

AGR 1515 Intro to GPS

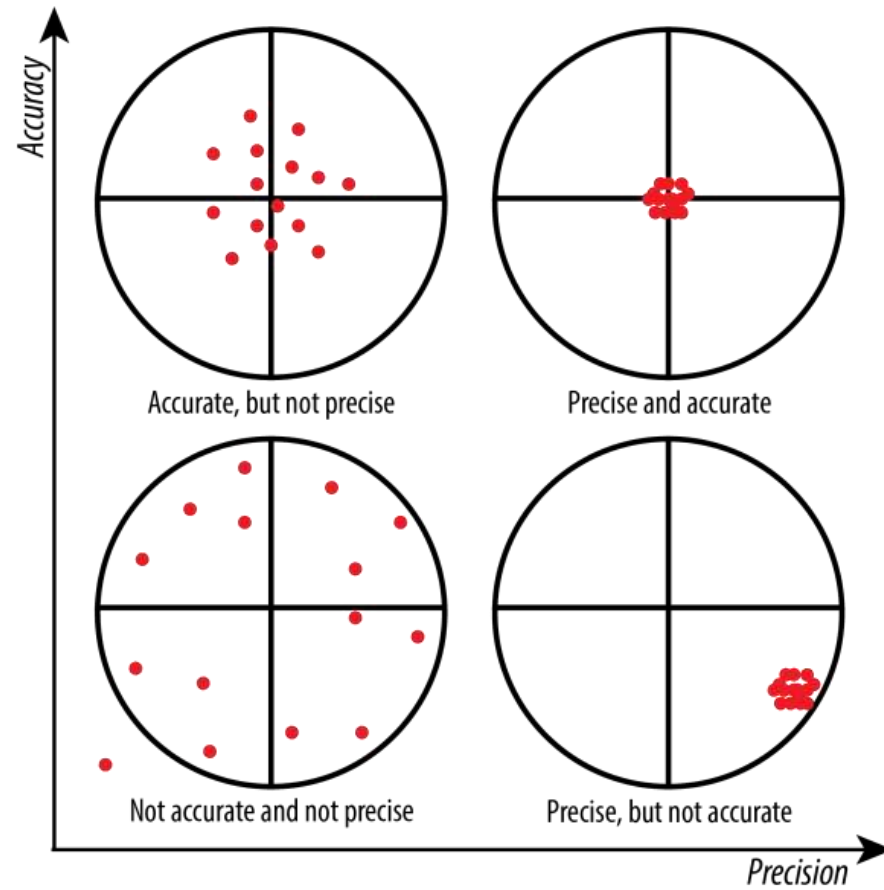
Adam Wehrman

Lecture 5

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GPS Accuracy



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How do we ensure precision and accuracy?

- Differential GPS
- RTK
- ...Basically making corrections for GPS errors.

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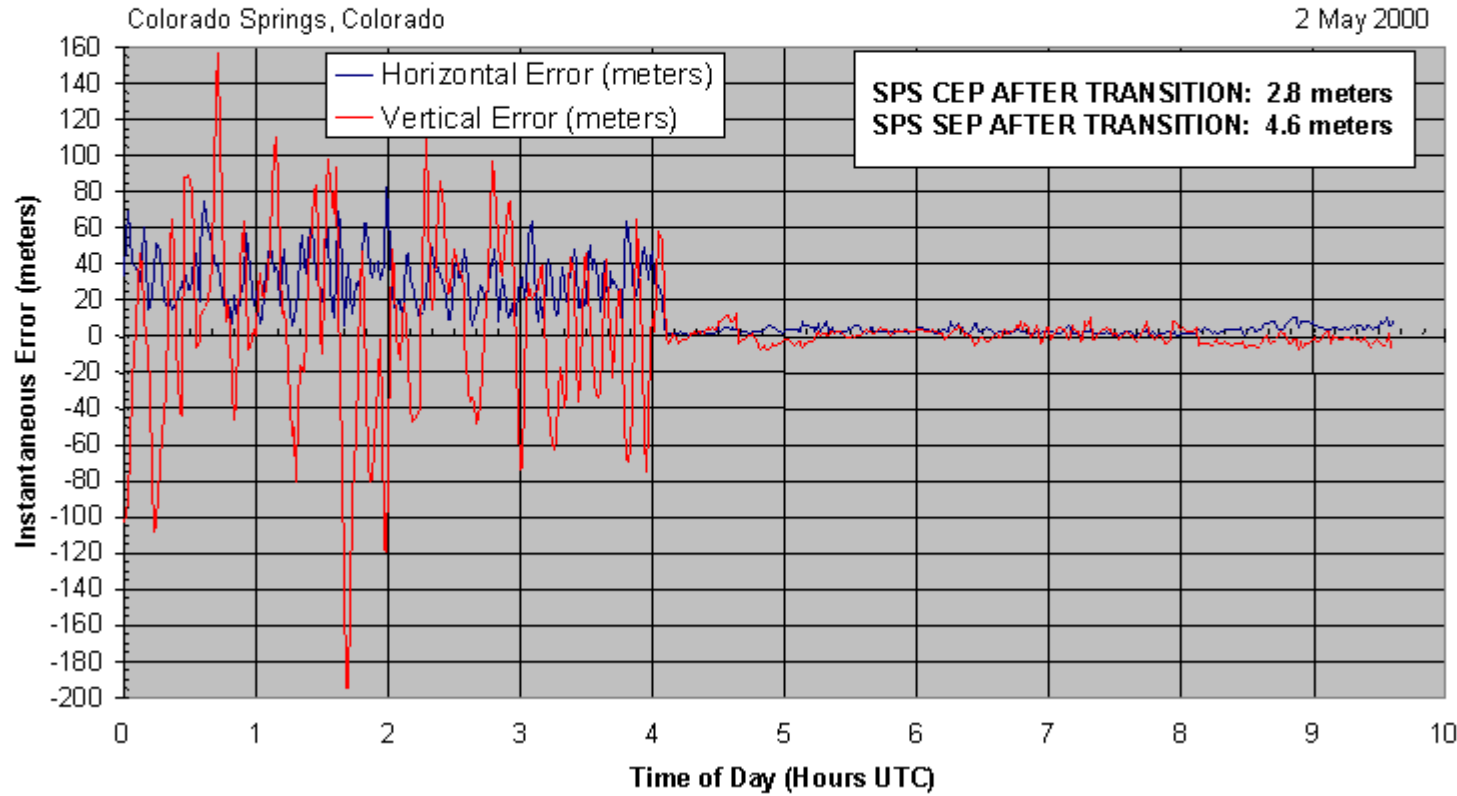
Selective Availability

