



Finding The Technology Path to Power Tomorrow's Farm

ISSUES AT HAND

With 9.5 billion people living on the earth by 2050, we will require an estimated 80% increase in agricultural outputs. The burden of this increase will fall on farmers - farmers who must now do more with less, while maintaining profitability. Statistics tell us there is a movement to fewer and larger farms, with a stable to shrinking amount of farmed land. Between 1991 and 2011, the number of Canadian farms decreased by 26%, while the size of the average Canadian farm increased from 598 acres to 778 acres. Total farmed land in 2011 was 160.2 million acres, or a reduction of 4.1% since 2006. Finally, between 1991 and 2011, there was a 24.8% decrease in farm operators. There are new technologies to support farmers, yet these technologies are not being fully leveraged. Niagara College's precision agriculture work, led by Dr. Mike Duncan, is developing tools to support and leverage technologies for the modern Canadian farm business.

A population of 9.5 billion will require food security. This is heightened with climate change, and people demanding higher-quality food. Farmers are expected to meet higher standards in order to maintain their social licence. With one-fifth of the world's freshwater, Canadian farmers have a significant natural capital advantage. With 1.31 acres of arable land per person, Canada is No. 3 in the world. The above-mentioned advantages showcase the opportunities for Canadian farmers to lead by example. To enhance these opportunities is the variable rate work of Dr. Duncan, who is researching with farmer partners, and incorporating the 4Rs of good nutrient stewardship: right source, right rate, right time, right place.

CURRENT & RECENT WORK

Dr. Duncan is in his fifth year as the Natural Sciences and Engineering Research Council of Canada's (NSERC) Industrial Research Chair for Colleges (IRCC) in Precision Agriculture & Environmental Technologies. Over the last 4+ years, Dr. Duncan has developed scalable digital tools for farm businesses. This is done by storing, analyzing, interpreting, and visualizing agricultural data. The data sources include farming partners, and in-house developed sensor tools and prototypes. Dr. Duncan's team develops algorithms to support farmers, consultants, Certified Crop Advisors (CCAs), retailers, agricultural suppliers (seed, fertilizer, and other field inputs), and more. Collaborations with farmers, government, and agricultural businesses have provided these partners with new perspectives on agricultural data, management zones, and variable rate practices.

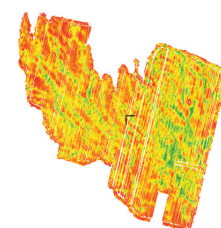
In an era of larger farms, and reduced farm labour, it is essential to make farm work more efficient with scalable technologies. For example, the current IRCC work has involved developing the Crop Portal (web tool) to process agricultural yield, soil, elevation data, and more. This is part of a collaborative project for Grain Farmers of Ontario, who have more than 28,000 members in Ontario. The Crop Portal is a powerful decision support system that supports OMAFRA (Ontario Ministry of Agriculture, Food and Rural Affairs), grain farmers, and consultants. It enables data to be cleaned, processed, and turned into valuable management zones for variable rate farming in a time efficient manner.

NEXT STEPS

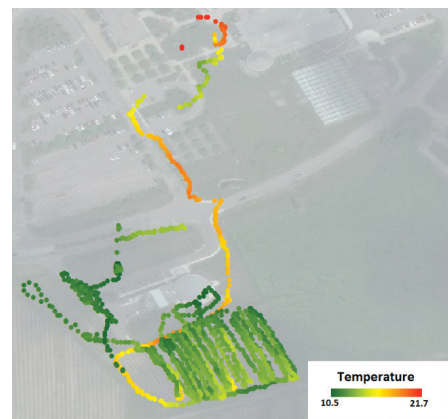
- Data gathering with robotics to gather a precise detailed picture of growing conditions, and reduce farmer time gathering data
- UAV (Unmanned Aerial Vehicle) algorithms and data analysis, which provide a unique viewpoint to better manage crops
- Custom sensor networks for ground-truthing and validation for farm practices and inputs (ex: seeds, chemical inputs, timing of management decisions, etc.)
- Second to second meteorology (micrometeorology) analytics to understand, identify, and mitigate the effects of harmful weather events (which are anticipated to increase in regularity with changes in climate patterns).



Dr. Mike Duncan, Industrial Research Chair in Precision Agriculture and Environmental Technologies.



