PRAIRIE PRECISION NETWORK INC.

INTER-ROW SEEDING GUIDE 2017

Contents

Purpose of this Guide

The purpose of this guide is to help with the establishment of an inter-row seeding program on a farm operation. It takes planning and proper management to make inter-row seeding successful. We have asked our customers who are currently doing inter-row for their input and also have referenced what we have learned in almost 10 years of interacting with inter-row seeding customers.

There are steps to follow to ensure the success of an Inter-Row program but nothing that cant be accomplished with some planning and forethought.

The results from Inter-Row are substantial and we have a few studies in the appendix portion of this guide. Our customers tell us anywhere between 5-15% yield increase since they have implemented the Inter-Row program on their operation.

We will cover what equipment is needed, why the need for RTK guidance, proper equipment setup and as well how to go about managing the data needed to be successful.

We hope that you find this guide beneficial!

Equipment Needed

GPS DRIFT

Something that everyone encounters with any entry level signal is GPS drift. This is where throughout the day the GPS receiver is accounting for position and calculation errors and causes the recorded line being used to “move” or drift. You usually see this when stopping to fill an air cart or sprayer and come back to the line and have to “shift” the line back to where you are located.

ALL entry level GPS signals have GPS drift. You may see it affect you one day and not the next depending on the direction of the drift. If drift is in an easterly direction and you are seeding east to west then you will not see the affects of drift that particular day. However if the GPS drift direction changes and goes north or south you will then some considerable drift depending on the day and where you are located. Another thing to consider is that GPS drift is not perpendicular to a direction heading or say 90 degree line. Meaning if you made an AB line with a compass heading, that heading accuracy will change when you come back to it. So a 90 degree line made one year will be a different 90 degree heading the next.

RTK accuracy eliminates this GPS drift by having a base station account for these errors in the GPS signal and send out the corrected signal to your machine. This allows for very high accuracy position-

RTK ACCURACY

For us to be able to come back to the same rows and achieve inter-row seeding success we need nothing more than to upgrade to RTK accuracy. There are other products on the market that steer the drill or follow a stubble row but our customers tell us that the simplest and most affective way to make inter-row successful is with RTK accuracy.

With PPN RTK accuracy and signal subscription a customer that is within coverage only need have RTK activated, a PPN Modem, active SIM card and an active network subscription. This is the most simplest and direct way to receive RTK corrections in Western Canada and Southern Ontario.

RTK EQUIPMENT

The following RTK equipment is needed to start down the path of inter-row seeding. All these items can be purchased from your local Prairie Precision Network Dealer.

- SF6000 RTK Ready receiver or equivalent (Figure 1)

FIGURE 1

- PPN Network Modem w/ Active SIM card (Figure 2)

FIGURE 2

- PPN Vehicle Kit (Figure 3)

FIGURE 3

Implement Setup

OFFSET CALIBRATION

Not very many seeding units pull straight and with lower guidance signals this is hardly noticed. As we move to a higher correction signal like RTK this offset becomes very evident (mostly because we want to widen out our tracking lines and take advantage of the full working width of the tool).

The important thing to consider here is that this will take time to determine the correct offset. Three passes in the field must be made to correctly measure the overlap and miss that is being observed. Once you are able to measure these then use the offset measurement guide to correctly calculate your "C" offset.

Other things to be aware of when trying to determine system accuracy, is how much the individual shanks move, correct leveling of a drill, opener wear, field conditions, tire pressure. Many things contribute to system accuracy and RTK will only highlight any problems you may have when trying to achieve greater accuracy in a field.

GREENSTAR IMPLEMENT SETUP

In the Greenstar menu, navigate to "H" or implement setup. Input your working width and tracking width. Make sure that these are the full width of the machine after you have measured.

Select the "Change Offsets" box (Figure 4)

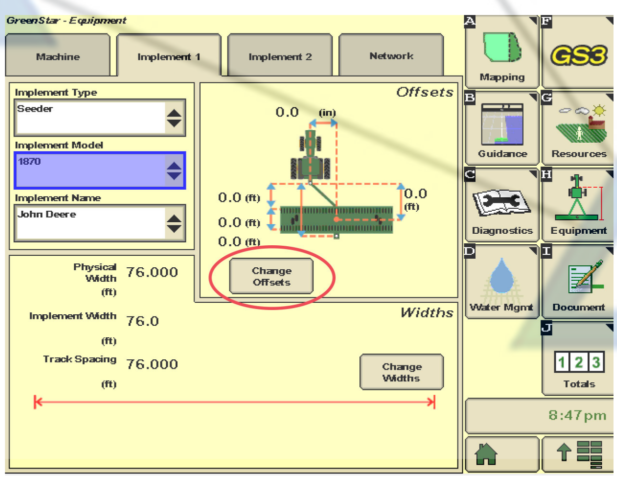

FIGURE 4

HOW TO CALCULATE IMPLEMENT OFFSET

1. MEASURE implement shank to shank and add one guess row, this is your TRUE implement width. Use this width as your implement and tracking width in Greenstar pages
2. MAKE three passes in the field to determine overlap/skip. Make sure to only measure overlap/skip once fully on Autotrac line and GPS error reads zero (Figure 7)
3. MARK down the overlap/skip that was recorded between all the passes. Divide this number in two and that will become your "C" offset in the Greenstar implement offset page.
4. The offset can be moved left or right as shown in the two pictures below. Select the button to move the offset from one side to another. (Figure 5 & 6)

