Smart Dairy Production

Professor Richard Dewhurst
SRUC: Future Farming Systems

Agri-EPI Centre Ltd

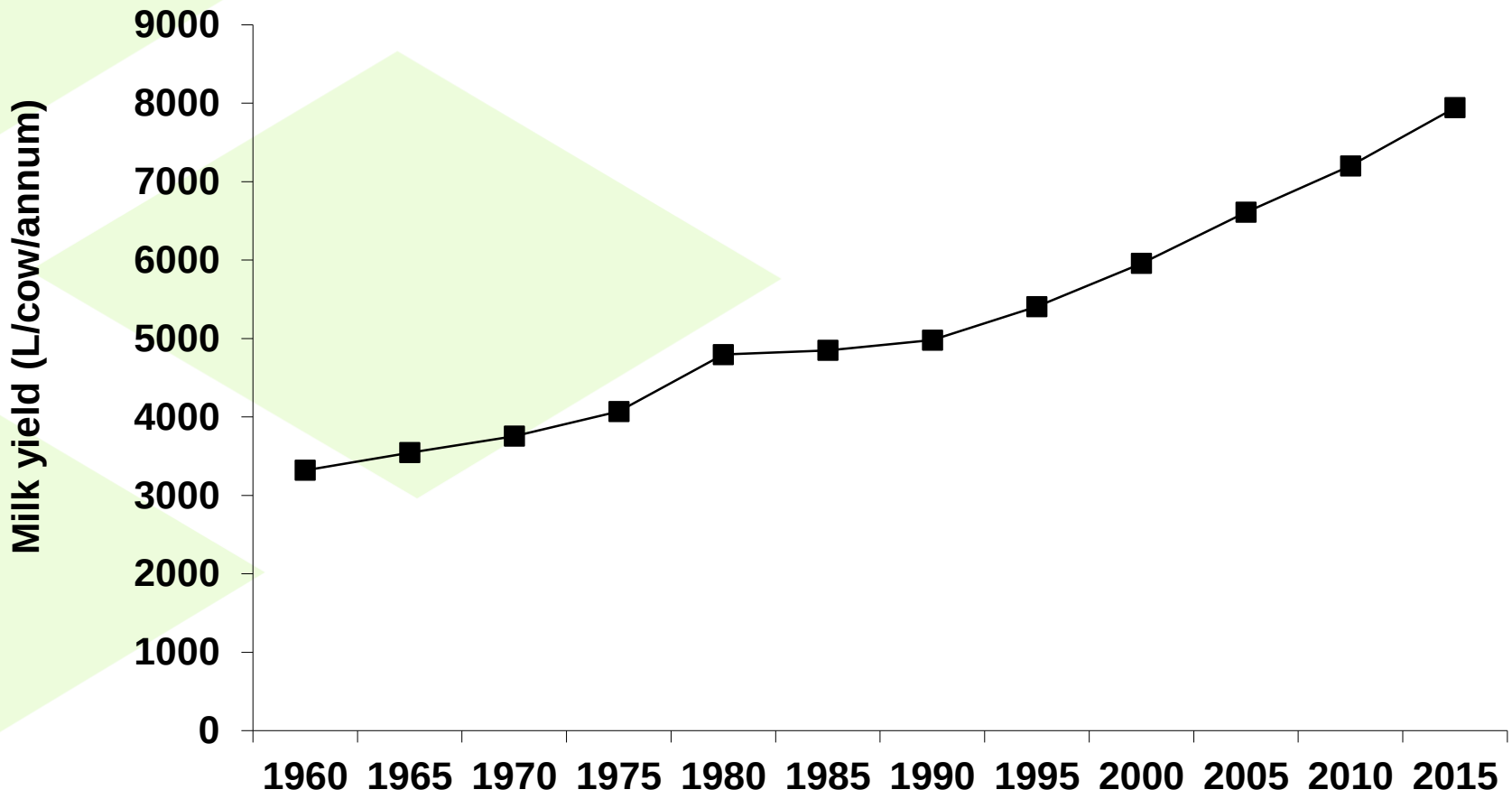
Leading the way in Agriculture and Rural Research, Education and Consulting

