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EVALUATION OF EMISSION REDUCTIONS AND COST SAVINGS IN SECTIONAL CONTROL AIR SEEDERS, DRILLS, AND SOWING EQUIPMENT ACROSS THE CANADIAN PRAIRIES

ON BEHALF OF

THE ALBERTA PULSE GROWERS COMMISSION

March 5, 2020

Alberta

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Humboldt, Saskatchewan

Phase 1

Research Report

Evaluation of Emission Reductions and Cost Savings in Sectional Control Air Seeders, Drills, and Sowing Equipment across the Canadian Prairies

For:
Alberta Pulse Growers
Leduc, Alberta

PAMI
Innovative Solutions
for Agriculture and Beyond

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Katelyn Gaetz, B. Sc. Ag., A. Ag
Project Leader

Lorne Grieger, P.Eng.
Project Manager, Agricultural R&D

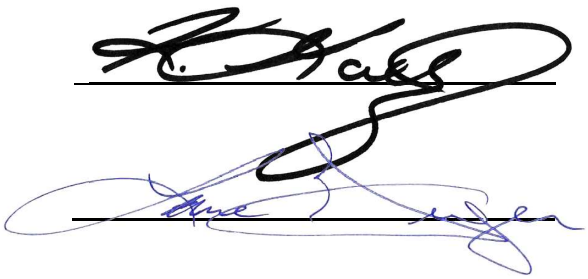

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Table of Contents

1. Introduction

Agricultural technologies have been rapidly evolving with the adaption of new, innovative ideas that lead to more productive and sustainable farming practices. These technologies have led to the use of larger equipment in Western Canada. Sectional control has also changed from manual to automatic implement shut-off options and a narrowing down to specific section sizes. Currently, the most precise automatic sectional-control technology on the market is individual opener control, which is capable of shutting off and/or varying the product (seed, fertilizer, etc.) being sown from the machine and raising individual openers out of the ground over previously seeded areas.

Automatic sectional control technology first appeared on the market around 2008 and has since made its way onto many Canadian farms. Across Western Canada, it is not uncommon to find misshapen field boundaries as well as in-field obstacles (tree bluffs, sloughs, rock piles, etc.). These obstacles lead to a greater opportunity for seeding overlap, as the equipment operator must manoeuvre around these points. To manage this overlap, manufacturers have made this technology available on most sowing equipment.

To reduce input costs and economic losses, overlap has been the main focus of sectional control. Seeding a previously seeded area can result in adverse effects. During seeding overlap the soil, where the seed and fertilizer are already in place, is disturbed when the openers are dragged through. As well, nitrogen fertilizers have been related to nitrous oxide (N_2O) emissions, which could potentially leach into the soil and run off into water systems. By reducing overlap, better nitrogen management is established, making it possible to mitigate potential losses while also achieving a net benefit for the environment.

The use of sectional control technologies has been proven to show benefits in combatting seeding overlap. Phase Two of this project will include a comparison of some different sectional control technologies via field testing, an analysis of cost savings and other associated benefits to reducing overlap, as well as the identification of potential positive environmental effects.

2. Project Objective

Phase One of this project involved conducting a literature review of currently available original equipment manufacturer (OEM) and aftermarket (AFT) sectional control technologies for air seeders, drills, and sowing equipment available in the Canadian Prairies.

3. Sectional Control Technologies

Many seeding implements now come equipped with automatic sectional control as an included feature. With the advance of agriculture technology, GPS systems have the ability to display multiple features to the equipment operator about the current task being performed. This tool is also used to show overlap percentages calculated through the GPS and display them on the monitor. Incorporating automatic sectional control allows benefits to be seen in real-time when comparing the field with the different technologies on a year-to-year basis. This section will aim to compare equipment with no sectional control to equipment with sectional control and equipment with sectional control plus automatic lift technology. Future technologies will also be discussed. **Figure 1** shows different sectional control methods as they relate to double-planted areas.

