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precision farming solutions

Society of Chemical Industry
Sustainable Intensification - Growth from Research and Technology

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EssentialsNET

GPS Correction Network

Precision Ag Update
Talk Outline

- How has Precision Agriculture changed over the last 15 years?
- Agronomic Use.
- Machine Control.
- Data Management.
- Summary and conclusions

Precision Agriculture Update

Where are we?

Precision Ag Tools

"Traditional" Precision Ag

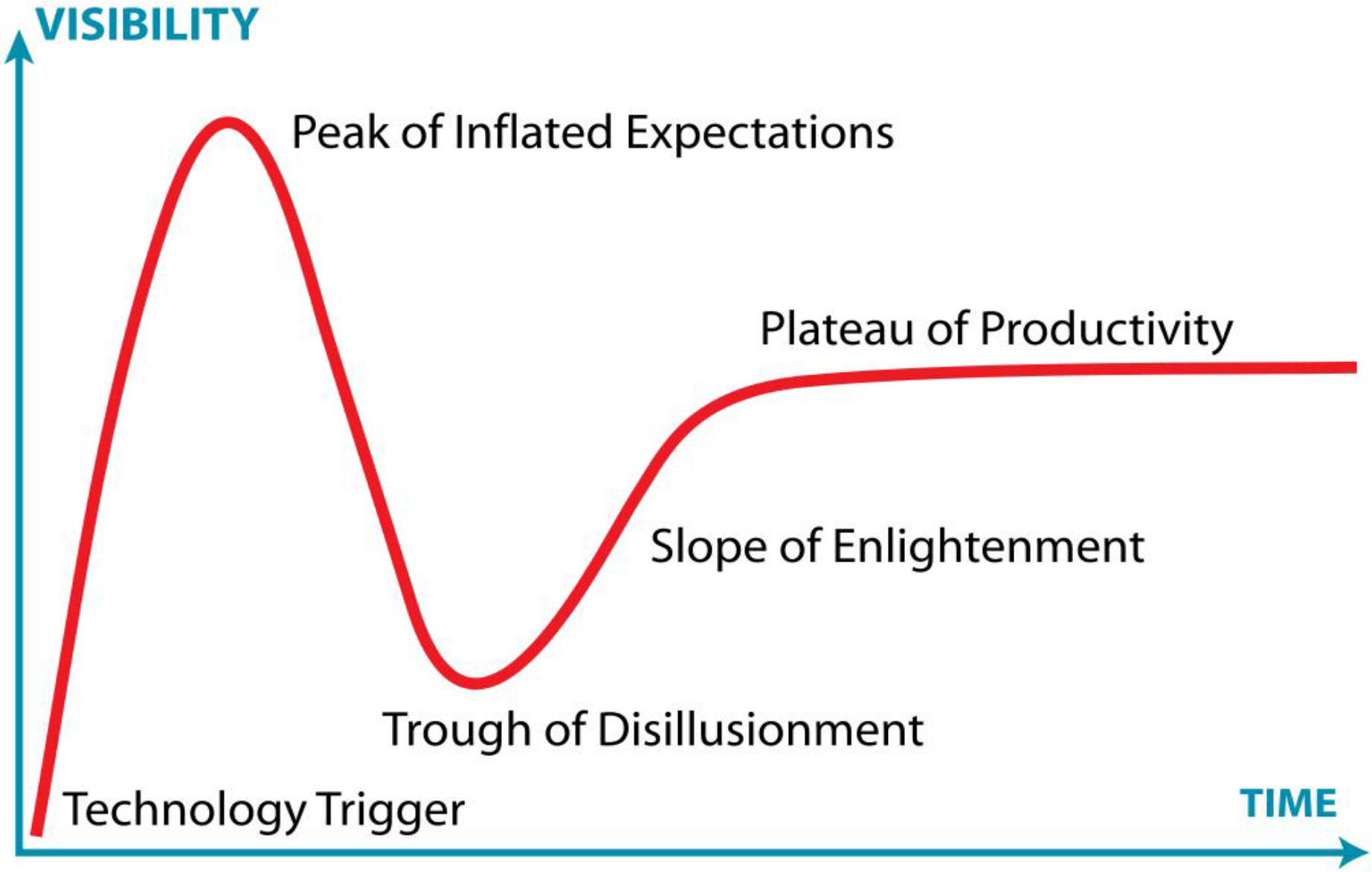
- Soil Sampling
- Soil Texture Mapping
- Yield Mapping
- Variable Rate Lime, P & K
- Variable Seed Rates
- Visual Guidance
- Autosteer
- Auto Section Control

"New" Precision Ag

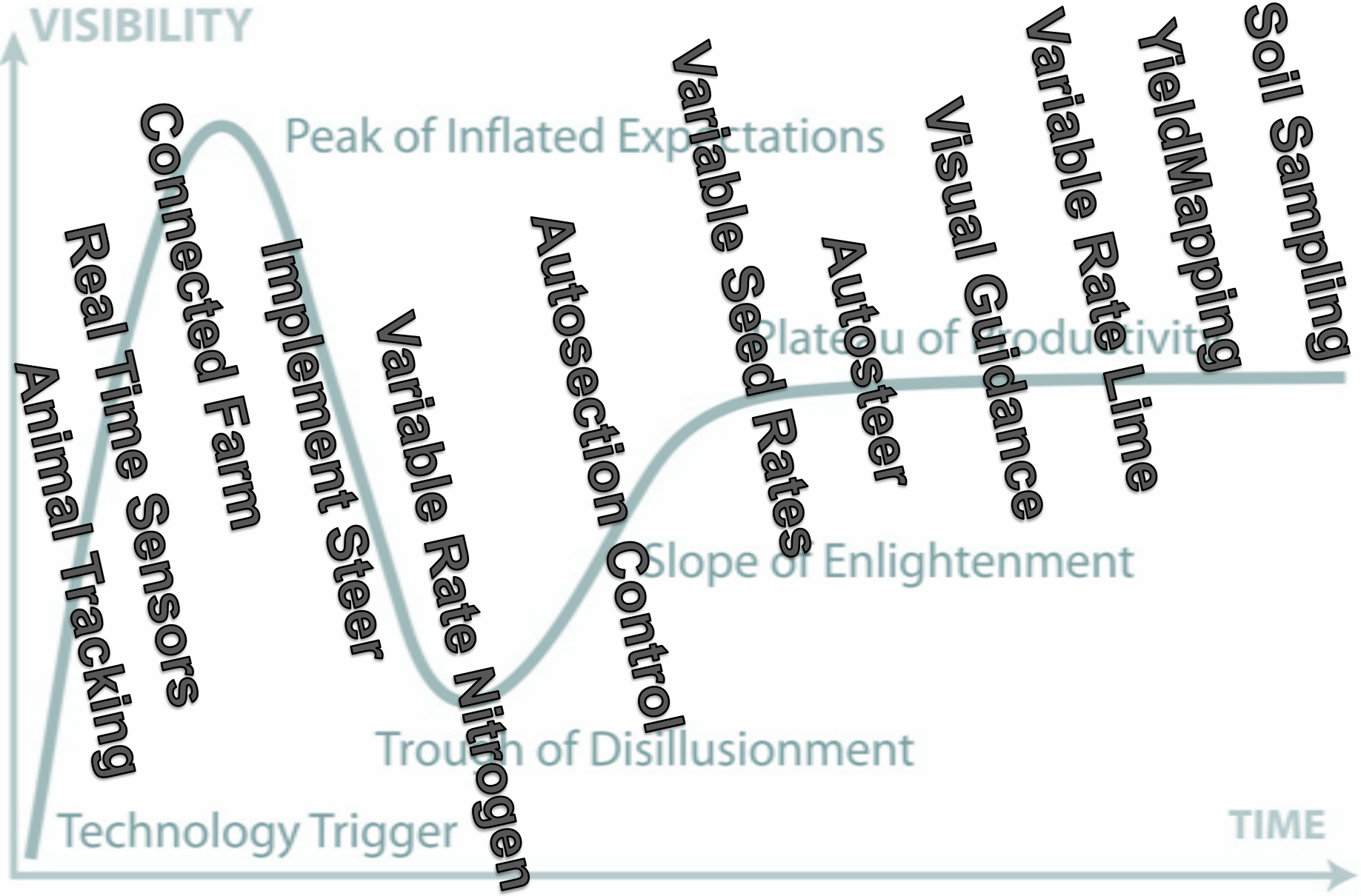
- Implement Steer
- Variable Rate Nitrogen
- Variable Rate PGR/Fungicide/Dessicant
- Real Time Sensors
- Internet Connected Machinery
- Animal Tracking
- Network RTK
- Connected Farm

Gartner “Hype” Cycle

Every new technology passes through these phases..



So where is Precision Ag in the cycle?



Precision Agriculture Update

Agronomic Uses

The Problem…

- Fields are not uniform.
- Therefore yields are not uniform.
- But it costs the same to grow a low yielding crop as a high yielding crop.
- So the profits vary according to yield.

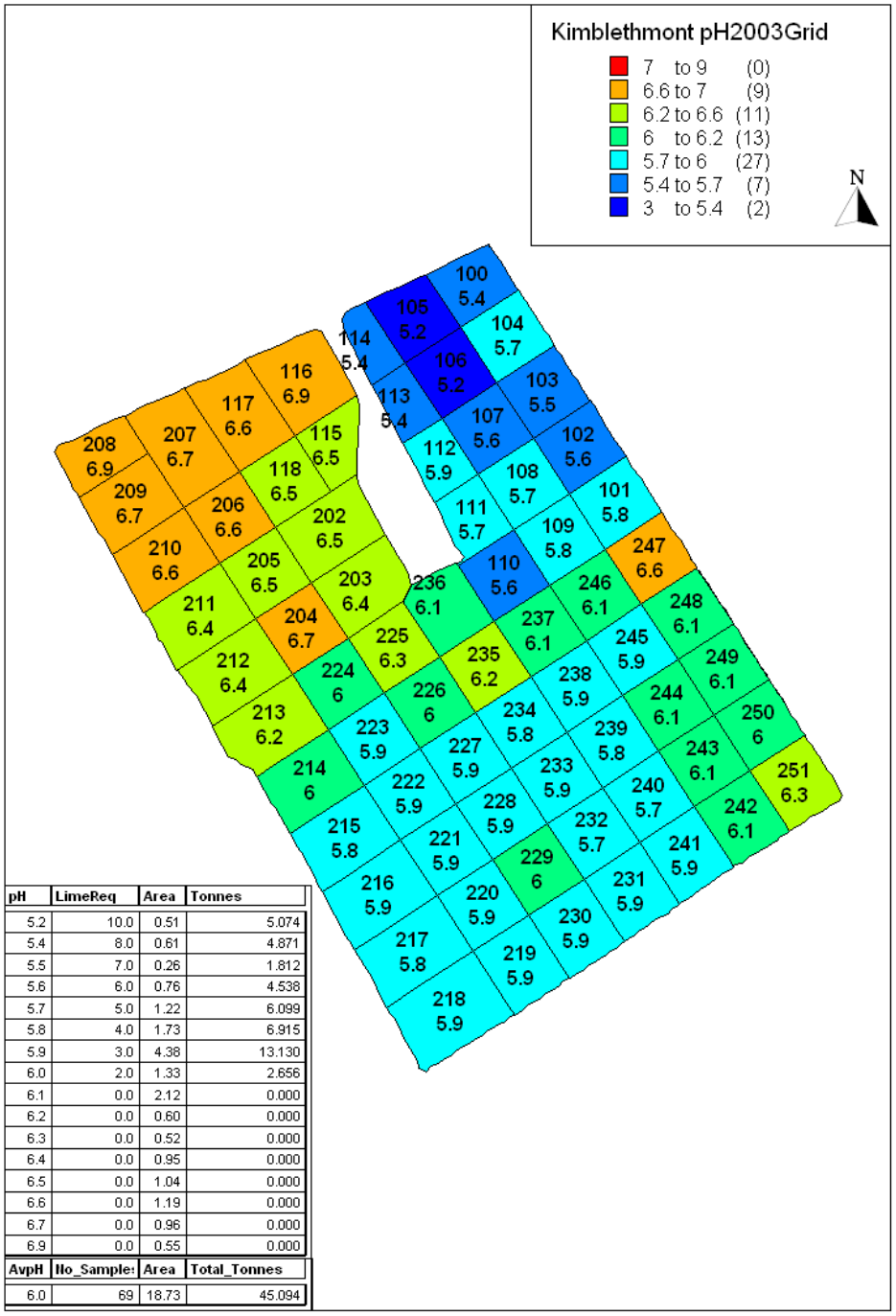
SO WHY DO WE UNIFORMLY APPLY CROP INPUTS?

Spatial variability in soils and crops

- Basically 2 types of variability.
- 1st Type of Variability
  - Management induced variability
  - Caused by the last 40 years of management!
    - Soil pH, Phosphate, Potassium, Magnesium.
    - Compaction, Field History.
    - Soil Mineral Nitrogen (SMN)
- You can *correct* these problems with precision agriculture!