- Intentional degradation of public GPS signals
- Implemented for national security reasons
- Accuracy was within about 100 meters

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SA Transition -- 2 May 2000



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Selective Availability

- Obviously people were afraid this would be turned back on
- In September 2007, US announced procurement of new GPS Satellites
- These new satellites didn't have the SA feature

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GPS Accuracy

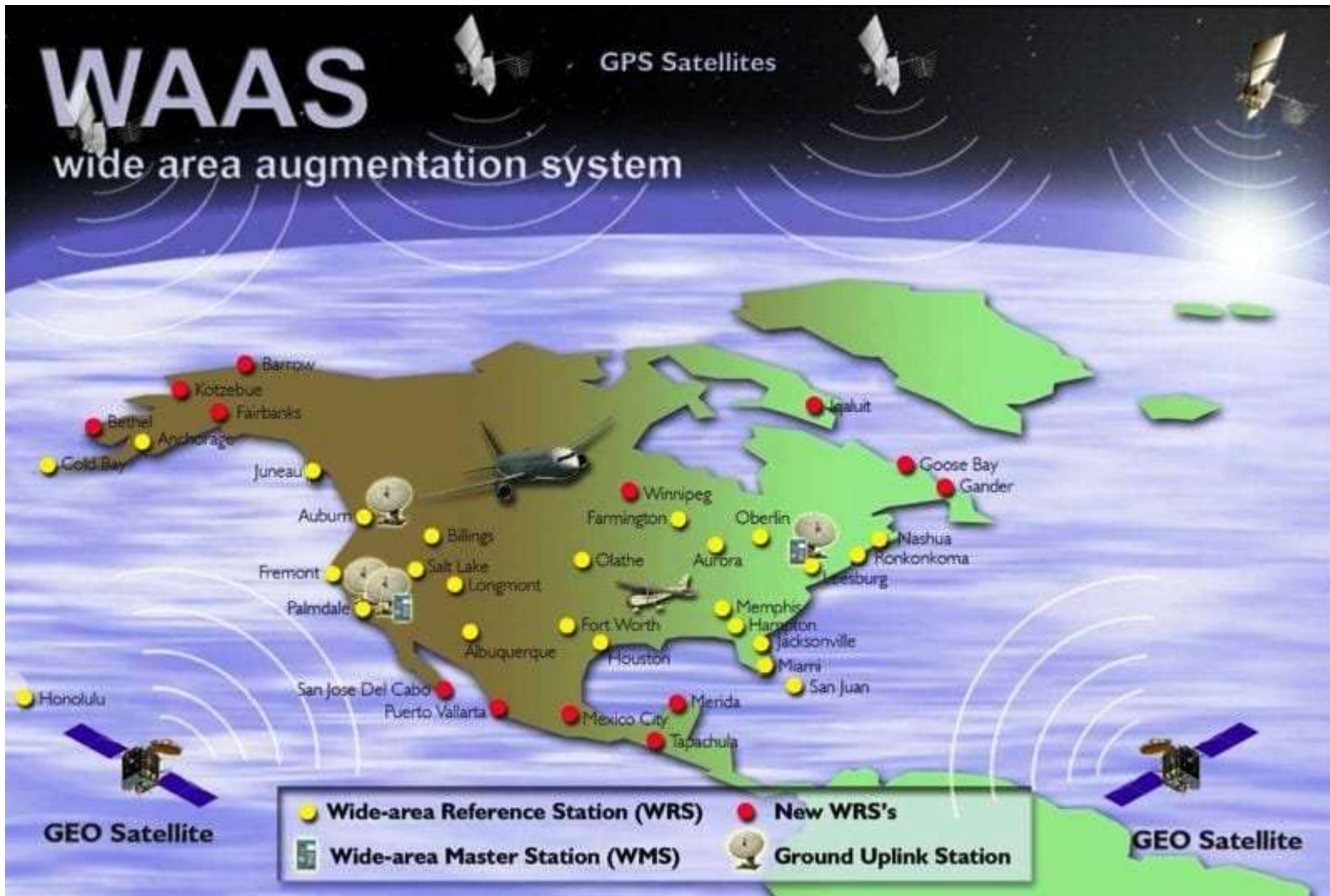
- With Selective Availability off, accuracy closer to 15 meters
- Differential GPS accuracy is 3-5 meters, down to 40 centimeters
- WAAS, less than 3 meters

