Comparison of Precision Ag Tools –
Appropriate Use of Site Specific Technology

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Precision Agriculture - Definitions

- Precision Agriculture is site-specific management. This means the management of the land to the smallest unit economically possible. It’s the management whereby spatial variations in soil characteristics above (topography) and below grounds (physical, chemical, and biological) are recognized and treated accordingly.
- PA has the capability to control chemical, fertilizer, and seed rates to achieve the greatest output per amount of input.
- A technique to efficiently manage inputs and increase profits.
- A system in which technology is used to acquire knowledge that improves crop management decisions.

When Should We Use Precision Agriculture ?

- PA is a tool to Manage Yield and Soil Variability.
  - Is there sufficient variability to manage ?
- What is the Feasibility of the PA Technology?
  - Is the technology adapted to your crop and available in your area?
  - Is the technology affordable?
- Adoption of PA Technology.
  - If the PA technology is adopted will it increase yields or save you money?

Sugarcane Yield Variability

Methods

- Rebecca Plantation, Schriever, LA
  - 11/19/2001, 12/11/2002, 11/ 13/2003
  - Plant cane, 1st, 2nd ratoon LCP 85-384
  - 8 acres, (69 rows x 870 ft)
  - Plots, 6 rows x 50 ft

- GraLyn Plantation, Patoutville, LA
  - 12/18/2001, 11/19/2002, 10/22/2003
  - 4th, 5th, 6th ratoon, LCP 85-384
  - 9 acres, (60 rows x 1123 ft)
  - Plots, 6 rows x 50 ft

- Both experiments harvested with Cameco combine harvester.
- Plot weights via weigh wagon with billet sampler.
- All samples analyzed for sucrose at USDA/ARS Ardoyne Lab.

Each plot was 50 ft in length, the technician would signal operator when at the end of plot. Also note billet sampler on weigh wagon.

Another view of the weigh wagon and billet sampler. Also note scale console on tractor.

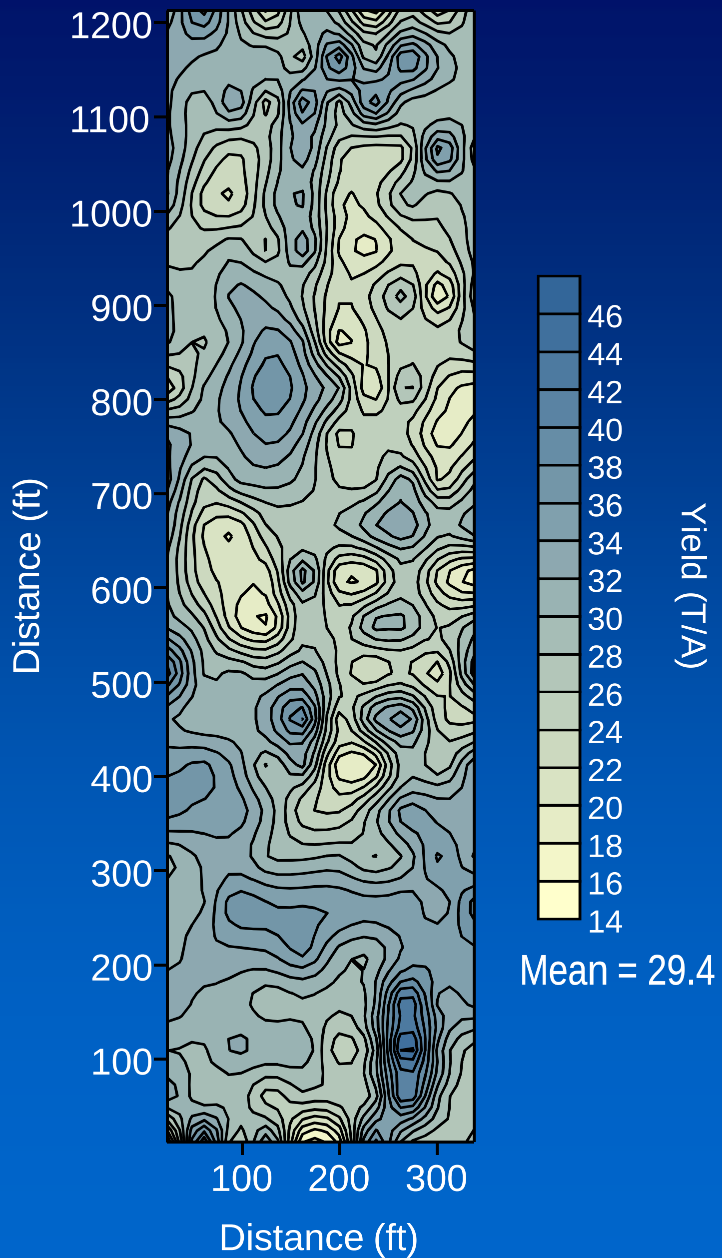
Yield Mapping Rebecca Plantation (LCP 85-384)

	2001 Plant Cane			2002 1st Stubble			2003 2nd Stubble		
	Tons T/A	TRS lb/T	Sugar lb/A	Tons T/A	TRS lb/T	Sugar lb/A	Tons T/A	TRS lb/T	Sugar lb/A
Mean	37.3	211.7	7,921	32.1	202.2	6,519	37.5	196.7	7,336
Min	15.9	123.2	2,361	13.5	122.3	2,608	24.0	133.0	4,607
Max	60.2	254.1	13,006	60.7	258.4	13,819	49.5	260.3	8,154
CV	17.0	10.8	20.9	23.6	9.7	26.8	13.0	9.7	13.3
Norm.	N	N	N	N	N	N	Y	Y	N

