UK-Canada Workshop on Smart Technologies for Agriculture

INTRODUCTORY PRESENTATIONS

Department of Bioresource Engineering

McGill University

10-12 July 2014

Canada

UK Science & Innovation Network

McGill

Harper Adams University

Precision Farming

Richard John Godwin FREng

Visiting Professor - Harper Adams University
Emeritus Professor - Cranfield University
Honorary Professor – Czech University of Life Sciences

Experience

- Background
  - Raised and worked on Oxfordshire farms in UK
  - Academic Qualifications: BSc – National College of Agricultural Engineering, Silsoe; MS - University of Illinois, PhD – NCAE/Reading University.
    Dr (hc) Slovak University of Agriculture, DSc (hc) Harper Adams University.
  - Professional Qualifications: FREng, CEng, CEnv, EurEng.
- Experience
  - Research/Teaching: NCAE/Silsoe College: 1974 – 2007:
    Research Officer to Professor, Dean & Pro-Vice Chancellor
  - Visiting Post Doc Researcher – Macdonald College/McGill University: 1975 and 76
  - Director of Cranfield University Centre for Precision Farming: 1995-2003
  - Research/Teaching/Mentoring/ Agric Eng Development: 2008 – present: Harper Adams University
- Application
  - Soil and Water Engineering and Management/Waste Management
  - Tillage and Traction
  - Soil Dynamics
  - Instrumentation – dynamometry
  - Precision Agriculture

Precision Agriculture: Experience

- Yield recording
  - Cereals grains
  - Straw/hay bales
  - Roots
  - Grass
- Variability assessment
  - Soil
  - EM38
  - Compaction sensor
  - Cereal growth
  - Onion seed placement
- Development of Practical Guidelines for farmers
- Economics
- Traceability and Automatic Chemical Application/ Mechanical Weed Control
- Controlled Traffic Farming
- Teaching material preparation "Elements of Precision Agriculture"
- Delivery of undergraduate, postgraduate and professional development programmes

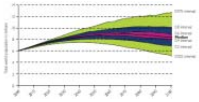
Recommendations from the UK agricultural industry

Feeding the Future

Innovation Requirements for Primary Food Production in the UK to 2030

1. **Use modern technologies to improve the precision and efficiency of key agricultural management practices**
   - Develop remote monitoring, control and application technologies to optimise input use efficiency, ... , sustain product quality and safety, reduce the impact of machinery traffic on land ...
   - Integrate and use the increasing volume of yield mapping & recording, and soil, crop and animal data, in order to develop better decision making tools...
   - Improve machine and instrument flexibility, inter-operability, applicability ... to promote delivery of the above.
   - Develop integrated strategic approaches to the use of nutrients and substrates to reduce environmental impact.

Feeding the Future, 2013,
National Farmers Union, Royal Agricultural Society of England, Agriculture & Horticulture Development Board, Agricultural Industries Confederation



Future challenges

Feed 9 billion in 35 years

- Increase yield
  - Controlled Traffic Farming – practical issues and international roll out
- Optimize fertilizer inputs
  - Development of soil nutrient sensors
- Optimize Water consumption/drainage
  - Improved control of irrigation systems and "in field" water management
- Optimize Energy use
  - Implement control of tractor for optimum tillage performance,
  - Reduce compaction
  - Reduce fertilizer requirements
- Generic
  - Lower cost, robust sensors
  - Plug and play interconnectivity of sensors/controllers/applicators
  - Training of operators, manufacturers and researchers

IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

UK-Canada Workshop
Smart Technologies for Agriculture
Montreal, QC, Canada
11 July 2014

Precision Opportunities in Crop Nutrition

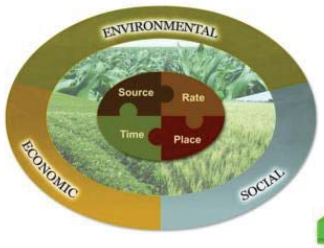
Tom Bruulsema, PhD, CCA
Director, Northeast Region, North America Program
Guelph, Ontario, Canada

Key Challenges

- Food and nutrition security
- Environmental impact of N and P use
  - Eutrophication
  - Greenhouse gases
  - Air quality
- Solutions
  - Sustainable intensification
  - Improved nutrient use efficiency
  - 4Rs – Right source, rate, time and place of application

4R PLANT NUTRITION
nutrient stewardship

4R: "right" means sustainable



Field to Market
The Keystone Alliance for Sustainable Agriculture

THE SUSTAINABILITY CONSORTIUM

Walmart
Sustainability HUB

How to Make a Difference - Fertilizer optimization

4R PLANT NUTRITION
nutrient stewardship

4R Adaptive Management for Plant Nutrition

Policy Level – Regulatory, Infrastructure, Product Development

Regional Level
Agronomic scientists, Agri-service providers

DECISION SUPPORT based on scientific principles

Recommendation of **right source, rate, time, and place** (BMPs)

Farm Level
Producers, Crop advisers

DECISION
Accept, revise, or reject

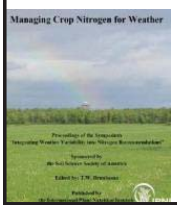
ACTION
Change in **practice**

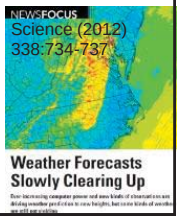
EVALUATION of OUTCOME
Cropping System Sustainability Performance

LOCAL SITE FACTORS
- Climate
- Policies
- Land tenure
- Technologies
- Financing
- Prices
- Logistics
- Management
- Weather
- Soil
- Crop demand
- Potential losses
- Ecosystem vulnerability

Improving nutrient use efficiency depends on adapting management to weather

❖**STRATEGY**
Support development of decision support systems that account for weather.





IPNI INSIGHTS
INTERNATIONAL PLANT NUTRITION INSTITUTE

December 2012

Reducing Loss of Fertilizer Phosphorus to Lake Erie with the 4Rs

Algal blooms in Lake Erie have been getting worse in the past few years. Phosphorus (P) has often been considered the nutrient controlling such blooms. The loads of dissolved P in the rivers draining into Lake Erie vary greatly year-to-year, but higher loads have become more frequent in recent years than in the mid-1990s. Agriculture is one of several sources of dissolved P.

This article outlines how crop producers in the Lake Erie watershed can reduce losses of P by adopting a 4R Nutrient Stewardship approach to guide their fertilizer application practices.

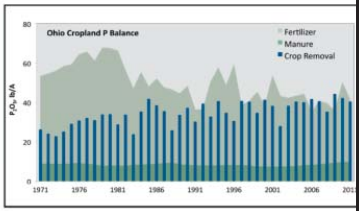


Figure 2. Phosphorus balance trend over time for Ohio cropland. *2011 fertilizer estimated.

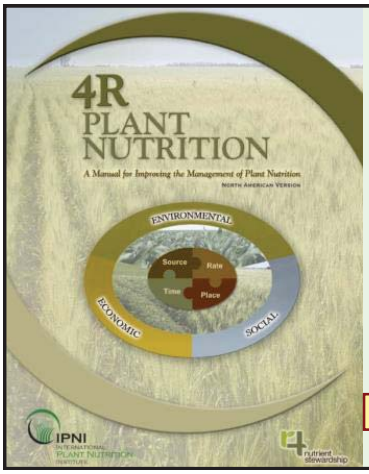
Background

Much of the cropland of the Lake Erie watershed is found in Ohio, with smaller areas in Indiana, Michigan and Ontario

4R PLANT NUTRITION
nutrient stewardship

4R Research Fund – *environmental, social, economic impacts of 4Rs on sustainability*

- **$7M** over 5 years across North America
- **Meta-analyses:** Review and analysis projects.
- **New Projects** – Measurement.
- Both to contribute measures of performance for 4R Nutrient Stewardship.
- For additional information: www.nutrientstewardship.com/funding



Thank You

http://nane.ipni.net

UK-Canada
La Coop fédérée

Alexandre Mailloux, R&D Director
July 11 2014

La Coop Network*

La Coop fédérée
$5.2 billion
9,984 employees
$1.6 billion in assets

Supply
$2.8 billion
1,335 employees
$717 million in assets

Marketing
$ 2.4 billion
8,649 employees
$857 million in assets

80 affiliated cooperatives
$3 billion
5,385 employees
$1.1 billion in assets

Highlights
- 100% Quebec owned
  - *62,000 members*
- Quebec expertise with 92 years of history
- Cooperative structure
- Dividends over five years
  - *La Coop fédérée : $66.5M*
  - *Cooperatives : $54.4M*
- Consolidation and development of regional economy

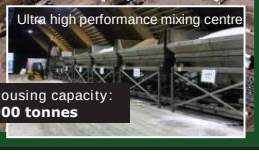
La Coop Network
$8.2 billion
15,369 employees
$2.7 billion in assets

De Facto Partnerships
$1.1 billion

* Data from 2012

Côte Ste-Catherine Fertilizer Distribution Center

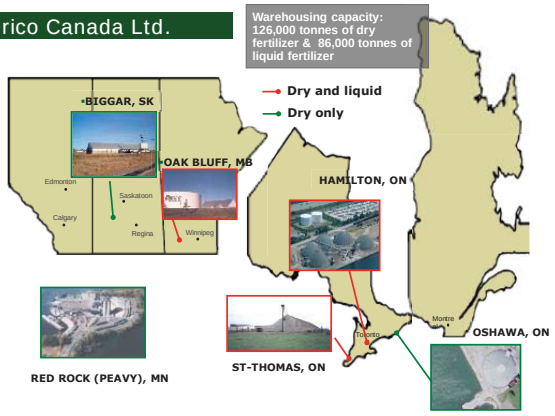
La Coop fédérée's largest distribution center for fertilizer raw materials. Serves Western Quebec's customers.



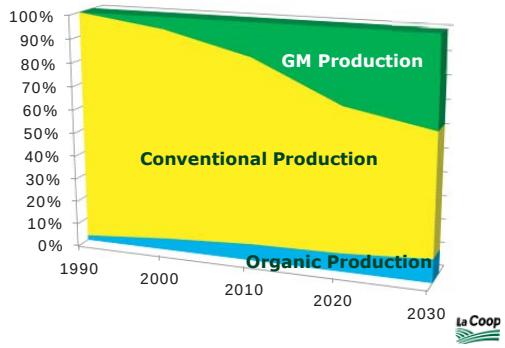
Warehousing capacity:
100 000 tonnes

Agrico Canada Ltd.

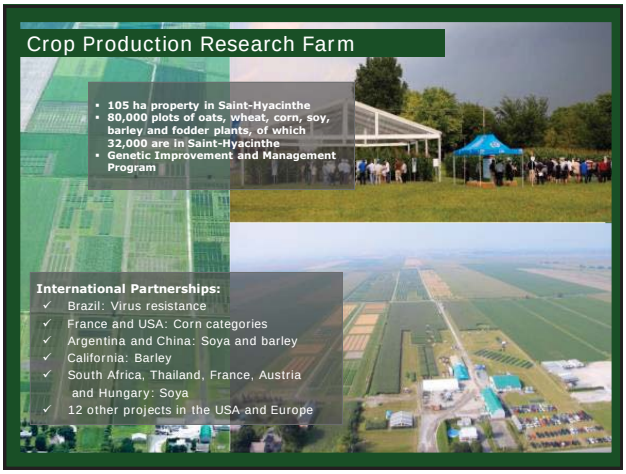
Warehousing capacity: 126,000 tonnes of dry fertilizer & 86,000 tonnes of liquid fertilizer



The Challenge; 9B in 35 years



Crop Production Research Farm



- **105 ha property in Saint-Hyacinthe**
- **80,000 plots of oats, wheat, corn, soy, barley and fodder plants, of which 32,000 are in Saint-Hyacinthe**
- **Genetic Improvement and Management Program**

International Partnerships:
- ✓ Brazil: Virus resistance
- ✓ France and USA: Corn categories
- ✓ Argentina and China: Soya and barley
- ✓ California: Barley
- ✓ South Africa, Thailand, France, Austria and Hungary: Soya
- ✓ 12 other projects in the USA and Europe

Company Background

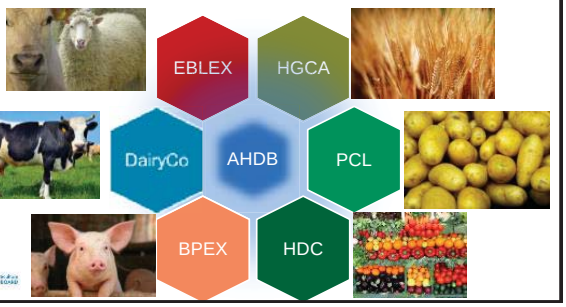
1996 : Soil sampling, Lime VR	
1997 : Yield map	
1999 : Veris validation (Electrical conductivity of the soil)	
2000 : Veris, soil sampling, management zone	
2001: Software to help facilitate mapping & discussions	
2008: Satellite imagery and zone management validation	
2011: Satellite imagery and web program for producers and advisors (2014)	

