Smart Dairy Production

Professor Richard Dewhurst
SRUC: Future Farming Systems

Agri-EPI Centre Ltd

Leading the way in Agriculture and Rural Research, Education and Consulting
Outline of talk

• Challenges for the industry
• Need for ‘systems’ thinking
• Opportunities from basic research
• Examples of new technologies
• Development and dissemination
Dairy industry success

- Average milk yield (UK) more than doubled in 50 years
Challenges

- Animal welfare
- Health of consumers
- Environmental impact
Challenges

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Challenges

‘Flexitarian’ diet

ARTICLE

Options for keeping the food system within environmental limits

The food system is a major driver of climate change, changes in land use, depletion of freshwater resources, and pollution of aquatic and terrestrial ecosystems through excessive nitrogen and phosphorus inputs. Here we show that between 2010 and 2050, as a result of expected changes in population and income levels, the environmental effects of the food
Challenges – staffing/scale

- Scottish herds now average 175 cows
- Automation of mundane physical tasks
- Increasing skilled aspects – data; technology
What’s needed (research)?

• System approach – linking across disciplines to identify ‘win-win’s

• Smart farming technologies have an important role alongside traditional biological disciplines
  – Understanding systems and interactions
  – Reducing mundane tasks
  – Providing management information
Example - nutrition

- Dietary treatments that cause sustained reductions in methane emissions tend to impair rumen function overall:

- Example: moderate to high levels of poly-unsaturated oils – reduce fibre fermentation in the rumen

- Example: high levels of starch – leads to rumen acidosis, with impaired fibre fermentation and other negative effects on animal performance
Low-methane yield sheep have smaller rumens and shorter rumen retention time

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Do we want smaller rumen and shorter rumen retention time?

Example - genetics

Low-methane yield sheep have smaller rumens and shorter rumen retention time

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System level thinking

• Reduced GHG emissions intensity by:
  – Reducing mortality
  – Increasing feed efficiency
  – Increasing fertility
  – Increasing longevity
  – etc.

• All areas where ‘smart’ technologies can help and where there are ‘win-win’s
New opportunities

- Animal and microbiome sequencing

- Imaging and sensing technologies
New opportunities

- Animal and microbiome sequencing
- **BREEDING for COMPLEX TRAITS**
- Imaging and sensing technologies
- **PRECISION AGRICULTURE**
A vision around variance

Deadweight (kg) vs Age (days)
Scottish dairy farm incomes

Scottish Government, 2018

<table>
<thead>
<tr>
<th>Income Range</th>
<th>Lower Quartile</th>
<th>Average</th>
<th>Upper Quartile</th>
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<tbody>
<tr>
<td>£0</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>£0.5K</td>
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<tr>
<td>£5-10K</td>
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<tr>
<td>£50-100K</td>
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<tr>
<td>&gt;£100K</td>
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<td>148,880</td>
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</table>

Farm business income range (2016-17)
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
- Developed algorithms to look at intake and rumination behaviour
- May be possible to identify other behaviours?
Combinations of technology

- Innovate UK-funded ‘Cow Health Monitor’ project
- Based on Fullwood Merlin\(^2\) robot
- Cow contentment high
- Sensor combinations for health
Nutrition biomarkers

Faeces

Urine

Milk

Hair

Breath
Selected-ion-flow-tube (SIFT-MS) equipment

Currently located at SRUC GreenCow Facility – linked to chambers
### Cow breath components (ppb)

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (ppb)</th>
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<tbody>
<tr>
<td>Ammonia</td>
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<tr>
<td>Dimethylamine</td>
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<tr>
<td>Trimethylamine</td>
<td>15.2</td>
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<tr>
<td>Acetaldehyde</td>
<td>29.9</td>
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<tr>
<td>Hexanal</td>
<td>8.2</td>
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<tr>
<td>Trans-2 hexenal</td>
<td>1.8</td>
</tr>
<tr>
<td>Cis-3 hexenal</td>
<td>3.6</td>
</tr>
<tr>
<td>Octanal</td>
<td>4.8</td>
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<tr>
<td>Decanal</td>
<td>1.6</td>
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<tr>
<td>Acetone</td>
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<tr>
<td>Butanone</td>
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<tr>
<td>Diacetyl</td>
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<tr>
<td>Acetophenone</td>
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<tr>
<td>Methanol</td>
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<tr>
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<tr>
<td>Propanols</td>
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<tr>
<td>Hexanol</td>
<td>0.5</td>
</tr>
<tr>
<td>Cis-3 hexen-1-ol</td>
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</tr>
<tr>
<td>Acetic acid</td>
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<tr>
<td>Propionic acid</td>
<td>13.2</td>
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<td>Butyric acid</td>
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<tr>
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<tr>
<td>Hexanoic acid</td>
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<tr>
<td>Hexenyl acetate</td>
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<tr>
<td>Methyl sulphide</td>
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<tr>
<td>Dimethyl sulphide</td>
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<tr>
<td>Toluene</td>
<td>17.1</td>
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<tr>
<td>Heptane</td>
<td>23.2</td>
</tr>
<tr>
<td>Octane</td>
<td>21.8</td>
</tr>
<tr>
<td>Nonane</td>
<td>7.6</td>
</tr>
</tbody>
</table>
What’s needed – beyond research?

• Development and demonstration
• Education – building awareness that our industry is increasingly high-tech and data rich
Development & demonstration

- Satellite farm network
  - Highly-instrumented farms
  - Gather real farm data
  - Development and demonstration of technology
Agri-EPI Centre – Dairy Development Centres
Somerset (Kingshay)
Somerset (Kingshay)
Shropshire (Harper Adams)
Dumfries (SRUC)
Calf facilities at Dumfries

- Individual recording of:
  - Milk intake
  - Water intake
  - Concentrate intake
  - Forage intake
  - Live weight

- Other equipment for monitoring calves and their environment
Primary/secondary education

• Promoting exciting technology and data aspects of the industry by linking directly to instrumented farms

• Smart Farm Learning Hub (Australia): https://smartfarmhub.education/

• SRUC Schools Data Project
Questions?