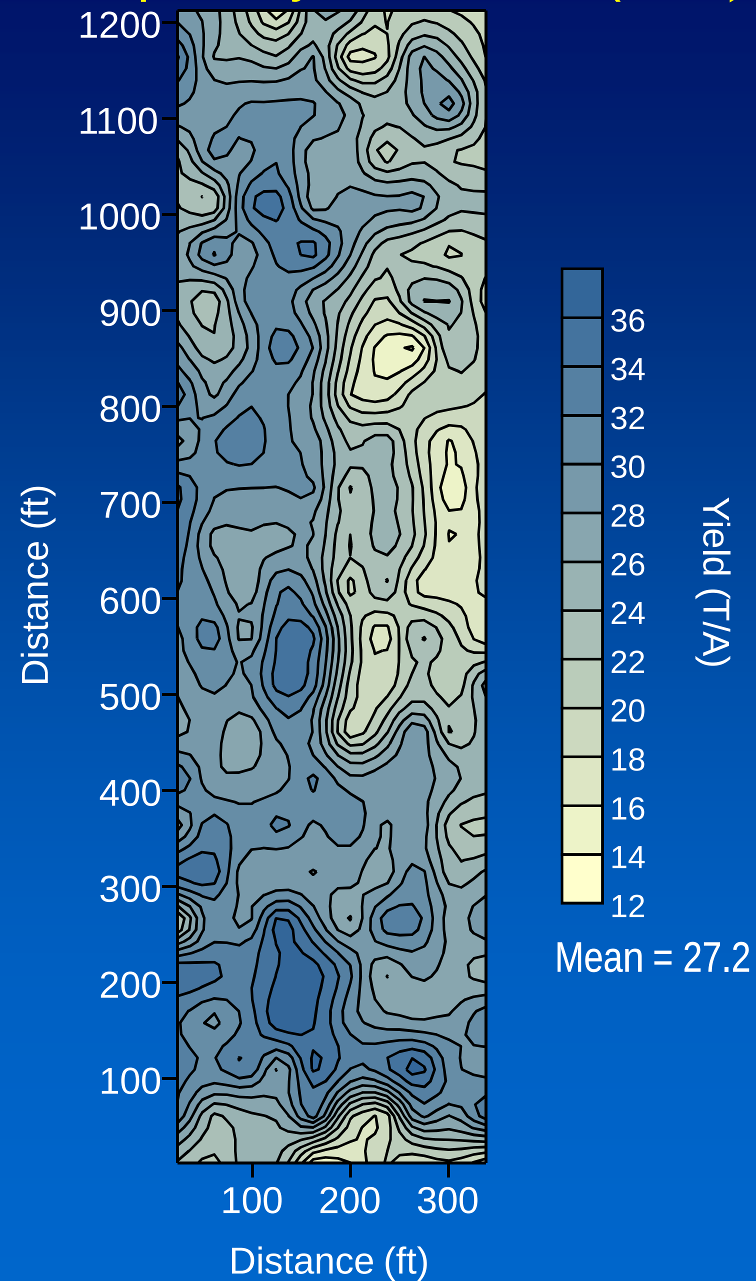
Yield Mapping GraLyn Farms (LCP 85-384)

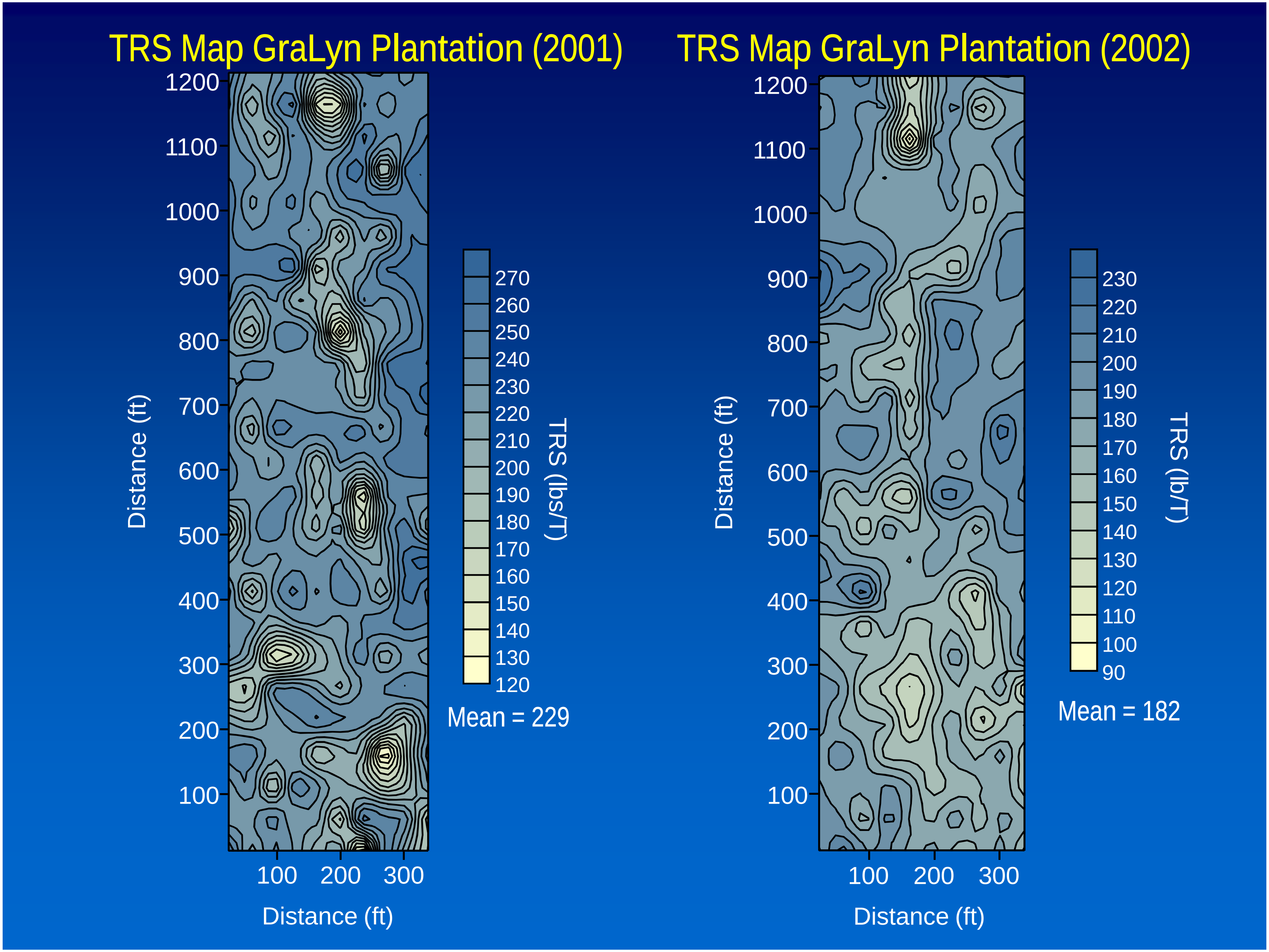
	2001 4th Stubble			2002 5th Stubble			2003 6th Stubble		
	Tons T/A	TRS lb/T	Sugar lb/A	Tons T/A	TRS lb/T	Sugar lb/A	Tons T/A	TRS lb/T	Sugar lb/A
Mean	29.4	229.3	6691	27.2	181.9	4,907	23.7	199.6	4,684
Min	13.5	100.5	2685	12.8	78.1	2,340	10.5	116.3	1,947
Max	51.4	280.3	11,100	39.4	235.1	7,317	41.3	242.5	8,097
CV	21.8	13.8	23.6	22.3	12.6	22.0	25.0	10.2	25.9
Norm.	Y	N	Y	N	N	Y	Y	N	Y

Yield Map GraLyn Plantation (2001)



Yield Map GraLyn Plantation (2002)




TRS Map GraLyn Plantation (2001)
Distance (ft)
1200
1100
1000
900
800
700
600
500
400
300
200
100
100
200
300
Distance (ft)
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
TRS (lbs/T)
Mean = 229
TRS Map GraLyn Plantation (2002)
Distance (ft)
1200
1100
1000
900
800
700
600
500
400
300
200
100
100
200
300
Distance (ft)
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
TRS (lb/T)
Mean = 182

Does Sugarcane Yield Exhibit Significant Variability?