Outline of talk

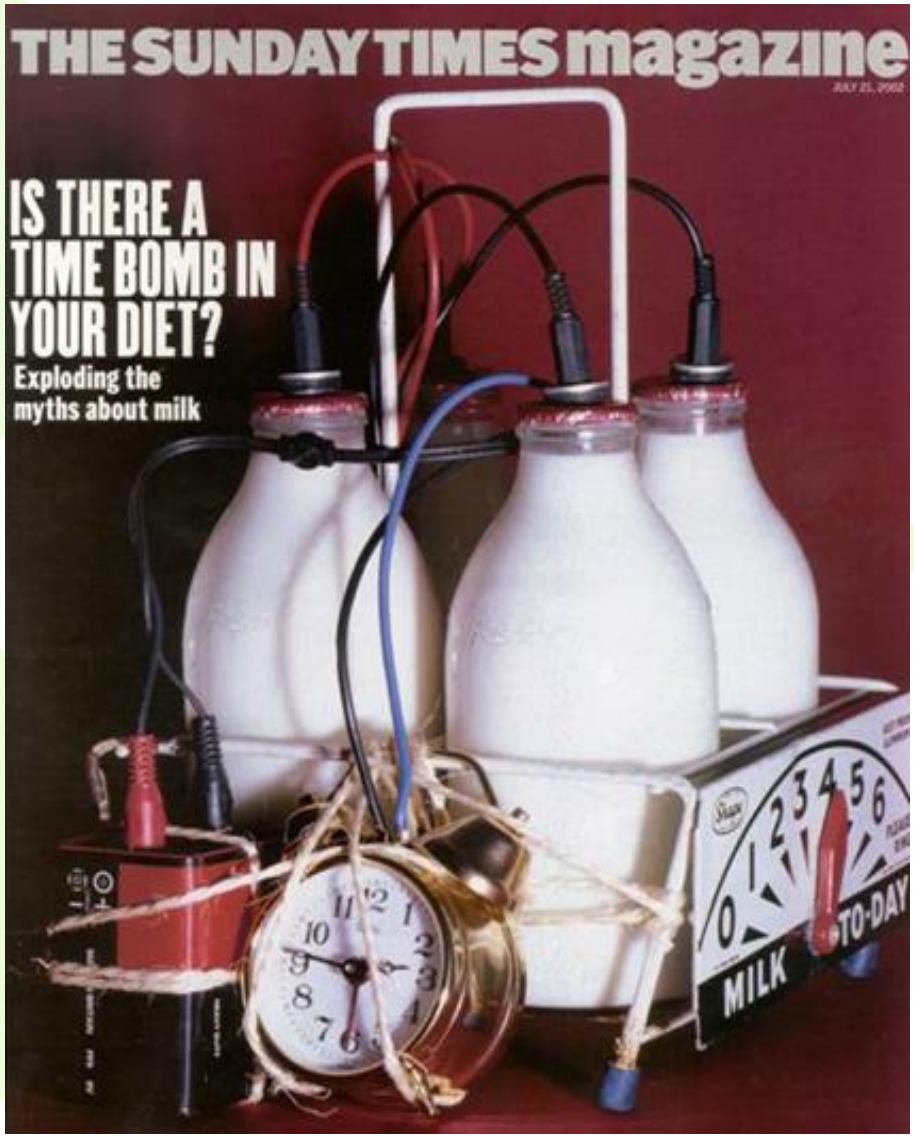
- Challenges for the industry
- Need for ‘systems’ thinking
- Opportunities from basic research
- Examples of new technologies
- Development and dissemination

Dairy industry success

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

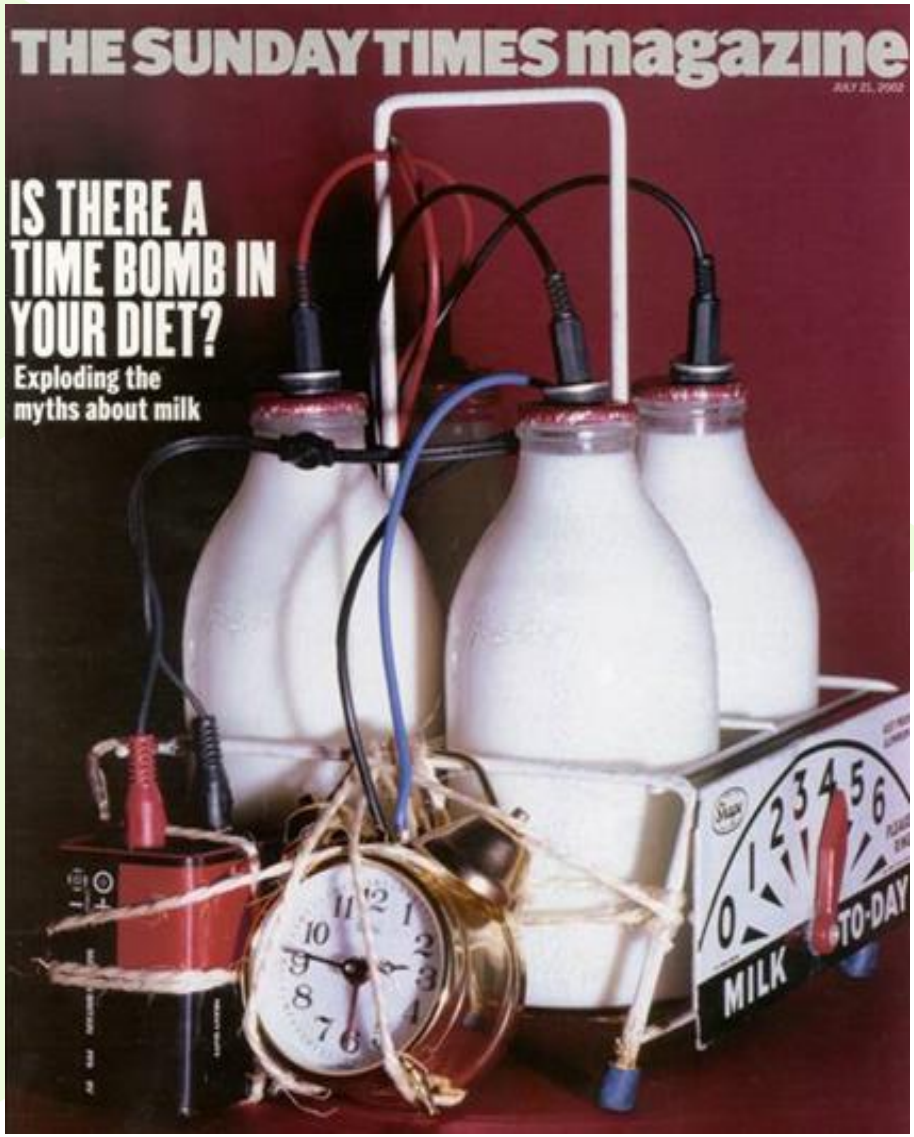


Challenges



- Animal welfare
- Health of consumers
- Environmental impact

Challenges



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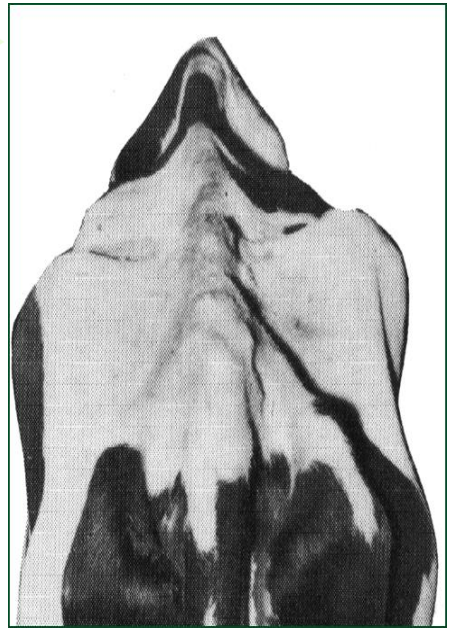

