# Final Report

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# Student Project No. [AHDB project number]

## Title: Statistical learning approaches to optimise the health, welfare, and productivity of calves on dairy farms

Short title: Optimising health, welfare, and productivity of calves on dairy farms

Robert Hyde

University of Nottingham School of Veterinary Medicine and Science, Sutton Bonington campus, Sutton Bonington, LE12 5RD
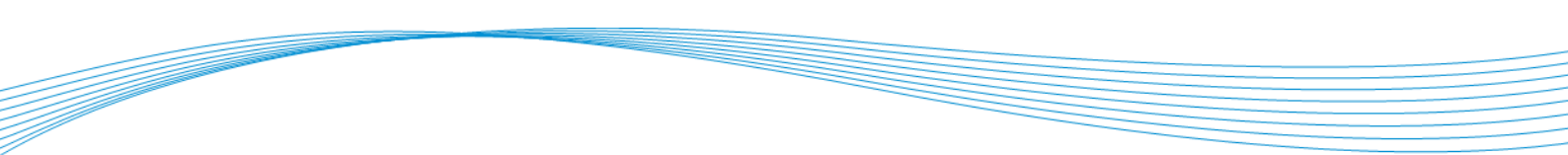
**Supervisors:** Peter Down, Martin Green, Chris Hudson

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# 1.  Industry Summary

The effective management of preweaned calves is one of the most important areas of dairy farm management, and can have substantial impacts in terms of health, welfare, and productivity. It is critical that veterinary advisors are able to implement proactive changes to housing and management likely to not only result in the largest improvements, but also be applicable to the majority of farms.

Over 21 million cattle deaths were analysed utilising national birth and death registrations from the national British Cattle Movement Service, to quantify distributional features, and factors affecting variation in mortality rates in calves in GB since 2011. Alongside providing a first benchmark for calf mortality rates in GB, factors associated with mortality rates were further explored, and results from statistical modelling suggest that environmental conditions such as mean monthly environmental temperature and month of birth play a significant role in calf mortality rates at a national level.

To identify the most important factors for optimal calf health and performance farm management practices were collected from 60 farms, resulting in a large number of potential housing and management variables affecting calf performance. Factors most likely to improve calf performance on the majority of farms were identified, and included management areas such as stocking demographics, milk/colostrum feeding, environmental hygiene and environmental temperature. These factors were subsequently tested as a calf health plan intervention in a randomised controlled trial to elucidate causality.

Health and performance outcomes were analysed for 60 dairy farms randomly allocated to receive the health plan as an intervention or no advice as a control. Growth rates were higher for calves on farms receiving the plan for both male or beef and dairy heifer calves, and results from statistical models suggest that male or beef calves had significant increased growth rates on farms receiving the plan than those that were not. Model predictions suggest that a farm with the highest number of interventions in place (15) compared to farms with the lowest number of interventions in place (4) would expect an improvement in mean growth rates from 0.65kg/d to 0.81kg/d for male or beef calves, from 0.73kg/d to 0.88kg/d for dairy heifers, a decrease in mortality rates from 10.9% to 2.8% in male or beef calves, and a decrease in diarrhoea rates from 42.1% to 15.1% in dairy heifers.

As part of this research, colostrum samples were also collected from enrolled farms, and a first benchmark of bacterial levels within colostrum on GB dairy farms was provided. Neonatal calves are relatively susceptible to heat loss, and research from the early phase of this study suggested

that reduced environmental temperatures are associated with increased calf mortality, and reduced growth rates. The impact of calf jackets and supplementary heat sources on the growth rates of preweaned calves were explored in a randomised controlled trial. Seventy-nine calves from a single British dairy farm were randomly allocated to receive heat lamps or calf jackets in a factorial study design. Regression model results suggest 1kW heat lamp usage significantly improved growth rates by around 90g/d, and jacket use was not significantly associated with growth rates.

Key messages:

- Analysis of national data suggests calf mortality is associated with breed type, sex, month of birth and environmental temperature.
- From analysis of the calf management practices of 60 dairy farms, several factors were identified as being associated with health and production outcomes in calves on dairy farms, including stocking demographics, milk/colostrum feeding practices, and both environmental hygiene and temperature.
- These factors were tested in a randomised controlled trial, by implementing an evidence-based calf health plan. Interventions from the plan were demonstrated to improve growth, mortality and diarrhoea rates.
- As these studies suggested that environmental temperatures appear to be associated both with mortality and growth rates, 1kW heat lamps and calf jackets were tested in a randomised controlled trial. Whilst calf jackets had no significant effect on growth rates, the use of 1kW heat lamps was associated with improved growth rates in young calves.

To provide farmers and veterinarians with access to the calf health findings of the thesis in interactive form, the University of Nottingham Herd Health Toolkit (www.nottingham.ac.uk/herdhealthtoolkit) was created, including tools relating to the management of colostrum, prediction of mortality rates and ultimately a bespoke calf health plan based on user inputs.

## 2.    Introduction

The effective management of calves is one of the most important areas on dairy farms, and can have substantial impacts in terms of health, welfare and productivity. Whilst there are many potential factors associated with calf health and performance, it is important for veterinarians and farmers to target improvements in management that are likely to result in both having the largest positive impact on calf performance, but also being applicable to the majority of farms.

This PhD aimed to identify key management factors associated with key calf performance outcomes and test these factors as a randomised controlled trial. The aims of this research are to identify key factors associated with health and productivity outcomes in preweaning calves using statistical learning techniques, which would then be tested as a randomised controlled trial to demonstrate effectiveness.

## 3.    Materials and methods

Data were collected from a national cattle database to calculate mortality rates in calves and identify factors associated with mortality rates.

To identify factors associated with morbidity and growth rates, 60 dairy farms were recruited across Britain and statistical learning techniques were utilised to identify factors associated with health and performance outcomes. These factors were utilised to create a calf health plan which was subsequently tested as a randomised controlled trial.

To further elucidate associations between temperature and growth rates, a randomised controlled trial was conducted where calves would either receive a calf jacket, 1kW heat lamp, both jacket and lamp, or no intervention.

## 4.    Results

Breed type, sex, month of birth and environmental temperature were associated with calf mortality rates at a national level.

Key factors associated with health and production outcomes for calves on dairy farms were identified, largely focusing on stocking demographics, milk/colostrum feeding practices, and both environmental hygiene and temperature. An evidence-based calf health plan including these factors were tested as an RCT, and shown to improve growth, mortality and diarrhoea rates.

1kW heat lamps and calf jackets were tested in a randomised controlled trial and whilst calf jackets had no significant effect on growth rates, the use of 1kW heat lamps was associated with increased growth rates.

## 5.    Discussion

Whilst there are many potential factors associated with calf health and production outcomes, this research has identified several management factors likely to be associated with key calf performance outcomes. These factors largely revolve around milk feeding, environment temperatures and the hygiene management practices of both colostrum equipment and calf housing.

By testing key management factors identified in this thesis as a calf health plan in a randomised controlled setting, it was shown that the implementation of points from this plan is likely to improve the growth rates and decrease morbidity and mortality rates of calves on dairy farms.

The effect of environmental temperatures has been further tested, and the provision of supplementary heat source in the form of a 1kW heat lamp has been shown to improve growth rates in a randomised controlled trial, further highlighting the importance of environmental temperature for young calves.

A number of farmer and veterinarian focused tools have been created based on this research, and the tools, health plan and reporting framework are all available through the University of Nottingham Herd Health Toolkit (www.nottingham.ac.uk/herdhealthtoolkit).

## 6.    References

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