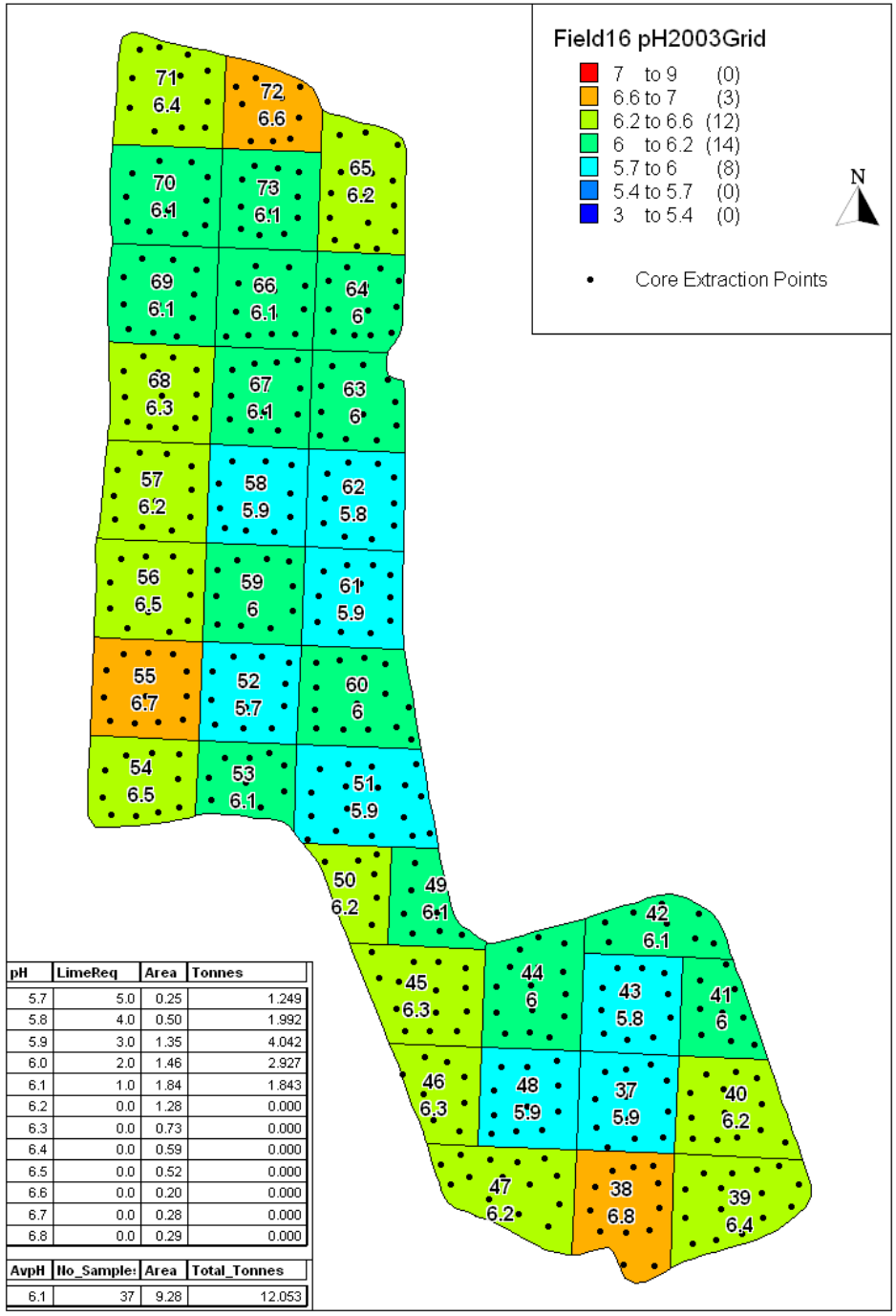
Equipment to map management induced variability

- Map soil pH, P and K changes.
- Can be done by hand.
- More often with an automatic sampler
- Use a low accuracy GPS handheld to grid the field and guide the sampler.
- Analyse in a laboratory.
- Create a map.
- Apply variably across field.



pH	LimeReq	Area	Tonnes
5.2	10.0	0.51	5.074
5.4	8.0	0.61	4.871
5.5	7.0	0.26	1.812
5.6	6.0	0.76	4.538
5.7	5.0	1.22	6.099
5.8	4.0	1.73	6.915
5.9	3.0	4.38	13.130
6.0	2.0	1.33	2.656
6.1	0.0	2.12	0.000
6.2	0.0	0.60	0.000
6.3	0.0	0.52	0.000
6.4	0.0	0.95	0.000
6.5	0.0	1.04	0.000
6.6	0.0	1.19	0.000
6.7	0.0	0.96	0.000
6.9	0.0	0.55	0.000

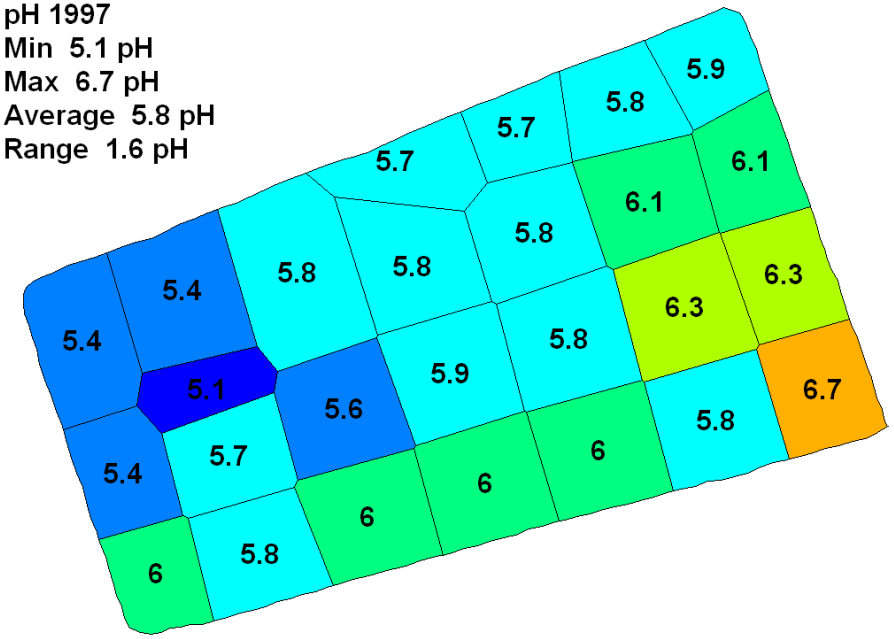
AvpH	No_Sample:	Area	Total_Tonnes
6.0	69	18.73	45.094



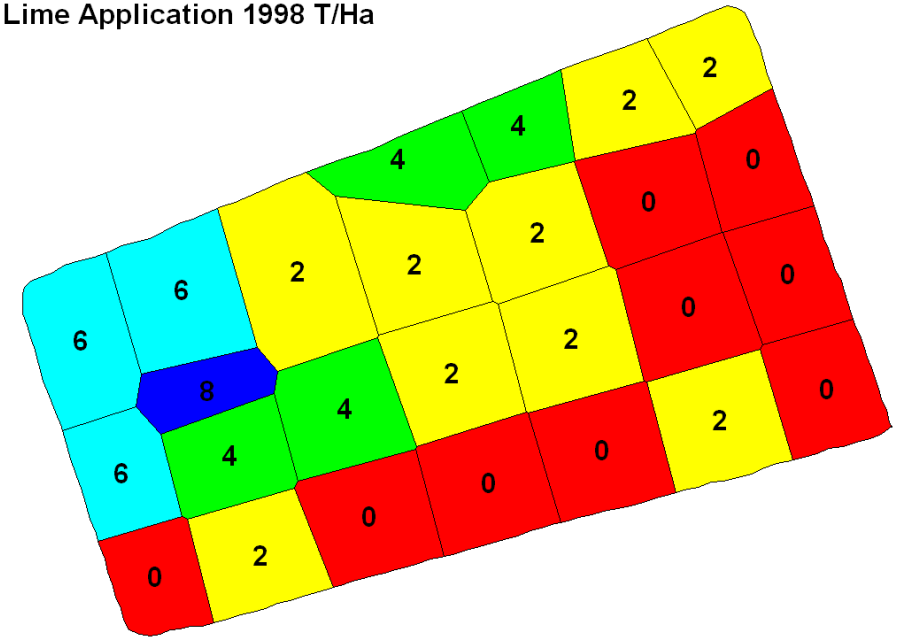
pH	LimeReq	Area	Tonnes
5.7	5.0	0.25	1.249
5.8	4.0	0.50	1.992
5.9	3.0	1.35	4.042
6.0	2.0	1.46	2.927
6.1	1.0	1.84	1.843
6.2	0.0	1.28	0.000
6.3	0.0	0.73	0.000
6.4	0.0	0.59	0.000
6.5	0.0	0.52	0.000
6.6	0.0	0.20	0.000
6.7	0.0	0.28	0.000
6.8	0.0	0.29	0.000

AvpH	No_Sample:	Area	Total_Tonnes
6.1	37	9.28	12.053

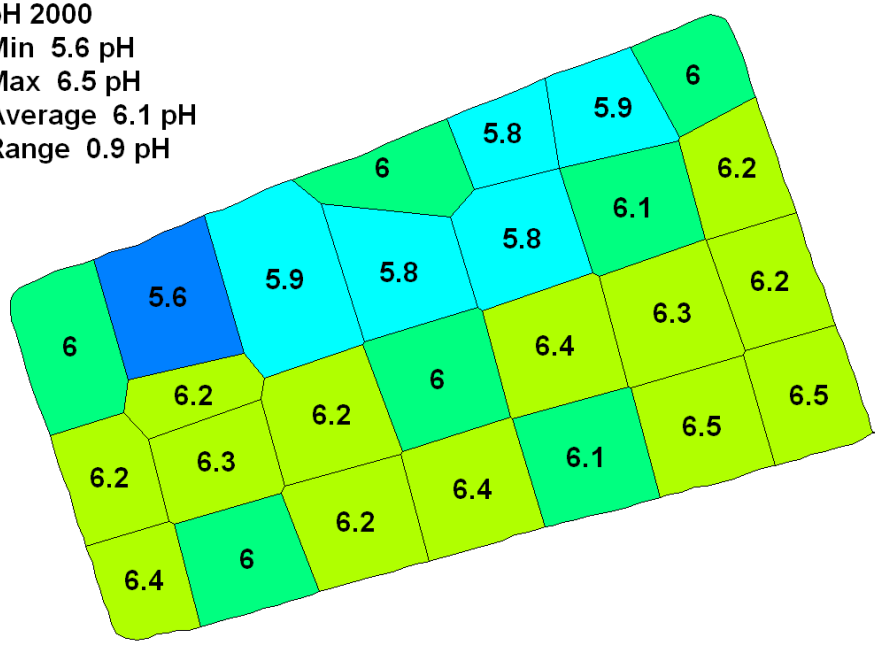
pH 1997
Min 5.1 pH
Max 6.7 pH
Average 5.8 pH
Range 1.6 pH



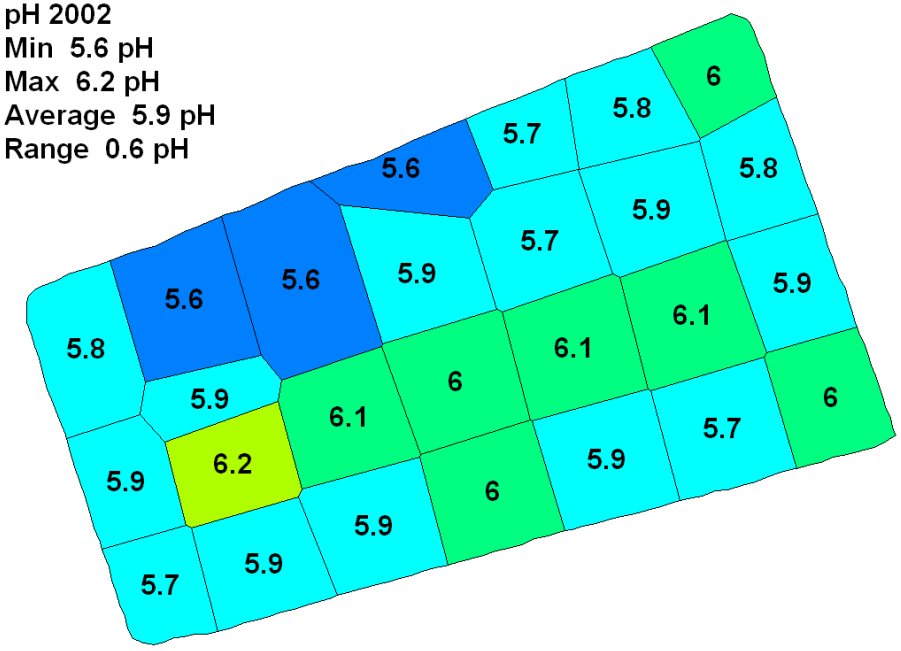
Lime Application 1998 T/Ha



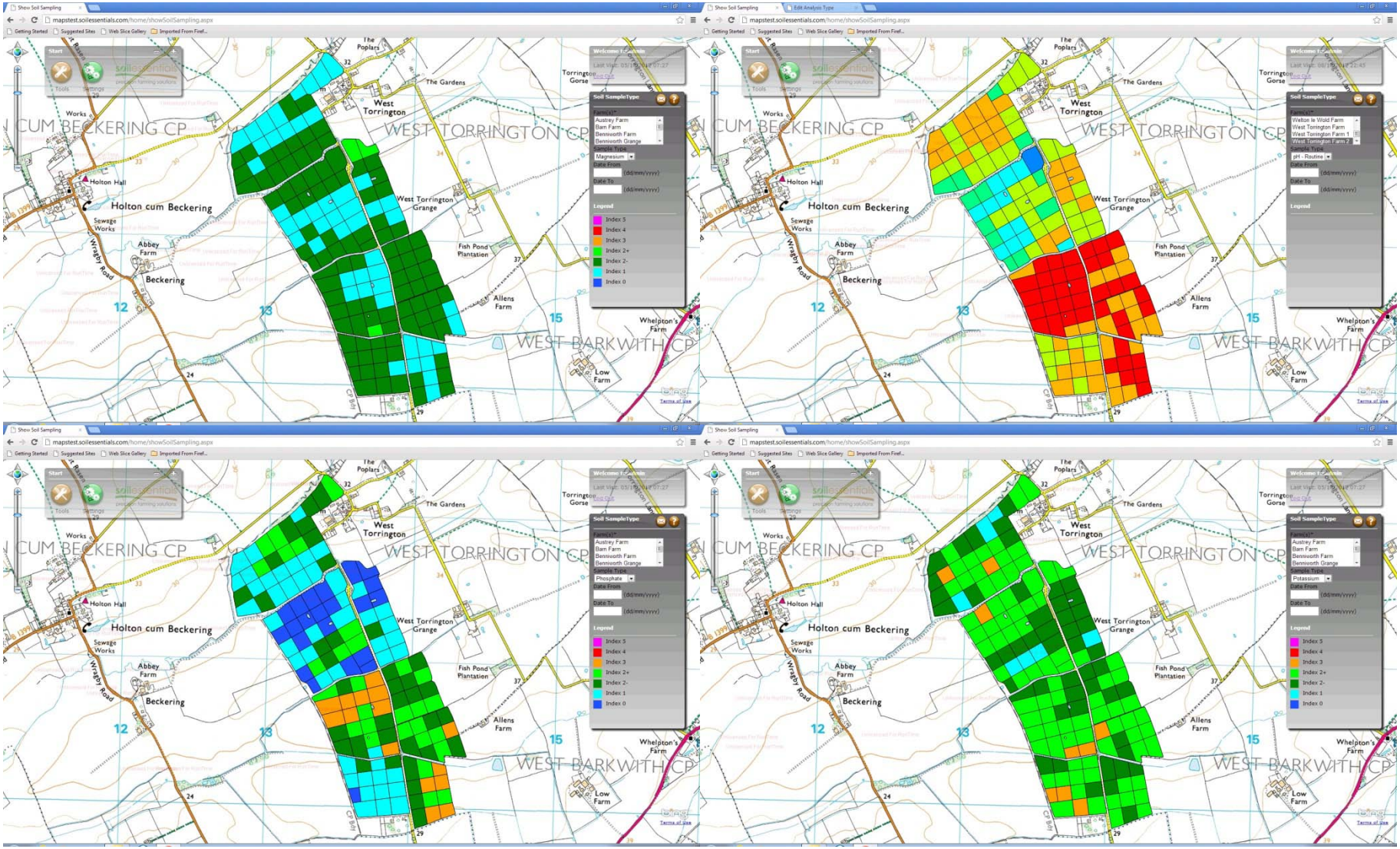
pH 2000
Min 5.6 pH
Max 6.5 pH
Average 6.1 pH
Range 0.9 pH



