INNOVATION IN LIVESTOCK PRODUCTION: FROM IDEAS TO PRACTICE

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WARSAW, POLAND

SRUC

"Advances in monitoring of livestock"

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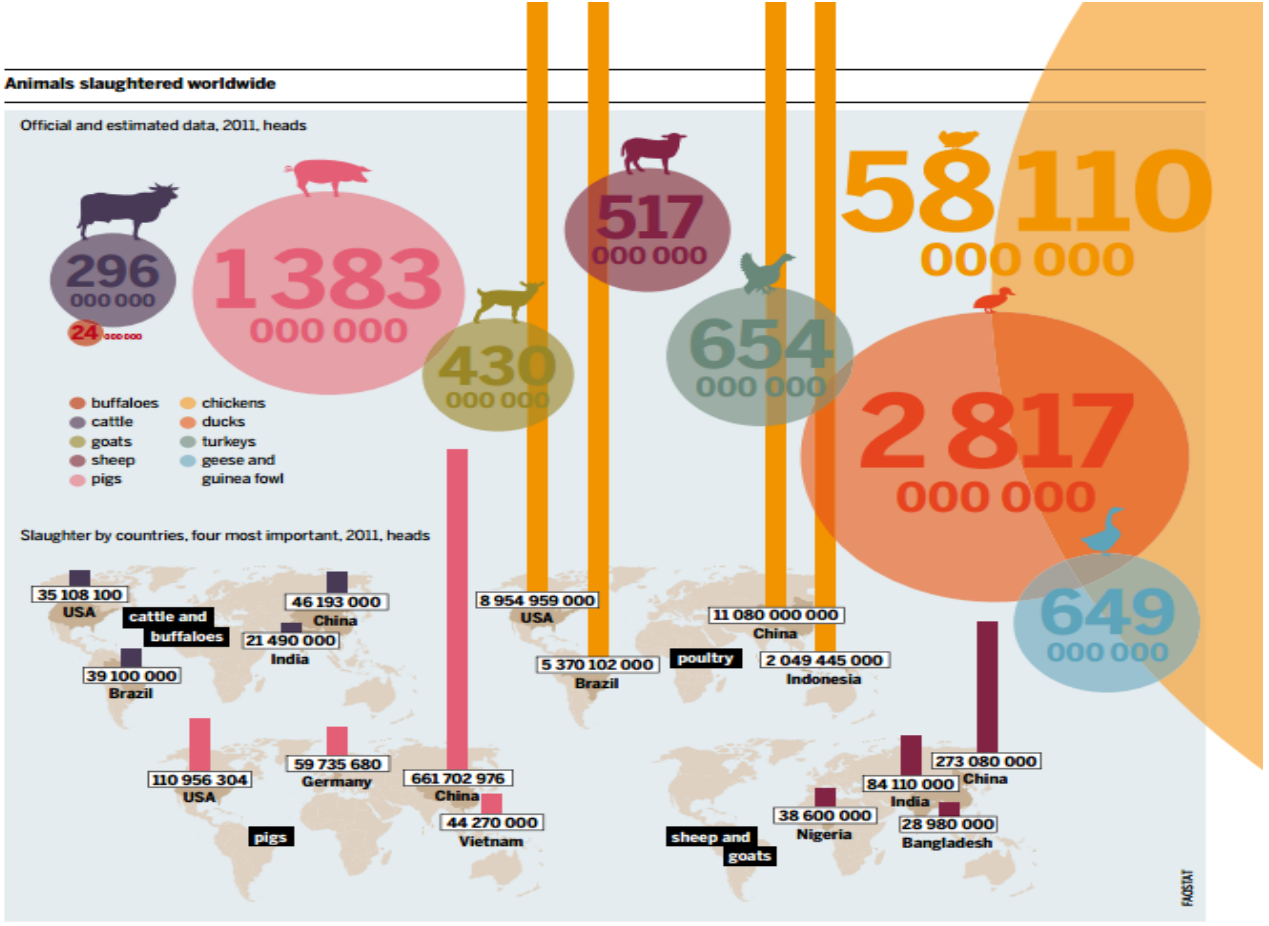
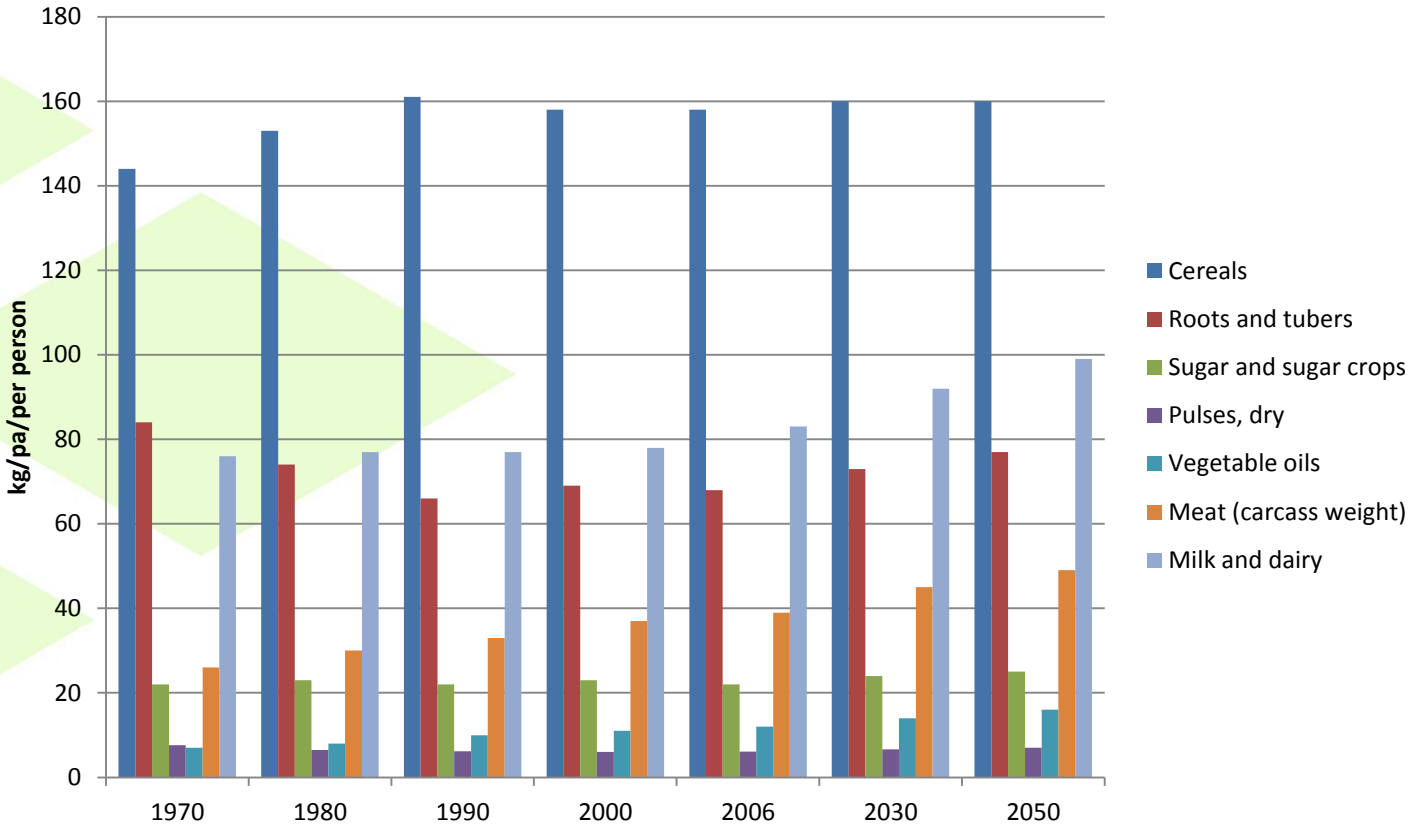
Future Farming Systems Group, SRUC