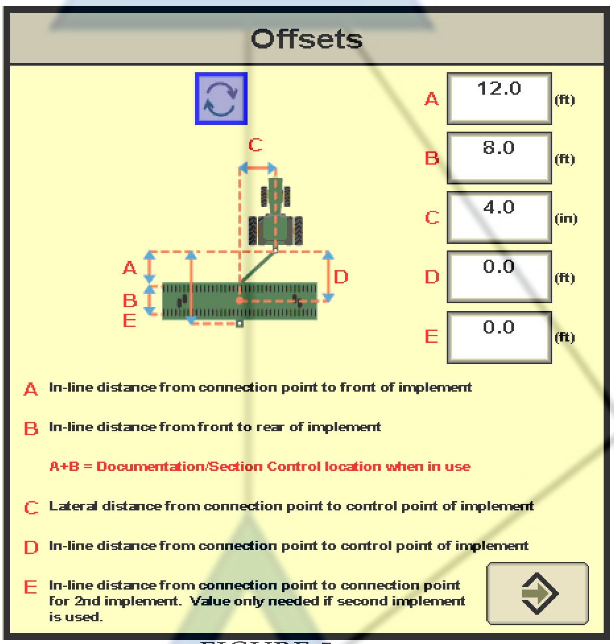

FIGURE 5

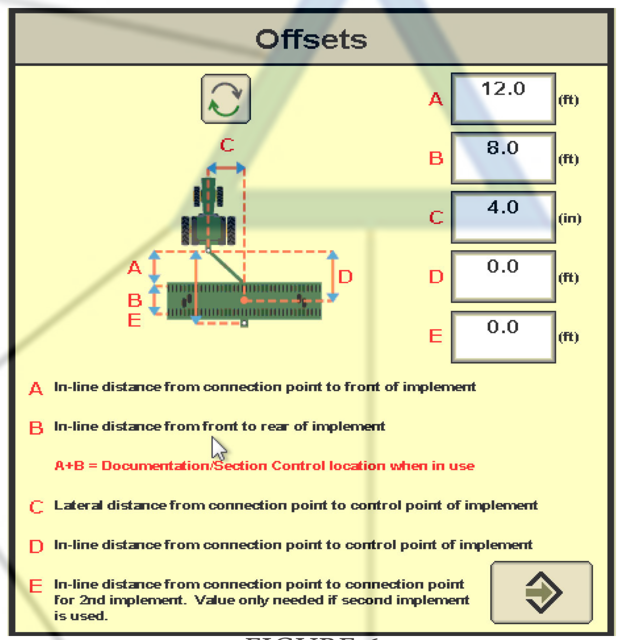

FIGURE 6

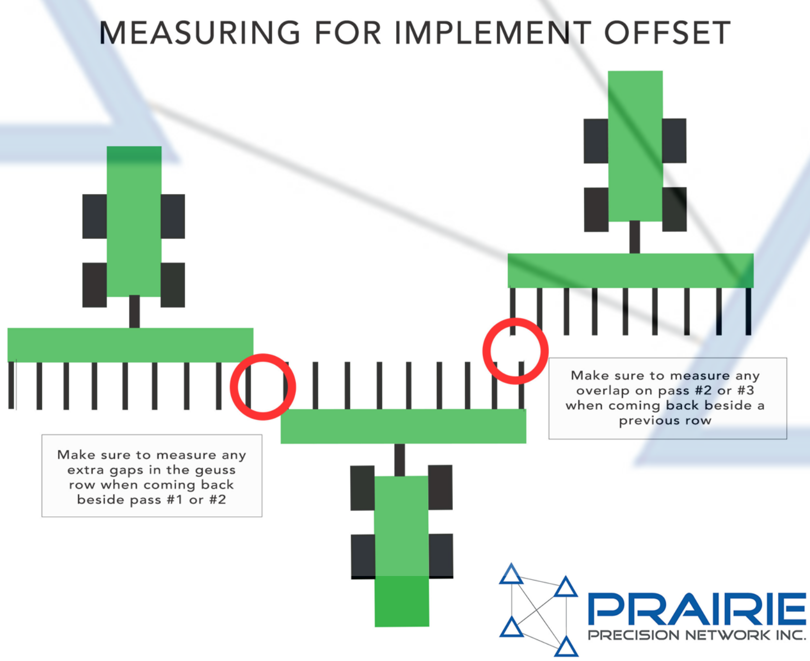

FIGURE 7

STARFIRE OPTIMIZATION

The heart of system accuracy is the Starfire Receiver. We want to make sure it is setup properly for RTK use and also how signal accuracy works and where to look in the Greenstar pages to see current accuracy.

The only setup item that needs changed is to set the hours on after shutdown to ZERO (Figure 8). When using RTK the convergence times to reach full signal is minutes. Making sure to set hours on after shutdown to zero allows the receiver to clear its memory and receive the best possible solution at startup.

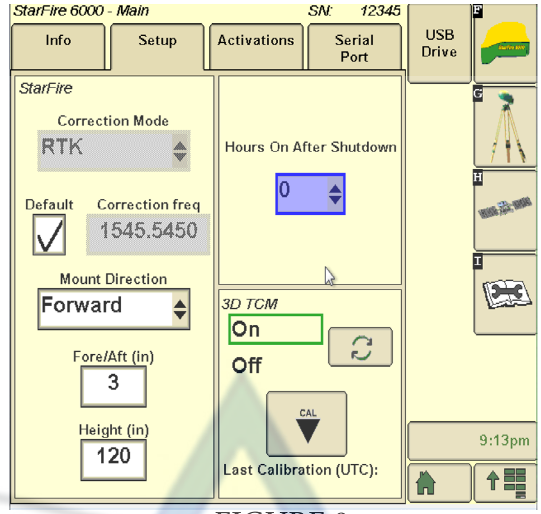

FIGURE 8

Understanding GNSS signal accuracy is also important when attempting to achieve higher accuracies. Figure 9 shows the Starfire main page which give a brief overview of what the current signal accuracy is at. While these are good we can also see a little more clearly what might be going on with the GPS skyplot page (Figure 10).

On this skyplot page you will want to pay attention to the PDOP value. This is the best overall calculation for how your Starfire receiver is performing. In Western Canada we like this value to be below 2.0 and in Southern Ontario 1.5-2.0. If it is higher it does not mean you will not have RTK corrections it just means that some satellites are not available to your receiver at that moment.

If you are not happy with your current satellite solution the only thing that can be done is to unplug the receiver and let it clears its memory for 2-5 minutes and then plug it back in.

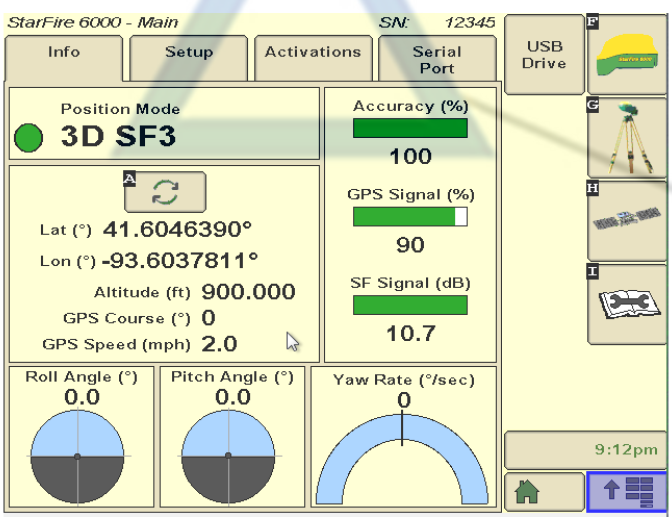

FIGURE 9

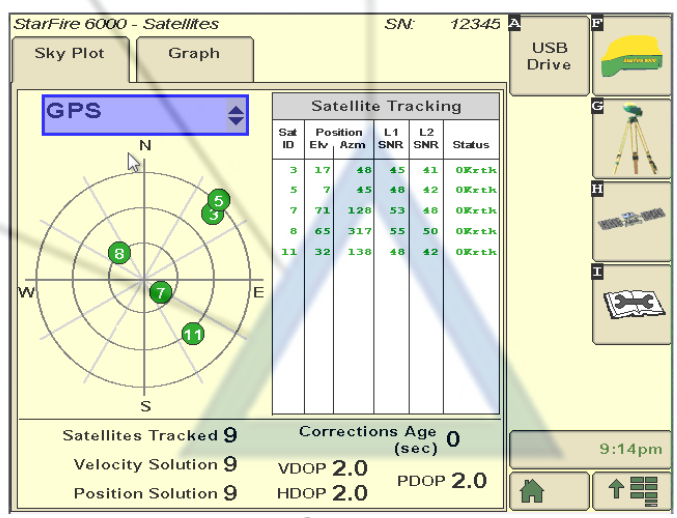

FIGURE 10

TCM CALIBRATION

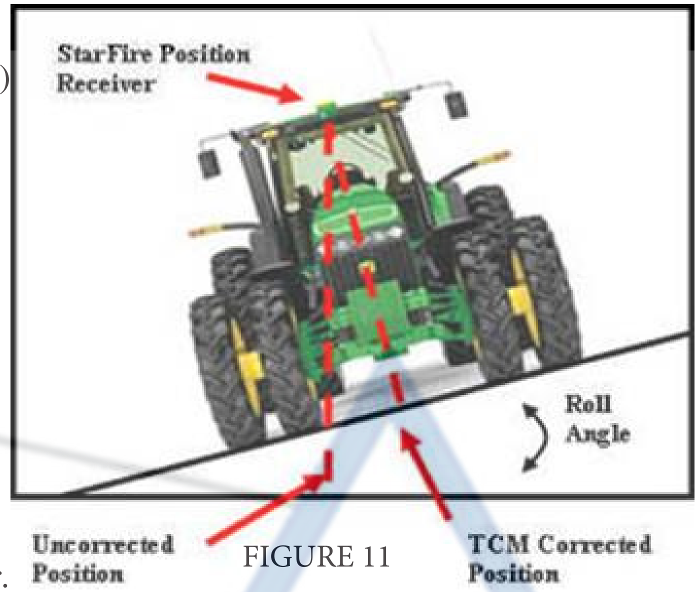

FIGURE 11

We need to make sure the TCM (Leveling Gyroscope) is calibrated. This needs to be done every time a receiver is moved from vehicle to vehicle. It doesn't take long and greatly affects system accuracy.

You can see what the results of not having a TCM installed would mean for a system on a side hill as in Figure 11. Without the proper calibration the system will move itself down the hill in this example and not remain perfectly on the line.