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Wide Area Augmentation System

- System of satellites and ground stations
- Originally developed for precision flight approaches
- Multiple ground reference stations across US
- Help make corrections from...
 - Clock errors
 - Atmospheric delay
- Sent back to receivers via stationary satellites

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Phones

- Augmented GPS
- Based on WiFi signals, cell towers, etc.
 - These act as “base stations”
- What happens if we go into “Airplane Mode?”

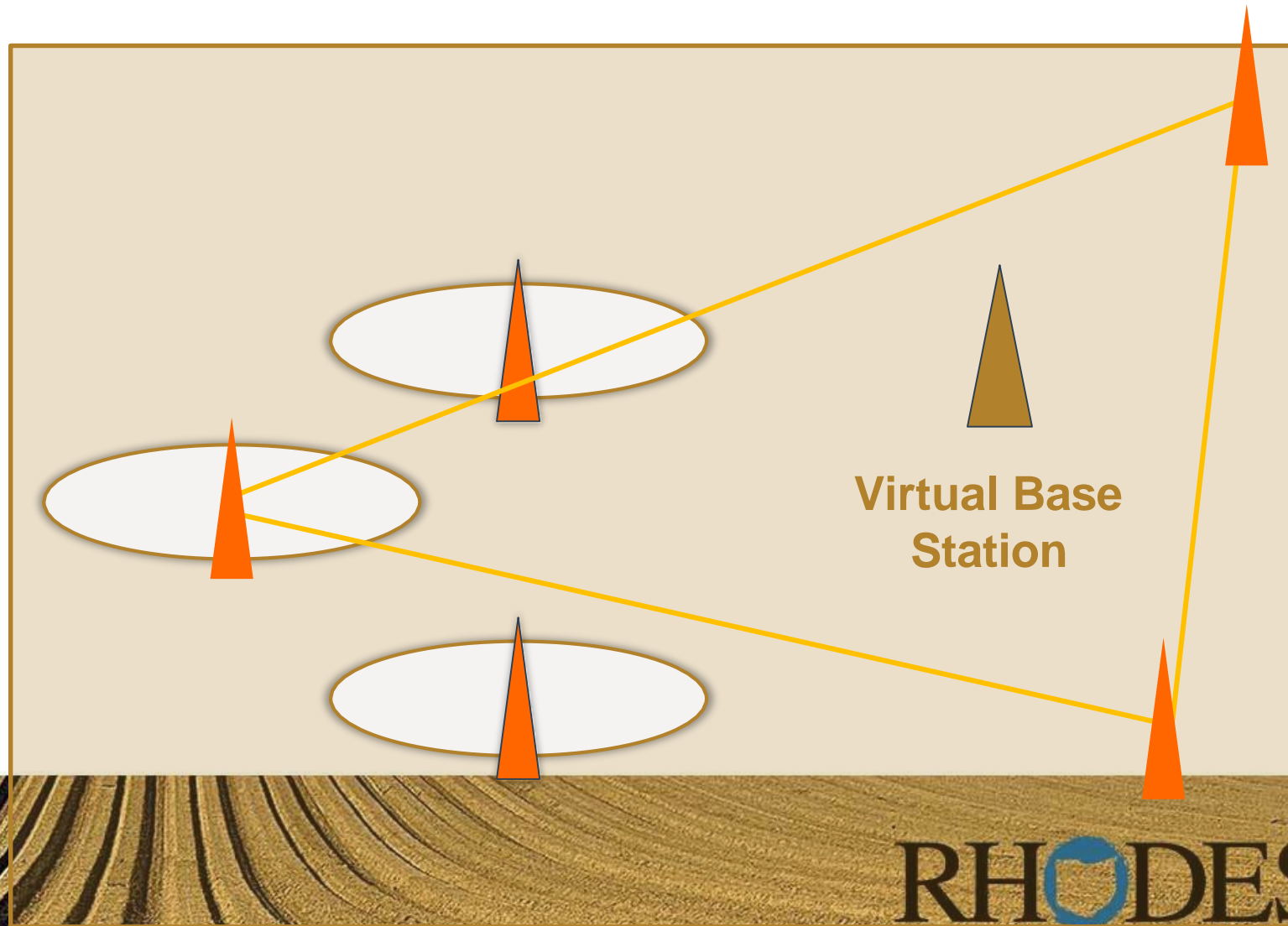
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Let's go outside

