Precision Agriculture with GPS Technology

Precision Land Management

By: Guy Palardy

The Evolution of GPS Techonology

Yesterday

- Guidance only
- Accuracy upgrades
- ‘Hydraulic Auto Steer
- Sprayer section control

Today

- Options for Auto-steer
- Controls tractor functions
- Implement control
- Seed shutoffs
- Control multiple inputs

Tomorrow

- Autonomous tractors
- 24 hour operation
- Sensors detecting changing field conditions
- Drones with NIR cameras

What can a GPS display do?

- Mark lagoons

What can a GPS display do?

- Mark obstacles such as power lines

What can a GPS display do?

- Import roadways and waterways

What can a GPS display do?

- Will not fix stupid

Precision Land Management

ROI

Return on Investment

Ergonomics

- Fatigue Factor
  - Comfort
  - Night time operation
- Ease of Operation
- Straight Rows
- Multi-task

Economics

- Fuel
- Labor
- Implement Efficiency
- Inputs
  - Seed
  - Fertilizer
  - Chemical
- Record Keeping
- Time Management
- Insurance
- Machine Tracking

Agronomics

- Yield Improvements
  - Overlap Control
  - Variable Rate
  - Fertilizer Utilization
- Minimize Soil Compaction
- Disease Control
- Land Production

- GPS Display Unit
  - WAAS, OmniStar, or RTK
  - Product Control
  - Implement Control
- Steering Options
  - Steering Wheel Rub Motor, Column Motor, or Hydraulic
- Data Management Software

Which product will give us ROI?

[redacted]

GPS basics

- Basics of GPS
- Display Choices
- Correction Options (4 options)
- Transferable Auto Steer (EZ-Steer)
- Fixed Auto Steer (EZ-Pilot, Auto Pilot)
- Implement (Steering, Product Control, Water Mgt)

- GPS = Global Positioning System
- Autonomous = No Corrections
- DGPS = Differential Global Positioning System (Correction)
- RTK = Real Time Kinematic (Correction)
- GNSS = Glonass (Russian) Satellites
- DOP = Dilution of precision
- SNR = Signal to Noise Ratio

Acronyms/Definitions

GPS - Global Positioning System

- Baseline 24 Satellites Orbiting Earth
  - 6 Orbits
  - 4 Satellites per orbit (some spares)
- Currently 32 in orbit but not all active
- Provide accurate position information worldwide
- Satellites broadcast precise time and orbit information
- Owned and Operated by the United States Department of Defense
- Paid for by US taxpayers

Basics of GPS

GLONASS – Global Navigation Satellite System

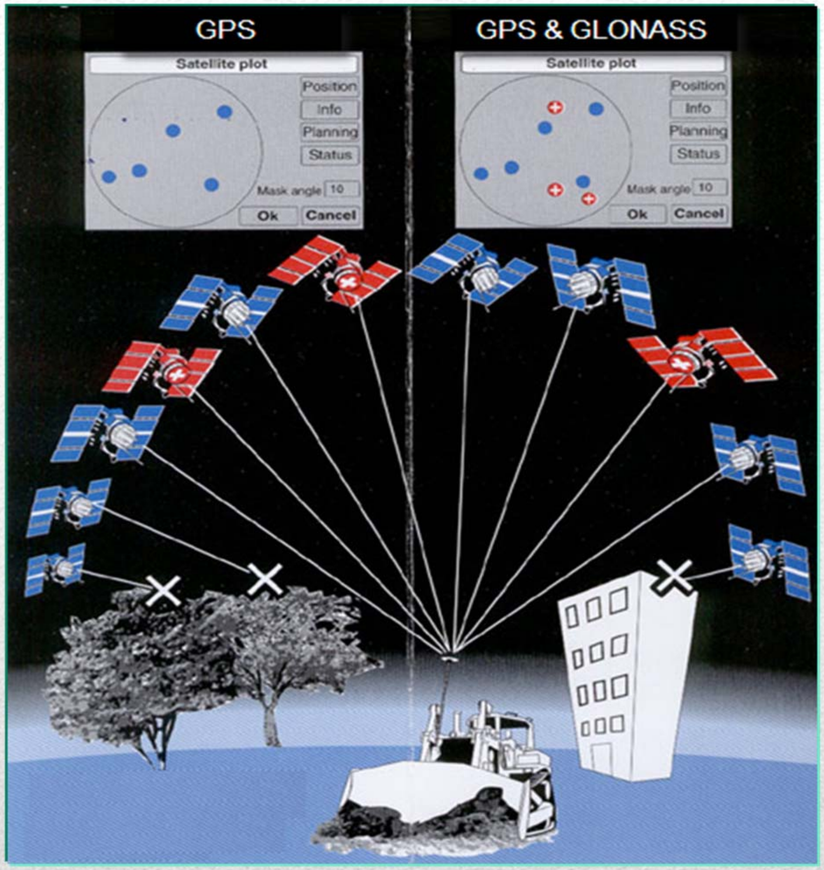
- Russian equivalent of the U.S. GPS
- Currently 19 Satellites in orbit (16 healthy as of 11/5/2009)
- Orbit the Earth at an altitude of about 11,868 miles (slightly lower than GPS)
- Launch of more satellites all the time

GLONASS

Advantages of using GLONASS:

Increase of available satellites

"Due to its orbit inclination, GLONASS provides better coverage than GPS in northern latitudes"



