PRECISION AGRICULTURE DEVELOPMENT IN CANADA

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ABSTRACT

This poster provides an overview of precision agriculture development in Canada. It focuses on the specific practices of auto steer tracking and variable rate nutrient application in the prairie region. The development of these practices has been largely driven by technology innovation and private sector crop consultants and equipment providers. Nevertheless, academia and government have supported this development through research since the 1990's and funding incentives to producers since 2005. While auto steer is a more recent development than variable rate nutrient application, it has experienced much faster and widespread adoption. The Agri-Environment Services Branch of Agriculture and Agri-Food Canada is currently assessing key challenges and investigating potential opportunities for further development and adoption of these practices.

Keywords: **precision agriculture adoption, incentives, and trends; GPS auto steer; variable rate nutrient application**

SUMMARY

A survey of almost 14,000 Canadian farmers in 2006 revealed that 23% of farms use global positioning system (GPS) equipment or products (eg. digital maps) on their operations (Haak, 2010). Overall use is greater in the prairie provinces and Ontario, possibly due to larger cropland areas.

Table 1. Percent Of Farms Using GPS In 2006 and Percent Of Farms With GPS Using It For Different Purposes.

Province(s) [1]	BC	AB	SK	MB	ON	QC	AP	Canada
Percent of Farms Using GPS Equipment or Products	9.9	26.1	27.8	31.4	24.6	10.7	15.3	23.2
Percent of Farms with GPS using it:								
To Collect Information For Soil and Crop Management	47.7	27.2	20.1	19.1	43.5	59.3	68.9	32.0
To Collect Information For Water Management	6.5	3.5	3.2	5.8	3.8	8.4	7.9	4.2
As a Tracking or Guidance System on Machinery to Eliminate Overlaps and Misses in Field Operations	52.6	82.6	89.9	92.3	66.1	46.6	58.2	77.9
To Target or Vary Fertilizer or Manure Application Rate	21.7	21.7	16.8	25.9	31.0	24.8	23.9	23.5
To Target or Vary Pesticide Application Rate	8.1	27.3	29.0	29.0	29.9	18.2	17.1	27.4

[1] Provincial Abbreviations: BC – British Columbia, AB - Alberta, SK – Saskatchewan, MB – Manitoba, ON – Ontario, QC – Quebec, AP – Atlantic Provinces.

(Source: Haak, 2010)

From 2005 to 2008 AAFC's National Farm Stewardship Program (NFSP) provided cost share funding for a suite of cost effective beneficial management practices (BMPs) designed to improve environmental sustainability. Precision farming (PF) applications included GPS information collection, GPS guidance (i.e.: autosteer, lightbars, software), and manual and variable rate controllers for variable rate fertilizer application. PF applications were typically incented at. 30% of cost up to a maximum of $15,000 per producer. As shown in Table II, these practices accounted for 35.0, 34.8, and 26.8 percent of total program spending in Alberta, Saskatchewan, and Manitoba, respectively (Haak, 2010). These are large percentages when considering that the NFSP incented about 80 different BMPs. This would suggest that adoption of PF applications has continued to increase significantly since 2006.

Table II: NFSP Precision Farming Projects, Dollars Spent, and % of Total NFSP Funds spent on Precision Farming, from 2005 to 2008.

Province	Alberta	Saskatchewan	Manitoba
# of precision farming projects	2,464	3,915	2,637
$ spent on precision farming projects	$10,249,771	$13,934,529	$10,504,319
% of NFSP funds in each province spent on precision farming	35.0	34.8	26.8

As shown in Table I, using GPS as a guidance or tracking system is by far the most widely used application (Haak, 2010), despite being a relatively new use. This is not surprising given the relative ease of implementation and assessment of economic benefits. A recent AAFC directed study by the George Morris Centre estimated economic benefits of auto steer by integrating literature values of overlap reduction with crop budgets from Ontario and Alberta (see Table III). For Ontario they found crop input savings of $8 to $22/acre and breakeven acres ranging from 183 to 509 to offset GPS fixed costs (Mussell and Schmidt, 2009) . In Alberta the crop input savings were lower and breakeven acres higher, because of less intensive cropping systems.

Table III: Economic Impacts of Auto Steer

Province	Crop	Annual Crop Input Savings [1]	Break Even Acres [2]
Ontario	Soybeans	$8.10	509
	Winter wheat	$12.90	320
	Corn	$22.60	183
Alberta	Spring wheat	$3.20	1,282
	Canola	$5.10	1095
Manitoba	Potatoes	$22.25	186

Notes: [1] Does not include additional benefits such as reduced operator fatigue, ability to work at night, less labour, improved yield, and reduced equipment depreciation.