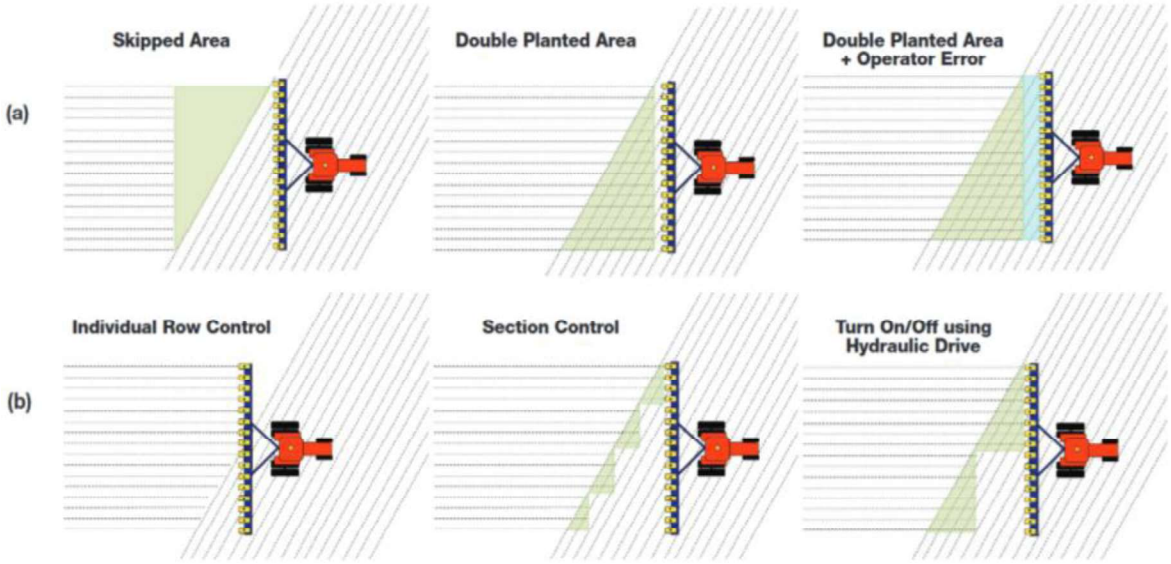

Figure 1. Comparing different methods of sectional control options (Runge, Griffin, Fulton, Virk, & Brooke, 2014).

Since 2008, many manufacturers have added sectional control technology as a standard feature to their equipment, as well as other companies developing AFT add-on options. This technology has evolved to better suit current farming operations in areas such as controllable section sizes, advanced product delivery systems, and accurate product distribution. By turning on and off the sections, product rates must be controlled to distribute accurate product amounts through the correct sections. **Table 1** displays a brief summary of the sectional control technologies available in Western Canada. These technologies are further explained in detail in **Section 3.1** to **Section 3.4.**

Table 1. Sectional control technologies in Western Canada.

Manufacturer	Sectional Control Technology	Attributes	OEM or AFT	Auto-Lift (y/n)	Sections Controlled
Bourgault Industries Ltd.	Auto Section Control (ASC)	knife-valve system, product rate adjusted on secondary manifold	OEM	n	6, 8 or 10
Bourgault Industries Ltd.	LiftMaster*	add on to auto lift/ lower implement at headlands	OEM	y	up to 10
Case IH (CNH Industrial LLC)	AccuSection	controls and meters each primary run separately	OEM	n	up to 4
Deere & Company	John Deere Section Control/ SectionCommand	software to control individual sections	OEM	n	up to 8
Intelligent Agricultural Solutions	Engage Zone Control	AFT add-on installed under meter housing, uses electric motors to actuate slide gates	AFT	n	up to 8
Morris Industries Ltd.	Input Control Technology (ICT)	metering wheels engaged/ disengaged individually by drive system	OEM	n	up to 10
New Holland Industries (CNH Industrial LLC)	IntelliRate	add-on kit to turn primary sections on and off (manual or automatically)	OEM	n	up to 8
Seed Hawk-Vaderstad	Sectional Control Technology (SCT)	individual meters controlled, knife openers lifted in sections	OEM	y	10 ft sections
SeedMaster	Auto Zone Command and FLIP	metering rollers controlled automatically by pneumatic cylinders	OEM	y	up to 10 (Nova cart) up to 5 (UltraPro)
TramRite	Controlled Seeding Systems (multiple)	AFT systems control product flow at slide gates	AFT	n	variable**

