

# In-line Milk Analysis and Identification of Health and Reproduction Events

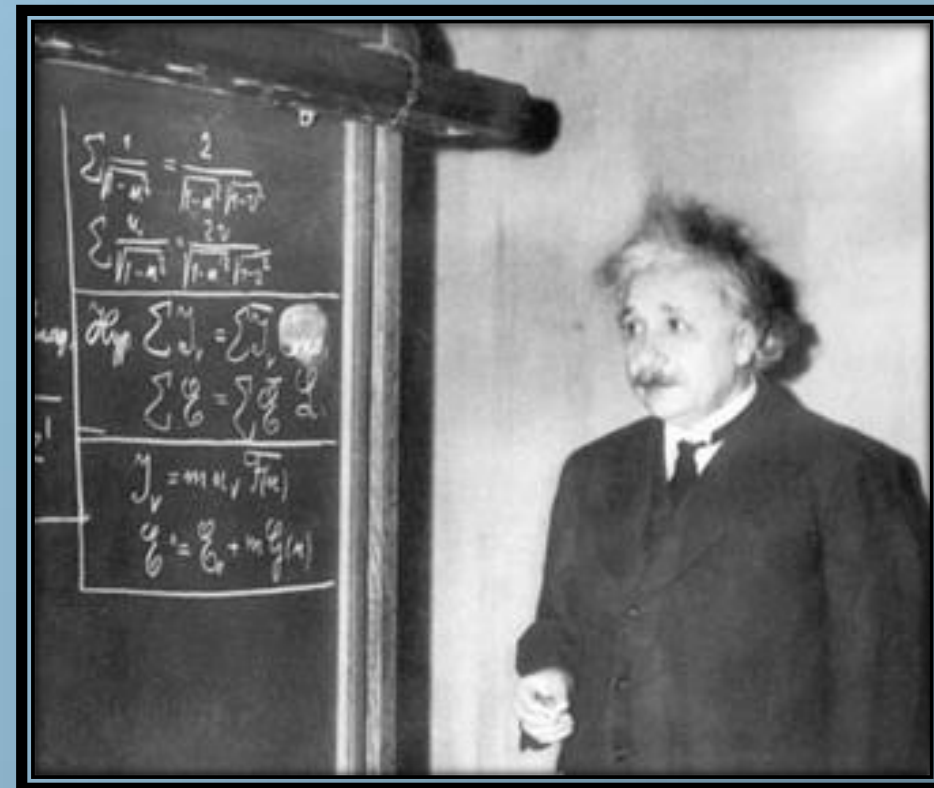
Jens Yde Blom

DVM, PhD

Lattec, Hillerød, Denmark

Hello Doc,  
I'm standing here with Daisy,  
and I haven't got the faintest  
clue what's wrong with her!

How to fill  
the gap?  
The dairy  
cow  
on-line



**FOSS**

 **DeLaval**



**lattec**

- 50:50 Partnership between Foss and DeLaval established in 2001
- R&D: Technical (Hardware, Software, Mechanics) and Biological
  - Technical and Biological support
  - Manufacturing and operations
    - Business development
  - Sales and Marketing through owners
- Situated in Hillerød (FOSS), ~28 people

# My Agenda

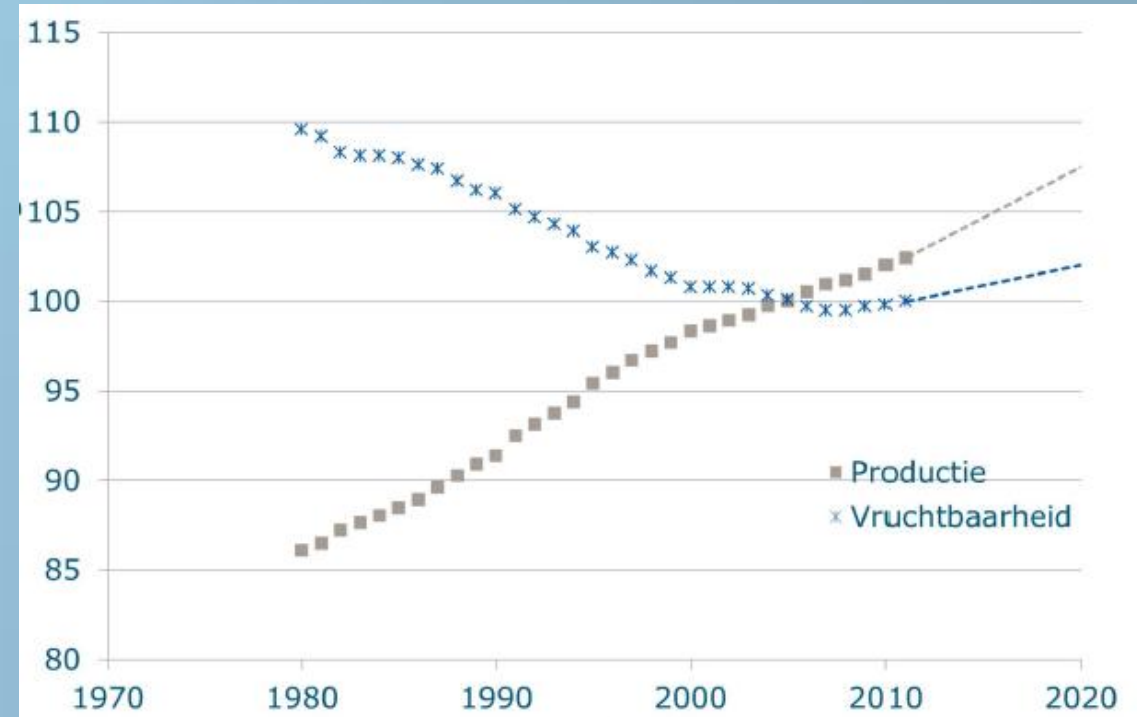
- 1. Purpose of in-line milk analysis on-farm**  
Early and precise diagnoses for decision making  
Welfare aspects of early diagnoses
- 2. Moving from data to usable decision making on-farm**
- 3. Which alarms does the farmer need to have?**
- 4. What can be measured in-line to-day?**
- 5. Additional data for precise diagnosis**
- 6. Herd Navigator<sup>TM</sup> as an example of a complete system**
- 7. Perspectives for the future**

# Why will Tomorrow's Cow be On-line?

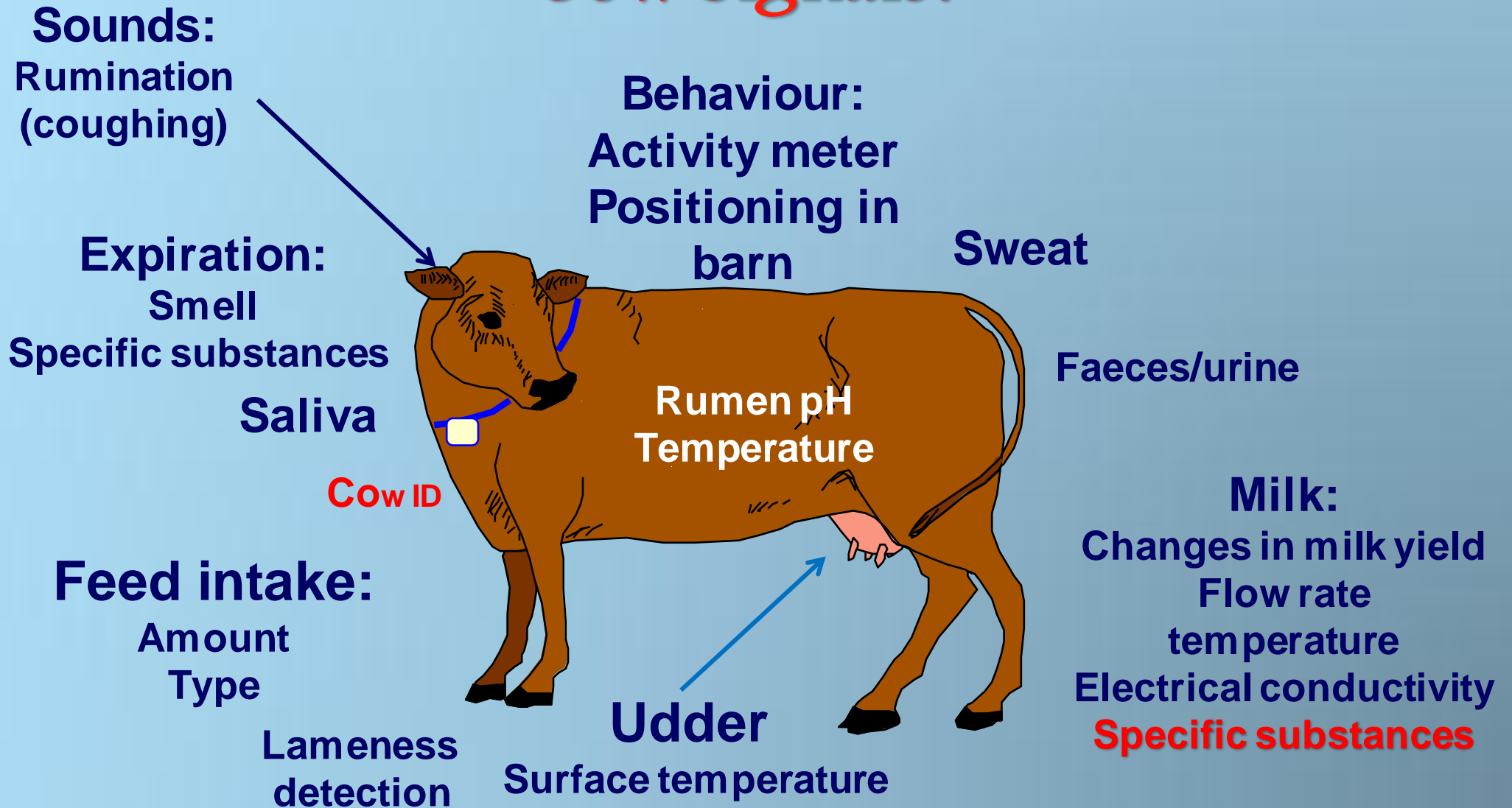
Low input/low output vs High input/high output systems

- Dairy herds grow larger
  - More cows to monitor
- Milk yields increase
  - Higher risk of disease and reproductive disorders
- Automated milking decreases cow - man interaction
- Hired milkers milk cows – and do nothing else!
- Income margins growing smaller
- Consumers' perception of animal welfare and health
- **On-line systems can be automated!**

Milk production goes up  
- and fertility goes down!