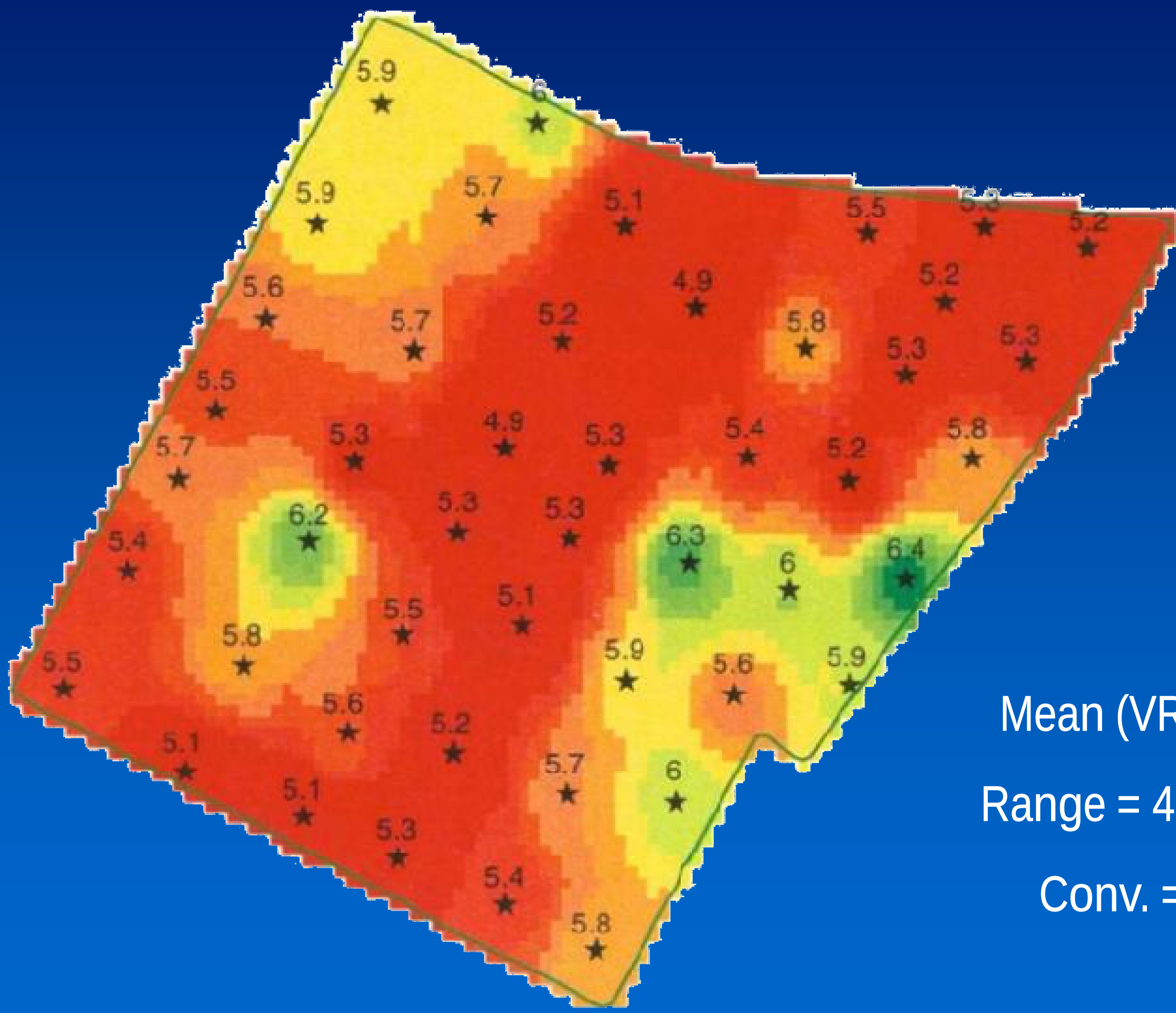
- Yes!!
- Substantial variability was exhibited in cane and sugar properties in all years and locations with the CV ranging from 10-14% for TRS, 13-25% for gross cane yield and 13-27% for sugar yield.

Soil pH Variability

Soil Grid Sampling

- Naquin Farms, Schriever, LA (49 acres).
- GPS based sampling (G&H Seed, Crowley, LA) and Farmworks.
- Grid size: 1 acre grids.
- Fields also sampled by conventional method (composite).
- Soil Analysis: pH, lime requirement.

