Genesis Crop Systems Inc
Project Report

MEASURING IMPACTS OF BLUEFIELD SEEDING SOLUTIONS SEED SENSING TECHNOLOGY ON MEETING PEI's NET ZERO GOALS AND ON OVERALL FARM PRODUCTIVITY ASSOCIATED WITH PEI POTATO PRODUCTION

January 27, 2024

Introduction

A privately funded precision agriculture project led by Steve Watts – Genesis Crop Systems Inc (GCS) and Evan MacDonald – Precision Agriculture Specialist in comparing potato planters using Bluefield Seeding Solutions' Seed Sensing Technology™ (SST) press wheel system in 2022 revealed that a potato producer adapting this technology could increase potato planter ground speeds while planting the crop without any negative impact on crop yield or value. In fact, when considered from current French fry processing and fresh market outlets, the research team concluded that the farmer participating in the trials increased the overall value of their crop by >$100 and $600 per acre for French fry and fresh market potatoes, respectively.

Although these results appeared promising from an agronomic and economic perspective, the research team was curious to understand what effect this adaptation might have on fuel consumption and overall Green House Gas (GHG) emissions associated with planting the potato crop, and what the overall impact might be if the majority of PEI potato farmers were to adopt the technology.

Subsequently, the team engaged West Point potato farmer Jonathan MacLennan – MacLennan Properties (MP) and initiated a new precision agriculture project on behalf of the PEI Potato Board and funded by the PEI Climate Challenge Fund to further confirm the impacts of installation of the SST on seed placement

accuracy and overall crop value but also on the effect of the SST technology on Greenhouse Gas Emissions associated with planting the potato crop and Nitrogen nutrient use efficiency considered from an N input/crop value viewpoint.

Methodology

Upon project approval, MP purchased and installed the SST kit on their 6 row Grimme potato planter.

The team identified five unique fields/planting speeds/variety combinations that would provide a wide scope of results that should be representative of the majority of PEI potato farmers.

While planting the trial fields, MP adjusted the planter speed as follows; grower standard practice – GSP (the speed the planter usually operated at for that particular variety and end use - Note that farmers planting potatoes for seed use plant at higher plant populations/tighter in row spacing intervals, and therefore travel at slower ground speeds while planting). Additional treatments implemented depended on the individual field in particular and ranged anywhere GSP+15% - GSP++60%.

The tractor operator could observe and record fuel consumption for any particular planting speed on a gal/hour basis with in cab monitoring equipment as well as seed placement accuracy with the SST display – *figs 1, 2*.

MP established trials at five sites; each containing three treatments (various planting speeds per site eg. 3, 4 or 5 mph).

Shortly after plant emergence, Evan MacDonald conducted low level drone flights over each treatment in each field. Drone data was processed using Solvi and analyzed in QGIS software to assess several metrics including: plant spacing accuracy, plant spacing consistency, % gaps, and canopy cover percentage. This technology allows for collecting large samples of data. Over 160,000 individual plants were counted and assessed in this trial with drone technology. Prior testing of this technology as part of

Evan's PhD project at UPEI revealed that plant counts and spacing analysis from drone imagery is > 97% accurate compared with manual measurements from the field.

It is important to note that the drone only acknowledges already emerged plants at the time of the survey. In some cases, uneven emergence can skew data if fields are surveyed too early. Nonetheless, this can be considered an "apples to apples" comparison, as every treatment within a field was surveyed at the same time.

Fig 1: In cab fuel consumption monitor; gal/hour parameter used for GHG emission calculations gcs2023

Fig 2: BSSI in cab seed placement accuracy monitor gcs2023

Just prior to commercial harvest, the team hand harvested four X ten ft strips from each treatment in each field. Tubers were placed in GCS storage and later evaluated for tuber size distribution, tuber number/plot and overall tuber quality. Data from this exercise was used to calculate overall crop value for all treatments.

Fuel consumption and planting speed data recorded during the planting process was used to calculate potential area planted per hour, diesel consumption on a per acre and per hour basis and ultimate CO2 emissions associated with any treatment at any site using the formula below:

1 liter of diesel weighs 835 grams. Diesel consist for 86.2% of carbon, or 720 grams of carbon per liter diesel. In order to combust this carbon to CO_2, 1920 grams of oxygen is needed. The sum is then 720 + 1920 = 2640 grams of CO_2/liter diesel.