- Navigate to 40.735616 N, 84.023948W
- First with Airplane Mode on
- Airplane Mode on, wifi on
- Airplane Mode off
- Gator with WAAS

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Guidance Technology

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Guidance



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Lightbars



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Guidance Advantages

- Lightbars
- Inexpensive
- 2-10% reduction in chemical usage

- Autosteer
- Increased precision
- Operator fatigue
- Opportunities
- Harder to show direct economic saving

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Table 8. Expected Net Returns as well as Profitability of Auto-Steer above the Base Case (%) as Input Prices Fluctuate by the Percentages Indicated^a

	Sub-Meter ^b	RTK ^c		Both ^d		
	Herbicide	Nitrogen	Seed	Herbicide	Nitrogen	Seed
20%	0.65	0.36	0.42	0.98	0.91	0.98
10%	0.60	0.34	0.37	0.92	0.88	0.92
0%	0.54	0.32	0.32	0.86	0.86	0.86
-10%	0.48	0.32	0.27	0.80	0.85	0.80
-20%	0.43	0.30	0.23	0.74	0.83	0.75

^a The percentages indicate the increase in net returns above the base scenario with the same increase in input price.

^b The impact of herbicide price fluctuations on the profitability of sub-meter auto-steer on the self-propelled sprayer when compared with the base case.

^c The impact of nitrogen and seed price fluctuations on the profitability of RTK auto-steer on the tractor when compared with the base case.

^d The impact of herbicide, nitrogen, and seed price fluctuations on the profitability of both sub-meter auto-steer on the self-propelled and RTK auto-steer on the tractor when compared with the base case.

https://www.researchgate.net/publication/227366831_A_Whole_Farm_Analysis_of_the_Influence_of_Auto-Steer_Navigation_on_Net_Returns_Risk_and_Production_Practices/download

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Case Study Summarized...

- Greatest average increase in expected net returns = .9% (\$3.35/acre)
- Break-even acreages all less than 1555 acres
- Payback period less than 4.5 years

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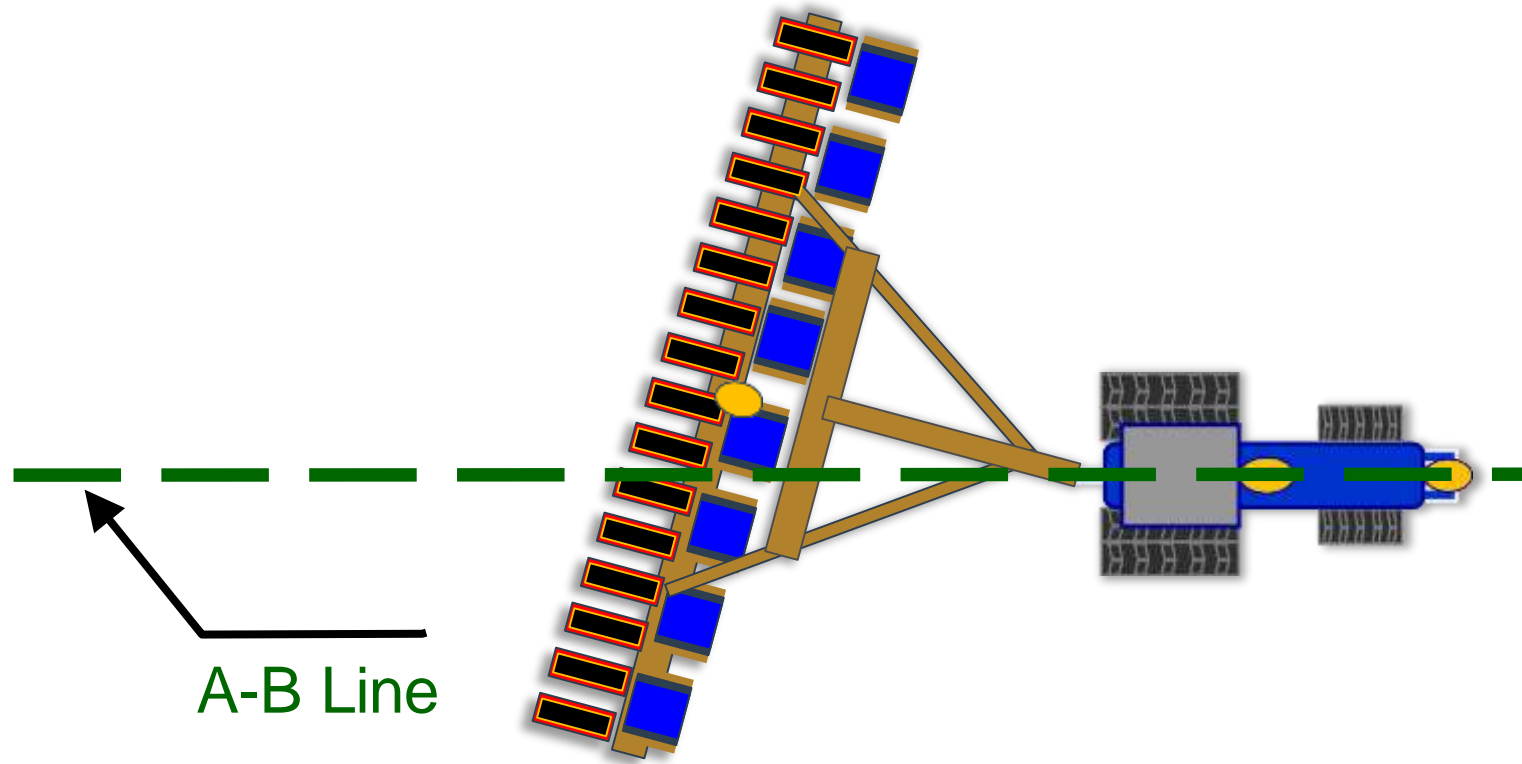
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AutoSteer Accuracy still limited