Naquin Farms Soil pH

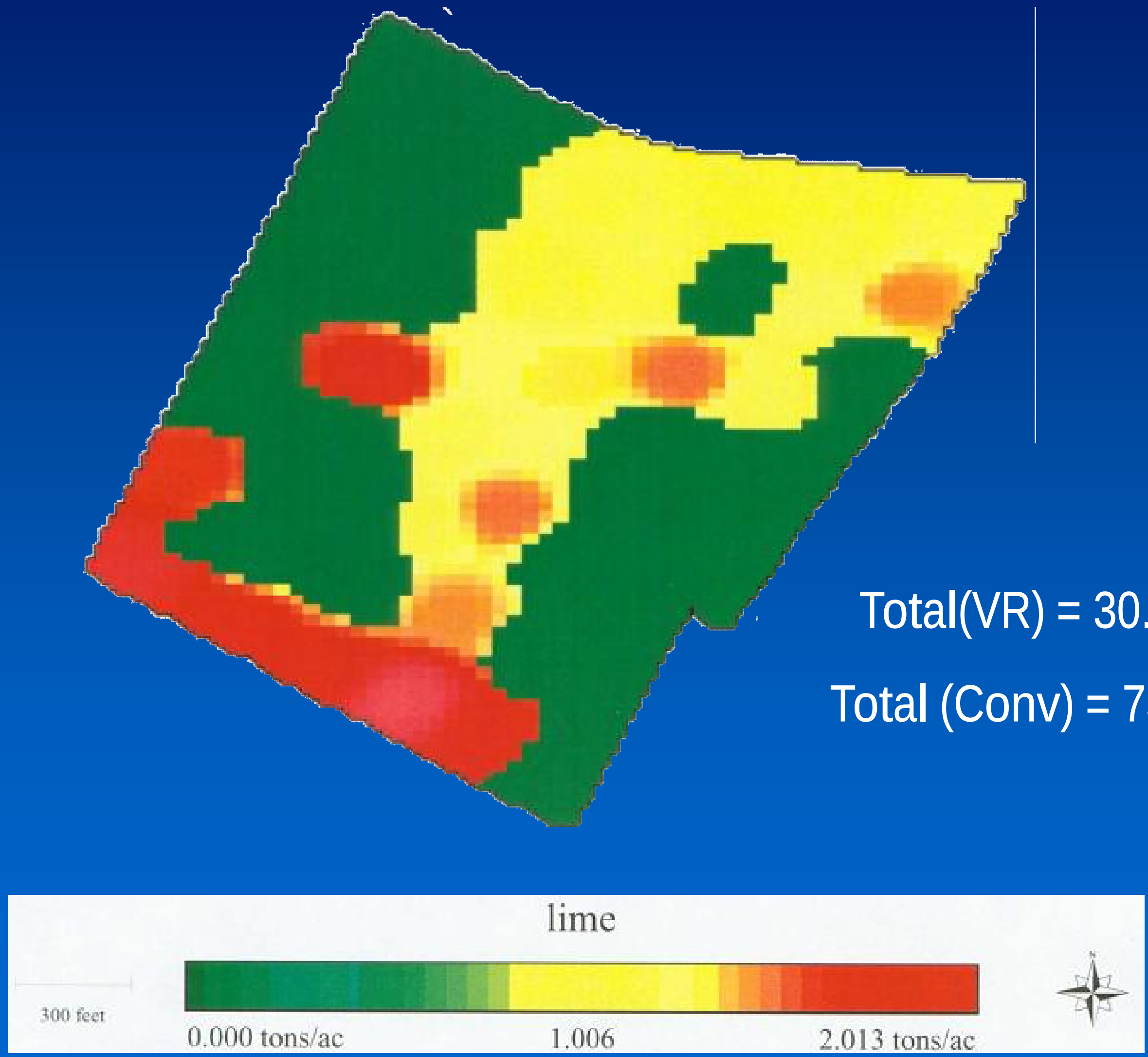


Mean (VR)= 5.5

Range = 4.9 – 6.4

Conv. = 5.7

Lime Application Map



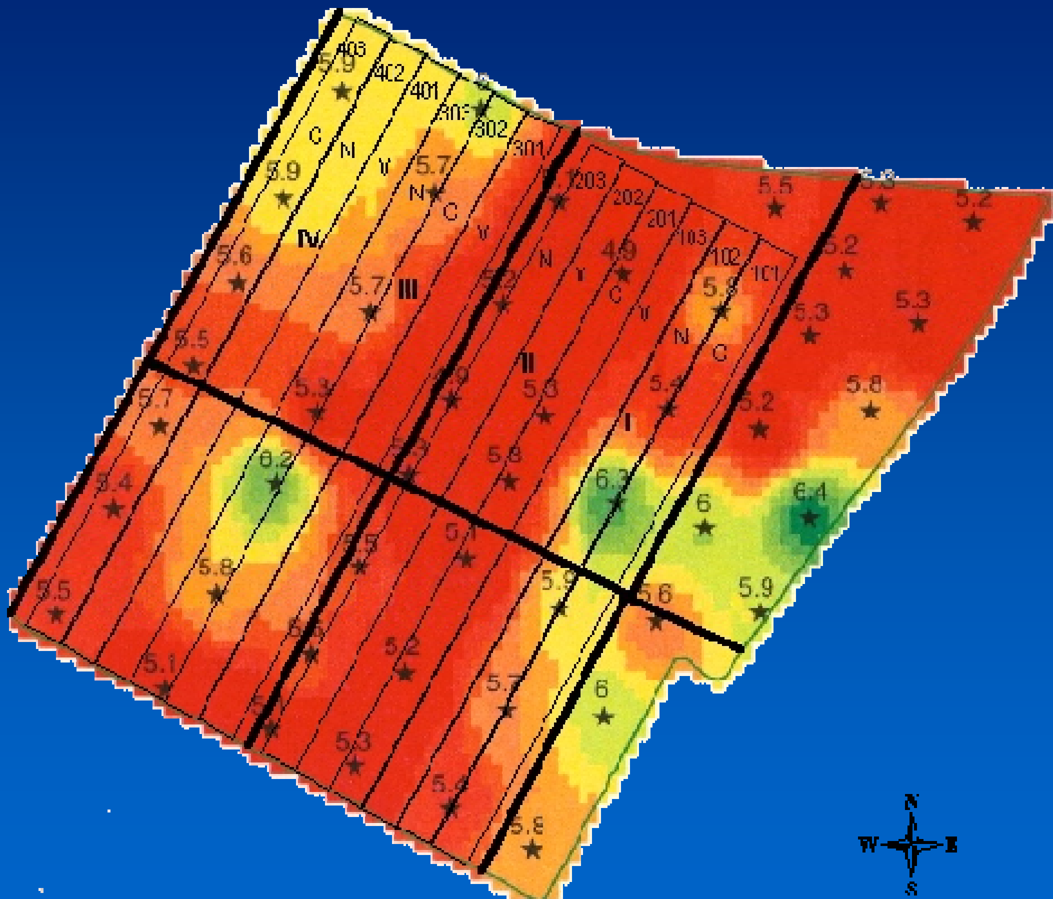
Total(VR) = 30.6 tons

Total (Conv) = 73.5 tons

Do Sugarcane Soils Exhibit Significant Variability?

- Yes!!
- Soil pH varied from 4.9 to 6.4 and lime rate from 0 to 2 tons/A.
- Is Variable-rate technology available?
  - Yes!!

Variable Rate Lime Test



- Naquin Farms (49 acres)
- Plots (1450 ft x 14 rows (80 ft)
- 3 Treatments, 4 Reps
  - No Lime
  - Conv, Lime (1 T/A)
  - VR Lime (0 – 2 T/A)
- VR application maps based on 1 acre grids.
- Conv. And VR Treatments applied with terrigator.
- Strips harvested in 100 ft sections to map yield and determine total plot weight.
- Cane and sugar yields

VR Application

• Three wheel Ag Chem terrigator.

• Application speed 23 mph (45 mph in pastures).

• Custom application (Purchase Cost ~ $250,000)

• Cab equipped with VR Controller, GPS and field computer.

• Fertilizer or lime will applied in accordance with the VR prescription map.

• Program will generate "As-Applied" map.

VR Application (Alternative)

- 5 ton Newton Crouch Lime-Fertilizer Buggy.
- Application speed 5-7 mph.
- Grower application
(Purchase Cost ~ $20,000)

- Cab equipped with VR Controller, GPS and field computer.
- Fertilizer or lime will applied in accordance with the VR prescription map.
- Program will generate “As-Applied” map.

Mid-Tech Computer, Rate Controller, Datalink, Boom Switch and GPS

Mid-Tech Regulating Valve, Flowmeter and Shutoff Valves (Flow Based System)

VR Lime Test Results, Naquin Farms 2002-2004

Treat ment	**Cane T/A**	**TRS lb/T**	**Sugar lb/A**	**Cane T/A**	**TRS lb/T**	**Sugar lb/A**	**Cane T/A**	**TRS lb/T**	**Sugar lb/A**
	Plant Cane			1st Ratoon			2nd Ratoon		
No Lime	27.1	199	5456	33.2	218	7219	24.0	241	5795
Conv. Lime	34.0	199	6833	36.3	221	8031	28.0	236	6600
VR Lime	29.4	199	5848	33.7	227	7642	25.0	236	5901
LSD (5%)	2.8	NS	622	2.8	5.2	483	1.4	4.6	351

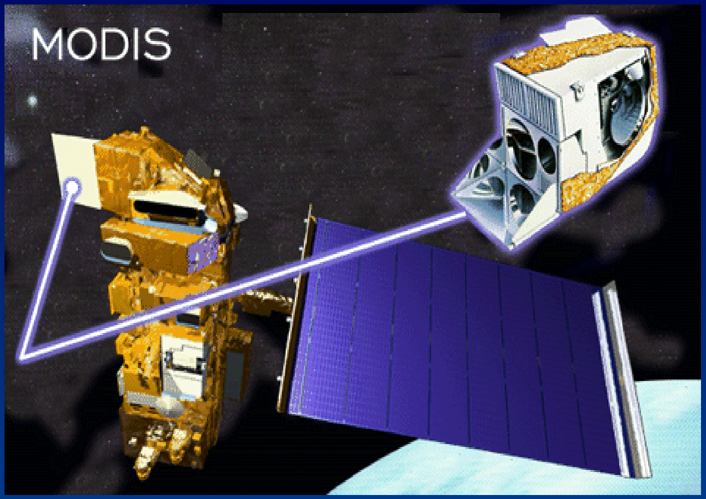
Summary

- **Uniform and VR lime application improved cane and sugar yields with the uniform method resulting in higher cane and sugar yields in 2002, 2003 and 2004. The VR method resulted in higher TRS in 2003. VR lime application reduced the total lime applied by almost 60% as compared to uniform application.**

- **Is the technology affordable??**
  - **Yes, for variable rate application technology.**
  - **Yes, if application (management) zones are created with EC.**
  - **No, if zones are created with grid sampling.**

Precision Ag Applications for Sugarcane

What are we working on and what is the technology's potential?