# How to Obtain Non-invasive Cow Signals?



# The Ideal Automated Monitoring System:

- Should explain underlying biological process
- Translated to management action (SOP's)
- Cost effective
- Flexible, robust and reliable
- Information readily accessible to farmer
- Commercial demonstration (works in real life)
- Continuous improvement and feedback loops

Dr. Jeff Bewley (Kentucky State University),  
Precision Dairy Conference 2013, Rochester, MN

# Automated Systems Available on the Market

- **MASTITIS DETECTION**

- In-line electrical conductivity in milk

- In-line Somatic Cell Count measurements

- IR cameras to detect increase temperature in udder quarters

- **HEAT DETECTION**

- Activity meters

- **MORE PARAMETERS MONITORED**

- **In-line Fat, Protein, Lactose, SCC**

- **At-line: Herd Navigator™: Mastitis, Reproduction, Ketosis, Feed composition**

# Which Alarms does the Farmer Need to Have?

- **True alarms!**
  - The reality: Muddy
  - Heat alarm – true heat or just a "follower"
  - Mastitis alarm – really true mastitis? – and should I treat the cow?
- **The no-alarms!**
  - Even worse – did I miss something?
  - The lame cow in heat, the silent heat
  - The Post Partum Anestrus/follicular cyst/luteal cyst cow showing no heat

**Next step – From the basic sensing to farm management**



# Alarms that Don't Feel Right Won't be Considered!

 Universiteit Utrecht

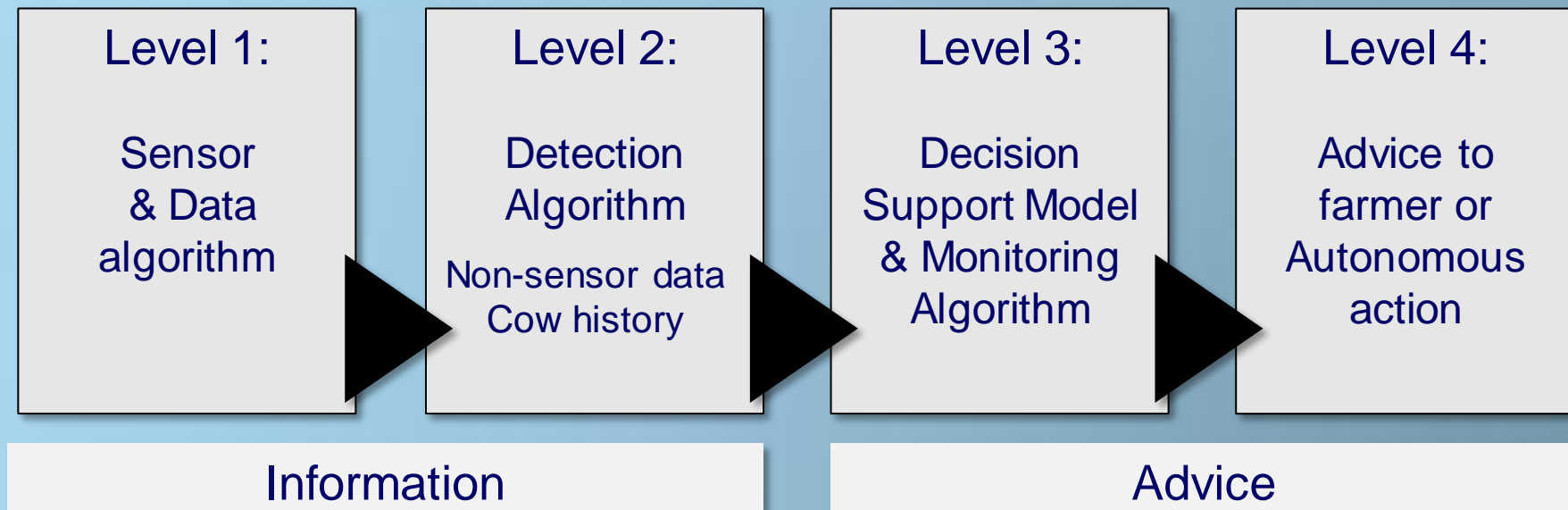
## Check alert in the barn

- Only 3,5% of the alerts are checked by the farmer!



**Buma et. al., 2013**

# The Four Stages of Meaningful Herd Management with Sensors



After Rutten et al. 2013

# The Four Stages of Meaningful Herd Management with Sensors

## – It Must be a System!

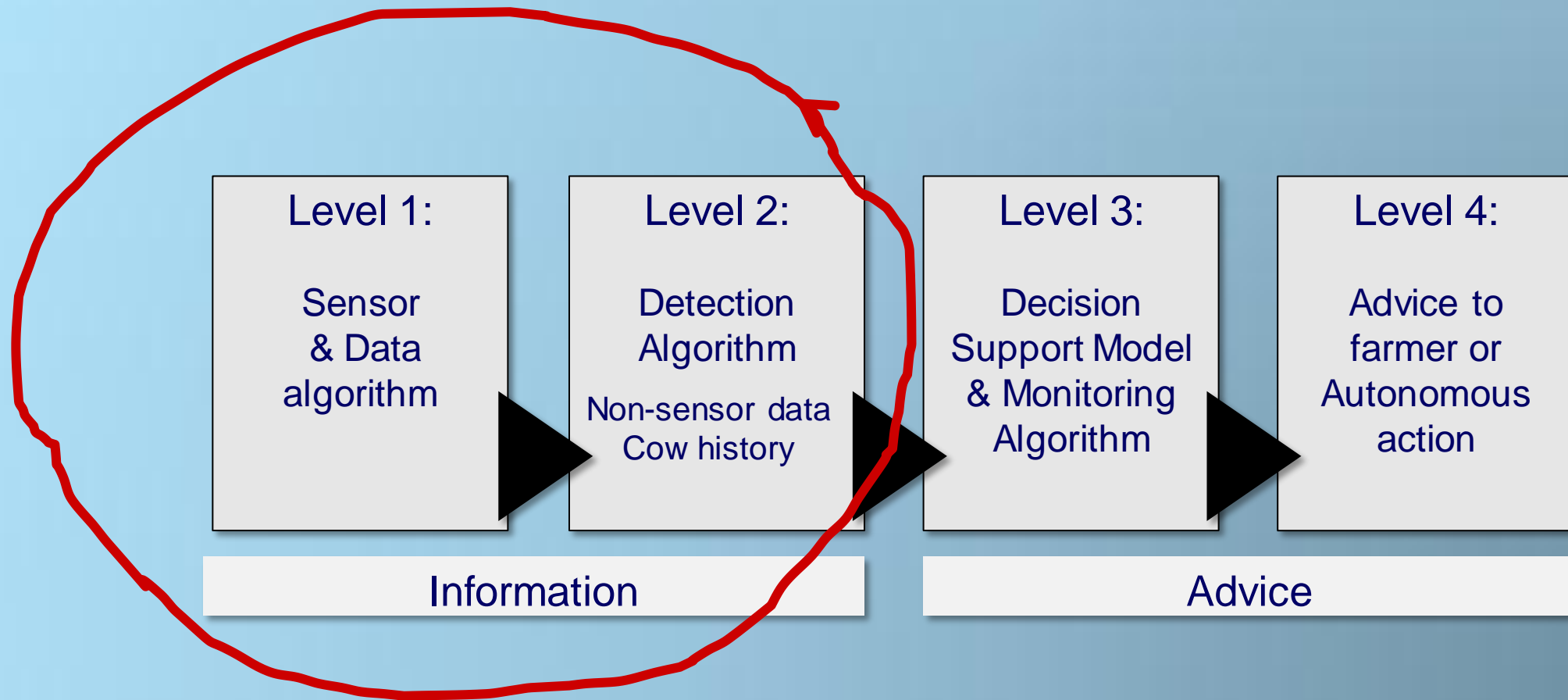
- an off-agriculture example!:



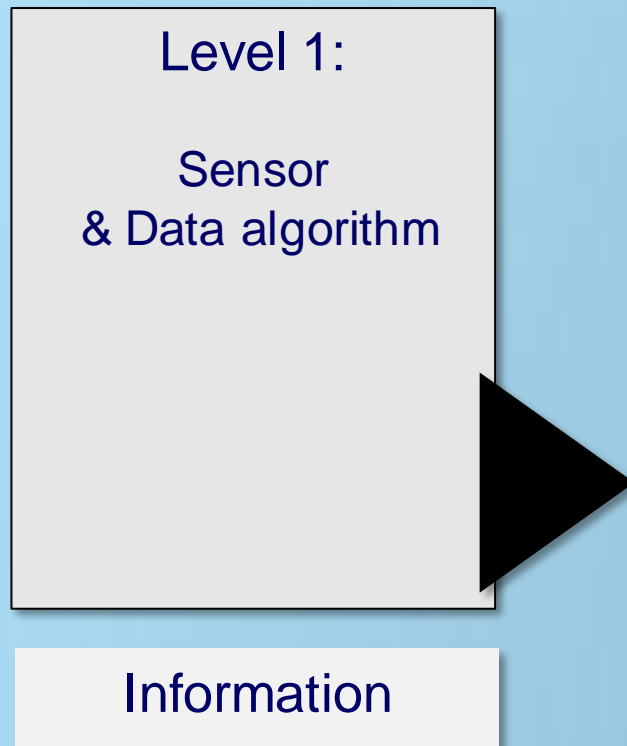
Health management  
Advice

After Rutten et al. 2013

# The Four Stages of Meaningful Herd Management with Sensors

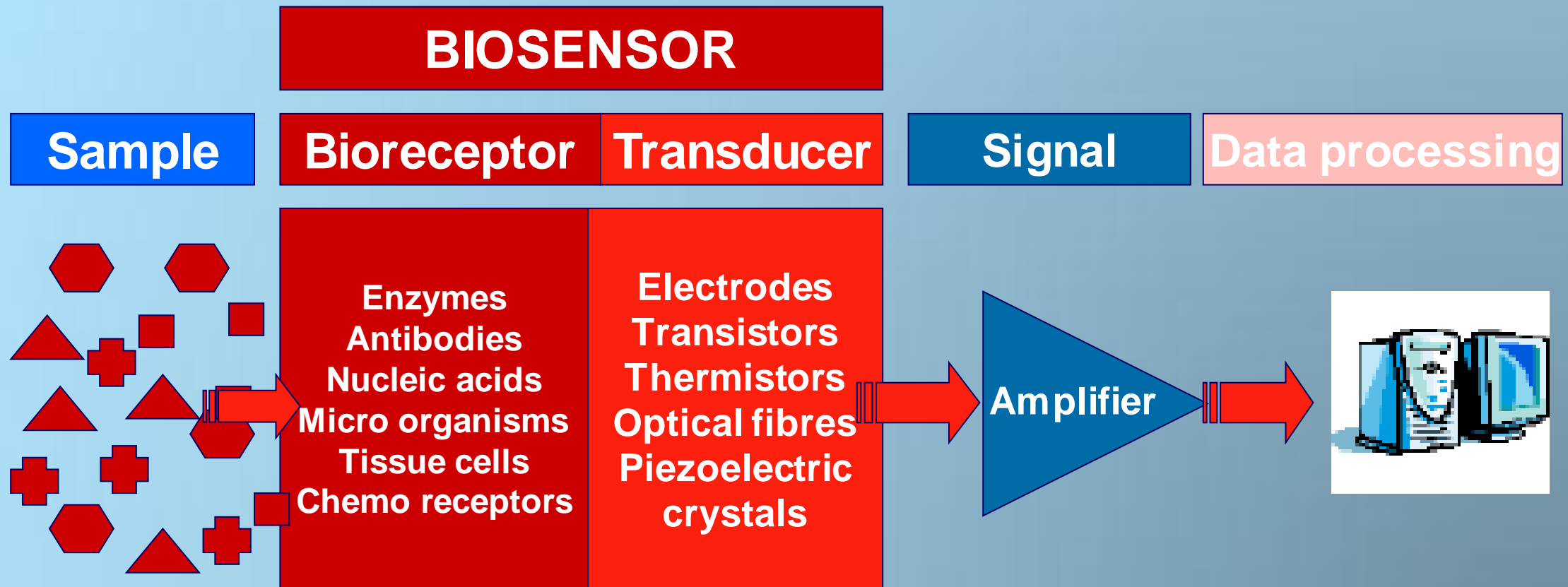


# The Four Stages of Meaningful Herd Management with Sensors



- Sensing technologies
  - Electrical conductivity (milk)
  - Rumen pH
  - Temperature
  - Activity meters
  - Cow positioning
  - IR-Cameras
  - Auditive sensors
  - Step plates for lameness
  - **BIOSENSORS**
  - **etc.....**