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Autosteer Accuracy

- Hardware
- GPS
- Machine Quality
- Calibration
- Implement Drift



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AB Line

- Pre-defined path
- Determines parallel machine passes within a field
- Can be saved and used over and over

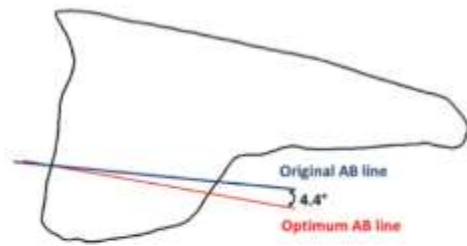


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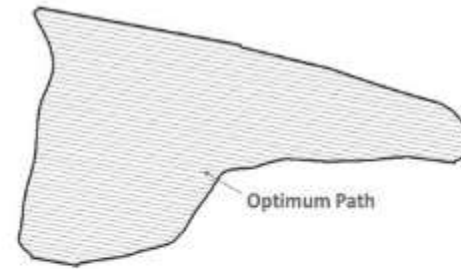
AB Line optimization

- Field Size and Shape
- Terrain
- Drainage Characteristics
- Entry point to field
- In-field obstacles
- Equipment Size
- Precision Agriculture technology

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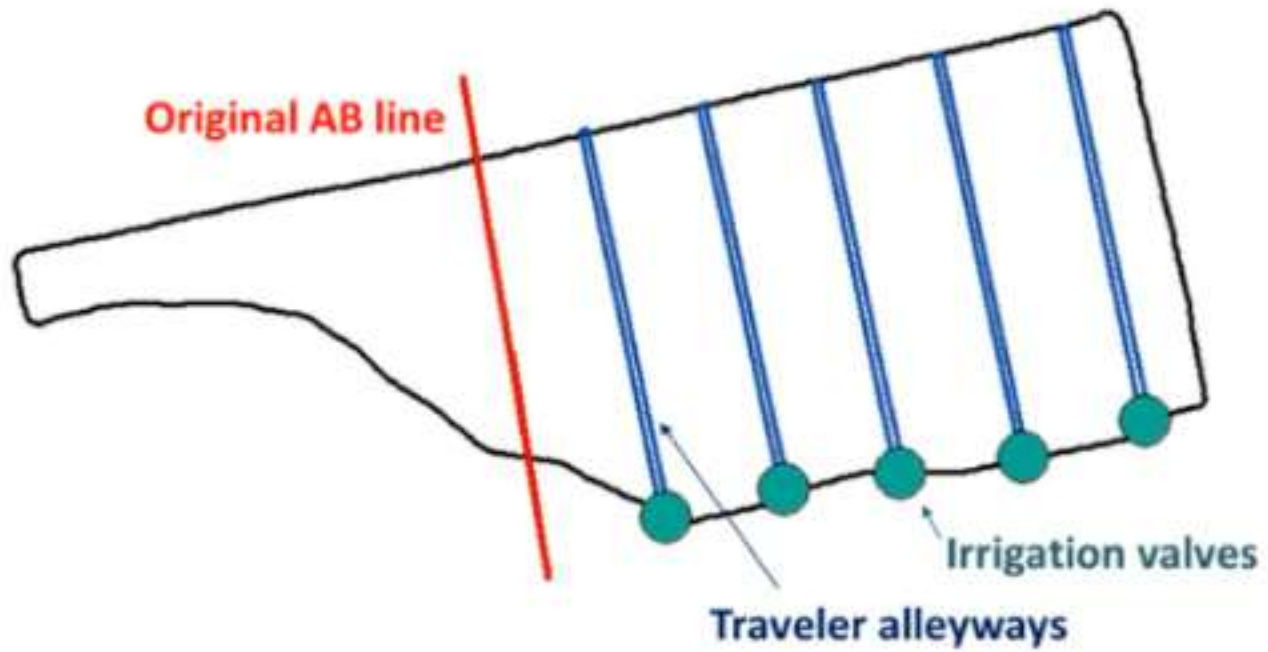


(a)