Follow your Starfire Operators Manual on how to properly perform a TCM calibration for your receiver.

The TCM can also be adjusted to account for implement draft. Where you are operating on a sidehill and the implement is drafting down and misses are occuring, we can change the TCM height to make our tractor move up or down the hill.

If we measure to the middle band on the Starfire receiver our tractor will remain on the line as in Figure 1 (142" default for 9R tractors). However if we move the TCM height down and fool the computer the tractor will read this new value and climb the hill if we lower the TCM height and come down the hill if we raise the TCM height.

Simply go to the Starfire main menu page and change the "Height" box (Figure 12). A warning will pop up (Figure 13) which can be disregarded. This warning will want you to perform a new TCM calibration at the new value and you should try to do this at your earliest convenience but can be skipped when accounting for sidehill draft. Just select "F" or enter to close that warning.

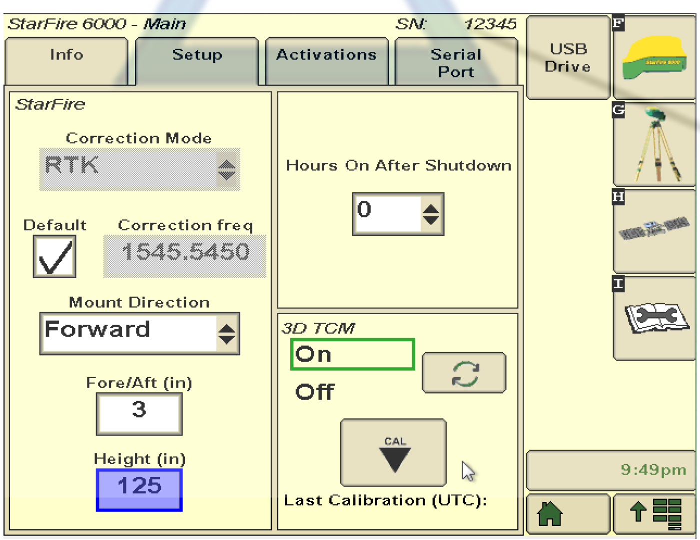

FIGURE 12

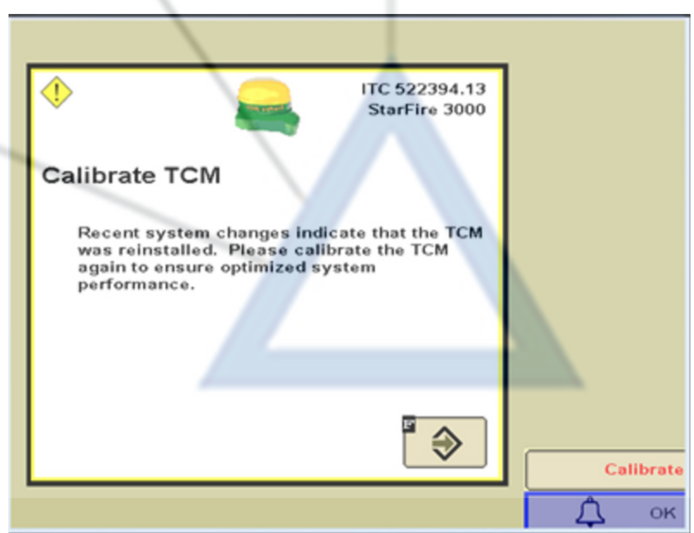

FIGURE 13

Tractor Setup

AUTOTRAC OPTIMIZATION

Many people when looking to optimize Autotrac go from the Starfire/Greenstar system straight to the implement. One big thing is in between these two, the tractor. It is important to make sure we consider the factors that this vital link can play in a properly optimized system.

Tire pressure and ballasting are critical to the guidance system. If we miscalculate these then it will cause other guidance issues especially in wet conditions. Follow the proper Deere guide when selecting ballast options.

One simple thing to do right after Starfire optimization, but BEFORE we look at the implement is our steering calibrations. Make sure to follow DTAC 92089 (Appendix D) and check your toe-in/toe-out and calibrate address XSC 23. Once these two items are completed follow up with a WAS Bias calibration as per DTAC 78634.

AUTOTRAC SETTINGS

In this guide we will cover hydraulic autotrac only. Autotrac Controller and Autotrac Universal take a different set of calibrations to achieve optimal system performance. Check with your local John Deere dealer if using either one of these Autotrac systems.

First we want to make sure that we understand where to go and how signal accuracy and machine and implement settings affect Autotrac accuracy. Once we have determined that our offsets, signal accuracy and machine/implement is setup correctly then we can change our Autotrac settings to achieve a very accurate steering system.

Different applications require different settings. Usually the difference is in relation to speed however field conditions can also affect how settings react.

Navigate to MENU - GS3 and then "B" or GUIDANCE. On this page you will see "Advanced Autotrac Settings" (Figure 14)

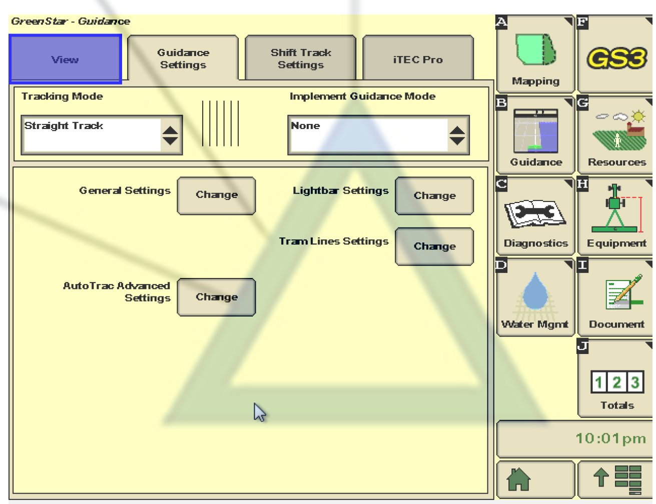

FIGURE 14

AUTOTRAC SETTINGS CONT.

There are SIX sensitivity settings we can adjust. We are going to focus on the first page (Figure 15). If you are not sure where to go with a setting, change it drastically to see the result clearly then tune.
Autotrac Settings:

1. Change Line Sensitivity tracking so tires do not weave back and forth but stay agressive enough to stay on the line
2. Line Sensitivity Heading should be lower than Tracking in slower applications and higher or even for higher speed applications
3. Steering Response Rate is very critical and affects system accuracy greatly. Make sure to keep this setting low enough that the Autotrac is not erratic.