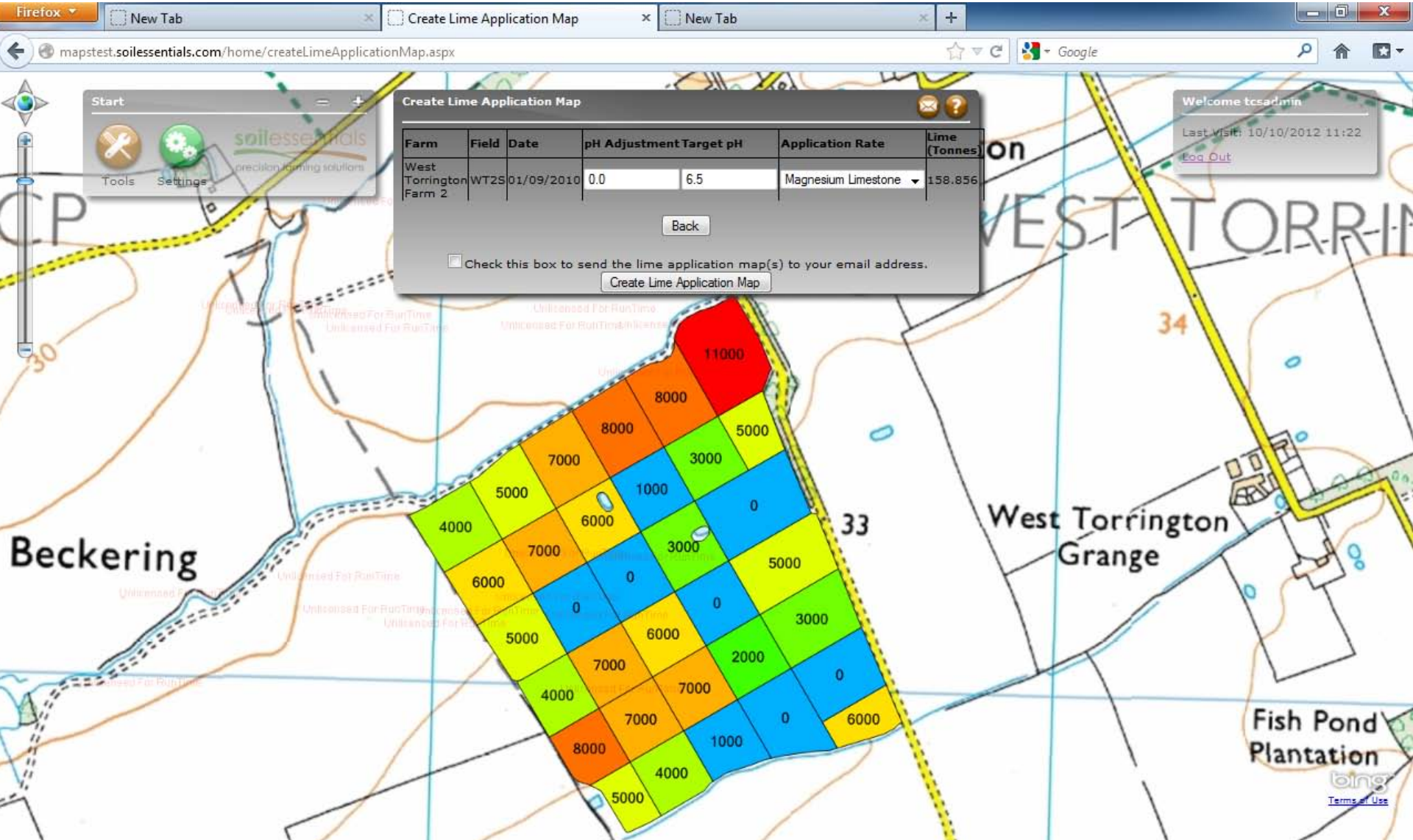
pH 2002
Min 5.6 pH
Max 6.2 pH
Average 5.9 pH
Range 0.6 pH



Soil pH, Phosphate, Potassium and Magnesium variability.



Creating a lime application map.



Spatial variability in soils and crops

- 2nd Type of Variability
  - Inherent variability
  - Caused by the last ice age !
    - Soil Texture
    - Soil Depth
    - Slope and aspect
    - Tree shading
- You can manage these problems with Precision Agriculture!

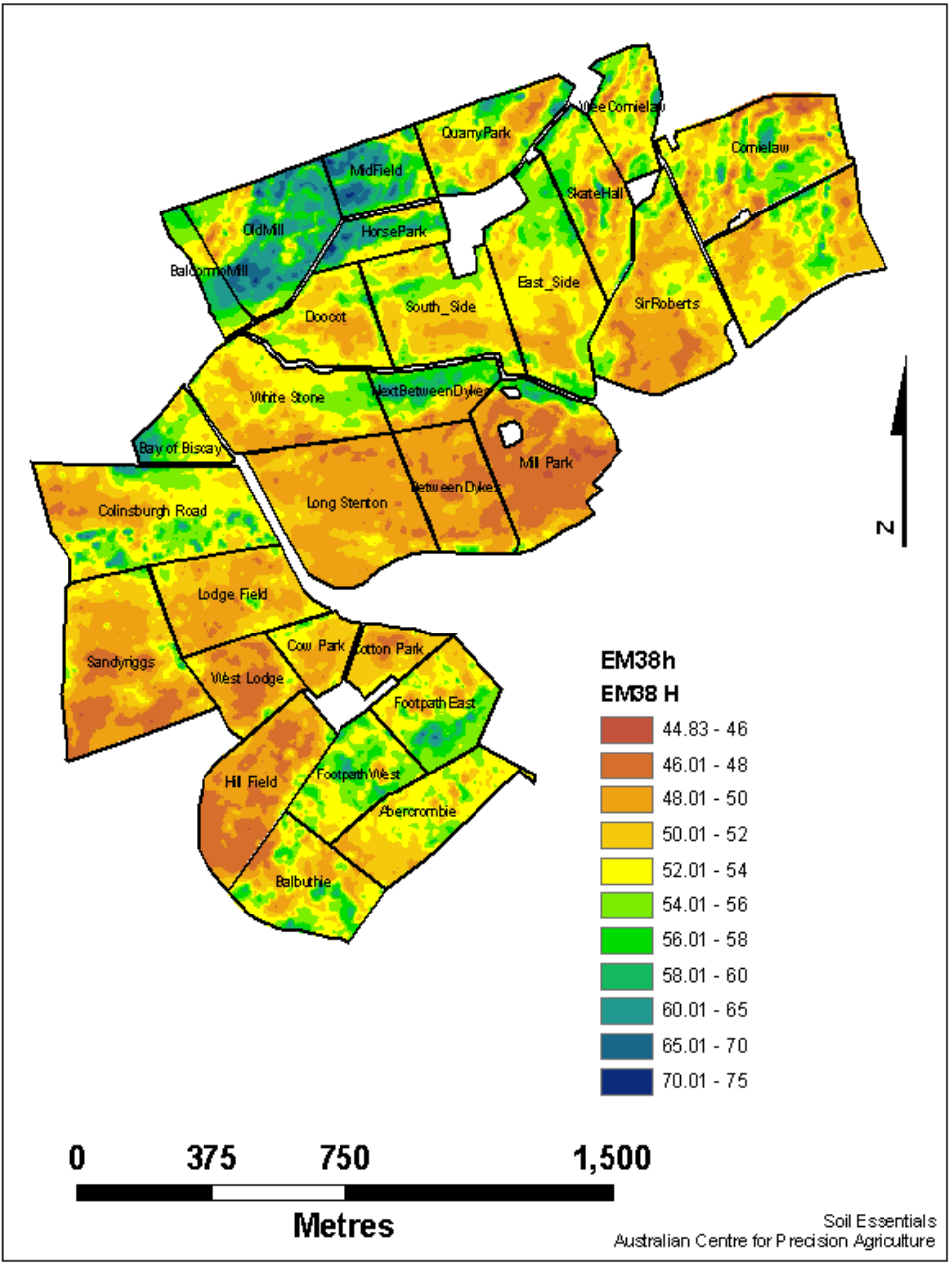
Spatial variability in soils and crops

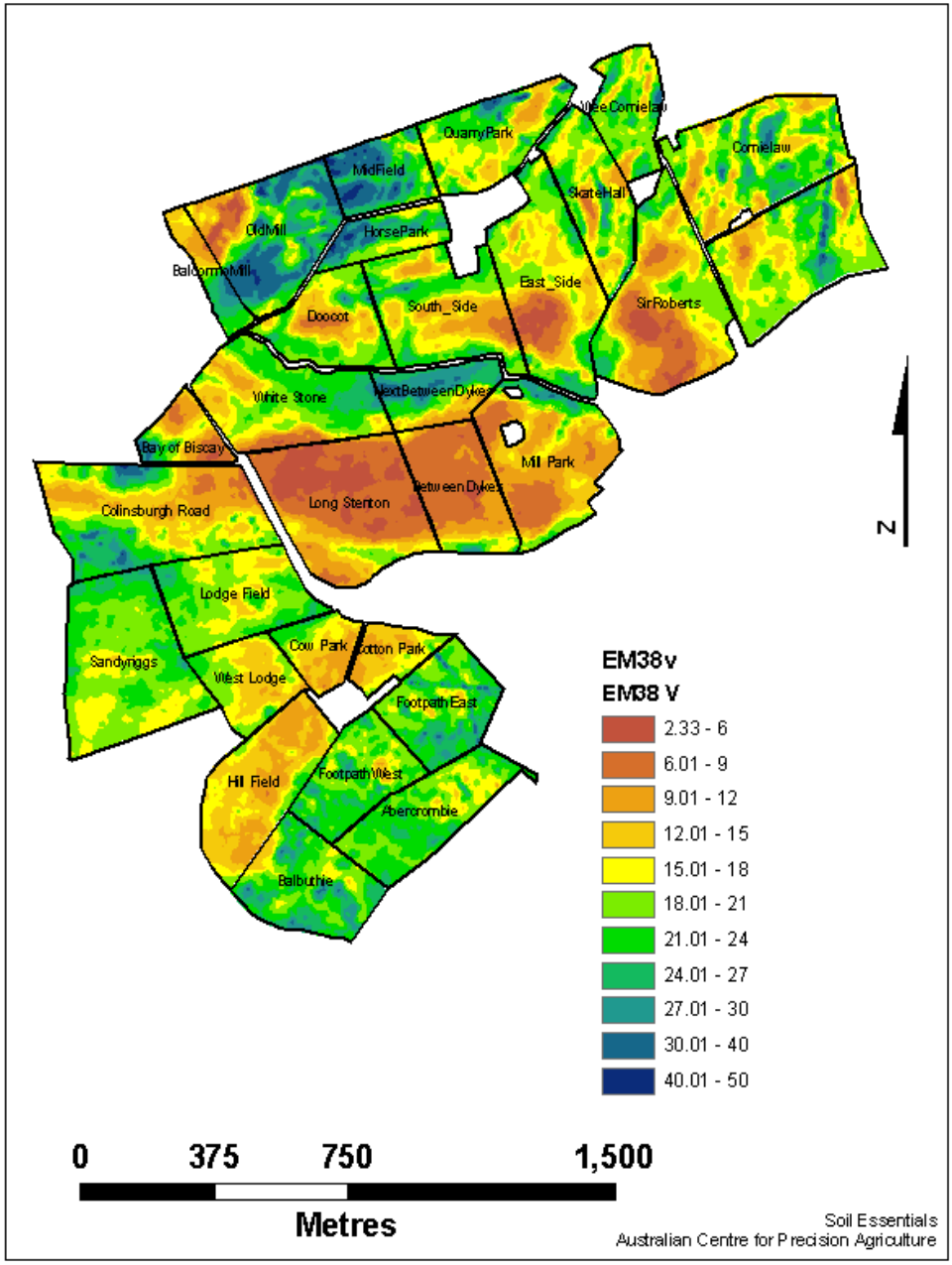
Tools to measure inherent soil variability

Veris EC Mapper

Gamma Radiometer

Geonics EM 38


QuarryPark
MidField
OldMill
HorsePark
BalcormoMill
Doocot
South_Side
East_Side
SkateHall
SirRoberts
Cornielaw
White Stone
NextBetweenDykes
Bay of Biscay
Mil Park
BetweenDykes
Long Stenton
Colinsburgh Road
Lodge Field
Sandyriggs
West Lodge
Cow Park
Cotton Park
FootpathEast
Hil Field
FootpathWest
Abercrombie
Balbuthie
N
EM38h
EM38 H
44.83 - 46
46.01 - 48
48.01 - 50
50.01 - 52
52.01 - 54
54.01 - 56
56.01 - 58
58.01 - 60
60.01 - 65
65.01 - 70
70.01 - 75
0
375
750
1,500
Metres
Soil Essentials
Australian Centre for Precision Agriculture