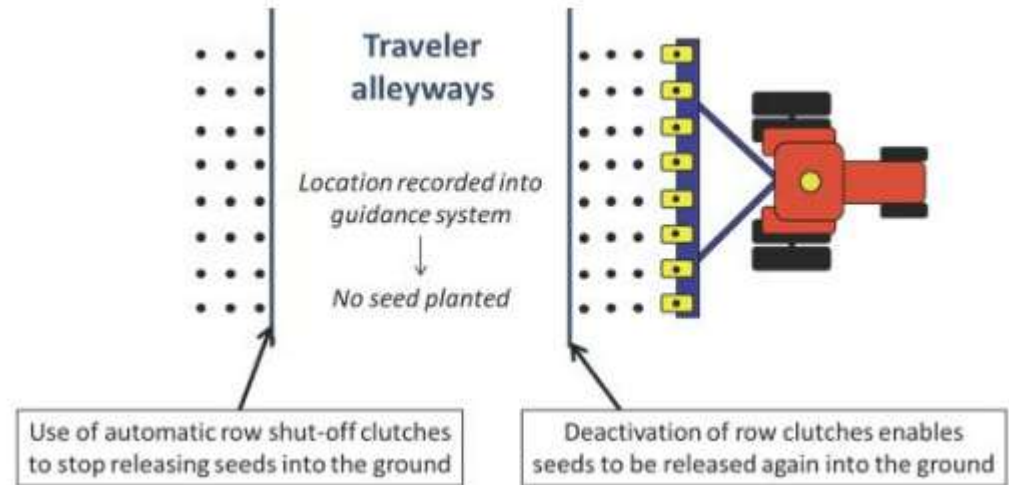
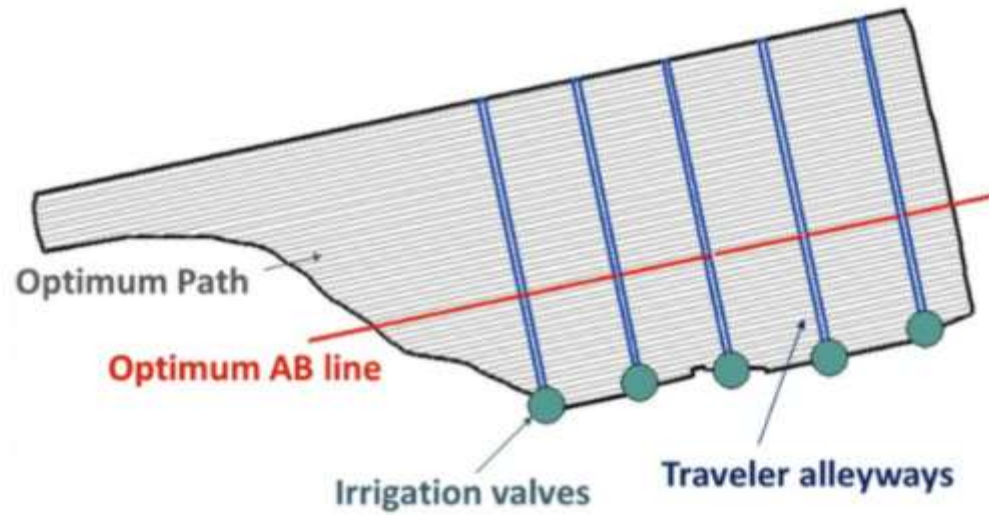


(b)

Figure 3. Example of Field 1 results for a category 2 field: a small adjustment of AB line orientation increased machinery efficiency; (a) Original versus optimum AB line overlain on original Field 1 boundary; (b) Optimum path or AB lines along with adjusted field boundary on the north and south sides.



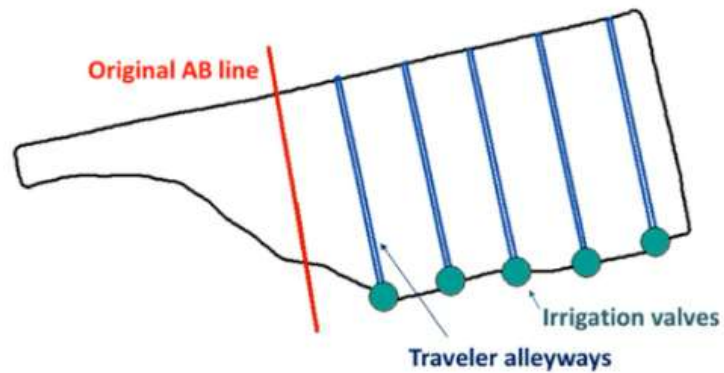
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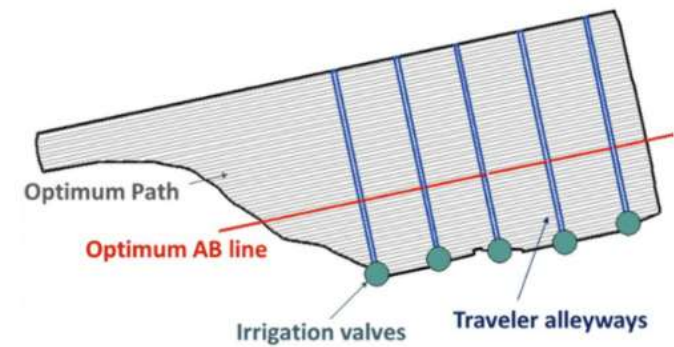
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AB Line Optimization