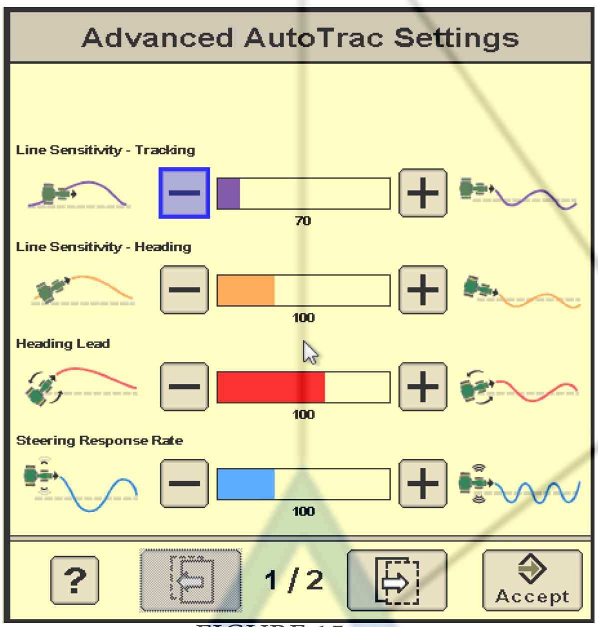

FIGURE 15

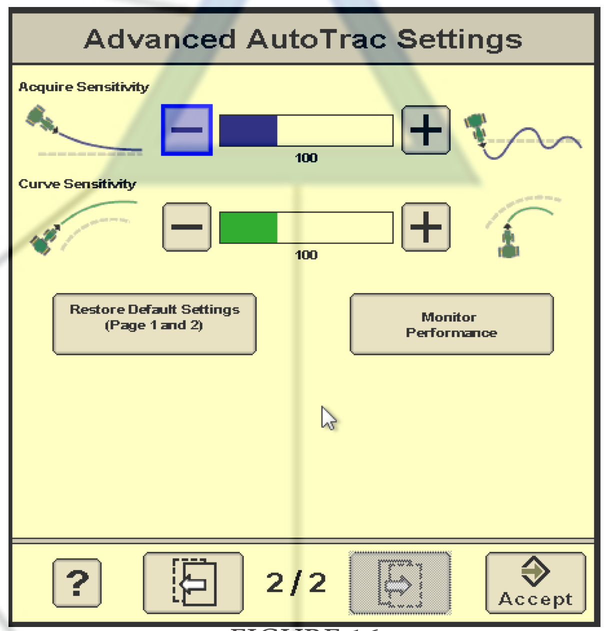

FIGURE 16

Once you think you have settings close go to page two of the settings page and select "Monitor Performance" (Figure 16)

This will show your "heading error" which is a much more clearer representation of the actual autotrac system error and accuracy. You can also change the Line Sensitivity Tracking and Heading values to tune in the system even more.

Feel free to tweak as much as you want as you can always restore "factory defaults" and go back to where you started.

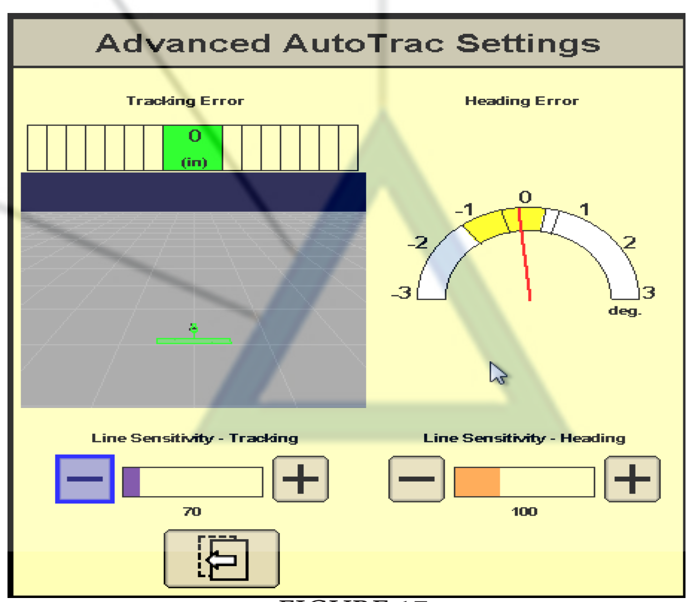

FIGURE 17

Guidance Line Management

OVERVIEW

It is very important for an Inter-Row program to save your AB lines and use them in subsequent years. This can easily be done with a GS3 2630 and John Deere Operation Centre. In this section we will explain the need for AB line management and how to do this easily with Wireless Data and the Operation Centre.

One big thing to consider....GO THE SAME DIRECTION FOR EACH AB LINE. Meaning that if your track "0" started on the east side of the field then make sure next year you start the same way. Some of our customer's enable a system where all even tracks start on the west side and all odd tracks start on the east side. This makes sure that offsets stay consistent, sidehill draft stays the same and you achieve the best results for inter-row seeding.

SAVING AB LINES

When using a GS3 2630 your guidance lines will be automatically saved. The only situation this will not happen is if you load a new profile via USB and overwrite all the saved data on the screen. Once guidance lines are created (Figure 18) they will be saved for THAT FIELD. You can go back and choose "list cleanup" (Figure 19) to delete individual lines if needed.