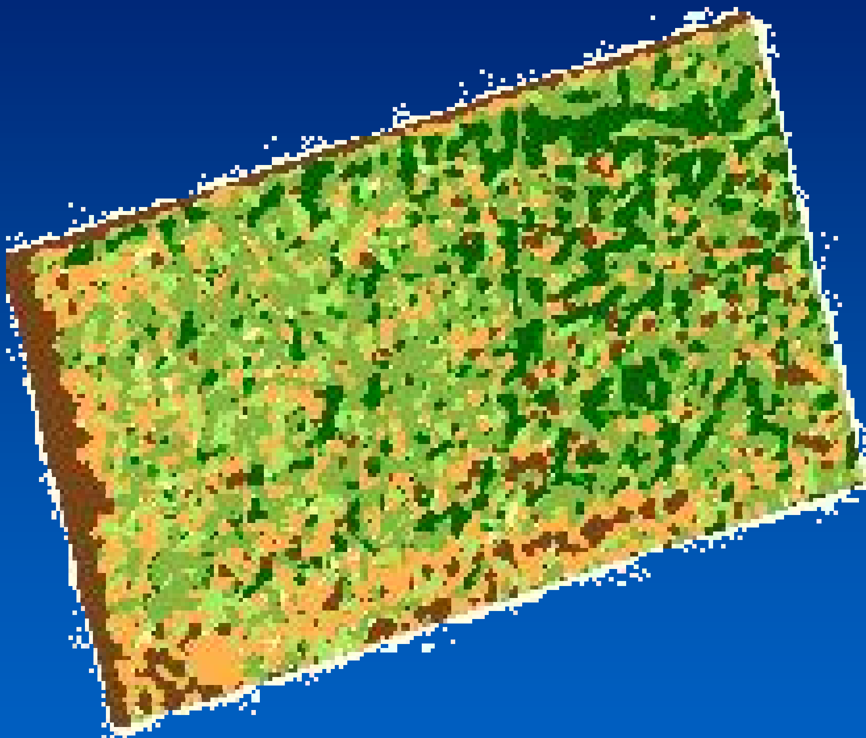
Remote Sensing is "defined as the acquisition of information about an object without being in physical contact with it."

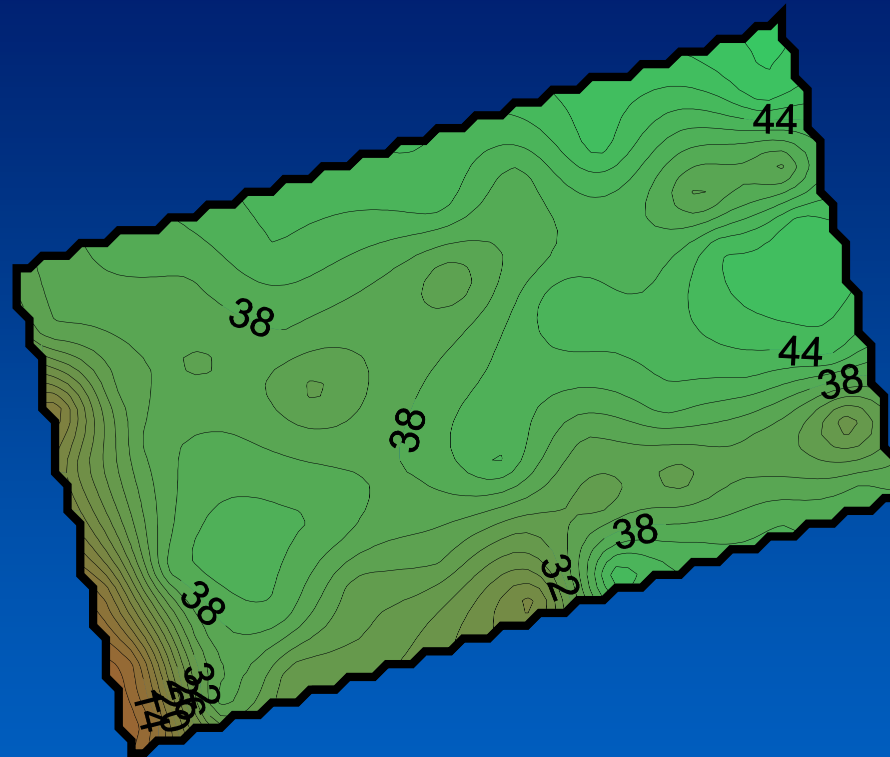
Methods

- Naquin Farms, Schriever, LA
  - 1st ratoon HoCP 96-540 - (39 acres)
  - 1st ratoon L 97-128 - (13 acres)

- Aerial imagery obtained November 6, 2006.
- Fields harvested November 20, 2006.
- All experiments harvested with Cameco combine harvester.
- Biomass estimates (gross cane yields) using weigh wagon.
  - Plots 100 ft x 10 rows (60 ft).

Magnolia Plantation, Schriever , LA
L97-128 (1st Ratoon) - Biomass Estimates





Remote Imagery

November 6, 2006

InTime Flight @12,000 ft

2-Meter Resolution

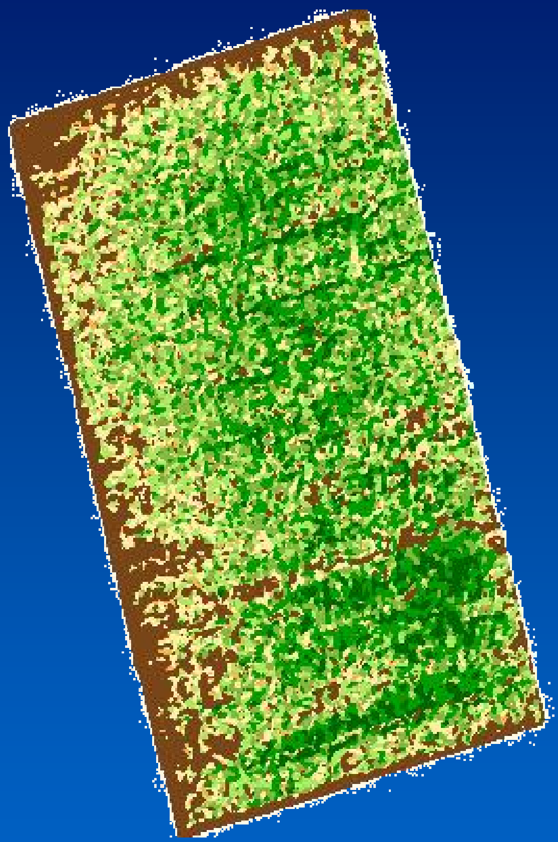
Actual Weights

November 20, 2006

Range: (16 – 51 T/A)