GLONASS

1. Atmospheric delays

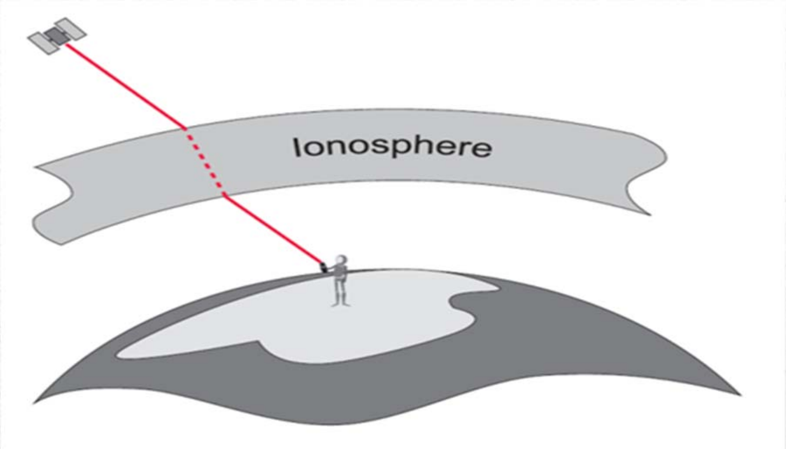
2. Clock Errors

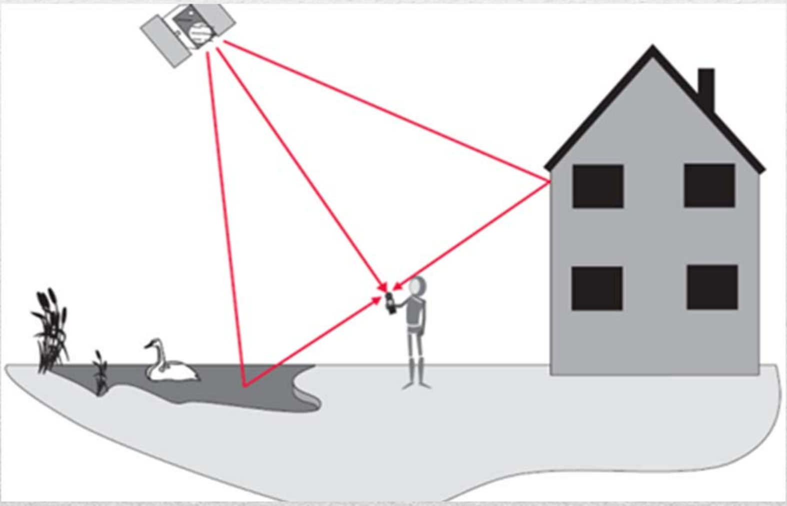
1/1,000,000 of a second = 1,000 feet of error

3. Multipath

4. Dilution of Precision

5. Ephemeris (orbital) Errors





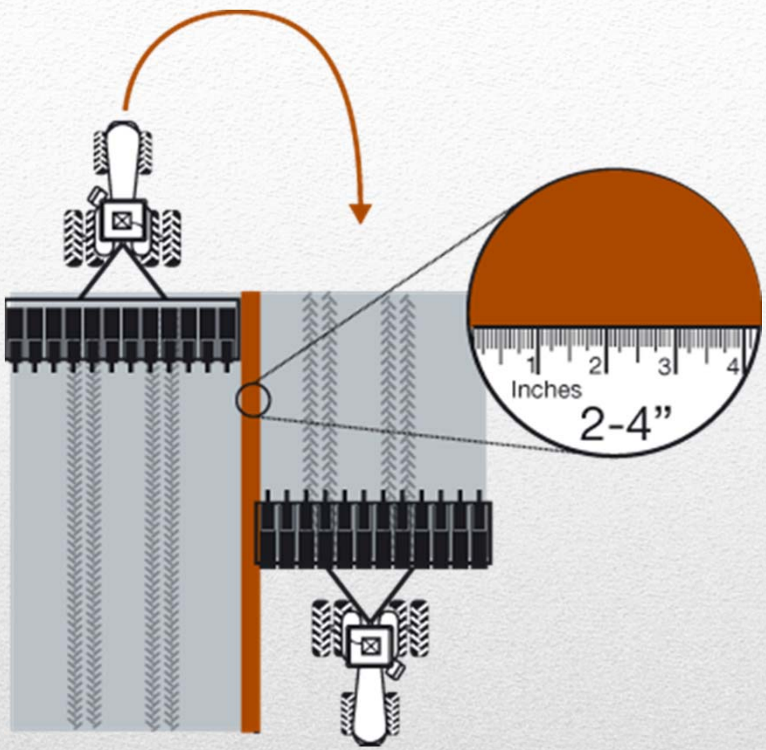
Source of Errors

- A DGPS base station measures GPS signal errors and then provides correction information to mobile GPS receivers
- A mobile receiver uses the correction information to compute its current position location
- The corrections can be broadcast from a geo-stationary satellite (WAAS or OmniSTAR) or ground based tower (RTK)

