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Sustainable Livestock production in the context of developing countries

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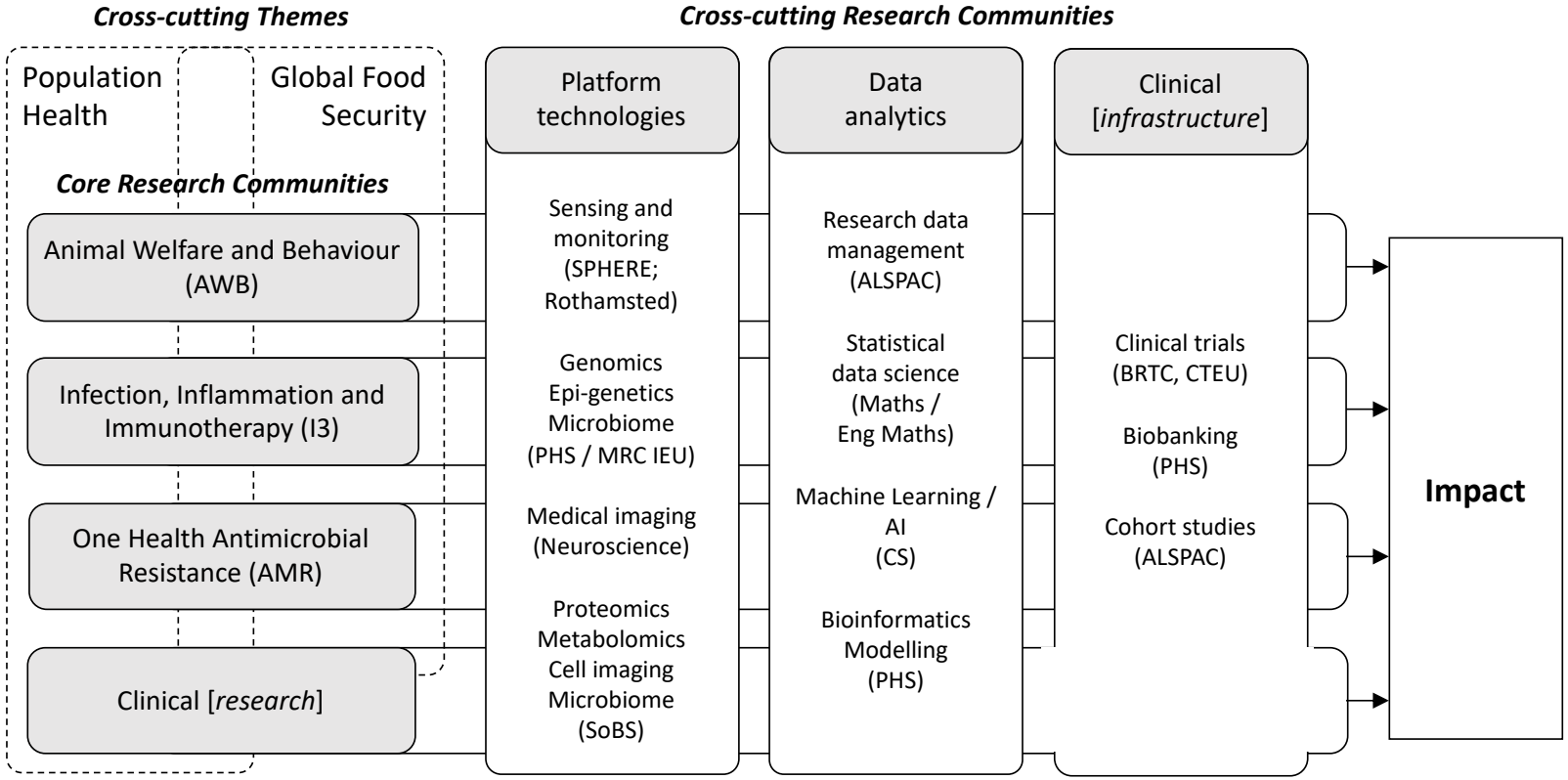
Bristol Veterinary School



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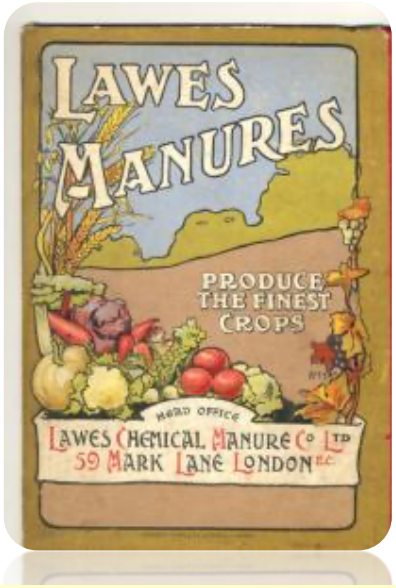
Rothamsted Research