*technology refers only to mechanical aspect of raising and lowering implement sections

**sections controlled depend on the equipment the technology is installed on

3.1 No Sectional Control/Manual Lifting

Though sectional control is standard on most equipment in recent years, older equipment types have to be controlled manually to reduce overlap. This mostly includes lifting and lowering the entire implement at headlands to avoid overlap, reducing the chance of plugging the openers and to prevent disturbing previously seeded ground. Though lifting at headlands does aid in preventing overlap, there is still a very large risk of inaccuracy since the decision as to when to lift the implement rests with the operator. This risk increases with the use of larger equipment, as the difficulty increases while manoeuvering around the fields. This also does not account for misshapen fields where one part of the implement is passing a previously seeded area and the other part is not. This act of double (or more) applications to a specific area is why sectional control was created.

3.2 Multiple-Zone Section Control

The most common automatic sectional control technology available in Western Canada uses individual meters to control product flow. The equipment operator sets a predetermined look-ahead time, which allows the GPS to determine when that

implement will cross a previously seeded area. As the implement reaches that area, the meter associated with that section automatically shuts off to prevent product from being released.

Depending on the size of the drill, these sections range in number and width. Typically, section size is anywhere between 6 and 10 ft, with the number of sections increasing with the drill size. The section width is dependent on opener spacing and the number of sectional control zones available on the air cart. The greater the number of sectional control zones, the narrower the sectional control width for a given toolbar width. Product flow from each meter flows to a distribution manifold where it is directed to the individual openers. The distribution manifold has a fixed number of openers that it can service; therefore, narrower opener spacing has a corresponding narrower sectional control width.

An assumption can be made that field shape and size have the most significant positive impact on automatic sectional control savings, with smaller, more irregular fields showing a greater benefit (Rahman, 2018). Being able to cross over previously seeded areas and having specific sections of the implement shut off greatly reduces overlap.

Common multiple-zone sectional control technologies used in Western Canada are discussed below:

- **Morris Industries Ltd.** uses **Input Control Technology (ICT)** to disengage individual metering wheels to stop product flow and control up to ten sections, averaging around 8 ft each (depending on drill size) (Morris Industries Ltd., 2020). The Morris metering system stays primed after shutting off the product flow, unlike others that purge remaining product.

- **The Bourgault Dual Auto Section Control (ASC)** system shuts down product flow while cleaning the lines (with air) to ensure all product is purged from six, eight, or ten individual sections (section size depends on equipment size) (Bourgault Industries Ltd. , 2020). The dual-auto section control refers to being able to control both the seed and fertilizer at different times. However, this system does not shut off product flow by the meters but uses a knife valve in the air line to divert the airflow and stop product flow. In the sections that are engaged, the auger speed is adjusted to place the correct product rate on the secondary manifold (Bourgault Industries Ltd. , 2020), ensuring that no extra product is being pushed through the engaged sections when others are shut off.

- **Case IH** uses **AccuSection** to control the meters using individual electronic meter drives, automatically shutting off up to four sections when crossing previously seeded areas (Case IH Agriculture, 2020). This technology is also used in planters as well as sprayers.