QuarryPark
MidField
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NextBetweenDykes
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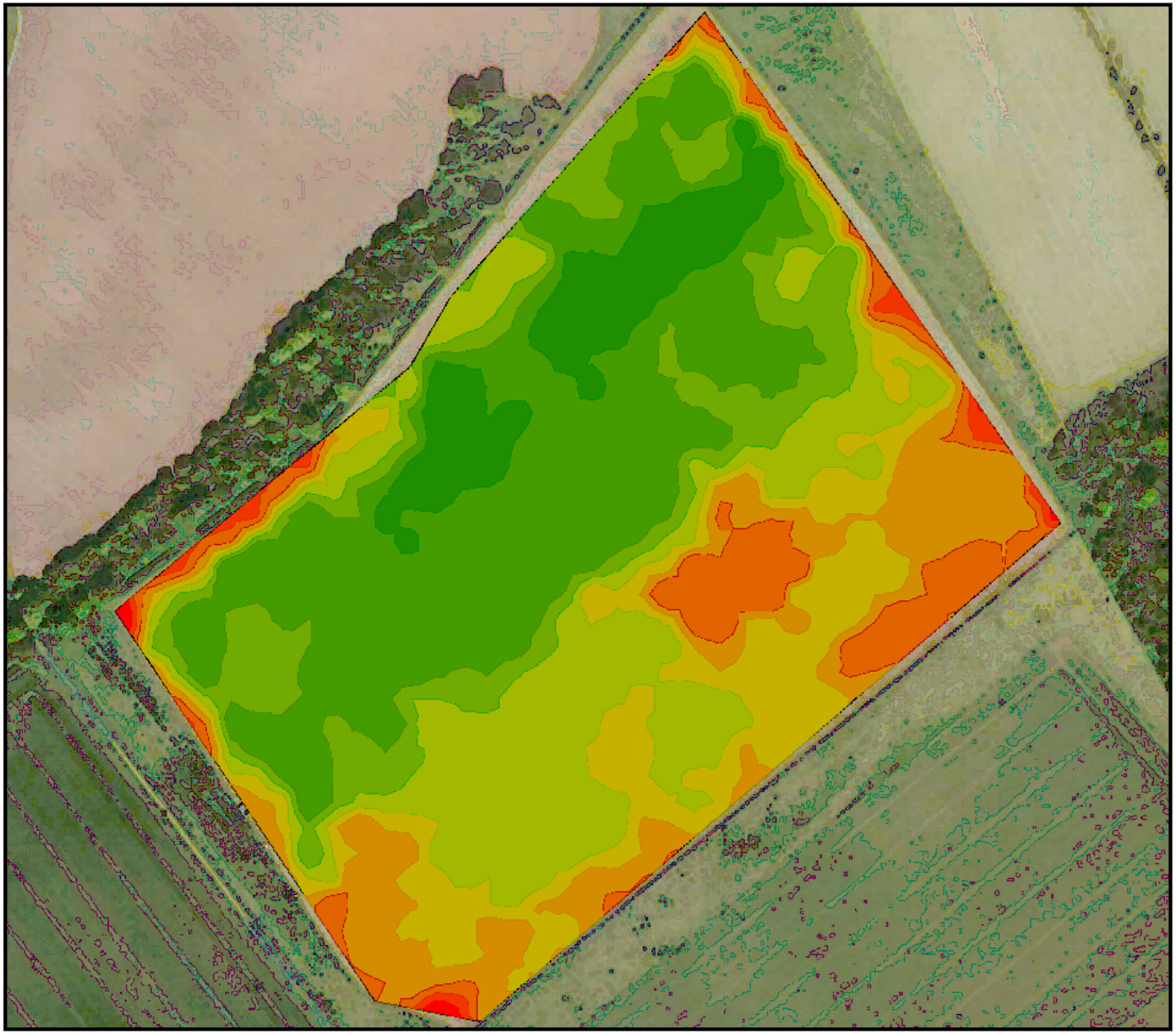
Colinsburgh Road
Lodge Field
Sandyriggs
West Lodge
Cow Park
Cotton Park
FootpathEast
Hil Field
FootpathWest
Abercrombie
Balbuthie
N
EM38v
EM38 V
2.33 - 6
6.01 - 9
9.01 - 12
12.01 - 15
15.01 - 18
18.01 - 21
21.01 - 24
24.01 - 27
27.01 - 30
30.01 - 40
40.01 - 50
0
375
750
1,500
Metres
Soil Essentials
Australian Centre for Precision Agriculture

Yield Mapping

Spittal - 2011 Seed Potatoes: Harvesting

Dry Yield

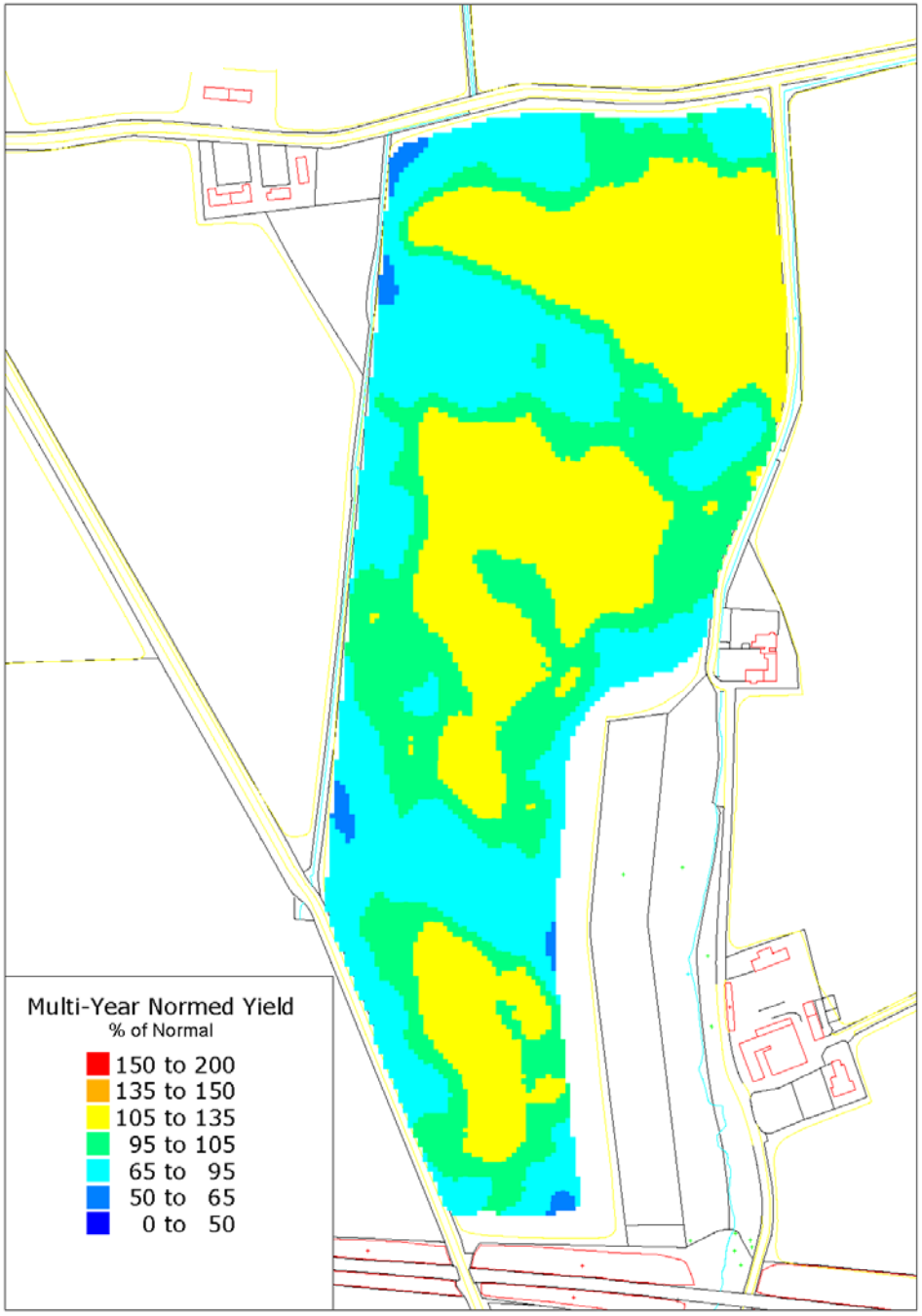


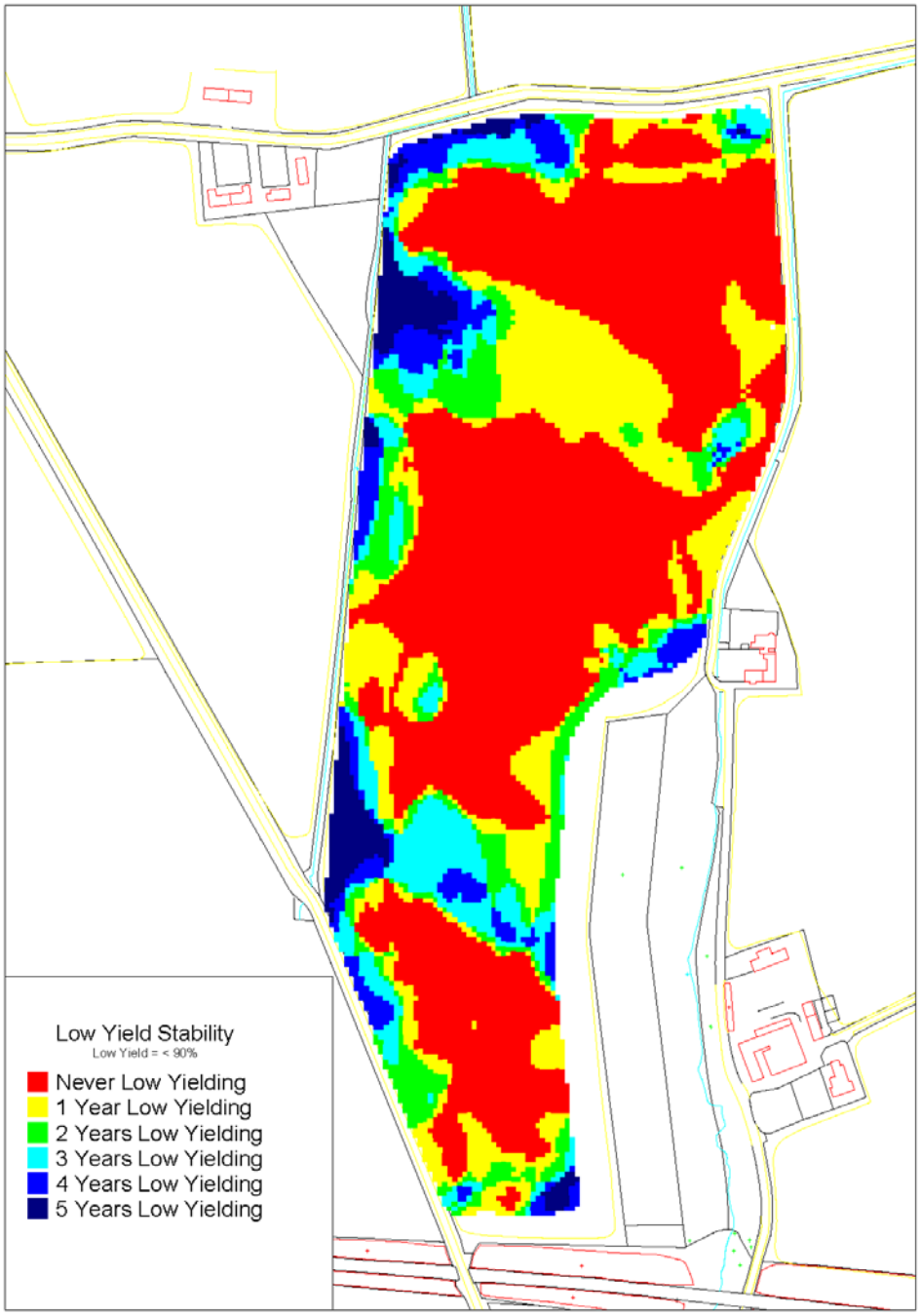
- 60.0 - 87.0 t/ha
- 55.0 - 59.9 t/ha
- 50.0 - 54.9 t/ha
- 45.0 - 49.9 t/ha
- 40.0 - 44.9 t/ha
- 35.0 - 39.9 t/ha
- 30.0 - 34.9 t/ha
- 25.0 - 29.9 t/ha
- 20.0 - 24.9 t/ha
- 0.0 - 19.9 t/ha

Client: Rented Potato Land
Farm: Harelaw
Field: Spittal
Crop: 2011 Seed Potatoes
Name: HARVESTING
Type: Harvesting
Area: 7.42 ha
Start Date: 03/10/2011 12:39
End Date: 13/10/2011 12:29
Engine Hours: 39.9 hr
In Operate: 0.0 hr
Harvest: 472.926 t
Avg: 63.74 t/ha

N

0 50 100
meters


Multi-Year Normed Yield
% of Normal
150 to 200
135 to 150
105 to 135
95 to 105
65 to 95
50 to 65
0 to 50


Low Yield Stability
Low Yield = < 90%
Never Low Yielding
1 Year Low Yielding
2 Years Low Yielding
3 Years Low Yielding
4 Years Low Yielding
5 Years Low Yielding

Gross Margin Improvement

- Soil sampling and VRA Lime.
  - Cost around £15 to £25 / ha
  - Total Saving around £60 / ha
  - GM improvement £35/ha for VRA Lime.
- VRA P and K
  - Only savings where you have high P or K
  - Or if P or K is low therefore yields can be improved.
  - GM improvement £10/ha for VRA P & K.

