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University College

Smart Farming at Harper Adams University College

Tomas Norton, PhD

Engineering Department

Outline

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1. Agri-Food in the EU: Challenges and opportunities
2. What is ‘Smart farming’?
3. Introduction to Harper Adams University College and our agricultural engineering courses
4. ‘Smart farming’ in practice at Harper Adams
5. Our Current research projects
6. Our future ‘Smart farming’ research interests
7. The UK National Centre for Precision Farming

Agri-Food Sector n the EU

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The EU Agri-Food Sector:

- EU is the worlds largest food and drink exporter with a 17% share of exports to world markets (Eurostat, 2008)
- 40% of the EU landmass is farmed (Eurostat, 2010): implying significant impact on the natural environment

Overall Challenges we face:

- Feed a growing population
- More efficient use of resources and production increase (twice more with twice less)
- Minimise waste and energy for reducing the ecological footprint
- Transparency and data communication across systems within the supply and production chain

Specific challenges in EU Agriculture

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- Animal health welfare
- Veterinary and zoonotic diseases (Avian flu, BSE, Foot & Mouth)
- Global environmental burden
- Limited non-renewable resources (water, soil, energy, nutrients)
- Product quality and safety
- Labour conditions
- Succession (costs/willingness)
- Future of the countryside (biodiversity)
- Global trading relations (north-south, WTO)

Depends on the place, culture, time perceptions…..

Sustainable intensification of Agriculture

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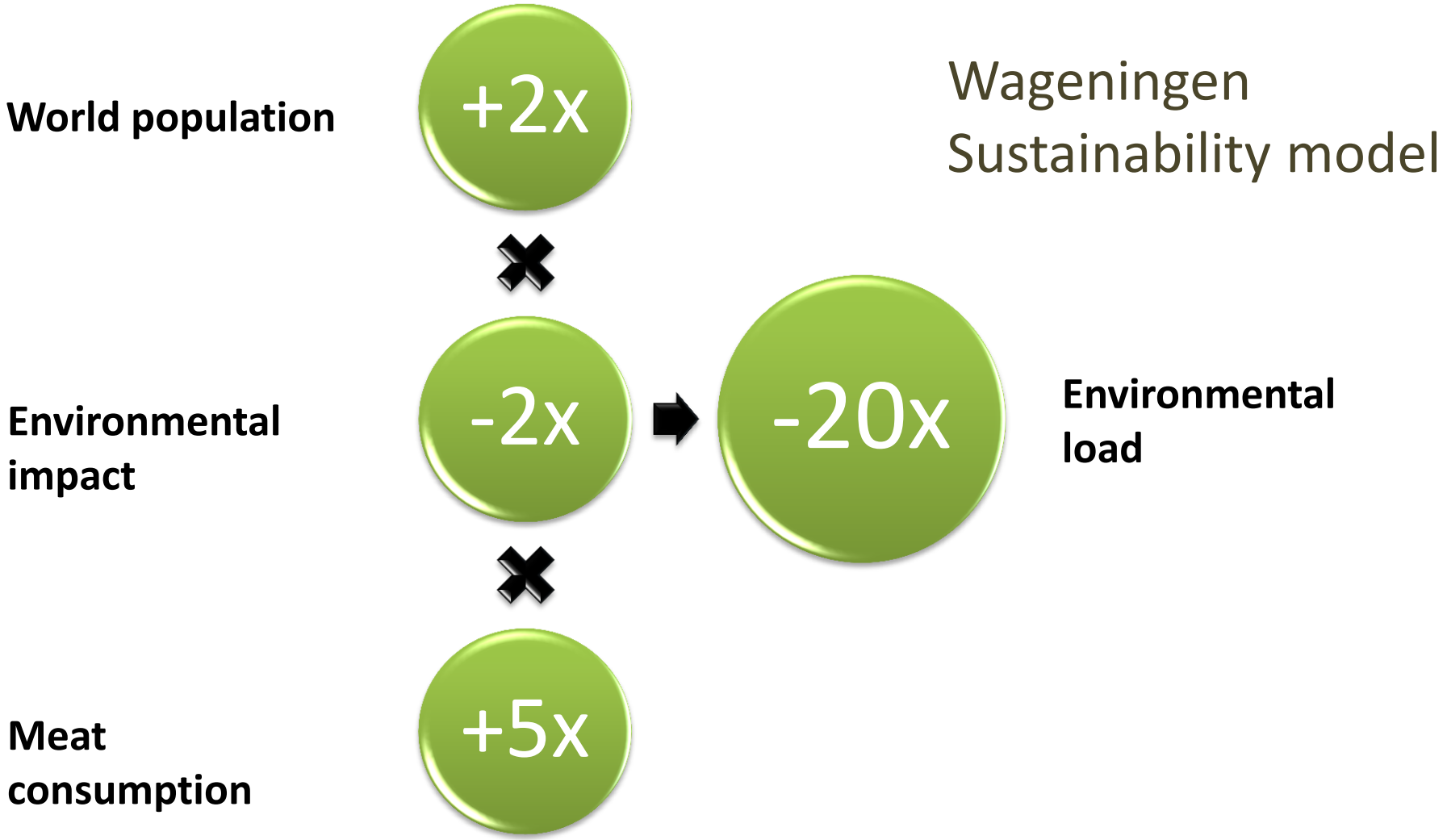
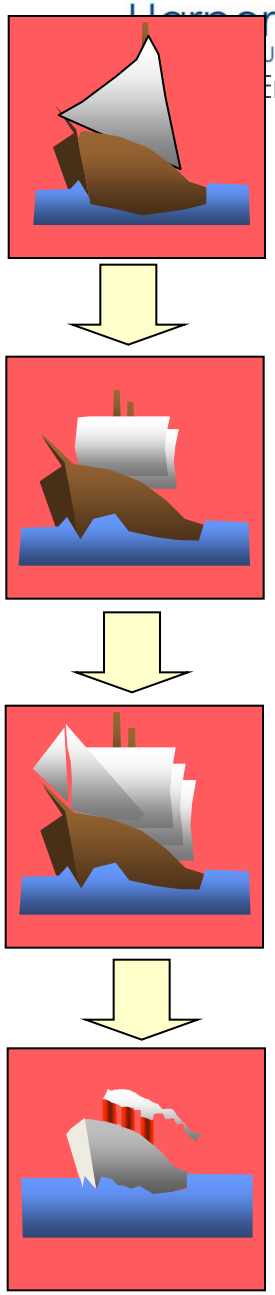


Wageningen
Sustainability model

Innovation for sustainable intensification

- **Use of resources**
  - Less waste, recycling, reuse
- **Continuous process improvement**
  - Optimal use of sensors and models for process design
  - Technology push/market pull
  - Less undesired effects of the process
- **System innovation**
  - Rethinking functions/needs
  - Improves dynamism/stability
  - Combine technology from different fields



(Eco-)Innovation in agriculture

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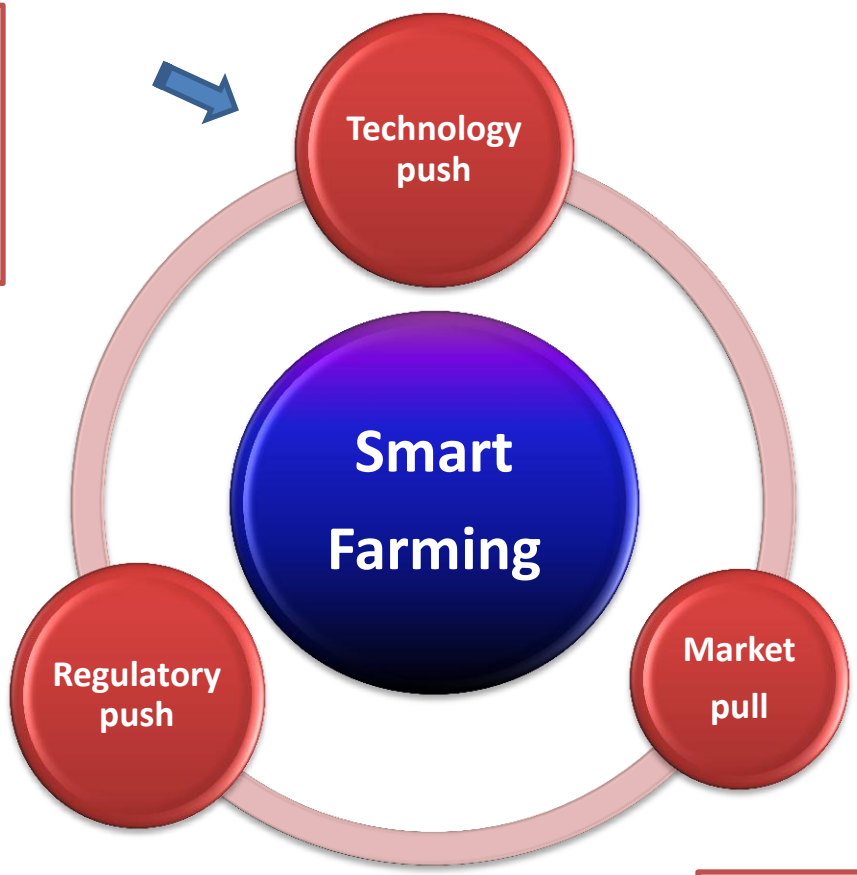
- Computer-based methods
- Process engineering management
- “Smart” sensors
- Images analysis
- Sound analysis



- Pesticide/fertiliser use
- Gaseous emissions
- Animal health and welfare
- Traceability
- Food security

?