- **John Deere** uses a GreenStar software application of **John Deere Section Control** to turn on and off implement sections that help the crop achieve its highest yield potential (Deere & Company, 2020). Like others, this technology allows for product shutoff when the GPS crosses previously set boundaries for areas that are not to be seeded. This technology can control up to four sets of implement sections through the GreenStar software activation (Deere & Company, 2020). **SectionCommand** is the name of the metering system that controls output from each meter. Up to eight sections can be controlled by opening and closing the gates on the meter, which, similar to the Morris ICT, stays primed so there is no interruption of product flow when the section is turned back on (Deere & Company, 2020).

Aside from equipment that includes sectional control as a direct option, there are some commercially available add-on technologies. Add-on options allow for producers to use the technology without having to purchase a new seeding implement.

- **Intelligent Agricultural Solutions** created the AFT add-on product **Engage Zone Control** specifically designed for John Deere air carts. By using electric motors to control the slide gates, this technology allows up to eight sections to be controlled per tank (up to three tanks per cart) without having to purchase a new drill to take advantage of this technology (Intelligent Ag, 2017).

- **New Holland** also has an add-on sectional control kit available to the market. These kits are available for P series New Holland air hoe drills and air disk drills, providing half-width sectional control across the drill, controlled by the Intelliview™ software. (New Holland Agriculture, 2014). All Flexi-coil P Series air carts come with manual sectional control, which can be connected to a GPS and controlled through **IntelliRate**. This system can control up to eight primary product runs (New Holland Agriculture, 2020). In utilizing the Intelliview™ software, the operator can choose to manually control the sections or connect through the GPS to engage automatic section shut off.

- **TramRite's Controlled Seeding Systems** provide AFT options for air seeders, air drills, and planters. These systems were designed to add sectional control to numerous implements by different manufacturers. Some examples of these systems include; control boxes for controlling the slide gates, adjustable slide gates for partial opening (spacers added to the free rod end of the cylinder), and control at the distribution towers by Y-diverters to divert the seed into a vacuum line (TramRite, 2019). These seeding systems are controlled by the associated GPS sectional control program through the monitor.

3.3 Sectional Product Control and Automatic Lift Technology

Along with sectional control, automatic implement lifting technology helps to prevent ground disturbance. Since the implement is capable of automatically lifting and shutting off product over previously seeded areas, this means less work and stress for the equipment operator.

The following automatic implement lifting technologies are currently available in market:

- **SeedMaster** uses **Auto Zone Command** and **FLIP** (Full Last Implement Pass) technology to control up to ten zones on their Nova carts and up to five zones on their UltraPro tanks, while Auto Lift raises and lowers openers across the entire toolbar (versus lifting and lowering individual sections) (SeedMaster, 2020). This Auto Lift technology raises the entire implement at the headlands, reducing the opportunity for operator error. The FLIP technology refers to a second headland being virtually established on the monitor beside the initial seeded headland, which is seeded after the entire field is done to account for reduced overlap and compaction caused by driving over previously seeded areas (SeedMaster, 2020). Essentially this leaves a "buffer" area for the equipment to turn around on unseeded land.

- In 2008, **Seed Hawk** was the first on the market with their **Sectional Control Technology (SCT)**. This technology stops product flow at individual metering units and lifts the openers in 10 ft sections when the implement crosses previously seeded ground (Vaderstad North America, 2020). This technology allows the product flow to stop to reduce overlap as well as the action of lifting the openers, which results in less ground disturbance in the previously seeded area. The ability to individually and automatically lift the sections out of the ground accounts for even less ground and seed bed disturbance to the previously seeded areas.

The option to include auto lift sectional control systems without the need to purchase new equipment is very beneficial to producers who wish to take advantage of the technology. **Bourgault** introduced its **LiftMaster** system, which is an add-on kit that automatically raises and lowers the openers at headlands (Bourgault Industries LTD., 2020).

3.4 Future Technologies

Precision agriculture is quickly evolving to enhance productivity with less stress on the producer. Many technologies have been created to support this. Curve compensation is a technology that is beginning be made more readily available in the market. This technology allows for an increase or decrease in product amount across the implement width while turning to evenly apply the product at the correct rate. While cornering, the outer end of the implement travels much faster than the inner end, so the product must

be distributed evenly. This technology is not a new concept; however, it is not a common feature across all sectional control products.