UK-Canada Workshop on Smart Technologies for Agriculture

Shamal Mohammed
Research Manager

HGCA- Agriculture and Horticulture Development Board (AHDB)

Agriculture and Horticulture Development Board (AHDB)



Background - Qualifications

Academic

•PhD, Cranfield University, UK (2010)
•*"APPLICATION OF REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM TO ESTIMATE IRRIGATED AREAS IN A TEMPERATE CLIMATE"*

•MSc, Sustainable Environmental Management – Water Management
•Post. Grad. Diploma, Land and Water Management
•BSc, Geology

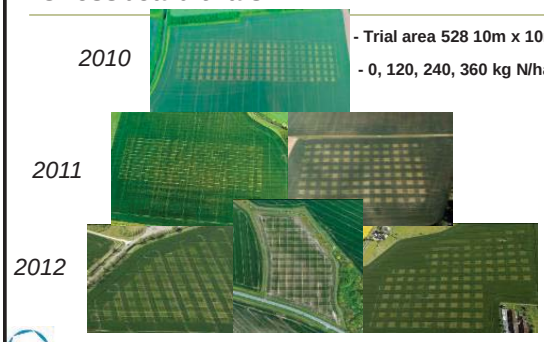
Professional
•Chartered Scientist(CSci)
•Professional Member (MI Soil Sci) - Institute of Professional Soil Scientists

Background - Experiences

- Research Manager Natural resources – Cereal Division –AHDB
- Chairman of Precision Agriculture and Informatics – AHDB
- Visiting Research Fellow – Cranfield University

Project	Cash (£)	In-Kind (£)
Auto-N	180,000	20,000
PhD Project	112,500	
Yield Map (RD3785)	202,000	
FarmingTruth		5,000
FramFUSE		14,000
BePRECISE	60,000	
Total	554,500	39,000

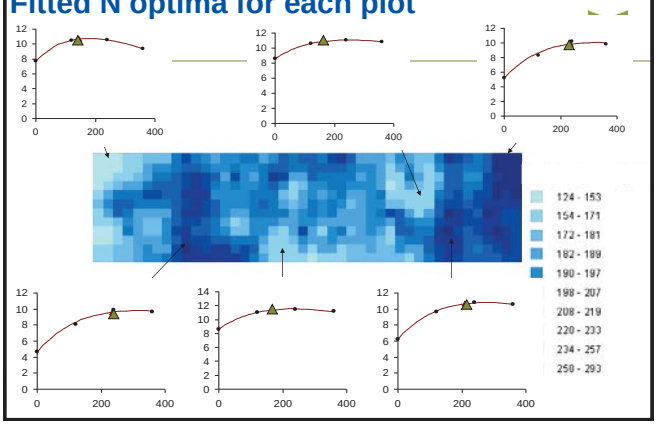
Variable Rate Application Chessboard trials



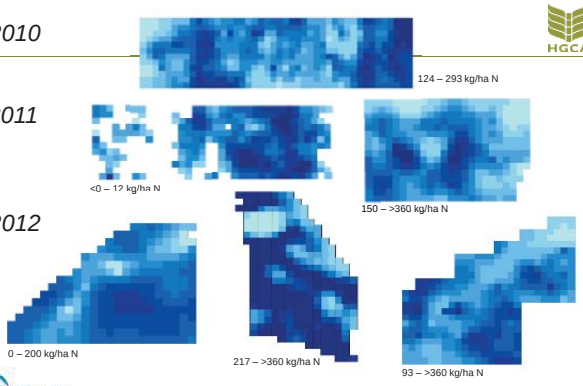
- Trial area 528 10m x 10m plots - 5ha

- 0, 120, 240, 360 kg N/ha applied

Fitted N optima for each plot



Variation in N optima



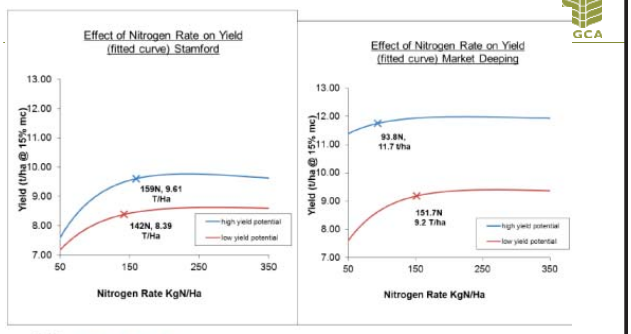
Lessons from Chessboard trials

Variation in N requirements is large
High variation in yield, soil N supply and fertiliser recovery.
Higher yielding areas tend to also have higher SNS
Areas with higher SNS can have lower fertiliser recovery

Most important is to improve the accuracy, this needs better prediction of:

- Crop N Demand
- SNS varies between
- Fertiliser recovery
-

$$\text{N requirement} = \frac{\text{Crop N Demand} - \text{SNS}}{\text{Fertiliser Recovery}}$$



VELCOURT
Europe's leading farming company

Key challenges and future opportunities

- **Improving the accuracy of applications**: Moving away from Precision farming toward Smart or "Intelligent Farming = Precision and Accuracy".
- **On farm data management**: Development of robust systems with a simple interface to store, analyse and process on-farm.
- **Expanding the application of technology in agriculture**: The intelligent farming system needs to go beyond variable rate application of fertiliser e.g. early disease detection

National Centre for Engineering in Agriculture: Precision Farming Projects

Dr Diogenes Antille
Research Fellow (Irrigated Soils)

UK-Canada Workshop 'New Technologies for Agriculture'
McGill University, Macdonald Campus, 10-12 July 2014

A Research Centre of the University of Southern Queensland

USQ Research

7 x Research Centres of Excellence

- **National Centre for Engineering in Agriculture (NCEA)**
- Australian Centre for Sustainable Catchments,
- Australian Centre for Sustainable Business Development,
- Centre for Systems Biology,
- Centre of Excellence in Engineering Fibre Composites ,
- Computational Engineering and Science Research Centre, and
- Centre for Rural and Remote Area Health.

A Research Centre of the University of Southern Queensland

National Centre for Engineering in Agriculture

"Develop solutions for a sustainable and profitable rural sector through applied engineering, research, training and commercialisation"

- Sugarcane,
- Cotton,
- Grains,
- Gas and mining sectors,
- Extensive and intensive livestock.

A Research Centre of the University of Southern Queensland

NCEA in Focus

NCEA & USQ

- Largest USQ research centre, established in 1994,
- Annexed to Faculty of Engineering; **only undergrad Ag. Eng. course in Australia**.
- Approx. AUD3M in external grants per year + strategic investment in personnel.

Personnel

- 30 FTE (externally funded staff) **≈40 Researchers**,
- Approx. 30 post grad. Students (PhD, DEng, MS by Res.),
- Adjunct positions.

Management

- Directorate Craig Baillie; Erik Schmidt; Principal Scientists.

A Research Centre of the University of Southern Queensland

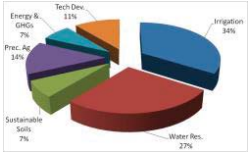
NCEA Programs and Themes

Program 1 : Irrigation and Nat. Res. Management

- **Irrigation and Water Management**
- **Sustainable Soil Management and Land Use**

Program 2 : Agricultural and Bio-Systems Engineering

- **Precision Farming Systems and Smart Technologies**
- **Agricultural Energy Use and Greenhouse Gas Emissions**



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Project information

- **GHG emission reductions from controlled traffic farming (CTF),**
  - Demonstrate the potential of CTF to mitigate GHG emissions in grain cropping,
  - Funding: DAFF
- **Developing remote and automatic grain crop attribute sensing technology,**
  - Proof of concept grain crop monitoring and automatic detection system for variety trials,
  - Funding: Grains RDC National Variety Trial .
- **Improving fertiliser use efficiency with controlled traffic farming (PhD-based),**
  - Agronomic, economic and potential environmental benefits,
  - Funding: USQ/NCEA, Gov. of Iraq.

Project information

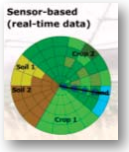
- **Precision weed map generation for weed spot-spraying in cotton**
  - Develop a weed spot-spraying field prototype; reduction in herbicide usage,
  - Funding: Cotton Research and Development Corp.
- **Costs and benefits of precision N application in irrigated cotton,**
  - Agronomic, economic and potential environmental benefits,
  - Funding: CRDC (subjected to approval).
- **Assessing the impacts of the round bale picker on cotton farming systems,**
  - Development of impact assessment framework,
  - Funding: Cotton RDC



Project information

- **Commercial prototype smart automation system for furrow irrigation**.
  - Commercial prototype adaptive real-time system for automation and control of furrow irrigation,
  - Funding: Cotton Research and Development Corp.
- **VARIwise: Advancing autonomous irrigation,**
  - Optimal overhead irrigation of cotton using **real-time variable rate irrigation control (VARIwise), being tested for fertigation,**
  - Funding: Cotton Research and Development Corp.





Project information

- **PA in sugarcane production**,
  - Evaluation and development of yield monitoring systems
  - Funding: Sugar Research Australia
- **SafeGauge for nutrients in sugarcane,**
  - Web-based management tool for fertiliser decision
  - Funding: Department of Environment.
- **Assist farmers in applying precision agriculture technology,**
  - Develop, test and deliver a training package to increase base level of understanding and uptake of PA technologies in sugar,
  - Funding: Sugar Research Australia.


Dr Diogenes Antille, Research Fellow (Irrigated Soils)
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THANK YOU

A Research Centre of the University of Southern Queensland

USQ UNIVERSITY OF SOUTHERN QUEENSLAND
fulfilling lives

Higth technology and organic farming

Jean Cantin, agronome, M.Sc.

Conseiller en grandes cultures biologiques
Direction Régionale de la Montérégie Est
jean.cantin@mapaq.gouv.qc.ca

Agriculture, Pêcheries et Alimentation Québec

CURRENT CREDENTIAL:

- B. Sc. - U. Laval_1986, sol plante
- M. Sc. – U. McGill_2006, fertilisation organique
- MAPAQ depuis 1992, grandes cultures
- MAPAQ – 2012, grandes cultures biologiques

Agriculture, Pêcheries et Alimentation Québec

ORGANIC FARMING:

- More than 25% increase in the use of pesticides in agriculture in 10 years (since 2004)
- Growing concern for food safety
- Production technique better controlled = Profitability
- Growth markets (Crops, Livestock Production, New England!)
  - Growth of over 15% per year since 2001
  - Imports account for 85% of organic sales
  - The demand for certified organic milk has x9 since 2000
  - Organic baby food have known 367% growth between 2006 and 2008.

Agriculture, Pêcheries et Alimentation Québec

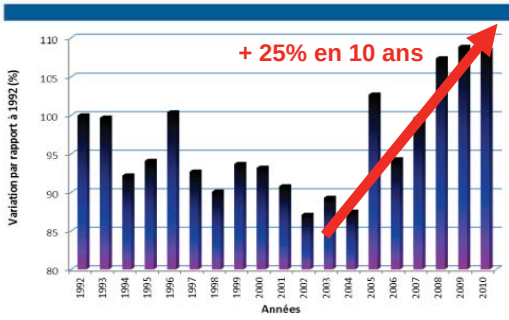
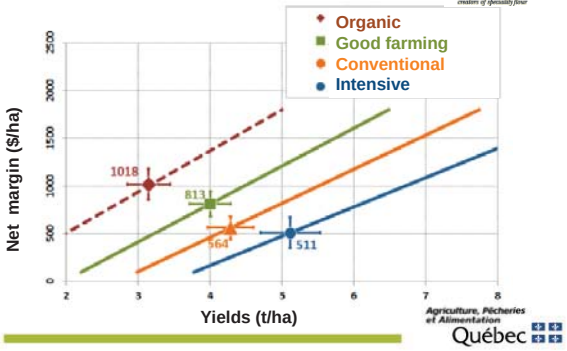


FIGURE 8 **Répartition des ventes de pesticides dans le secteur de la production agricole végétale de 1992 à 2010**

Source : I. GORSE et C. BALG, 2013. Bilan des ventes de pesticides au Québec pour l'année 2010, Québec, MDEFP, 85 p.