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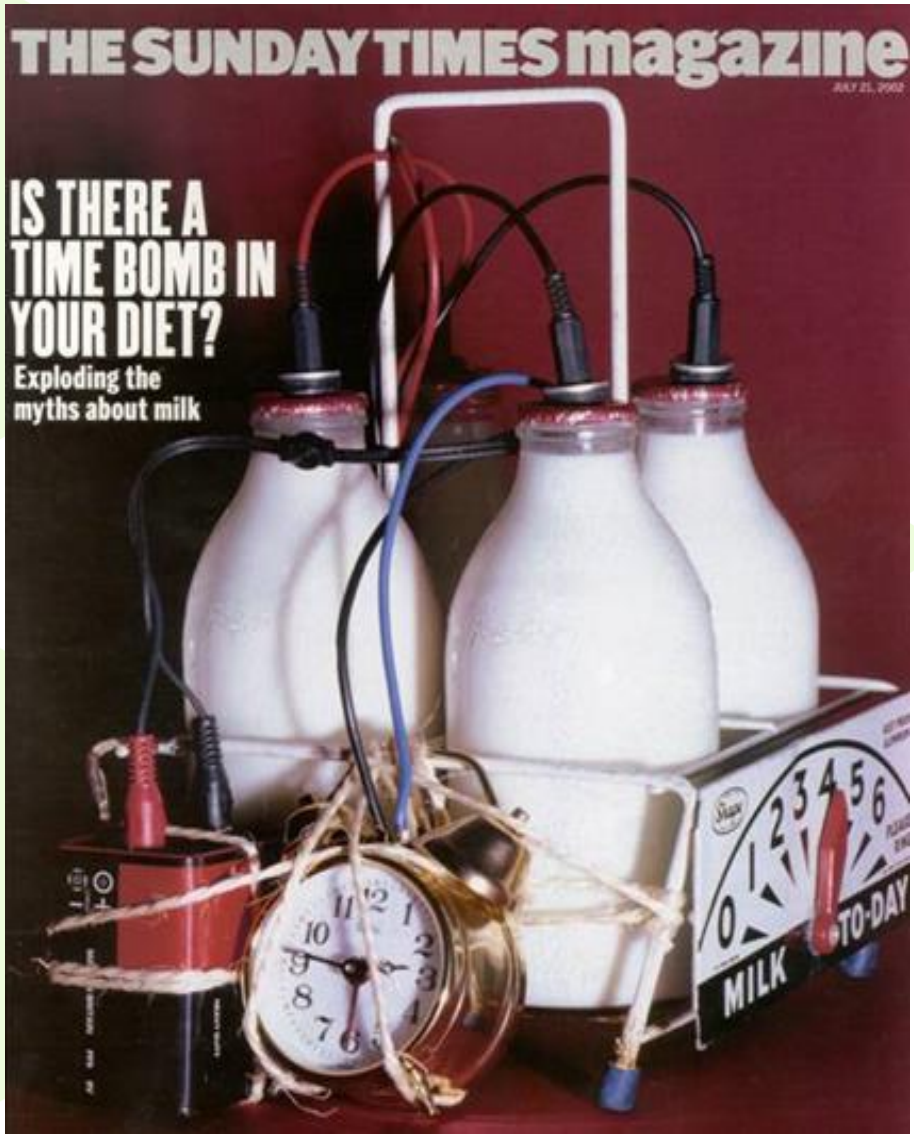