Corrections

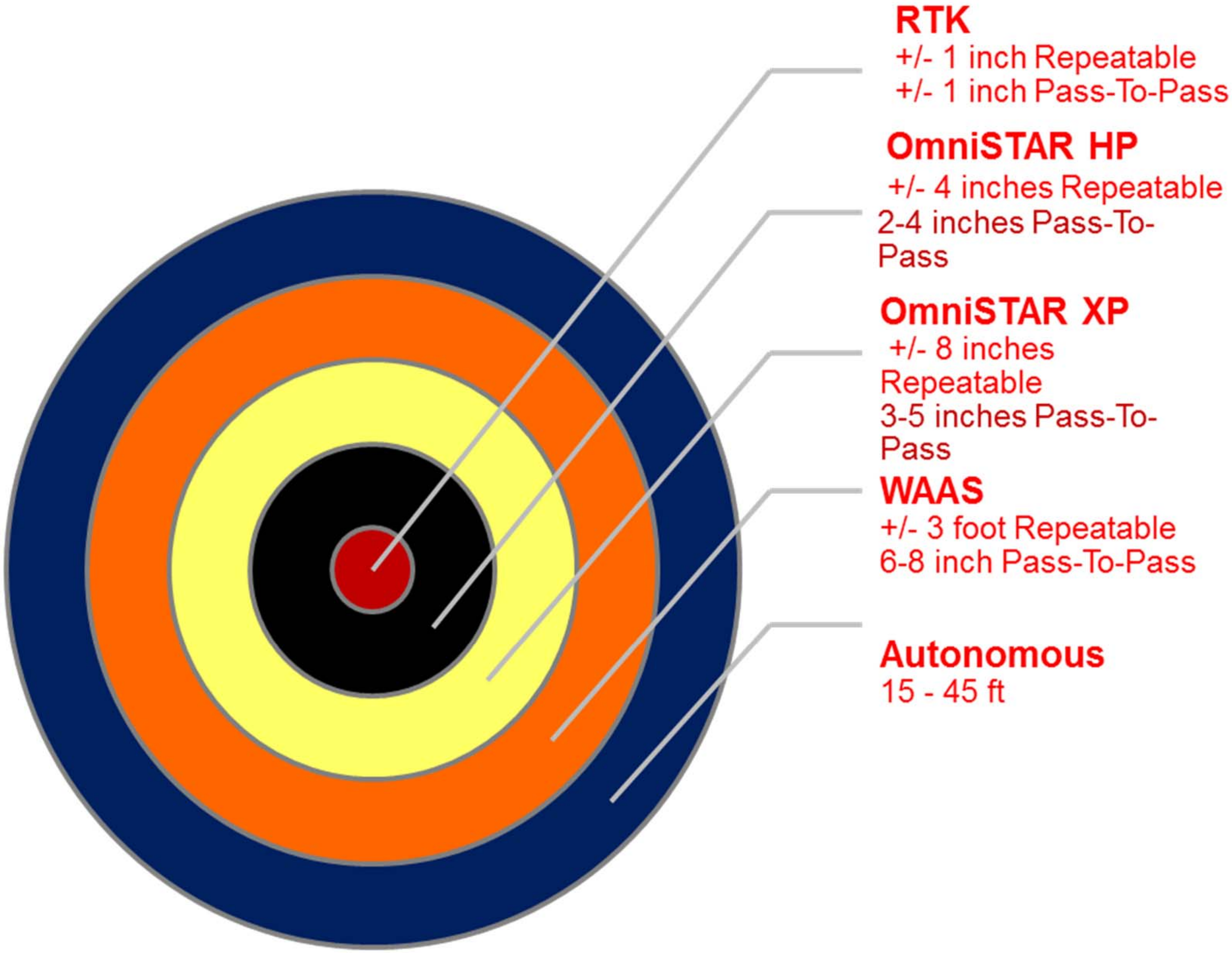
Pass-to-Pass Accuracy

- "How close am I to my last pass?"
- GPS moving, collected over 15-20 minutes typically
- In Ag "Pass-to-Pass" or "Swath-to-Swath"
- High pass to pass accuracy does not equate to high static accuracy
- Smoothing & filtering improves pass to pass
- Difficult to return to mapped areas in the field if static accuracy is low