Rothamsted Experimental Station (now known as Rothamsted Research) was established in 1843



Developed a fundamental understanding of plant nutrition and produced the world's first commercial chemical fertilisers

Unique capabilities

2 campuses - 4 sites with 830 ha field environments
3 National Capabilities (NWFP, LTE, RIS)
Specialised science facilities (GM, Phenotyping, Bioimaging, Metabolomics, GHG, Radar, Insectary,.....)

~600 people - 35+ nationalities

310 Research (80 Scientists, 80 PostD, 150 Specialists)
120 Support (80 Business support, 40 Op. services)
120 others (VW, 0-hr, Apprentices)
65 PhD students – rising

Annual budget

~£35 million; BBSRC strategic funding: ~40%

Wide range of partnerships

UK and >50 countries
Industry collaboration: ~10-12% of income
3 AgriTech Centres (Agrimetrics, CACS, CIEL)

Scientific output

~270-300 journal papers p.a.
15-20 in journals with IF >9; median IF 3.2

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Steps to sustainable livestock

With improved breeding and cultivation, ruminant animals can yield food that is better for people and the planet, say **Mark C. Eisler**, **Michael R. F. Lee** and colleagues.

The need for efficient food production has never been greater. One in seven humans is undernourished[1]. Urbanization and biofuel production are reducing land availability, and climate change, lack of water and soil degradation are decreasing harvests. Over the past decade, cereal yields per hectare have fallen in one-quarter of countries. Meanwhile, developing nations and the growing world population are farming has thundered ahead with little regard for sustainability and overall efficiency (the net amount of food produced in terms of inputs such as land and water). With animal protein set to remain part of the food supply, we must pursue sustainable intensification and figure out how to keep livestock in ways that work best for individuals, communities and the planet.

Almost all of the world's milk and much of and humans, ruminants have a series of forestomachs leading to the true stomach. In the forestomachs, the largest of which is the rumen, microbes break down fibrous plant material into usable calories and also provide high-quality microbial protein. Ruminants can graze in marginal areas, such as mountainsides or low-lying wet grasslands. This helps to reserve agricultural fields for growing human food.

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Major Challenges for Livestock:

- Population Growth
- Climate Change
- Urbanisation
- Biodiversity loss
- Biofuel Production
- Demand For Animal Protein

Focus areas for livestock solutions:

1. Consumption of human food by livestock
2. Poor animal health and welfare
3. Environmental footprint
4. Species/genotypes not suited to environment
5. Human nutrition – focus on healthy food
6. Husbandry and management

