

AABP foundation Competitive Research Proposal

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Abstract

To estimate the effects of calf hutch microenvironment on calf health outcomes.

1 Goal and Objectives

To utilize a dataset of environmental data collected over 12 months at a commercial calf rearing facility to assess the effect of calf hutch microenvironment on calf health outcomes.

The Objectives of this project are as follows:

1. To investigate the actual microenvironments calves are exposed over the course of a year in a typical management setting in the San Joaquin Valley.
2. To compare hutch environments predicted from local weather monitoring stations to actual hutch microenvironment.
3. To investigate what effect hutch microenvironment has on calf health outcomes, as measured by treatment.
4. To combine research findings into an accessible form that can be utilised by dairy producers in the day to day running of their operations.

2 Justification

Heat stress is one of the most important diseases affecting modern animal agriculture, causing US livestock industries an estimated \$2.4 billion annual loss, of which the dairy industry accounts for the largest portion, at an estimated loss of \$897 million annually[1]. These losses are mostly due to reduced milk yield, impaired reproduction, and increased susceptibility to infectious diseases and consequently increased mortalities.[2, 3]

Heat stress is likely to become more important in the future due to the impacts of climate change, which is predicted to increase the occurrence of extreme weather and rapid temperature changes[4]. A study utilising various climate models predicted a 10% milk yield drop and a substantial 35% drop in conception rate due to the effects of climate change, with the greatest effects felt in the important dairying areas of south west USA[5].

Most of the previous research focuses on the effects of heat stress in Mature cows, who are housed and milked in areas with a variety of environmental modifications (fans, sprinklers,shade etc.) to alleviate the effects of heat stress.[6] Little thought or research effort has been devoted to assessing the effect of heat stress on the future milking herd, the calves, even though heat stress has shown to have various detrimental effects on calf rearing. [7, 8]

The proposed study utilises electronic temperature and humidity devices to log calf level hutch microenvironments over a 12 month period on a commercial dairy. This data will be used to quantify actual conditions experienced by calves, compare recorded conditions to those measured with both local and county wide weather stations, and compare environmental conditions to calf health records to estimate the effect of environment on calf health.

3 Background information, pertinent literature review

Hutch housing is the most common housing environment of calves in the United States, with nearly 75% of dairy operations utilising some form of individual pen/hutch.[9] This is for good reason, as the Individual calf hutch placed outdoors is the best environment for prevention of respiratory disease [10], and calves raised in hutches are less likely to be treated for scours. [11] Hutches have the advantage that calves can move between three distinct microenvironments in the rear of hutch, front of hutch, and outdoor area [12] This advantage is soon lost as the temperature rises, and the calf becomes hyperthermic. Calves have a quite narrow thermoneutral zone of 10 - 20 degrees celcius [13], and besides having a much narrower range than mature cows, calves are less able than older animals to regulate their own body temperature.[14]

There has been no research into the microenvironment within the hutch itself, especially under high temperatures. Temperature heat indexes are often used to assess and predict the impact of heat stress on mature cow production, Hot hutch environments have been shown to negatively impact Serum IgG absorbtion [7]. Almost 20% of dairy calves have failure of passive transfer (<10mg/mL measured by RID at 1-7 days old)[9], so any further impairment of IgG absorbtion is very likely to impact future health outcomes.[15]

A hot environment may negatively impact early growth of calves, leading to reduced production as adults [16]. A study by Lacetera found lower wither height, hip width, and Body Condition Score in 5 month old Holstein calves that were exposed to hot conditions early in life [8]

There has been some investigation into the effects of hutch microenvironments on calf health, [7, 17, 18], however these studies differ in many important ways from that proposed, which make its application to the California Dairy industry difficult. Stott's study was conducted in Arizona, which has a similar hot dry climate during the summer, However the study calves were housed in corrugated iron hutches in full sun, with solid side-walls which would severely restrict ventilation[7]. This is in comparison to the typical wooden 'California style' triplet calf hutch widely used on dairies in the San Joaquin valley. The Wooden side walls will reduce the amount of radiant heat transferred to the calves, and the common design featuring missing panels on the side and back would dramatically improve ventilation, an important factor in both reducing temperature and disease control[19]. Other studies have focused on calves housed in calf barns, a common housing method in the midwest where winter temperatures make hutch housing impractical [18]. The environment within these calf barns is very different to the calf hutches in califonia, and obviously the environmental differences make it difficult to draw direct comparisons from these studies.

The proposed study alleviates these issues due to data collection taking place on a commercial dairy, and hence findings are directly applicable to the hundreds of thousands of calves raised in a similar manner in califonia every year.

4 Materials and Methods

The dataset to be used in this project was previously collected by . . . and features collected over a 12 month period (October 2003 to October 2004). While the environmental data was being collected, 25,000 calf treatment records were also obtained for the same period, featuring calf id's and treatment given. Hobo data loggers have been used extensively in similar projects and proved a reliable measure of actual environmental conditions[20, 21]. The number of treatments given, as a proxy for calf health would form the response variable of our predictor model.