The agriculture industry is rapidly advancing in terms of technology and is aiming toward more productive and sustainable farming practices. **Clean Seed Capital Group** based in Burnaby, British Columbia, has developed a new revolutionary seeder, the **CX-6 Smart Seeder**. This seeder includes six-product digital metering for each independent opener, essentially making each row an independent six-product variable rate drill (Clean Seed Capital, 2020). This technology allows for row-by-row control of product and true overlap protection, as each row's meter is controlled. The CX-6 Smart Seeder also has accurate turn compensation that adjusts the products in each opener row to maintain consistent product inputs (Clean Seed Capital, 2020). This is the most precise overlap system currently operating in Western Canada.

Planters have been piquing the interest of Western Canadian farmers because of their accuracy. Previously, planters were purchased to aid in accurate corn and soybean planting and are often seen in the United States. Today, planters are used with multiple crop types and are being adapted to accurately place smaller seed, which is beneficial to producers who can utilize it for multiple crops. Though planters are not new to the agriculture market, they are on the rise in Western Canada. When planters shut off the product flow, they cut off the vacuum at the seed disk forcing the seeds to drop back into the seed meter's pool (Ag Leader, 2010). Current companies offering automatic sectional control preinstalled in their planters include AGCO/White, Case IH (CNH), Horsch, John Deere, and Kinze. Aftermarket add-ons are also offered for planters by companies including Ag Leader, Precision Planting, Raven and Trimble (Runge, Fulton, Griffin, Virk, & Brooke, 2014). Planters are thought to be more precise when it comes to seed placement and uniformity; however, there can still be issues with overlap if sectional control is not being used. It has been stated that by cutting a rectangular quarter section in half diagonally to two triangle-shaped pieces, a 12-row planter can cause overlap up to 2 acres in size (Nowatzki, 2010). Adding in misshapen borders and in-field obstacles increases overlap, which is what a common field in Western Canada looks like. With the growing interest in planters in Western Canada, this is another option available to producers that includes sectional control technology. Curve compensation technology is a more common feature on planters than seeders. **Figure 2** displays an in-field image of individual opener, sectional control planting technology. This shows how utilizing sectional control can result in minimal overlap.

Figure 2. Individual opener sectional control from a planter (Precision Planting, 2020).

4. Overlap Effects

4.1 Input Costs

Farming inputs account for a very large portion of the total costs for an operation. Farmers spend a lot of time and consideration choosing the best products for their farms; however, these do not come free. Seed, seed treatment, fertilizer, herbicide, fungicide, and insecticide are a few main inputs that are common across most Western Canadian farms. There are many publicly available sources of up-to-date farming production costs to help producers better understand total inputs and to estimate cost savings from overlap reduction, such as Alberta Agriculture and Forestry (Alberta), The Crop Planning Guide (Saskatchewan), and Crop Production Costs (Manitoba). The cost benefits vary based on field complexity (e.g., a perfectly square field will show less of a benefit than a misshapen field with many obstacles).

There have been many claims in the industry regarding savings when using overlap technology, which has been mostly generated by producers. Though it is very difficult to measure precise savings of sectional control technology due to the many unique field situations, the common result is that when used and managed properly, sectional control can result in cost savings.

As a simple example, if a producer is able to reduce their overlap by 3%, this can have a significant impact on cost savings. If the producer grows 2,500 acres of canola, based on the 2020 Crop Production Costs guidelines inputs (seed, seed treatments, fertilizer, chemical) of approximately $175/ acre, this could result in savings of over $13,000 in that year alone (Manitoba, 2020). Though this number drastically changes from field to field, there is much evidence supporting input and cost savings when using this technology in combination with logistical strategies for preventing overlap. **Figure 4** demonstrates an area in a field that had been double seeded.

