Digitalisation of the dairy value chain

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Dairy Research & Innovation Centre

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

More value from dairy

- **Improving technical efficiency of dairy farming** – has been SRUC's focus
- **New product development** – including from current co-products
- Support to **valorise the 'production story'**- improve and verify delivery on consumer concerns, such as cow welfare, biodiversity, C footprint
- **Optimising factory processes** based on information about farm processes – 'Advanced Manufacturing'; 'Industry 4.0'

UK dairy industry statistics

- 1.9 million dairy cows
- 14.7 billion litres of milk annually
- Farm-gate value of ~£3.6 billion
- UK dairy processors have a turnover of £10.2 billion

Precision farming

- Management of livestock production using **continuous, automated and real-time monitoring** of individual animal productivity, health and welfare and their environment
- Provides the data required to make **informed management decisions**

Sensor examples

‘Eyes’

- Thermal cameras (early detection of infection – mastitis)
- 3D cameras and automated weighing platforms (growth; frame size; body condition)
- Micro-doppler radar – lameness
- Cameras or light beams – lying times

‘Ears’

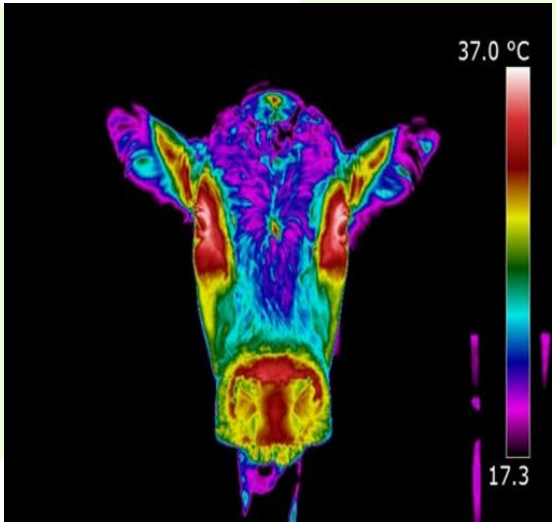
- Acoustic recorders (coughing for early detection of respiratory disease)

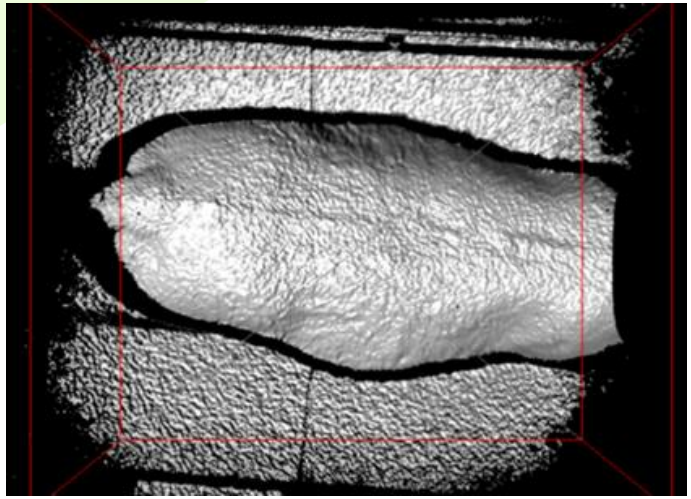
‘Noses’

- Gas sensors for environment of housed cows (methane; ammonia;…)
- Gas sensors for milk taints (e.g. in vats)

Technology from other sectors

- Thermal imaging – defence (night vision)
- 3D imaging – computer games
- Ultrasound imaging – medical physics
- Accelerometers – aircraft and bridges (vibration)
- Laser methane detector – health & safety





New uses for ‘old’ sensors

- Accelerometers originally applied to monitor oestrus activity
- Subsequently developed algorithms to look at intake and rumination behaviour
- May be possible to identify other behaviours?

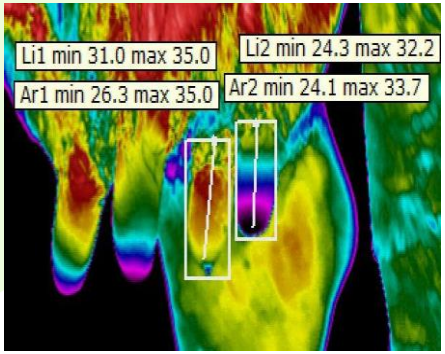
Dairy robotics & sensing

SRUC

ROBOTIC MILKING

THERMAL IMAGERY
e.g. mastitis detection

IN-LINE MILK ANALYSIS
- Milk composition
- Biomarkers of metabolic disease



ANIMAL SENSORS
Collar-mounted accelerometers
Activity, feeding behaviour

EARLY-HEALTH DETECTION DECISION SUPPORT SYSTEMS

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- **Optimising factory processes** (yield and quality) based on information about farm processes