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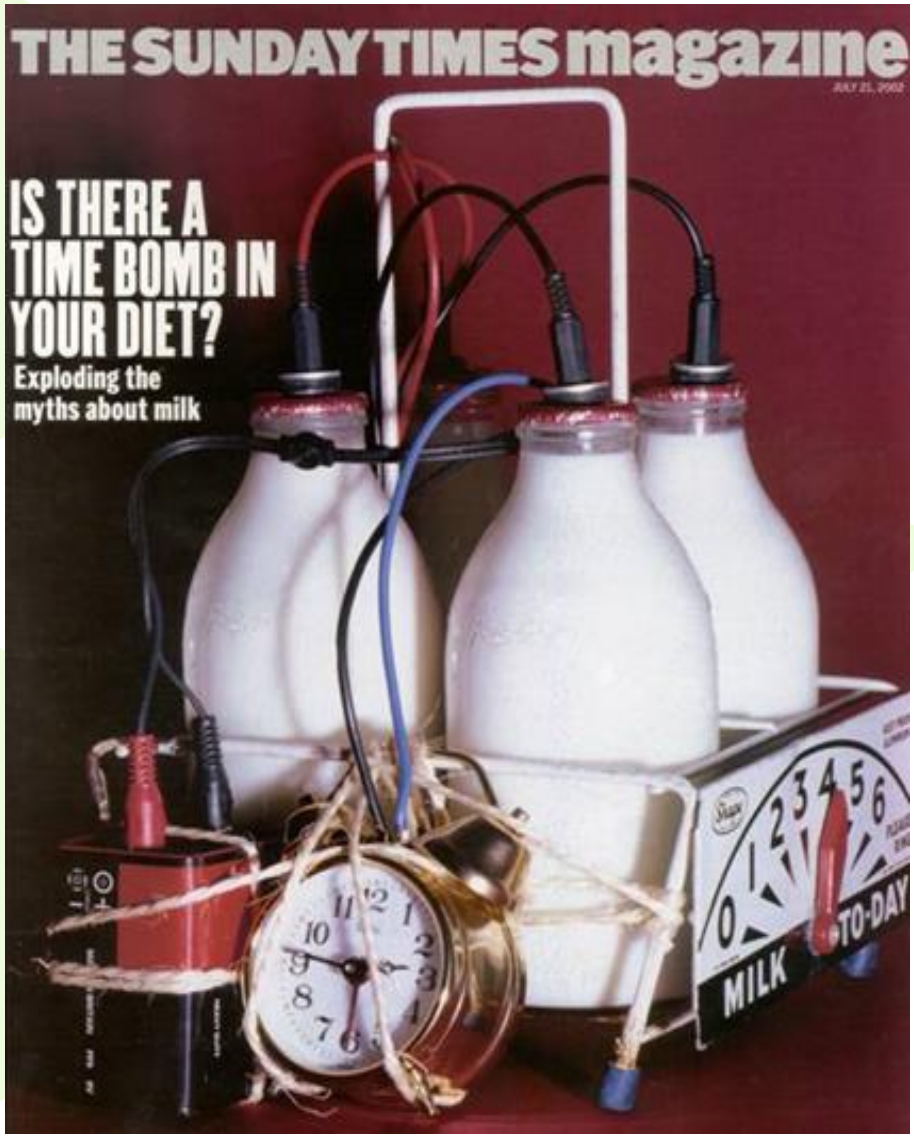

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Challenges

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'Flexitarian' diet

ARTICLE

https://doi.org/10.1038/s41586-018-0594-0

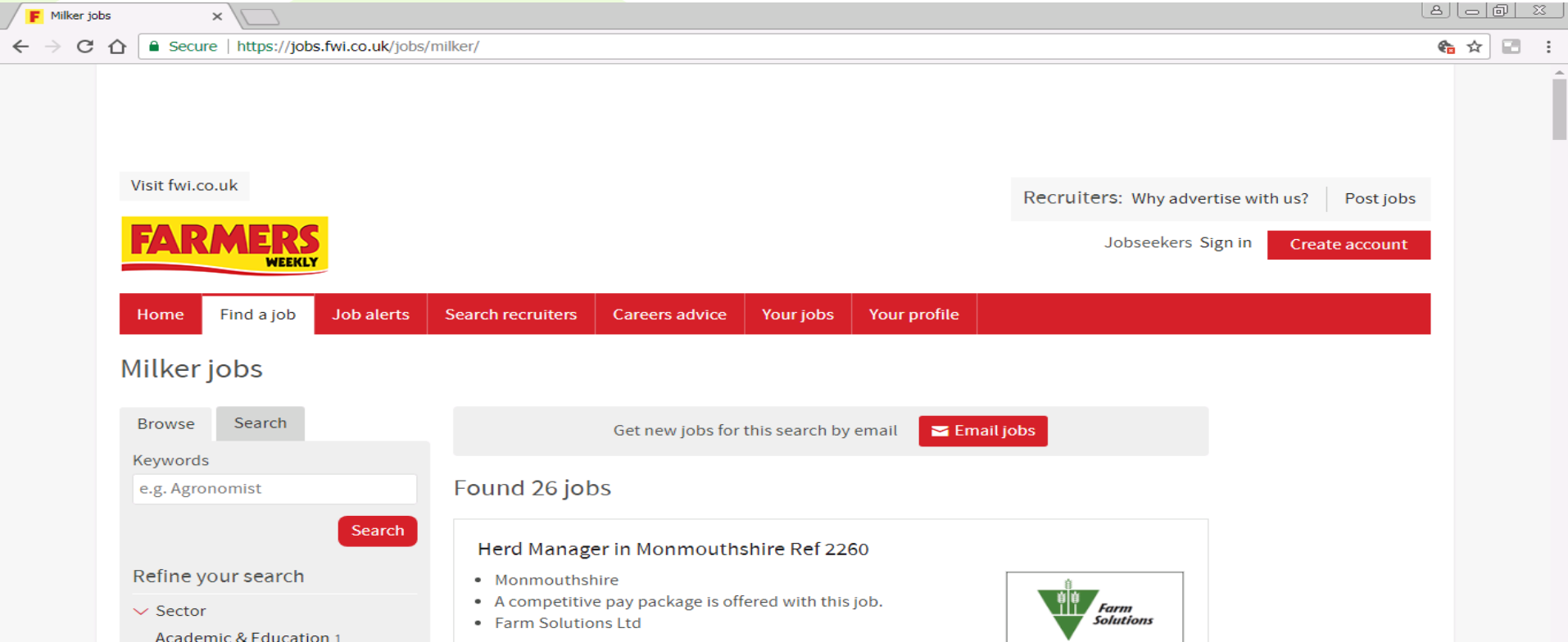
Options for keeping the food system within environmental limits

Marco Springmann[1,2*], Michael Clark[2], Daniel Mason-D'Croz[4,5], Keith Wiebe[4], Benjamin Leon Bodirsky[6], Luis Lassaletta[7], Wim de Vries[8], Sonja J. Vermeulen[9,10], Mario Herrero[5], Kimberly M. Carlson[11], Malin Jonell[12], Max Troell[12,13], Fabrice DeClerck[14,15], Line J. Gordon[12], Rami Zurayk[16], Peter Scarborough[2], Mike Rayner[2], Brent Loken[17,14], Jess Fanzo[17,18], H. Charles J. Godfray[1,19], David Tilman[20,21], Johan Rockström[6,12] & Walter Willett[22]