There is a large market for technological innovation

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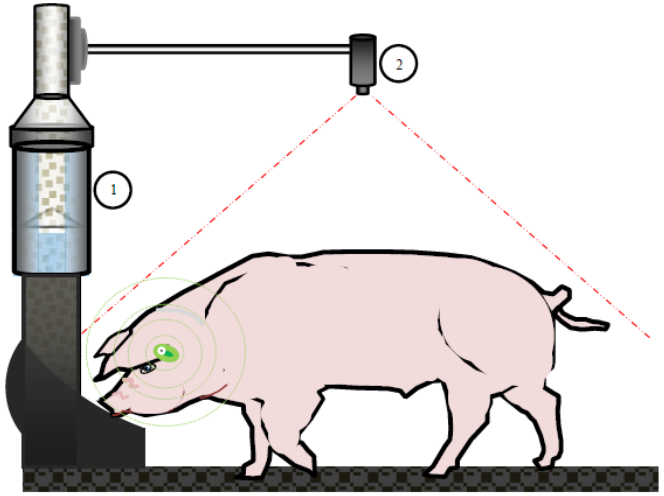
- 40% of the EU landmass is farmed
- 258 million ton meat/year
- 7 billion pigs available
- 40 billion chickens

Big market for sensor-based technology



Smart Farming innovation and ICT Infrastructure

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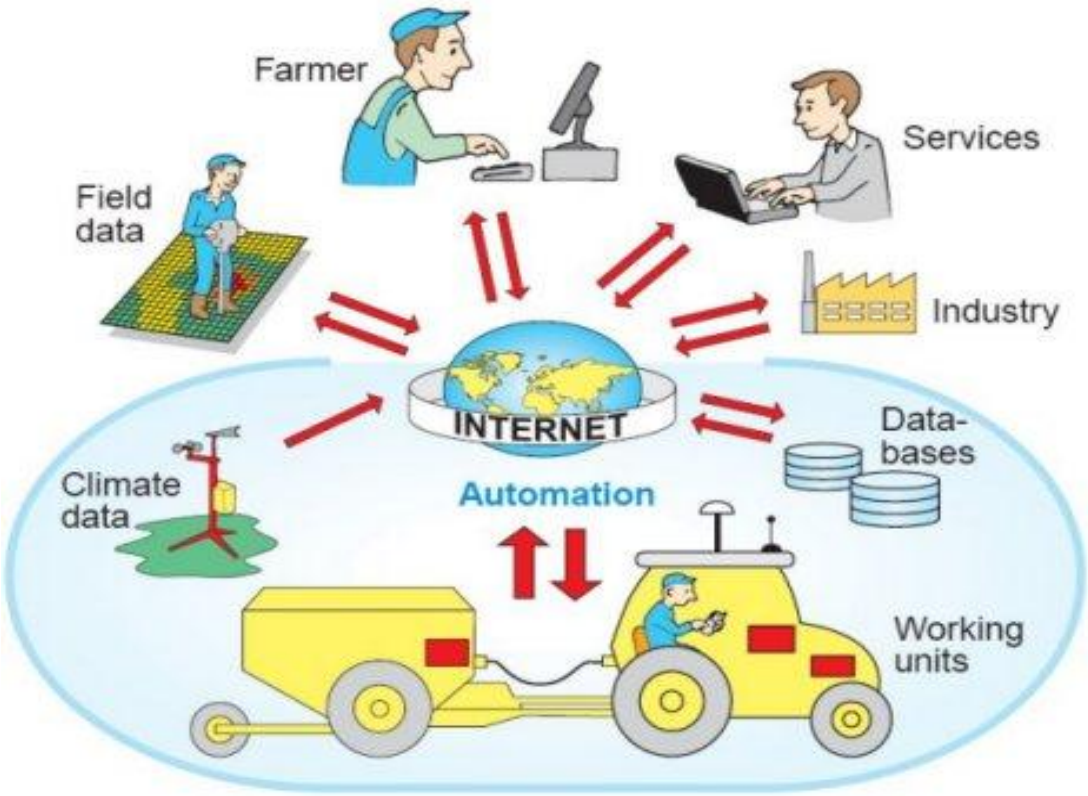

- **Major Problem in the EU**
  - Large amount of fragmented data
  - Poor integration
  - Insufficient support for users of technology
- **Underlying Issues**
  - Semantic interoperability, reliability, integrity of data, how to deal with large amounts of data produced
  - Large complex of actors: from inputs to supermarkets

Modern ICT and Object-Connected ICT are fundamental to Smart Farming

Implementing new technologies through Smart Farming

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- Gives an integrated ***systems*** approach to treating animals, crops and land selectively

- Improves the overall ***efficiency*** of the farming process by understanding the variability of soil and crops

- ***Integrates*** appropriate Information Technology tools and techniques to enable farm managers to get a better understanding and control of their fields and animals and "**supporting on-farm decision making**"

What are the reasons for adopting Smart Farming practices?

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- Increased efficiency by treating system selectively
  - Better understanding and management
  - Less waste
    - Increased economic returns
    - Reduced environmental impact
  - May avoid new restrictive legislation
  - Quality payments
    - Traceability needed from supermarkets.

The basics of Smart Farming!

- Smart Farming is the management of farm variability to improve economic returns and reduce environmental impact
- Spatial variability
  - Physical changes across the system
- Temporal variability
  - Physical changes from year to year
- Predictive variability
  - Management predictions differ from reality

Smart Farming requirement #1:
Measure the variability

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- Assess the extent of spatial variability
  - Animal performance/Crop yield data (maps)
  - Soil maps
  - Remote Sensing
  - Field walking
- Assess the extent of temporal variability
  - Measure for up to 4 years for inter-year stability
  - Measure during growing season for intra season stability

Smart Farming requirement #2.
Understand the variability

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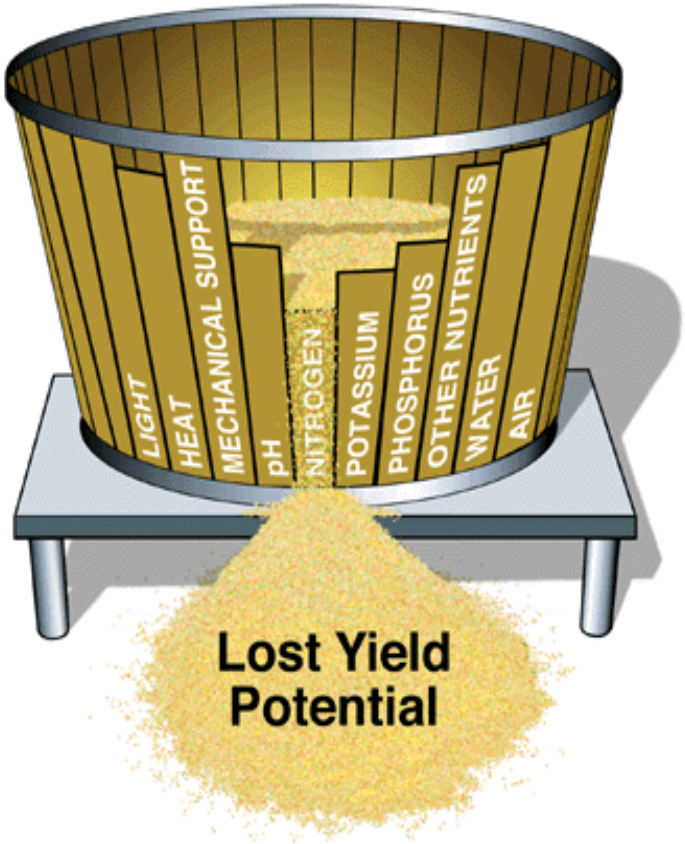
- Identify the significance
  - Look at the costs
    - Gross Margin maps
  - What are the trends?
    - Trend maps
  - What is happening now?
    - Remote Sensing, Tissue maps
- Identify causes of variability
  - Easy with anecdotal evidence
  - Difficult to prove



Example: Spatial variability

(Yield map showing changes over an area)