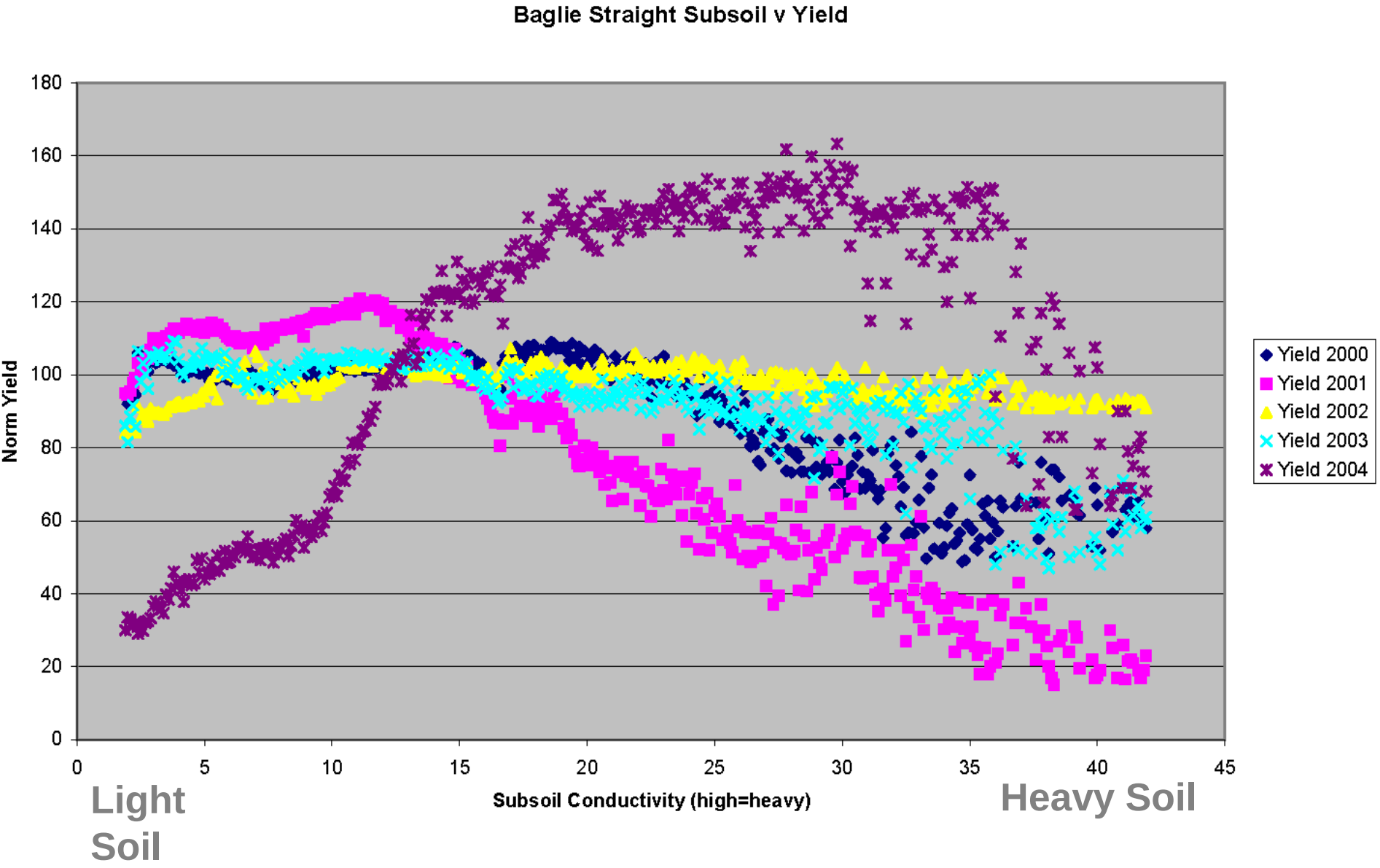
Gross Margin Improvement

- VRA seeding = £5 per ha
  - Target seed to where it will be the most benefit to crop yield potential.
  - or where slug pressure is high.
- Improvement of low yielding sites = £10 per ha
  - Find the cause of low yielding areas – if you can solve the problem you improve the GM for many years.
  - If you can't improve the yield then cut costs in those areas or don't farm them (environmental schemes?)

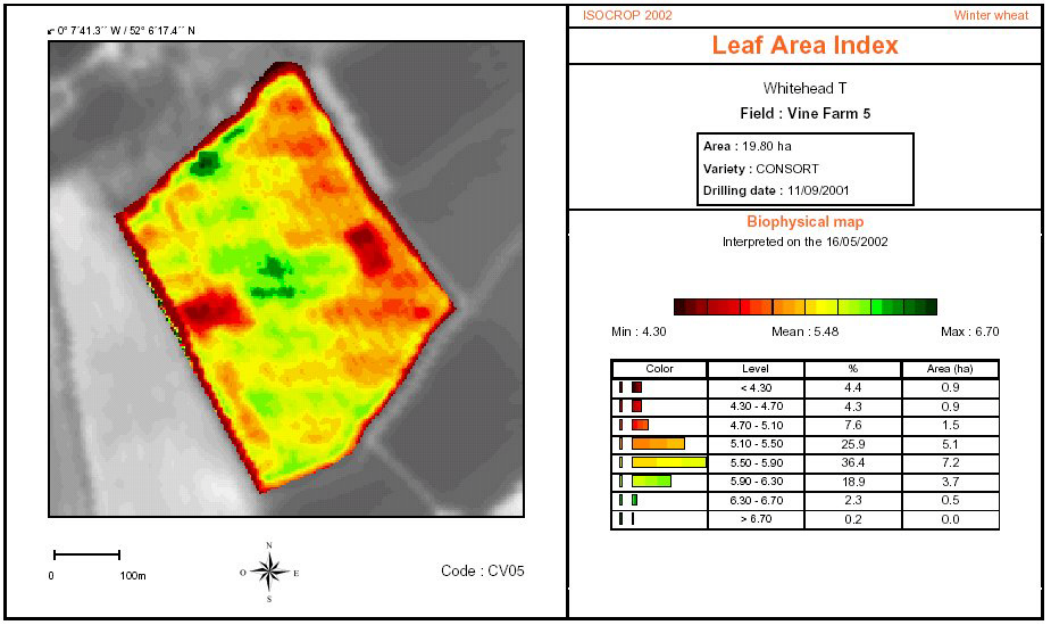
Spatial variability in soils and crops

- So we can measure and map:
  - Soil texture
  - Soil fertility
  - Soil depth
  - Crop yield
  - Crop nitrogen, phosphate & potash content and off take
  - Forecast yield zones
- What more do we need! ?

We need control of the WEATHER!


Baglie Straight Subsoil v Yield
Norm Yield
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
45
Subsoil Conductivity (high=heavy)
Yield 2000
Yield 2001
Yield 2002
Yield 2003
Yield 2004
Light Soil
Heavy Soil

Real Time Crop Sensors.



ISOCROP 2002 Winter wheat

Leaf Area Index

Whitehead T

Field : Vine Farm 5

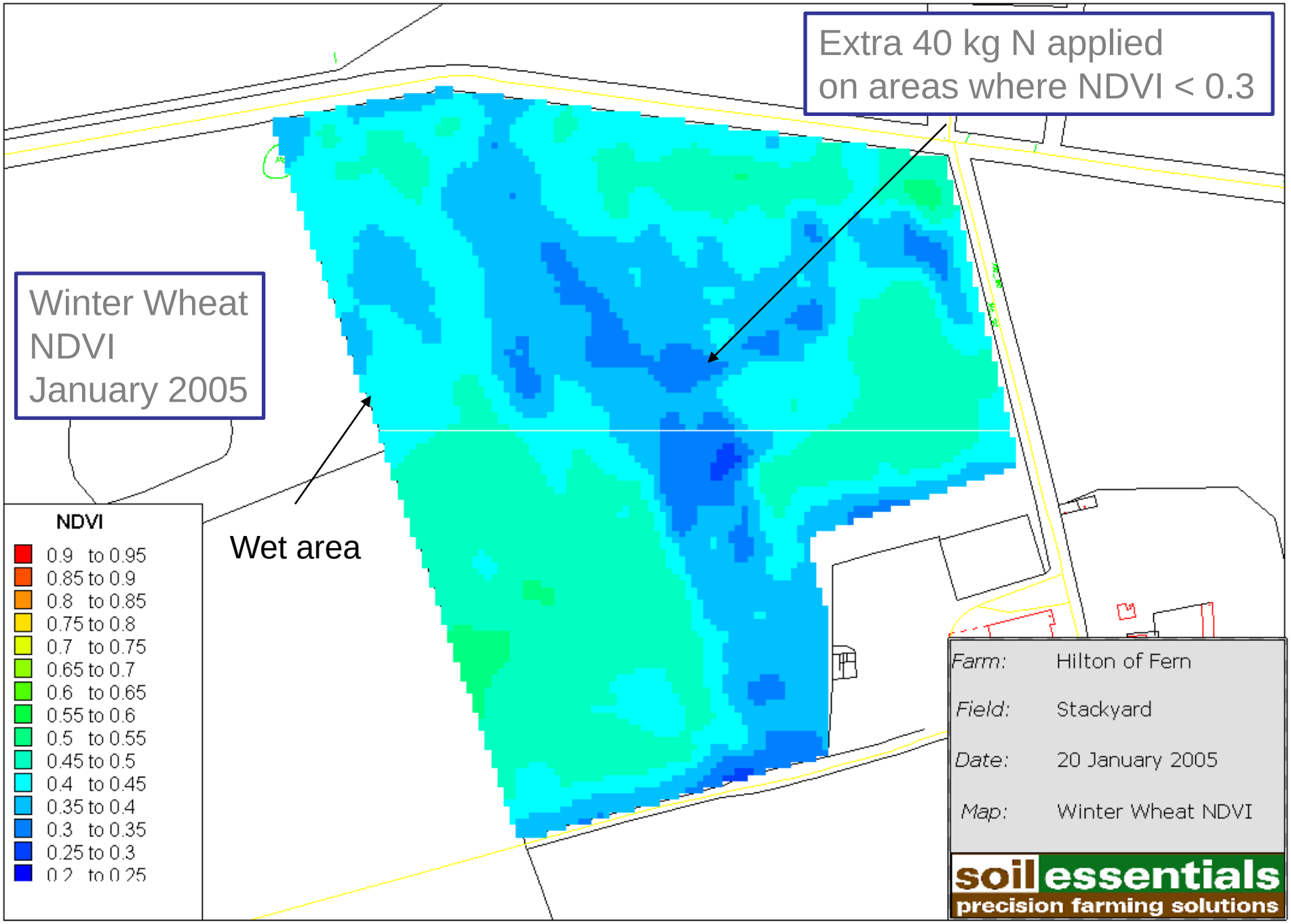
Area : 19.80 ha
Variety : CONSORT
Drilling date : 11/09/2001

Biophysical map

Interpreted on the 16/05/2002

Min : 4.30 Mean : 5.48 Max : 6.70

Color	Level	%	Area (ha)
	< 4.30	4.4	0.9
	4.30 - 4.70	4.3	0.9
	4.70 - 5.10	7.6	1.5
	5.10 - 5.50	25.9	5.1
	5.50 - 5.90	36.4	7.2
	5.90 - 6.30	18.9	3.7
	6.30 - 6.70	2.3	0.5
	> 6.70	0.2	0.0