Leading the way in Agriculture and Rural Research, Education and Consulting

Global Livestock production - current

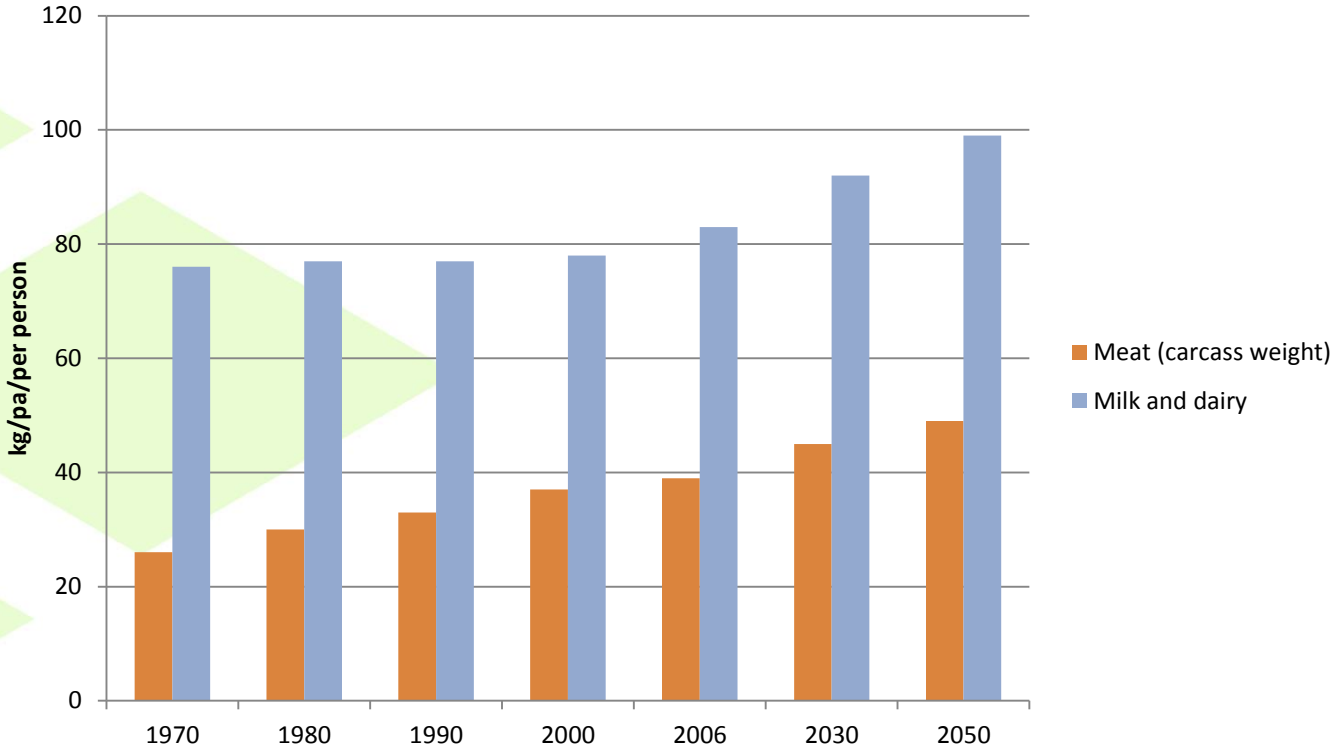


FAO world projections all foods..



Source :WORLD AGRICULTURE TOWARDS 2030/2050 The 2012 Revision

FAO world projections – meat and milk…



Source :WORLD AGRICULTURE TOWARDS 2030/2050 The 2012 Revision

So… the Driver…

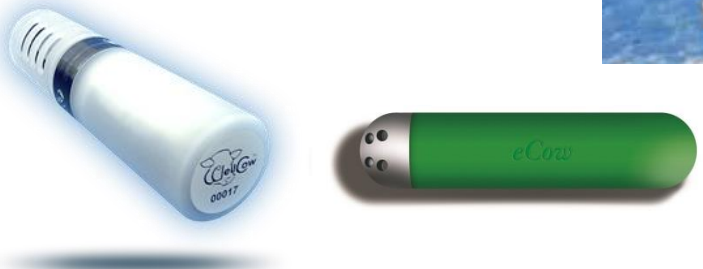
- **Improvements in the yield and sustainability of livestock food products**.

How can monitoring livestock contribute?

  - Sensing systems to accurately monitor aspects of the production **system**
  - acquisition of data
  - conversion of this data into information
  - effective livestock production management (production efficiency, health, sustainability etc)
  - On-animal and fixed systems

Animal mounted - needs and examples..