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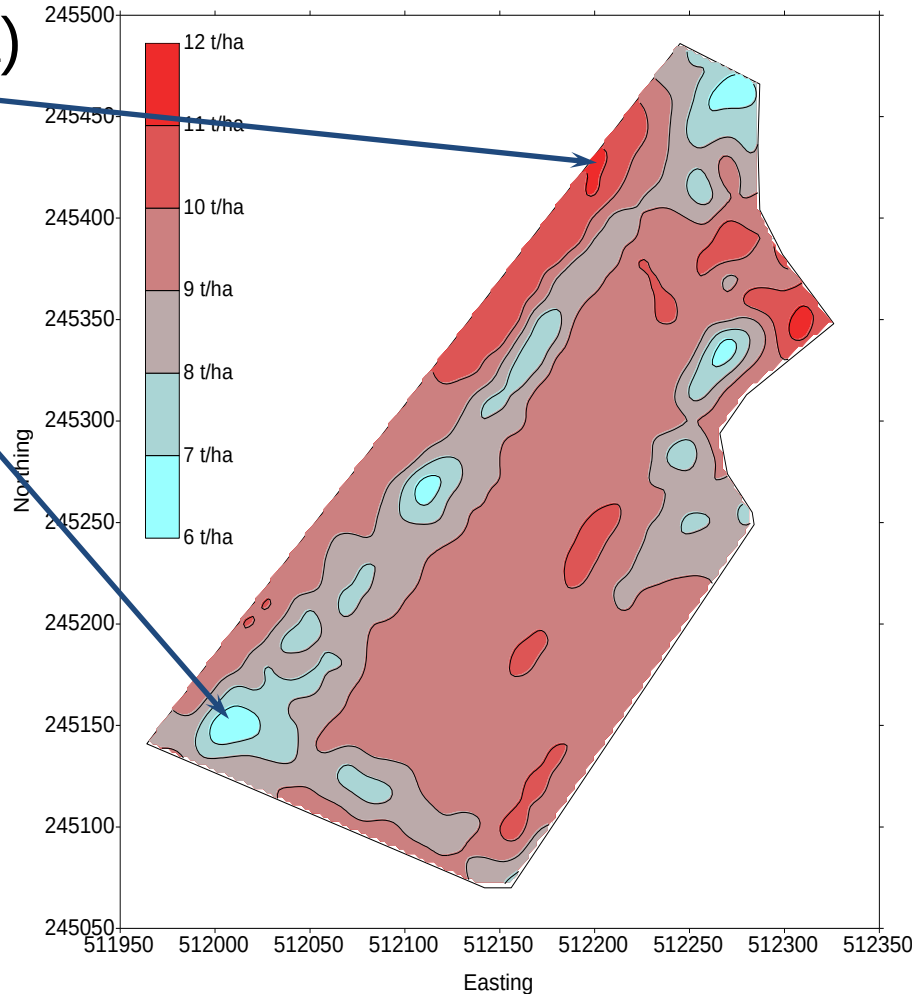
High yielding area(12t/ha)

Low yielding area (6t/ha)

Quantifies spatial variability.



Smart Farming requirement # 3:
Control the inputs (manage the variability)

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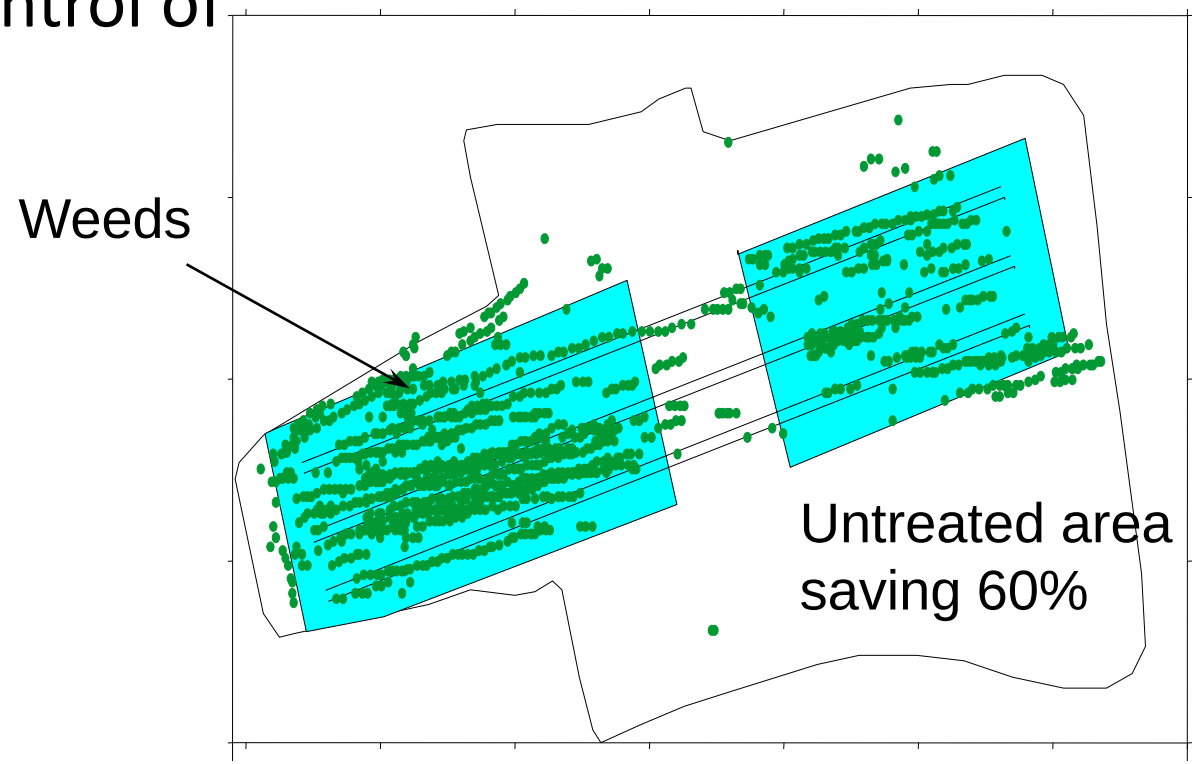
- Spatial and temporal control of
  - Cultivations
  - Seed
  - Fertilizer
  - Sprays
  - Harvesting
- Based on management
  - Management practices



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Taking on the current Agricultural challenges at Harper Adams University College

HARPER ADAMS core business

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Focus is solely on sciences for land-based industries

Learning

Undergraduate
Post Graduate
Continuing Professional Development
Vocational Education
Short course

Research

Applied research & development
Pure research & development

Commercial

Consultancy,
Commercial research,
Technology Transfer,
Commercial Trials,
Market Research,
Business Development

HARPER ADAMS: KEY FACTS

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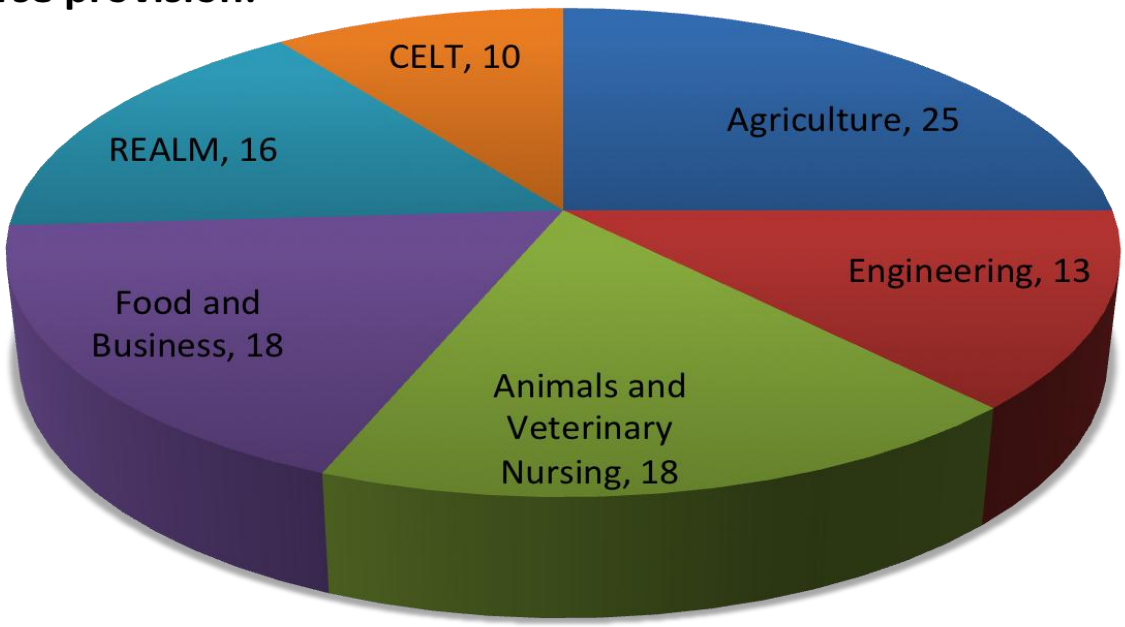
- **Five Key Departments:**
  - Crop and Environment
  - Animal production
  - Agri-Business
  - Engineering
  - Food Science

Course provision:



HARPER ADAMS: KEY FACTS

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Recent achievements:

University College of the Year:

2008,

2009,

2010,

2011 and

2012

[Sunday Times University Guide]

Ranked 6th in UK HEIs for teaching excellence

[Sunday Times University Guide]

Top UK HEI for graduate employment

70% of our research rated as internationally important

Student satisfaction:

91%, National Student Survey (2010/11)

In top 10 HE institutions in the UK, (2012).