[2] Acres required to balance annual crop input savings with annualized fixed cost of a mobile RTK based GPS equipment.

(Source: Mussell and Schmidt, 2009)

An additional AAFC funded study by the Prairie Agriculture Machinery Institute (PAMI) involved a preliminary assessment of the reduction in theoretical overlap as a result of using auto steer compared to manual steer in different field scenarios. Overlap for manual steer was normally calculated by comparing the actual acres covered by manually operated field equipment (as determined by an acre counter) with the actual field area as determined by GPS measurement or crop insurance records. For the auto steer system overlap was estimated using a computer desk top analysis of a georeferenced image of the same fields. In this analysis side to side overlap was assumed to be zero except for the final pass. Perimeter overlap calculations were based on the assumption that 50% of the unit width overlapped into the headlands previously travelled. Obstacle overlap calculations were based on the assumption that 60% of the unit width overlapped a previously travelled headland pass around the obstacle as this was the worst case found in modeling. The modelling assumed that the operator would override the auto steer when manually initiating a headland turn at an optimum point.

While all scenarios resulted in overlap reduction, the magnitude varied considerably depending on equipment width, number of obstacles, and field size and shape (Gregg et al., 2008). Despite this variability, the PAMI study didn't come close to capturing the diversity and complexity of factors influencing the change in overlap between manual and auto steer guided systems. Therefore, AAFC is proposing to conduct more detailed assessment in this area. One of our goals is to ultimately develop a computer tool that would determine optimum direction and pattern of field equipment travel given various inputs such as a field boundary / obstacle map, digital elevation model, and field equipment size. Included in this tool would be the capability to assess the impact of changing various inputs, such as squaring off sinuous field or obstacle boundaries.

Another, completely different type of GPS application, involves variable rate nutrient application (VRNA). Despite being available to producers since the early 1990's a relatively small percentage have implemented VRNA (Haak, 2010). At an early stage scientists in Saskatchewan recognized that understanding both spatial and temporal variability was critical to making VRNA succeed (Beckie et al., 1997 and Pennock, et al., 2001). Spatial factors are related to soils and landscapes, while temporal factors are dominated primarily by weather. A surge in research and demonstration projects in the 1990's addressed primarily the spatial factors, which provided some positive findings that producers could capitalize on. For example, areas with low levels of salinity can now be properly identified and mapped using GPS based diagnostic tools such as EM conductivity meters. This typically results in a significant cost saving due to reduced fertilizer application.

Temporal factors have not been adequately assessed, likely due to their uncontrollable nature, despite being a major constraint especially in regions with highly variable weather. Nevertheless, a greater understanding of temporal variability could lead to better fertilizer recommendations using delayed or split applications. Real-time and in-crop variable rate applications of nitrogen to account for spatial and temporal variability have been investigated with the optical Greenseeker sensor technology since 2005 at Indian Head, Saskatchewan (Holzapfel, 2009). With this technology a single pass at the 5-6 leaf stage in cereals or mid-bolting stage in canola measures NDVI reflectance from the crop canopy, and instantaneously calculates and applies an appropriate rate of nitrogen. Algorithms used to make this calculation estimate crop yield potential and compare the values to a non-nitrogen limiting area in the field. From this information, the sensor then adjusts N applications across the field based on the reflectance values recorded by the sensor. Research has shown that applying 50-66% of target N rate at seeding time greatly reduces the risks associated with using post-emergent nitrogen technologies.

In spite of a reduction in research after the 1990's in the Canadian prairies and ongoing challenges and uncertainty of benefits, the private sector has continued to promote and develop VRNA mainly through crop consultants. Recently, there has been an attempt to recognize and quantify the greenhouse gas reduction benefits of VRNA through a carbon credit protocol in the province of Alberta (Alberta, 2010). Given the continued interest amid unanswered questions, AAFC is proposing to undertake a thorough assessment of VRNA in Canada.

The objectives of AAFC's proposed assessment of both GPS tracking and VRNA include:

- quantifying the current and potential benefits of these applications
- identifying research priorities to address key challenges and opportunities for further advancement
- providing improved information and decision support tools to help producers design, implement, and measure the impacts of these applications.

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