- Robust, robust and robust!!
- Energy?
- Cost?
- Do they measure something useful?
  - Livestock production efficiency - sensor combinations
  - Livestock performance - imaging solutions
  - Livestock health – novel diagnostics



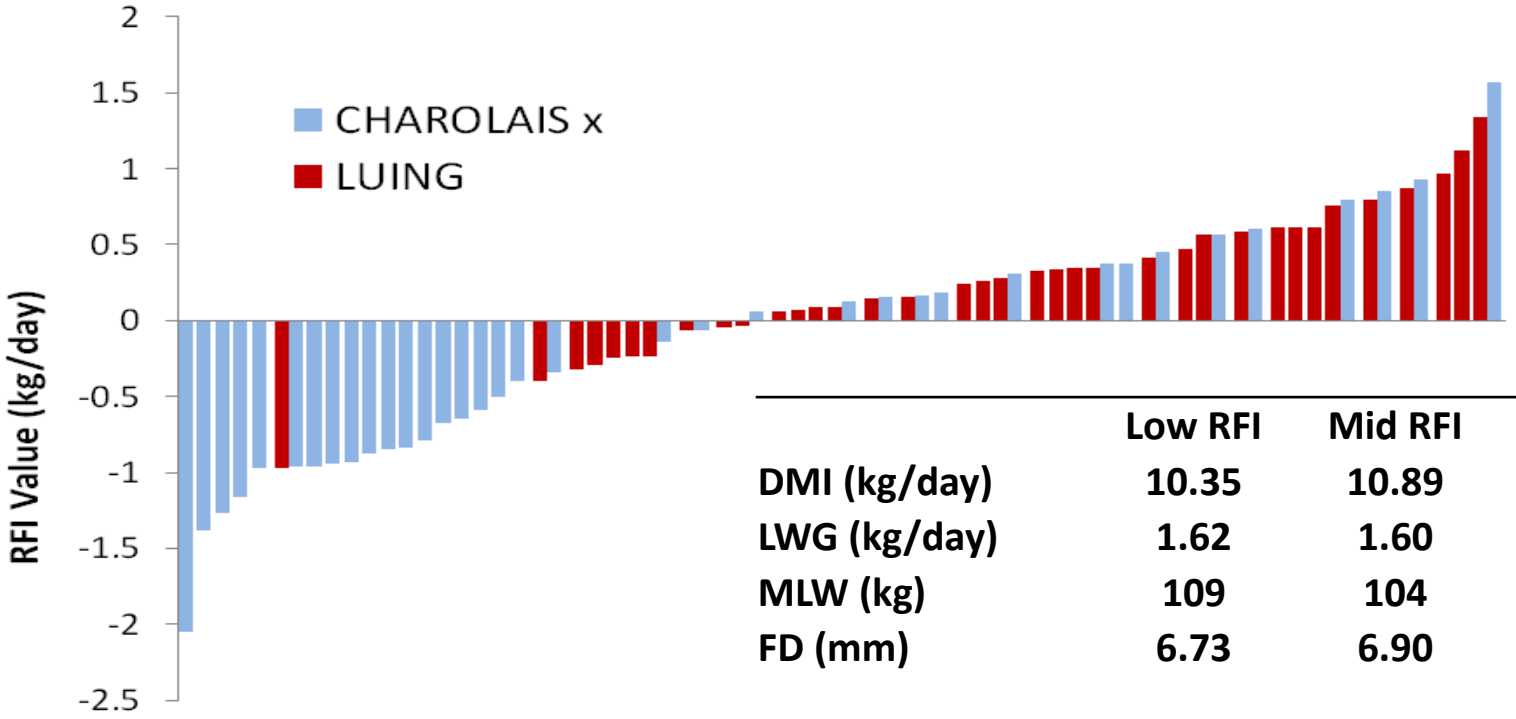
“Capital intensive” measurements – large ruminants..

GreenCow – SRUC R&D facility

InsentceHoko feeders (44 in total) – 32 with methane hoods

Can measure up to 132 animals at one time

Monitoring for individual efficiency in beef cattle



	Low RFI	Mid RFI	High RFI
DMI (kg/day)	10.35	10.89	11.92
LWG (kg/day)	1.62	1.60	1.62
MLW (kg)	109	104	111
FD (mm)	6.73	6.90	6.79
FCR (kg DMI:LWG)	6.50	6.86	7.47
RFI (kg/day)	-0.78	0.09	0.69

Duthie et al 2014

Studies confirming economic importance

	Comparison	Difference in feed eaten (same gain)	Financial gain
Stabiliser bulls (UK)	Top vs Bottom	25%	£92/animal over 205 days
Simmental bulls (Ireland)	Top ⅓ vs Bottom ⅓	14%	€35/animal over 105 days
Angus or Hereford bulls (Canada)	Top ⅓ & Bottom ⅓	3.4 kg 'as fed'	C$47/animal over 140 days
CH/CHx steers – high concs (SRUC)	Top vs Bottom	28% (3.8 kg Dry Matter)	£85 over 120 days
Luing steers – high forage (SRUC)	Top vs Bottom	31% (4.2 kg Dry Matter)	£95 over 150 days

Example - “Precision Beef” project

- Developing animal mounted sensor systems
- Developing complimentary sensor systems for feed measurement, on feeder wagon.
- Combined decision support system
- Target – measurement of individual intake efficiency

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GILDEN photonics

Keenan

silent herdsman

Harbro
QUALITY LIVESTOCK NUTRITION

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Example - “BeefMonitor” project

- Auto-weigh and novel camera system captures range of performance (economic) measures
- Patented
- Sheep/goats??

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INNOVENT TECHNOLOGY

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Scotbeef
LIMITED

Project co-funded by:
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Animal product monitoring

- Product quality AND animal health
- In-line systems
- Dairy cow health (integration of sensors)
- Carcass quality
- Meat quality

The Scottish Government
Riaghaltas na h-Alba

QMS
QUALITY MEAT SCOTLAND

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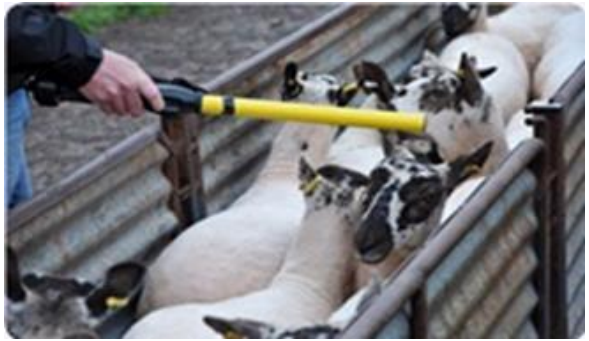
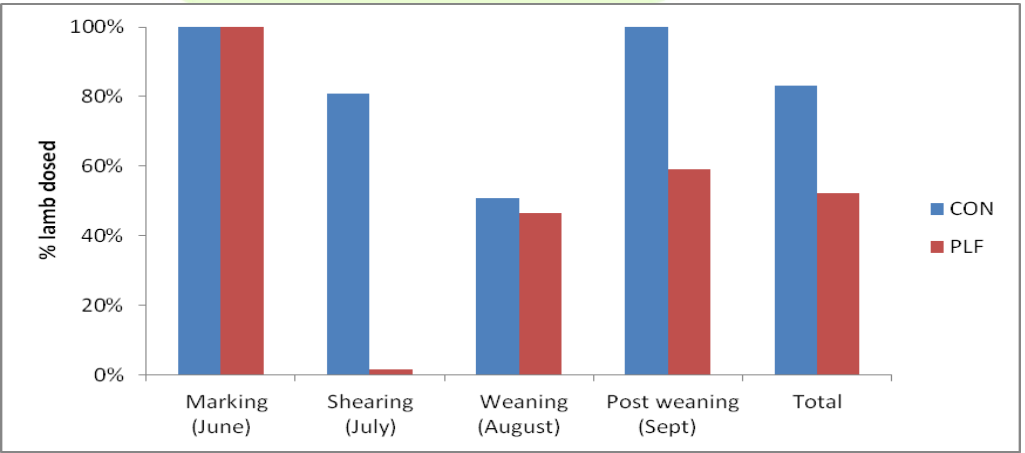
Electronic identification