Extra 40 kg N applied
on areas where NDVI < 0.3
Winter Wheat
NDVI
January 2005
Wet area
NDVI
0.9 to 0.95
0.85 to 0.9
0.8 to 0.85
0.75 to 0.8
0.7 to 0.75
0.65 to 0.7
0.6 to 0.65
0.55 to 0.6
0.5 to 0.55
0.45 to 0.5
0.4 to 0.45
0.35 to 0.4
0.3 to 0.35
0.25 to 0.3
0.2 to 0.25
Farm: Hilton of Fern
Field: Stackyard
Date: 20 January 2005
Map: Winter Wheat NDVI
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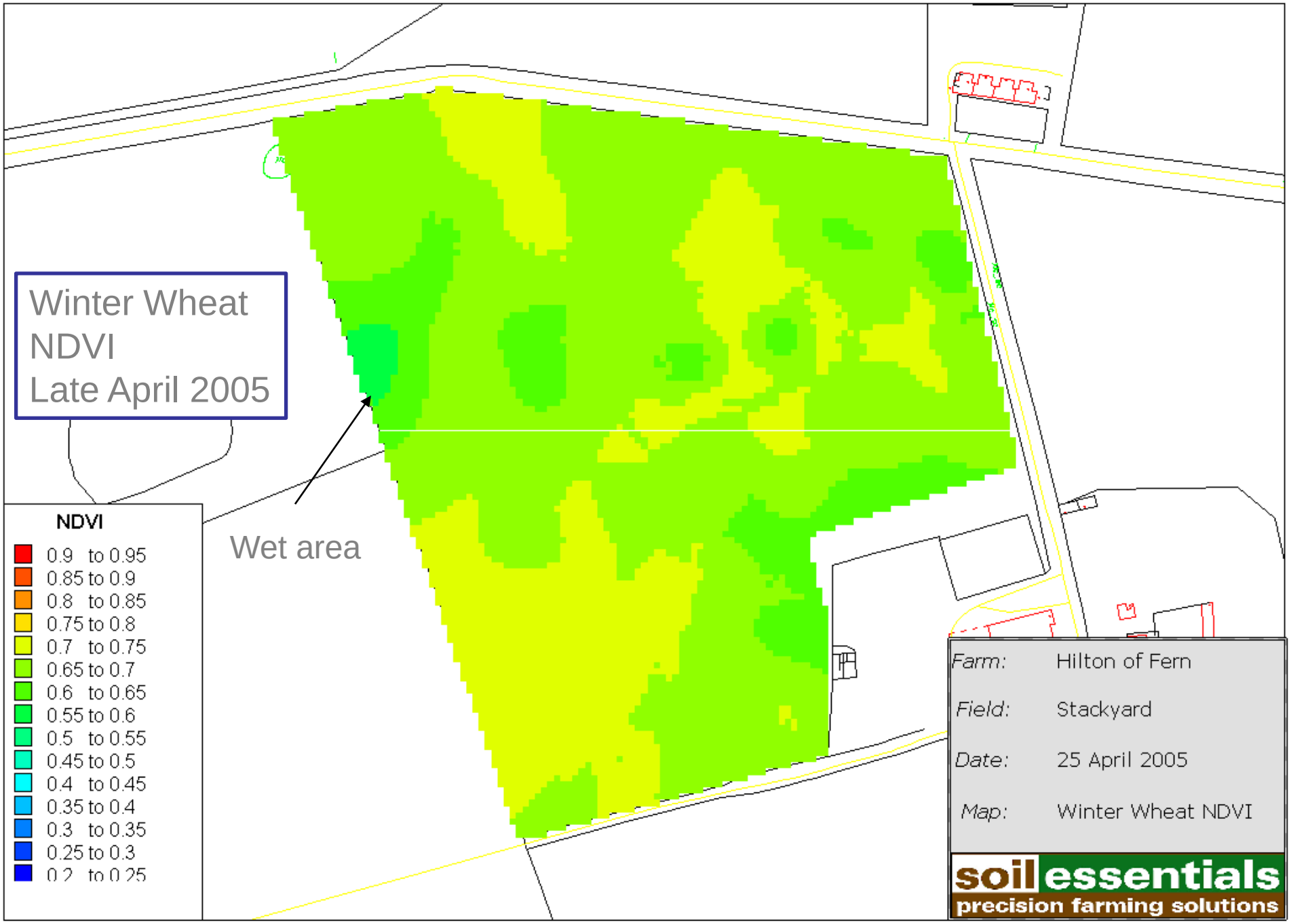
Winter Wheat
NDVI
Late April 2005
Wet area
NDVI
0.9 to 0.95
0.85 to 0.9
0.8 to 0.85
0.75 to 0.8
0.7 to 0.75
0.65 to 0.7
0.6 to 0.65
0.55 to 0.6
0.5 to 0.55
0.45 to 0.5
0.4 to 0.45
0.35 to 0.4
0.3 to 0.35
0.25 to 0.3
0.2 to 0.25
Farm: Hilton of Fern
Field: Stackyard
Date: 25 April 2005
Map: Winter Wheat NDVI
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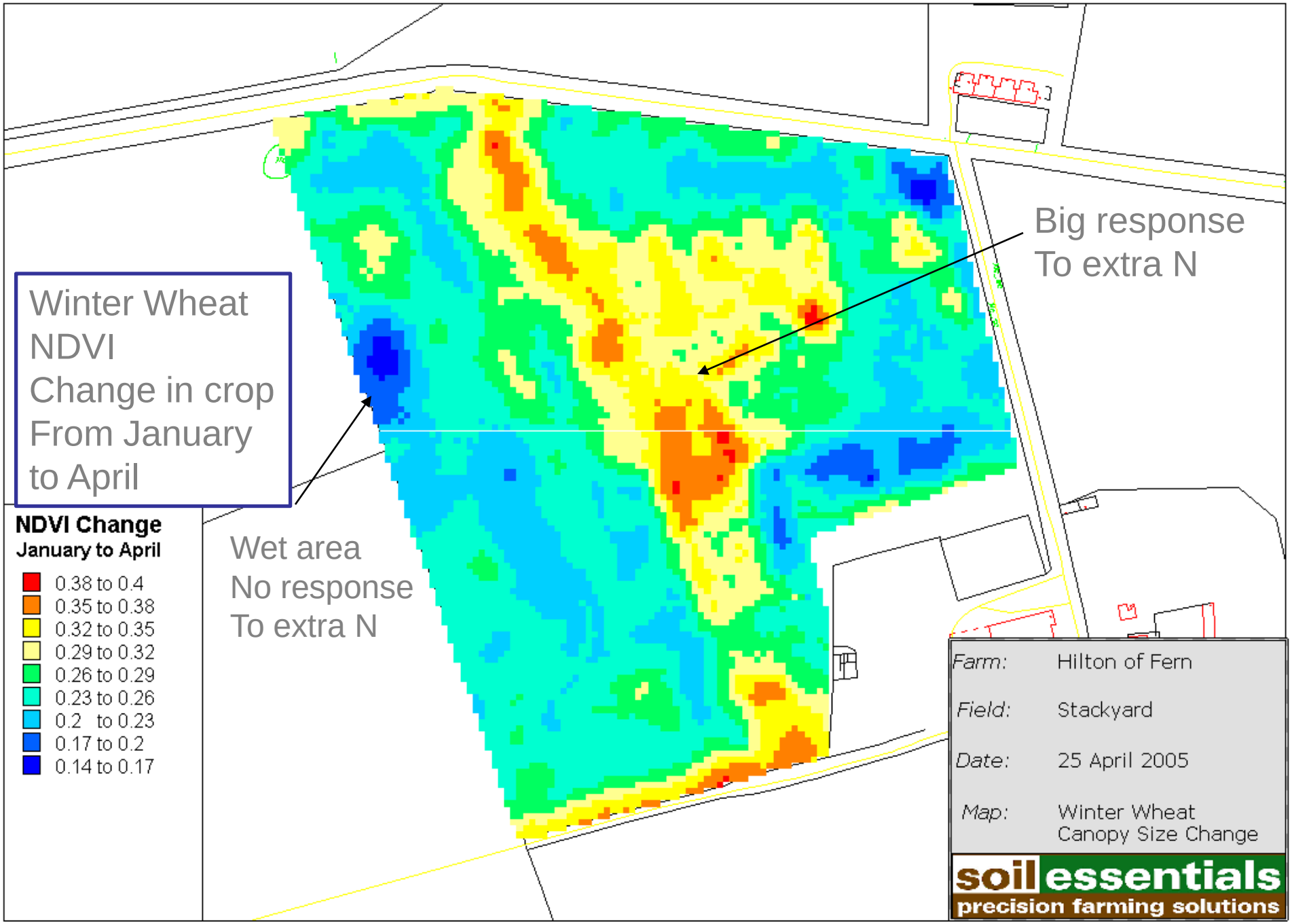
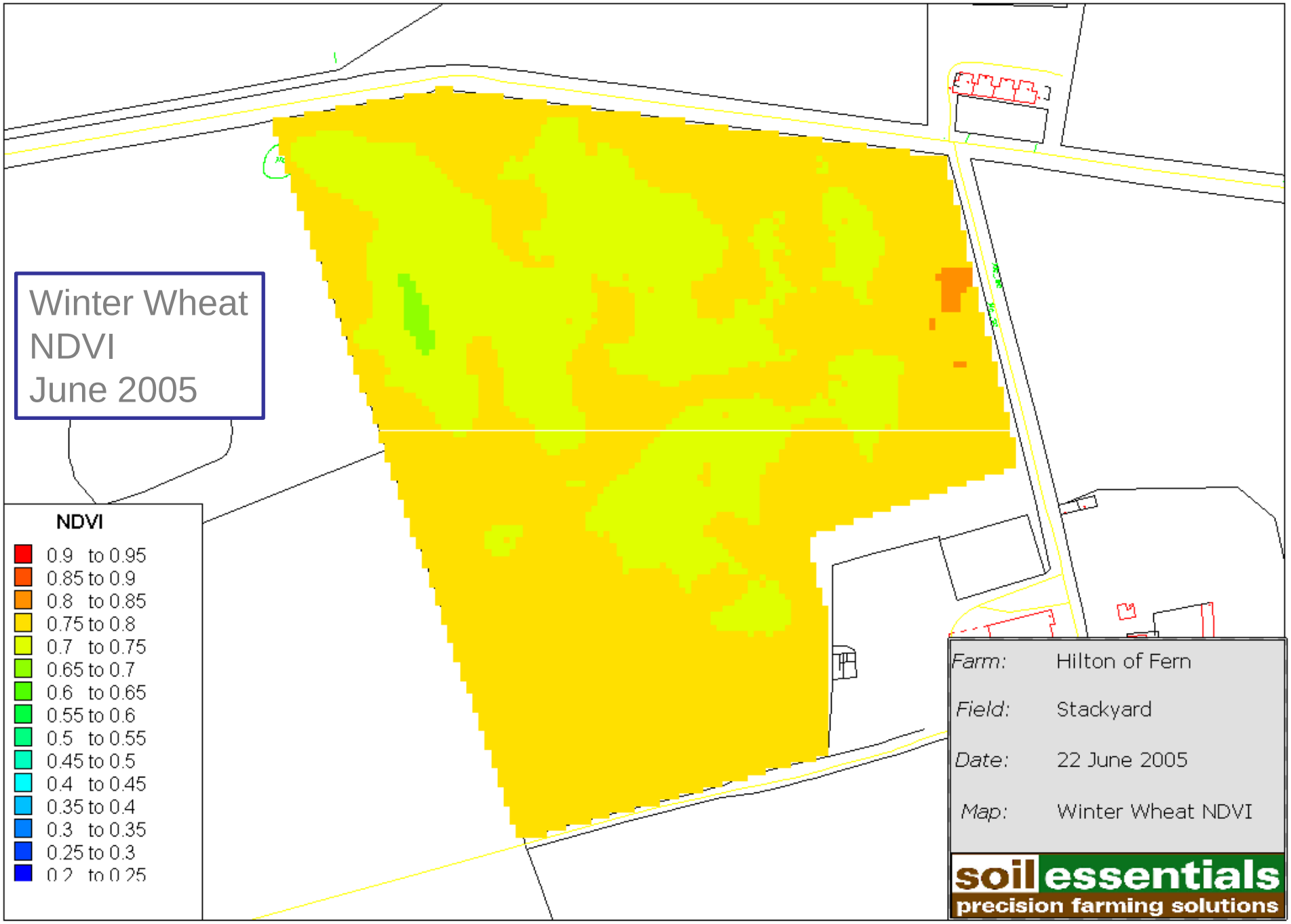

Winter Wheat
NDVI
Change in crop
From January
to April
Big response
To extra N
Wet area
No response
To extra N
NDVI Change
January to April
0.38 to 0.4
0.35 to 0.38
0.32 to 0.35
0.29 to 0.32
0.26 to 0.29
0.23 to 0.26
0.2 to 0.23
0.17 to 0.2
0.14 to 0.17
Farm: Hilton of Fern
Field: Stackyard
Date: 25 April 2005
Map: Winter Wheat
Canopy Size Change
soil essentials
precision farming solutions


Winter Wheat
NDVI
June 2005
NDVI
0.9 to 0.95
0.85 to 0.9
0.8 to 0.85
0.75 to 0.8
0.7 to 0.75
0.65 to 0.7
0.6 to 0.65
0.55 to 0.6
0.5 to 0.55
0.45 to 0.5
0.4 to 0.45
0.35 to 0.4
0.3 to 0.35
0.25 to 0.3
0.2 to 0.25
Farm: Hilton of Fern
Field: Stackyard
Date: 22 June 2005
Map: Winter Wheat NDVI
soil essentials
precision farming solutions

Gross Margin Improvement

VRA Nitrogen = £25 per ha (£37 last year).

- Consistent with HGCA Precision Ag report of £25 per ha per year.
- Crop Scouting – find poor areas
- Easier harvesting- more even crop with less lodging.
- More efficient use of N – increases nitrogen use efficiency.
- Lowers N leaching.


Machine control and monitoring in
Precision Agriculture.

Machine Control – what can it do?

- Steer machines to within 25mm of where they should be.
- Control the rates of seed, fertiliser and agrochemicals
- Automatically switch boom sections on and off.
- Change the rates of products depending on where it is in the field.
- Monitor and report vehicle performance.
- Make yield maps.
- Use real time crop sensors to map and apply nitrogen based on crop N status.
- All at the same time!

Machine Control Systems

- Market is maturing – users want 1 console in the cab to do EVERYTHING
  - Autosteer, rate control, variable rate application, nitrogen sensing, auto section control, yield monitoring, implement steering…
  - The rise in ISOBUS popularity means in some cases all these functions will be integrated into the tractor.
  - Data management is becoming an issue…

Global Navigation Satellite Systems (GNSS)

- GPS - USA
- GLONASS - Russia
- Galileo – Europe (under construction)
- BeiDou – China (under construction)

Key GPS Accuracy Specs

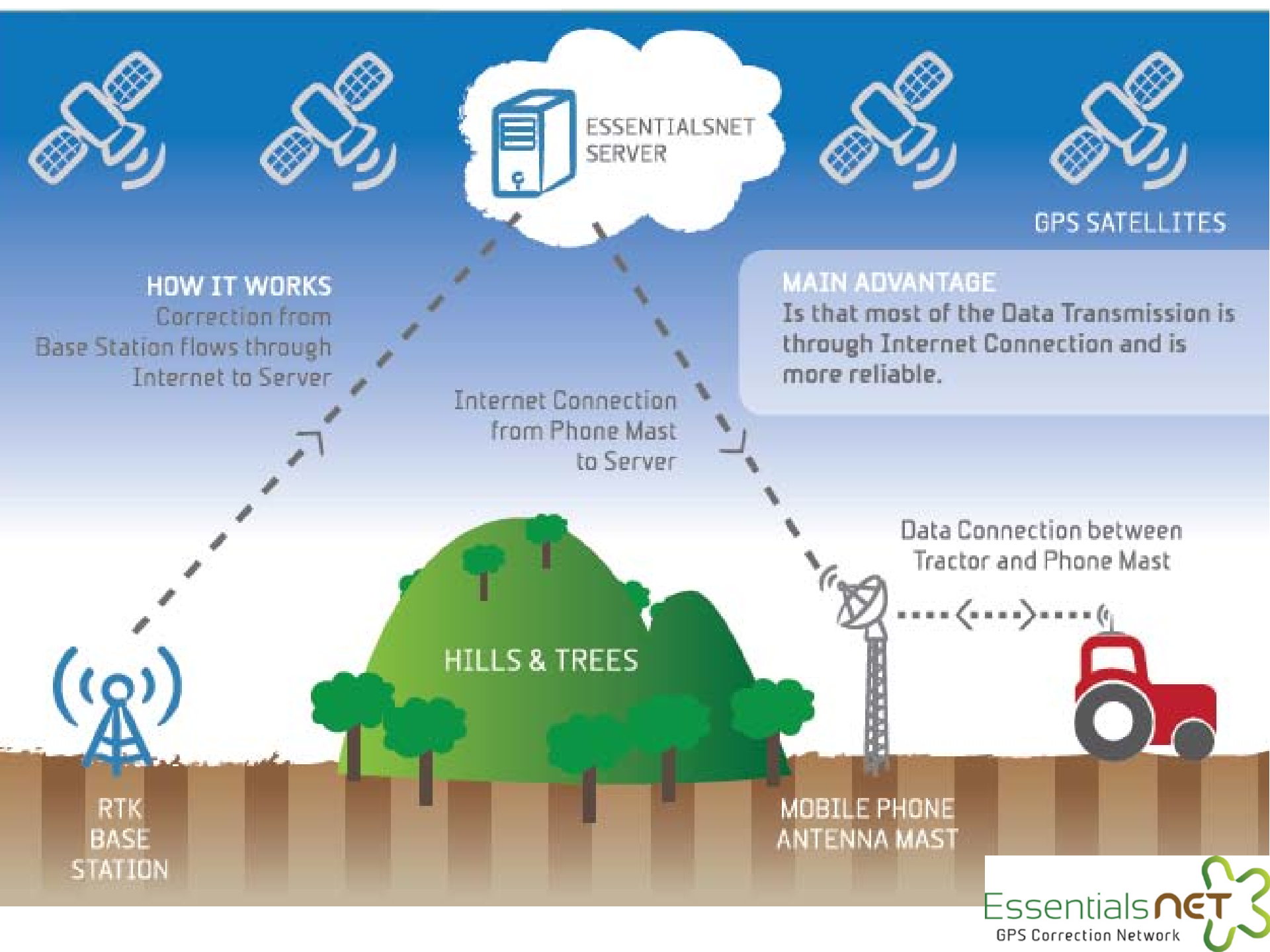
- Static "Absolute" Accuracy
  - "How close am I tomorrow?"
  - Often referred to as STATIC ACCURACY
  - GPS is stationary, data collected over 24 hrs
  - High cost, not always needed in Agriculture.