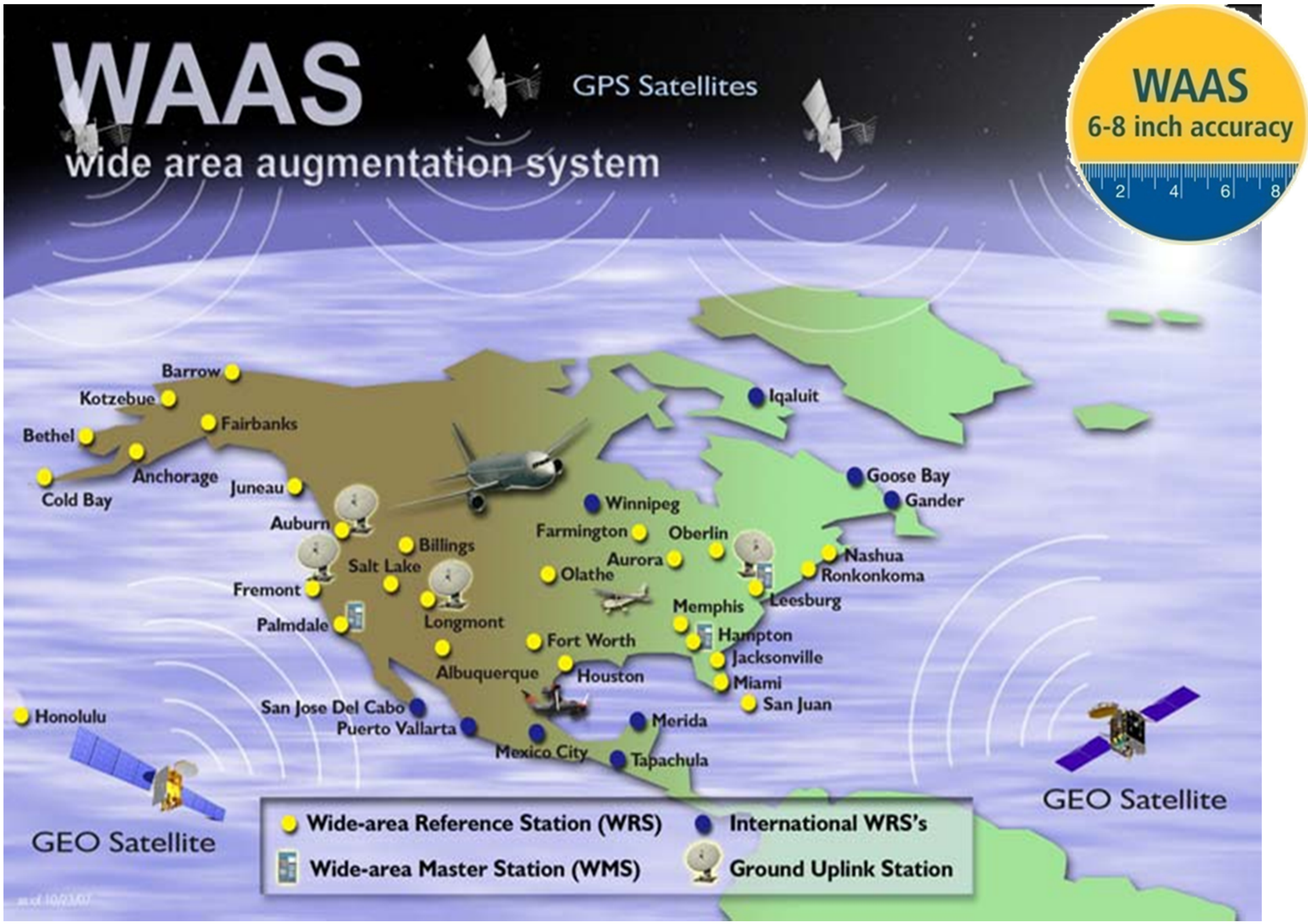


Key GPS Accuracy Specs

Correction Options



GPS


WAAS
wide area augmentation system
GPS Satellites
WAAS
6-8 inch accuracy
2
4
6
8
Barrow
Kotzebue
Fairbanks
Bethel
Anchorage
Cold Bay
Juneau
Auburn
Billings
Salt Lake
Fremont
Palmdale
Longmont
Albuquerque
Iqaluit
Goose Bay
Gander
Winnipeg
Farmington
Oberlin
Aurora
Olathe
Nashua
Ronkonkoma
Leesburg
Memphis
Hampton
Fort Worth
Jacksonville
Houston
Miami
San Juan
Honolulu
San Jose Del Cabo
Puerto Vallarta
Mexico City
Merida
Tapachula
GEO Satellite
GEO Satellite
Wide-area Reference Station (WRS)
International WRS's
Wide-area Master Station (WMS)
Ground Uplink Station

OmniSTAR XP / HP

- XP/HP is a dual frequency (L1/L2) GPS augmentation service
  - Can measure the true Ionosphere error at the reference station and user location, substantially eliminating this effect in positioning accuracy
  - Requires an unlock for the receiver
  - XP/HP utilizes a convergence process to develop a positional solution.
  - Can take up to 20 minutes on some receivers to reach full convergence

North America - OmniSTAR XP / HP

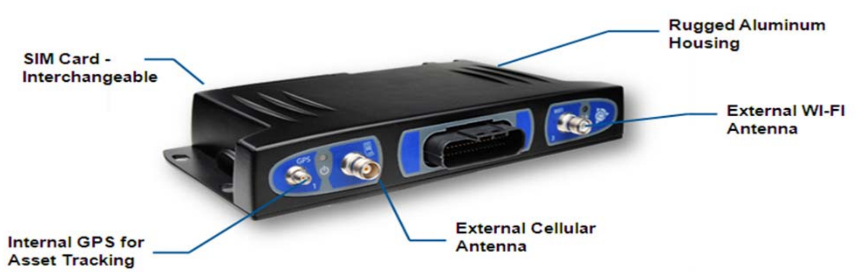
- Requires Subscription:
  - VBS - $800/year, or $400/3 months, plus $100/mo for additional months
  - XP - $800/year, or $400/3 months, plus $100/mo for additional months
  - HP - $1500/year, or $750/3 months, plus $190/mo for additional months

  - Note: Month to month extensions must be ordered before the existing subscription has expired.