HARPER ADAMS: KEY FACTS

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>1300 acres

Engineering Courses

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Agricultural Engineering

MEng / BEng (Hons) / BSc (Hons) / FdSc

Agricultural Engineering with Marketing & Management

BSc (Hons)

Engineering Courses

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Off-Road Vehicle Design

MEng / BEng (Hons) / BSc (Hons) / FdSc

Off-Road Vehicle Design with Marketing & Management

BSc (Hons)

Degree Options

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MEng	Year 1	Year 2	Placement	Year 4	Year 5
BEng	Year 1	Year 2	Placement	Year 4	
BSc	Year 1	Year 2	Placement	Year 4	
FdSc	Year 1	Placement	Year 3		

All our Courses are accredited by IAgrE (&IMechE)

Course Overview
BEng (Hons) Agricultural Engineering

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1st Year: Theory

2nd Year: Application of Theory, in prep for:

Placement

3rd Year: Industrial Application

- **Individual Major Project**
- **Group Enterprise Projects**
- Engineering Mechanics
- Product Development & Testing
- Principles of Management
- Mechatronics
- Field Engineering & Farm Buildings

Course Overview
BEng (Hons) Agricultural Engineering

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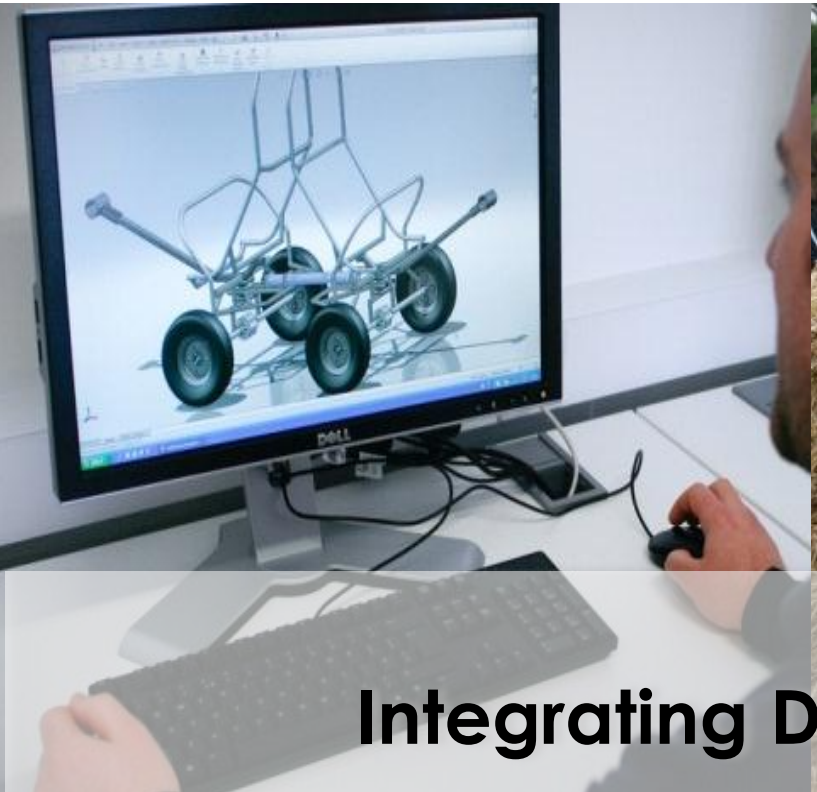
1st Year: Theory

2nd Year: Application of Theory, in prep for:



Integrating Design, Build & Test Project

Student Projects

AgEng: Automated Mechanical Planter

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Student projects: Tractor 2030

Course Overview
BEng (Hons) Agricultural Engineering

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1st Year: Theory

2nd Year: Application of Theory, in prep for:

Placement

Employment:

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More than **93%** of 2009/10 Harper Adams graduates went into **full-time employment**

"Graduates can expect to find exciting, well-paid jobs in design, test and development, marketing, product support and ultimately senior engineering management."

Key Agricultural Engineering Facility:
Indoor Soil Hall

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Smart farming in practice at Harper Adams:

Farming Resources

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- 400 cow dairy unit
- 240 sow pig unit
- Intensive beef unit
- 200 ewe early lambing flock
- Grass finishing beef and lamb
- Intensive pig and poultry systems

Livestock production units

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Dairy

Pigs

Poultry

Level of integrated computer systems

The Harper Adams Dairy Unit

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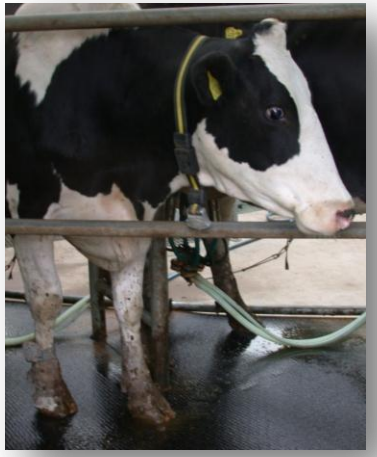
- Examples of ‘Smart farming’ on the Harper Adams **Dairy Unit** include:

Precision feed mixing

Precision feeding



Behaviour monitoring

Milk quality monitoring

PLF technology: inside the parlour

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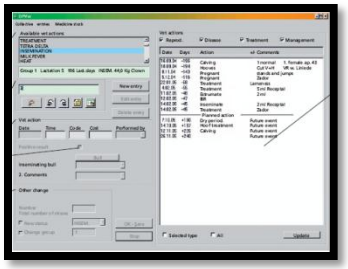
1.

6.



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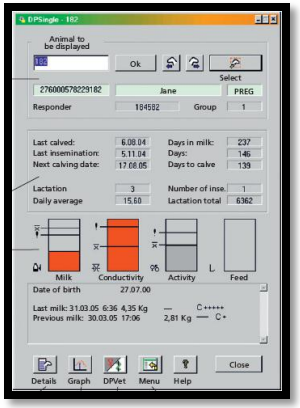

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Performance of new dairy unit

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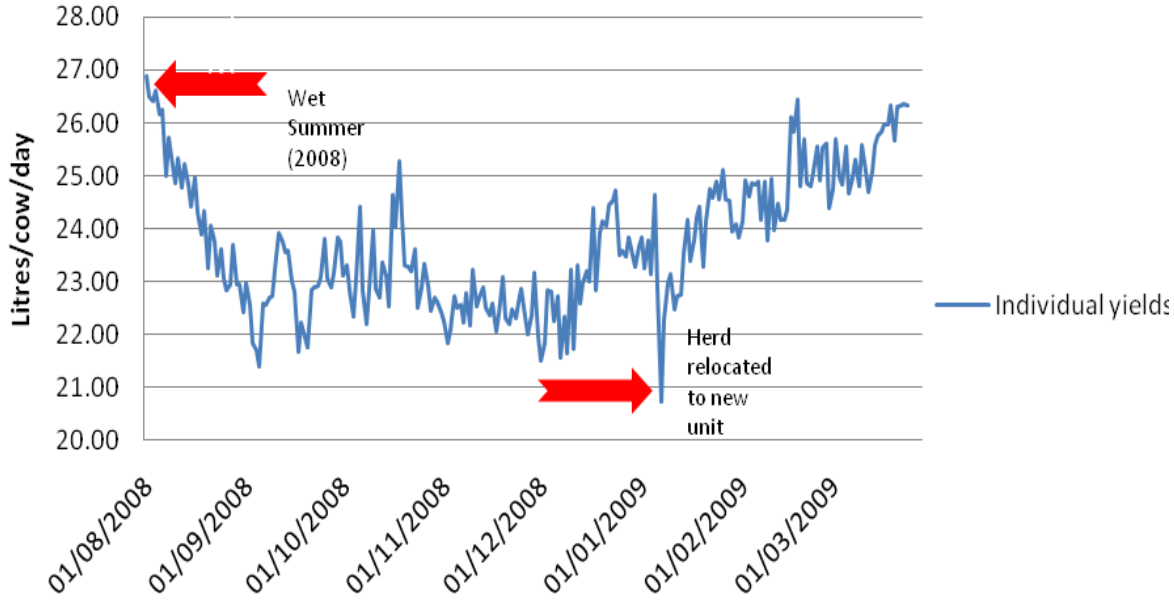
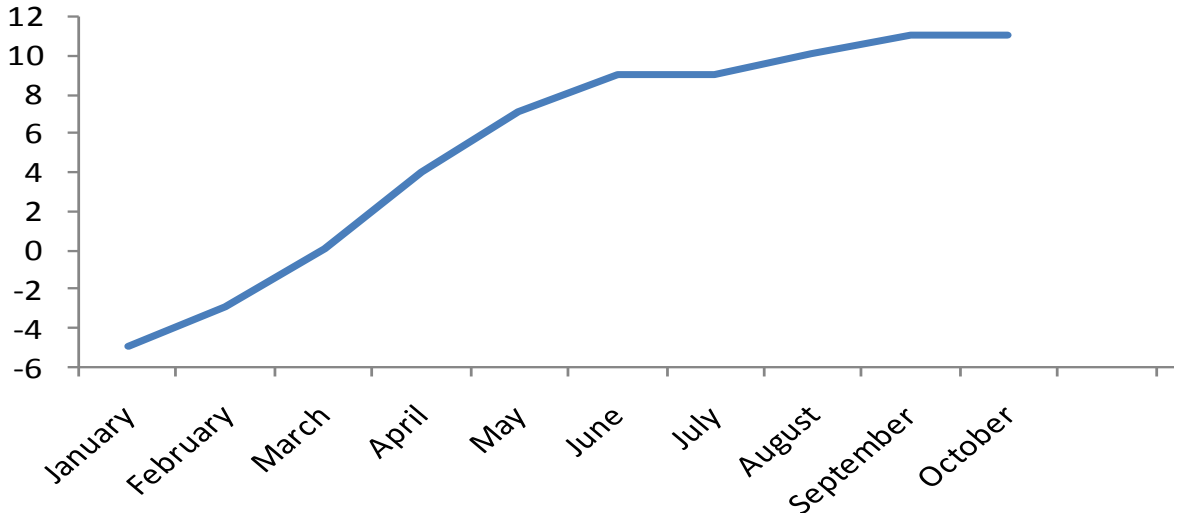
Milk yield per cow