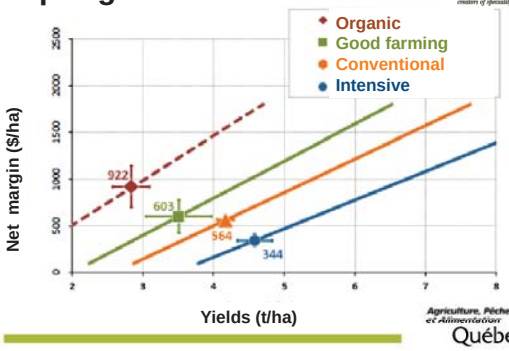
Québec

Winter Wheat



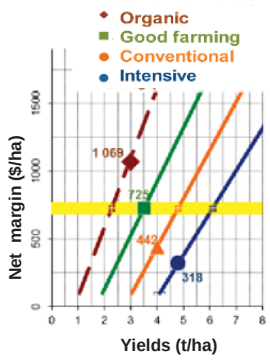
Agriculture, Pêcheries et Alimentation Québec

Spring Wheat



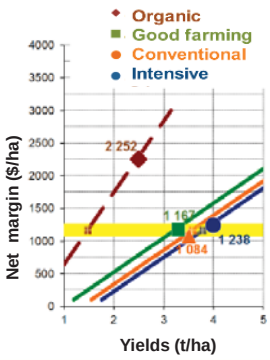
Agriculture, Pêcheries et Alimentation Québec

Wheat



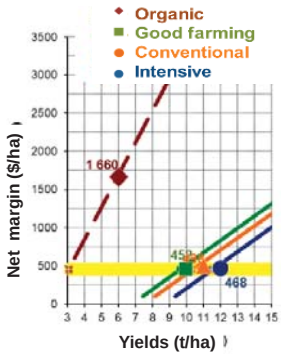
Agriculture, Pêcheries et Alimentation Québec

Soybean



Agriculture, Pêcheries et Alimentation Québec

Corn



Agriculture, Pêcheries et Alimentation Québec

HIGHT TECHNOLOGY:

- Autoguide optic!

Agriculture, Pêcheries et Alimentation Québec

HIGHT TECHNOLOGY:

- the sole limit is your imagination !

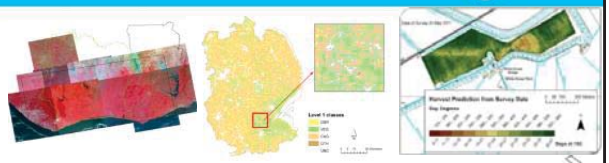
Agriculture, Pêcheries et Alimentation Québec

Agri-informatics with applied remote sensing

Dr Toby Waine, Academic Fellow in Land Resources Monitoring
Course Tutor MSc Geographical Information Management

www.cranfield.ac.uk

Vegetation monitoring with remote sensing



Commodity traders
UNODC, LUCAS 2012

Magellium,
DMCii Ltd.

Growers,
ESA

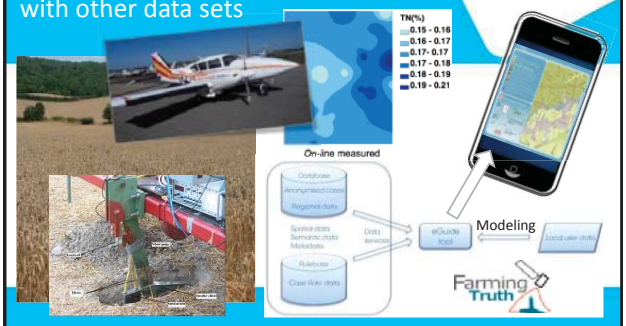
Scale

Regional crop inventory
- Food security
- Asset management
- Governance (tax)
- Policy

Field level inventory
- Food security
- Asset management
- Enforcement (Levy)
- Environmental modelling

Precision Farming
- Food security
- Sustainable agriculture
- Precision Irrigation
- Environmental compliance

Fusion of remote sensing with other data sets



Creation and collection → Storage → Processing → Modelling → Interpretation → Display and Dissemination

Data → Information

Experience to evidence based management decisions

- Information rich agricultural systems

grit.com

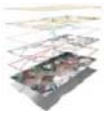
space-solutions.eu

"I know my fields and which crops are suitable - the good areas and bad areas"

New Holland

Agriport365.com

Interactive information systems with image processing algorithms



Data layers

FarmingTruth Web-based Information System - Electrical Conductivity Layer

Augmented reality to display datasets

Novel ways to interact with remote sensing data

Agro-ecosystems underpinned by Agri-informatics

Cranfield UNIVERSITY

What is the appropriate spatial and temporal scale?

©Alastair Parvin for Building Design Magazine

www.cranfield.ac.uk

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Remote sensing – Earth observation

As a source of information for Precision Agriculture

McGill University
July 11 2014

1

effigis

Yacine Bouroubi

Experience

- Chief scientist, Effigis GeoSolutions, since 2013
- Teaching, Remote sensing and GIS, since 2003
- Post-doc, AAFC (N. Tremblay), 2009-2013
- Research assistant, AAFC (N. Tremblay), 2003-2009

Education

- PhD, remote sensing, 2009
- BSc & MSc, electrical engineering, 1995 & 1998

2

effigis

Information needs in Precision Agriculture

Needs

- **Crop observation**
  - Yield estimation
  - Damages assessment
  - Management zones
  - Detection of weeds, pests and diseases
  - Variable rate technology – site specific management
    - **Application of fertilizer**, herbicide, pesticide and irrigation
- **Soil observation**
  - Texture
  - Organic matter
  - Management zones
  - Variable rate technology

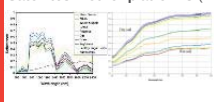
Tools

- **Remote sensing**
  - Optical – thermal – SAR (pol)
  - Multispectral – hyperspectral
  - Spatial – airborne – proximal
- **Other technologies**
  - Sensors, VRT, Web, mobile, …

3

Remote sensing for Precision Agriculture

Satellites + other platforms (Airborne, UAV, tractors) → **Vegetation (and soil) indices (more than 500)**



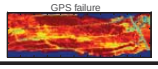
Spectral signatures → multi-(hyper-) spectral sensors → **VIs**

http://www.indexdatabase.de

Sometimes: radiometric or geometric distortions or limitations

Vignetting

GreenSeeker & CropCircle: only NDVI



GPS failure

Biomass, LAI, CHL, Yield, SOM, …

Use as inputs in models

4

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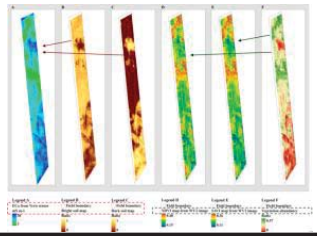
Remote sensing for Precision Agriculture

Example: crop and soil information from a single WordView-2 image (8 bands)
- Dark soil abundance well correlated with ECa (R>0.8)
- Vegetation abundance well correlated with SAVI (R>0.9)



SAVI from Pleiades and UAV+MiniMCA images

5

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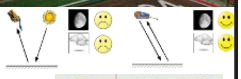
Remote sensing for Precision Agriculture

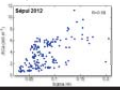
Radar (SAR) remote sensing

- Still useful in night time and cloudy conditions
- Sensitive to surface roughness (biomass) and dielectric constant (soil and canopy moisture)
- More complex (polarimetry) and less accurate than optical sensors

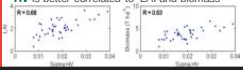


Example : crop status (C band, multi-polarisations)

HH is better correlated to ECa (soil moisture/texture)

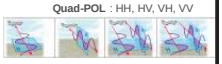


HV is better correlated to LAI and biomass



Can improve

Quad-POL : HH, HV, VH, VV



Polarimetry

$$\begin{bmatrix} R_H \\ R_V \end{bmatrix} = \begin{bmatrix} S_{HH} & S_{HV} \\ S_{VH} & S_{VV} \end{bmatrix} \cdot \begin{bmatrix} T_H \\ T_V \end{bmatrix}$$

6

Thank you!

Yacine Bouroubi PhD
Scientifique en chef – Observation de la Terre
Chief Scientist – Earth observation

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Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Crop Nutrition and Management Group

Nicolas Tremblay et al.
Saint-Jean-sur-Richelieu, Quebec
Canada

Member of the Board
International Society for Precision Agriculture

12th
International Conference on Precision Agriculture
Sacramento, California, July 20-23, 2014

Team


effigis
Yacine Bouroubi, former post-doc


Nicolas Tremblay, agr., Ph.D.
Lead


Lucie Grenon
Agropedology


Julie Surprenant
M.Sc. candidate


Philippe Vigneault
Geomatics, remote sensing


Carl Bélec
Agronomy and coordination

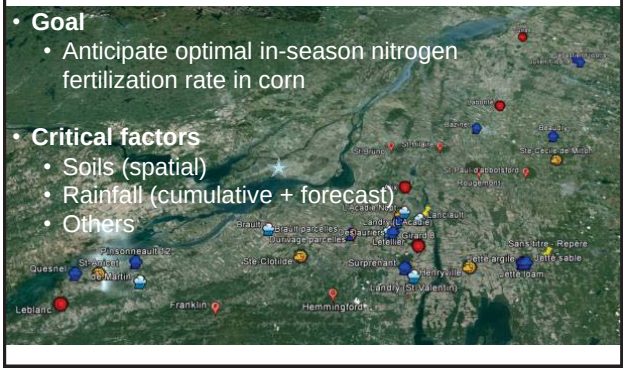

Edith Fallon
Instrumentation

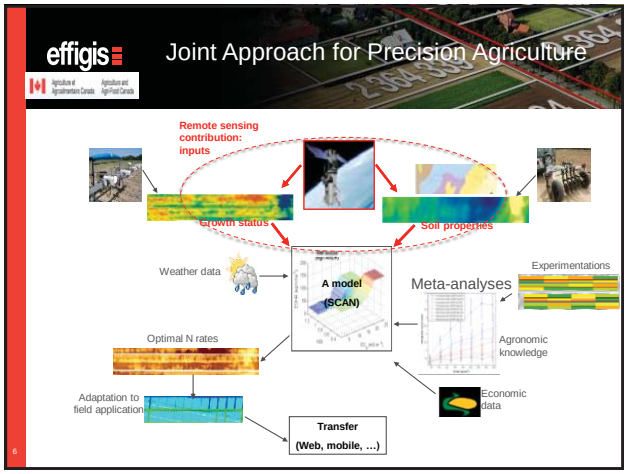

Marcel Tétreault
Lab and field

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Experimental locations 2013

- **Goal**
  - Anticipate optimal in-season nitrogen fertilization rate in corn
- **Critical factors**
  - Soils (spatial)
  - Rainfall (cumulative + forecast)
  - Others





Zoner.ag

Precision agriculture solution to increase productivity and profit in crop farming

...because every acre matters

Zoner.ag

Main issues

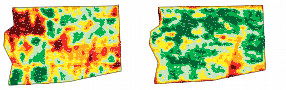
- Natural field variability

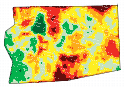
– both spatial and temporal;

- Large fields;
- Lack of information;
- Many different concepts offered;
- Multiple data types and formats;
- Scalability.

We need multi-year data

2007 2010 2013





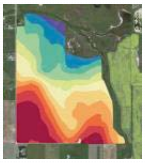
• Management decisions = field history + weather

www.Zoner.Ag

www.Zoner.Ag

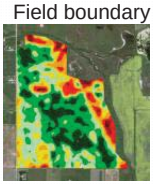
Integration of information

Field boundary

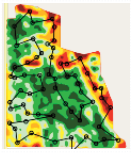


Elevation

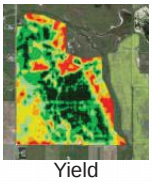
Soil EC



Yield potential



Soil sampling



Yield

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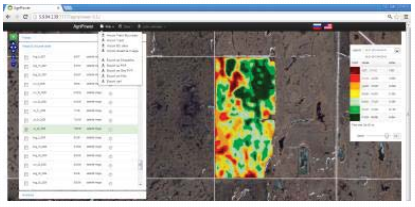
Opportunities

- Historical analysis of imagery and delineation of management zones;
- Land assessment;
- Assessment of current crop conditions and field monitoring;
- Weather monitoring and history;
- Forecast of crop diseases;
- Environmental monitoring;
- Training and education.

Zoner.Ag

- Automated analysis of satellite imagery for 30 years;
- Integration with yield data, soil EC and other layers;
- Delineation of zones and creation of Rx files;
- Integrated with historical and current global weather data;
- Web-based.