OmniSTAR = 1-888-883-8476

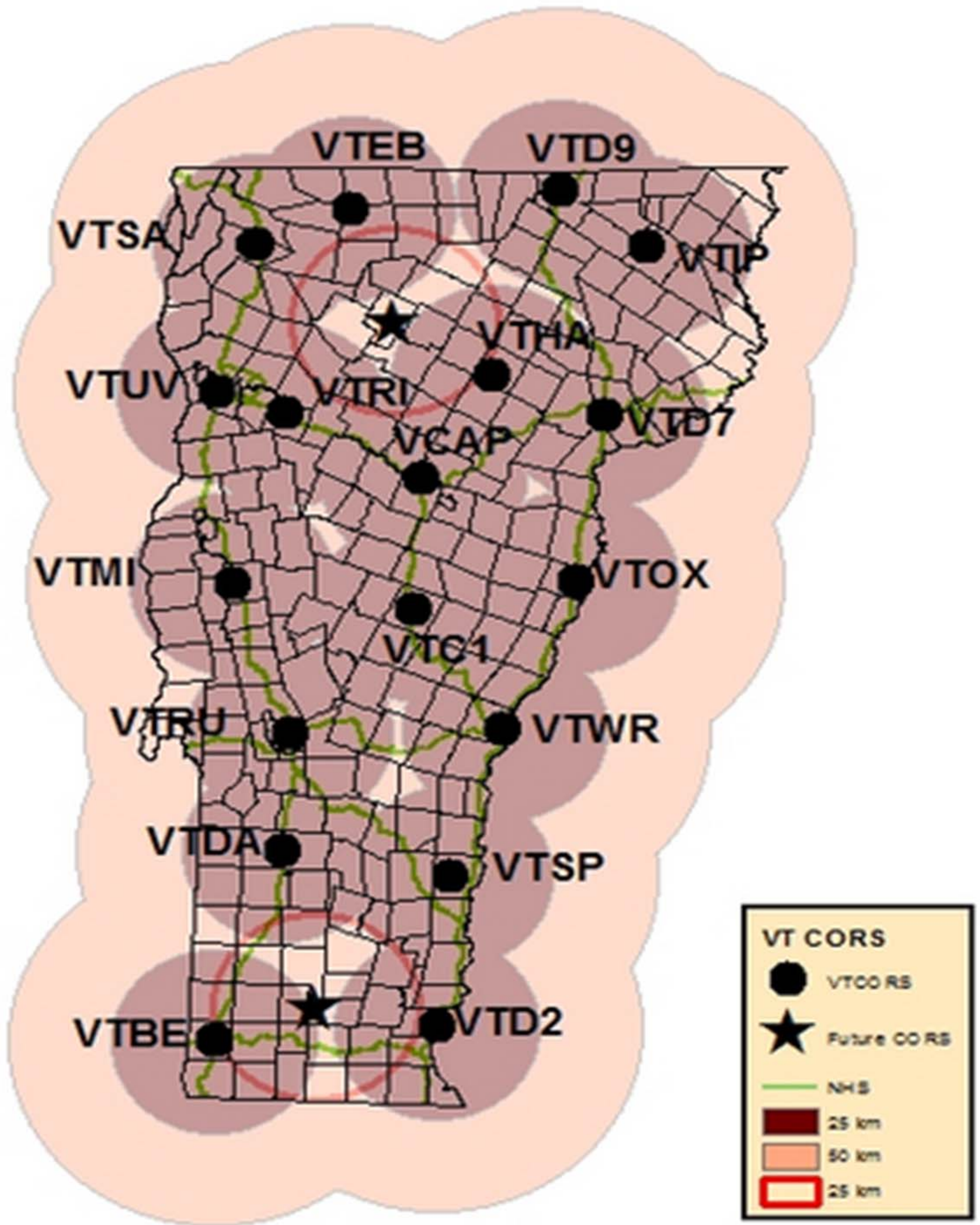
RTK

- Real Time Kinematics – R.T.K.
- Requires:
  - A base station – either mobile or fixed
  - Two radios – to communicate the correction
  - An upgrade of the receiver is necessary
  - Sometimes – repeater stations to fill in signal shadows
  - Once a customer has a base station, or a signal can be leased, adding additional units only requires a rover radio and a receiver upgrade.