- EU mandatory for all sheep
- Antenna and wand type readers common
- Wand typical range 30cm
- Antenna max claimed range 1m
- Applications e.g. target selective anthelmintic treatment – based on weight gain..





C Morgan-Davies et al -2014

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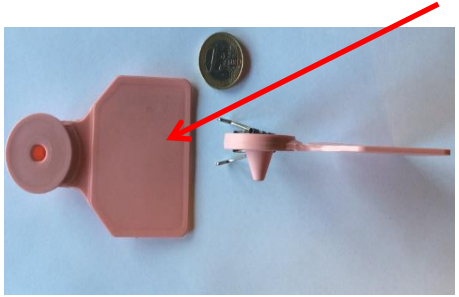
Electronic identification – future?

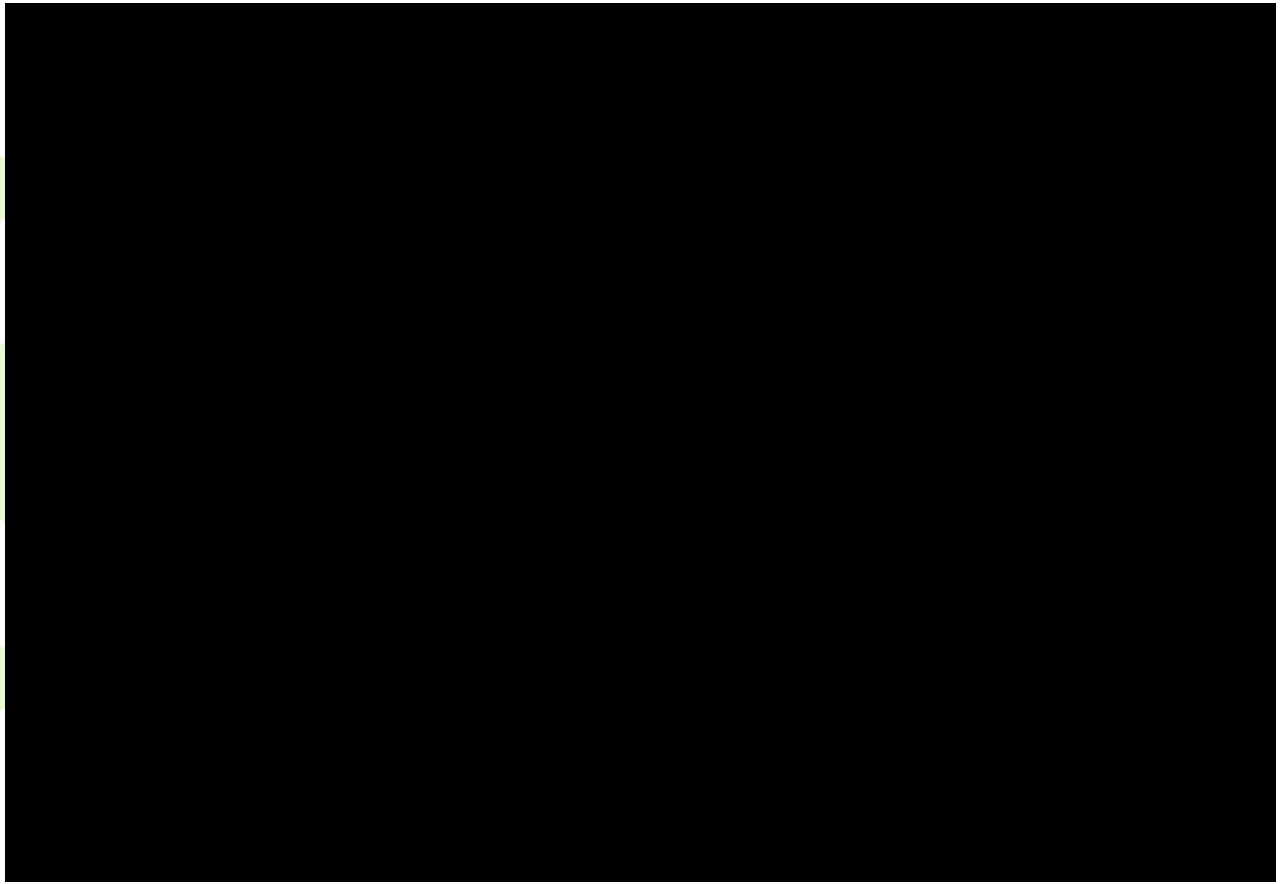
- National/EU sheep system, LF only (ISO 11784/11785)
- UHF offers some advantages (long range, no contention, read/write etc)
- ScotEID Trialing dual LF-UHF
- Regulatory/standards issues
- Bovine EID Regulation currently voluntary. 18 July 2019 – option to make compulsory. ISO or "equivalent" standard
- Traceability depends on technology & governance

dual LF/UHF



www.ScotEID.com

UHF EID trial

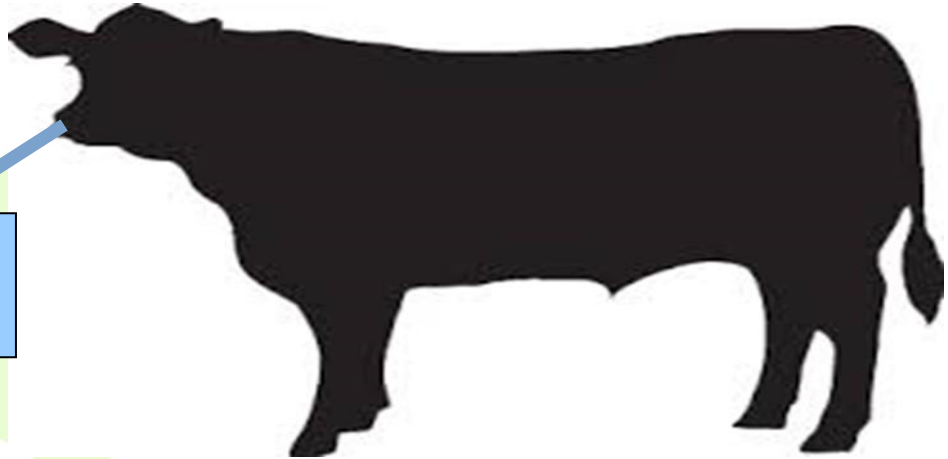


Virtual Fencing – sensors and control!