Nitrogen use efficiency based on units of N applied vs crop value was calculated for each treatment.

Results

All raw data is provided in the attached Appendices 1 & 2.

Drone Analysis

Drone results from this trial revealed that planter performance was not compromised with GSP+ and GSP ++ treatments compared to GSP. It should be noted that at one site there were significant issues with uneven emergence and small plant size at the time of survey (Clearwater seed field). We have left that site out of the drone analysis section.

There were no differences between treatments when comparing target vs measured spacing. In terms of assessing planter consistency, GSP + and GSP ++ treatments had the lowest standard deviation (plant spacing) at 3 out of 4 sites. GSP had the lowest number of “gaps” at 3 out of 4 sites. In this case, a gap was considered anything greater than 20” between plants. Regarding canopy cover percentage, GSP + performed best at 3 out of 4 sites. There is often a correlation between early season canopy cover percentage and yield, and that was the case in this trial.

Yield Analysis

All raw data is supplied in the attached Appendix 1. As the planting speed increases were not consistent for all fields (eg GSP, GSP+20%, GSP+33% vs GSP, GSP++33%, GSP++60%), treatments are reported as GSP, GSP+ and GSP++. Note that two of the fields were planted for processing purposes, so marketable yield values include all tubers > $1^{7/8}$" dia less any off-type tubers; the remaining three fields were planted for seed purposes and seed yield includes all tubers less than 10 oz weight,

In general, Jonathan MacLennan reported that he felt the SST technology provided great value to his potato farm in that it

allowed him to use the seed placement monitor (fig 2) to dial in the most efficient planting speed for any particular field/variety/seed lot combination.

Crop Yield vs Planting Speed

At most sites there was little if any penalty in total or marketable yield values associated with increasing planter speeds as described above (figs 3&4, respectively). In some cases, yield values actually increased from a numerical sense when operating speeds increased over GSP values.

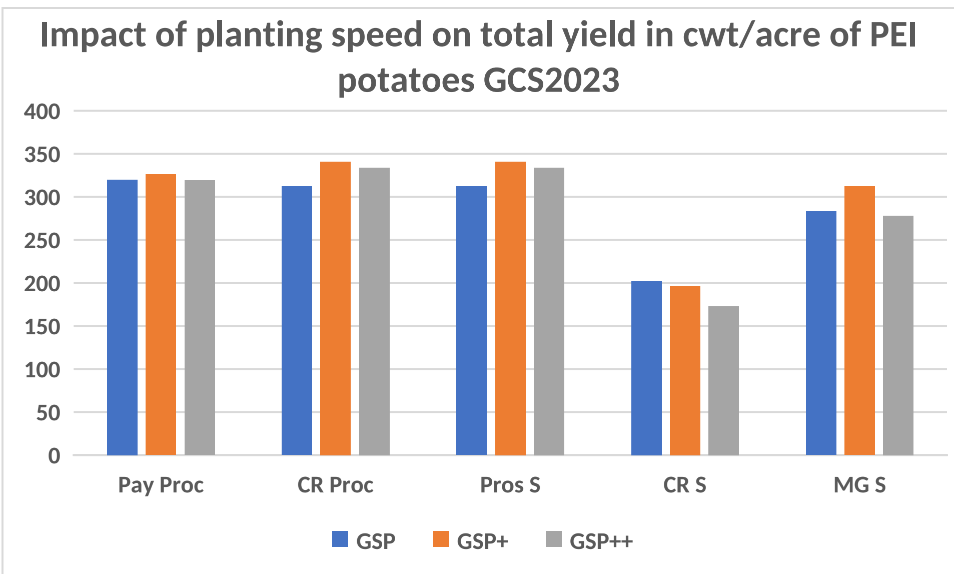

Fig 3: Impact of planter speed on total yield in cwt/acre on PEI potatoes – Pay Proc=Payette Russet *processing*, CR Proc=Clearwater Russet *processing*, Pros S=Prospect *seed*, CR Clearwater Russet *seed*, MG S=Mountain Gem Russet *seed* gcs2023

There were no statistical differences in yield between treatments. GSP + had the highest marketable yield at 3 out of 5 sites. In terms of crop value, over the 5 trial sites, GSP + average value was $5,011/ac. GSP ++ was $4,724/ac and GSP was $4,473/ac. These figures were calculated using contract specifications and grading data from harvest strips.

