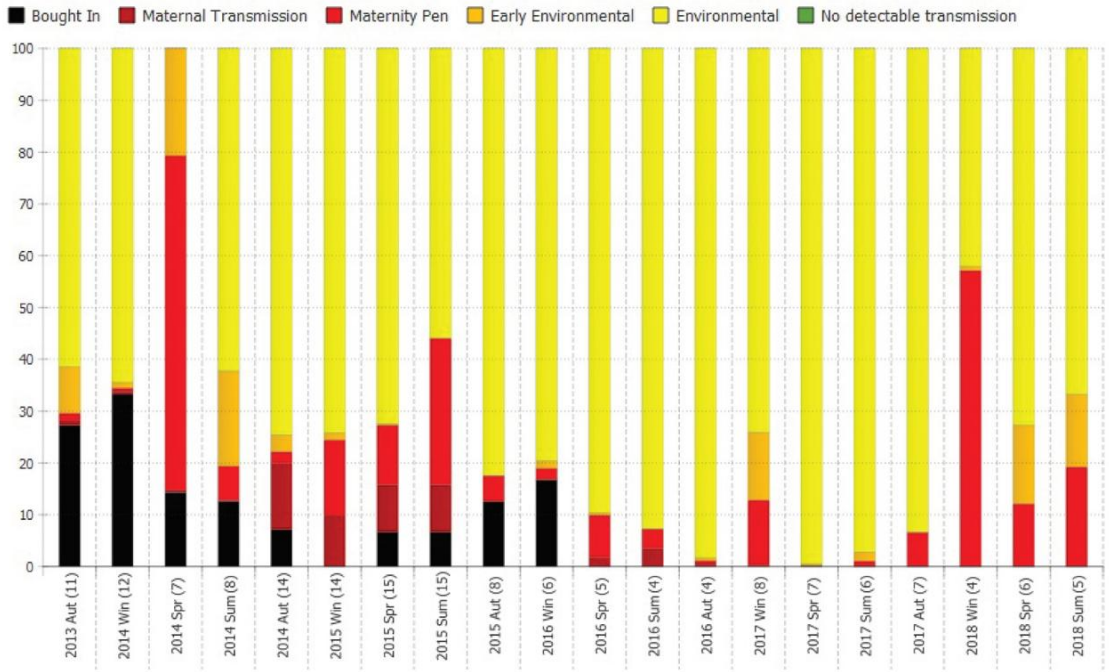
Perceived maternal transmission risk is **HIGH**

The infographics above illustrate the perceived environmental and maternal transmission risks in the next 4 months based on the 'density' of Cluster 3 and 4 cows calving and the probability of dams being cluster 3 or 4 at calving respectively. The perceived risk can be 'low', 'moderate', 'High' or 'Very High'.

Overall data quality is **EXCELLENT**
Historic testing data is **EXCELLENT**

Data quality can be **EXCELLENT**, **GOOD**, **ADEQUATE** or **LIMITING** based on the frequency and proportion of animals tested and the quality of other underlying data such as service sire information.

Johne's Disease Pattern Trends



This graph assesses the disease patterns and likely route of transmission in the herd based on cohorts of heifers, on a rolling annual basis over a five-year period. Our research has demonstrated that the cluster scores of high cluster dams can be correlated with the score of their offspring, and that the 'density' of high-risk animals calving can be correlated with the cluster scores of calves born to low-risk dams. Therefore, we can infer the likely origin of infection within the herd over time. Using this approach, we can look at the underlying probability that heifers in Clusters 3 and 4 were bought in, acquired infection through maternal transmission, in very early life, in early life or due to undefined factors/timing. This helps inform the likely success of past management given that period of high transmission risk in the early environment are often correlated with later rises in heifer cluster scores.

Johne's control is a
MAJOR issue.
The disease situation
appears to be **STABLE**

Finally, we pull together an assessment of the current Johne's situation with respect to current performance and likely 'direction of travel'.

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