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

Example - genetics

British Journal of Nutrition (2014), **111**, 578–585
doi:10.1017/S0007114513002936

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

John P. Goopy[1*†], Alastair Donaldson[1], Roger Hegarty[2], Philip E. Vercoe[3,4], Fa
and V. Hutton Oddy[1]

[1]*Agriculture NSW, Beef Improvement Centre, Trevenna Road, Armidale, NSW 2351, Australi*
[2]*School of Environmental and Rural Science, University of New England, Armidale, NSW 23*
[3]*School of Animal Biology, University of Western Australia, Perth, WA, Australia*
[4]*UWA Institute of Agriculture, University of Western Australia, Perth, WA, Australia*

(Submitted 14 December 2012 – Final revision received 1 August 2013 – Accepted 3 August 2013 – First published

(a)

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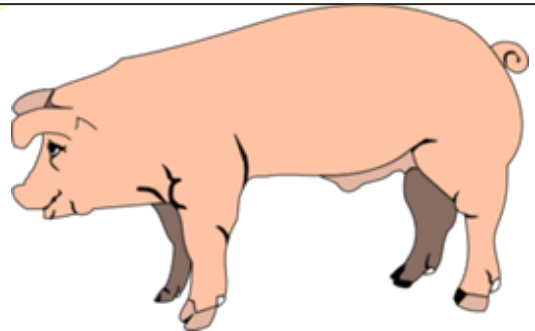
Do we want smaller rumen and shorter rumen retention time?



(a)

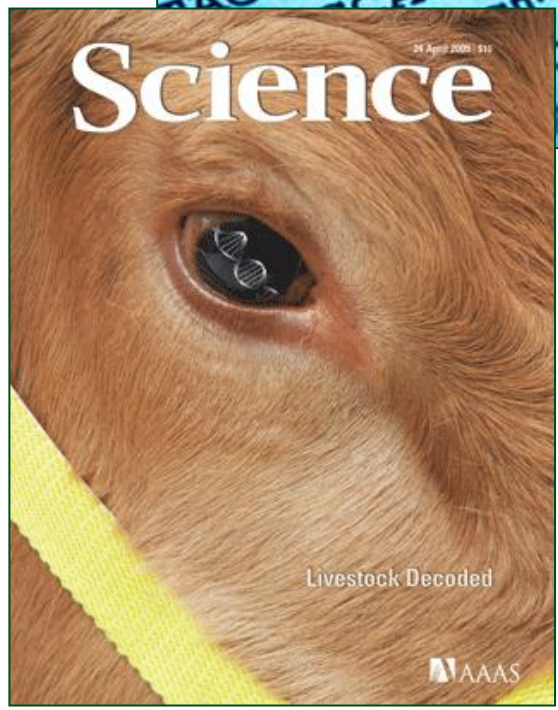
System level thinking

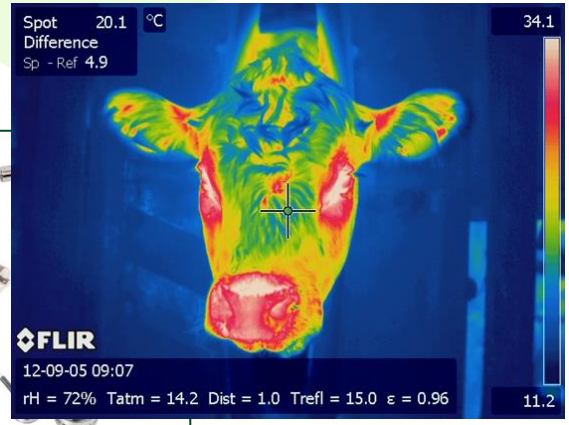
- Reduced GHG emissions intensity by:
  - Reducing mortality
  - Increasing feed efficiency
  - Increasing fertility
  - Increasing longevity
  - etc.
- All areas where ‘smart’ technologies can help and where there are ‘win-win’s