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soilessentials
precision farming solutions

UK-Canada Workshop on Smart Technologies for Agriculture

Jim Wilson
Soilessentials Ltd, Hilton of Fern, By Brechin, Angus, Scotland. DD9 6SB
jim@soilessentials.com

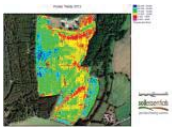
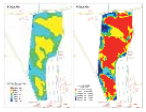
EssentialsNET
GPS Correction Network

SoilEssentials Structure

- Based in Scotland, office in England, resellers in Europe.
- Sell direct and through dealers(agronomists, machinery dealers, spray contractors. …)
- 20 Employees
  - Agronomists (potato specialists), Mechatronics, IT Developers.
- 3 divisions
  - Agronomy
    - Soil Sampling, Yield Mapping, Soil Texture, Agronomic advice
  - Machine Control.
    - Trimble Resellers (auto steer, section control, variable rate)
    - EssentialsNET RTK network
    - Holland Scientific Plant Sensors
    - Potato yield monitors.
  - Research Projects & IT Development
    - Aim is to take farm based sensor data, use it in crop recommendation algorithm's
    - Satellite imagery, UAV's, tractor mounted sensors
    - Soil Sampling, soil texture, irrigation management
    - Farm quality control- crop temp monitoring, quality assurance, diesel tank logistics, weather stations

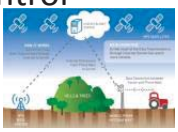
Agronomy

- Soil Sampling,
  - Grid pH Sampling
  - Zone based Routine
  - DNA probes, PCN
- Yield Mapping,
  - Cereals and Root Crops
  - Yield map production service
  - Normalised, Reliability Index
- Soil Texture,
  - EMI & texture sampling
  - Slope, aspect, historical imagery.
- Agronomic advice
  - Qualified agronomists
  - Potato expertise.


Machine Control

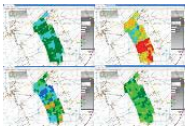
- Trimble Resellers
  - No radio corrections used.
  - auto steer
  - implement steering
  - section control
  - variable rate planting on root crops.
  - connected farm for file transfer between EssentialsMAP and tractor console.
- EssentialsNET RTK network.
  - UK coverage
  - NTRIP
- Holland Scientific Plant Sensors
  - European Distributors
  - Researchers
- Potato yield monitors.
  - To fit onto Grimme Equipment.



Research & IT Development

- KORE project
  - European Space Agency
  - Sat imagery, UAV and tractor mounted sensors.
- Web Development
  - Own IT staff
  - Web based precision ag portal with soil sampling, remote sensing, UAV, yield mapping, etc
  - FarmLive.
  - Using web connected sensors to monitor farm assets – fuel tank sensors, crop monitoring, cameras – all into customised web portals.

KORE
knowledge • observation
response • evaluation

Questions?

Precision Ag - Ontario, Canada

Doug Aspinall
Land Resource Specialist
OMAF-MRA, Guelph

Ontario

Doug Aspinall

- BSc. Biology, Carleton University. 1973
- BSc. Soil Science, University of Guelph, 1977

- Soil Surveyor, OMAFRA, 1981- present
  - Conventional soil surveyor, 1981-1985, 1990-1995
  - Soil conservation advisor: development ,evaluation and promotion of conservation and no-till practices in Ontario, 1985-1990
  - Precision Agriculture: variable rate N for corn using delta yield approach, yield mapping, LandMapper segmentation, GIS, 1995-2000
  - Nutrient Management: manure registry and tracking system, GIS, 2000-2003
  - Predictive Digital Soil Mapping (PDSM), high resolution DEMs, SoLIM, LandMapper, 2003 to present, working at a 5x5 m resolution
  - Precision Agriculture: management zone delineation and characterization. Yield mapping, PDSM for soil class and property mapping, proximal and distal sensing, nutrient application maps 1995- present

Management Zones

- Management Zone = f (CEC and Yield Index)
- Yield Index: temporal and spatial patterns of productivity from multiple years of yield monitor data
- CEC = f (% Organic matter and % clay)

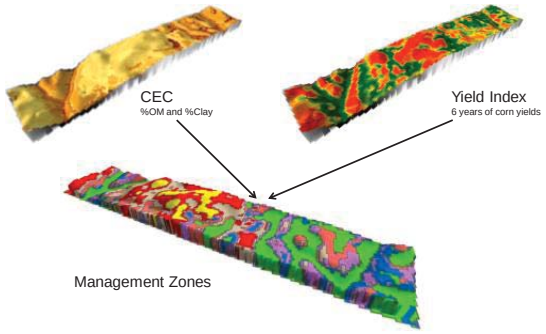
  CEC= ((0.5*%clay)+(%OM*2)) (Soil Fertility Handbook, Pub. 611. 2006. pg. 35)
- %clay and %OM f (environmental covariates-%slope, wetness index, %z2str, curvatures) from:

  digital elevation models
  distal - airborne and satellite imagery
  proximal – Veris EC, Soil Optix? Others ?

  +

  measured values of %clay and %OM

Management Zones – soil, landform, yield



Issues to be Resolved

Delineating Zones
- Yield, topography, soil properties, imagery, distal or proximal sensors?
- Real time sensing? No need for zones?

Soil Sampling
- strategies for sampling for calibration

Crop Response to change of inputs or variable rate
- Where is the biggest bang for the $$.$$?
- Nutrients, population, hybrids?
- New strategies for assessing response

Thank You

Please cite this presentation as:

Aspinall, J.D. 2014. Precision Agriculture – Management Zones, Ontario, 2014. PowerPoint Presentation, Montreal, PQ, July 11, 2014.

Questions may be directed to:

Doug Aspinall
Environmental Management Branch,
Ontario Ministry of Agriculture and Food and
Ministry of Rural Affairs,
Guelph, Ontario, Canada
N1G 4Y2

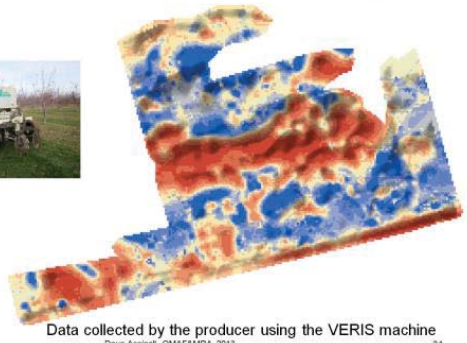
Doug.aspinall@ontario.ca

Ministry of Agriculture and Food
Ministry of Rural Affairs

Ontario

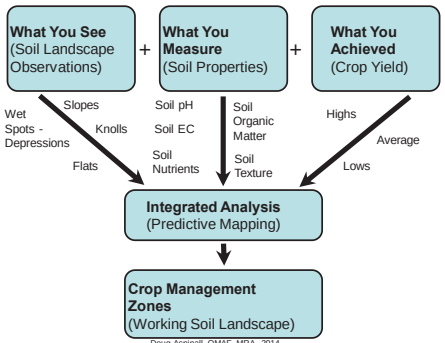
Ortho Image: Field Segmentation

Electrical Conductivity (EC)



Data collected by the producer using the VERIS machine

Management Zones – An Integration of Yield, Soils and Landscape



Zone Soil and Fertility Properties

	Zones	
Properties	Green	Yellow
Yield Index	High Above Average	Low Below average
CEC	High	Low
Curvature	concave	Convex
%OM	4.2	3.8
%sand	38	73
%silt	35	8
%clay	27	5
pH(H2O)	7.4	5.5
Texture	loam	Lfs
bICarb P	24	28
K ppm	238	97
Mg ppm	370	80
Ca ppm	1850	1010
pH	7.0	5.7
%K	4.1	2.3
%Mg	20.7	6.2
%Ca	62.2	46.7
%H	13	44
	Always best yielding areas in field	Always poorest yielding areas in field
		Stunted plants, small cobs
		Mg deficiency

UK/Canada Precision Ag Workshop – Montreal, QC

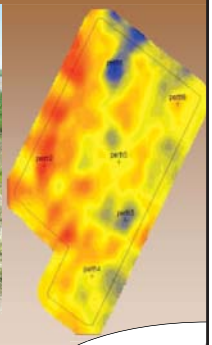
Practical Precision Inc.

Paul Raymer

- Grew up on a dairy farm in Ontario
- Mechanical Engineer - Mobile Equipment
- Worked in non-ag industries: Forestry, Automotive & Military
- Specializing in various sensing technology (Greenseeker, SoilOptix)

Optical Sensing

High Resolution Soil Sensing



Texture & Nutrient Properties

Smart Farming Challenges

- **Move from "Technology Push" to "Technology Pull"**
- **Achieve better understanding of plant growth & key elements that create yield**
- **Threshold of what to "chase"**

Smart Farming Challenges

- **DIY factor – HAS to be easy to use + Reliable**
- **Overcome Fear & Complacency = Trust**
- **Prove Value**

Precision Agriculture Technologies

Kenneth A. Sudduth

Research Agricultural Engineer
USDA Agricultural Research Service

Adjunct Professor of Bioengineering
University of Missouri

Columbia, Missouri, USA

Agricultural Research Service
the in-house research arm of the U.S. Department of Agriculture

Introduction

- BS & MS Agricultural Engineering – University of Missouri
- PhD Agricultural Engineering – University of Illinois
- Hydraulic Systems Engineer – John Deere Product Engineering Center (1980s)
- Research Ag Engineer and Project Leader – USDA-ARS
  - Proximal soil sensor development and evaluation
  - Grain yield mapping systems and data processing
  - Management zones and spatial analysis
  - Proximal and remote crop sensing
  - Agronomic, economic, and environmental evaluation of precision agriculture systems
- Incoming President (2014-2016) – International Society of Precision Agriculture

Agricultural Research Service

Proximal Soil Sensing

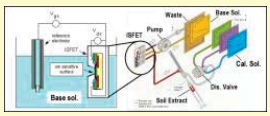
Sensor fusion

Vis-NIR reflectance

Soil strength/compaction

Apparent electrical conductivity

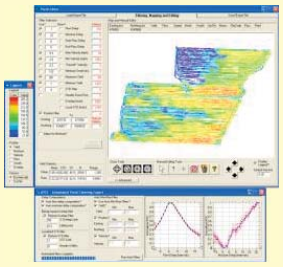
Soil macronutrients



Grain Yield Mapping

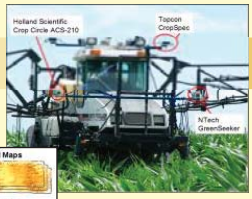
Cut-width sensing

Yield Editor 2.0 processing software

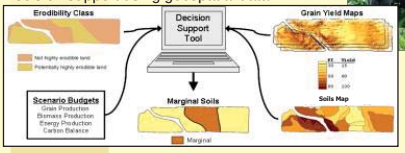


Corn harvest population sensing

PA System Evaluation



Decision support using geospatial data



In-season nitrogen

Landscape targeting of perennial bioenergy crops

Yield & water quality

Challenges and Opportunities

- Implementation needs
  - Standards, interoperability, data exchange
  - Operation that is seamless to the user
  - Benefits clearly documented and communicated
  - Training (users, service providers, consultants, etc.)
- Research needs
  - Sensor fusion for important soil and plant parameters
  - Algorithm development and testing across broad areas and conditions
  - Long-term evaluation of environmental and economic benefits
  - Integration of precision management with advanced crop genetics
  - Targeting of management systems (e.g., crops) to landscape variability

Agricultural Research Service

Smart technologies for agriculture

UK-Canada Workshop 10–12 July 2014 Montreal

Sven Peets

speets@harper-adams.ac.uk

Background

- PhD 2009 Cranfield University Silsoe
  - Specification, design and evaluation of an Automated Agrochemical Traceability System
- BSc 2000 & MSc 2002 Estonian Agricultural University
  - Agricultural energy engineering
  - Energy efficiency of buildings
- Researcher 2009–2011 Estonian University of Life Sciences
  - Biosystems engineering
  - Precision Livestock Farming

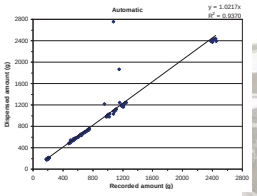
Current credentials

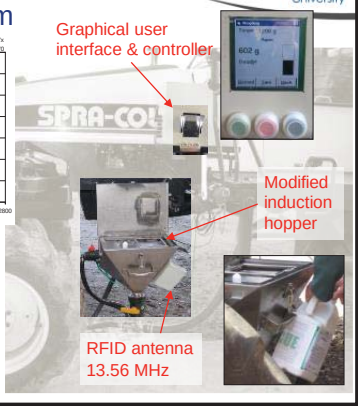
- 2011– Lecturer at Harper Adams University in Mechatronics and Agricultural Engineering
  - Subject coordinator of Precision Farming
- Main teaching duties
  - Instrumentation and Electrics
  - Mechatronics
  - Precision Farming Technology
- Research activities
  - Autonomous vehicle for strawberry picking robot
- Research interests
  - Radio Frequency Identification, Traceability, Automation, ISOBUS, Human-machine interface