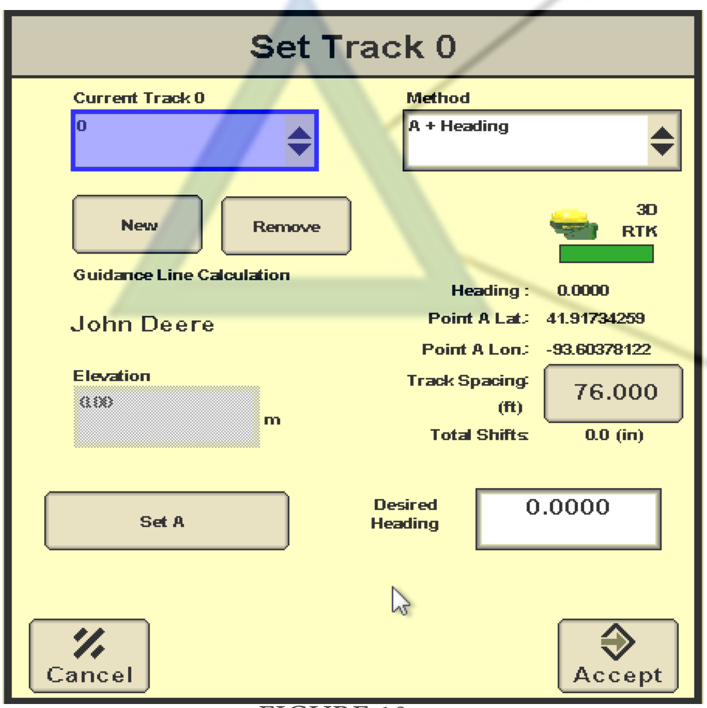

FIGURE 18

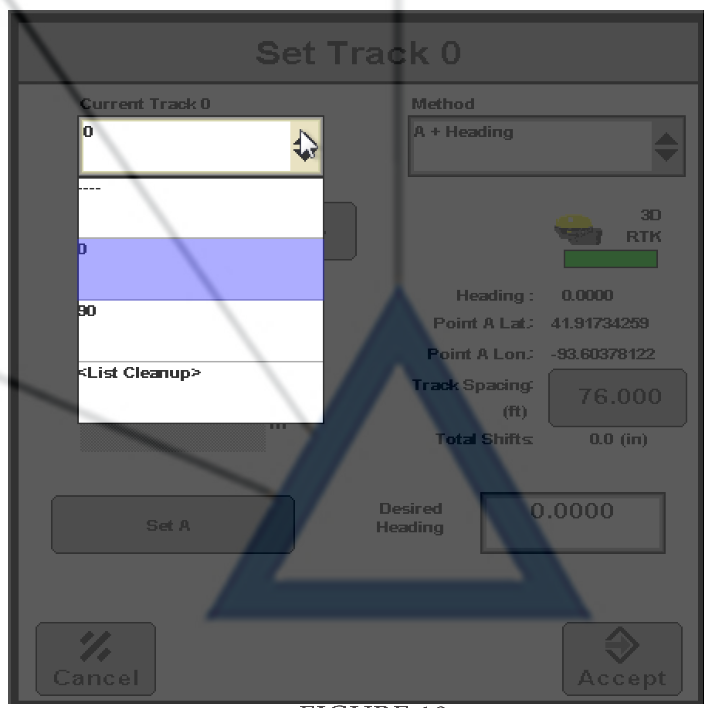

FIGURE 19

Appendix A

Growing New Ideas

Inter-Row Seeding Activates Canola

BY MIKE GRETZINGER

Figure 1. 2014 inter-row plots. L-R. PHOTO: FARMING SMARTER

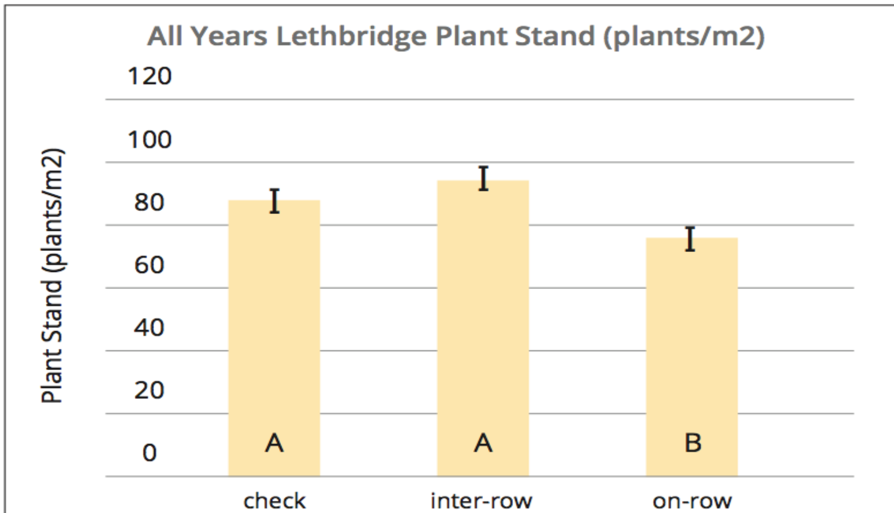

Figure 2. Lethbridge plant stand 2011, 2012 and 2014. P<0.001

Farmers are skeptical and often ask if they should try inter-row seeding. Will it justify the cost of enhanced guidance systems such as RTK (real time kinematics)? Farming Smarter recently completed a four-year study hoping to shed some light on this topic.

From 2011 to 2014, we conducted four years of replicated research trials for the project: Seeding Between the Lines: evaluating the potential of inter-row seeding for canola in southern Alberta. Our objective was to evaluate inter-row seeding by measuring seedling establishment and yield in relation to different stubble orientations.

For the purpose of this project, we defined inter-row seeding to be crops not seeded on the previous stubble row. The background theory is that inter-row seeding could improve your bottom line by providing better seed placement, better seed to soil contact, better germination and better microclimate for the seed, all leading to higher yields.

We collected four site years of plant stand data to evaluate emergence differences, two site years weed densities to compare crop competition and three site years of soil temperature data as an indicator of microclimate for the seedling. We collected three years yield data (one lost to flooding).

We designed the trial to compare inter-row (anything seeded between the previous stubble rows), on-row (directly on the previous stubble row) and check plots (no specific orientation i.e. no RTK) using our pillar laser disc-hoe openers as well as our stealth paired row-hoe openers. The trial was a four rep, RCBD design with medium to large plots (approximately 100m2). We seeded plots at approximately 5lbs/ac (100 seeds/m2). Figure 1 shows the 2014 site.

The results showed some clear, significant differences between treatments. **Figure 2** shows Canola seeded directly on the row had significantly lower plant stands than canola seeded between-rows and in the check plots. We saw this result for three of the four years and as an overall trend in the project. In all cases, our plant stands stayed within the Canola Council of Canada's recommended target plant population of 70-140 plants per square meter (7-14 per square foot). The soil temperatures were not significantly different for seedlings established inter-row vs. on-row, suggesting that soil temperature is likely not the reason for the difference in plant stand. **Figure 4** shows how much more consistent, mechanical disturbance we saw from seeding on-row vs. inter -row; which is the most likely reason for the emergence difference.

Figure 3 shows Canola seeded with pillar laser disc/hoe openers yielded significantly higher than canola seeded with stealth paired row hoe openers. However, only the opener types had a significant effect on yield. Inter-row seeding did not significantly affect final canola yield compared to on-row seeding or

Figure 4. Comparing the stubble disturbance for on-row versus inter-row seeding with the Stealth paired row hoe opener.
PHOTOS: FARMING SMARTER

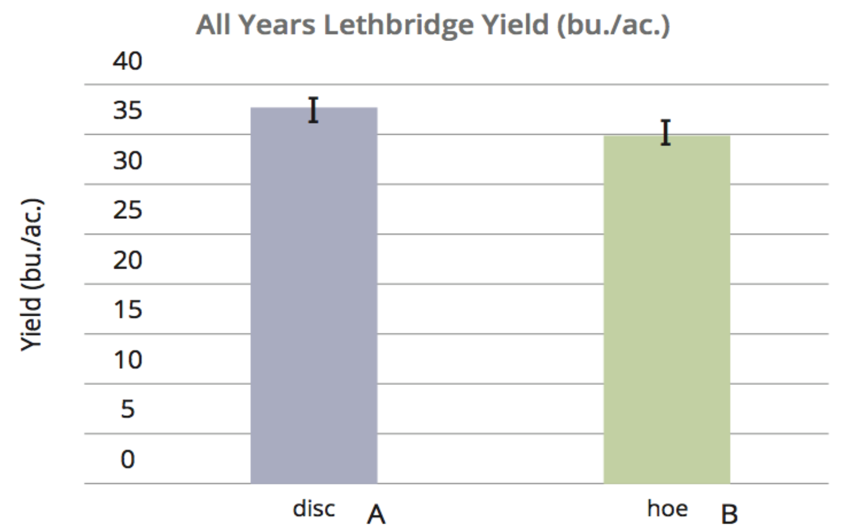

Figure 3. Combined data for Lethbridge yield in 2011, 2012 and 2014. 36 plots each. P = 0.0033.

PHOTO: MIKE GRETZINGER

check plots. There was no statistical difference in weed density for any of the treatments suggesting weed competition was not confounding the results

Based on these results, we suggest that inter-row seeding is not one size fits all, but depends heavily on your current guidance setup, seeder type and general farming practices.

If you already take advantage of auto-steer and GPS with an advanced signal, then you might as well inter-row seed too. If nothing else you should get better plant stands to guard against pest and environmental pressures. You might also want to consider inter-row seeding if you tend to have low germination, but don't want to spend extra money on increasing your seeding rate.

Appendix B

SHORT COMMUNICATION

Extra-tall stubble can increase crop yield in the semiarid Canadian prairie

Herb Cutforth[1], Brian McConkey[1], Sangu Angadi[2], and Doug Judiesch[1]

[1]SPARC, Agriculture and Agri-Food Canada, P.O. Box 1030, Swift Current, Saskatchewan, Canada S9H 3X2; and [2]New Mexico State University, Agricultural Science Center, Clovis, NM 88101-9998, USA.
Received 16 August 2010, accepted 30 March 2011.

Cutforth, H., McConkey, B., Angadi, S. and Judiesch, D. 2011. **Extra-tall stubble can increase crop yield in the semiarid Canadian prairie**. Can. J. Plant Sci. **91**: 783–785. Previous research in the semiarid prairie showed that crop yields increased as the height of standing stubble increased to 30 cm. Recent technology permits seeding into higher standing stubble. A 3-yr (2001–2003) study was conducted at Swift Current, SK, to determine how seeding canola, pulse, and wheat into cultivated, short (about 15 cm high), tall (about 30 cm high), and extra-tall (about 45 cm high) standing stubble affected crop yield. Crop yield and the overall average water use efficiency increased linearly as stubble height increased to 45 cm. Water use was independent of stubble height.

Key words: Direct seeding, extra-tall stubble, crop yield, water use

Cutforth, H., McConkey, B., Angadi, S. et Judiesch, D. 2011. **Le très grand chaume peut accroître le rendement des cultures dans la partie mi-aride des Prairies canadiennes**. Can. J. Plant Sci. **91**: 783–785. Des recherches antérieures dans la région mi-aride des Prairies avaient révélé une hausse du rendement des cultures quand on laisse le chaume jusqu'à une hauteur de 30 cm. Des technologies récentes permettent en effet d'ensemencer en dépit d'un chaume plus haut. Les auteurs ont effectué une étude de trois ans (de 2001 à 2003), à Swift Current (Saskatchewan), pour déterminer comment les semis de canola, de légumineuses et de blé sur du chaume court (environ 15 cm de hauteur), grand (environ 30 cm) et très grand (environ 45 cm) affectent le rendement des cultures. Le rendement des cultures et l'efficacité moyenne d'utilisation de l'eau progressent de façon linéaire avec la hauteur du chaume, jusqu'à 45 cm. La quantité d'eau utilisée ne présente aucun lien avec la hauteur du chaume.