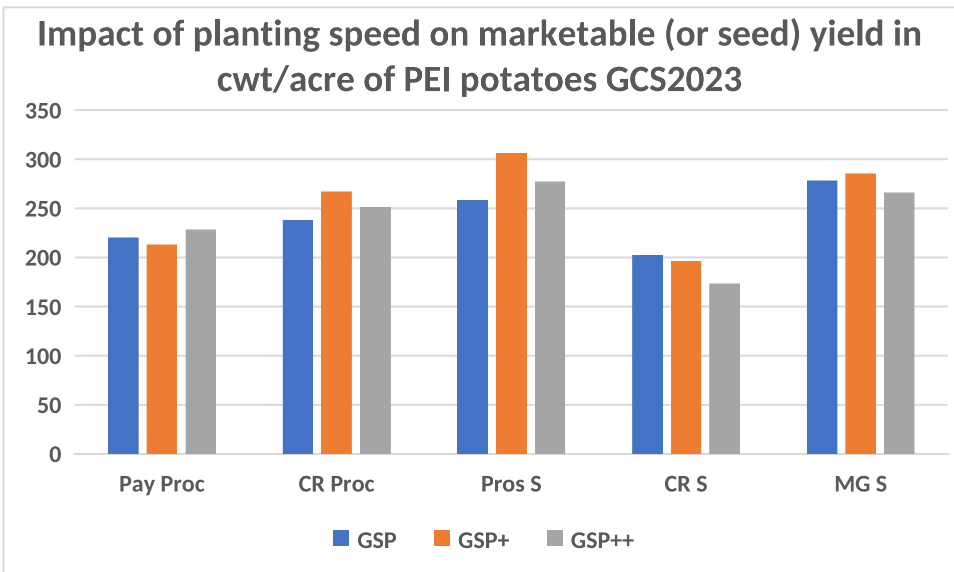

Fig 4: Impact of planter speed on marketable (or seed) yield in cwt/acre on PEI potatoes – Pay Proc=Payette Russet *processing*, CR Proc=Clearwater Russet *processing*, Pros S=Prospect *seed*, CR Clearwater Russet *seed*, MG S=Mountain Gem Russet *seed* gcs2023

N_2O Emissions vs Planting Speed

The GHG emissions values calculated based on tractor monitoring equipment did not equate with those expected at all sites – fig 5. Sites CR proc, Pros S and MG S would be more reflective based on previous observations and the fact that an increase in tractor

operating speed should not result in a linear increase in tractor fuel consumption. It may be possible that the monitor measuring fuel consumption screenshots may not have been consistent in all cases (eg slope of travel or quantity of seed in seed bunker at time of screenshot). On average, however, there was a 4-5% reduction in CO_2 emissions on a per acre basis when comparing GSP+ and GSP++ to GSP operating speeds during potato planting operations.

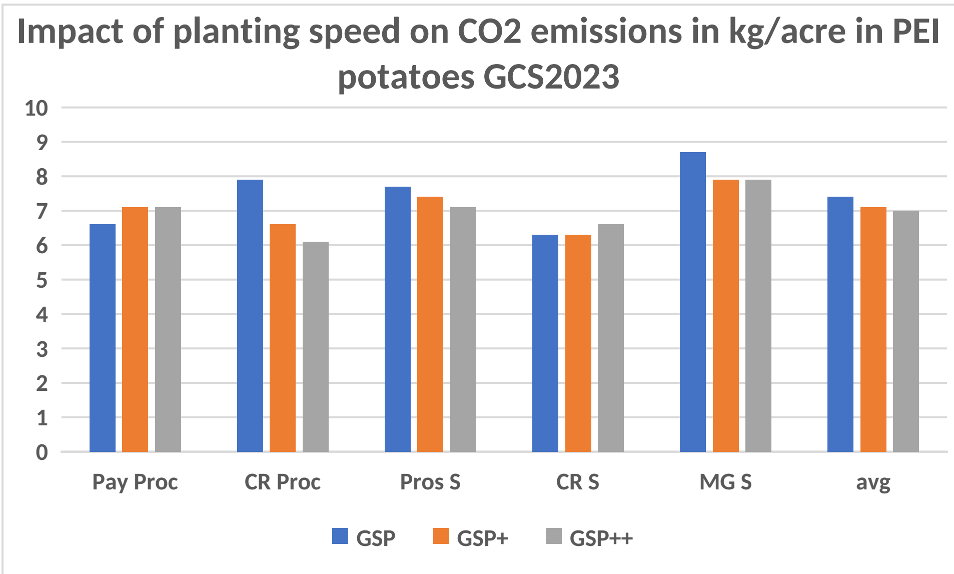

Fig 5: Impact of planter operating speeds on CO2 emissions in kg/acre associated with planting PEI potatoes gcs2023