- Pass-to-Pass Accuracy
  - "How close am I to my last pass?"
  - GPS moving, collected over 15-20 minutes typically
  - In Ag "Pass-to-Pass" or "Swath-to-Swath"
  - Lower cost and can often be adequate.

Autosteer is Changing.....

- Traditionally radio is used to transmit corrections to each tractor.
- But this does not allow 2 way communication.
- So increasingly autosteering tractors are receiving corrections from the internet (with the last hop by mobile phone).
- This allows tractors to become part of:

"The Connected Farm"



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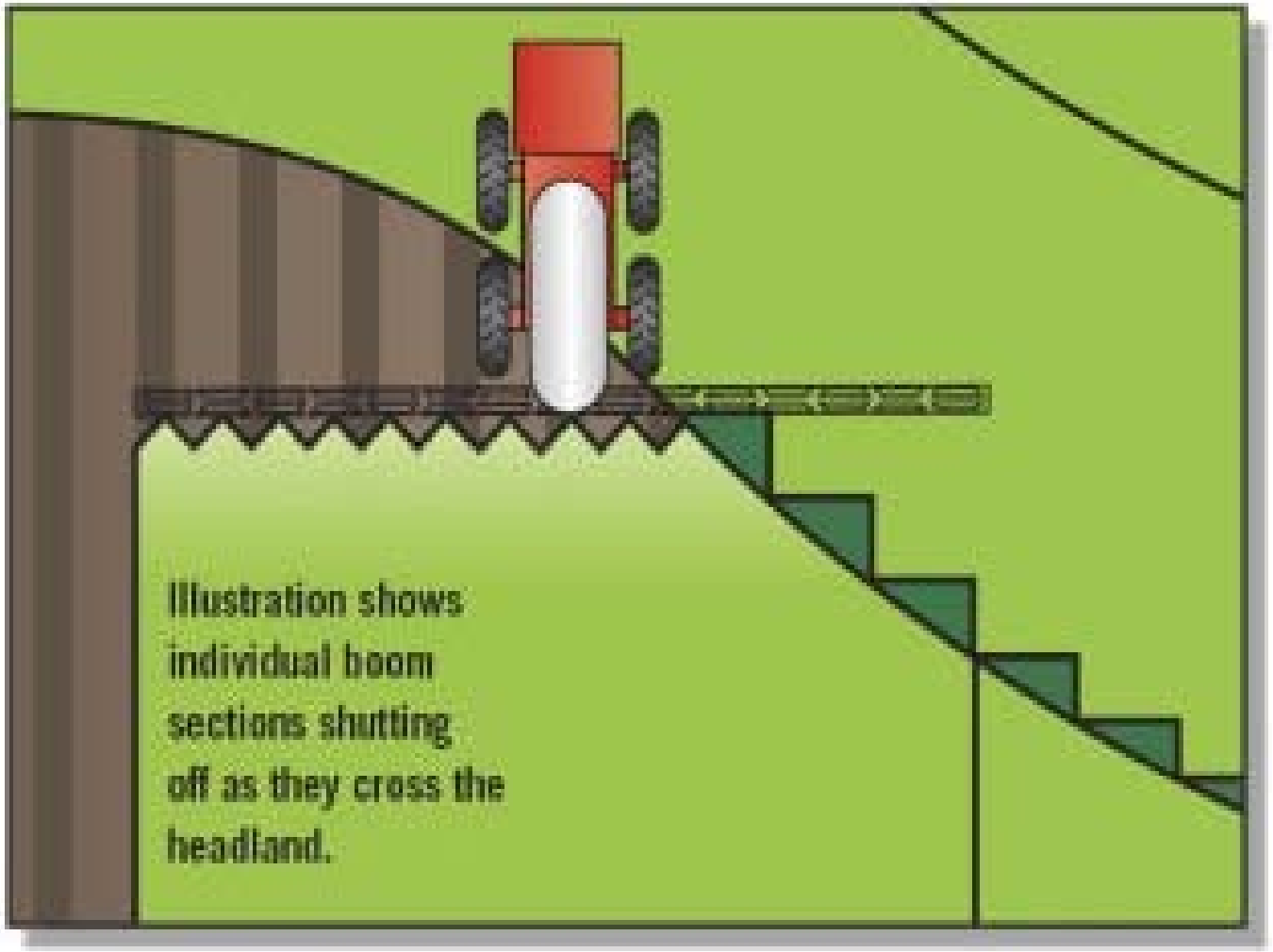
GPS Correction Network

Auto Section Control

Sprayers, Planters, Drills, Spreaders.



Passive Implement Steer

- Steers the Tractor offline to keep the implement online.

Benefits:

- **Control the implement position**
- **Simple to install**
- **Inexpensive**
- **Bed Formers, Drills**

Active Implement Steer

Actively Steer implement with hydraulics.

Benefits:

- **Reduce fertilizer**
- **Precise seed placement**
- **Steer any implement**
- **Controlled Traffic**
- **Inter row spraying.**

With the ability to accurately and repeatably place seed, fertiliser and agrochemicals Active Implement Steer will cause a revolution in crop seeding, fertilising and agrochemical application in the next decade.

Gross Margin Improvement

RTK Autosteer - £30 per hectare.

- 5% average overlap in cereals and potatoes
- Less stress on men and machines
- Longer working hours
- More potato beds, fewer cereal tramlines.

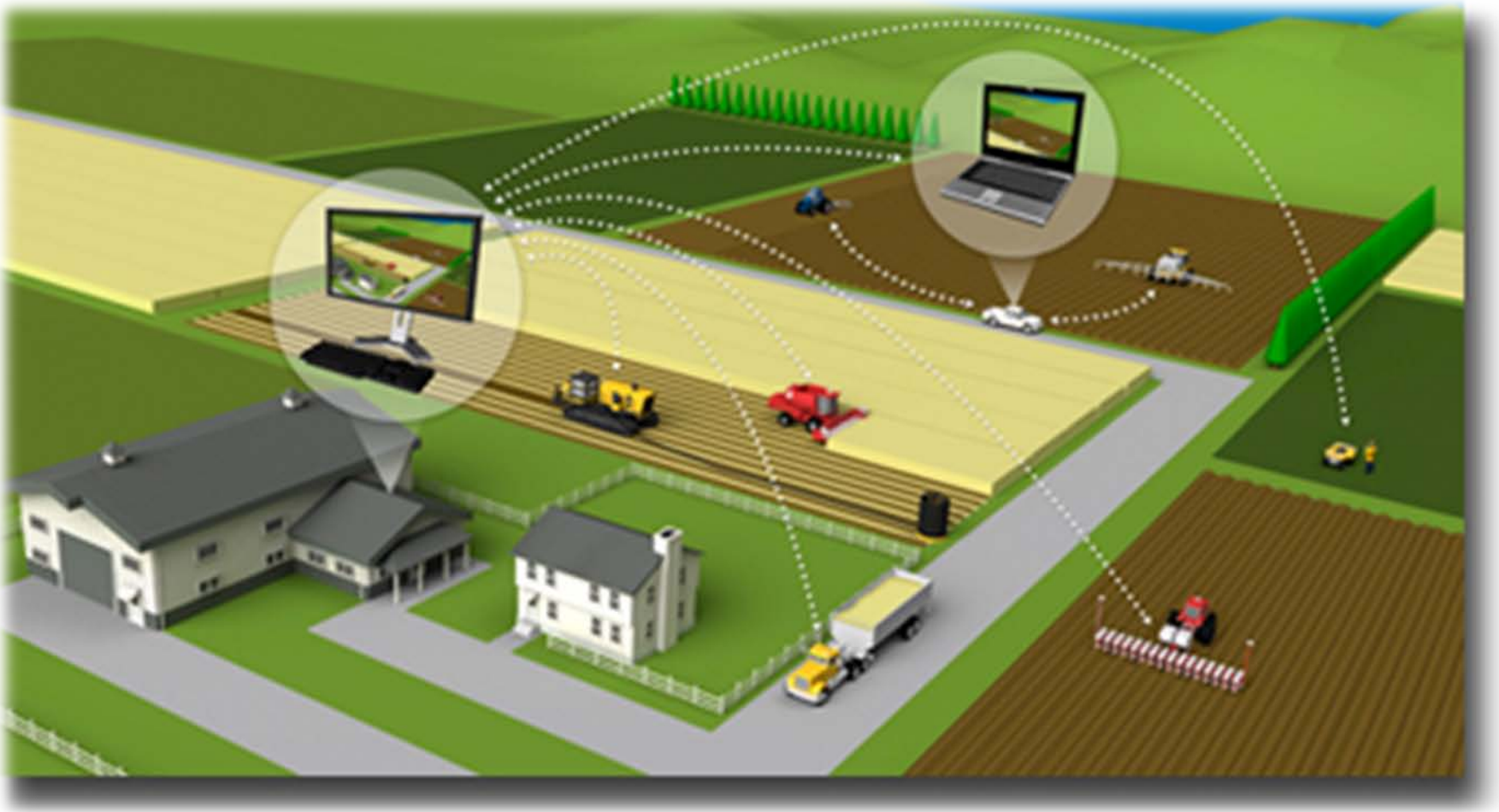
- Autoboom section control
  - Save on chemicals, seed fertilisers.
  - 5% to 30% chemical saving.
  - No marking out at potato planting.
  - Less crop damage.
  - Less stress on men and machines.

Data Management

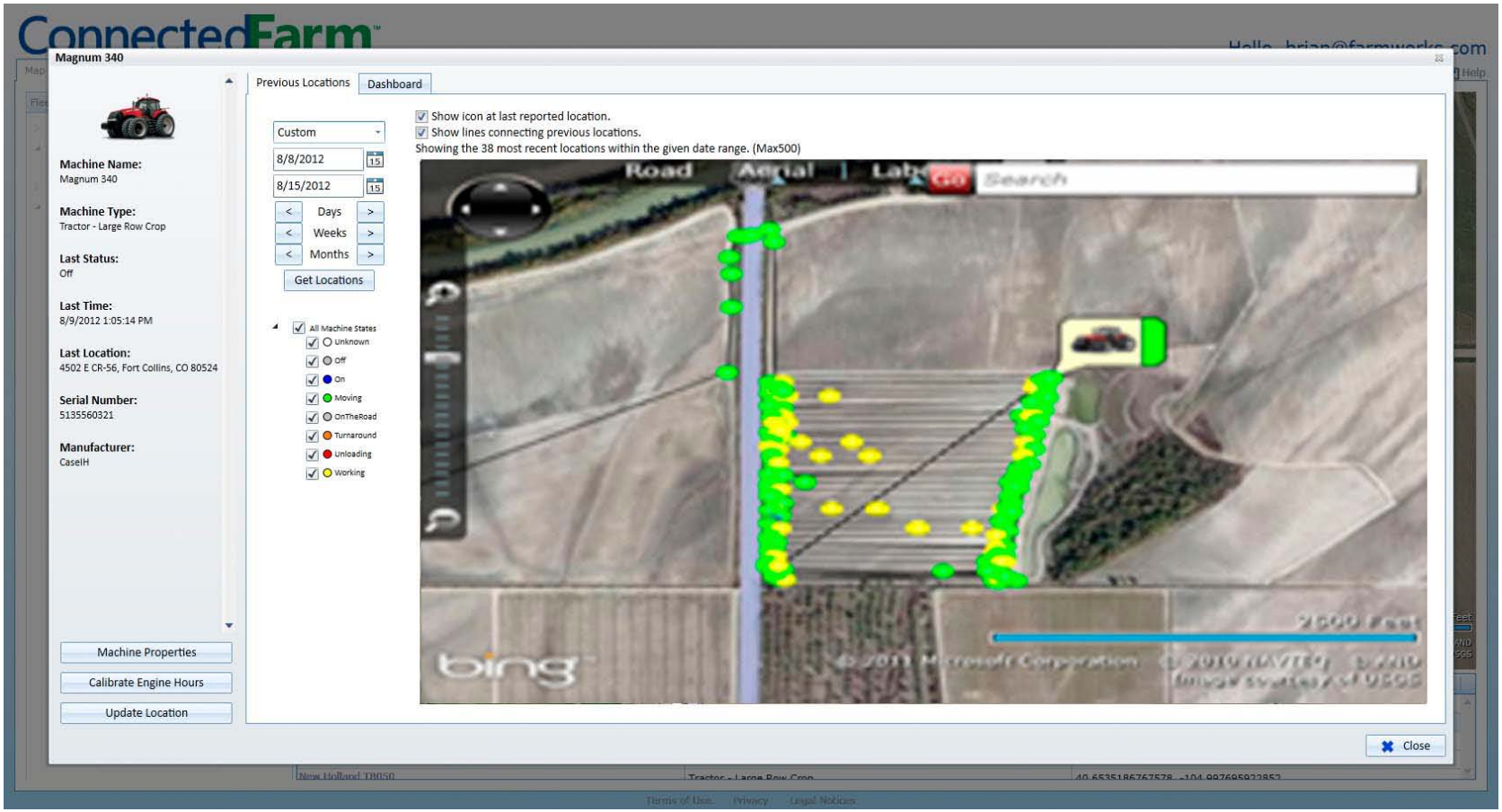
Data Management

- Data management is one of the biggest problems facing users.
- But now machines are connected to the internet data can be sent from the farm office to the tractor without the operator doing anything.
- Work jobs, VRA maps, yield maps, etc can all be synchronised.
- Tractor performance can be monitored.
- This allows tractors to become part of “The Connected Farm” and solves data transfer problems