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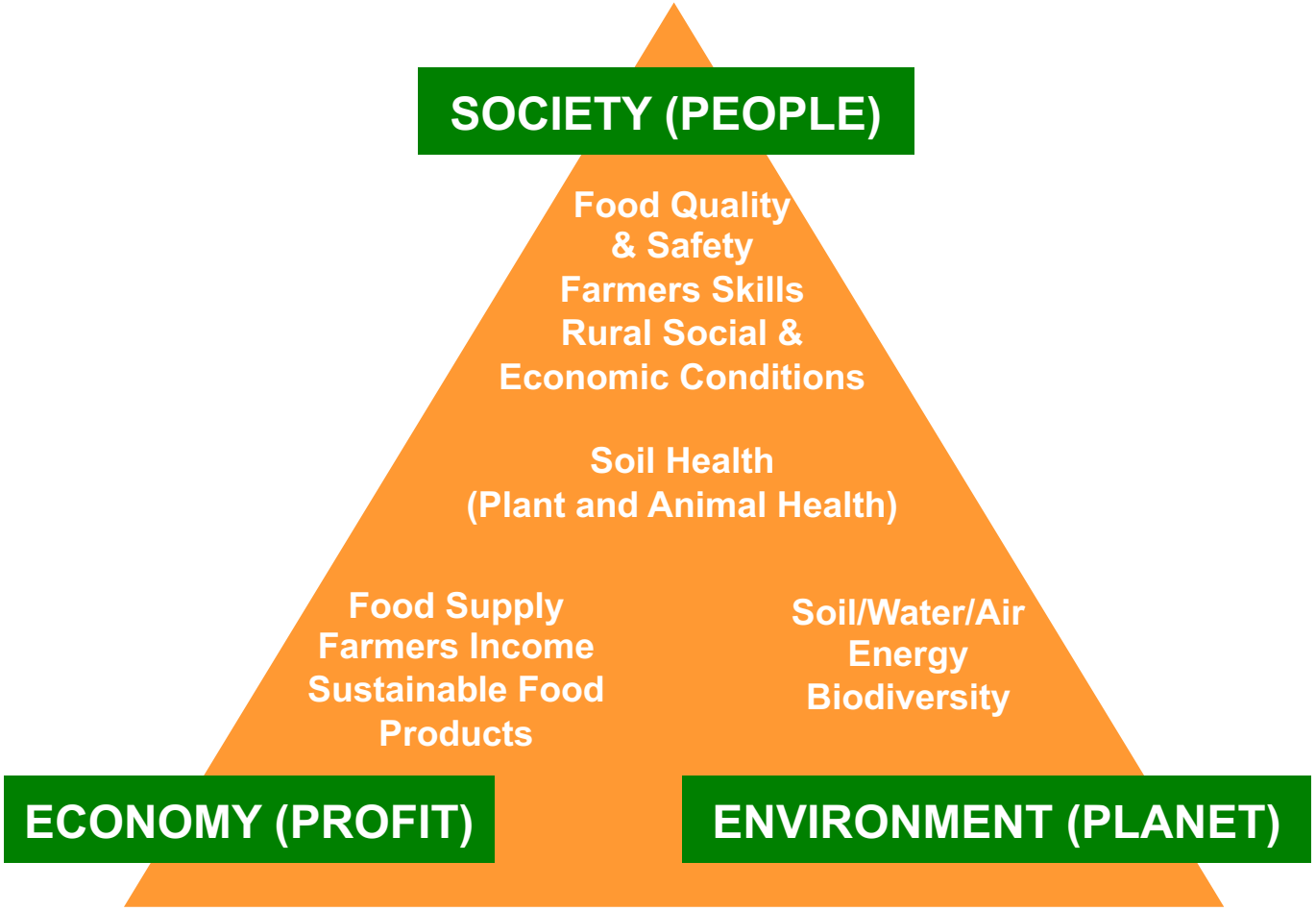
Sustainable Farming Systems