Day 0

Day 1

Nutrition biomarker example



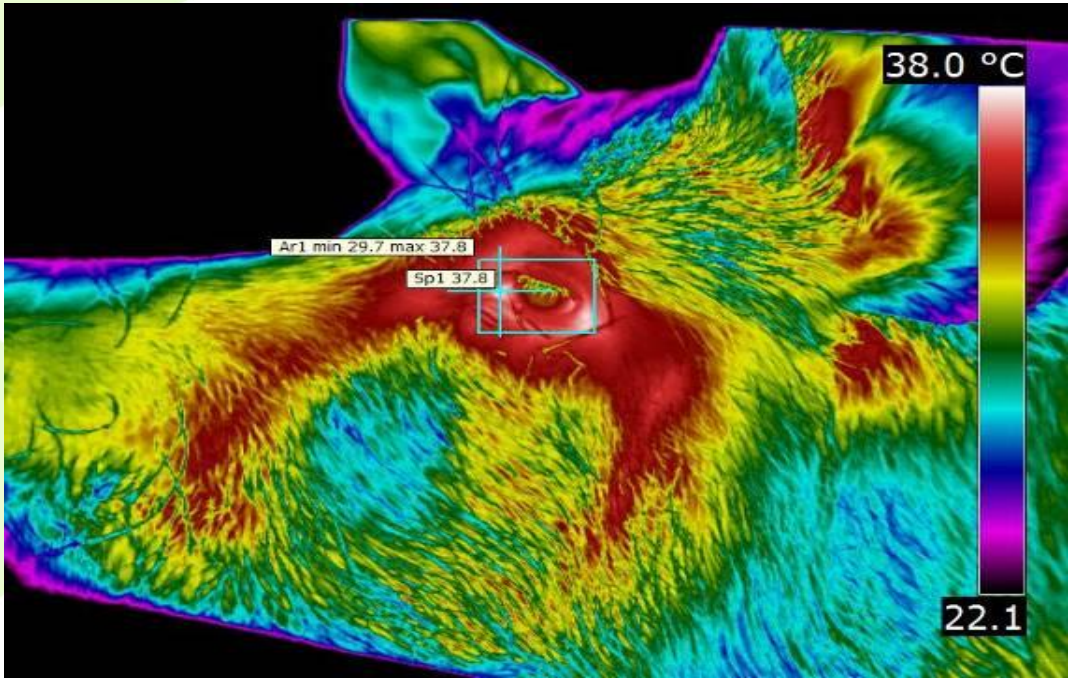
Breath analysis in real-time using SIFT-MS: selected-ion-flow-tube mass spectrometry

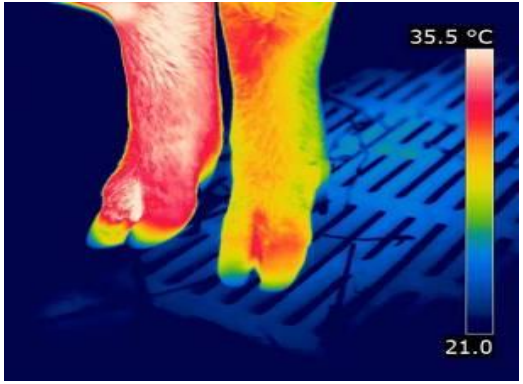
Cow breath components (ppb) – *Dewhurst et al*

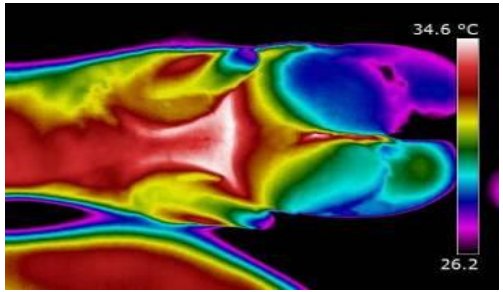
Ammonia	22.5
Dimethylamine	28.8
Trimethylamine	15.2
Acetaldehyde	29.9
Hexanal	8.2
Trans-2 hexenal	1.8
Cis-3 hexenal	3.6
Octanal	4.8
Decanal	1.6
Acetone	786.2
Butanone	140.8
Diacetyl	8.9
Acetophenone	0.8
Methanol	231.0
Ethanol	88.5
Propanols	9.2
Hexanol	0.5
Cis-3 hexen-1-ol	7.7
Acetic acid	54.1
Propionic acid	13.2
Butyric acid	28.7
Valeric acid	11.9
Hexanoic acid	4.8
Hexenyl acetate	4.2
Methyl sulphide	2.3
Dimethyl sulphide	226.3
Toluene	17.1
Heptane	23.2
Octane	21.8
Nonane	7.6