# The Principle of Operation of a Biosensor



Adapted from Valasco-Garcia & Mottram, 2003



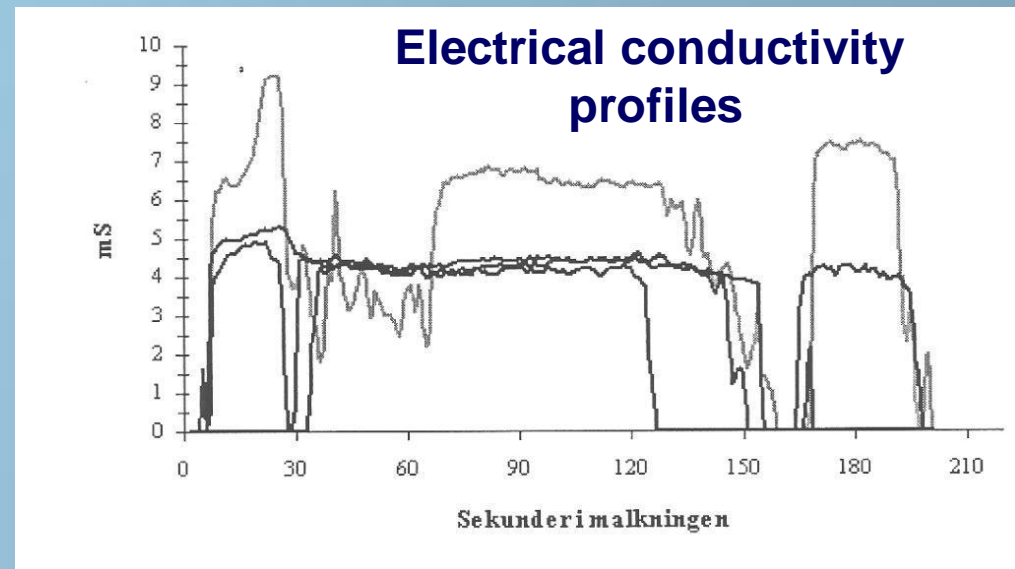
# The Four Stages of Meaningful Herd Management with Sensors

Level 1:

Sensor  
& Data algorithm

Information

- One measurement or several make no advice - just another data source

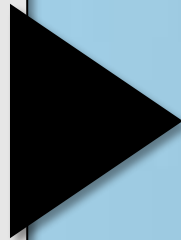


*"We drown in data, but lack information"*

# The Four Stages of Meaningful Herd Management with Sensors

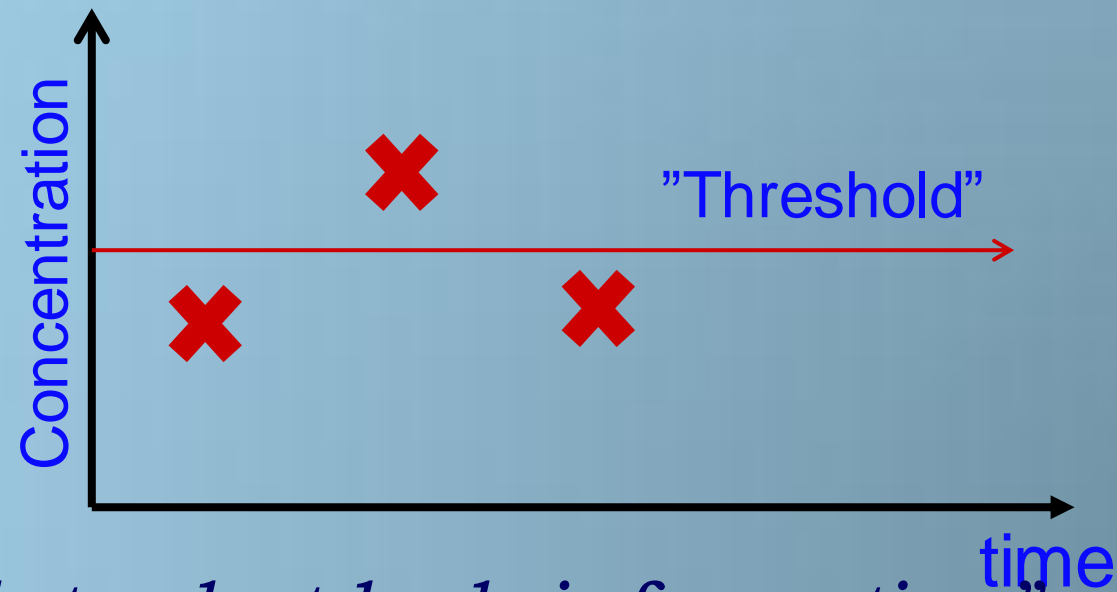
Level 1:

Sensor  
& Data algorithm



Information

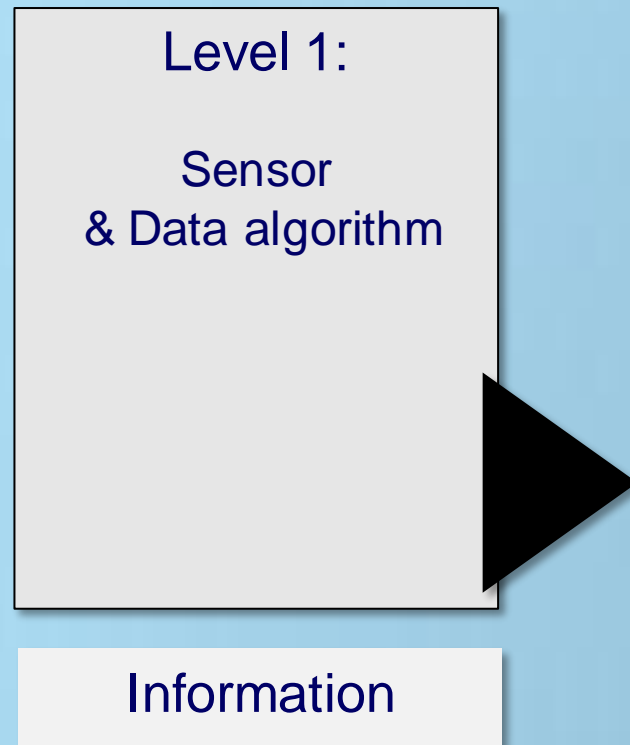
- One measurement or several make no advice - just another data source



*"We drown in data, but lack information"*

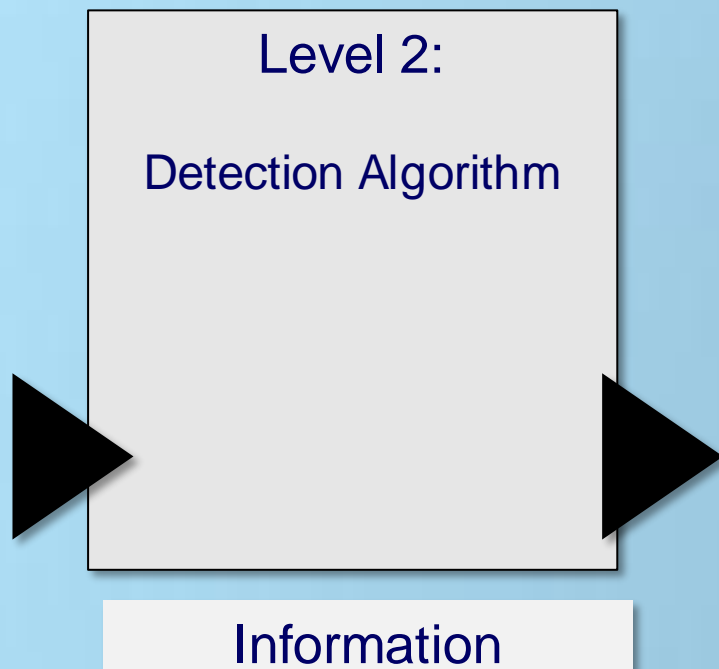


# The Four Stages of Meaningful Herd Management with Sensors



- "Making sense of data"
- Algorithms to process time series of data
- Sensitivity of sensor
  - The ability of the system to detect the true condition
- Specificity of sensor
  - The ability of the system to classify the truly healthy animal as healthy
- Sensitivity/specificity not adequate for time series analyses
- **THEN WHAT?**

# The Four Stages of Meaningful Herd Management with Sensors



- **Sensitivity & Specificity for mastitis detection based on electrical conductivity:**
- Milking robot 1:
  - Sensitivity 47 %, Specificity 99 % (Rasmussen et al., 2007)
- Milking robot 2:
  - 74 % clinical cases missed
  - 60 % false positive alerts
  - **3 % of alerts checked by farmer**  
(Buma et. al., 2013)

# The Four Stages of Meaningful Herd Management with Sensors

Level 3:

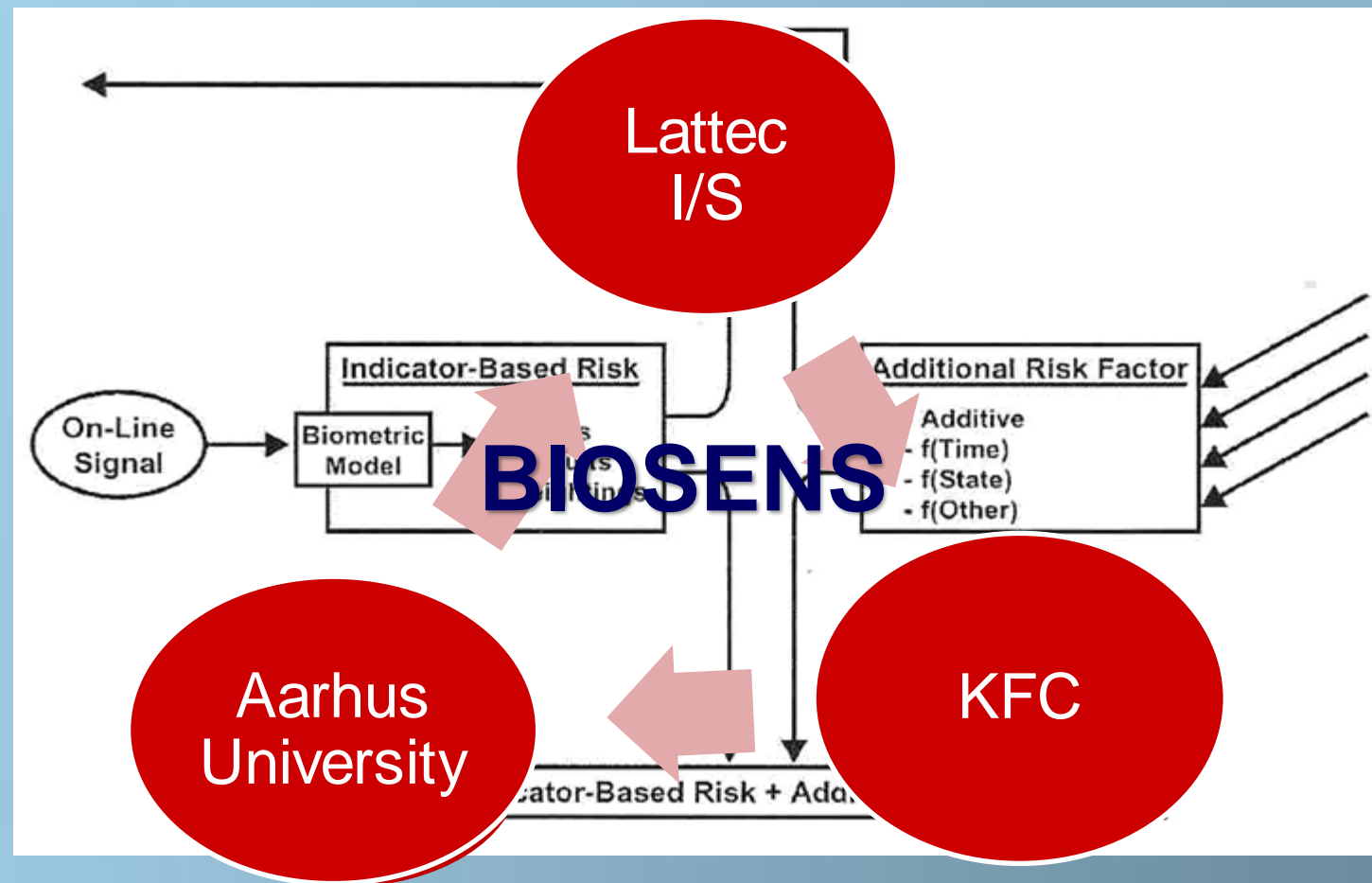
Decision Support Model &  
Monitoring Algorithm

Advice

- **A. Sensor data**
- **B. Cow specific information (local/central database)**
  - Breed
  - Lactation number
  - Lactation stage
  - Milk yield
  - External heat/pregnancy check
  - Body condition
  - Economic considerations

# The BIOSENS Project: Development of the Biomodels for Herd Navigator™

- Developed by the Faculty of Agricultural Sciences, Aarhus University, Denmark and tested in the research farm (150 cows)
- More than 60 international scientific publications – 25 employees
- Testing in 6 commercial dairy farms in Denmark (1,660 cows)
- Today servicing >28,000 cows in 16 countries



# The Biomodels for Herd Navigator™

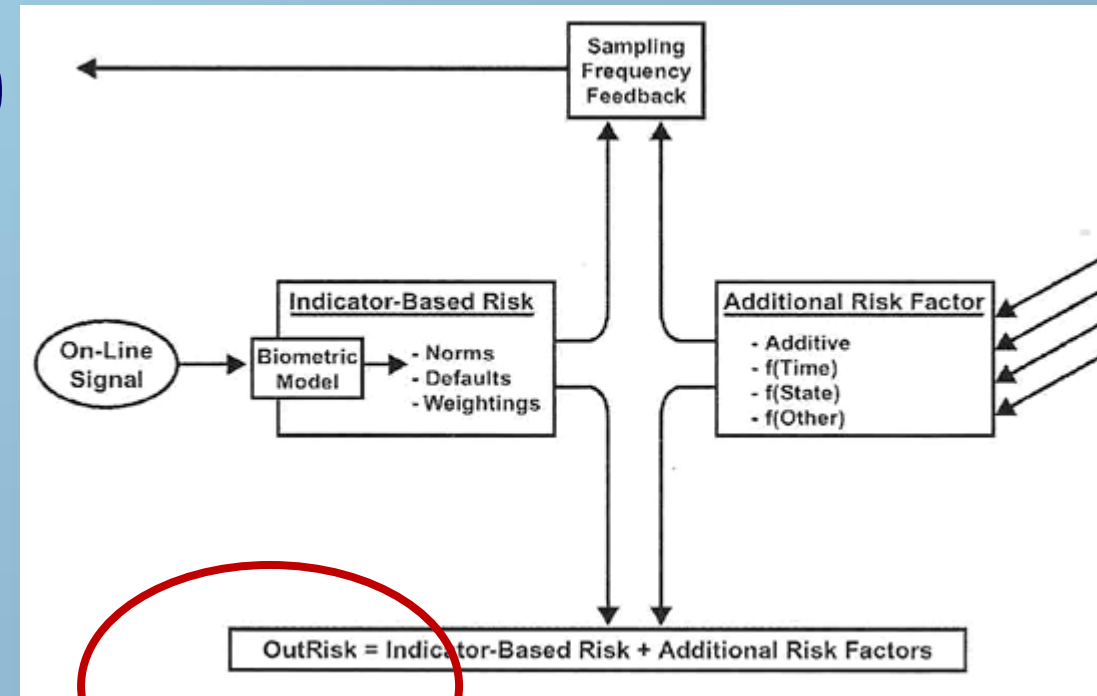
## – Time Series Models

### ■ Primary input:

- Lactate Dehydrogenase (mastitis)
- Beta Hydroxy Butyrate (ketosis)
- Progesterone (reproduction)
- Urea

### ■ Available other data:

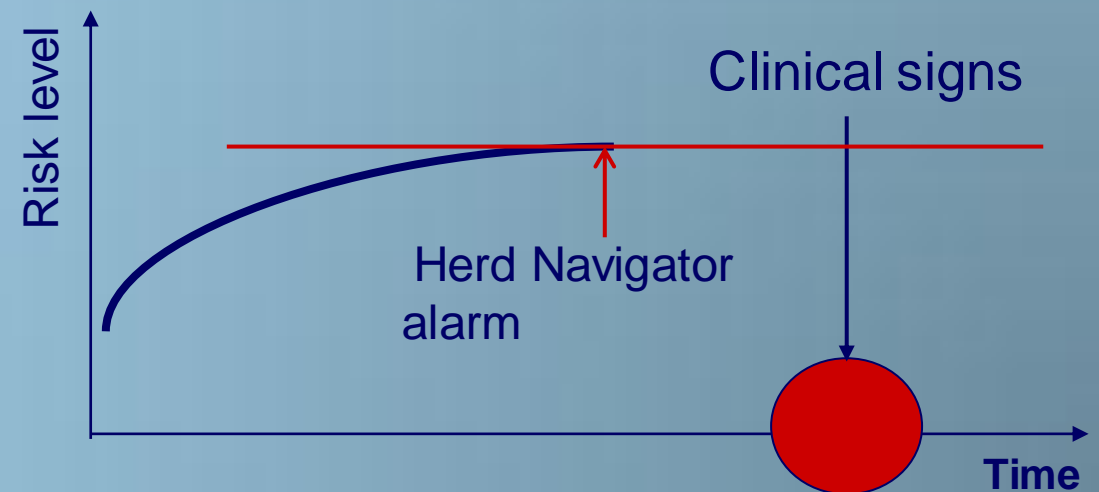
- Cow specific data
- Milk yield
- Stage of lactation
- Breeding data
- Observational data



**Model output: Risk of conditions in question**

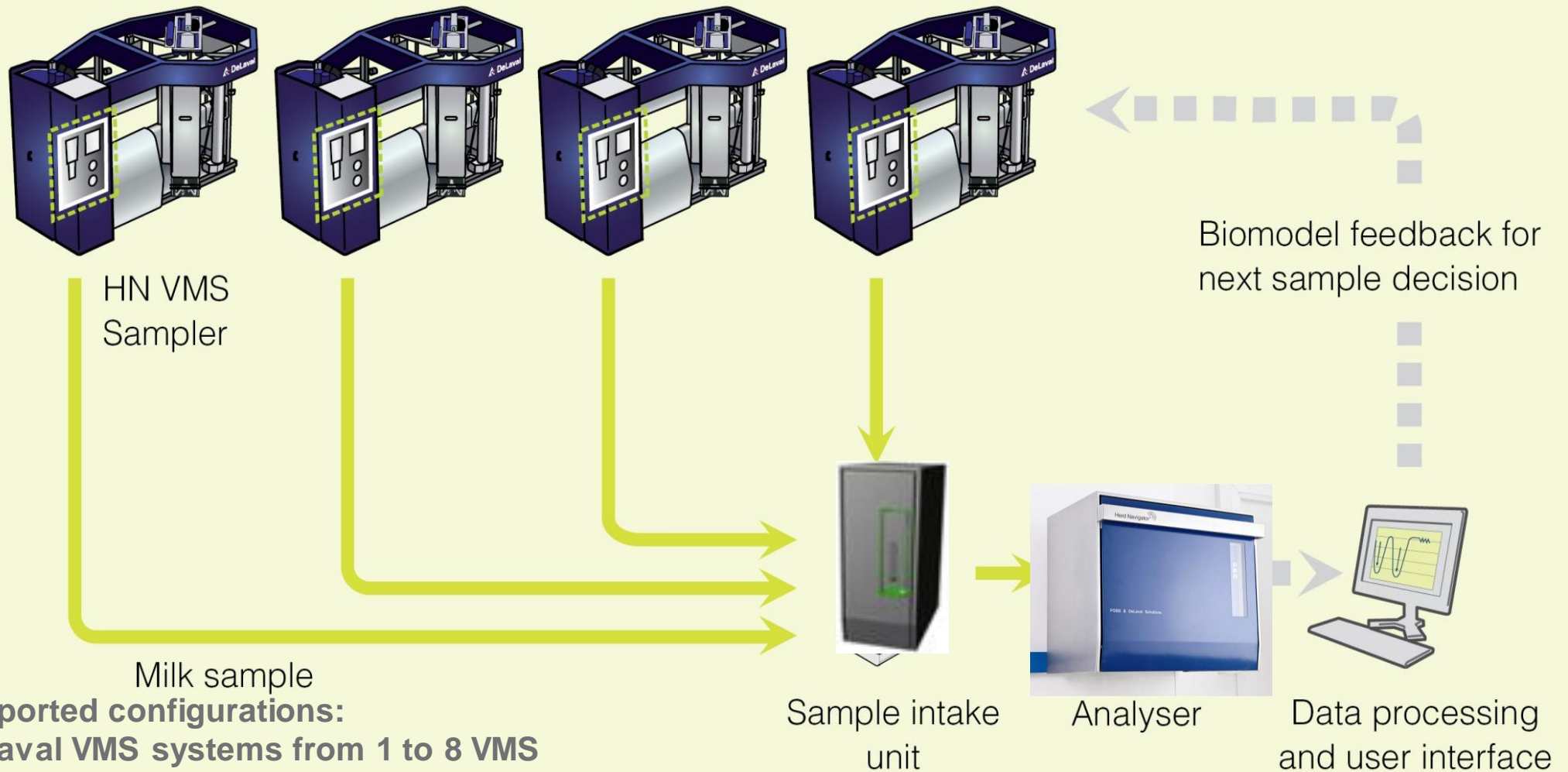
# The Concept of Risk Profiling

- Disease is not a yes/no issue!
- Diseases and disorders develop gradually
- Early warning allows for
  - Additional diagnostics, e.g. bacteriological culture
  - Less aggressive medication
  - Less tissue damage
  - Less discomfort for the cow
  - Less production losses