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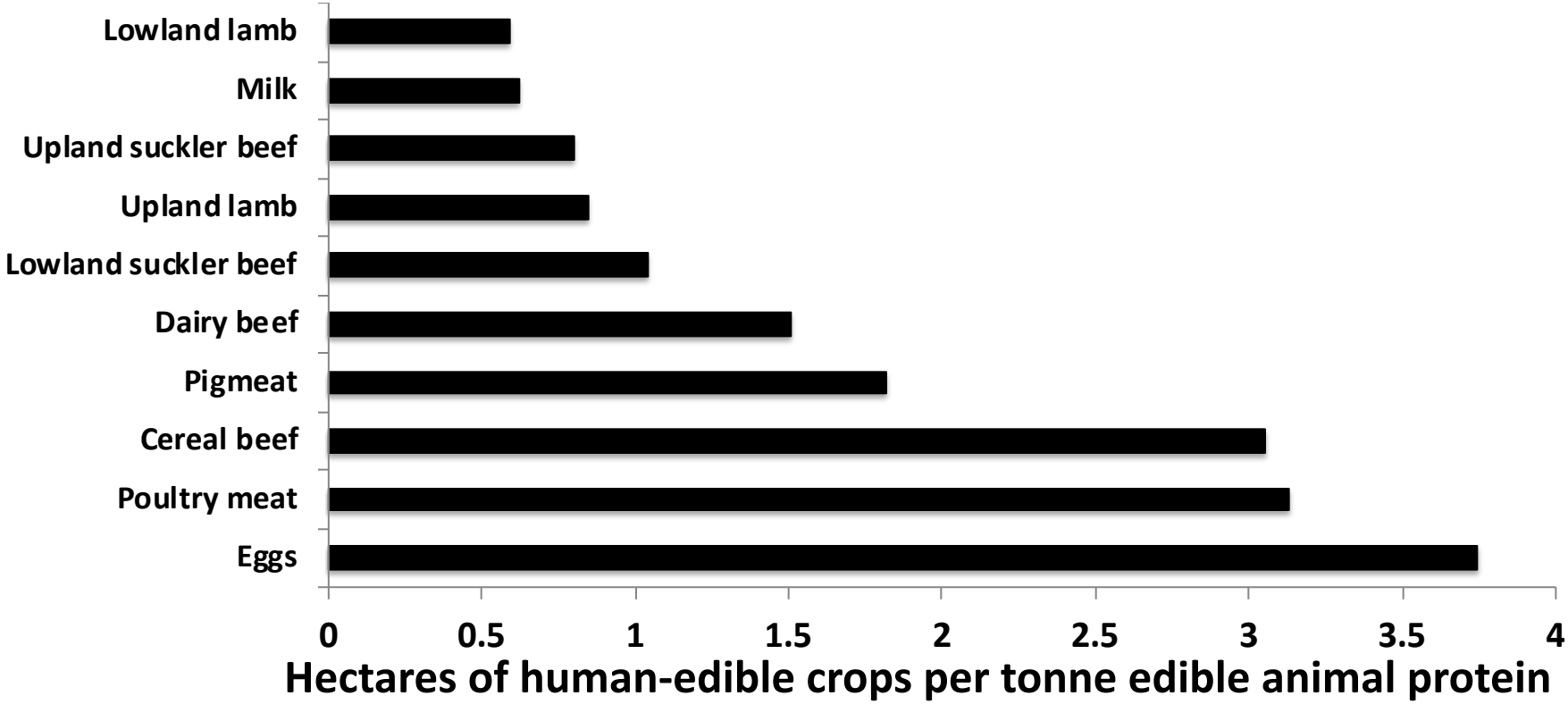
How much arable land is required to produce human-edible feed for livestock?