Mots clés: Semis directs, très grand chaume, rendement des cultures, utilisation de l'eau

From previous research in the semiarid region of the western Canadian prairies, we know that compared with seeding into cultivated stubble the average increases in yield when seeding canola, pulse and wheat into tall (30 cm high) standing stubble are about 16, 13, and 12%, respectively, and the average increases in water use efficiency (WUE) are about 11, 16, and 12%, respectively (Cutforth and McConkey 1977; Cutforth et al. 2002, 2006). As well, we found that growing season evapotranspiration (water use) is not affected by stubble height. When the seedlings are small, tall stubble alters the microclimate near the soil surface by reducing the daily average wind speed, soil temperature, and incoming solar radiation, and increasing the reflected solar radiation when compared with cultivated stubble. Further, throughout much of the growing season, potential evapotranspiration at the soil surface, measured using minilysimeters (Caprio et al. 1985), is significantly lower in tall stubble (Cutforth and McConkey 1977; Cutforth et al. 2002). Tall stubble, compared with cultivated stubble, increases yield by increasing the proportion of water that is transpired by the crop rather than lost through evaporation at the soil surface, and by decreasing the deleterious effects of mechanical stress imposed on the crop by wind (Grace 2003).

Recent advances in seeding technology, such as guidance systems and straw deflectors, have enabled producers to seed into the very tall standing stubble that remains after harvesting with combines equipped with either direct-cut headers or stripper headers. Will crop yield continue to increase as stubble height increases above 30 cm? Therefore, in this study, we compared the effect of wheat stubble standing at various heights, including extra-tall stubble, on water use and grain yield in wheat, canola and chickpea.

This study was conducted on a Swinton loam soil (Orthic Brown Chernozem) at the Agriculture and Agri-Food Canada, Semiarid Prairie Agricultural Research Centre (SPARC), Swift Current. All treatments overwintered as extra-tall (45+ cm) standing wheat stubble to equalize snow trapping with the four stubble treatments [extra-tall (45+ cm), tall (30 cm), short (15 cm) standing stubble, and cultivated stubble] deployed just

Abbreviations: WU, water use; WUE, water use effeiciency

Table 1. Average monthly air temperatures and monthly precipitation totals for April and for the growing seasons (May through August) of 2001 to 2003, as well as the long-term mean monthly mean air temperature and precipitation total

	T_{mean} (°C)				Precipitation (mm)			
Month	2001	2002	2003	Mean[z]	2001	2002	2003	Mean[z]
Apr.	5.4	0.0	6.0	4.6	9.8	11.0	51.5	22.0
May	12.2	8.5	10.9	0.9	22.6	21.9	41.9	43.7
Jun.	15.0	15.7	15.1	15.4	31.8	143.9	78.7	72.8
Jul.	19.7	19.6	19.8	18.6	63.0	73.1	8.3	52.6
Aug.	20.7	15.5	21.5	17.6	3.2	102.2	20.7	42.9
Total (MJJA)					130.4	352.1	201.1	234.0

[z]Long-term mean (1885 to 2002).

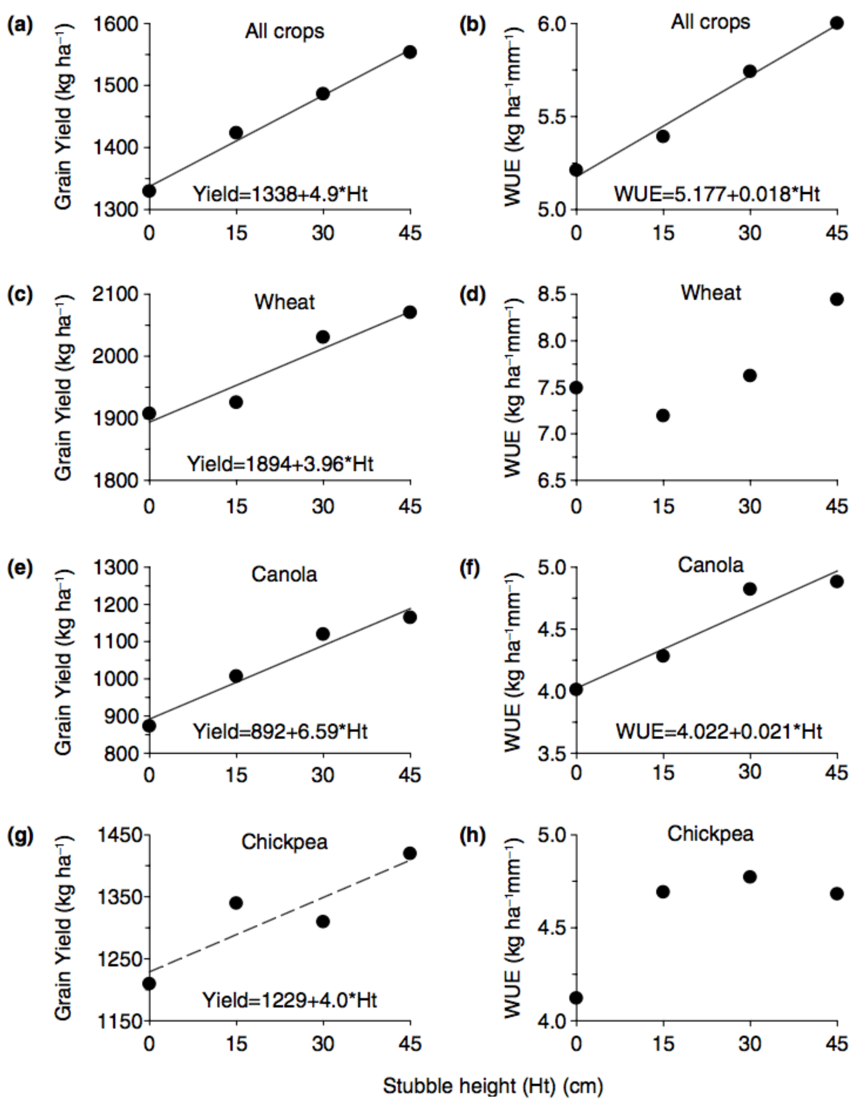

Fig. 1. Effect of stubble height on grain yield and water use efficiency (WUE) when averaged across years (2001–2003) and crops (wheat, canola, chickpea) (a and b, respectively), and when averaged across years (2001–2003) for wheat (c, d), canola (e, f), and chickpea (g, h). Relationships are significant at $P < 0.05$. (Chickpea: yield vs. stubble height was significant at $P = 0.108$.)

before seeding in the spring. Stubble plots measured 40 × 40 m. Spring wheat (*Triticum asetivum* L. 'Eatonia'), Argentine canola (*Brassica napus* L. 'Arrow'), and kabuli chickpea (*Cicer arietinum* L. 'Chico') were seeded using a Bourgault Air Coulter drill (Bourgault Industries Ltd., St. Brieux, SK S0K 3V0) with 20-cm row spacing. Seeding dates were 2001 Apr. 25–27, 2002 Apr. 29–30 and 2003 May 03. Each crop was seeded in a sub-plot measuring 13 m × 40 m within each stubble treatment plot. The crops were seeded with stubble rows and no attempt was made to seed between stubble rows. The chickpeas were inoculated with appropriate peat-based inoculants applied to the seed, and were sprayed for disease control as required. Fertilizers were applied as per soil test recommendations. Herbicides were used for weed control as required. Crops were harvested with a Massey Ferguson 550 combine (AGCO Corporation, 4205 River Green Parkway, Duluth, GA 30096). Soil water to the 1.2 m (4 ft.) depth was measured gravimetrically just before seeding and just after harvest. From these measurements, water use (WU) was calculated:

$$\text{WU} = (\text{soil water at seeding} - \text{soil water at harvest}) + \text{growing season preciptation}$$

Water use efficiencies (WUE) were calculated:

$$\text{WUE} = \text{grain yield}/\text{WU}.$$

Linear regression analysis was used to determine the relationship of stubble height to grain yield and to WUE over the three growing seasons. Unless otherwise stated, we chose $P < 0.05$ as the probability level for statistical significance. Statistical analyses were performed with the JMP software package (SAS Institute, Inc. 1995).