# How the Herd Navigator Works

## Working principle for Herd Navigator for VMS

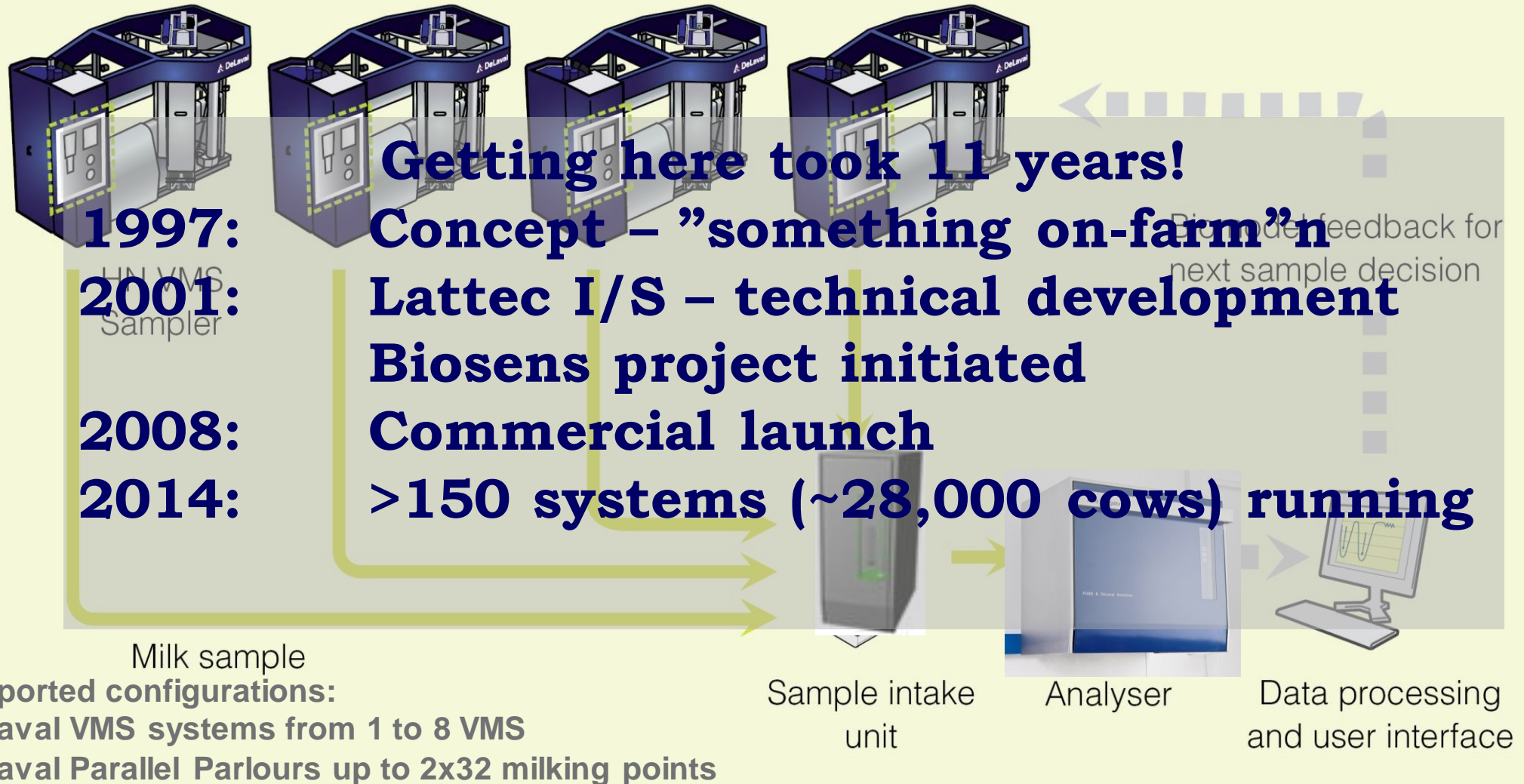


**Supported configurations:**  
DeLaval VMS systems from 1 to 8 VMS  
DeLaval Parallel Parlours up to 2x32 milking points



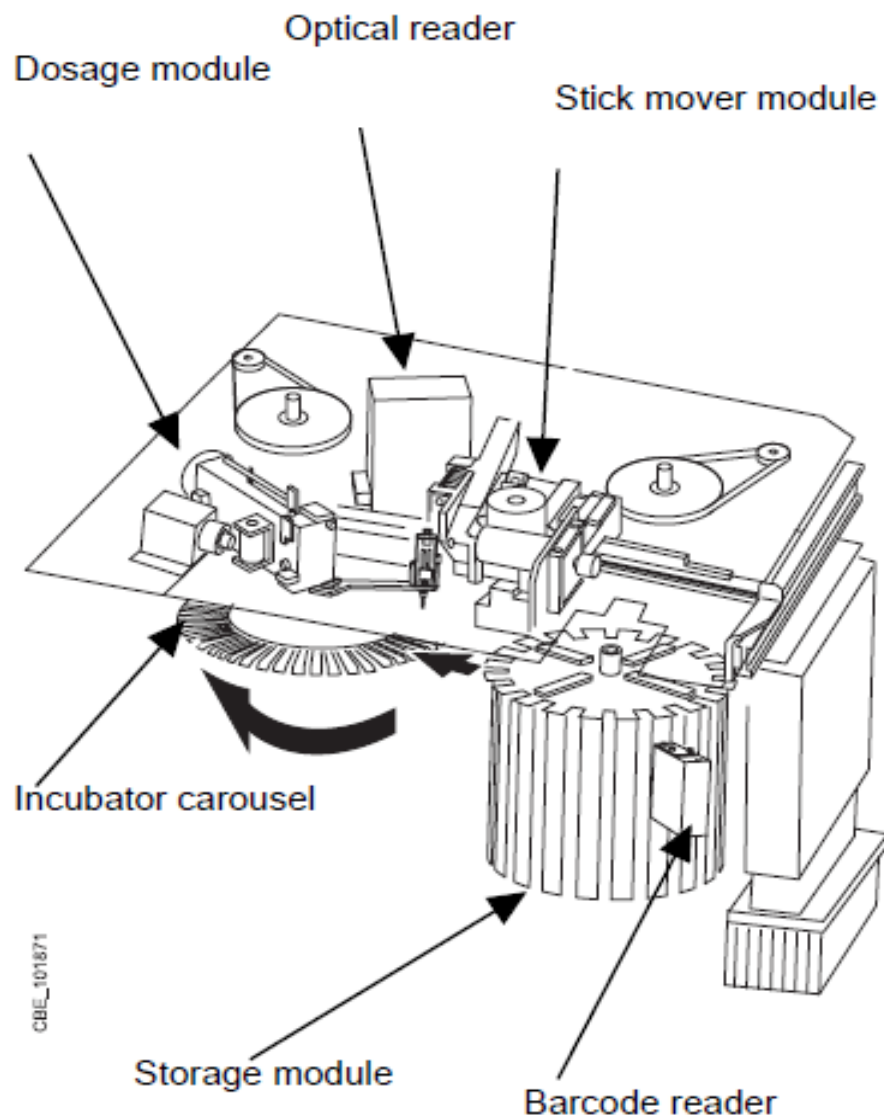
# How the Herd Navigator Works

## Working principle for Herd Navigator for VMS





# The Analysis Process



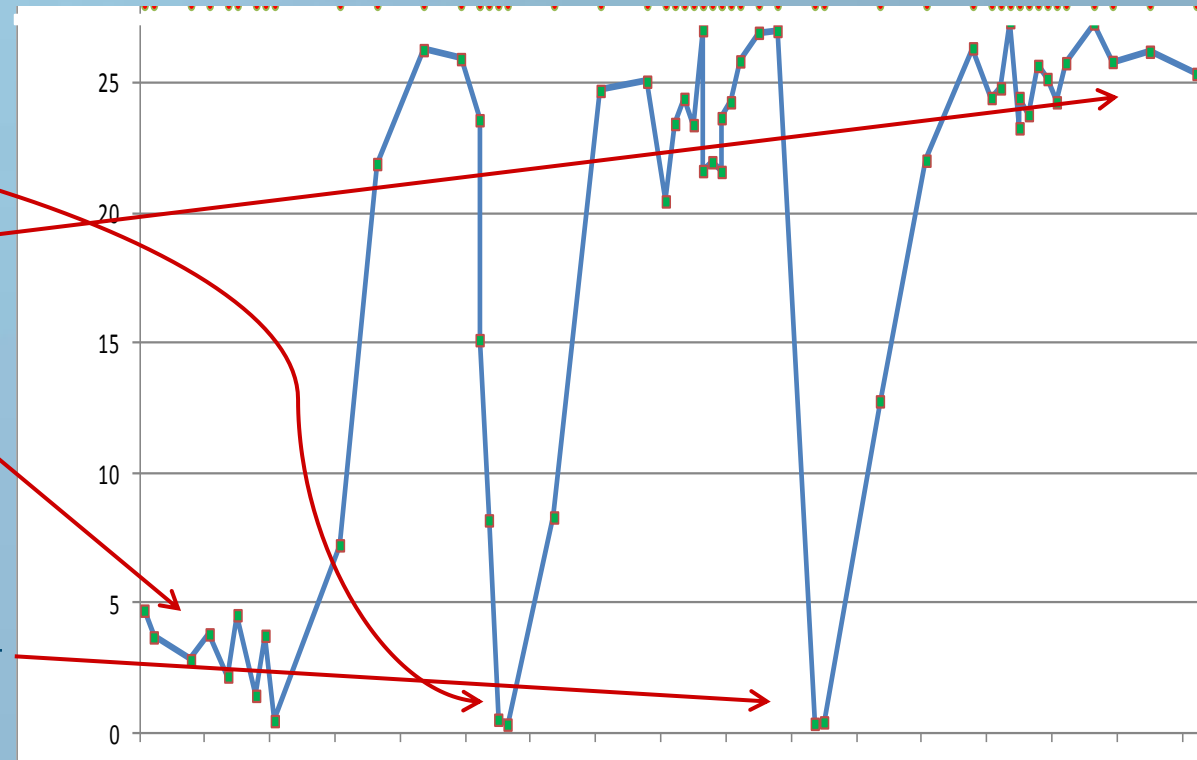
- The selected dry stick is pushed onto the incubator carousel
- The carousel rotates and when the stick is positioned below the needle drops of milk are applied on top of it (for progesterone mixed with diluent)
- During the incubation time a reaction takes place and the stick becomes colored
- The optical reader scans the intensity of the colour
- The result is processed in the HN software and transformed into a concentration used in the Biomodel