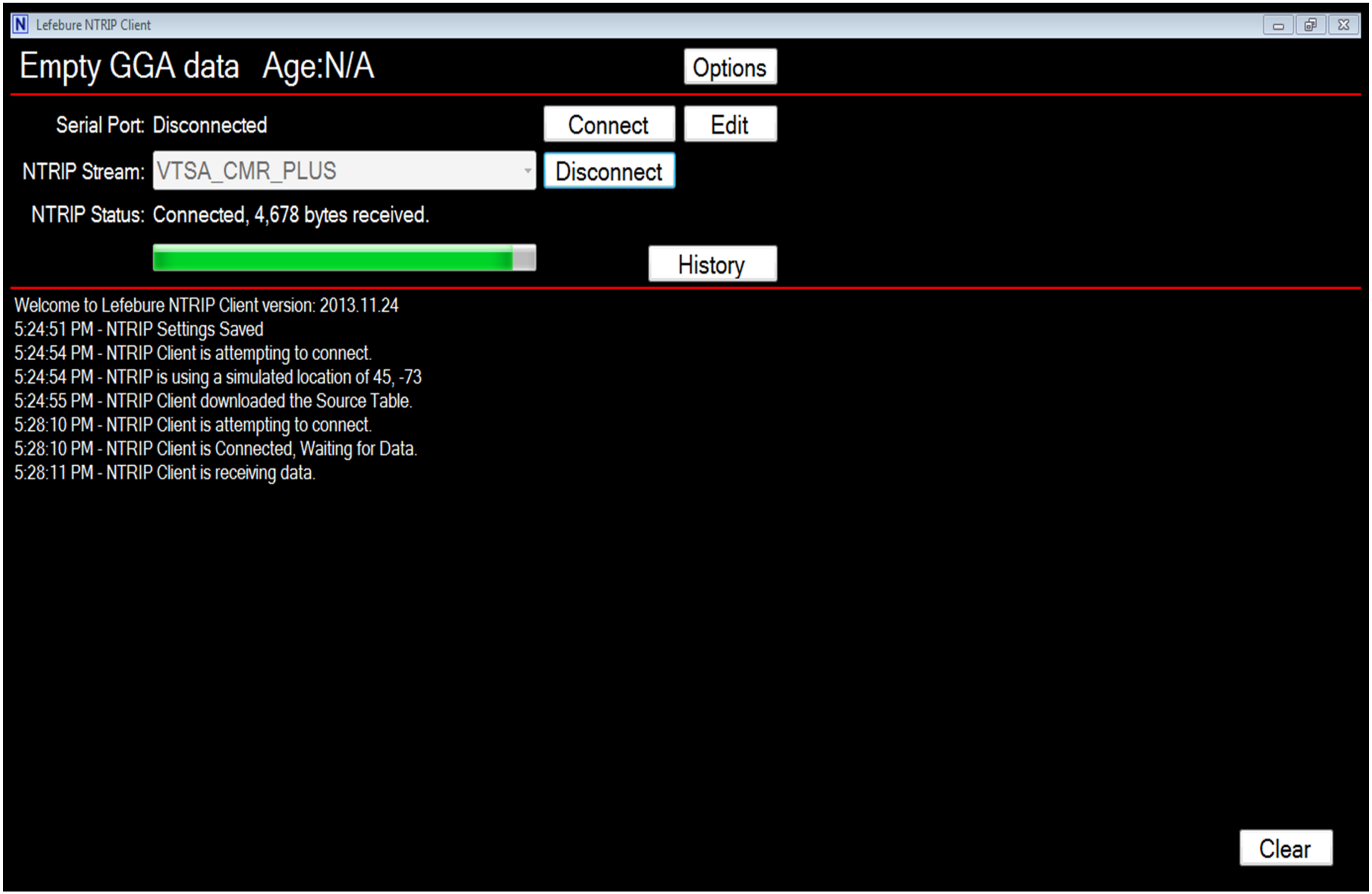


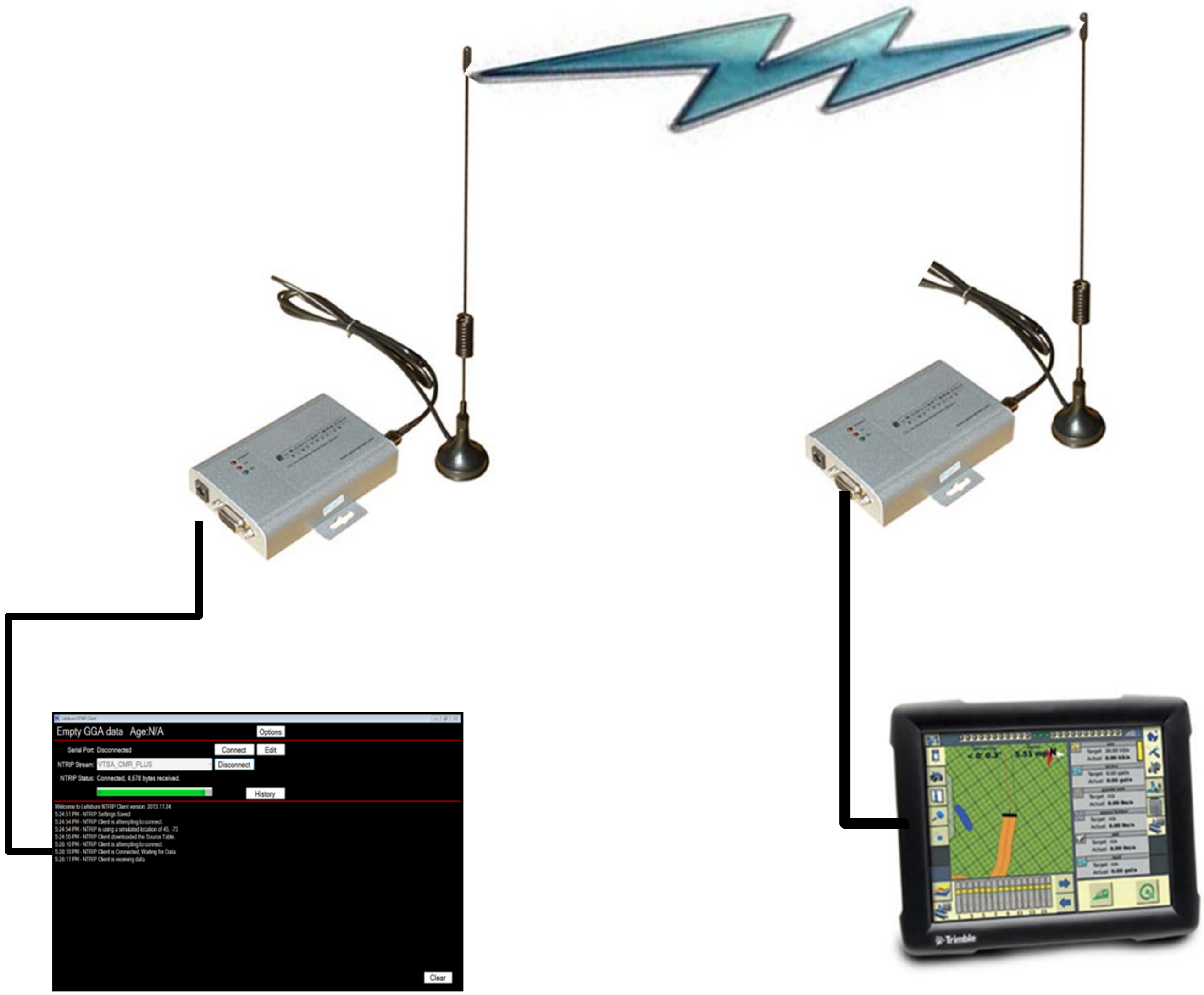
VT CORS (VECTOR) Interactive Map

Click CORS station on map for station information



NTRIP Client




Empty GGA data Age:N/A
Options
Serial Port: Disconnected
Connect
Edit
NTRIP Stream: VTSA_CMR_PLUS
Disconnect
NTRIP Status: Connected, 4,678 bytes received.
History
Welcome to Lefebure NTRIP Client version: 2013.11.24
5:24:51 PM - NTRIP Settings Saved
5:24:54 PM - NTRIP Client is attempting to connect.
5:24:54 PM - NTRIP is using a simulated location of 45, -73
5:24:55 PM - NTRIP Client downloaded the Source Table.
5:28:10 PM - NTRIP Client is attempting to connect.
5:28:10 PM - NTRIP Client is Connected, Waiting for Data.
5:28:11 PM - NTRIP Client is receiving data.
Clear
Trimble

DCM-300 MODEM

GSM Global Network Coverage[1]	√
Verizon Network Coverage[2]	√
Office Sync	√
Vehicle Sync	√
Vehicle Manager	√
CenterPoint VRS or RTX Correction Services	√
Third Party Correction Services	√

Notes:
1. With DCM 300G Model
2. With DCM 300C Model

EZ-Steer Features

- Electronic motor drive
- 50Hz Update Rate
- 15 minute install
- Fits > 1000 vehicles
- Compatible for:
  - EZ-Guide 250
  - FM-750
  - FM-1000

EZ-Pilot

- NEW low cost assisted steering solution
- Integrates steering actuator motor on the steering column
- Compatible with FM-1000 and FM-750 ONLY!
- Mid range steering accuracy
- Better than EZ-Steer

Auto Pilot

- Hydraulic steering
- Highest accuracy
- Less Clutter in the cab
- Permanent installation
- Steering sensor
- Faster response

Questions????