Also during the data collection period, a commercial weather station was placed on the calf rearing facility. The information collected by this station will be compared to the data gathered from each calf hutch to analyse the accuracy of predicting hutch microenvironment from weather station data. The on farm weather station records will also be compared to data available from government weather stations at locations surrounding the calf rearing facility, to determine if local on farm conditions can be predicted from a combination of nearby government weather stations. These findings could be used to predict farm-level heat stress levels and forecasts, allowing improved management of both calves and mature cows. These results will be combined to form a heat stress monitoring and prediction software to be hosted on a server at the VMTRC, UC Davis. This data can be freely accessed by local stakeholders via a website, automatic email updates/alerts, and smartphone applications that utilise GPS facilities to give an accurate localised heat stress forecast.

References

- [1] N.R. St-Pierre, B. Cobanov, and G. Schnitkey. Economic Losses from Heat Stress by US Livestock Industries. *Journal of Dairy Science*, 86(31):E52–E77, June 2003.
- [2] C T Kadzere, M R Murphy, N Silanikove, and E Maltz. Heat stress in lactating dairy cows : a review. 77:59–91, 2002.
- [3] H. Hammami, J. Bormann, N. M’hamdi, H.H. Montaldo, and N. Gengler. Evaluation of heat stress effects on production traits and somatic cell score of Holsteins in a temperate environment. *Journal of Dairy Science*, pages 1–12, January 2013.
- [4] M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and Eds C.E. Hanson. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Technical report, Intergovernmental Panel on Climate Change, 2007.
- [5] PL Klinedinst, DA Wilhite, G L Hahn, and KG Hubbard. The potential effects of Climate Change on summer season dairy cattle milk production and reproduction. *Climate Change*, 23(9698):21–36, 1993.
- [6] D V Armstrong. Heat stress interaction with shade and cooling. *Journal of dairy science*, 77(7):2044–50, July 1994.
- [7] G H Stott, F Wiersma, B E Menefee, and F R Radwanski. Influence of environment on passive immunity in calves. *Journal of dairy science*, 59(7):1306–11, July 1976.
- [8] N Lacetera, B Ronchi, U Bernabucci, and A Nardone. Influence of heat stress on some biometric parameters and on body condition score

- in female Holstein calves. *Rivista Agric. Subtrop. e Trop.*, 88(1):81–89, 1994.
- [9] NAHMS. *Heifer Calf Health and Management Practices on U.S. Dairy Operations, 2007*. Number January. USDA, 2007.
 - [10] R J Callan and F B Garry. Biosecurity and bovine respiratory disease. *VETERINARY CLINICS OF NORTH AMERICA FOOD ANIMAL PRACTICE*, 18(1):57–78, 2002.
 - [11] D Waltner-Toews, S W Martin, and A H Meek. DAIRY CALF MANAGEMENT, MORBIDITY AND MORTALITY IN ONTARIO HOLSTEIN HERDS. III. ASSOCIATION OF MANAGEMENT WITH MORBIDITY. *Preventative Veterinary Medicine*, 4:137–158, 1986.
 - [12] R E Brunsvold, C O Cramer, and H J Larsen. Behavior of dairy calves reared in hutches as affected by temperature. *Transactions of the ASAE-American Society of Agricultural Engineers*, 28, 1985.
 - [13] K.G. Gebremedhin, C.O. Cramer, and W.P. Porter. Predictions and measurements of heat production and food and water requirements of Holstein calves in different environments. *Trans. ASAE; (United States)*, 24:3, January 1981.
 - [14] R J Christopherson. EFFECTS OF PROLONGED COLD AND THE OUTDOOR WINTER ENVIRONMENT ON APPARENT DIGESTIBILITY IN SHEEP AND CATTLE. *Canadian Journal of Animal Science*, 56(June):201–212, 1976.
 - [15] TE Besser and CC Gay. The importance of colostrum to the health of the neonatal calf. ...*clinics of North America. Food animal practice*, 1994.

- [16] P C Hoffman. P C Hoffman The online version of this article , along with updated information and services , is located on the World Wide Web at : Optimum Body Size of Holstein Replacement Heifers 1 ABSTRACT :. pages 836–845, 1997.
- [17] Kenneth V Nordlund. Practical considerations for ventilating calf barns in winter. *The Veterinary clinics of North America. Food animal practice*, 24(1):41–54, March 2008.
- [18] a Lago, S M McGuirk, T B Bennett, N B Cook, and K V Nordlund. Calf respiratory disease and pen microenvironments in naturally ventilated calf barns in winter. *Journal of dairy science*, 89(10):4014–25, October 2006.
- [19] BP Smith. Large animal internal medicine. pages 602–643, 2002.
- [20] Brad Scharf, Michael J Leonard, Robert L Weaver, Terry L Mader, G Leroy Hahn, and Donald E Spiers. Determinants of bovine thermal response to heat and solar radiation exposures in a field environment. *International journal of biometeorology*, 55(4):469–80, July 2011.
- [21] F D Jousan, L a de Castro e Paula, J Block, and P J Hansen. Fertility of lactating dairy cows administered recombinant bovine somatotropin during heat stress. *Journal of dairy science*, 90(1):341–51, January 2007.