Thermal Imaging potential

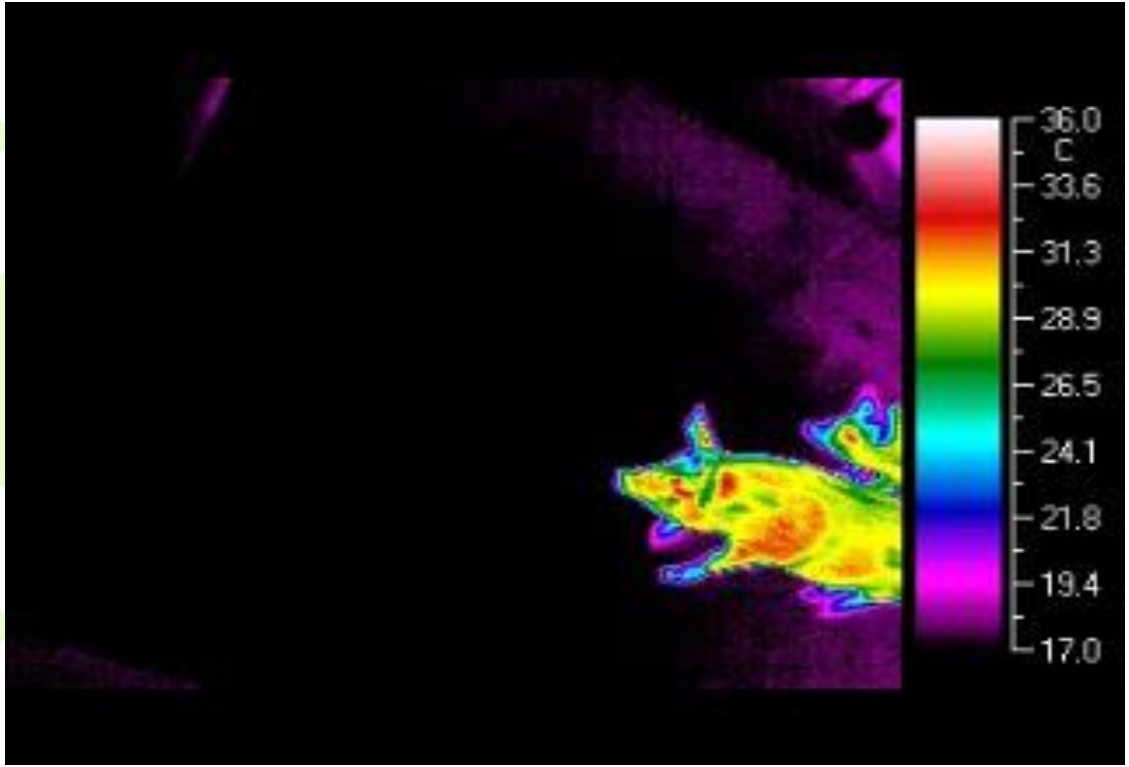
- **Eye & body temperature, lameness, reaction to stress and other behavioural challenges in pigs**







Thermal Imaging capabilities



Animal health – e.g. Sheep scab

- Allergic dermatitis caused by *Psoroptes ovis*
- One of the top 5 sheep diseases in Scotland

Eradicated from Britain in 1952, reintroduced in 1973
NOW notifiable…

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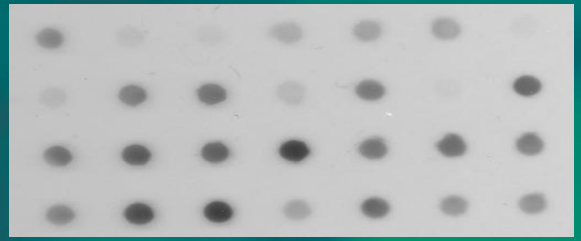
Pen-side diagnosis

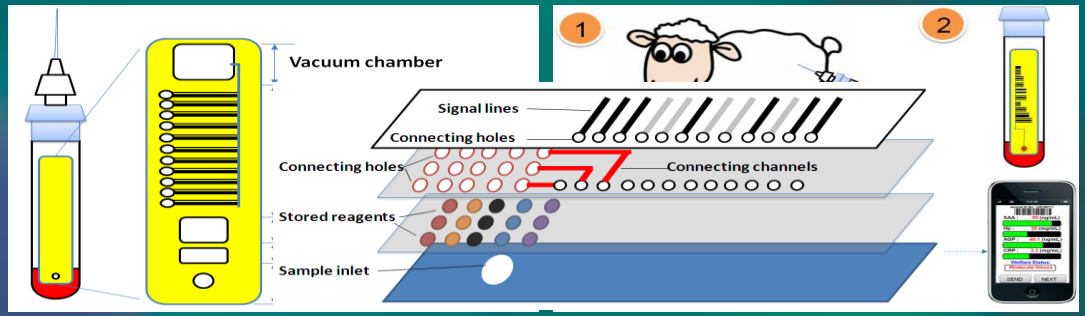
- Why might a pen-side test be useful:
  - Markets/shows
  - Bringing new stock onto farm/quarantine
  - Confirmation of suspected disease (skin scraping –ve but clinical signs)

3D paper-based microfluidic platform

- 1D = static ELISA (dot blot)
- 2D = paper lateral flow device
- 3D = stacked LFDs (interconnecting channels)

- Individual assays for BMs and anti-Pso o 2
- Single barcoded read out





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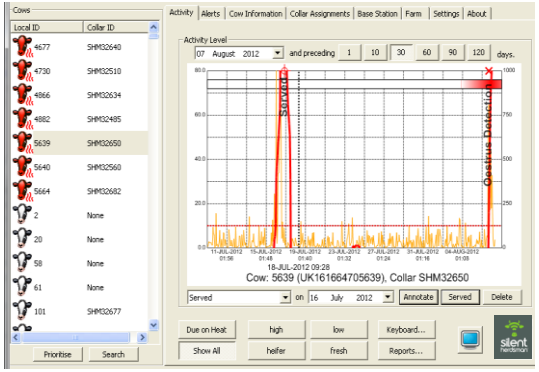
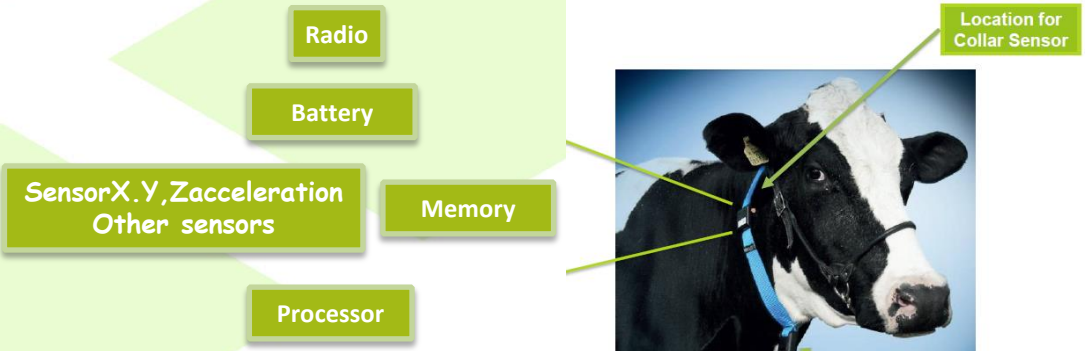
Reproductive efficiency and rumination

- Reproductive efficiency improves economic performance
- Collar mounted activity monitoring – relating to oestrus.
- Complimentary monitoring of rumination and feeding





Sensitivity *TP/(TP+FN)*	90.3 %
Positive Predictive Value *TP/(TP+FN)*	93.3%
Accuracy *(TP+TN)/(TP+TN+FP+FN)*	90%
Specificity *TN/(TN+FN)*	85-90%
False Alarm Rate *FP/(TN+FP*	10.5%