Strip-till in Vermont
Can it be viable?


Strip-Till

University of Minnesota

Table 8. Phosphate suggestions for corn production in Minnesota.*

		Soil test P (ppm)									
		v. low		low		medium		high		v. high	
Expected	Bray:	0-5		6-10		11-15		16-20		21+	
Yield	Olsen:	0-3		4-7		8-11		12-15		16+	
		Bdcst	Band	Bdcst	Band	Bdcst	Band	Bdcst	Band	Bdcst	Band
bu/acre		--------------------- P_2O_5 per acre to apply (lb per acre) --------------------									
< 100		60	30	40	20	25	20	10	10-15	0	10-15
100 – 124		75	40	50	25	30	20	10	10-15	0	10-15
125 – 149		85	45	60	30	35	25	10	10-15	0	10-15
150 – 174		100	50	70	35	40	30	15	10-15	0	10-15
175 – 199		110	55	75	40	45	30	15	10-15	0	10-15
200 +		120	60	85	45	50	35	15	10-15	0	10-15

** Use one of the following equations if a P_2O_5 recommendation for a specific soil test value and a specific expected yield is desired.*

P_2O_{5Rec} = [0.700 - .035 (Bray P ppm)] (expected yield)

P_2O_{5Rec} = [0.700 - (.044 (Olsen P ppm)] (expected yield)

No phosphate fertilizer is recommended if the soil test for P is higher than 25 ppm (Bray) or 20 ppm (Olsen).

University of Minnesota

Table 9. Potash suggestions for corn production in Minnesota.*

	Soil test K (ppm)									
	v. low		low		medium		high		v. high	
Expected	0-40		41-80		81-120		121-160		160+	
Yield	Bdcst	Band	Bdcst	Band	Bdcst	Band	Bdcst	Band	Bdcst	Band
bu/acre	--------------------- K_2O per acre to apply (lb per acre) -------------------									
< 100	100	50	75	40	45	30	15	10-15	0	10-15
100 – 124	120	60	90	45	50	30	20	10-15	0	10-15
125 - 149	145	75	105	55	60	40	20	10-15	0	10-15
150 - 174	165	85	120	60	70	40	25	10-15	0	10-15
175 - 199	185	90	135	70	80	50	25	10-15	0	10-15
200 +	205	105	160	80	90	55	30	10-15	0	10-15

** Use one of the following equations if a K_2O recommendation for a specific soil test value and a specific expected yield is desired.*

K_2O_{Rec} = [1.166 - .0073 (Soil Test K, ppm)] (expected yield)

No potash fertilizer is recommended if the soil test for K is 175 ppm or higher.

[redacted]