Increased planter speeds resulted in an increase in acres planted per hour in all cases - fig 6. Increases ranged from 22% to as high as 62% above the current GSP planting speeds depending on the field/variety/seed lot in question. This could result in reductions of 16 – 23 hours of planting time on a 600 acre farm with a mixed variety/plant population scenario.

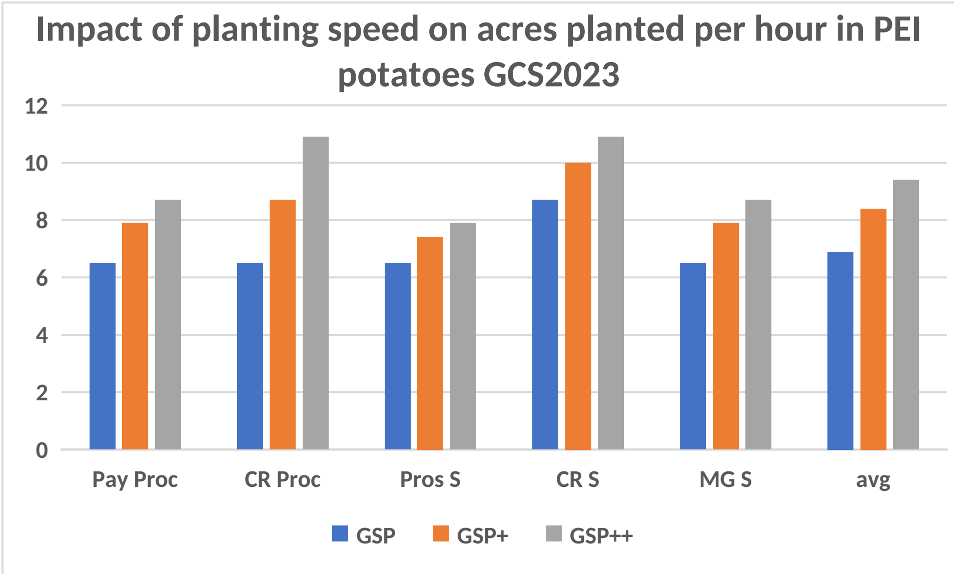

Fig 6: Impact of planter operating speeds on acres planted per hour on PEI potatoes gcs2023

When considering increase of planting speeds on potential changes in crop value, all sites except CR S had similar or higher crop values than the GSP planting speeds fig 7. It is possible that the length of growing period (planting – crop desiccation) was simply not long enough for the Clearwater seed field to reach a higher yield level as the CR Proc field did show a positive response in this regard.

There may be several ways to report overall nutrient (in this case nitrogen use efficiency – NUE), one approach is to consider crop revenue in $/acre vs lbs nitrogen applied to attain this revenue. Although NUE values for the two processing fields appear lower (fig 8), these are reflected via lower prices in general for processing potatoes in general plus the fact that most processing potatoes require higher amounts of nitrogen fertilizer to produce yields and quality required by the customer.