Strength in Places bid

- Digital Dairy Value-Chain for South-West Scotland & Cumbria

- SRUC, University of Strathclyde, UWS
- Dairy companies – multi-national to SME
- Sensor companies
- Communications/digital security companies

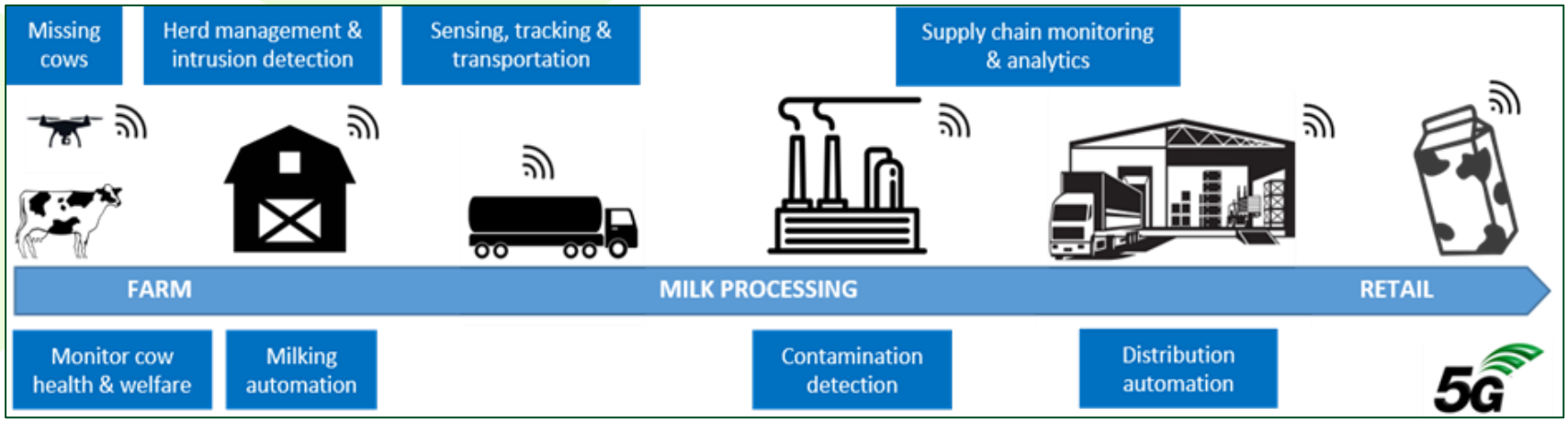
Digital dairy value chain

Traceability, control, efficiency, speed, connectivity, transparency, provenance

Demonstrator 1 – verifying positive animal welfare to the consumer

Demonstrator 2 – optimising transport network

Demonstrator 3 – the smart milk processing factory (advanced manufacturing)



Sensor location - examples

- Satellites/drone (e.g. herbage monitoring)
- Soil; water courses
- Air (e.g. meteorological station; emissions monitoring)
- Animal stations (e.g. water trough; robot milker)
- Diet kitchen and feed robot; feed troughs
- Animal-mounted
- Housing environment
- Farm cameras
- Milking equipment
- Farm energy use
- Farm dairy plant
- Bulk tank
- Milk tanker
- Factory – milk intake; silos; processes

Examples: milk losses & waste

- Every 2^{o}C increase in milk storage temperature halves shelf-life
- Antibiotic failures (~0.25% of collections) due to milking plant errors (18%), animal identification mistakes (41%), misuse of medicines (26%) or other reasons (15%)
- Freezing point depression (water contamination?) – diet, plant maintenance, weather, water supply

Examples: Off-flavour & odours

- Causes of rancidity: diet; cow stress; milking equipment problems (air leaks); freezing or over-agitation in the bulk tank
- Causes of oxidised flavours: inadequate cleaning or incorrect cleaning agents; minerals in water supply; diet (high PUFA; low vitamin E)
- Feed flavours – transmitted to milk via lungs or gut – issues with some silages and co-products (e.g. brewers grains; sugar beet pulp; brassicas)

Examples: bacteria & somatic cells

HEALTH – HYGIENE – MAINTENANCE –STORAGE

- High somatic cells and bacterial counts associated with enzymes that can affect product quality (even after pasteurisation)
- Enzyme-associated defects (proteolysis) with UHT shelf-stable milk (e.g. gelation, taste defects)
- High SCC increases cheese moisture and reduces cheese recovery; high bacterial counts can also reduce cheese yields
- Spore-forming bacteria surviving pasteurisation associated with product defects