Faculty of Agricultural and Nutritional Sciences

Christian-Albrechts-University of Kiel
Institute of Animal Breeding and Husbandry

Mastitis and lameness detection using different statistical methods

E. Kramer[1], D. Cavero[2], E. Stamer[3] and J. Krieter[1]

[1]Institute of Animal Breeding and Husbandry
Christian-Albrechts-University of Kiel
[2]Lohmann Tierzucht GmbH
[3]TiDa Tier und Daten GmbH

Introduction

- **Mastitis and lameness:**

1. **Increasing incidence of diseases such as mastitis or lameness**
2. **Decreasing time for detection of diseases by farm staff**
3. **Economical relevance of mastitis and lameness**

   Mastitis costs: 150 – 200 €/ cow/ year (DVG, 2002)

   Lameness costs: 312 €/ cow/ year (KÖNIG and LANDMANN, 2008)

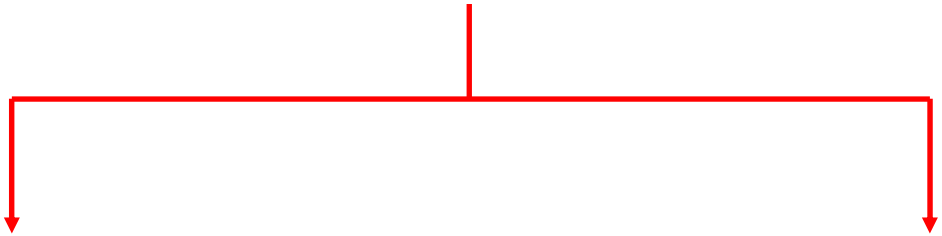
Introduction

- **Preconditions for automated disease detection**
  - **Automatic delivery of repeated measures for every cow with the use of adequate sensor technique in the barn**
  - **Data processing with management systems and transformation into reliable daily alert lists for the farmers**

➢ **Our objective: Application of different methods for an early detection of mastitis and lameness**

Data description

- **Dairy research farm Futterkamp of the Chamber of Agriculture of Schleswig-Holstein**
- **Data collection period: August 2006 - February 2007**
- **~ 13,500 observations, 135 lactations of 118 cows**



Training data

- **90 lactations**
- **9,074 records**
- **50 cows/day on average**

Test data

- **45 lactations**
- **4,604 records**
- **30 cows/day on average**

Data recording (Futterkamp)

Parameter	Recording frequency
Milk yield	each milking
Milk solids - Fat-%, protein-% - SCC and urea content	weekly
Live weight	each milking
Water intake	each visit at the water trough
Feed intake	each visit at the feeding trough
Activity	each hour
Reproduction (calving, pregnancy, insemination)	permanently
Health (treatments of diseases)	
Body condition score	monthly

Material – Input variables

Means ($\bar{x}$) and standard deviations (s) of the input traits

Trait	Unit	$\bar{x}$	s
Milk yield	(kg)	34.0	7.9
Dry matter intake	(kg)	20.7	3.7
Water intake	(kg)	85.3	17.4
Feeding visits	(n)	51.9	21.5
Feeding time	(min)	180.0	51.5

Disease definition

- **Output variables (reference data):**
  - **Claw and leg diseases: 2 definitions:**
    - **Day of treatment including 3 days before (Treat3)**
    - **Day of treatment including 5 days before (Treat5)**
  - **Mastitis: 2 definitions:**
    - **Day of treatment and/or SCC >400 including 2 days before treatment/measurement ((Treat400)2)**
    - **Day of treatment and/or SCC >400 including 4 days before treatment/measurement ((Treat400)4)**
  - ➢ **"Disease blocks"**
  - ➢ **6 days after last treatment considered as unknown days**

Definition of claw disease days

Cow	Date	Treatment
0002	25AUG06	0
0002	26AUG06	0
0002	27AUG06	0
0002	28AUG06	0
0002	29AUG06	1
0002	30AUG06	1
0002	31AUG06	1
0002	01SEP06	0
0002	02SEP06	0
0002	03SEP06	0
0002	04SEP06	0
0002	05SEP06	0
0002	06SEP06	0
0002	07SEP06	0
0002	08SEP06	0
0002	09SEP06	0
0002	10SEP06	0
0002	11SEP06	0
0002	12SEP06	0
0002	13SEP06	0

disease block: Treat3 (day of treatment and the 3 days before)

unknown (6 days after last treatment)

healthy

Disease distribution

- **Cows with at least 1 case of mastitis : 13.4% of all cows**
- **Cows with at least 1 case of lameness: 25.2% of all cows**

Training data for the two definitions of mastitis (81 cows)

Definition	Days of mastitis	Days of health	Days of Mastitis/ days of health
(Treat 400)2	124	8556	1.4%
(Treat 400)4	205	8457	2.4%

Methods

- **Fuzzy Logic, Neurofuzzy**
  - **Fuzzification (transformation into linguistic variables)**
  - **Set of rules ("if-then-rules") and fuzzy inference**
  - **Defuzzification (scalar - one output value)**
- **Input parameter for the lameness detection models:**
  - **Milk yield, dry matter intake, water intake, dry matter intake behaviour, activity, information about preliminary cases of lameness**
- **Input parameter for the mastitis detection models:**
  - **Milk yield, dry matter intake, dry matter intake behaviour, information about preliminary mastitis cases**

Multivariate analysis - Results lameness

Classification parameters of lameness detection from the training and the test data by the fuzzy logic models

Training data	Fuzzy model	Block sensitivity	Specificity	Error rate	TP /day	FP /day
Treat5	Fuzzy	75.0	70.1	98.4	0.3	20.7
Treat5	Neurofuzzy	92.9	77.0	97.0	0.5	15.6
Test data						
Treat5	Fuzzy	72.7	75.4	98.8	0.2	17.3
Treat5	Neurofuzzy	70.0	77.4	97.6	0.4	15.7

TP = true positive; FP = false positive

Treat 5 = disease block: day of treatment and 5 days before

Average herd size: training data: 50 cows; test data: 34 cows

Multivariate analysis - Results mastitis

Classification parameters of mastitis detection from the training and the test data by the fuzzy logic models

Training data	Fuzzy model	Block-sensitivity	Specificity	Error rate	TP /day	FP /day
(Treat400)4	Fuzzy	78.0	77.5	96.5	0.6	15.5
(Treat400)4	Neurofuzzy	82.4	72.5	94.4	1.1	18.5
Test data						
(Treat400)4	Fuzzy	94.1	83.6	95.0	0.6	11.3
(Treat400)4	Neurofuzzy	85.7	76.8	95.8	0.7	16.1

TP = true positive; FP = false positive

(Treat400)4 = disease block: day of treatment or SCC>400 measurement and 4 days before

Average herd size: training data: 50 cows; test data: 34 cows

Summary and Conclusion

- **Traits used in this dataset did not seem to be suitable to detect diseases such as lameness or mastitis**
  - **Development of other sensor techniques necessary ("DCC/OCC", *DeLaval* and "StepMetrix", *Boumatic*)**

- **Huge variance of the observed traits between and within cows**
  - **Detecting unique patterns before and during a disease is difficult.**

- **"Adverse" ratio between disease days and days of health**
  - **High error rates are anticipated.**

Thank you for attention!

Cow: „Endy"; Owner + Breeder.: E. Kramer. Dorenborg