Most significant impact

- AACTS – Automated Agrochemical Traceability System
  - Novel prototype which identifies and quantifies the amount of agrochemicals as they are loaded into crop sprayer
  - RFID tag data set for agrochemicals identification
  - Integration with pesticide database
  - Weighing system within induction hopper
  - Agrochemical traceability at tank level
  - Integration with ISOBUS (ISO 11783)
  - Very well accepted by the users

AACTS – Automated Agrochemical Traceability System





Challenges

- Efficiency
  - Less inputs, better machinery, higher yields
- Enough food for the world's population
- Food safety and quality
- Environmental impact
- Reduction of wastage
  - At all instances of the supply chain
- Seamless data management and communication
  - Reduction of data clutter
- Practical value for farmers

Solutions

- Improving the efficiency of machinery (smarter)
  - Sensors
  - ISOBUS
  - Electrification of implements
  - Telematics

- Automated electronic data recording
  - Traceability
  - Compliance

- Integrated data management
  - User friendly interfaces and tools
  - Decision support

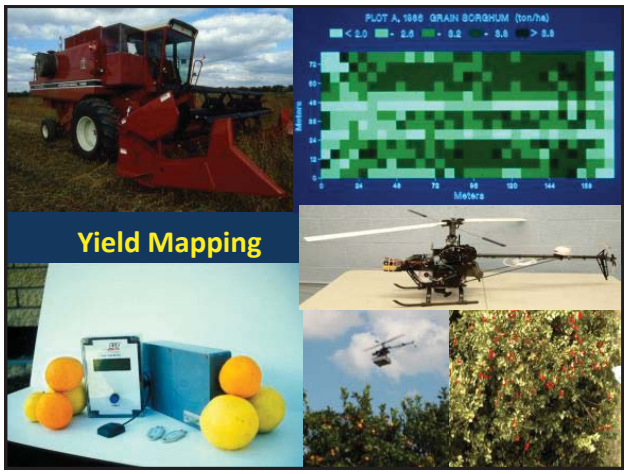
Current Credentials of John K. Schueller

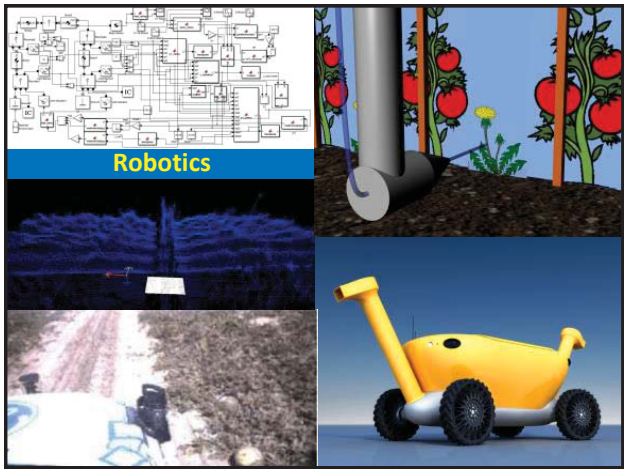
Professor of Mechanical and Aerospace Engineering and Affiliate Professor of Agricultural and Biological Engineering

- Director— University of Florida Center for Manufacturing Innovation
- CIGR (Chair of Section III and USA rep on Executive Board)
- ASABE (Fellow)
- SAE (Fellow, Teetor Award)
- Club of Bologna (Management Committee)
- *Computers and Electronics in Agriculture* (Editor-in-Chief)
- EurAgEng (Founder Member)
- ASME
- SME (Senior Member)
- ISAE (Life Member)
- ASEE
- Served on over 200 M.S. thesis and over 100 Ph.D. supervisory committees in ten majors
- Taught over twenty different university lecture courses
- Co-author of both editions of *Machine Design for Mobile and Industrial Applications*
- Technical visits to over twenty countries
- University Senator, Secretary of Engineering Faculty Council, and Faculty Union Senator at the University of Florida

UF UNIVERSITY of FLORIDA

schuejk@ufl.edu





Key Challenges

- Noncompatible agronomic/horticultural data and knowledge
- Weather and climate integration
- Unknown desired control actions
- Islands of automation
- Physical, chemical, and biological interactions
- Understanding causes of sensor responses
- Actuator dynamic accuracies and costs

John K. Schueller schuejk@ufl.ed

NIAB TAG — Silsoe Spray Application Unit

Paul Miller

Silsoe Spray Applications Unit (part of NIAB TAG)

Research interests include:

- **Improved application of plant protection products, including:**
  - ❖ *Targeted "spot" and "patch" application*
  - ❖ *Spray drift prediction and management*
  - ❖ *Automated machine control options*
- **Characterising crop canopies**
  - ❖ *Mainly for fertiliser inputs but also PPP's*
- **Cost/benefits of using new technologies**
  - ❖ **Including precision approaches to arable systems**

NIAB TAG — Silsoe Spray Application Unit

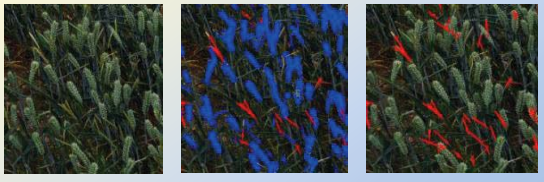
Detection of individual weeds by image analysis

- **Particularly for specific applications – e.g. Volunteer potatoes in vegetable crops**

NIAB TAG — Silsoe Spray Application Unit

Weed patch identification by image analysis and pattern recognition

- **E.g. Black-grass in a wheat crop**



For detection (of control failure) in one season for treatment in a subsequent season

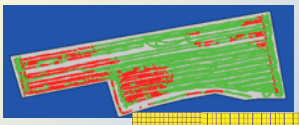
[*From Murdoch, de la Warr et al., 2011*]

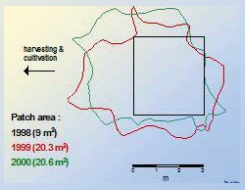
NIAB TAG — Silsoe Spray Application Unit

Interpretation and decision making

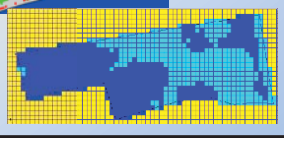
Accounting for factors such as weed seed movement and application accuracy

Initial weed map





Treatment map for sprayer controller



With an interface to decision support systems

NIAB TAG — Silsoe Spray Application Unit

Using inter-row and over the row treatments with precision guidance

NIAB TAG — Silsoe Spray Application Unit

Sensing crop canopy characteristics - using multiple boom-mounted sensors

To determine:

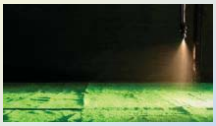
- **canopy structure**
  - **leaf area and tiller numbers**
- **crop colour**

Using spectral reflectance and ultrasonic height measurements

NIAB TAG Silsoe Spray Application Unit

Managing spray drift






Using nozzle design, boom height control, and spatial management linked to models

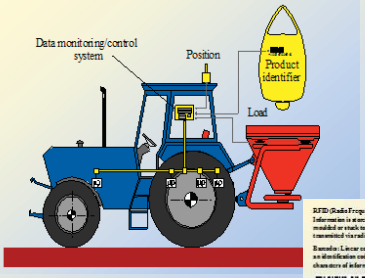
NIAB TAG Silsoe Spray Application Unit

Future directions

- **Increasing requirement to maintain crop yield and quality**
  - → *Chemicals use (fertiliser and PPP's) will continue*
  - → *Pressure on chemical use will increase - availability - targeting, timeliness and dose*
- **Increasing need for accountability**
  - → *Traceability for food production*
  - → *Environmental stewardship and compliance – e.g. LERAPs in the UK*
- **Increased automation (adoption of technology)**
  - → *Including decision support tools*

NIAB TAG Silsoe Spray Application Unit

Towards better record keeping



Product identifiers from:
- **Bar codes**
- **RFID**

NIAB TAG Silsoe Spray Application Unit

Research developments - timeliness

- **Is there a balance between precision and work rate – temporal vs spatial resolution?**



Broadacre arable vs high value horticultural crops?

FUSE TECHNOLOGIES

Connecting your farm enterprise like never before.

Dave Truelove - AGCO

AGCO Your Agriculture Company

Background

- Brought up on family farm in Warwickshire, still in the family and run by my brother
- Worked for 10 years in agricultural dealership workshop specialising in New Holland tractors and combines
- Join AGCO as Technical Training Instructor 2000
- Promoted to Technical Service Manager for Challenger Tracked and Articulated tractors in 2003 covering Europe, Africa and Middle East regions (including Eastern Europe)
- Joined ATS precision farming group in AGCO in 2009 and held various positions from Global Sales Support Manager, Product Manager for integration of ATS products onto Global Tractor platforms and currently transitioning to focus on the "off-Board" technology as Product Manger for Global Machine Health and Condition Monitoring

Key Accomplishments

I have been deeply involved in the following New Product programs:

- Development and integration of the current AGCO Auto-Guidance
- Development and global roll out of AGCO Telemetry solution (AGCOMMAND)
- Connections between AGCO's ISO Task Management and fleet management telemetry products
  - Conducted numerous Voice of Customer programs regarding smart farming technologies in Western Europe, Eastern Europe and South America to define the AGCO product offering and FUSE strategy

I am responsible for the global dealer Electronic Diagnostics tools and have implemented the following:

- Alignment of AGCO's global vehicle Electronic Diagnostic Tools
- Roll out of new global distribution partner for dealer diagnostic tools program
- Introduction of on-line software delivery system for the dealer network.
  - This requires regular liaison with global dealer network regarding support and diagnostics of Electronic systems

Most Challenging Issues regarding Smart Technologies

- Lack of consistent data format for precision farming data
  - Many "open standards" are being developed in isolation which will result in many incompatible "standards" in the field.
- Availability of a complete "seed to store" smart farming tools. Many independent technologies available but the farmer is the "systems integrator" who make them all work together through the crop cycle.
- Inconsistent implementation of the ISObus 11783 standards by machinery manufacturers
- Customer support services
- Customers interested in these technologies often have higher knowledge levels than the agricultural dealer network.

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1998

TODAY

1

Ag Leader Technology

Cloud farming

AgFiniti® Powered By Ag Leader®

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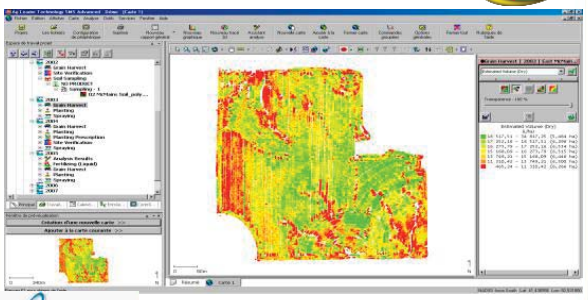
Ag Leader Technology

Data management analysist

SMS



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Nitrogen management

- Crop sensor OptRx

- Variable rate on the go

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Ag Leader Technology

CONTROL

CONTROL

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5

Please allow me to introduce myself,

Adrien Douelle, agr.

Diploma :

- **Engineer** in Agriculture (ESITPA, France).
- **Agronomist** in Québec.

Experience in Agronomy :

- Iowa State University : 6 months internship : Long term tillage on **soil quality**.
- Agronomist in Groupe ProConseil : council to farmers in **Agro-environment**.
- Agronomist in Groupe JLD-Laguë : specialized in **Precision Agriculture and water management**.

Groupe JLD-Laguë

Biggest Dealership in Québec :

- 14 Stores
- 425 employees

My job : Water management

Design soil leveling plan to improve superficial drainage.

Why? Poor drained soil :

1. Amount of precipitation (snow and storm).
2. Clay soils.

Results :

1. Increase yield and soil productivity.
2. Less erosion.

Techniques used :

1. Topography survey register with RTK GPS System.
2. Plans made with OptiSurface Designer.
3. Leveling by farmers with scraper.

My job : Data management

Helped farmers to manage their agronomic datas.

1. **Apex** : John Deere data management software :
   - Yield maps.
   - Prescription maps : seeds and fertilizer modulation.

2. **Field Conect** : Meteorological station.
   - Sensors recorded : soil humidity, growing degree day, evapotranspiration, air and soil temperature.
3. **MyJohnDeere.com** :
   - Machinery information centralized in a cloud.
   - Wireless data transfer : goodbye data loss!
   - Field Analizer : the easiest way to compare and interpret datas.