% difference in milk production performance compared to previous year



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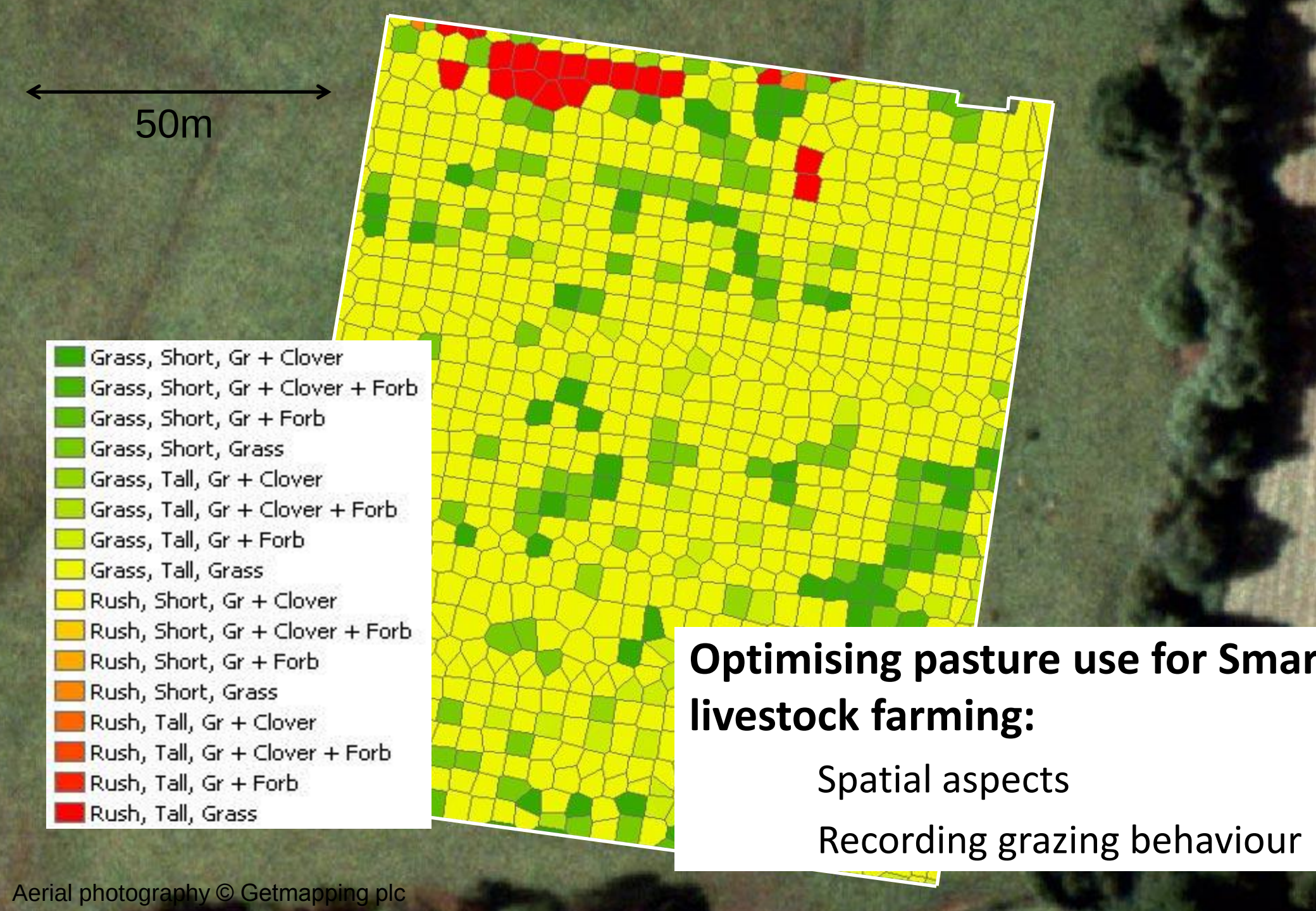
Smart Farming

RESEARCH AT HARPER ADAMS


50m
Grass, Short, Gr + Clover
Grass, Short, Gr + Clover + Forb
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Grass, Short, Grass
Grass, Tall, Gr + Clover
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Rush, Short, Gr + Clover
Rush, Short, Gr + Clover + Forb
Rush, Short, Gr + Forb
Rush, Short, Grass
Rush, Tall, Gr + Clover
Rush, Tall, Gr + Clover + Forb
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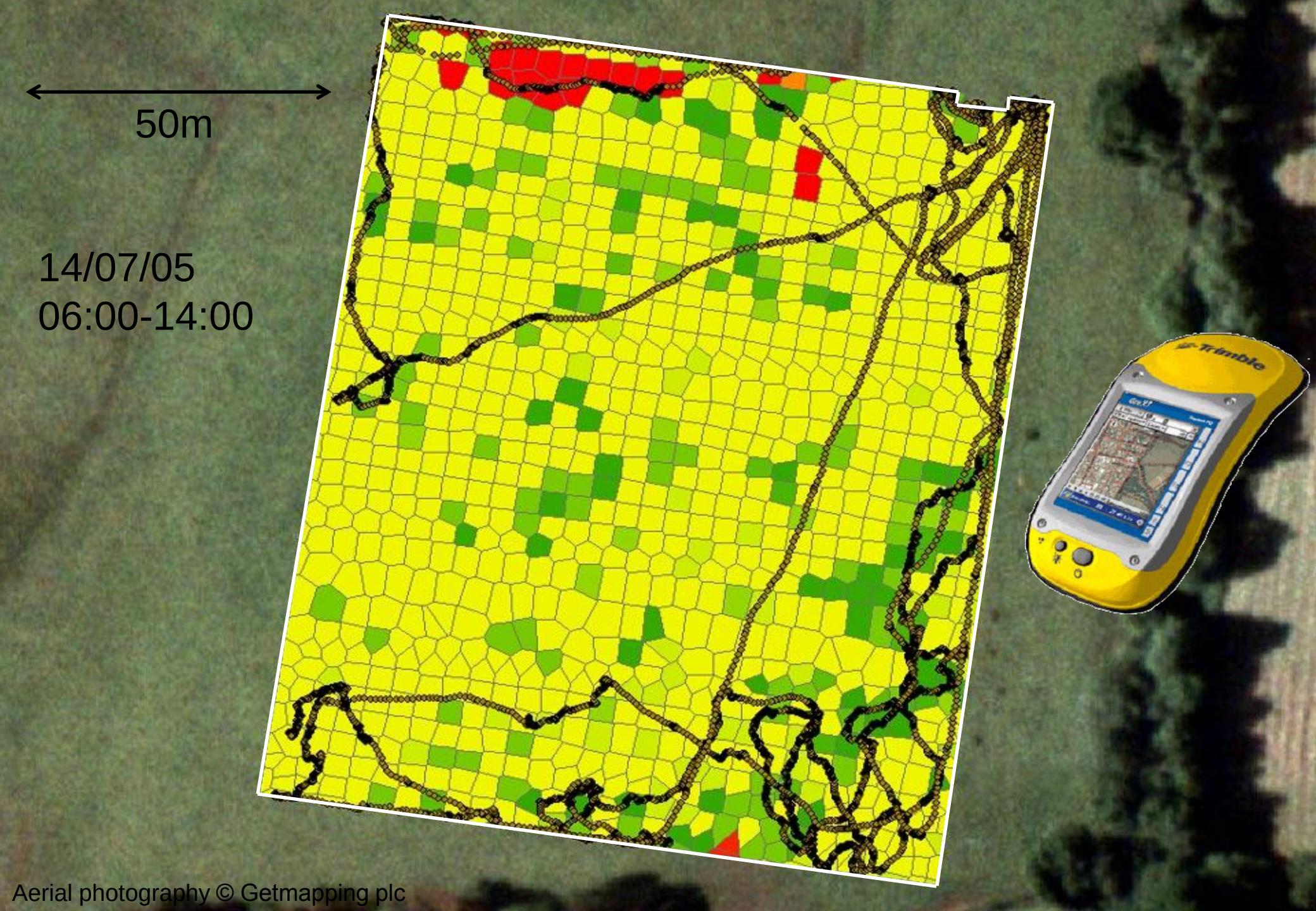
Rush, Tall, Grass
Optimising pasture use for Smar
livestock farming:
Spatial aspects
Recording grazing behaviour
Aerial photography © Getmapping plc