Wilkinson and Lee, 2017

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www.globalfarmplatform.org

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Global Farm Platforms: Locations

GLOBAL FARM PLATFORM
Towards Sustainable Ruminant Production

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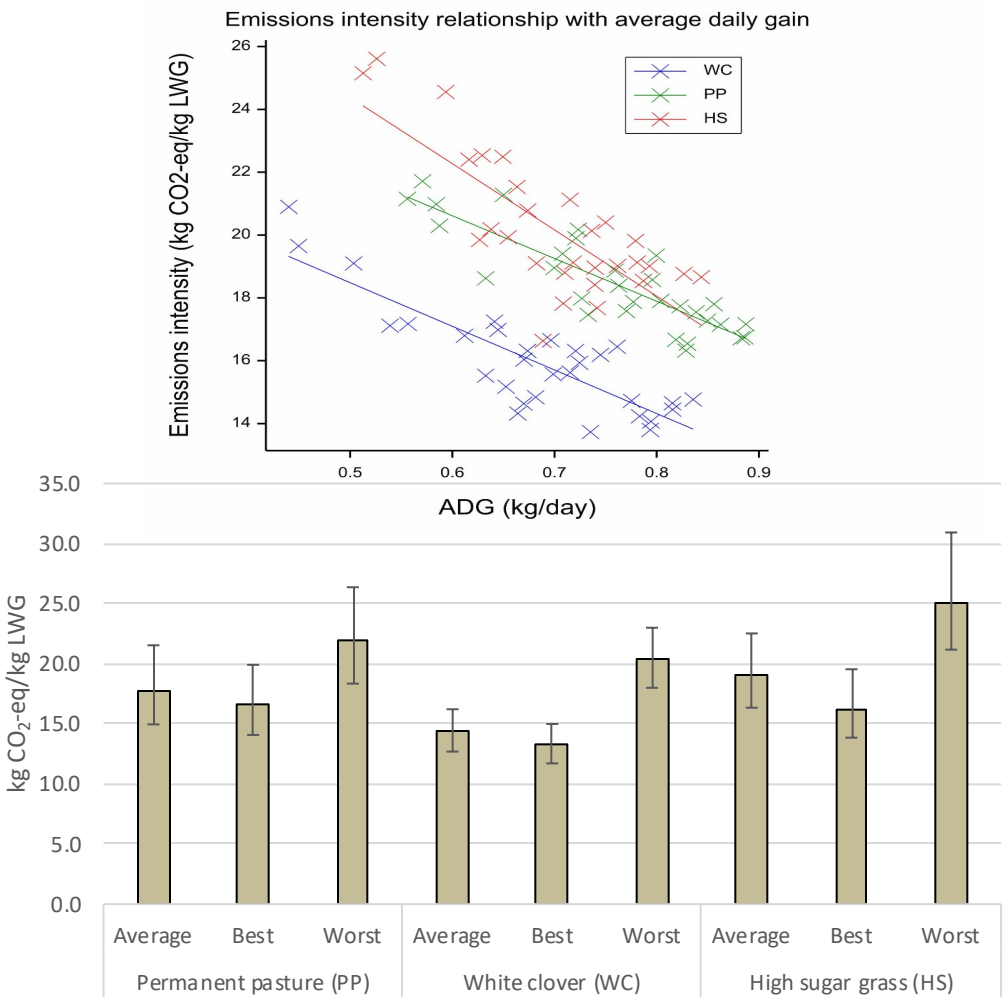
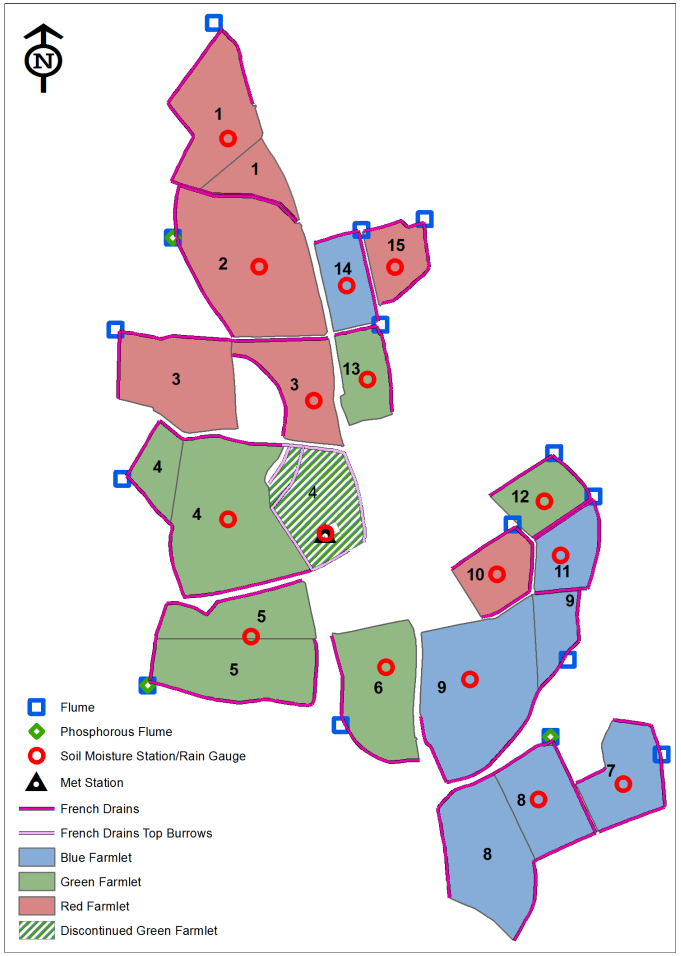
Carbon Footprint, North Wyke





McAuliffe et al., 2018. *Journal of Cleaner Production*, 171, 1672-1680.