My agronomic vision of future in Quebec

Keep the potential of our soil :

1. Introduce **new crop** in rotation to decrease pesticide dependence.
2. Maximize **cover crop** to keep soil structure and decrease erosion.
3. Facilitate the **access of precision agriculture** for medium-sized farm.
4. **Global warning** : Bad or Good for Agriculture in Québec?

David Whattoff

Agricultural Development Manager – SOYL

Background

- Arable farm management & agronomy
- Viticulture

Commercial PF Experience

- Nutrient mapping
- Nitrogen (Satellite NDVI)
- Electrical conductivity scanning (DUALEM)
- Compaction mapping
- UAV data acquisition & processing

SOYL Research & Development

- Variable depth cultivation
- Variable rate irrigation

SOYL

4,000 customers

1 million hectares

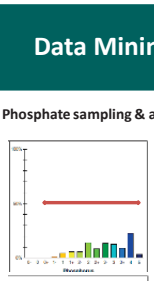
60 staff

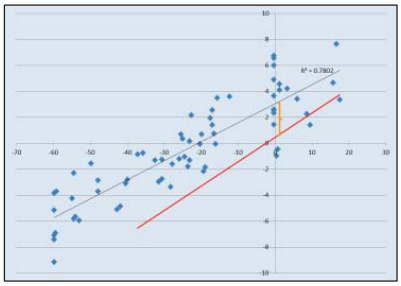
SOYL Precision Crop Production

Long Field				LONG			Calc. Area = 12.14			Soil Type = PotashReleasing Clay		
2012	Winter Wheat						Straw incorporated			Yield goal = Variable		
Nutrient	PPM			Index			Kg/Ha Product			Target	Frequency	Fertiliser Tonnages
	Max	Avg	Min	Max	Avg	Min	Min	Avg	Max	Index		
Potassium	207	180	114	2+	2	1+	0	2	43	2	Annual	**MOP** **0.03**
Phosphorus	32	14	9	3	1+	1-	121	200	241	2	Annual	**TSP** **2.42**

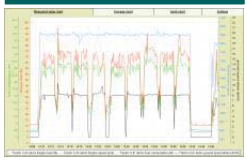
Data Mining

Phosphate sampling & analysis





Variable Depth Cultivation



SOYL

Challenges

- Data integration – existing data with online sensors
- Data portability – size and format
- PF solution cross compatibility
- Cost effective remote sensors
- Training – manufactures, researchers, customers
- Commercial ramp – getting research to broad acres

UK – Canada Workshop on Smart Technologies for Agriculture

Ian Yule

Professor in Precision Agriculture,

Massey University, Palmerston North.

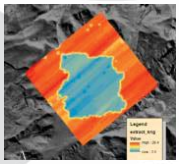
Introduction

- Professor in Precision Agriculture.
- Been in New Zealand since 1997 from the UK.
- Head up a group focused on precision agriculture research for New Zealand. Commercialisation and adoption a strong focus. *Following slides demonstrate a sample of unique work.*
- Examples include:
  - Improving fertiliser application technologies.
  - Focus on pasture and grazing systems, Development of tools and techniques around pasture measurement.
  - Initial work on Variable Rate or Precision Irrigation, now a commercial reality.
  - Development of precision dairying.
  - Research interest in aerial topdressing industry and hill country fertiliser application.
  - Strong focus on proximal and remote sensing.

Aerial Top dressing Pioneering to Precision

Early days transformed hill country.
Because of climate hill country response to fertiliser application.
Servicing approximately 12,000 farms and stations.

Present situation:
Requirement to improve spreading accuracy in order to achieve full benefit for farmers and look at precision placement of fertiliser on larger hill country blocks.



Computerised control of the aircraft hopper allows greater accuracy and change on the move at 60ms^{-1}.
Figure shows part of a flight with a 25ha paddock isolated where field boundary is recognised and a different rate applied.
This will also reduce off target application from pilot operated systems.
Next focus is to have fertiliser application informed by remote sensing.

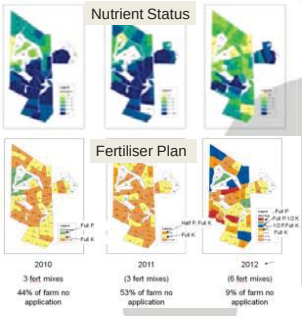
Developing new pasture quality measurement techniques

Developing remote sensed methods for pasture quality measurement. ME, OMD. Protein etc.

Currently examining a range of options:
- Proximal or ground based systems.
- Multi-rotor RPAS (UAV)
- Fixed Wing RPAS (UAV)
- Hyperspectral imaging from aircraft

Significant differences in on farm pasture quality and bio mass production present a large opportunity to increase and optimise productivity.

Precision dairying. Nutrient Inputs



Paddock by paddock soil testing on dairy farms is proving successful.

Initial case study work demonstrated benefit and this had been backed up by adopting farmers.

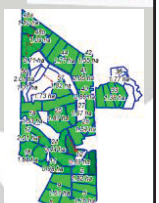
In some cases initial 40% reduction in base fertiliser use. Significant cost saving from simple measurements.

Subsequent balanced fertiliser program still giving significant benefit.

Significant proportion of spreader fleet VRA capable.

Some interest in sensor based systems to reduce nitrogen use.

Precision Dairying: Pasture Measurement

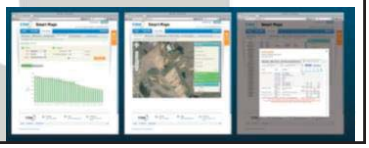


Massey University initially developed a pasture measurement tool which has been successfully commercialised by a local company.

The product has seen significant development and is being adopted by New Zealand dairy farmers, it is a fast, reliable, semi automated method of measurement. Current version has increased automation in data capture and download, linked to web based farm management software.

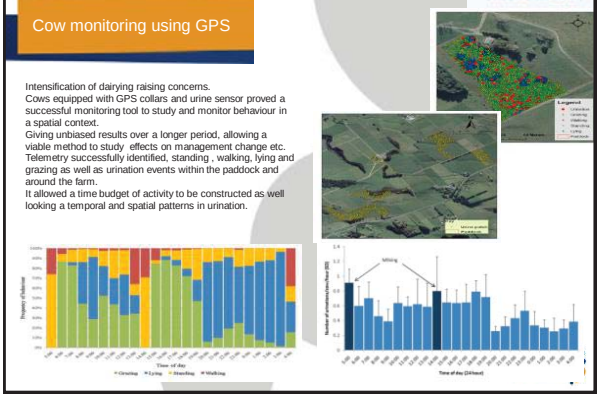
Farmers have found a significant benefit in using this technology and it had caught international attention.

Pasturemeter has been further developed and integrated into farm management software for dairying including other operations.



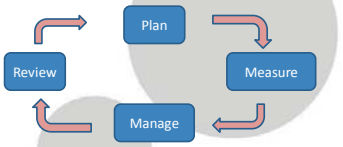
Cow monitoring using GPS

Intensification of dairying raising concerns.
Cows equipped with GPS collars and urine sensor proved a successful monitoring tool to study and monitor behaviour in a spatial context.
Giving unbiased results over a longer period, allowing a viable method to study effects on management change etc.
Telemetry successfully identified, standing , walking, lying and grazing as well as urination events within the paddock and around the farm.
It allowed a time budget of activity to be constructed as well looking a temporal and spatial patterns in urination.



Promotion of Precision Agriculture

- Strong advocates for Precision Agriculture.
- It is now a much talked about subject in New Zealand.
- Formation of a Precision Agriculture Association of New Zealand, (PAANZ) hopefully a step forward in that advocacy. Other research groups taking an interest
- Emphasis on PA philosophy as much as technology.



UK-Canada Workshop
on Smart Technologies for Agriculture

Jana Galambošová
E-mail: Jana.Galambosova@uniag.sk
Slovak University of Agriculture in Nitra, Slovak Republic

Slovak University of Agriculture in Nitra, Slovakia

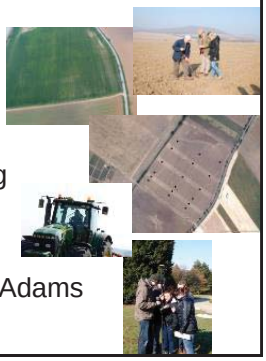
established in 1946

Personal background

- 2003 – 2007: **PhD (SUA in Nitra)**
  and MPhil (Cranfield University at Silsoe),
  aimed at ground based remote sensing sensors for VRA of Nitrogen
- 2006 – up to date: assistant professor at Faculty of Engineering, SUA in Nitra

Precision Farming Research & Education activities

- Controlled Traffic Farming
- Variable rate application of Nitrogen
- Precision farming course for MSc students of Ag Eng
- Lectures for farmers/ farm managers (Slovakia)
- Short courses with Harper Adams University



Most significant impact related to smar technologies for agriculture in Europe/Slovakia

- VRA of fertilisers - increased efficiency of fertiliser use, respecting the variability
- machinery guidance/CTF - possibility to improve machinery efficiency

BUT:

- Yield monitoring/soil variability determination/avoiding soil compaction...still problems in practical applications

Key challenges in Europe/Slovakia

- **food safety and quality** together with commerce requirements (**higher yields & lower costs**)
- **sustainable soil quality**
- **avoiding soil compaction**

THROUGH PrecAg technologies BUT

- User-friendly technologies/decision guidelines development
- „real“ use of the smart technologies/not only declaration
- Avoiding „overfill“ with data- obtaining data **AND** their further use
- Lack of „skilled“ managers

Precision Agriculture

Dr John V Stafford

CEng, CEnv, F I Agr E

Background/ Qualifications

- BSc Cybernetics & Instrument Physics, Reading University
- PhD Tribology, Reading University
- Industrial research – piston ring lubrication
- Soil mechanics, Silsoe Research Institute
- Sensing systems, Silsoe Research Institute

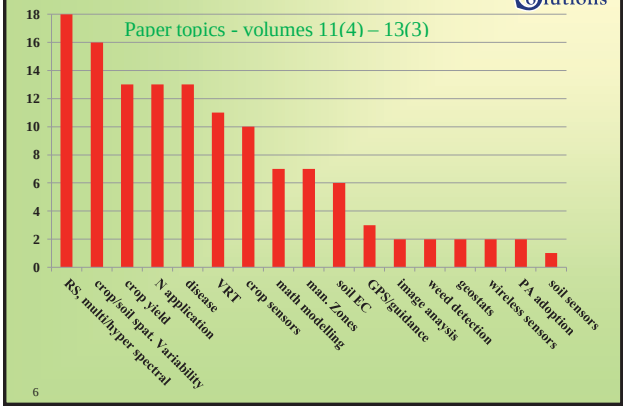
Experience: Precision agriculture 1990s: Silsoe Research Institute

- location systems / GPS
- Spatially variable herbicide application
- Seedbed variability
- Yield mapping sensors
- spatial &temporal variability of cereal yield
- Spatial variability of potato cyst nematode
- Delineation of management zones
- Weed detection & discrimination
- Site-specific management of sugar beet
- Initiated ECPA, Warwick University 1997

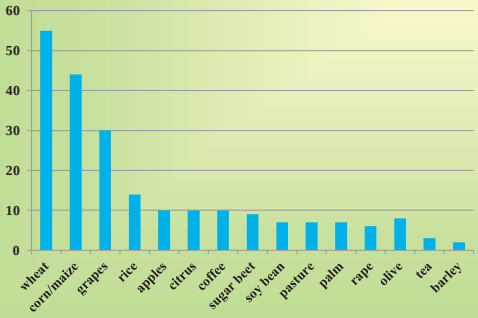
Experience: Precision agriculture 2000 - present

- Editor-in-Chief: Precision Agriculture vol 1 – 15 (current)
- Chairman & Proceedings Editor: biennial European Conference on Precision Agriculture
- President (2012-14): International Society of Precision Agriculture

Precision Agriculture journal Impact Factor : 1.73 (2012)



Crop types – submitted papers 2005-12



Challenges for Precision Agriculture

- Food security
- water availability
- soil quality
- land availability
- energy cost/availability
- pesticide/herbicide resistance
- environmental protection
- data interpretation

A specific need – cost-effective sensing systems to reliably detect / discriminate weeds, pests & diseases.

