Data Networking in Precision Livestock Farming
for Improved Calf Rearing

CIGR World Congress 2006
September 3-7, 2006
Bonn, Germany

Viktoria Spreng
Matthias Rothmund
Hermann Auernhammer

Weihenstephan Center of Life and Food Sciences
Department of Life Science Engineering
Agricultural Systems Engineering
Structure

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1. Introduction and objectives

**Precision Livestock Farming**

**Information Technology in Livestock Farming**

- Creates better management information for animal production by networking electronic process control systems.

**Electronic systems**

- Provide information about food intake, animal behavior, animal health and other parameters.

→ Data have to be acquired, validated, processed and fed back to control of the overall system.

→ Unusual or critical situations can be detected as early as possible.

But: Many proprietary solutions of different manufacturers available.
1. Introduction and objectives

Data networking in process control – calf rearing

- Milk feeding robot
- Concentrate feeding robot
- Drinking water robot
- Roughage weighing trough
- Animal weighing machine
- Temperature measuring system

Control

Data networking / Data management

- Milk feeding management
- Fore stomach development
- Weaning date
- First calving age
- Health management
- Early illness detection

Calf rearing
1. Introduction and objectives

Aims and method

Aims of the research project:
• Estimation of technical and informational requirements
• Deduction of the potential of complex networked systems in calf rearing

Method:
• Implementation of a comprehensive feeding and monitoring system for calves
• Linkage of all - up to now available - technical components
• Acquisition of highly resolved process parameters
  (individual milk, water and feed intake, body weight, body temperature)
2. Experimental setup

**Technical setup for controlled calf feeding**

Site: Experiment farm 'Hirschau', Technische Universitaet Muenchen

- **Littered lying area**
- **Agricultural Systems Engineering**
- **CIGR 2006**
- **A Roughage weighing trough**
- **B Milk feeding robot**
- **C Seesaw**
- **D Animal weighing machine**
- **E Temperature measuring system**
- **F Concentrate feeding robot**
- **G Drinking water robot**

![Diagram of technical setup](image)
3. Utilized technology

Technical setup - Hirschau

- **Concentrate feeding robot**
  - Mechanical flap for scanning whether drinking calf is empty or filled
  - Delivers defined amount of water
  - Amount and concentration of milk can be defined by operator for each calf

- **Automatic roughage weighing trough**
  - Trough weight is measured when entering and leaving the station
  - System accuracy of 33 g with a resolution of 10 g
  - One control unit for each trough
  - Plates avoid RFID interferences
  - Forefoot weight extrapolated to an overall weight by using a system internal calibration factor

- **Automatic tongue temperature measuring system**
  - Sucker with two separated compartments: upper one implies milk, lower one an inserted temperature sensor
  - Sensor measures tongue temperature during suckling

- **Drinking water robot**
  - Records drinking water intake of each calf
  - Dispenses defined amount of water (50–500 ml per filling quantity)

- **Automatic animal weighing system**
  - Forefoot weighing machine in front of the milk feeding station
  - Forefoot weight extrapolated to an overall weight by using a system internal calibration factor

- **Milk feeding robot**
  - Main unit of process control
  - Amount and concentration of milk can be defined by operator for each calf

- **Moveable seesaw**
  - Avoids push away of a drinking calf
  - Inhibits multiple suckling during drinking

- **Concentrate feeding robot**
  - Mechanical flap for scanning whether drinking calf is empty or filled
  - Delivers defined amount of water
  - Amount and concentration of milk can be defined by operator for each calf

- **Automatic roughage weighing trough**
  - Trough weight is measured when entering and leaving the station
  - System accuracy of 33 g with a resolution of 10 g
  - One control unit for each trough
  - Plates avoid RFID interferences
  - Forefoot weight extrapolated to an overall weight by using a system internal calibration factor

- **RFID**
  - Calves tagged with a RFID transponder
  - Individual drinking and feeding

- **Automatic roughage weighing trough**
  - Trough weight is measured when entering and leaving the station
  - System accuracy of 33 g with a resolution of 10 g
  - One control unit for each trough
  - Plates avoid RFID interferences
  - Forefoot weight extrapolated to an overall weight by using a system internal calibration factor
5. Recorded parameters

Calf individual recorded parameters

**Milk feeding robot**
- Retrieved amount of milk [ml]
- Number of break-offs
- Suckling speed [l/s]
- Number of visits at the station

**Temperature measurement system**
- Tongue temperature [°C]

**Animal weighing machine**
- Body weight [kg]

**Concentrate feeding robot**
- Retrieved amount of concentrate [g]
- Number of visits at the station

**Drinking water robot**
- Retrieved amount of water [ml]

**Roughage weighing trough**
- Retrieved amount of hay [g]
- Number of visits at the station

Database
5. Recorded parameters

Calf individual recorded parameters

Milk feeding robot
- Retrieved amount of milk [ml]
- Number of break-offs
- Suckling speed [l/s]
- Number of visits at the station

Temperature measurement system
- Tongue temperature [°C]

Animal weighing machine
- Body weight [kg]

Concentrate feeding robot
- Retrieved amount of concentrate [g]
- Number of visits at the station

Drinking water robot
- Retrieved amount of water [ml]

Roughage weighing trough
- Retrieved amount of hay [g]
- Number of visits at the station

Database
5. Recorded parameters

Example – data of calf no. 817

- Amount of concentrate [kg/d]
- Amount of roughage [kg/d]
- Amount of milk [l/d]
- Amount of water [l/d]
- Body weight [kg]
- Body temperature [°C]
6. Conclusion and outlook

System validation using control parameters

**Technical parameters**

- Amount of milk
- Amount of concentrate
- Amount of water
- Amount of roughage
- Body weight
- Tongue temperature

**Control parameters**

- Clinical examination
- Carcass
- Rectal temperature
- Animal watching
- Weighing for control
- Blood analyses

**Validation**

- Fore stomach development
- Early illness detection
6. Conclusion and outlook

Conclusion

• The established calf feeding and monitoring system allows to get individual, highly resolved data.

• By networking, the data of the single technologies can be fed into one common database.

• Control measurements are necessary to validate the technical acquired data.

→ Early illness is detectable and fore stomach growth can be estimated.

After further processing and data networking, algorithms have to be developed for the implementation within a knowledge-based decision support system.
Thanks for your attention!

Thanks for supporting this research project to:

- **Foerster-Technik GmbH**  
  (Engen, Germany)

- **DeLaval GmbH**  
  (Glinde, Germany)

- **Bavarian State Research Centre for Agriculture (LfL)**  
  (Freising, Germany)

Contact:  
viktoria.spreng@wzw.tum.de