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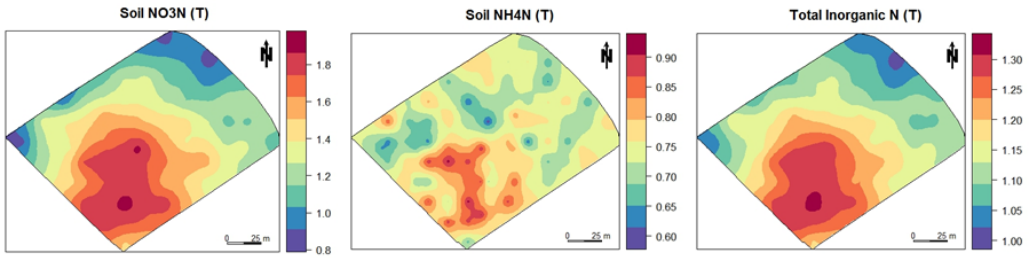
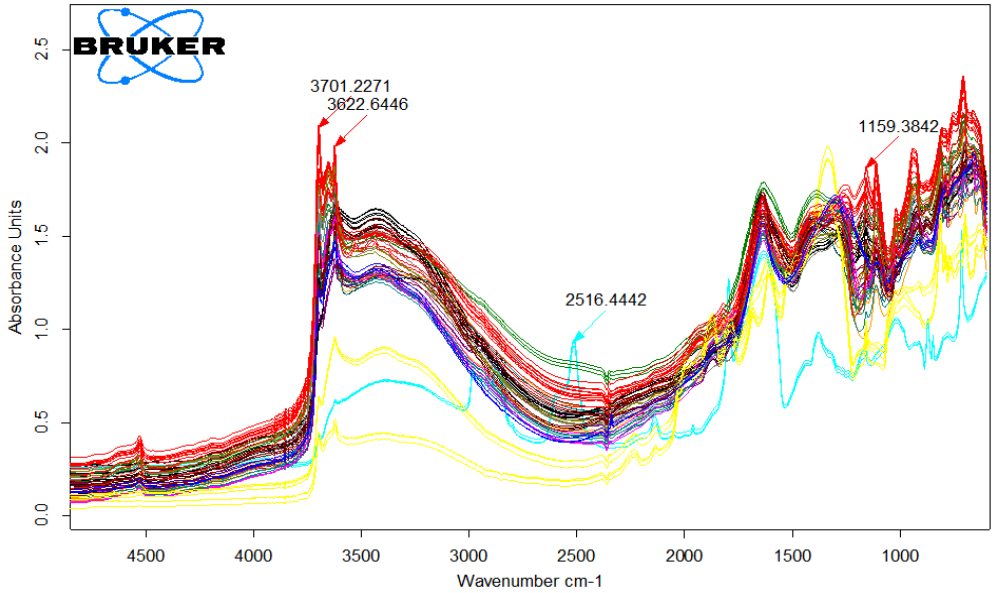
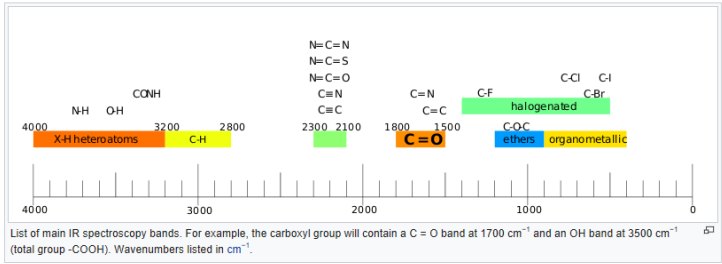
Spatial studies – Precision Agriculture





Response	Significant predictors (P < 0.05)
Gases:	
N_2O flux	Soil Moisture
CO_2 flux	Easting + Soil moisture + Elevation + Aspect
CH_4 flux	WFPS + Bulk density
Soils:	
NO_3N	Intercept + Total C + Total N + C/N + Elevation
NH_4N	Soil moisture + Soil pH
Total Inorganic N	Total C + Total N + C/N



List of main IR spectroscopy bands. For example, the carboxyl group will contain a C = O band at 1700 cm^{-1} and an OH band at 3500 cm^{-1} (total group -COOH). Wavenumbers listed in cm^{-1}.

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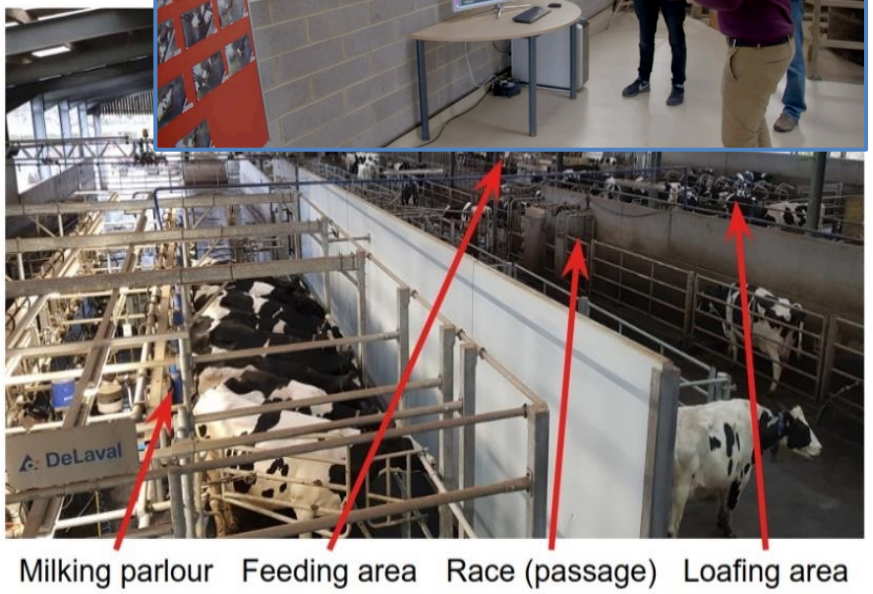
The Alan Turing Institute