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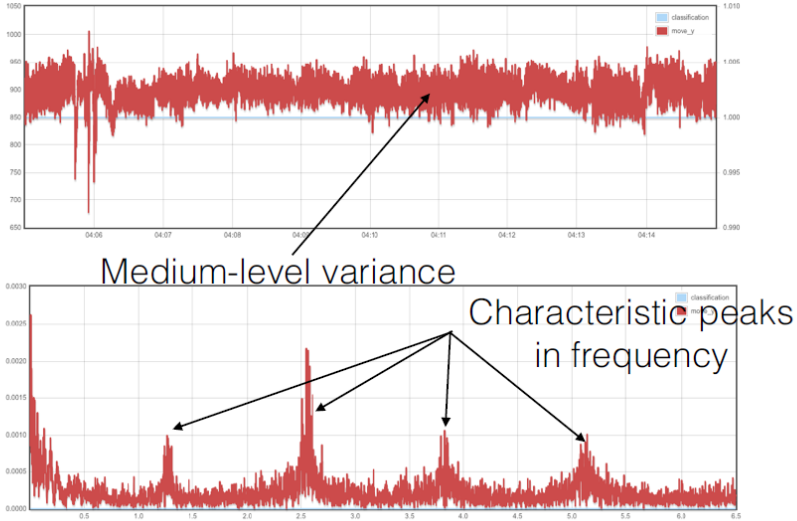
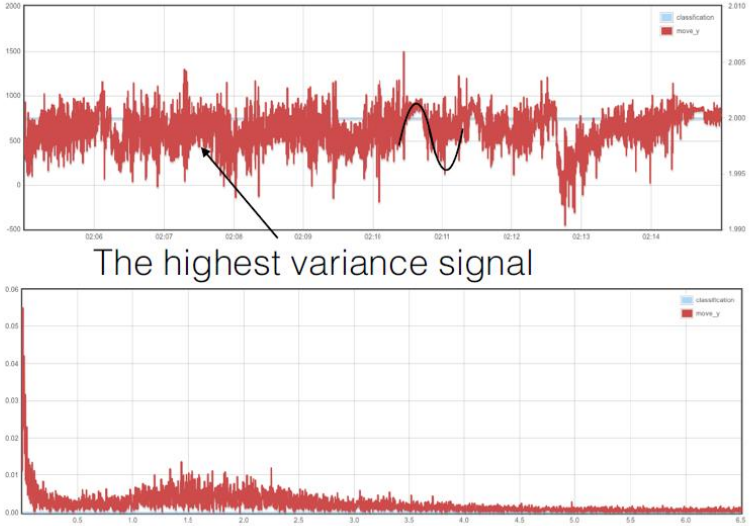
Feeding and rumination

Rumination



Eating



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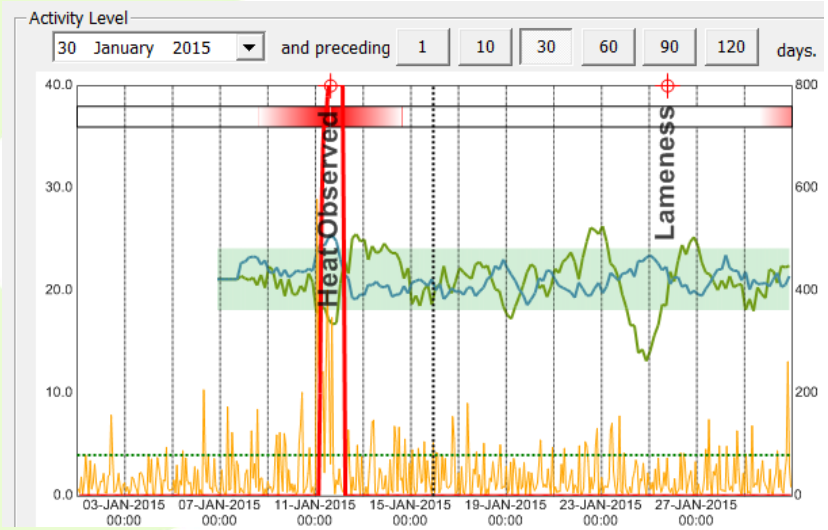
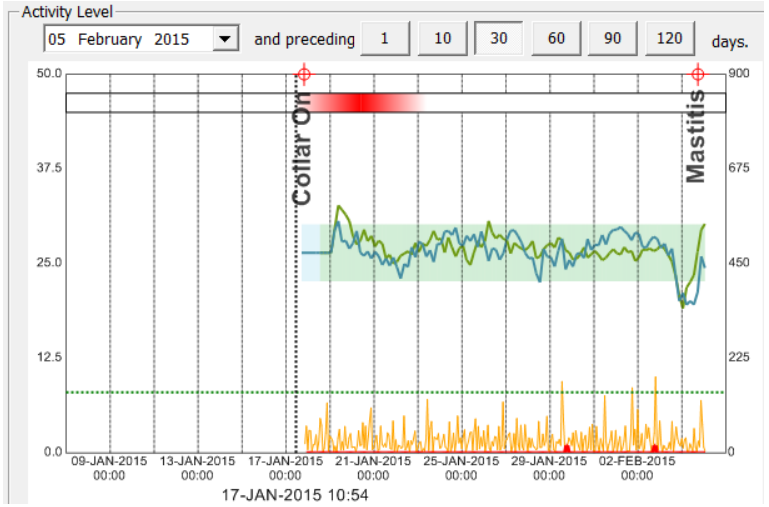
Individual application examples

LAMENESS

- Normalised Eating/Rumination
- Flagged when out of bounds (green shade)



CLINICAL MASTITIS



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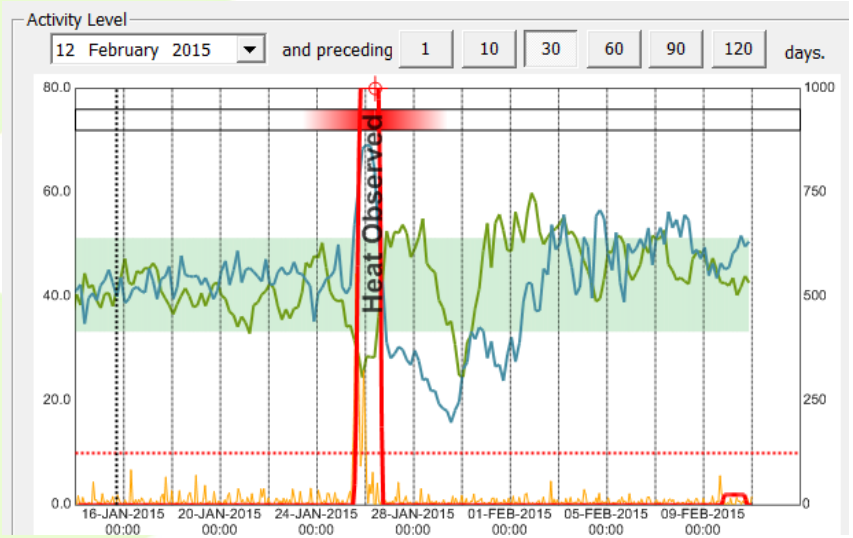
Individual application examples

