Sustainable Intensification?
Global perspective

Threats or Opportunity

• As farmers we are tasked with providing 100% of the world’s food

• In the future we will may be encouraged to also supply 60% of the world’s energy

• 2012 – World population exceeded 7,000,000,000 (Billion)

• 2050 – World population predicted to be 9,000,000,000+ (Billion)

• Change in global diets

• World food production needs to significantly increase to support this growth
Increasing Population – Limited Recourse

Very limited potential to increase arable land

Improved living standards increase protein consumption per person requiring more grain for animal feed

The only solution is to increase agricultural productivity

Source: IFA, Worldmarkets.com
Evolution of Precision Agriculture

Figure 1: The evolution of (precision) agriculture

Past
- 19th Century: The Plough
- 1980s: GMO
- ~2008: Machinery & GPS Tracking

Present
- Confused Farmer (Overwhelmed by data)

Future
- DATA INSIGHT
- Connected Ag Weather Stations
- Doppler Weather Forecast
- Plant Sensors (e.g. sap flow)
- UAV with Sensor Payload

Incremental Benefit over Previous Generation

New Growth Potential for Farmers
What is Sustainable

Job or Food?
Will we reinvent the wheel

Agriculture running on renewables!
How do we fill the Gap
Agricultural Price Challenge

Bigger is better?

UK AGRICULTURAL TRACTOR REGISTRATIONS (> 50 hp)

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
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<tbody>
<tr>
<td>Units</td>
<td>13068</td>
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<td>Annual % Change</td>
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<td>3.8</td>
<td>14.6</td>
<td>10.1</td>
<td>-12.2</td>
<td>-11.1</td>
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<td>Total horsepower (000’s)</td>
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<td>1741</td>
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<td>2153</td>
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<tr>
<td>Annual % Change</td>
<td>-12.2</td>
<td>4.4</td>
<td>19.6</td>
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<td>-8.8</td>
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<tr>
<td>Average horsepower</td>
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<td>150.4</td>
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<tr>
<td>Annual % Change</td>
<td>-1.0</td>
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<td>-1.2</td>
<td>1.8</td>
<td>2.6</td>
<td>1.6</td>
</tr>
</tbody>
</table>

18% increase in 8 years
Increasing Scale of Agriculture

More with less - increase productivity and efficiency
Combine Harvester Scale
Scale – Data

\[ m < 0 \quad \text{decreasing} \]

\[ m > 0 \quad \text{increasing} \]
Less data – reducing resolution

Yield Data 2004

Yield Data 2014
Changes in data size and resolution

High Resolution
UAV
5 CM Pixel

High Resolution
Satellite
2 M Pixel

Low Resolution
Satellite
20 M Pixel

50 CM
10 TIMES BIGGER
THAN A UAV PIXEL
Management challenges

Conventional or traditional field management

Field
One rate

Optimised management

Sub-Field
Variable rate

Single plant management

Single plant
Individual rate

Leaf scale management

Leaf
Leaf rate
Why are animals Different to Plants?
Hands Free Hectare - Pre-Drilling Herbicide Application
ESTABLISHING
GROWING
HARVESTING
MANAGING
Limitations cost Money

• **Identify** limiting factors

• **Use Knowledge** to identify Limitations

• **Measure** What works

• **Measure** What does not work

Under performing areas cost yield and reduce income
Precision Mapping

If we can see the problem -
Precision Agriculture

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FUTURE
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An Innovate UK funded collaborative feasibility study between:
Field Robotics – possible future

Current Ag problems
Limited time windows = ever larger machines
Reduced rural labour = ever larger machines
Compaction limiting yield cause large machines
Lack of resolution for PF cause large machines

Small robot solution
Reduced compaction = increase yield?
Increased resolution = improved PF = margin gain?
Robots operate in “swarms” = same area covered
Swarm requires management = job retained
Staff Losses with Robotics?

Figure 3: number of agricultural workers in the UK, 1925-2010 (in thousands)

Hands Free Hectare – world first

Project outline

“Automated machines growing the first arable crop remotely, without operators in the driving seats or agronomists on the ground”

Project objective

1. World first automated field growing cycle: drilling, husbandry/agronomy and harvest
2. Challenge perception of automation capability and inspire through media coverage
3. Utilising machinery and technologies that are available and affordable not bespoke and expensive:
   Commercial compact Ag machinery
   “Open source” automation
4. 1 year project…. One chance!!
We have modified our tractor with the autopilot from a drone. They are conventionally used to plot waypoints around where you want to...
Crop Protection
WiFarm

• Open source farm communication network
Field Variability Tool

• Low cost
• Field variability guide
• Build a business case
• Combine with all your data
• Build your own precision strategy
• Linked to your phone
Weather Data

• Individual field scale weather forecasting module
• Better planning of field operations
• Automating field records with live weather links
• Vehicle trackers automating record keeping
• Crop models to inform Risk and Pressure
Hardware sale down with industry sales figures

Agricultural tractors (over 50 hp)
Moving annual total registrations

Units