New opportunities

– Animal and microbiome sequencing

– Imaging and sensing technologies

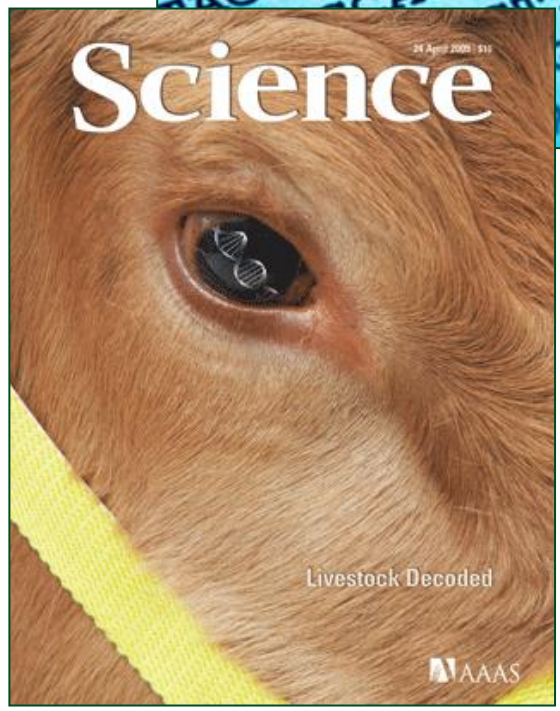


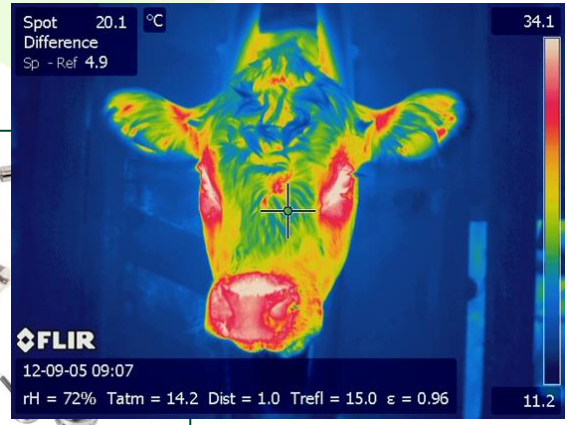


New opportunities

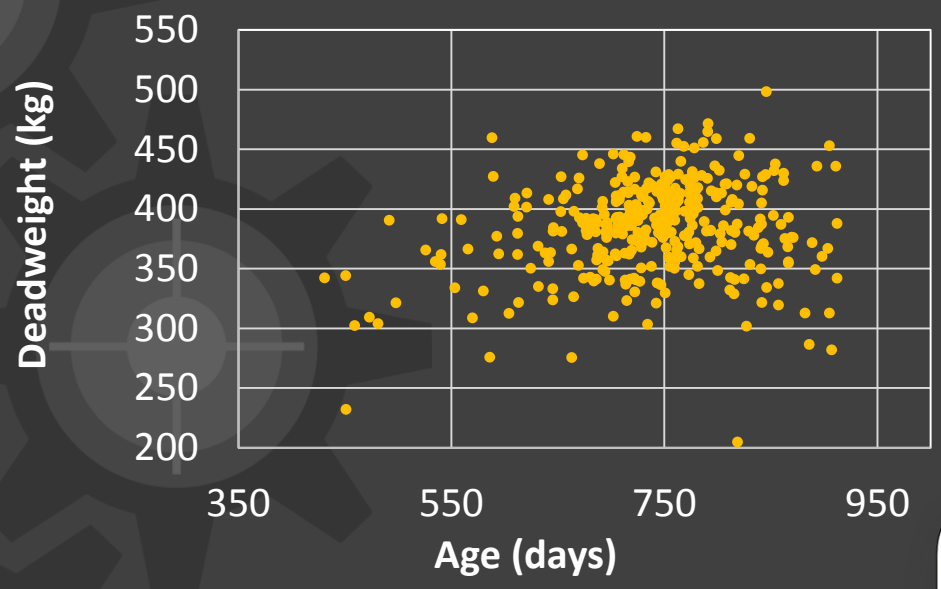
- Animal and microbiome sequencing
- **BREEDING for COMPLEX TRAITS**

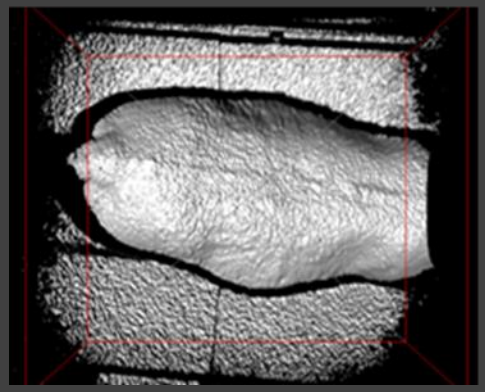
- Imaging and sensing technologies
- **PRECISION AGRICULTURE**