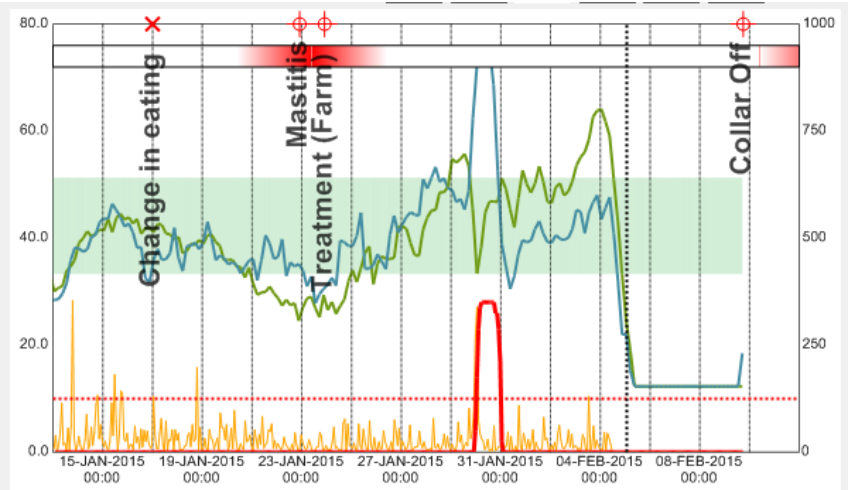
INJURED BACK – RECEIVING TREATMENT

Normalised Eating/Rumination

- Flagged when out of bounds (green shade)



MASTITIS – THEN CULL



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Sub-acute ruminal acidosis - “SARA”

- Sub acute ruminal acidosis is a significant performance affecting condition
- Intra-ruminal bolus to measure pH and temperature.
- Wireless telemetry to local receiver, then to cloud-based database

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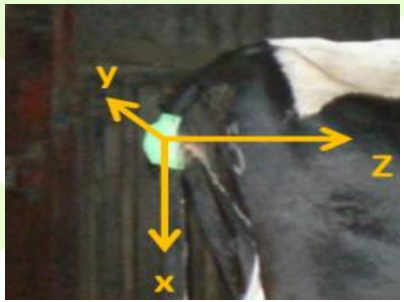
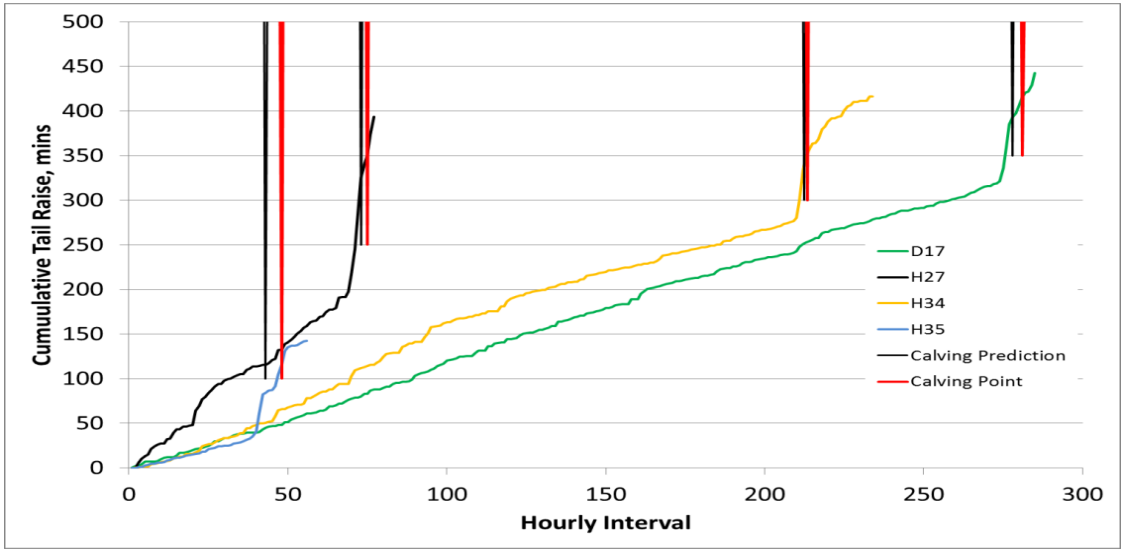
Parturition...

- Additional animal mounted sensor complements main platform sensor
- Accuracy 96%.
- ETA production late 2015..





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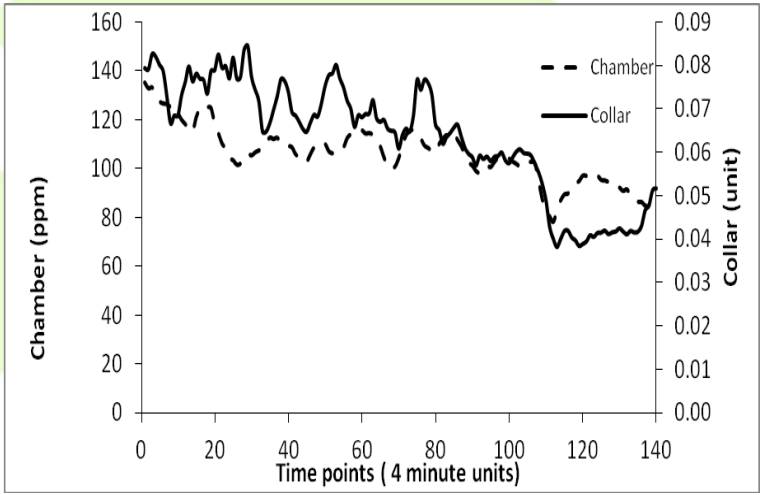
GHG emissions

- On-animal measures
- Wireless technology
- “Live” CH_4 output



Sensor networks – integrated systems – digital technology and telemedicine – the future??

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Goats and sheep?

THANK YOU

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