Bristol Vet School's John Oldacre Centre: Farm Research Data Platform



- £1M Capital grant to create the world's most intensively monitored dairy farm at our commercial facility
- Instrumentation including:
  - Blanket sound and video surveillance (32+ HD cameras)
  - Infrastructure for commercial & research IoT / wearables
  - Detailed biomechanical/biosensor/thermal analysis at specific locations
    - *e.g.* gait analysis while walking through the Race after milking
  - Capture of individual cow inputs (feed type and amount), metabolic physiology (boluses), emissions (methane/ammonia), outputs (milk production/quality) and vet interventions
  - Meteorology station and inline sampling/monitoring of drain runoff

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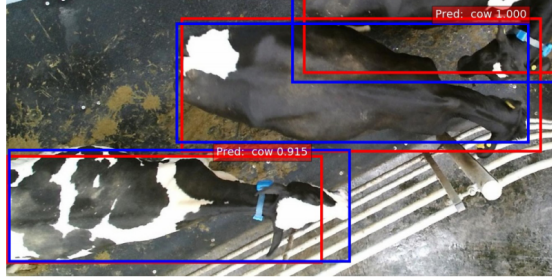

A platform for tackling One Health grand challenges

Unlike 'precision farming' that aims to directly optimise day-to-day management, our platform will realise a longitudinal cattle cohort to answer fundamental research questions:

- **Global Food Security:** Understanding animal resilience to intensified production while ensuring sustainable resource use
  - *Effect of genome, epi-genome & microbiome etc on resilience directly applicable to the human realm: Cattle more accessible than human cohorts and with a substantially shorter timeline to study transgenerational effects*
- **Welfare and Cognition:** Studying social/environmental interactions, for high welfare practice, optimising housing and to advance basic cognition and behaviour research
- **Behaviour Change:** Studying the influence of automated monitoring on farmer/vet behaviour
- **Health monitoring:** A testbed for developing and validating sensors and data integration methods, prior to translation to human health scenarios

Why Bristol? *Combining Bristol's leading expertise in Cohort Studies (ALSPAC), Genetic Epidemiology, AMR, Sensing and AI with Bristol Vet School's leading Sustainability, Welfare and AMR research*

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Smallholder Dairy Cooperatives in Addressing Sustainable Goals in ODA Countries

Partner Institutions: LUANAR (Malawi), the University of Ghana, the University of Nairobi (Kenya), the International Livestock Research Centre and the University of Western Australia

Objective 1: *Define best practice in smallholder Dairy Cooperatives to promote food security in ODA countries. Early career researcher exchange visits between Malawi, Ghana and Kenya will characterise elements of smallholder dairy farmers and cooperatives using a data collection tool, and identify intervention targets to improve efficiency..*

Objective 2: *Assess the possibility of including smallholder cooperatives as "Research Farms" in the Global Farm Platform. By evaluating current and potential data collection infrastructure.*

WON Worldwide Universities Network

Research Development Fund

University of Nairobi

LUANAR

SEEK WISDOM

ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

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Animal Welfare - a pillar of sustainability

- BBSRC UK-India partnership
- Welfare of Dairy Cows in India
  - 38 farms in Kerala
    - Animal and environment observations

Welfare issues identified:

- Behavioural restriction- short tethering
- Lack of access to water and roughage
- Poor physical comfort
- Heat stress

Welfare challenges of dairy cows in India identified through on-farm observations
Siobhan Mullan, Surej J. Bunglavan, Elizabeth Rowe, David C. Barrett, Michael R. F. Lee, Deepa Ananth and John Tarlton
Animals **(in press 2020)**

Dr Mullan leads the Global Animal Welfare Assurance initiative (www.gawassurance.org)

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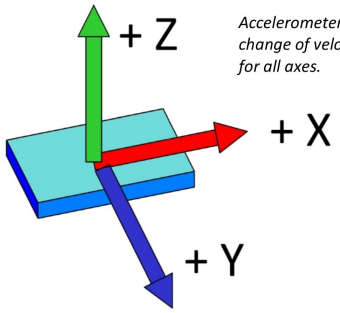
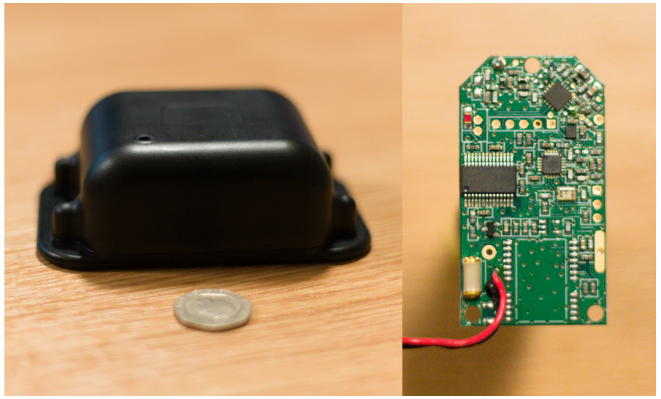
Small Ruminant Monitoring



Accelerometer measures the value of change of velocity (acceleration, m/s^2) for all axes.