The very diverse growing conditions experienced during the course of this project provided a unique opportunity to study the effects of stubble height on crop yield and crop water use even though the data set was limited to 3 yr. Overall, 2001 was extremely dry and very warm – a severe drought year; the 2nd driest and 5th warmest year on record for Swift Current (Table 1). Precipitation was 52% of normal. Thus, 2001 was a very stressful year for crop growth and yield. The dry weather continued throughout 2001 until the end of May 2002. The soil profile was extremely dry. The rest of 2002 was wet, especially for the months of June through September. The growing season of 2003 began fairly wet, but became extremely dry later in the season. July was extremely dry and hot, while August was dry and very hot – July and August 2003 were the 3rd driest and 3rd warmest on record.

Averaged across crops and years, the overall crop yield and WUE were linearly dependent on stubble height (Fig. 1). Yield and WUE were highest for crops grown in the extra-tall stubble and lowest for crops grown in the cultivated stubble. Generally, compared with cultivated stubble, extra-tall stubble increased yield by about 17%. Except for chickpea, grain yield for each crop increased linearly as stubble height increased to 45 cm high (Fig. 1). Although not significant ($P = 0.108$), the yield of chickpea also tended to increase with stubble height. As well, the overall average WUE and the WUE for canola increased linearly as stubble height increased to 45 cm (Fig. 1). There was a tendency for the WUE of wheat to increase with stubble height, but not for chickpea. For a given crop, total water use was not affected by stubble height (data not shown) and, therefore, the proportion of evapotranspiration (water use) transpired by the crop increased as stubble height increased (Cutforth and McConkey 1997).

Previously, we found yield and WUE were increased as stubble height increased to 30 cm (Cutforth and McConkey 1977; Cutforth et al. 2002, 2006). In this preliminary study, yields and, to a lesser extent, WUE in the semiarid prairie increased linearly as stubble height increased to at least 45 cm. With the advent of stripper headers, stubble heights after harvest can exceed 60 cm in the dry semiarid prairie. Will crop yields continue to increase linearly as stubble heights increase in excess of 60 cm? Further research into the effect of stubble heights in excess of 60 cm on crop growth and yield is warranted to determine the limit at which stubble height becomes detrimental.

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Caprio, J. M., Grunwald, G. K. and Snyder, R. D. 1985. Effect of standing stubble on soil water loss by evaporation. Agric. For. Meteorol. **34**: 129–144.

Cutforth, H. W. and McConkey, B. G. 1997. Stubble height effects on microclimate, yield, and water use efficiency of spring wheat grown in a semiarid climate on the Canadian prairies. Can. J. Plant Sci **77**: 359–366.

Cutforth, H. W., McConkey, B. G., Ulrich, D., Miller, P. R. and Angadi, S. V. 2002. Yield and water use efficiency of pulses seeded directly into standing stubble in the semiarid Canadian Prairie. Can. J. Plant Sci. **82**: 681–686.

Cutforth, H. W., Angadi, S. V. and McConkey, B. G. 2006. Stubble management and microclimate, yield and water use efficiency of canola grown in the semiarid Canadian Prairie. Can. J. Plant Sci **86**: 99–107.

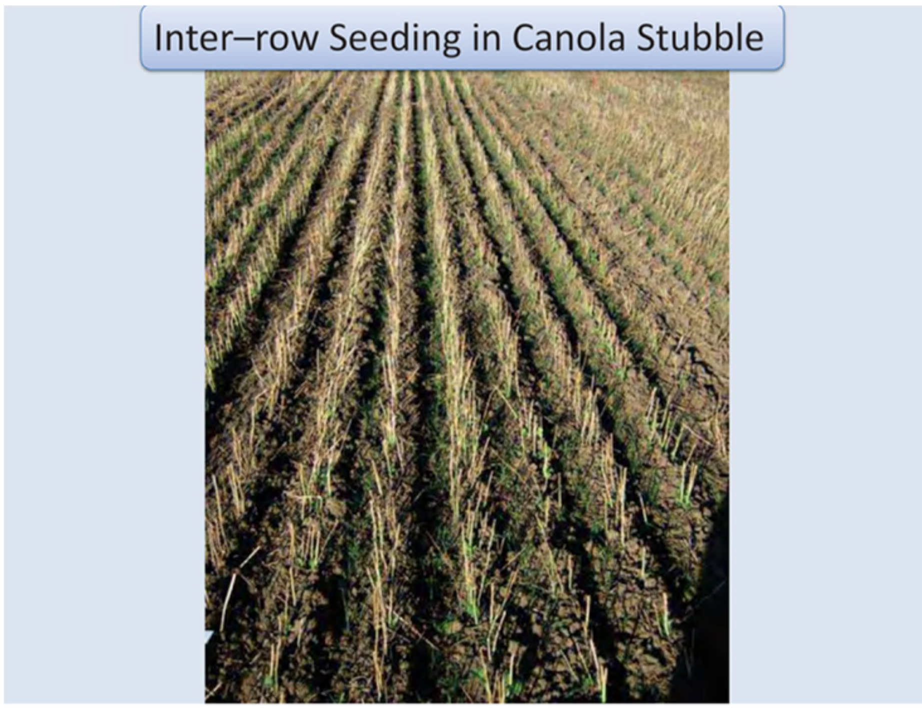
Grace, J. 2003. Mechanical stress and wind damage. Encyclopedia of applied plant sciences. Book Series. Academic Press, London, UK. pp. 6–23.

SAS Institute, Inc. 1995. JMP statistics and graphics guide, Version 3.2. SAS Institute Inc., Cary, NC.

Appendix C

Controlling Soil Temperature With Inter-Row Seeding

A recent project from Ag Canada researched the effects of soil temperature on wheat yield in no-till versus conventional tillage and the results were very surprising. Standing residue and soil cover during grain fill can seriously improve wheat yields in most years.