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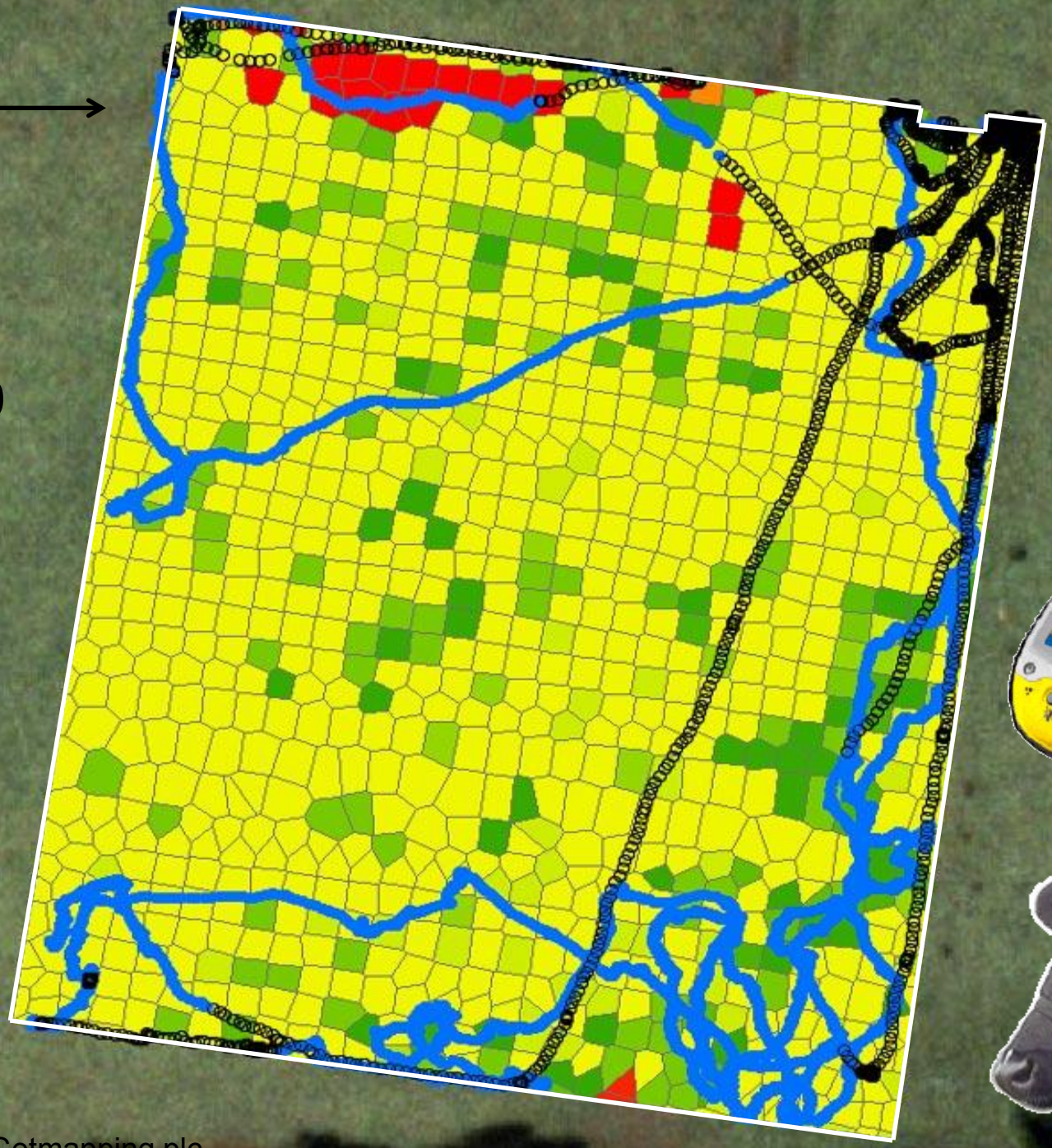

Bioacoustics

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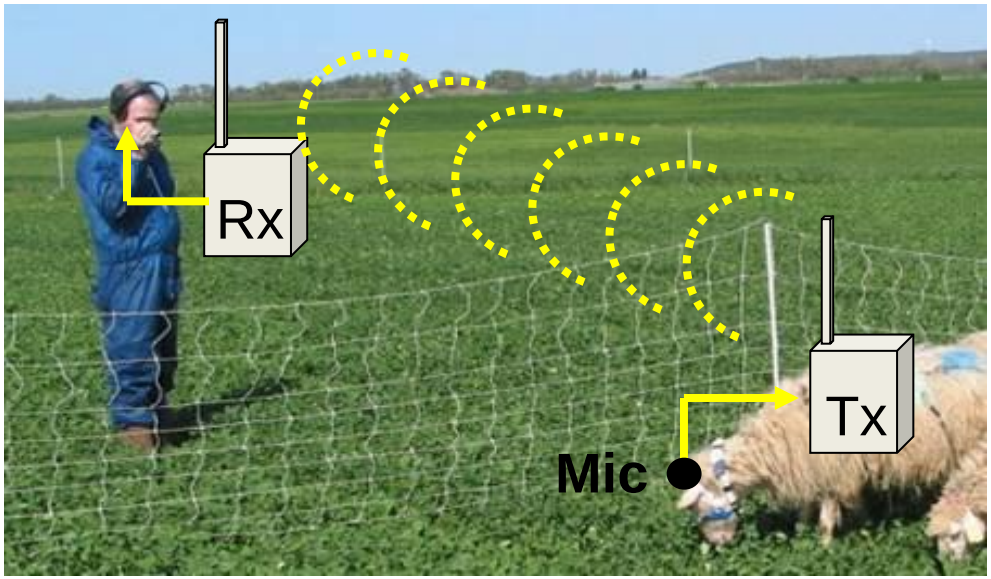