Mean: 38 T/A

Magnolia Plantation, Schriever, LA
HoCP 96-540 (1st Ratoon) - Biomass Estimates

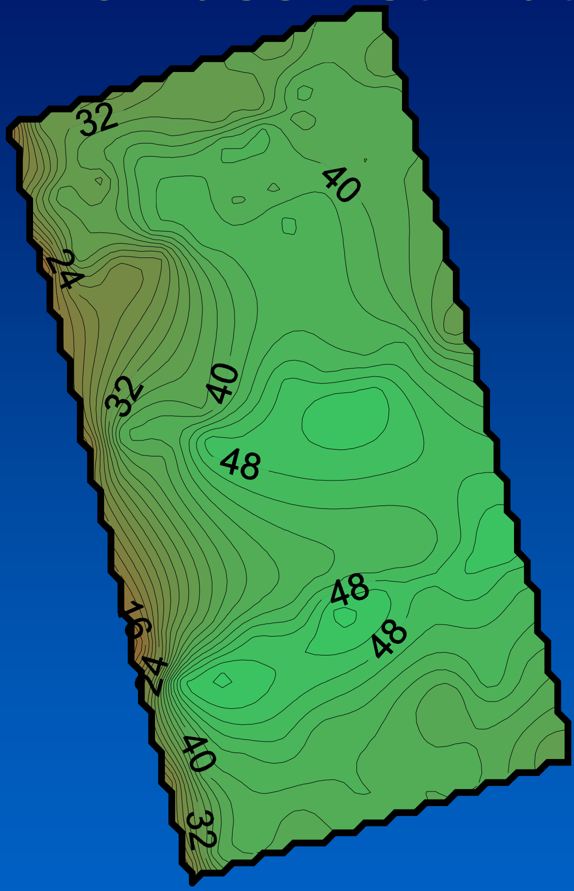


Remote Imagery

November 6, 2006

InTime Flight @12,000 ft

2-Meter Resolution



Actual Weights

November 20, 2006

Range: (12 – 52 T/A)

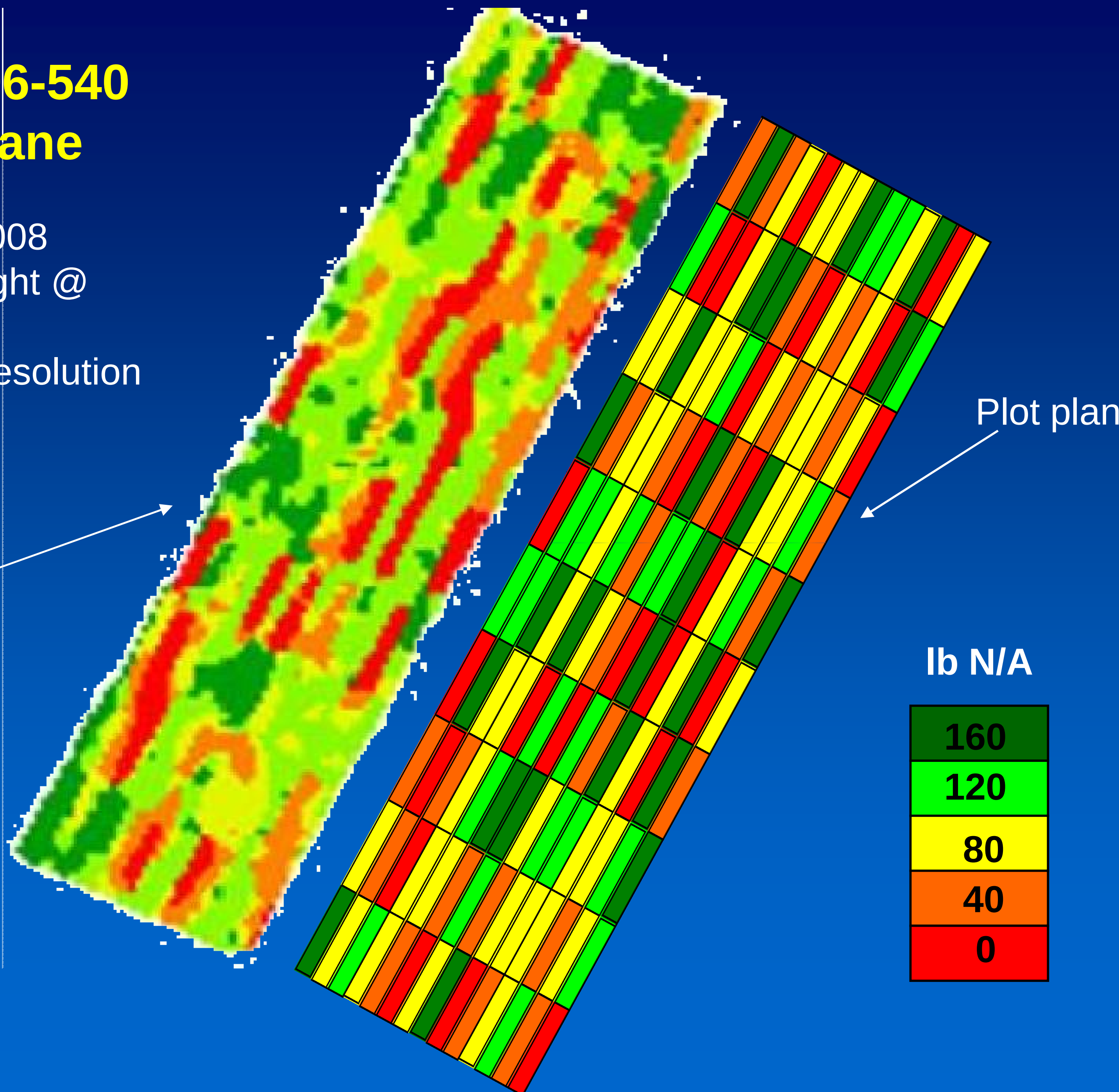
Mean: 40 T/A

Remote Sensing of Nitrogen Stress in Nitrogen Fertility Trials

- Gravois Farms – HoCP 96-540, PC, 1st Stubble.
- 3 rows x 100-ft, 8 reps
- 0, 40, 80, 120, 160 lbs N/A (32% UAN)
- Aerial imagery obtained July 14, 2008, August 18, 2008.
- No ripener applied.

HoCP 96-540
Plant Cane

July 14, 2008
InTime Flight @
12,000-ft
2-Meter Resolution
Vari-N



Summary of Remote Sensing Studies

- Aerial imagery could be used to identify areas with lower biomass and these areas were correlated with lower yields (T/A).

- Aerial imagery could be used to effectively identify areas in the field undergoing nitrogen stress.