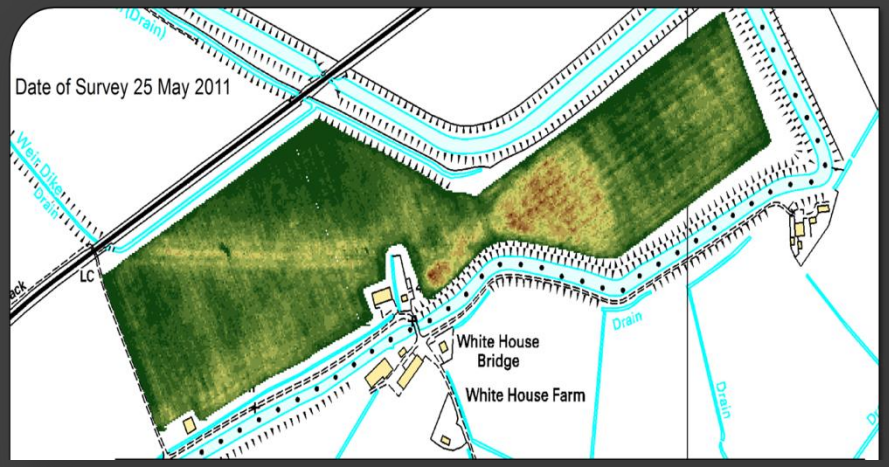




A vision around variance







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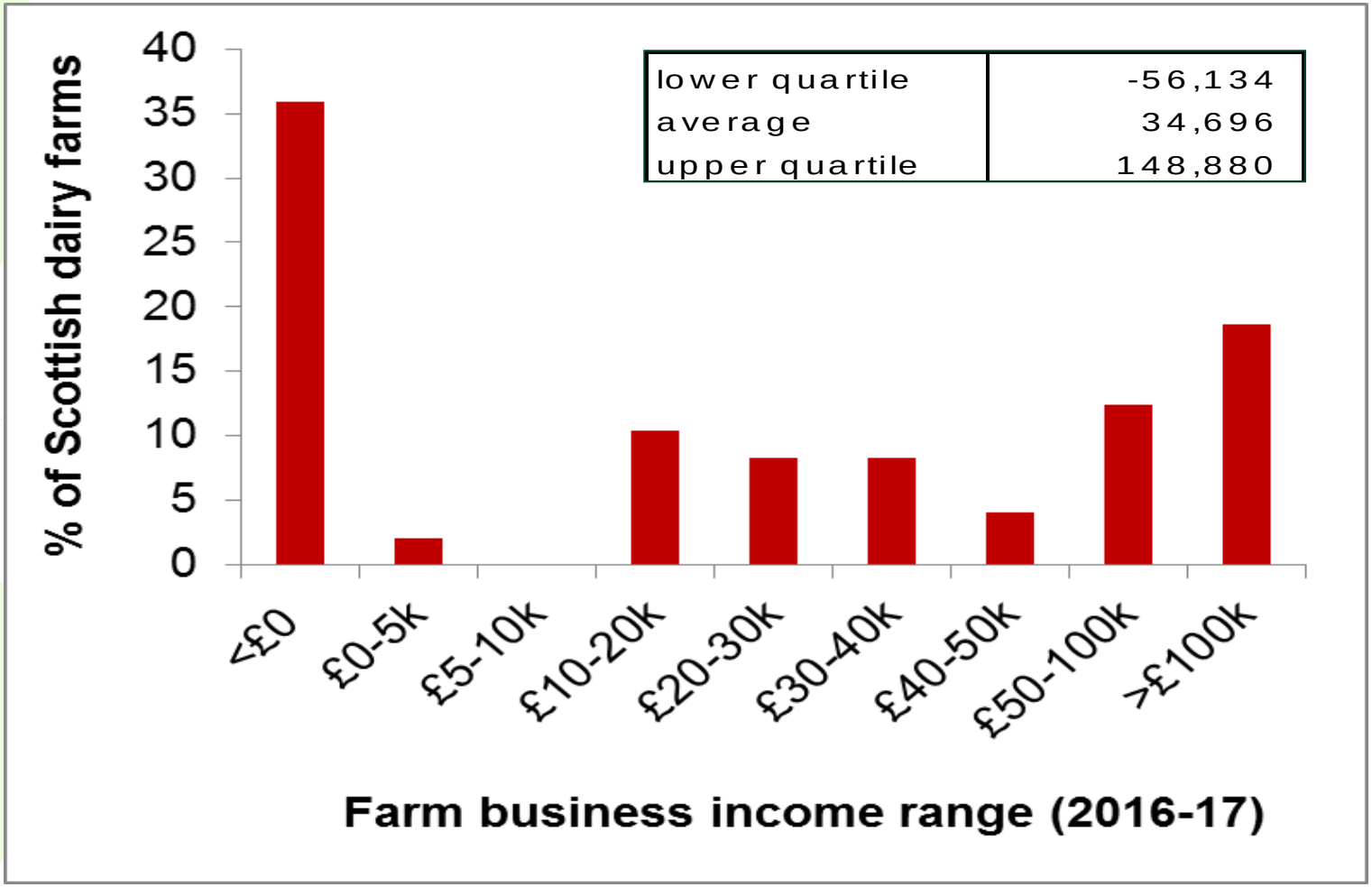
Scottish dairy farm incomes

