UK-Canada Workshop on Smart Technologies for Agriculture

WORKSHOP REPORT

Department of Bioresource Engineering

McGill University

10-12 July 2014

Canada

UK Science & Innovation Network

McGill

Harper Adams University

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Executive Summary

This document reports on the UK-Canada workshop on Smart Technologies Applied to Agriculture held at McGill University on July 10-12, 2014.

The aim of modern technologies, frequently called “precision agriculture” or “smart farming”, involves numerous innovations to help farmers increase crop productivity while conserving their resources and improving the environment. This is achieved by engaging different technologies that address spatial and temporal changes within an agricultural production system. As a result precision agriculture has today developed into an information-driven management philosophy focused on matching the production process to changing environmental, growing and marketing conditions. Smart technologies include automated navigation, proximal soil and crop sensing, remote sensing, variable rate application of agricultural inputs, modelling of agricultural processes, optimization of farm operation logistics, agro-robotics and product input and output traceability.

This report summarizes the discussion of 37 experts who participated in the workshop and is followed by their overall recommendations. After discussing various aspects related to 1) nitrogen and other chemicals management, 2) soil and water, 3) agricultural automation, and 4) energy and logistics, the group agreed that site-specific management of crop production inputs is important for producers in the UK and Canada. A number of practitioners involved in the workshop shared their views on practical aspects of precision agriculture services. The main challenges were recognized as being related to the equipment itself, software and data processing logistics and agricultural policies.

In terms of future collaboration, four areas of common interest were defined: 1) professional training of farmers, contractors, advisers and researchers, 2) joint research and product development, 3) creation of a common data exchange hub, and 4) joint business ventures. The follow-up workshop is to be held in the UK.

Introduction

The workshop participants frequently referred to the following topics throughout their introductory presentations:

- Increase yield (efficiency)
- Food and nutrition security
- Optimize fertilizer inputs (improve the accuracy of applications)
- Optimize water consumption/drainage
- Environmental impact of nitrogen and phosphorous use
- Pesticide/herbicide resistance
- Sustainable soil quality (avoiding soil compaction)
- Weather and climate integration
- Natural field variability
- Scalability (large fields)
- Delineating zones
- Optimized soil sampling
- Achieve better understanding of plant growth and key elements that create yield (physical, chemical and biological interactions)
- On farm data management (practical values for farmers)
- Data portability (size and format)
- User friendly technologies/decisions guidelines development (too many different concepts offered)
- Training (manufacturers, researchers and costumers) (lack of “skilled” managers)
- Cost effective sensing systems
- Overcome fear and complacency
- “Real” use of smart technologies (not only declaration)
- Proof of value
- Commercial ramp - getting research to broad acres
- Reduction of wastage (efficiency)
- Unknown desired control actions
- Island of automation
- Understanding causes of sensor responses

Workshop Summary

The workshop titled "UK-Canada Workshop on Smart Technologies for Agriculture" was held at McGill University on 10-12 July 2014. It was organised by Dr. Viacheslav Adamchuk of the Department of Bioresource Engineering at McGill University, Professor Richard Godwin of Harper Adams University, and Dr. Mario Rivero Huguet, UK Science and Innovation Network Officer in Montreal. The workshop brought together 37 experts from the UK and Canada with invited guests from Australia, New Zealand, Nigeria, Slovakia and the United States with specialist expertise in precision agriculture areas.

The aim of this workshop was to explore the extent to which modern technologies are realistically applied in the UK and Canada. With a number of similarities in the way smart technologies are adopted in both countries, it is important to increase awareness and share successful developments between Canadian and UK workshop participants and also with specialists from other countries. Many of the smart farming technologies that are popular today were developed and adapted in both countries at the beginning of the precision agriculture era. Despite the recent decline in support for agricultural engineering research, a number of academic institutions, as well as technology and service providers remain world leaders in precision agriculture. Due to the emerging concern for future global food security as world population rises, there is a growing interest in these technological innovations in agriculture. Hence, this workshop was organized to initiate a dialogue to seek ways to strengthen on-going technology developments, evaluate the potential for markets for precision agriculture in both countries as well as consider better ways to export UK/Canada-based products and services to other countries.