# Herd Navigator™ Analysis Instrument



# The Four Parameters in Herd Navigator™

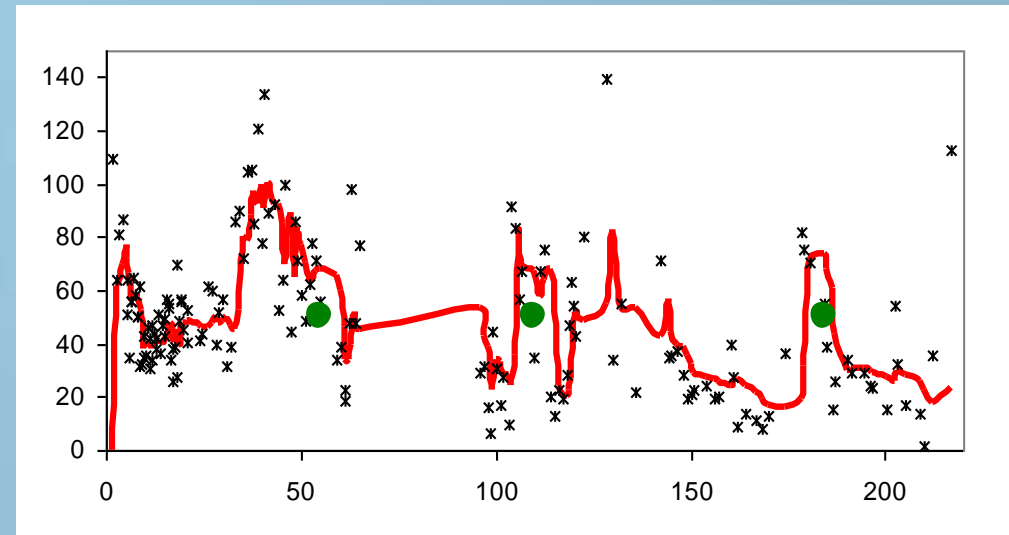
- **1. Progesterone**
  - Heat
  - Heat quality
  - Pregnancy
  - Post Partum Anoestrus
  - Follicular cysts
  - Luteal cysts
  - Early Embryonic Mortality
  - Abortions



# The Four Parameters in Herd Navigator

- **2. Mastitis Risk**

- Measurements of Lactate Dehydrogenase (LDH)



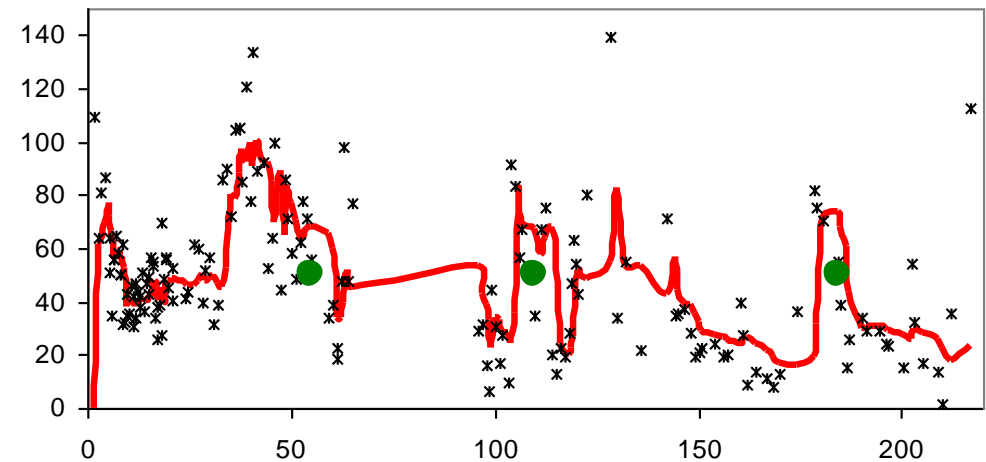
- **3. Ketosis Risk**

- Measurements of Beta Hydroxy Butyrate (BHB)

# The Four Parameters in Herd Navigator

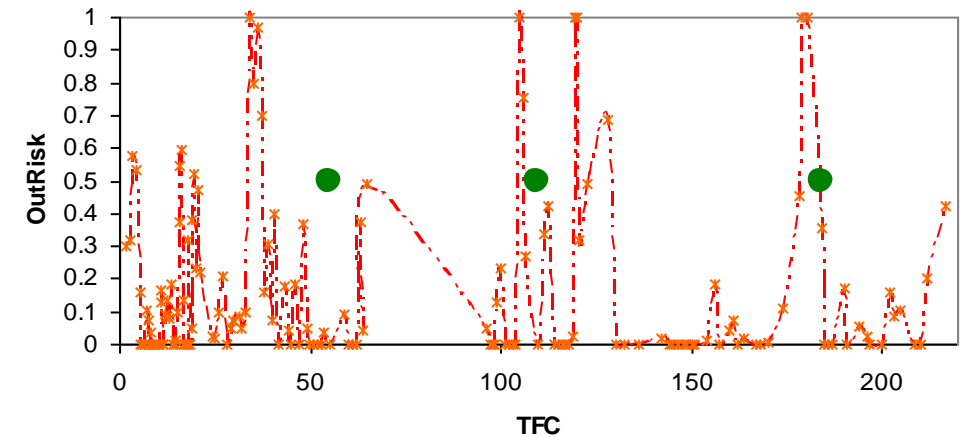
- **2. Mastitis Risk**

- Measurements of Lactate Dehydrogenase (LDH)



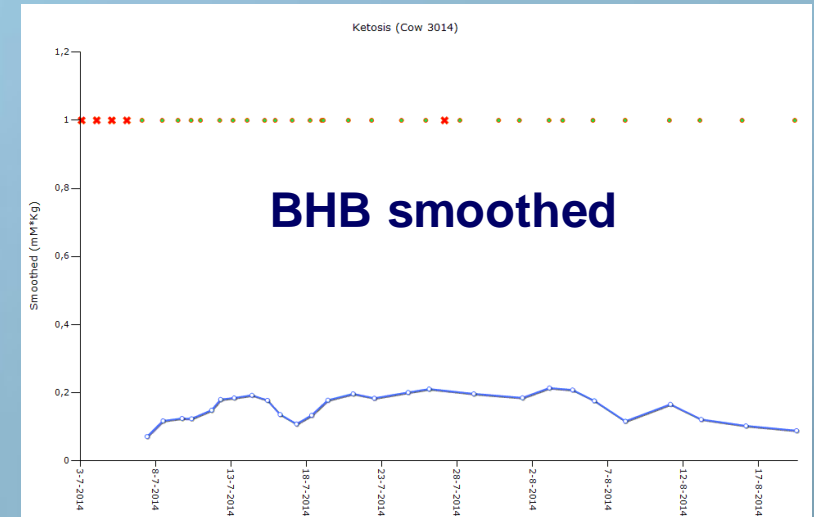
- **3. Ketosis Risk**

- Measurements of Beta Hydroxy Butyrate (BHB)



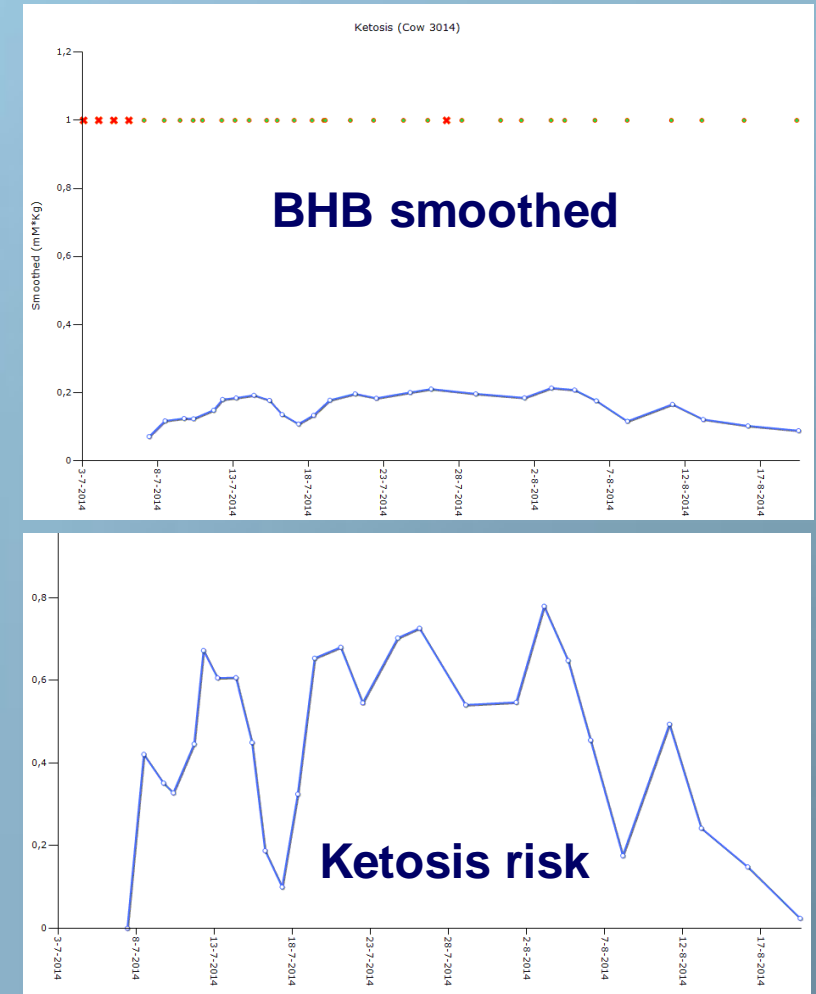
# The Four Parameters in Herd Navigator

- **3. Ketosis Risk**
  - Measurements of Lactate Dehydrogenase (LDH)



# The Four Parameters in Herd Navigator

- **3. Ketosis Risk**
  - Measurements of Lactate Dehydrogenase (LDH)