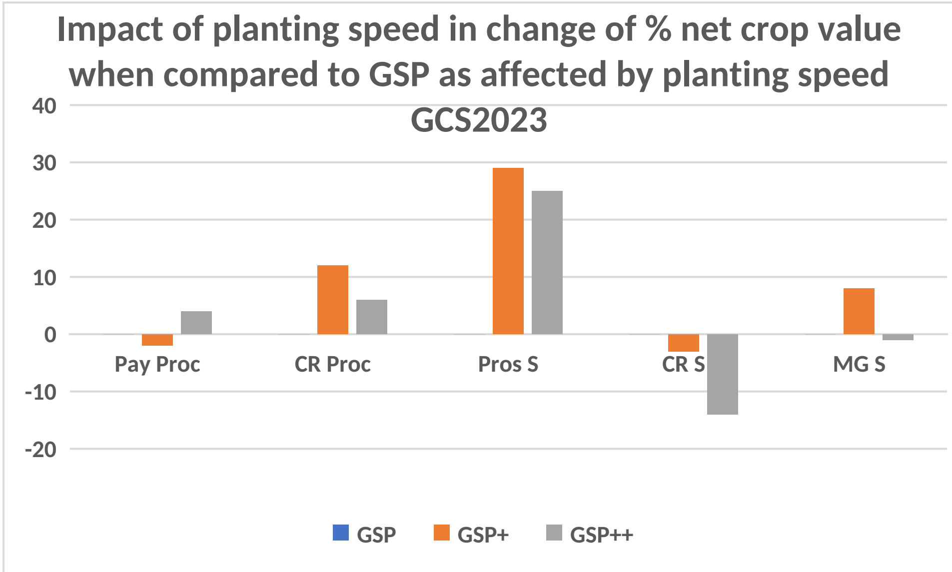

Fig 7: Impact of planter operating speeds on change in net crop value when compared to GSP speed in PEI potatoes gcs2023

NUE values were higher in a couple cases (Pros S; GSP+ in MG S) treatments and relatively flat in the two processing fields. Clearwater S results are more or less related to comments above in lower than average yield/crop values.

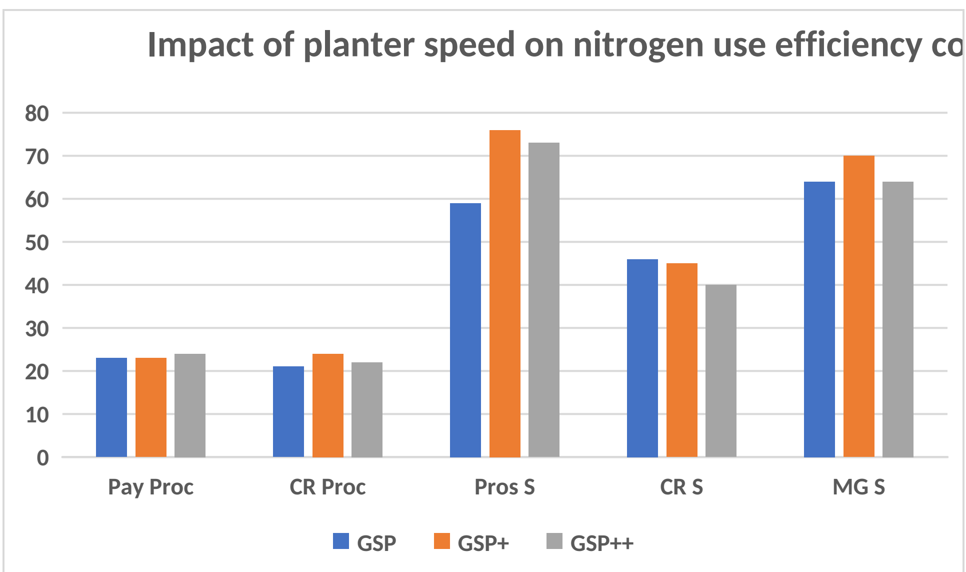

Fig 8: Impact of planter operating speeds on nitrogen use efficiency ($ crop revenue/lbs N applied) in PEI potatoes gcs2023

Conclusions

Installation of the Bluefield Seeding Solutions *Seed Sensing Technology* on a Grimme 6 row potato planter at MacLennan Properties farm in West Cape PE allowed the farmer to plant the potato crop at faster speeds while maintaining/improving crop yield and value than previously thought possible using past grower standard practice operation speeds.

These increases in planter speeds resulted in more efficient planting operations with no penalty in crop yield, quality or value in most cases with the possible exception of the CR S field.

Overall GHG emissions were reduced 4-5% on average across all sites. Although this may not seem like a significant reduction, every step counts towards the PEI potato industry helping agriculture and society in general meet their climate change adaptation goals.

In addition to providing an improved efficiency in planting operations, the technology also adds another incremental, although difficult to measure benefit to the farming enterprise; the notion of what a condensed planting operation time might provide in overall crop productivity. Consider that in some years a farmer may have 60-70% of their crop planted and then be faced with rain delay that in some cases may last longer than a week.

The project team wants to acknowledge and thank the PEI Climate Challenge Fund for providing monetary support for this project.