- Reduced number of turns by 62%
- Increased length of passes by 154%



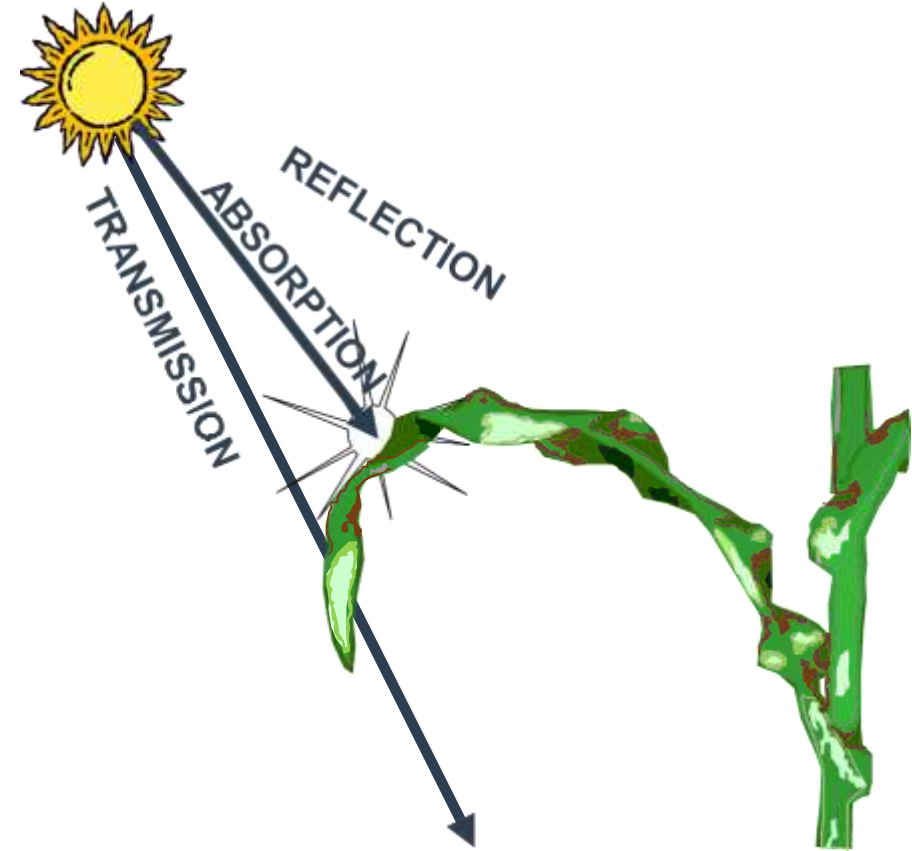
VS.



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Remote Sensing

- The process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance



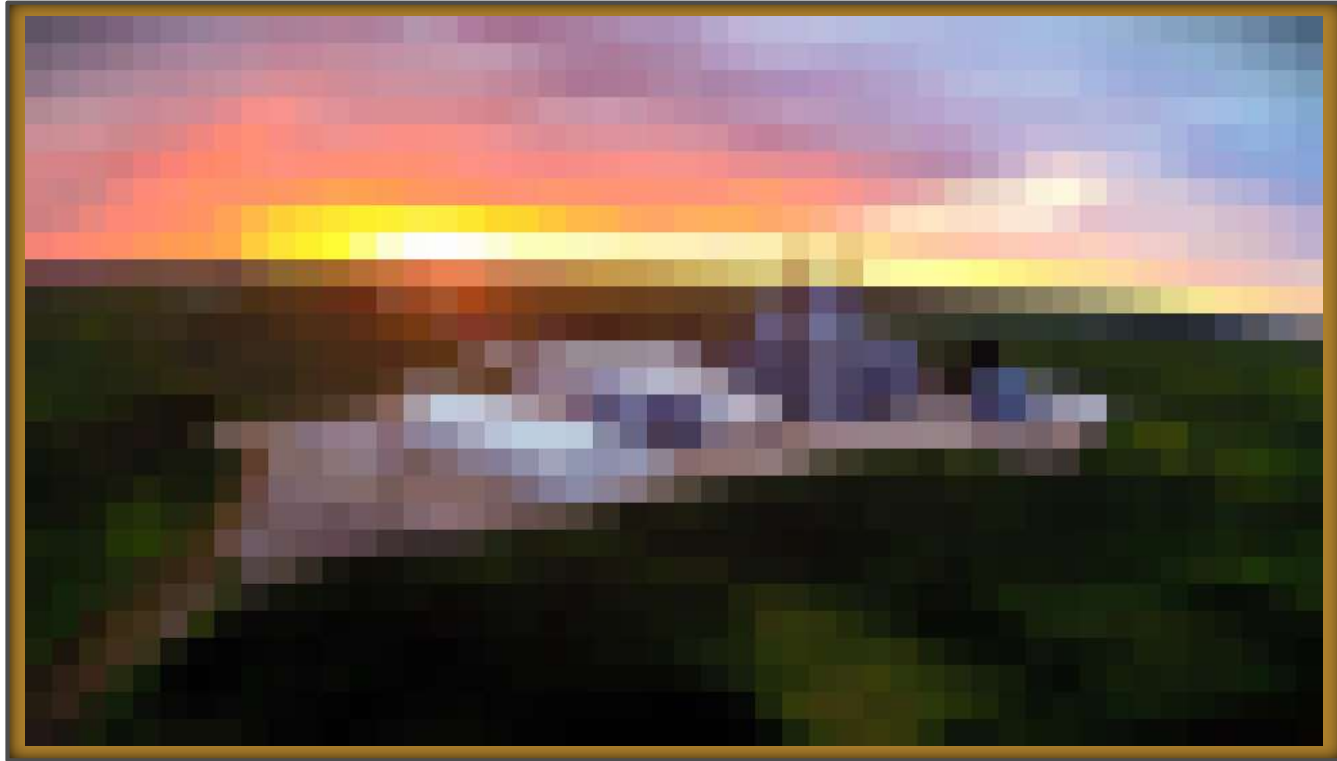
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Sensing Platforms