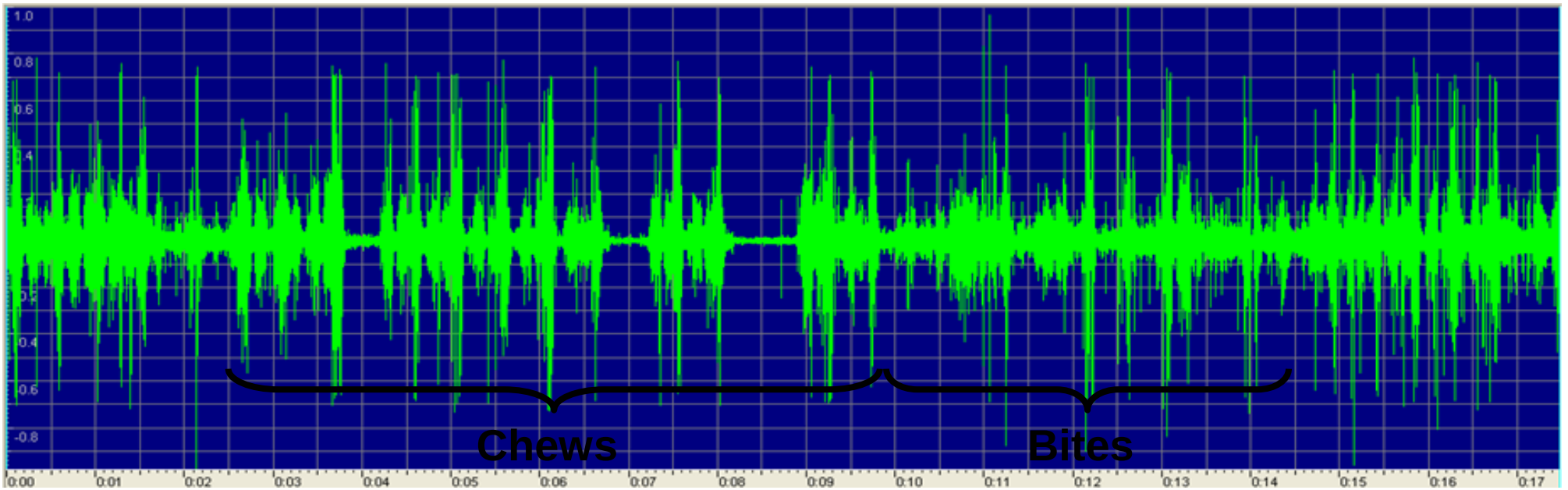

Design of Livestock Buildings

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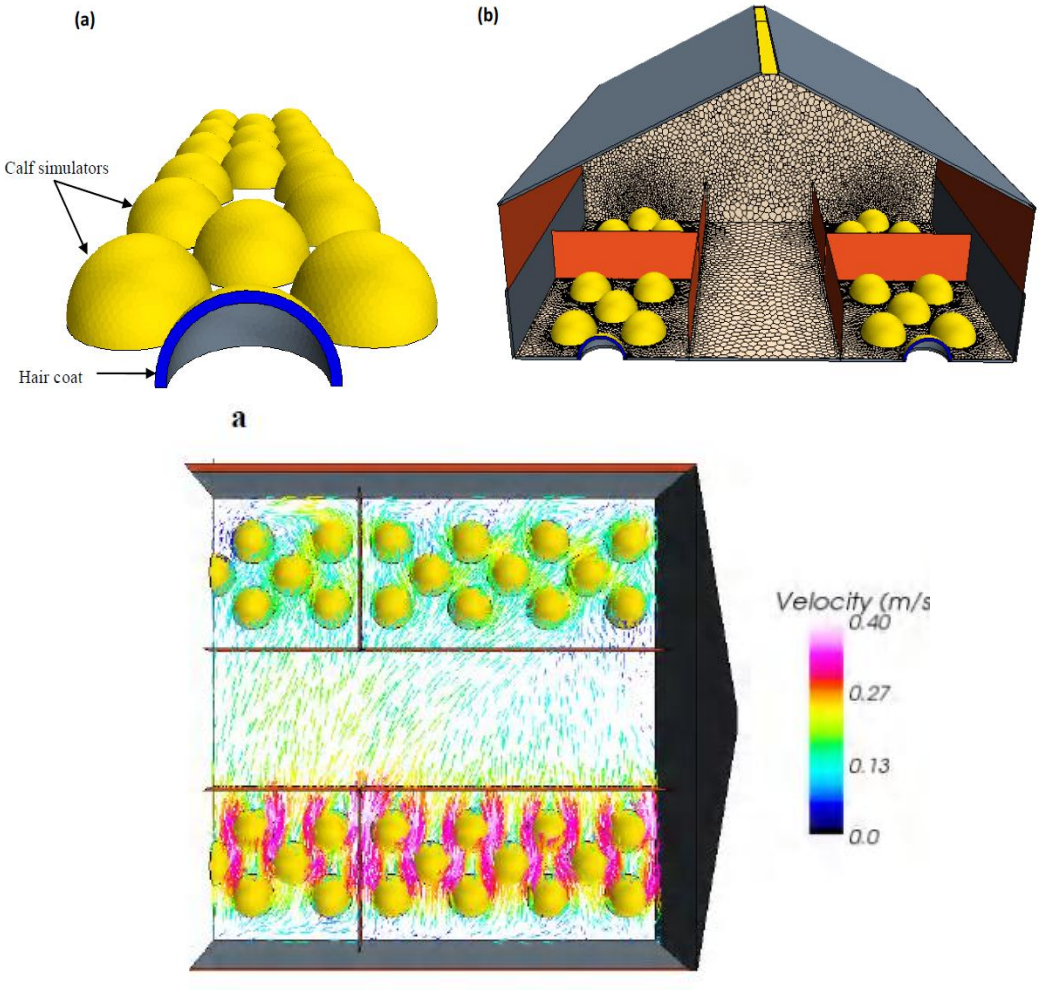

Design of livestock Transport Vehicles

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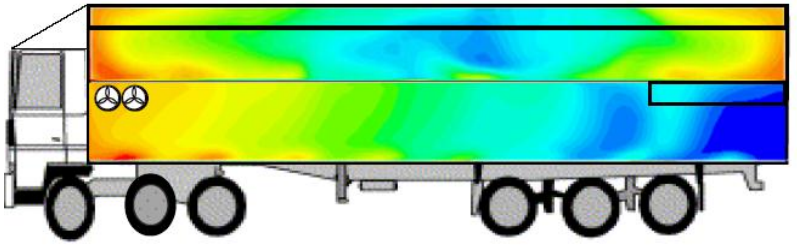

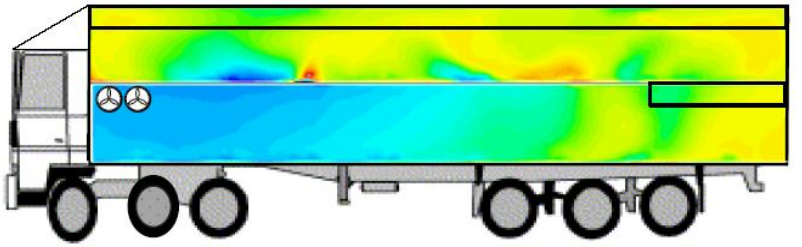

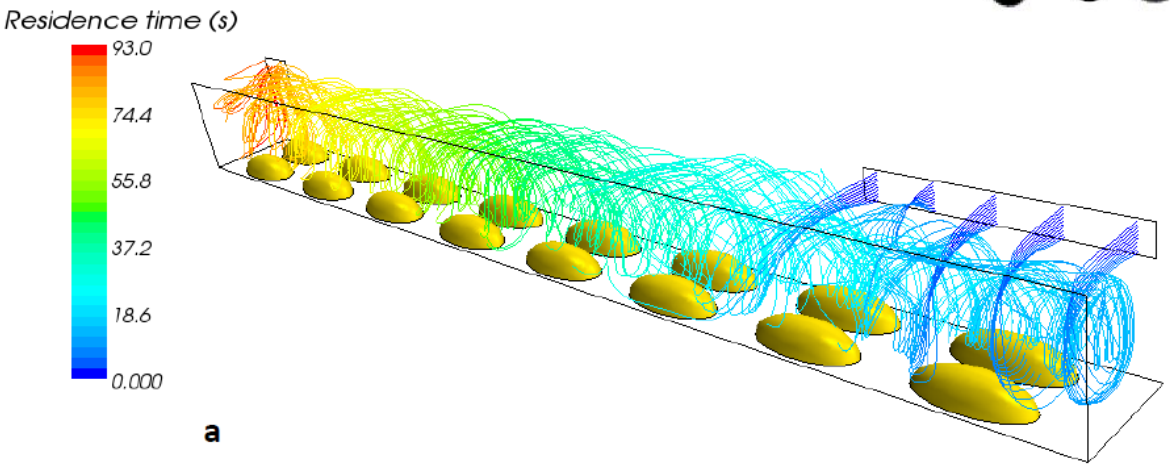

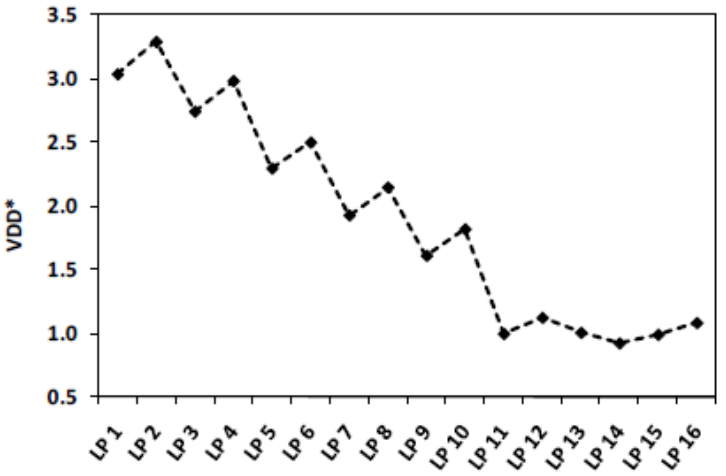

Research

Dr T Norton

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PhD studentship Climate Change Adaptation of livestock buildings

To develop energy efficient building design and energy end-use strategies for current buildings.

For this, high resolution whole building simulation will be used as a tool to optimise building performance for different climatic data and to establish a classification (prioritization) of adaptation measures for pig buildings in future UK climates based on the building performance data obtained from the developed models.

Research

J Ward

Harper Adams
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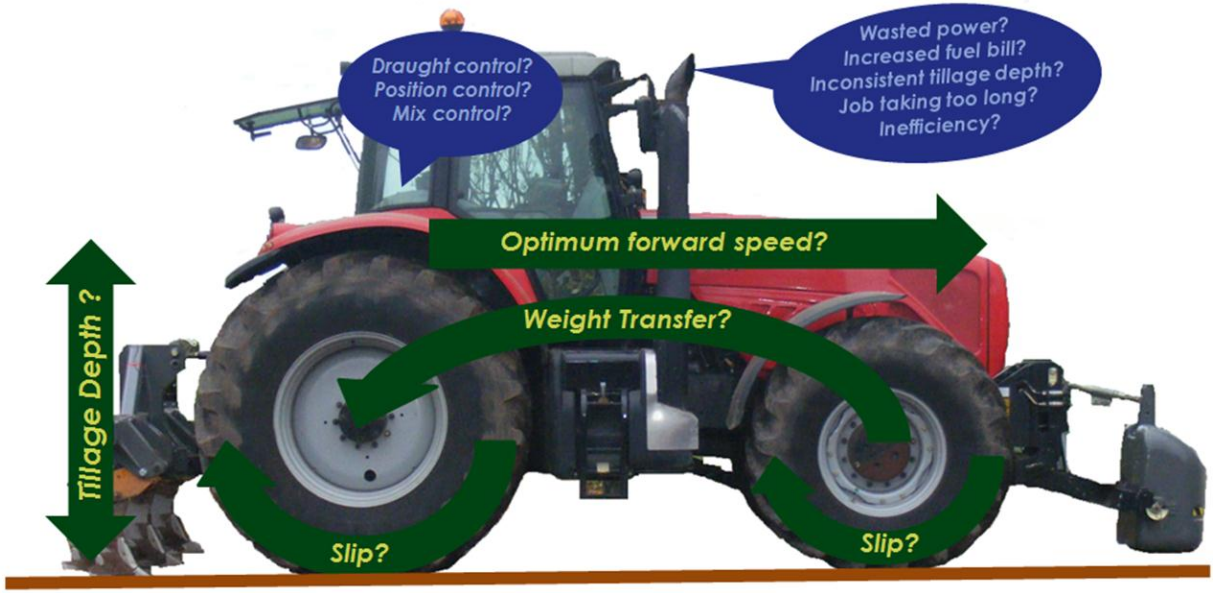
The Control of Agricultural Tractors Carrying Out Draught Cultivations