- Potential Uses:
  - Development of harvest schedules to maximize efficiency.
  - Identification of fields requiring supplemental nitrogen.
  - Identification of management zones for variable rate N application the following season.
  - Identification of zones for variable rate ripener application (based on biomass).

- Is the technology available in your area?
  - Uncertain for imagery from airplanes (InTime) although cost-effective (1-2 $/a.)
  - Yes for satellites, but not perhaps economically at a sufficient resolution level.

Yield Mapping in Sugarcane

- The adoption of Precision Agriculture by the Louisiana Sugarcane Industry has been slowed somewhat due to the unavailability of a working yield monitor for the sugarcane chopper harvester. Several were evaluated in Louisiana from 2002 to 2007, but results were inconsistent.

  –Load-cells on elevator

  –Infra-red profile detector on elevator

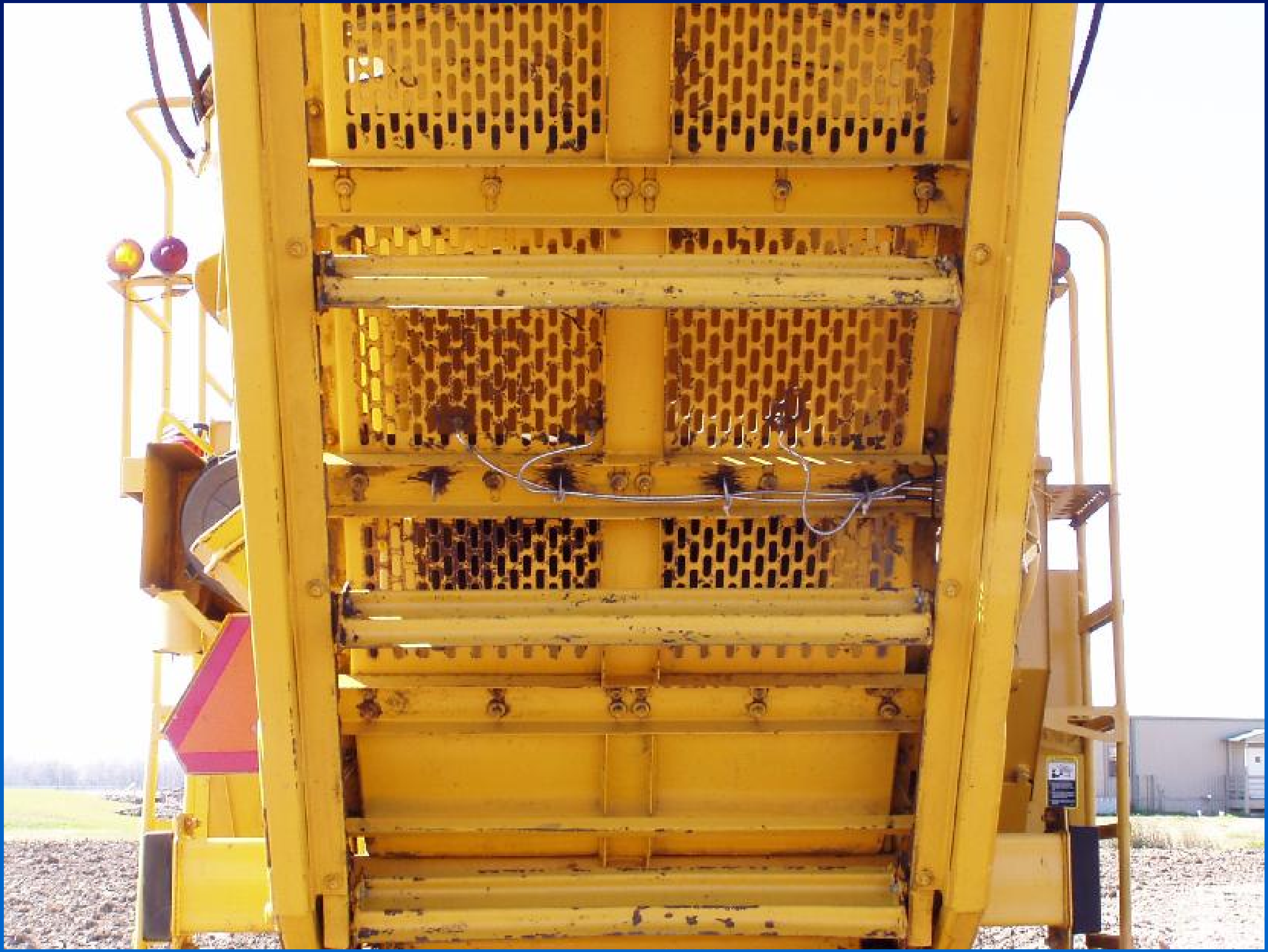
  –Ultra-sonic profile detector on elevator

  –Dr. Randy Price (Kansas State University, Ag Engineering) developed several fiber - optic, “duty-cycle”, yield monitor that we are currently testing.

    - Below Elevator
    - Above Elevator

Duty-Cycle – Percentage of time that sensors “sees” cane vs. does not “see” cane, from both above and below elevator. Above elevator sensor also attempts to estimate total height of cane on elevator.

Experimental Yield Monitor (Below Elevator Optical Sensor)



Experimental Yield Monitor (Below Elevator Optical Sensor)

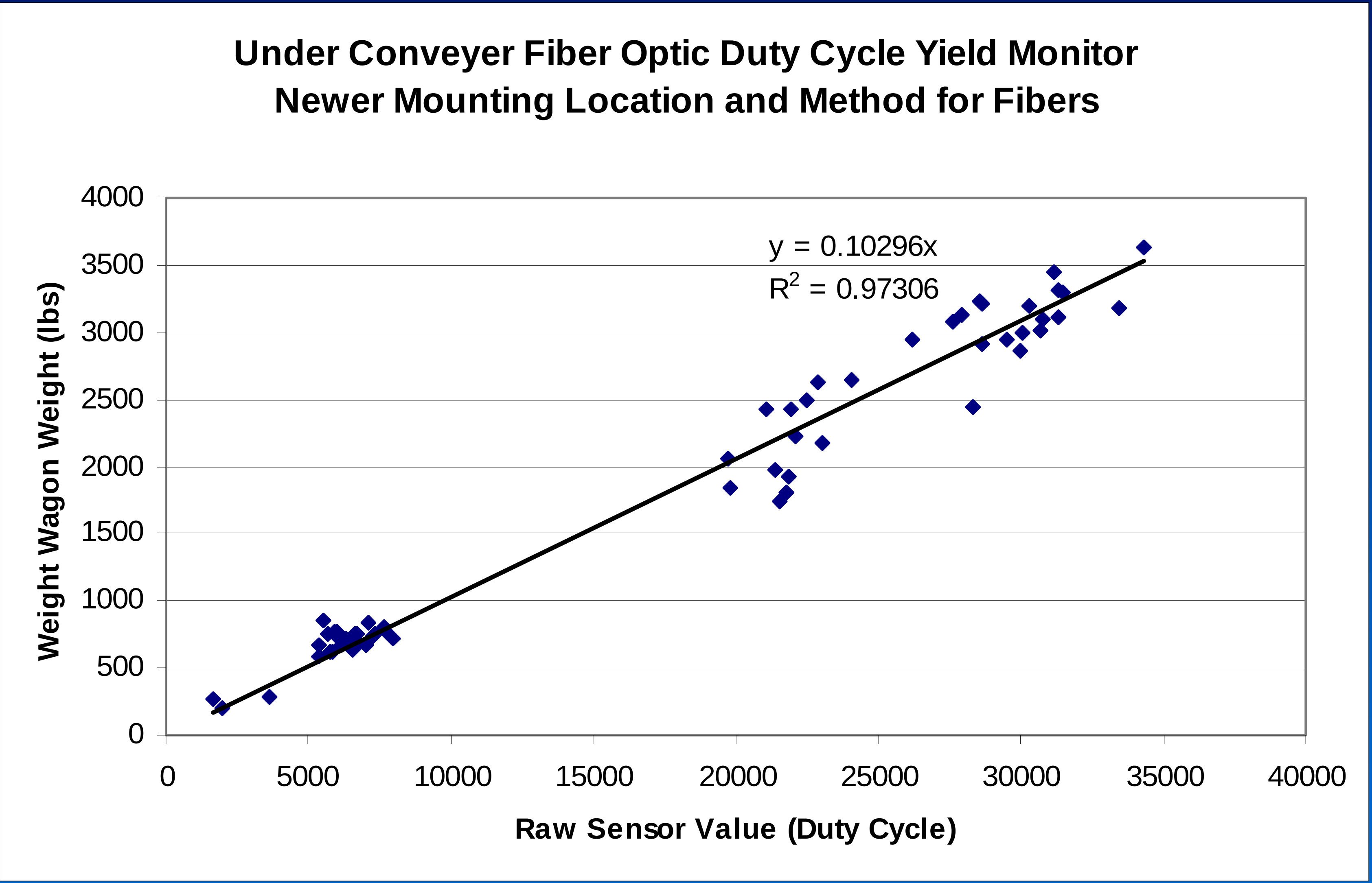
Experimental Yield Monitor (Below Elevator Optical Sensor)