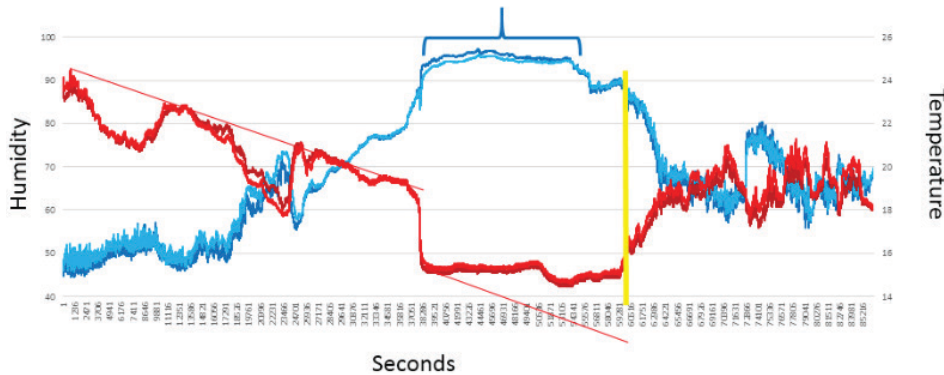
Yield map processed with the Crop Portal and its custom tools.



Visualized temperature data collected with Dr. Duncan's robot prototype.

EVOLUTION OF DR. DUNCAN'S WORK

The next era of Dr. Duncan's work will assess and address the barriers to remotely operated farming. This will involve collaborating with farmers, seed companies, hardware companies, agTech investors, inventors, University researchers, government, and more. This work will use higher volumes of agricultural and weather data. Outcomes will focus on actionable analytics. The scalable solutions will provide value with a clear return on investment (ROI). These solutions and technologies will help to support the larger modern farms by scaling their efforts.



Thermodynamics from the NC vineyard. The red lines are the upper (3 metres above ground) and lower (1m above ground) temperature sensors, the blue lines are the upper and lower relative humidity sensors. The data, the sensors, and the associated analytics will help farmers to identify and mitigate harmful weather events.

The idea is to both examine, and define the future technologies that will drive a remotely operated farm operation. This will enable the modern farmer to profitably make all the food our rapidly growing world population will need. For project partners, this will create intellectual property (IP) to refine current products and services, and develop new products and services.

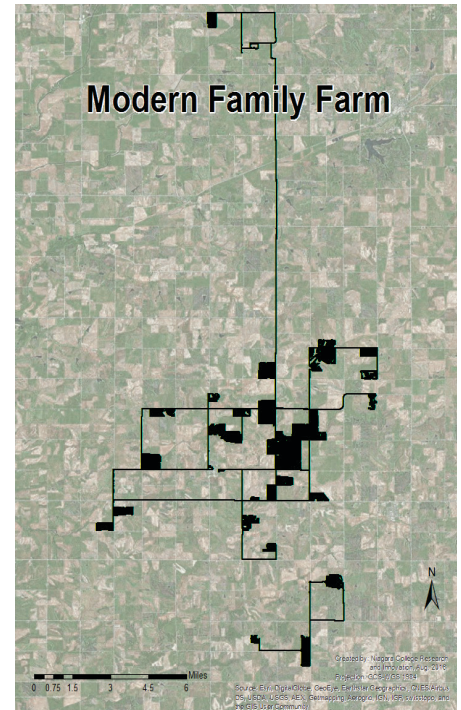
ROLE OF PARTNERS

Our partners provide direction, and advice, as well as staff time, in-kind donations of data, and cash support for projects. Dr. Duncan's company partners provide specialized knowledge of their business, and problems they are facing. The resulting precision agriculture tools are intended to benefit partners, their team members, and clients. Niagara College helps to serve as an independent innovation team. We create tools and provide a new perspective on your issues. We are always looking for new partners to move our combined work forward. The goal is to create value for your business.

VIDEO SUMMARIES OF DR. DUNCAN'S WORK

- [From Yield Maps to Prescription Maps](#) - Overview of the precision agriculture process in grain fields.
- [Yield Probability Index \(YPI\)](#) - Dr. Duncan's management zone algorithm.
- [Faces of Innovation: Refining agriculture by the power of data](#) - Collaboration with Dr. Duncan and brilliant Ontario grain farmer Rick Willemse.
- [Research Paper](#) - Yield Pattern Stability in Ontario Farm Fields.

To collaborate or learn more, contact [Dr. Mike Duncan](#)



The farm business of today and the future is getting larger, and more geographically spread out. Precision agriculture and remote operation technologies will support farmers with operations of this nature.

NIAGARA COLLEGE RESEARCH & INNOVATION



Dr. Duncan, and the Agriculture & Environment Innovation Centre Team, Summer 2016.

One of the main benefits of working with Niagara College, is the access to hand-picked students. The group is comprised of computer programmers and Geographic Information Systems (GIS) students, who are top-notch, and looking for experience working on real projects. Cash investment in the team supports these students, results in significant leveraged research funding, and IP for the partner. Dr. Duncan's students start with a grounding in real-time data processing. Computer programming, open source technologies, mobile applications, database development, and environment, are part of their experiences before finding opportunities, ideally with company partners.