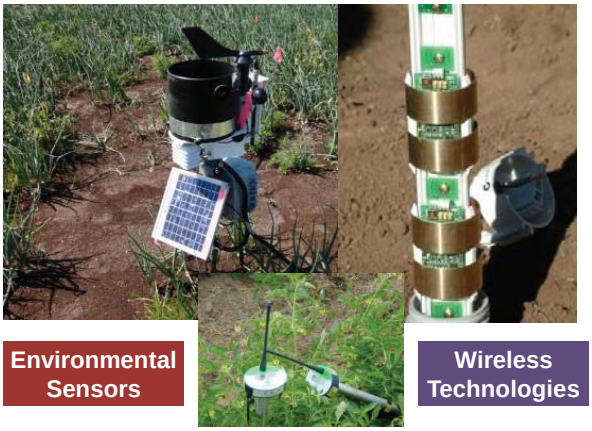
UK Science & Innovation Network

McGill

UK-Canada Workshop
Smart Technologies for Agriculture

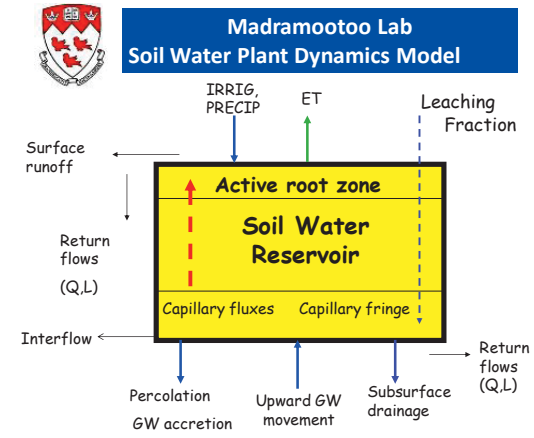
Introductory Presentation
Professor Chandra A. Madramootoo Eng.
Department of Bioresource Engineering
Dean, Faculty of Agricultural and Environmental Sciences
McGill University

Water Conservation in Agriculture

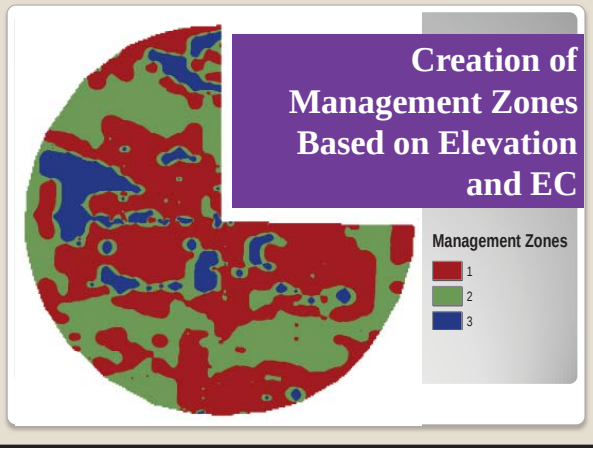


Environmental Sensors

Wireless Technologies



Variable Rate Irrigation



Soil and Crop Sensing
Coupled With Environmental Sensing
Linked to Mobile Platforms

Moving from supply managed to demand driven irrigation

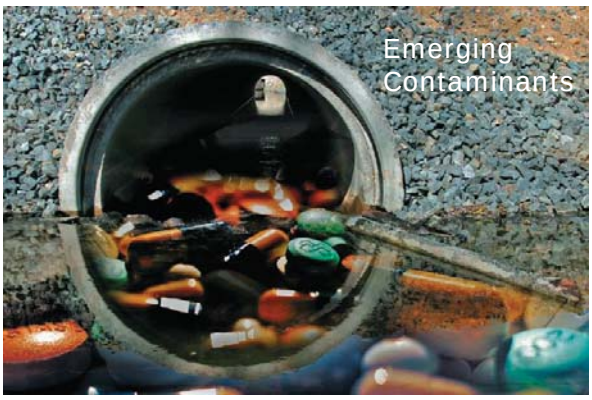
Incorporation of water use and ET data to predict crop yields and profits

McGill

Non-Point Source Pollution from Emerging Contaminants

Shiv Om Prasher

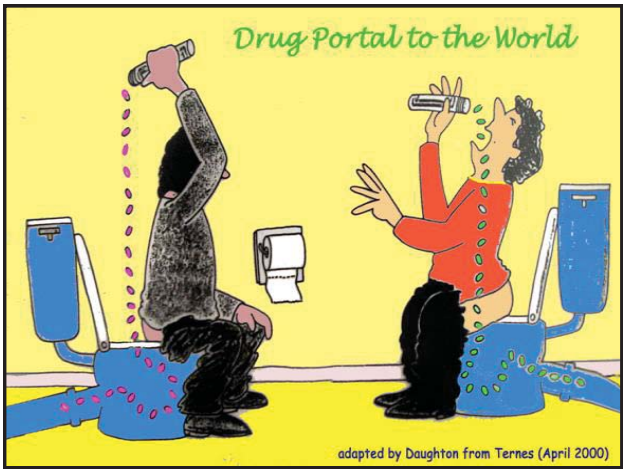
James McGill Professor
Bioresource Engineering
McGill University

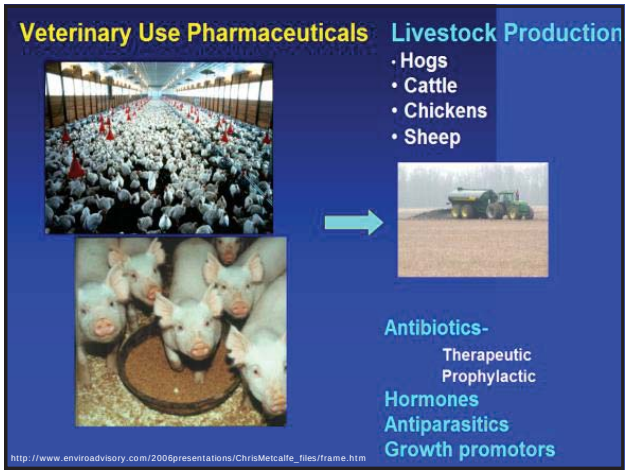


http://pubs.acs.org/doi/pdf/10.1021/es072658j

Human Use/Overuse of Pharmaceuticals

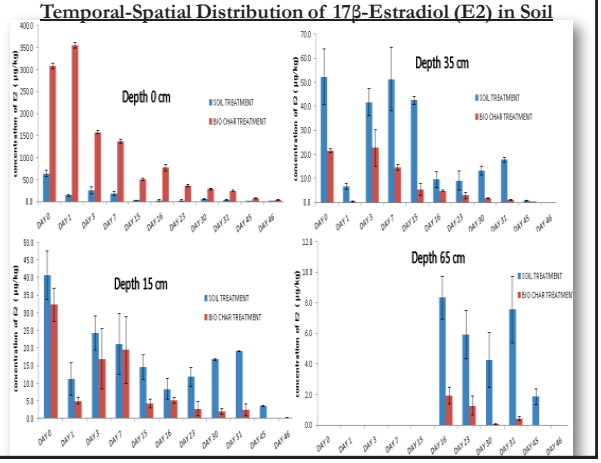
http://www.dtsc.ca.gov/AssessingRisk/PPCP/upload/01_Daughton.pdf



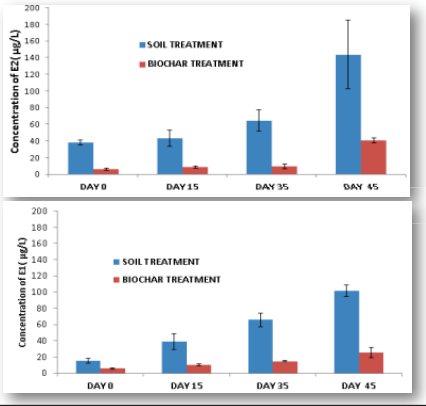


Methodology

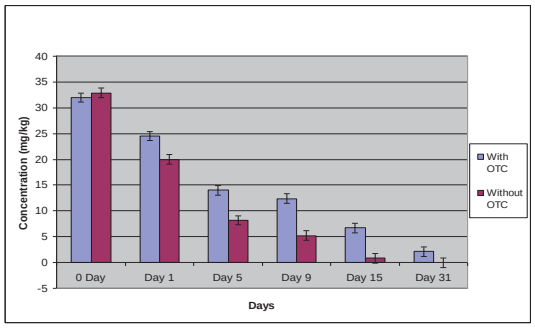
Temporal-Spatial Distribution of 17β-Estradiol (E2) in Soil



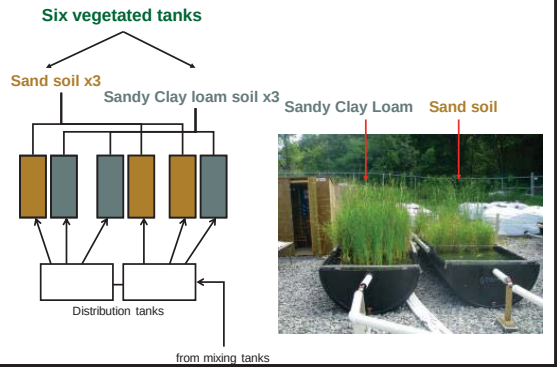
Temporal-Spatial Distribution of 17-Estradiol (E2) and Estrone (E1) in Leachate



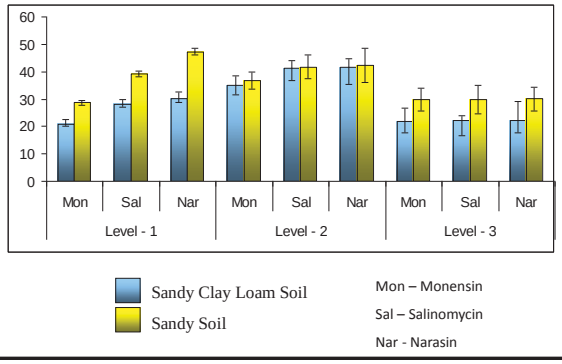
Metribuzin Concentration at Soil Surface



Constructed Wetland Site



Removal Percentage of Poultry Antibiotics



Current Projects

- Biochar
  - Effect of biochar on the fate and transport of antibiotics and hormones
  - Pesticide persistence and movement in soil affected by biochar treatment
  - Effect of biochar amendments on the fate and transport of pathogens in soil
- Computer modeling – field and watershed scales
  - Antibiotics, Hormones, Pesticides, Fertilizers, Pathogens
  - SWAT, DRAINMOD, HYDRUS, RZWQM
  - Stakeholder engagement in physical modeling
- Development of BMPs

Credentials of Vijaya Raghavan

- **B Eng (1967, Bangalore U, Mech. Eng.),**
- **M.Sc. (1970, U. Guelph, Agri. Eng.),**
- **Ph.D. (1973, Colorado SU, Agri. Eng.).**

- **James McGill Professor**, McGill U.(since 2002)
- **Chair**, Dept of Bioresource Engineering.(1993-2003)
- No. of **Graduate Students supervised**:126 (109 completed)

Fellow at:
- Royal Society of Canada **(RSC)**
- Canadian Society for BioEngineering **(CSBE)**
- American Society of Agricultural and Biological Engineers **(ASABE)**
- American Society of Mechanical Engineers **(ASME)**
- Indian Institution of Engineers**(IIE)**

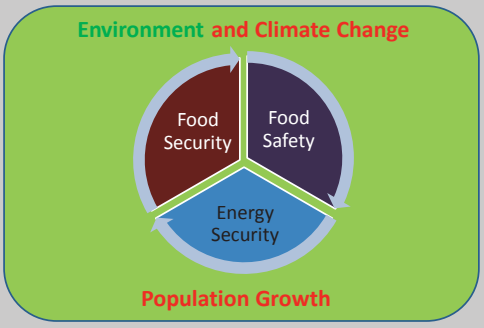
Foreign Fellow at:
- National Academy of Agricultural Sciences, India **(NAAS)**

Member of:
- Food Advisory Committee **(Health Canada)**
- Institute on Science for Global Policy **(ISGP)**

Key Accomplishments

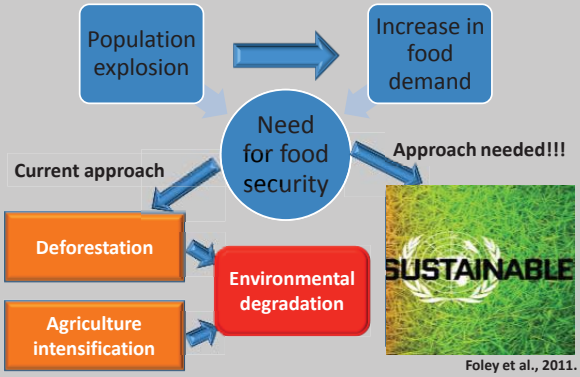
1. Studies on **soil compaction** and slip.
2. **Drying** using **particulate medium**.
3. Develop large scale **controlled atmosphere storage** units.
4. Develop **microwave drying** systems.
5. Studies on **double-pipe helical heat exchanger**.
6. Develop a method for **microwave pasteurization** of **in-shell eggs.**
7. Induction of **positive physiological activity** in produce by stress.
8. Technology transfer and developmental projects to ensure **food security (India, China, Brazil, Thailand, Malaysia, West Africa).**

Challenges Facing Agriculture



Sustainable solutions for sustainable future

Approaches to Alleviate Food Security



Foley et al., 2011.