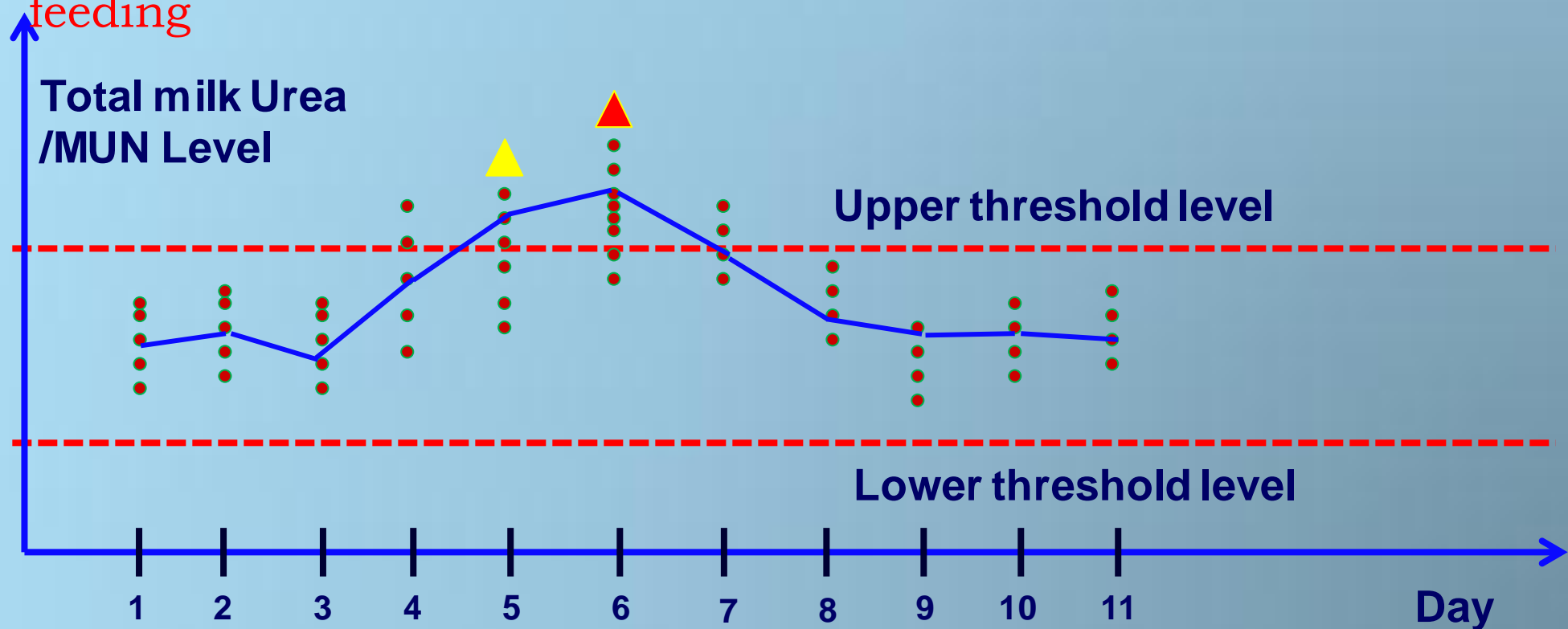


# The Four Parameters in Herd Navigator

## 4. Urea level

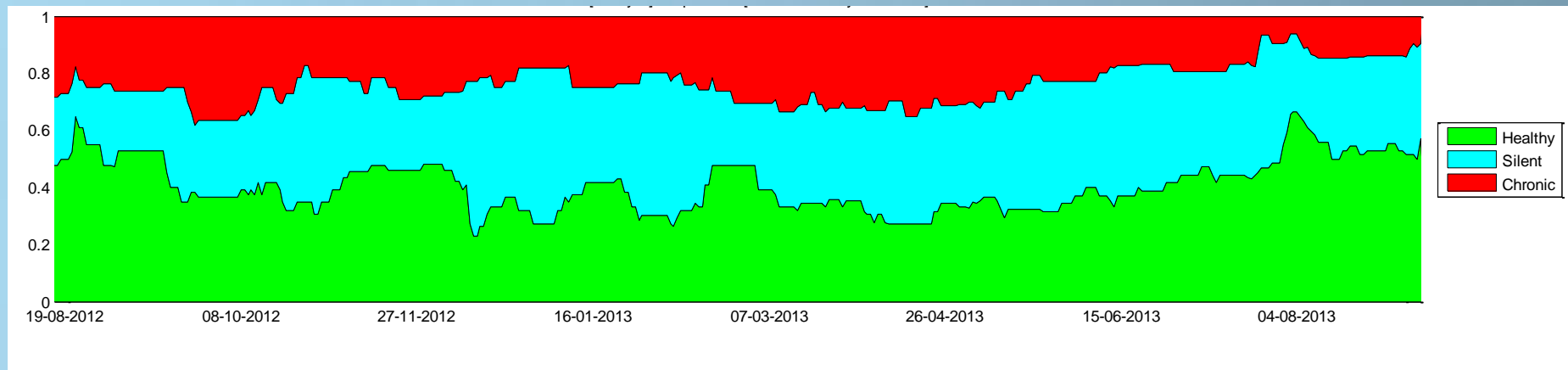
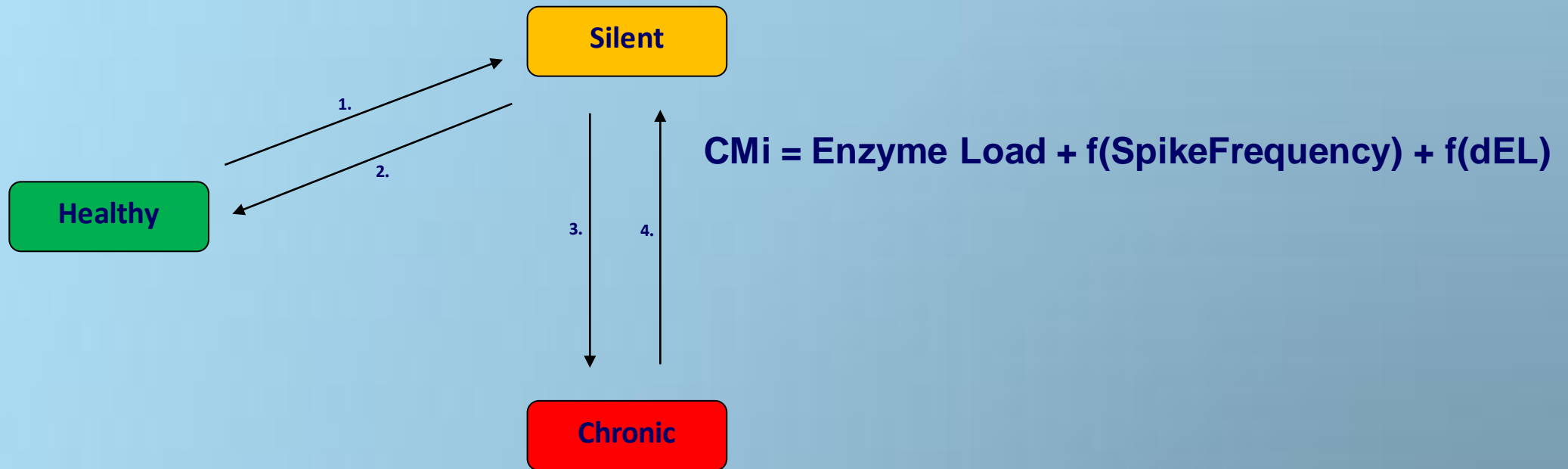
- Monitoring of protein and energy feeding

- ▲ Significant deviation  
Alarm in DELPRO or APW
- ▲ Non-significant deviation





# Whole Herd Monitoring Algorithm: Udder Health Classification Model



# The Four Stages of Meaningful Herd Management with Sensors

Level 4:

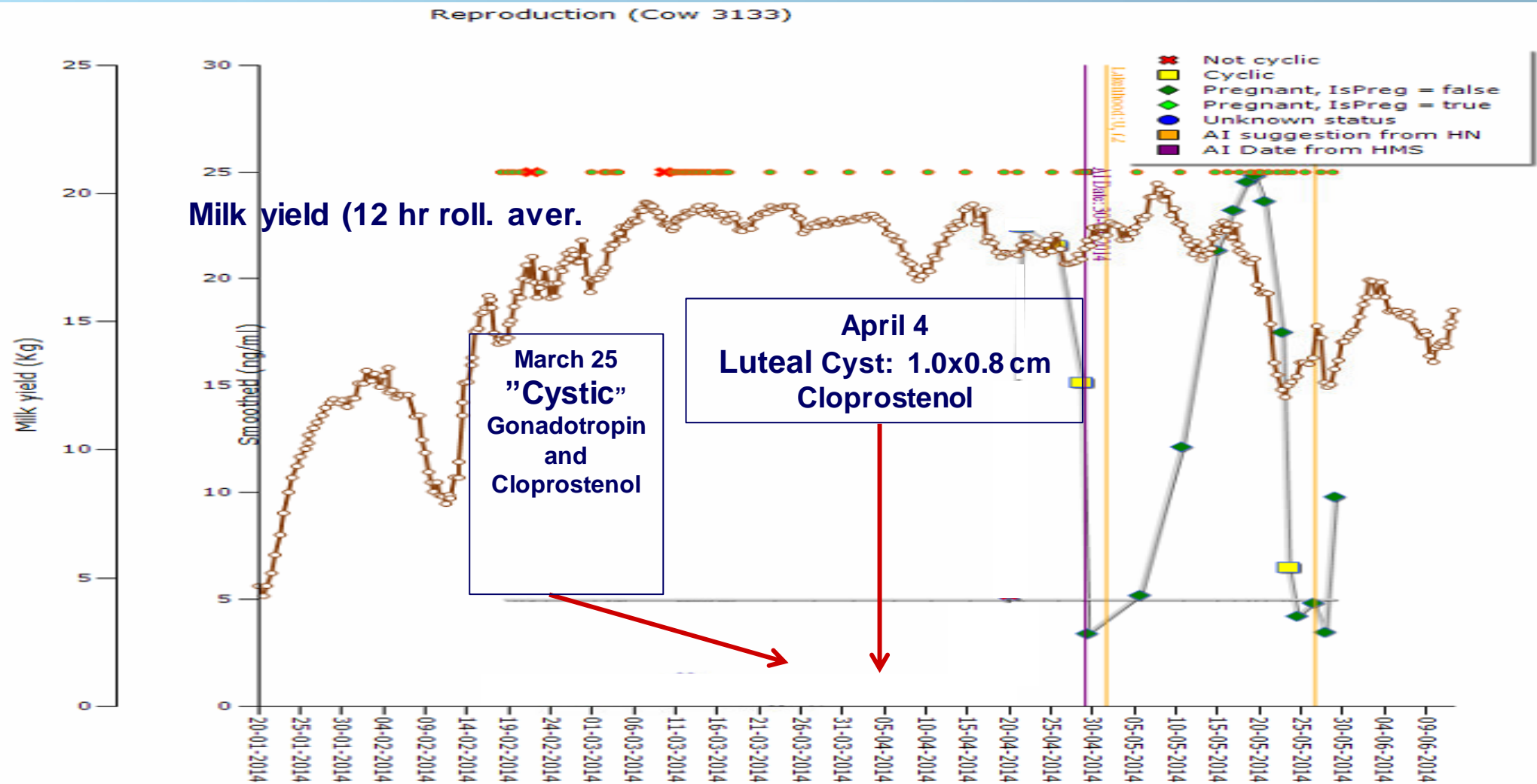
Advice to farmer or  
Autonomous action



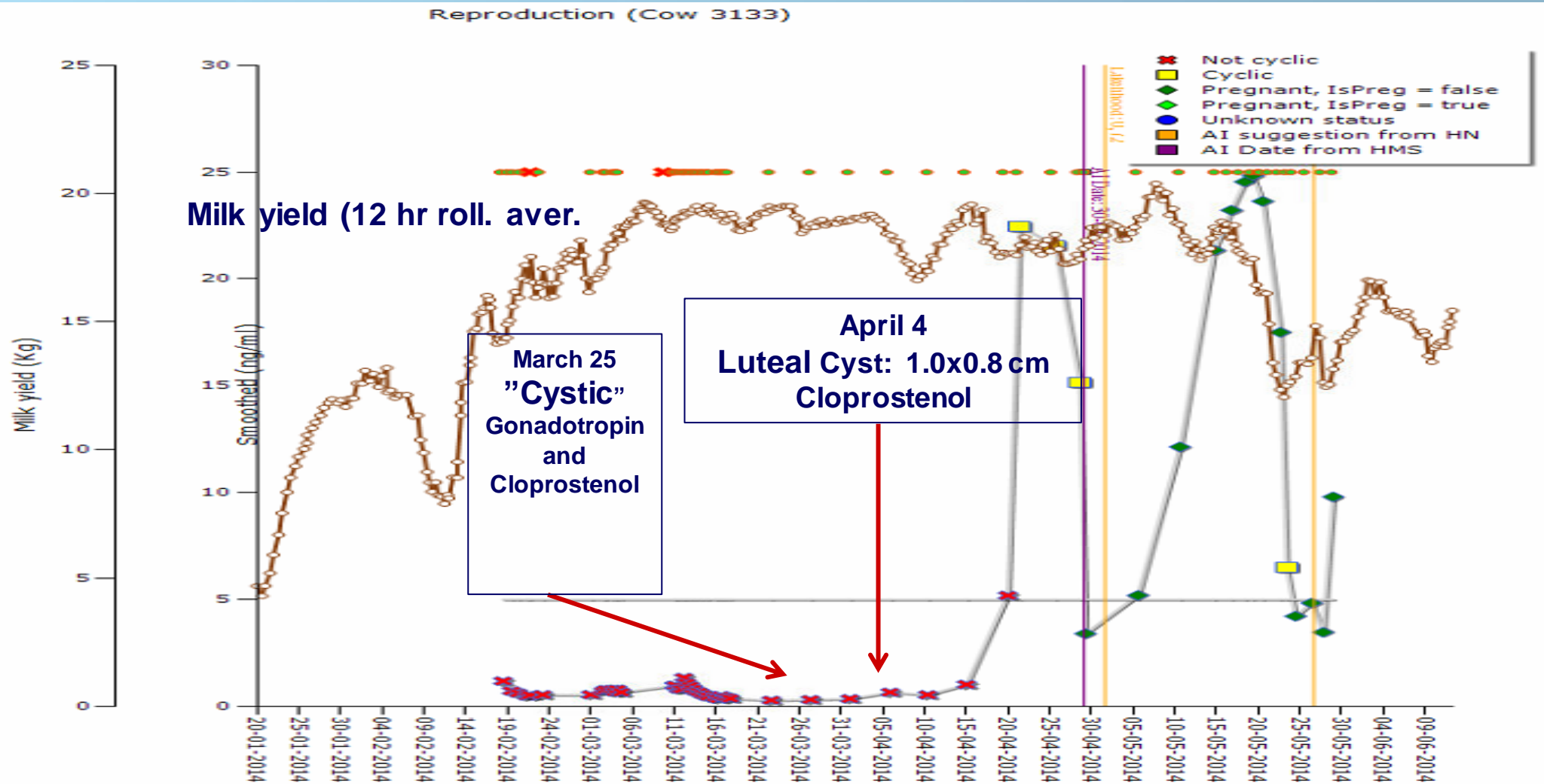
Advice

- Standard Operations Procedures (SOPs)
- Treatment protocols
  - Clear cooperation from herd adviser/vet!

# Actions of the "blinded" Vet.



# Now with Progesterone Data!



# The Four Stages of Meaningful Herd Management with Sensors

Level 4:

Advice to farmer or  
Autonomous action

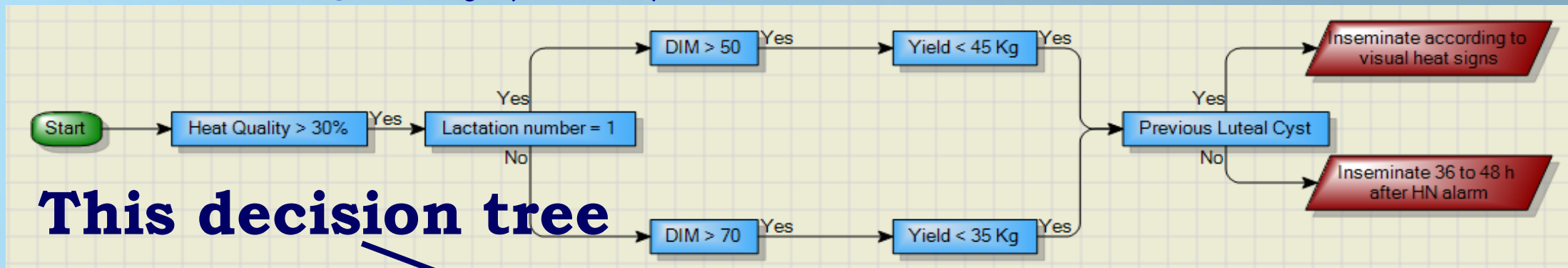
Advice

- Standard Operations Procedures (SOPs)
- Treatment protocols
  - Clear cooperation from herd adviser/vet!
- Follow up on efficacy of treatment
- **If the customer follows this he can harvest the full potential!**

# Herd Navigator Reports and Standard Operations Procedures – an Example

## SOP Criteria:

- Days from calving, Lactation number and Milk Yield.
- Heat Quality (>30%)

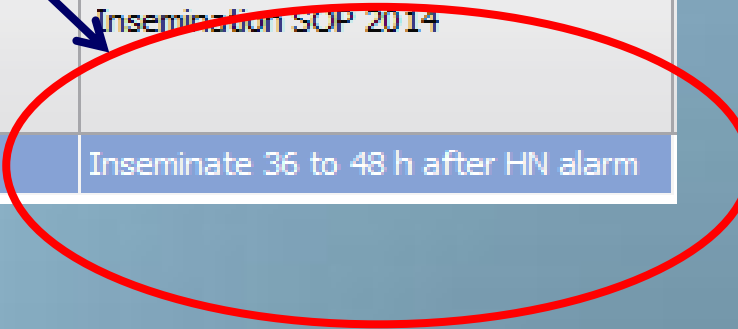


**boils down to this**

Animal Number	Animal Name	Group Number	Lactation Number	Days In Milk	Avg Daily Yield Last 7d	Number Of Inseminations	HN Heat Alarm	HN Heat Hours Since Alarm	HN Heat Quality [%]	HN Luteal Cyst Alarm	HN Missing Sample Alarm	Insemination SOP 2014
9	Tina	1	1	137	30,91	3	Yes	53	70			Inseminate 36 to 48 h after HN alarm

# Herd Navigator Reports and Standard Operations Procedures Anyone can React to it

**This is what to do!**



Daily Last 7d	Number Of Inseminations	HN Heat Alarm	HN Heat Hours Since Alarm	HN Heat Quality [%]	HN Luteal Cyst Alarm	HN Missing Sample Alarm	Insemination SOP 2014
30,91	3	Yes	53	70			Inseminate 36 to 48 h after HN alarm

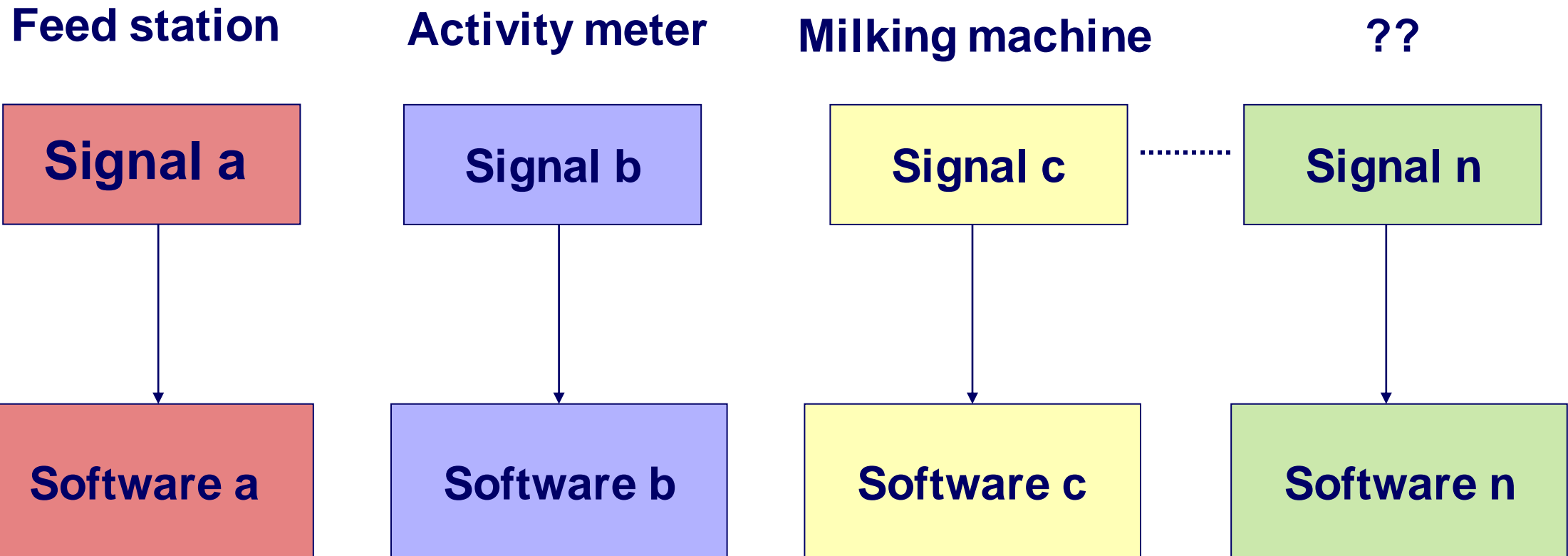
# The Future?

- **We do know:**
  - New monitoring technology will be developed
    - User or technology driven?
- **The user will demand:**
  - Added value of system
    - Benefit/cost relations
    - System saves time
  - Systems must communicate





# How to Confuse the Dairy Manager:



**Several warning messages and alarms**  
**Conflicting messages?**

# The Future?

- **We do know:**

- New monitoring technology will be developed
- User or technology driven?

- **The user will demand:**

- Added value of system
  - Benefit/cost relations
  - Systems that saves time
  - Ease of mind
- Systems must communicate
- Easy to use and understand systems
- Bewley's theorems fulfilled!



A photograph of a dolphin and a cow jumping out of the water. The dolphin is on the left, leaping upwards with its tail visible. The cow is on the right, also leaping upwards with its legs tucked. The water is a vibrant greenish-blue, and the sky is a clear, bright blue. The scene is captured in a way that makes it appear as if the cow is flying like a dolphin.

# Thank You!

We strive to  
keep cows flying!

Website: [Herdnavigator.com](http://Herdnavigator.com)

lattec