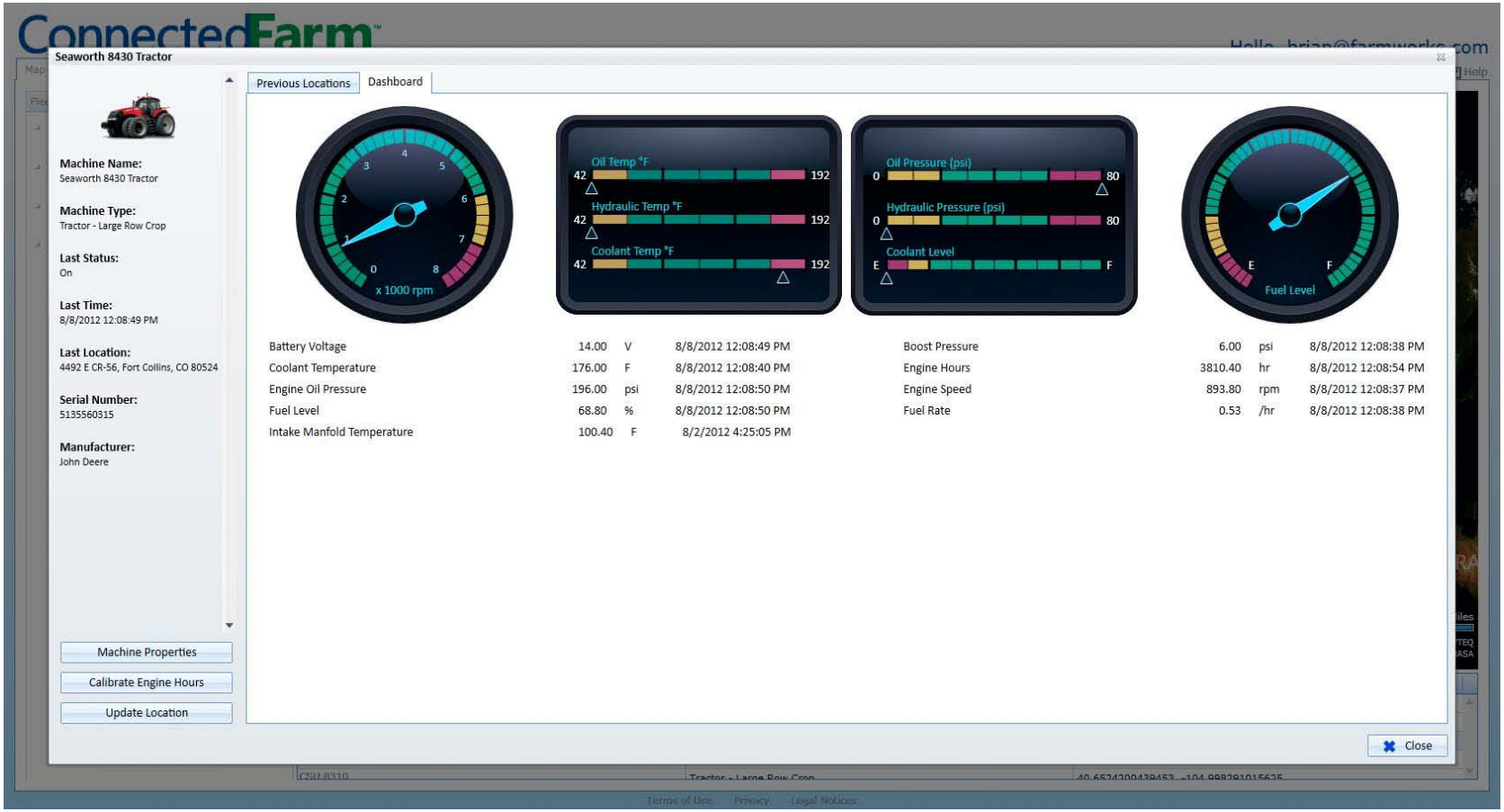
The Connected Farm



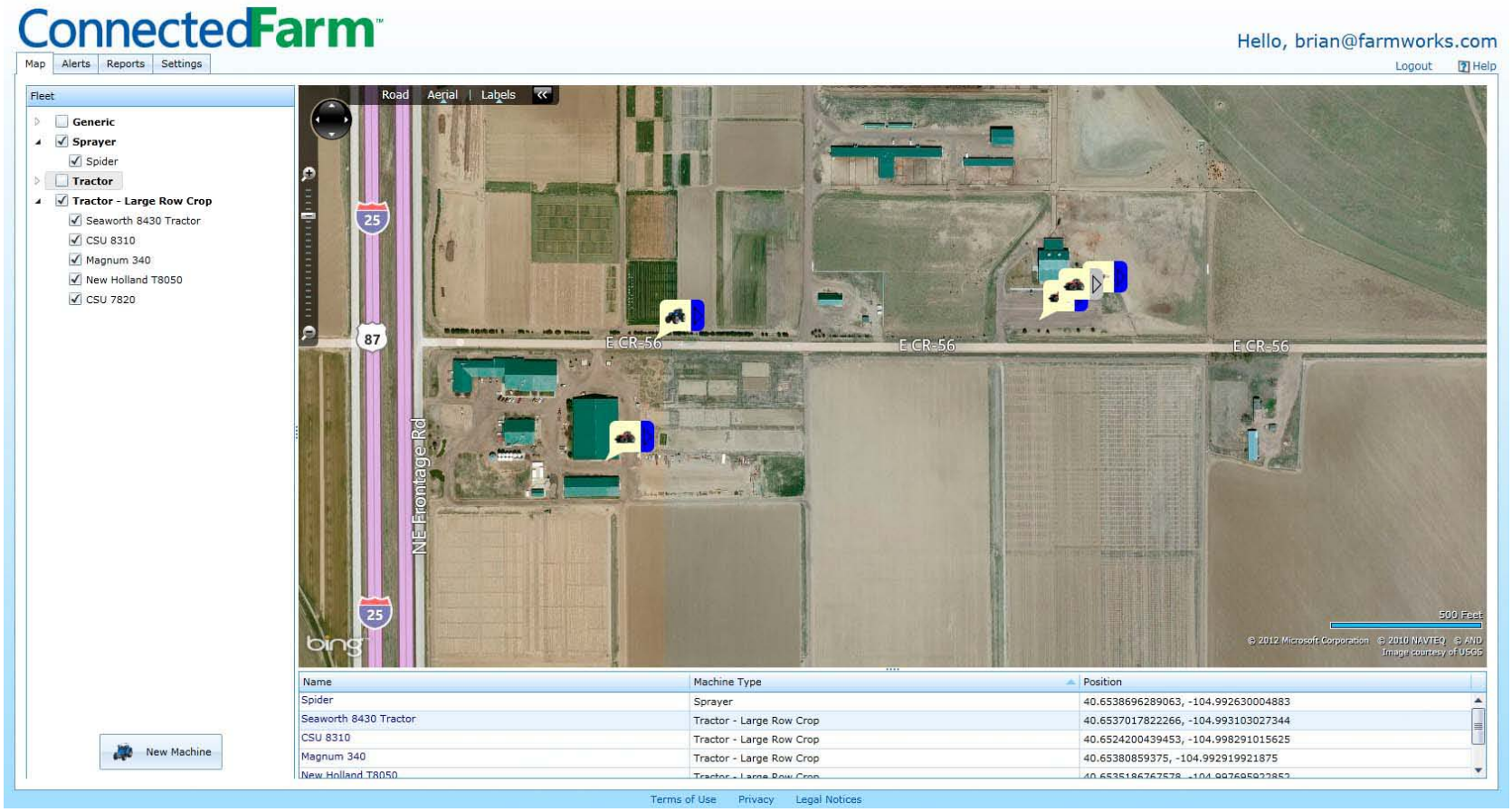
Monitor vehicle events live



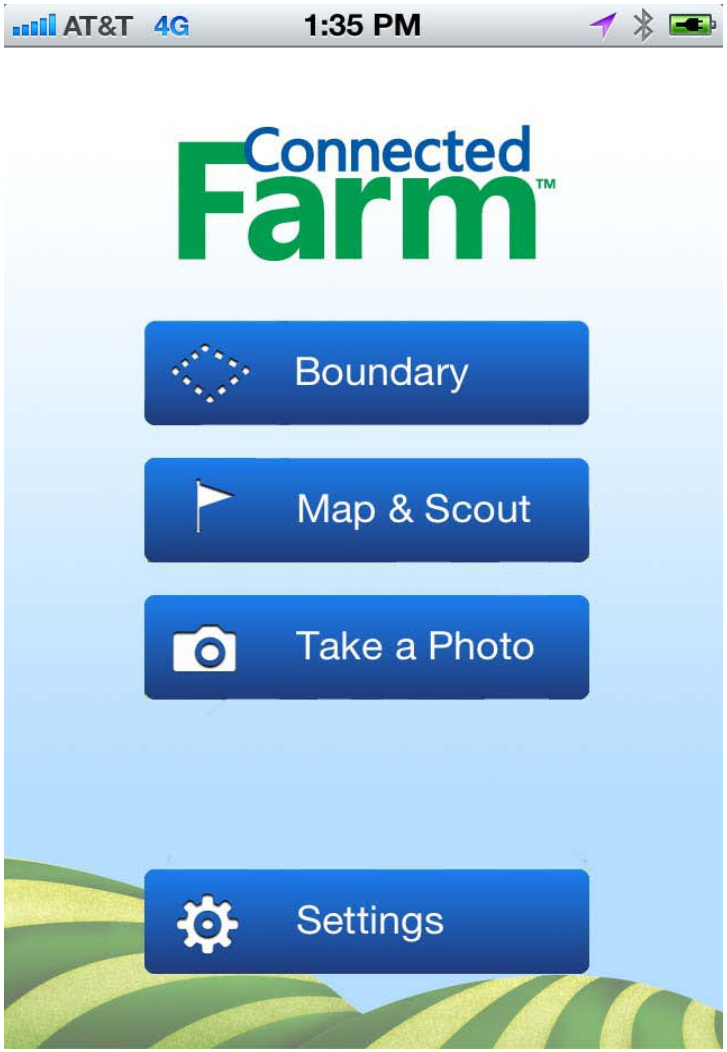
Monitor vehicle performance live

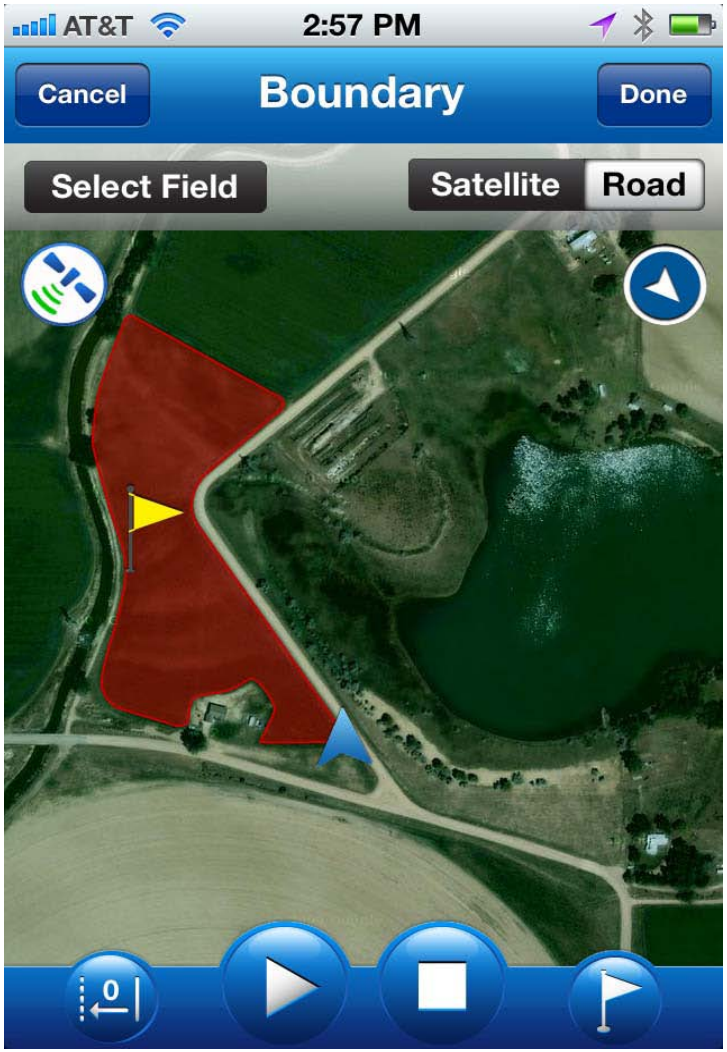


Monitor vehicle position live



And now iPhone and android apps..





Conclusion 1

- The key to making P. A. work is choosing which of the many different tools and techniques will give the best return.
- Use soil sampling and VRA to fix management induced variability.
- Then manage the inherent soil variability with soil texture mapping.
- Manage year to year weather variability with real time crop sensors.

Conclusion 2

- Autosteer lowers high machinery costs through overlap reduction and more efficient working.
- Autosection control, rate control and variable rate application lowers crop growing costs and improves crop quality.
- To get the full benefit of these systems you need automated data management.
- Monitoring, mapping and recording machinery operating efficiency through telematics can identify performance and operator improvements

Questions?