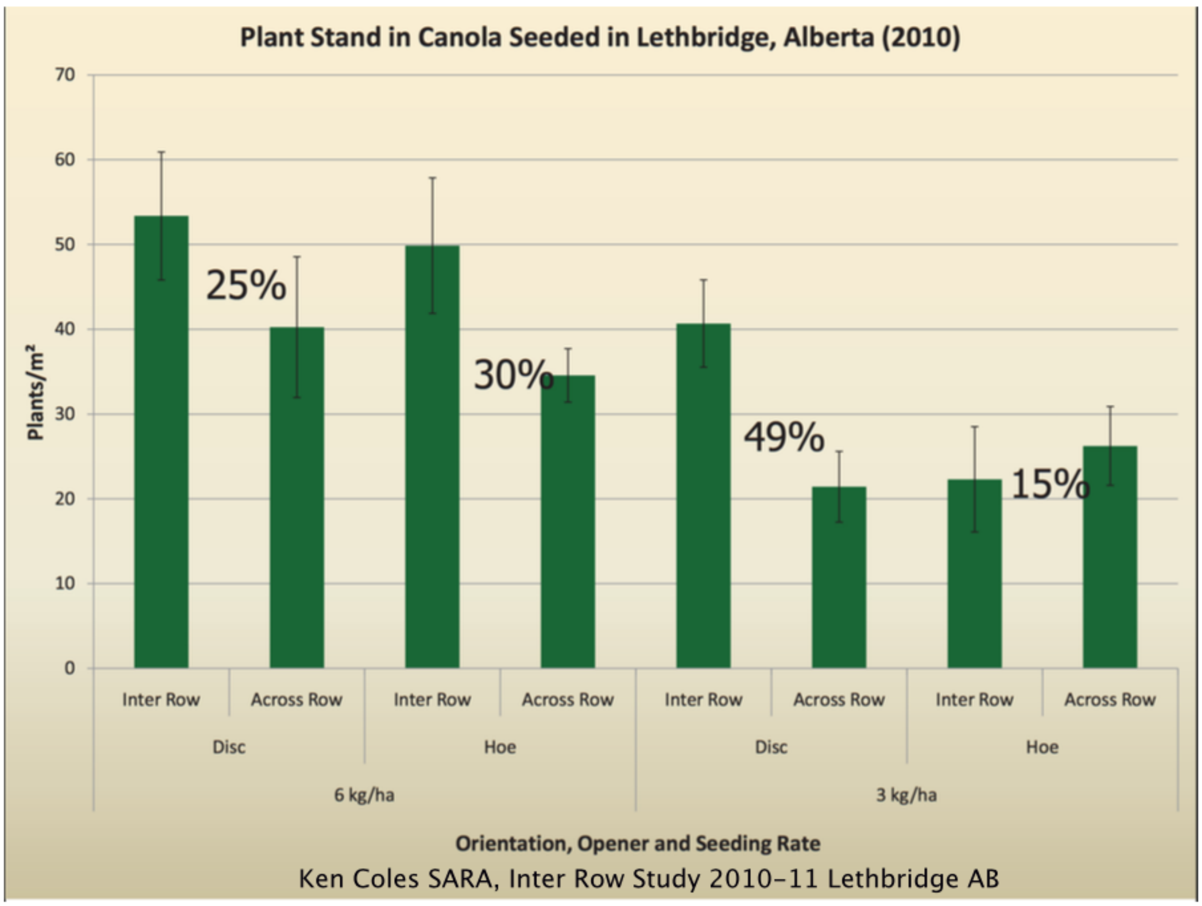


The results showed that by reducing soil temperature during the grain fill stage, increased aboveground biomass between 33-160% and wheat yield by 18-147% except in one year when heat and moisture stress were limited. The take home from the research showed that soil temperature had a greater impact on wheat yield than above ground plant temperature. In fact when soil temperature was heated to 35C for a given time, yields in wheat dropped by 60%. The same plants exposed to 35C temperatures above ground only suffered a 48% yield loss.

The research also revealed that every 1C soil temperature above 20C during grain fill dropped grain weights in wheat by 3%. So, for example, if you're daytime high and low was 30C and 15C respectively, your average temperature would be 22.5C, which is 2.5C above the critical level. That works out to a 7.5% reduction in grain weight. On a 55 bu/ac wheat crop that works out to a 4 bu/ac loss or $33.00/ac at today's wheat prices.

If you look at the chart above it shows soil temperature readings across five weather stations from Lethbridge (purple), Morrin (yellow), St Albert (green), Dapp (blue) and Fairview (red) from June 30 to Sept 1, 2012. Most of the province had excellent rainfall, which kept ground temperatures cool except for the south. You can see the Lethbridge average is a few degrees above 20C throughout grain fill. According to the research, grain weights in this area would have dropped 9% from hot soil temperatures. A little Steve's quick math will tell you that's $30 to $40/ac in lost revenue for those without proper residue cover.

In Western Canada, we rarely think about heat causing a concern except perhaps during flowering. Even fewer would think temperatures between 20C and 30C could affect wheat yield. The reality is that poor soil cover, seeding on a diagonal and exposing soil, 10 to 12-inch row spacing or SBU's below 40% could easily put soil temperatures in this critical range during grain fill. Our black soils are heat magnets and without residue cover or standing stubble soil temperatures can rise well above 20C during grain fill.



The solution to managing soil temperature is simple. Instead of relying on combines to provide even residue spread (which they don't), or heavy harrows to move straw (which they struggle with), ***inter-row seeding is the answer.*** Having the area between the rows filled with standing stubble is a great way to reflect light and reduce soil temperature. As you can see in the photo above, the chickpeas are growing between last years stubble. The stubble acts as an insulator and reflects heat. It allows you to cut taller and reduce the amount of residue on the surface so it doesn't impact germination and emergence, which is a win-win. Inter-row seeding has worked very well on our farm. Reducing soil temperatures during grain fill is just another benefit everyone should be taking advantage of. There could be $30 to $40/ac in it for your time. SL

Research:
http://beyondagronomy.com/newsletter-archive/february-26-2013

Appendix D

Solution Number: 92089

Solution Summary: 6R/7R/8R/9R Wheeled Tractors - AutoTrac Performance is Unsatisfactory

Publication Date: May 1 2014

Paper copies of solutions may not be the most current solutions

Complaint or Symptom :

Tractors equipped with SBBC (XMC/XSC) control unit experience AutoTrac™ wandering, S-ing, poor line acquisition, and/or unsatisfactory performance.

Problem or Situation :

There are many different tractor and implement combinations making it difficult to tune AutoTrac™ . SBBC calibrations calculate deadband compensation values that may be too low or to high causing wandering, S-ing, line acquisition issues, and/or unsatisfactory AutoTrac™ performance.

Solution :

1. Verify system accuracy as performance may be normal. Review AutoTrac™ Setup for Optimizing Performance and Accuracy (Solution 82742).
2. Return all of the AutoTrac™ Advanced settings back to DEFAULT.
3. Make sure SBBC (XMC/XSC) has been updated to the latest software available in John Deere Custom Performance (SDS).
4. Verify that wheels are aligned (Toe-in/Toe Out).
5. Verify tire pressures on front of tractor match, and tire pressures on rear of tractor match.
6. Verify steering cylinder leakage is not excessive.
7. Verify that there is not an excessive amount of drift when driving straight (without steering wheel input).
8. Perform a steering valve calibration using XSC address 23. If calibration fails with "E-Time" refer to (Solution 95057).
9. Perform a WAS Bias calibration (Solution 78634).

   ● Manual WAS Bias: Enter XMC 042—Steering Angle and Status. Make sure the tractor is pointing straight; this can be done by measuring both of the steering cylinders to a common point under tractor. Once centered/straight ahead is verified, Press the next button and enter button to save.
10. Perform a TCM calibration as specified in Service Advisor and/or the instruction on the GPS

receiver screen. Note: It is crucial that this is performed on flat/level ground and the dimensions are correct for the receiver.

11. Setup an A-B line and begin to AutoTrac™ . "AutoTrac™ Advanced setting should still be at Default.

    • If performance is not satisfactory, enter into XSC Address 178. This allows for adjustment of the AutoTrac™ valve deadband.

    • If your AutoTrac™ issue is: slow s'ing, too sluggish, and/or is exhibiting slower response, try Increasing the value in XSC Address 178 from 100 to 110. This will increase the AutoTrac deadband by a Valve by 10mA, which will give you a more aggressive valve command with quicker response. You can continue to increase to try and remedy issue.

    • If your AutoTrac™ issue is: fast s'ing, too aggressive, and/or is exhibiting jerky response, try Decreasing the value in XSC Address 178 from 100 to 90. This will decrease the AutoTrac deadband by a Valve by 10mA, which will give you a less aggressive valve command with slower response. You can continue to decrease to try and remedy issue.

12. Verify AutoTrac™ performance is satisfactory.

13. Depending on vehicle setup, some minor AutoTrac™ Advance Settings may need to be tweaked (Solution 82724). Some "critical" AutoTrac™ Advanced Settings performance adjustments:

    • XSC 193—AutoTrac™ Sensitivity, this value is considered to be "Valve Command Ramping/Raising Strength"

    • XSC 199—AutoTrac™ Inner Loop Scale Factor, this value is considered to be "Speed of Valve Command Correction"

14. Continue to make above adjustments until AutoTrac™ performance is satisfactory.

Additional Information :

The software improvements discussed within this solution are not compatible with Track machines. Improvements for those complaints are being investigated separately. Refer to DTAC (Solution 92294).

6190R, 6105R, 6115R, 7215R, 6125R, 8335R, 8235R, 6210R, 9510R, 7200R, 8310R, 9410R, 7230R, 6140R, 8285R, 6150R, 9560R, 9460R, 7260R, 8360R, 6170R, 8260R, 9360R, 7280R

VALVE, STEERING, AutoTrac, PTS, EJLFY12N, TRAC ELEC, 1620