The workshop was organised around four discussion sessions that focused on different aspects of modern technologies and public concerns:
Session 1: Nitrogen and Other Chemicals
Session 2: Soil and Water
Session 3: Agricultural Automation
Session 4: Energy and Logistics

In particular, it was recognized that precision agriculture was an essential component of modern farming practices in both the UK and Canada. The optimisation of the use of agricultural inputs was the most frequently discussed topic along with other key issues as follows:

- Crop Nutrition
    - Improved understanding of the dynamics of available soil nitrogen
    - Development of soil nutrient sensors and improved strategies for the application of primary fertilizers and trace elements

    - Improved agronomic decision making and weather forecasting
    - Development of techniques for identifying the factor(s) limiting crop performance
- Soil and Water
    - Improved control of irrigation systems and “in-field” water management to optimize water use
    - Improvement of soil physical conditions by controlling field traffic to specified lanes by auto-guidance and/or reduced vehicle weight and contact pressures
    - Spatially variable soil management practices to reduce greenhouse gas emissions
    - The role of big data collection and improved weather forecasting techniques
- Energy and Logistics
    - Reduced nitrogen fertilizer use by site-specific management
    - Reduced energy requirements due to automated guidance systems
    - Control of tractor implements for optimum tillage performance
    - Use of crop modeling with weather data inputs to estimate nitrogen losses
- Agricultural Automation
    - Further developments in robotic systems – especially weed control
    - Applications to both “broad acre” and intensive cropping
    - Improved plug and play interconnectivity of sensors, controllers and applicators to make them seamless and less demanding of farmers, agronomists and contractors.

The introduction, presentations and this report as well as other workshop details can be accessed at: http://adamchukpa.mcgill.ca/ukca_workshop.

Recommendations

It was concluded based on past experience that a two-level control strategy is the most appropriate way to implement site-specific crop management. At the first level, knowledge of past history, agro-climatic conditions and economic restrictions define the overall norm for seed or fertilizer use. At the second level, both remote and proximal sensing technologies can be used to optimize the use of inputs in response to changing local growing conditions within a single landscape. There is a tendency to mix both levels of control, which may lead to miscommunication between crop producers and service providers.

Among different crop inputs, the variable application of mineral nitrogen fertilizer was targeted as a key area for further development. Strategies for varying application rates have been approached from both predictive and reactive management strategies. The 4R stewardship[1] (rate, timing, placement and source optimization logistics) is a way to address contemporary drawbacks limiting fertilizer use efficiency. Among technologies discussed, regional modeling based on meta-data analysis allows for crude estimation of what is best for a given production scenario. On a field scale, yield history, real-time imaging, crop canopy sensing, proximal soils sensing and soil-based management zones are all appropriate technologies that allow the recognition of spatial inconsistencies of yield response to a specific agricultural input. Non-uniform water availability through the growing season is an essential component of the decision-making process.

It was recognised that the balance between crop production and environmental consequences could be influenced by precision farming approaches. In Europe the registration of plant protection products is already being limited due to the occurrence of active substances in ground and surface water and fertiliser use is restricted to limit ground water concentrations. Such restrictions are likely to apply more widely than just in Europe in the future. Soil management influences the production of greenhouse gases and again is an issue of increasing importance. There is an important need for research to further develop a currency for the environmental consequences of agricultural production. In doing so the balance between production and environmental outcomes can be better quantified and the effects of improved precision be evaluated.

Undoubtedly smart technologies allow for increased profitability, something that is confirmed by a limited number of studies and many anecdotal reports from

[1] The 4R philosophy is an innovative and science-based approach that offers enhanced environmental protection, increased production, increased farmer profitability, and improved sustainability. The concept is to use the **right fertilizer source**, at the **right rate**, at the **right time**, with the **right placement**. Implications of the 4R nutrient stewardship system will spread far and wide through agriculture and society as a whole (*http://www.nutrientstewardship.com*).

farmers and their agronomists. Great variation in production practices, subsidy policies, crop and fertilizer markets, and availability of technical support create a diversity of benchmarking points (conventional best management practices to be improved on using precision agriculture). As such, the difference between net profitability when technology is or is not applied is complex to calculate. Furthermore, it is very difficult to give a quantitative assessment of the environmental benefits and it does not appear feasible to establish monetary expression of such benefits in every case. However, it is important to remember that smart technologies provide the means to conduct structured assessments of the long-term impact of different practices with regards to the health of watersheds and the well being of rural communities.

As components of smart cropping systems, elements of automation help farmers to implement optimized cropping scenarios as well as improve production ergonomics. The level of technology acceptability and adoption relies not only on technology breakthroughs, but also on proper communication between machinery manufacturers and end users. The farmer can currently use many solutions, but a number of options are generally suitable only for specialized agribusiness structures or large production enterprises. The important factor of economy-of-scale is readily applicable to modern crop production.

In terms of future collaboration, four areas of common interest can be defined: 1) professional training of farmers, contractors, advisers and researchers, 2) joint research and product development, 3) a common data exchange hub, and 4) joint business ventures. Based on the workshop results, it follows that the UK, Canada and other countries are faced with the need to explore suitable options in each of these four categories. Joint efforts may help preserve resources, add versatility and enhance the exchange of expert knowledge. These are expanded below:

1. With regards to **training**, dealing with specific farming groups as well as service providers would improve commercially available solutions. Furthermore workshops, such as this one, enhance information exchange, which stimulates novel thinking and the constructive evolution of existing practises as well as planning upcoming developments. The UKTI could be in a position to support such activities. Webinars and other means of remote participation can compliment cross-Atlantic visits to pursue training programs at a relatively low cost.