(a) (b)

Figure 4. Automatic row control (a) versus double seeding (b) (CNH Industrial America LLC. , 2020).

4.2 Crop Effects

Double inputs can have certain negative effects on the crop. Excessive seed population as well as product application can negatively affect some sensitive crops, which typically reduces yield (Deere & Company, 2020). Too much fertilizer can lead to green seed as well as lodging. When a crop lodges, it creates difficulty during harvest, which can ultimately lead to crop being left in the field after harvest. Also, higher seeding rates can increase plant density and create a warm, humid environment that is more susceptible to disease development. Due to this, spray timing is a risk, as the producer may miss the optimal spray window because of disease development timings. By reducing overlap, one can assume greater field uniformity and ease of spray and harvest timing decisions, both of which would provide the producer with a higher-yielding crop and improved return on investment (ROI).

4.3 Environmental Effects

Overlapping can increase some negative environmental impacts. Mobile nutrients in fertilizers (i.e., nitrogen in the NO_3^- form), as well as some forms of herbicides, move with water. If a product is overapplied and the plant does not take it in, the nutrient can leach into groundwater and other water systems causing detrimental effects on the water chemistry as well as eutrophication. In overapplying products, what is not used by the established plants will be left in the soil or moved through to other areas via waterways.

To improve field efficiency, many producers look to remove these obstacles as opposed to being forced to manoeuvre around them (removing rock piles, draining sloughs, cutting down tree bluffs, etc.). These areas provide habitat for pollinators, predators, and parasitoid insects, which increases overall biodiversity (bees, bats, birds, butterflies, small mammals, etc.).

These obstacles also play a role in how the field responds to weather events, depending on size. Tree bluffs or “shelter belts” are great for capturing moisture, shielding winds and hail, as well as reducing the risk of erosion with extensive root systems. Yield has been shown to increase with more non-crop land cover within or near these boundaries (Galpern, Vickruck, Devries, & Gavin, 2019). **Figure 4** shows how shelter belts reduce wind impact.

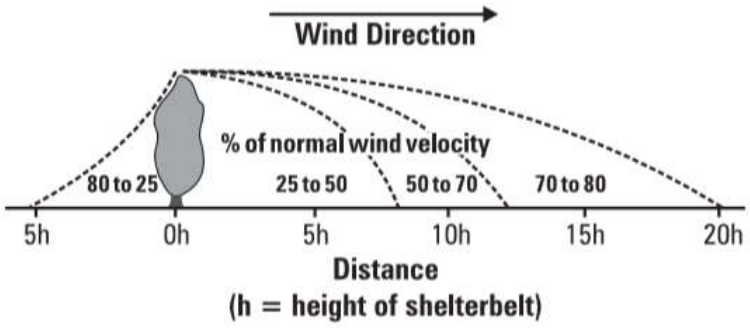

Figure 4. Reduction of wind velocity by a shelter belt (Casement & Timmermans, 2017).

By leaving the obstacles in the field and using technologies such as sectional control to mitigate overlap, the entire field can benefit in terms of environmental health and overall sustainability.

5. Conclusion

Sectional control is available through many different manufacturers and found as an available tool on almost all new seeding equipment. It is a technology that has been adopted by many producers to help reduce input costs and increase productivity in individual farming operations. Incorporating this technology has proven to show many benefits, unique to different farming operations. Phase Two of this project will study some of these technologies in the field to further understand the benefits of sectional control.

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For further information with regards to this report, please contact:
Katelyn Gaetz at kgaetz@pami.ca

Saskatchewan Operations
Box 1150
2215 – 8th Avenue
Humboldt, SK S0K 2A0
1-800-567-7264

Manitoba Operations
Box 1060
390 River Road
Portage la Prairie, MB R1N 3C5
1-800-561-8378

Corporate Services
Box 1150
2215 – 8th Avenue
Humboldt, SK S0K 2A0
1-800-567-7264