Working towards sustainable solutions through postharvest technologies

"Appropriate" technologies to reduce postharvest losses
- Improvement of **storage structures and practices**
- Longer **shelf-life** and better **nutritional quality** of food
- **Processing of foods** to retain nutritional quality

Value addition to agricultural residues
- Feedstock for **biofuel** and **bioenergy** production
- Source of **bioactive compounds**
- Production and uses of **biochar** and **hydrochar**
- Sources of **biofibers** for production of **biomaterials**

Working towards sustainable solutions

Microbial fuel cell

Hussain A, Tartakovsky B, Guiot SR, Raghavan, 2011

Biochar

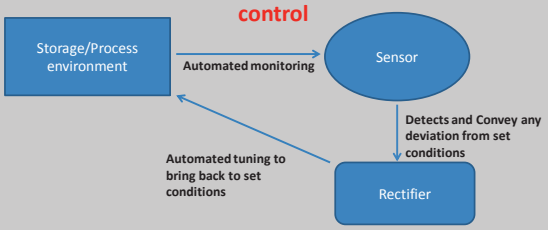
Dutta and Raghavan, 2010

Microwave retting of flax

G.Nair ,D.Rho,V.Yaylayan, V.Raghavan,2013

Visions for the FUTURE

Real time feedback sensory systems to aid in better process control

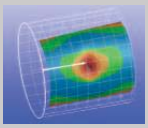


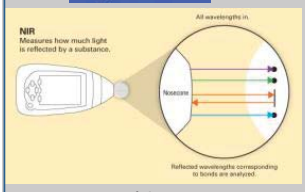
Better and efficient control of storage systems	**Better process control and high yield of quality material**
-Ripening -Quality -Pathogens	-Microwave- Biochar and hydrochar -Microwave- Drying

Visions for the FUTURE

Non – destructive quality assessment

Modelling





Real time

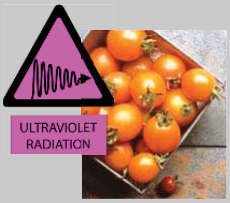
Better technology transfer

Mechanization procedures from develop world should be transferred to other developing and under developed world

High yield and better food security

Visions for the FUTURE

Lycopene rich tomatoes



Lycopene richer tomatoes

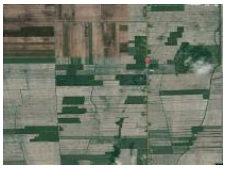
Manipulating growth/storage environment and genetic identity to improve production of target compound in the produce.

Bravo et al., 2013.

Examples of Precision Agriculture use in Canada

Caroline Begg, Ph.D.
- Director of Internship for the Farm Management and Technology Program
- Every year approximately 60 students on internships on farms across Canada and elsewhere
- Faculty Lecturer in Plant Science, McGill

St Alexandre and Ormstown Qc



- Rogantini farms in Ormstown
- 1581 acres (640 ha), cash crop corn and soya
- New generation is interested in precision agriculture but the fathers want nothing to do with technology

Two farms in St Alexandre
- Keurentjes , 3000 acres (1214 ha), cash crop corn and soybeans
- Yield maps for 12 years and using
- Auto steer, sprayer automatic turnoff
- Very proactive – goes to farm shows in France

- Bertrand, 5000 acres (2023 ha) plus about 20,000 swine spread over various farms
- Crops mainly corn with some soybeans
- No technology – reason given is that the father does not know how to turn on a computer

Lesyk farms, Saskatchewan

One section = 640 acres = 1 sq mile = 259 ha
- Works 12,000 acres (4856 ha) – 6,000 ac in Birsay and 6,000 ac in Yorkton
- Crops: green peas, lentils, Durham wheat, canola
- Flies between sites and does transport some machinery – 6 hour trip
- Uses auto steer with the air seeder, with GPS
- Herbicide sprayer, auto steer with automatic turn off and would adjust spraying according to speed

- No yield maps on their combines
- Newest combine had a yield monitor but not using
- In much of western Canada, extensive farming
- Easier to seed around wet spots- the topography is knoll and depression (sloughs), which vary year to year
- Do not sub surface drain, do not reseed areas

Saint-Valérien-de-Milton QC

- Billy Beaudry (Les productions Beaudry) about 1975 acres (800 ha) plus 800 sows
- Uses precision agriculture technology and he commented that the most popular item is “just a display showing you where to guide your tractor when spraying or fertilizing. It's cheap, often used with WASS correction which is free and the payback is very quick due to less overlapping and less wasted product. After that, farms with more acres are using automated guidance on one or two tractors on the farm”
- Most new combines have yield maps

Saint-Valérien-de-Milton QC

On Les production Beaudry
- first trial for variable rate planting this spring. We now have automated guidance on 2 tractors and the self propelled sprayer.
- In the fall, we switch the guidance system in one tractor to put it in the combine
- In the spring, manure application, fertilizer application and planting is done with the auto steering systems
- N application using the GreenSeeker system
- Looking to do strip till with automated guidance to be able to plant on the same row year after year

Comments on precision agriculture

- (Billy) Precision equipment has become very reliable now. In our first years of use, we would sometime loose signal and have to put the markers down on the planter. Now, I'm on my third year in a row not using my markers at all on the planter.
- I (Billy) would say Precision ag pays back, but for the most advance systems that are more expensive, it takes many acres to cover the cost.
- That's why smaller farms generally tend to have less precision equipment. Farms with older manager too will use less technology has they aren't able to fix their issues themselves when having problem with their GPS system

UK-Canada Workshop
on Smart Technologies for Agriculture
Ste-Anne-de-Bellevue, Quebec, Canada

Viacheslav I. Adamchuk

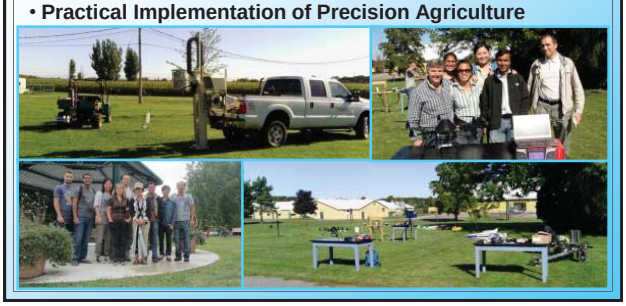
Bioresource Engineering Department
McGill University

July 11, 2014

McGill

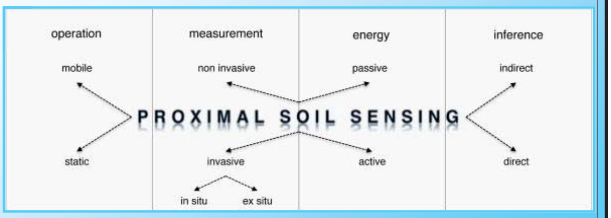
Precision Agriculture and Sensor Systems Team

- Development of Proximal Soil and Plant Sensing Systems
- Geospatial Data Processing and Management
- Practical Implementation of Precision Agriculture

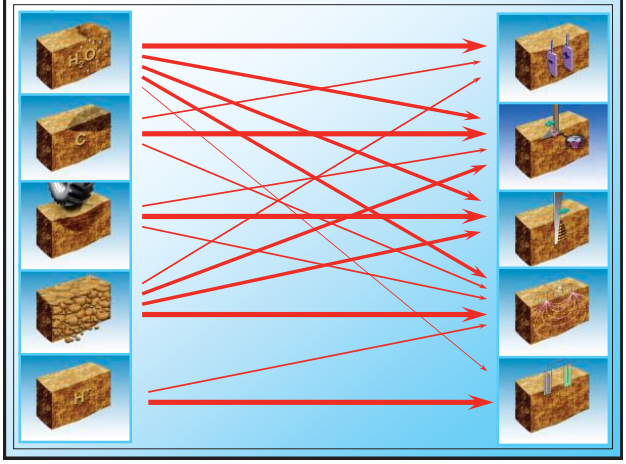


Proximal Soil Sensing

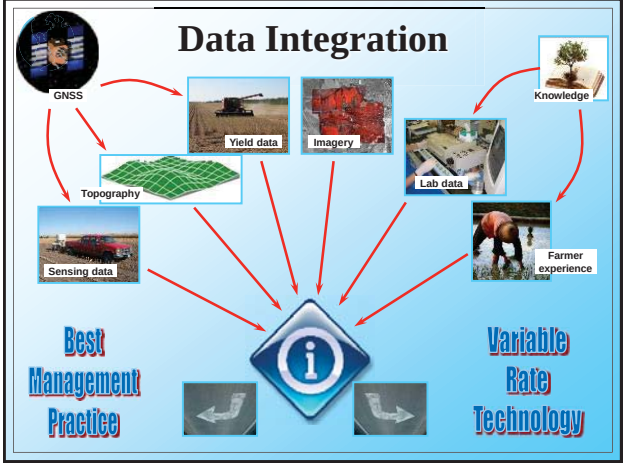
Proximal Soil Sensing (PSS) is a set of technologies developed to measure the physical, chemical and biological properties of soil when placing the sensor in contact with, or at a proximal distance (less than 2 m) to, the soil being characterized



Advances in Agronomy 113: 237-283



Data Integration



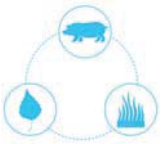
http://adamchukpa.mcgill.ca
E:mail: viacheslav.adamchuk@mcgill.ca

UK Industry sectors

- The UK Agri-Tech industry comprises three key sectors:

- Plant Science
- Animal Health
- Precision Agriculture

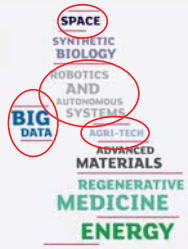
– Using modern technologies to improve agricultural management practices
– Applying modern genetic and breeding approaches
– Better understanding of interactions between soil, water and crop/animal processes
– Developing more effective management of crop weeds, pests and diseases
– Management of animal disease within farming systems



8 Great Technologies

Precision Agriculture

- **Positioning**
- **Remote sensing**
- **Automation and machine control**
- **Increased accuracy of application**
- **Data handling and transfer**
- **Wireless technology**
- **Decision support systems**



UK Strategy for Agricultural Technologies

- **Over £400 million each year from Government agencies**
- **Establish an UKTI Agri-Tech Organisation**
  – To promote foreign trade and inward investment in R&D and Agri-Tech Companies
- **£90 million investment in world-class Centres for Agricultural Innovation**
  – Centres will support the wide-scale adoption of innovation, technologies and skills in the food and farming supply chain
  – This includes up to £10 million for a Centre for Agricultural Informatics and Metrics of Sustainability
- **Creating a £70 million Agri-Tech Catalyst**
  – Will improve the translation of research into practice
  – Includes £10 million to support the transfer of technology and new products to developing countries

Why invest in UK Agri-Tech?

FINANCIAL INCENTIVES
•New £70m Catalyst Fund
•£90m for Agri-Tech Centres
•R&D tax credits & Patent Box
•Gateway to European market

WORLD CLASS LOCATIONS
•Cambridge - #1 University
•Rothamsted- 170 yrs experience
•Norwich – 4 Research Centres
•York – Biovale Cluster

INFRASTRUCTURE
•3 of top 5 Global Universities
•20% of workforce in Science
•Over 100 science parks
•Syngenta & Bayer sites in UK

AGRI-TECH EXPERTISE
•Chemical discovery
•Plant science & genomics
•Precision agriculture leaders
•Animal health expertise

UK – Canada Workshop

Driving Efficiency

Back Ground

- HND Agriculture – Arable cropping Harper Adams
- Started working with precision agriculture – 1998
  - Yield Mapping
  - Soil Sampling
  - Remote Sensing
  - Yara N Sensor
- Nuffield Farming Scholar 2004 (Precision Agriculture)
- Precision Decisions 2004 (UK)
- 2012 – Precision Decisions Zambia
- 2014 – UK Trade and Investment specialist Adviser – Precision Agriculture

Precision Decisions

Our Business

- Topcon
- Arag
- Yara – N Sensor and Tester
- Agronomic Solutions
- Soil Sampling
- Soil Scanning
- Variable rate
- Software Support
- Data management

Challenges

Precision What about the basics?

- Farmers!
- Horse Power
- Scale
- Resolution – Data Collection
- Resolution – Application
- Resolution – Yield and Qualification
- Communications
- Internet of things!