2. Due to similarities in terms of crop production and the adoption of technology in parts of the UK and Canada, joint **research** programs would be very beneficial to further collaboration. A specialized narrow-focus discussion between interested parties is needed to initiate joint research activities. Despite a number of ideas generated during the workshop, it is premature to declare a formulated joint research team.

3. A **shared data** space to exchange measured crop response characteristics appears to be a well-suited first-in-line program that is of interest to researchers and service providers on both sides of the Atlantic. The Agriculture and Horticulture Development Board is in the process of a similar internal (UK) initiative with substantial secured funding. Some of CFI-AAFC-IPNI works pertaining to 4R implementation can be viewed as a similar Canadian initiative. Exploring the benefits of joint activities between both initiatives may yield a set of valuable projects involving both research bodies and agribusiness entities.

4. It would be attractive to study the potential joint **business** opportunities when technologies originating from one country compliment emerging practices elsewhere. However, it is difficult to incubate such ideas without clearly defined one-on-one interaction that may need external support.

A second workshop to be held in the UK is planned to further develop the cooperation, identify the key issues and build strong collaborative scientific, practical and business relationships.

Workshop Program

<u>July 10, 2014</u>	
18:00 – 20:00	Welcome dinner Chandra Madramootoo, Viacheslav Adamchuk, Richard Godwin, and Mario Rivero Huguet
<u>July 11, 2014</u>	
08:30 – 08:40	Welcoming remarks Viacheslav Adamchuk
08:40 – 11:00	**Participant Introduction, Challenges and Opportunities**
11:00 – 12:30	Visit to Macdonald farm
12:30 – 13:30	LUNCH
13:30 – 14:15	**Session One: Nitrogen and Other Chemicals** Paul Miler and Nicolas Tremblay
14:15 – 15:00	**Session Two: Soil and Water** Chandra Madramootoo and Richard Godwin
15:00 – 15:30	BREAK
15:30 – 16:15	**Session Three: Agricultural Automation** John Schuller and Sven Peets
16:15 – 17:00	**Session Four: Energy and Logistics** Vijaya Raghavan and Kenneth Sudduth
17:00 – 17:30	**Discussion Summary** Viacheslav Adamchuk and Richard Godwin
18:00 – 20:00	Networking dinner
JULY 12, 2014	
08:00 – 08:30	Workshop review
08:30 – 10:00	**Synthesis of discussions, reports and ideas** John Statfford and Viacheslav Adamchuk
10:00 – 11:00	**Future Plans** Clive Blacker and Mario Rivero Huguet
11:00 – 12:00	LUNCH
12:00 – 13:00	Closing remarks

List of Participants

Name	Affiliation[1]	Country
Viacheslav Adamchuk	McGill University	Canada
Diogenes Antille	U Southern Queensland	Australia
Doug Aspinall	OMAFRA	Canada
Caroline Begg	McGill University	Canada
Clive Blacker	UKTI	UK
Yacine Bouroubi	EffiGIS	Canada
Tom Bruulsema	IPNI	Canada
Jean Cantin	MAPAQ	Canada
Adrien Douelle	Groupe JLD-Laguë	Canada
Jana Galambosova	SPU v Nitre	Slovakia
Richard Godwin	Harper Adams University	UK
Chandra Madramootoo	McGill University	Canada
Alexandre Mailloux	LaCoop Federee	Canada
Alex Melnitchouck	IntelMax Corp	Canada
Jean-Francois Messier	Farm	Canada
Paul Miller	NIAB/TAG	UK
Shamal Mohammed	AHDB	UK
John Ohu	University Of Maiduguri	Nigeria
Sven Peets	Harper Adams University	UK
Shiv Prasher	McGill University	Canada
Vijaya Raghavan	McGill University	Canada
Paul Raymer	Practical Precision	Canada
Mario Rivero Huguet	UK Science and Innovation	Canada
John Schueller	University of Florida	USA
John Stafford	Silsoe Solutions	UK
Kenneth Sudduth	USDA-ARS	USA
Nicolas Tremblay	AAFC & ISPA	Canada
Dave Truelove	AGCO	UK
Toby Waine	Cranfield University	UK
David Whattoff	SOYL	UK
Jim Wilson	Soil Essentials	UK
Ian Yule	Massey University	New Zealand

[1]Institutional affiliations are provided for purposes of identification only. The views expressed by participants during the discussions were their own and hence do not necessarily represent those of their institutions.