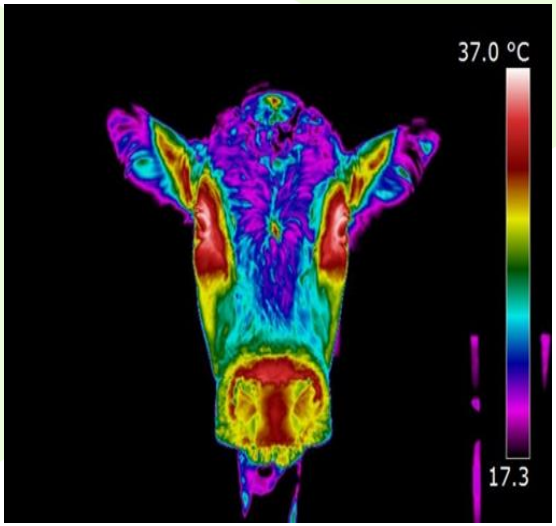


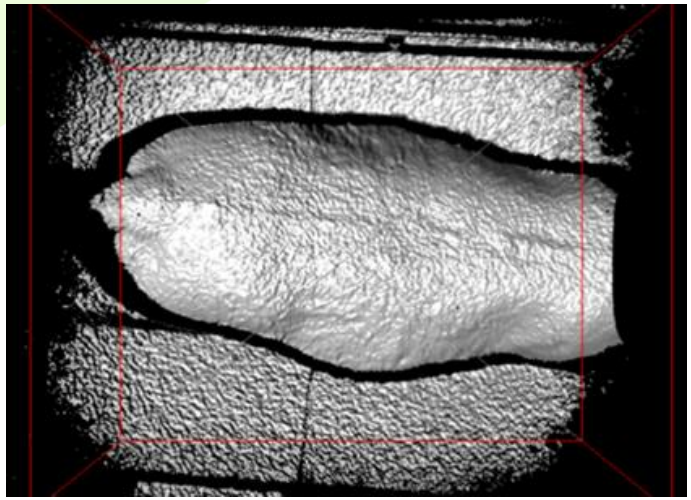
Scottish Government, 2018

Examples developed in Scotland

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





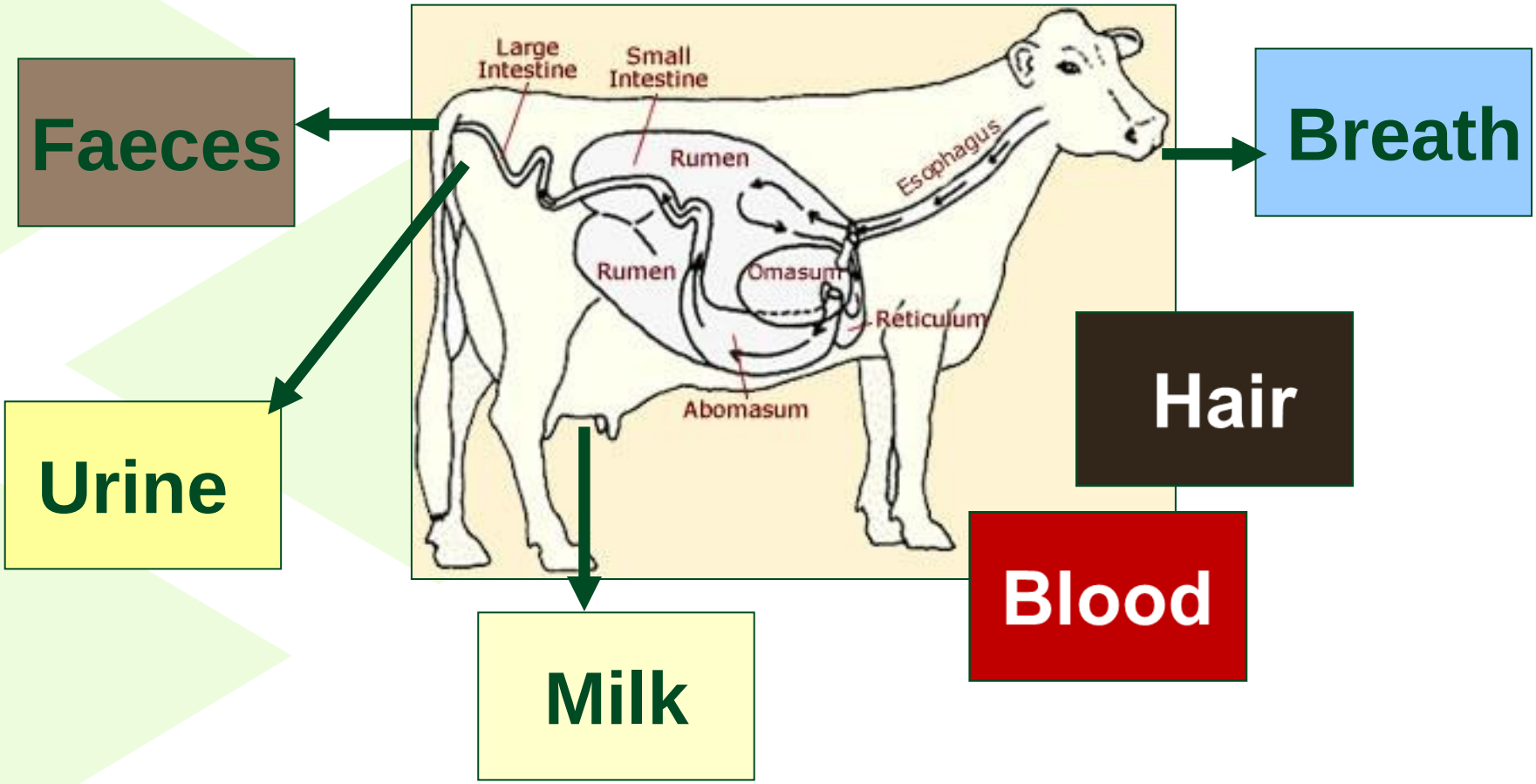
New uses for ‘old’ sensors

- 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



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

Currently located at SRUC GreenCow Facility – linked to chambers

Cow breath components (ppb)

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

What's needed – beyond research?

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

Development & demonstration

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- Satellite farm network
  - Highly-instrumented farms
  - gather real farm data
  - development and demonstration of technology

Agri-EPI Centre – Dairy Development Centres

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Somerset (Kingshay)

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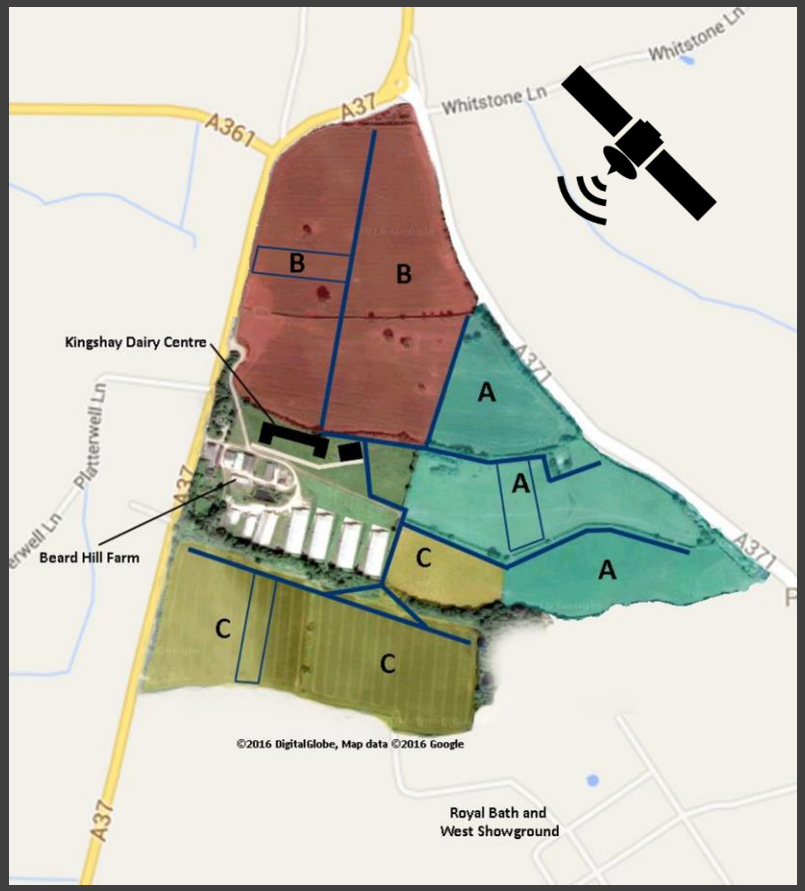

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Shropshire (Harper Adams)

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?