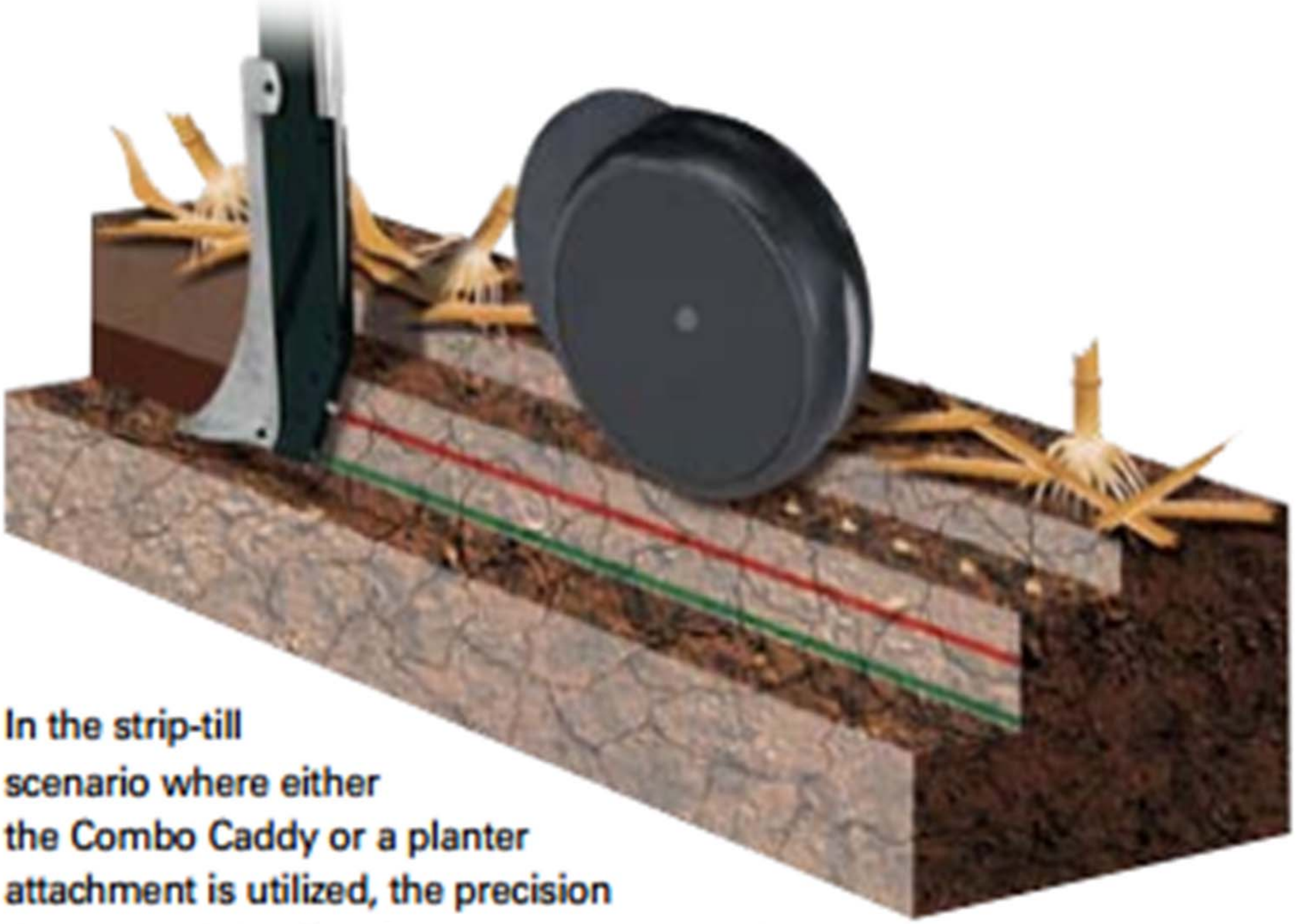

BLU-JET

12R30 Orthman 1tRIPr

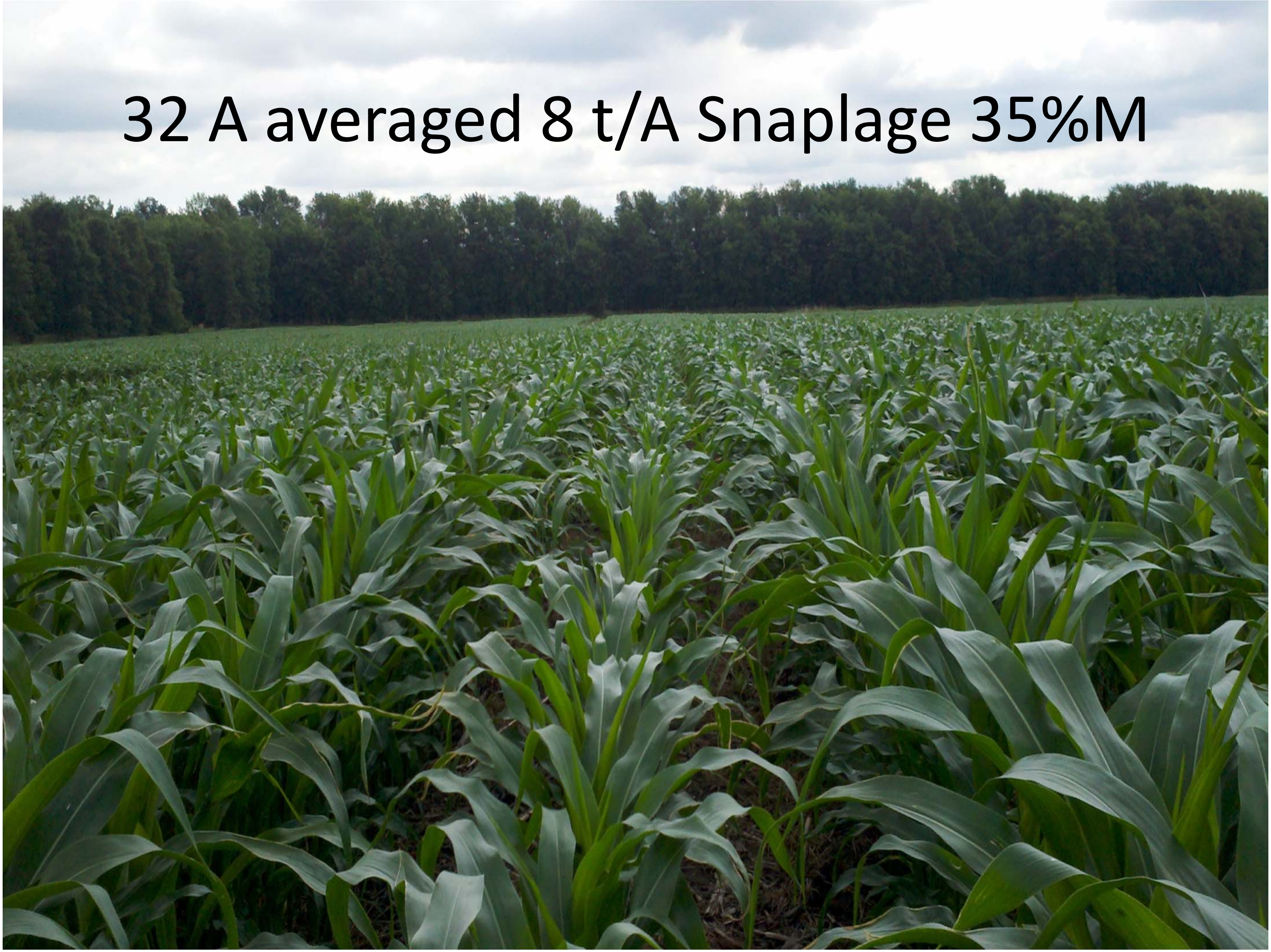
Striptiller ready to lay down some Strips!


Now the
Kverneland
Modification

1tRIPr
CAUTION



In the strip-till scenario where either the Combo Caddy or a planter attachment is utilized, the precision tillage shank is offset from seed placement by 2" as pictured above. The illustrated scenario allows for starter fertilizer 2" below the seed for early growth as well as additional deeper fertilizer to promote root development later in the plant life cycle.


32 A averaged 8 t/A Snaplage 35%M

Things to do differently for 2014

- Broadcast 200 lbs/A Sul-Po-Mag early
- Already Striptilled clay fields minus UAN
- Inject sidedress N instead of surface apply
- Herbicide sprayer follow planter (you never know when you'll get 10" of rain)

More Questions ????

[redacted]