Research
Dr I Guy

ABB Power and productivity for a better world™

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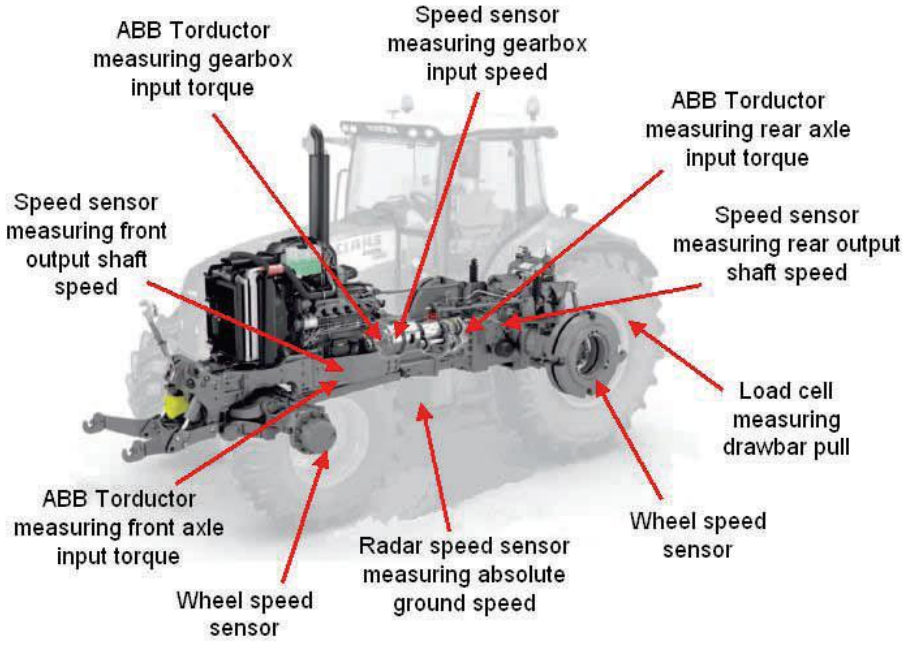
A postgraduate research project to investigate and measure off-road vehicle power and efficiency.



- At speeds of less than 1mph, only **50%** of engine power goes to the axles. *(The hydraulic pump is responsible for a 15KW constant load - equivalent to pulling a constant 2.5 tonne load)*
- The useful engine power is split **40%** to the back axle and only **10%** at the front, which is intriguing for a 4WD system where a more equal distribution might be expected
- A further **50%** of the power is then lost through slip, to give an overall measured efficiency of around **25%**

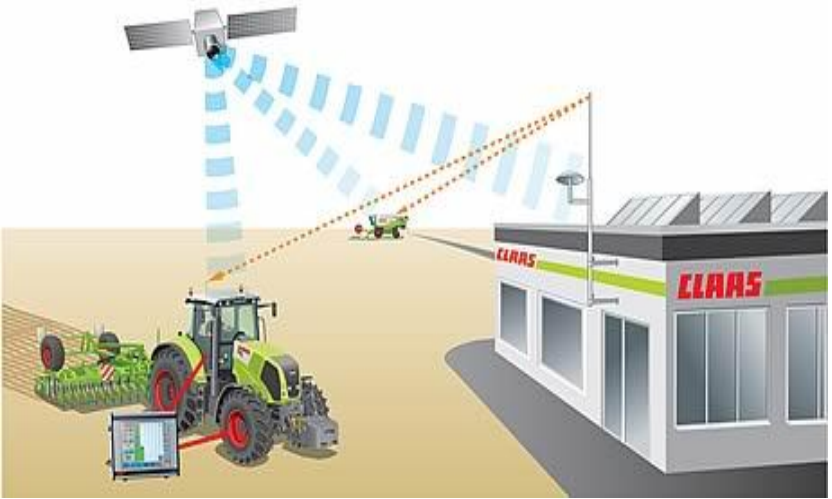
Torductor® sensor fitted to the input shaft on the modified tractor

Precision Farming through robotics

- The management of arable variability to improve economic returns and reduce environmental impact
  - **Spatial variability**

    Physical changes across the field
  - **Temporal variability**

    Physical changes from year to year



EU Research Proposals

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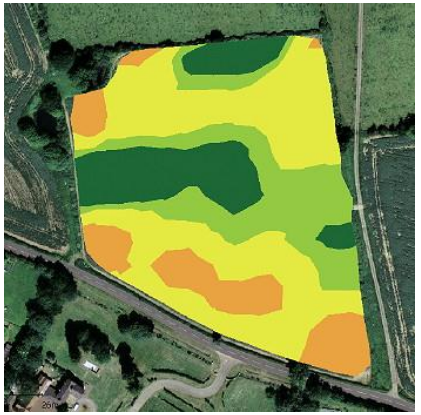
Precision Integrated Farming (PIF) Training Network

(EU Marie Curie Initial Training Network - results released in July)

PIF is an emerging supra-disciplinary field that closely interacts with many technical disciplines as well as social-economics and psychology.

Expertise in this discipline will bring competitiveness in other strategic fields such as smart grids for monitoring and control of resources (IoT enabled logistics and energy usage), embedded systems and sensing technologies (many new sensors required to quantify natural processes using photonics), robotics and mechatronics (special mobile platforms required to improve agricultural production).



Future research areas

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- Development of **new sensor** technologies
- Commercial development of **existing research** technologies
- **Integration** of data from a variety of PLF sensors to enhance the accuracy of support information e.g. the 'virtual shepherd'
- Development of a 'smart farming' **service industry** to deliver PLF solutions to meet the needs of farmers

National Centre for Precision Farming

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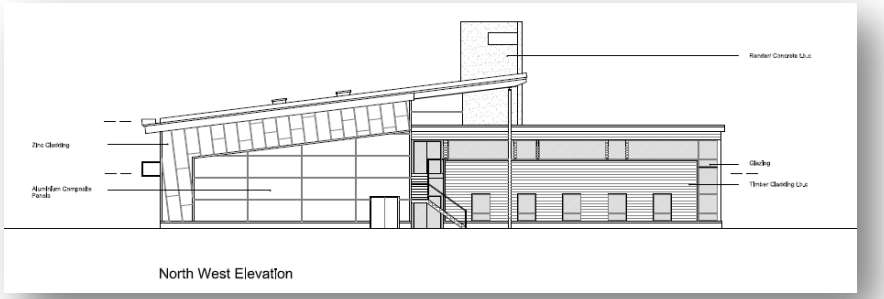
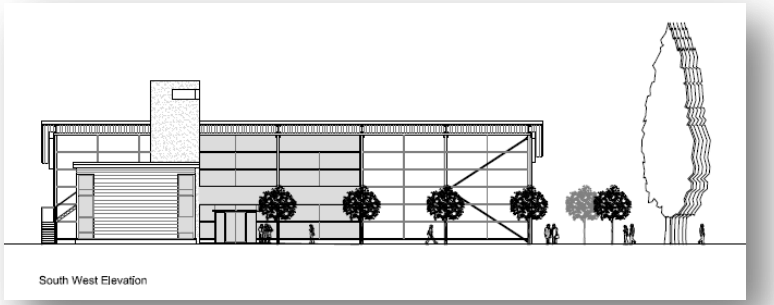
- Centre is to aim to stimulate debate, innovation and understanding as we all make the transition to smarter farming.
- *promote new, appropriate technologies and techniques to help farmers meet today's goals*





Launch of the centre at Westminster:

http://www.youtube.com/watch?feature=player_embedded&v=lUZdkP3QloQ#!

HARPER ADAMS: International Research Collaboration

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- We partner the University of Nottingham, Cranfield University and Rothamsted Research in the BBSRC Advanced Training Partnership scheme
- Research collaboration with Aarhus and Gent, Copenhagen, KU-Leuven and ILVO
- Student exchange links with the University of Missouri and Cornell University
- Long standing collaboration with Beijing Agricultural University
- Developing links with 4 other Chinese universities specialising in agriculture

Solutions can be translated: lets work together

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Thank you