Experimental Yield Monitor (Above Elevator Optical Sensor)

Experimental Yield Monitor (Above Elevator Optical Sensor)

Experimental Yield Monitor (Above Elevator Optical Sensor)

Experimental Yield Monitor (Under Elevator Optical Sensor)

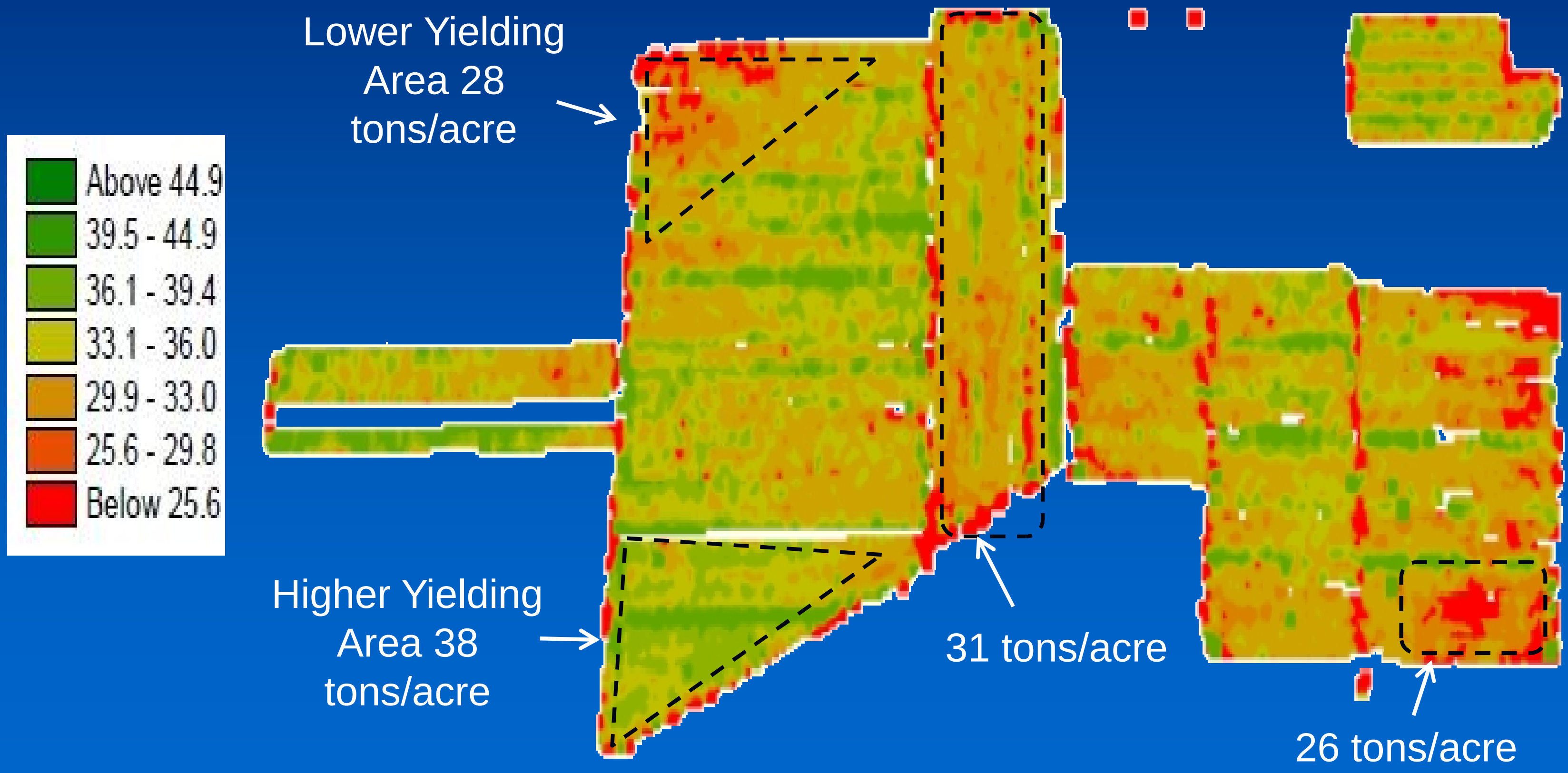


Percent Error for Truck Load Out Weights

Same Day Calibration

Raw Sensor Reading	Actual Weight (lbs)	Estimated Weight (lbs)	Error (%)
411000	43200	42000	2.78
460000	46222	47007	1.70
437000	45420	44657	1.68
475000	47560	48540	2.06
		Aver. Error	2.05
		St. dev.	0.51

Field Yield Maps



Summary Yield Monitor Trials

- Linear calibration results were obtained for both the below and above conveyor yield monitors.
- The monitor achieved a 2.0% accuracy per day on weights near 46,000 lbs and maintained a 2.5% overall accuracy (standard deviation 2.55) for several weeks when calibration loads were added per day.
- Is the technology available in your area?
  - Not yet, but in the near future.
- Is the technology affordable?
  - Yes, total cost ~ \$4,000 – \$5,000.

Conclusions

- Substantial progress has been made in Precision Agriculture Technologies for sugarcane. However, if we look where the technology is for other crops we still have a long journey ahead of us.


Questions ?