RFID



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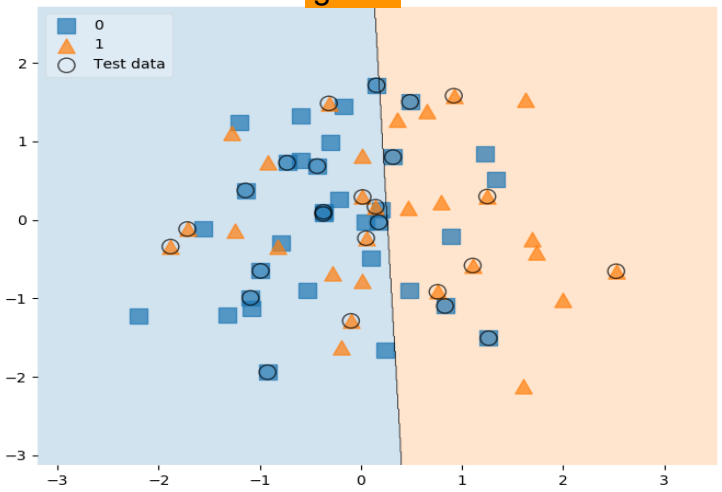
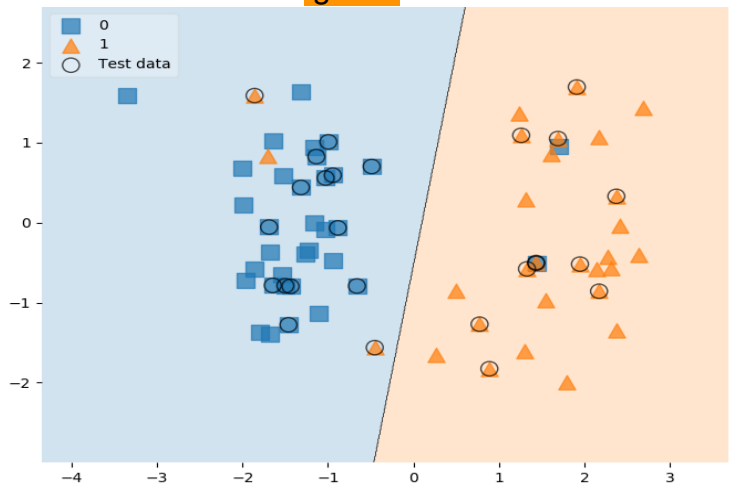
Detecting ill health

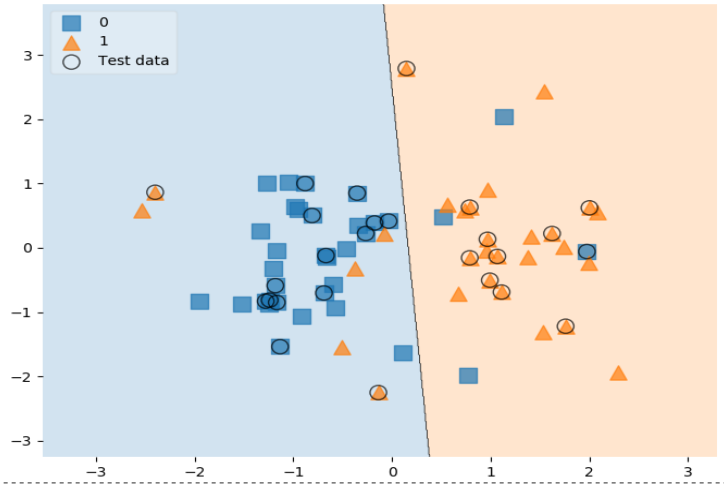
3 weeks before goats turn FAMACHA 2



1 week before goats turn FAMACHA 2



2 weeks before goats turn FAMACHA 2



When sheep and goats turn FAMACHA 2