- Satellite
- Manned Aerial
- Unmanned Aerial
- Proximal

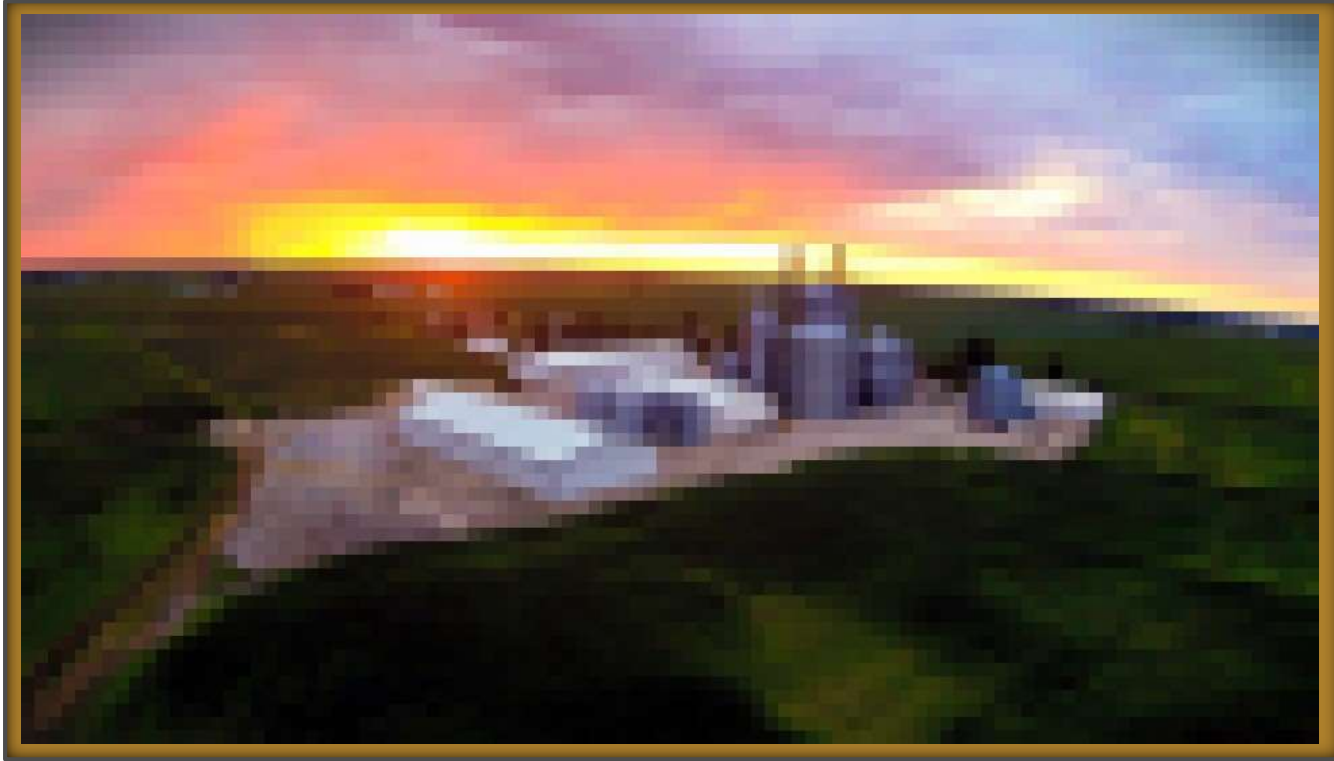


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Resolution Differences

Satellite/ Sensor	Spatial Resolution
UAV/Drone	submeter
Aerial	submeter
LANDSAT	30 meters
RapidEye	5 meters
AVHRR	1000 meters

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Resolution (meters)

Data Points (Pixels)/Acre

Points/Hectare

1000

0.004

0.01

80

0.6

1.56

30

4.5

11.1

23.5

7.3

18.1

20

10

25.0

15

18

44.4

10

40

100

5

162

400

4

253

625

3

450

1111

2

1012

2500

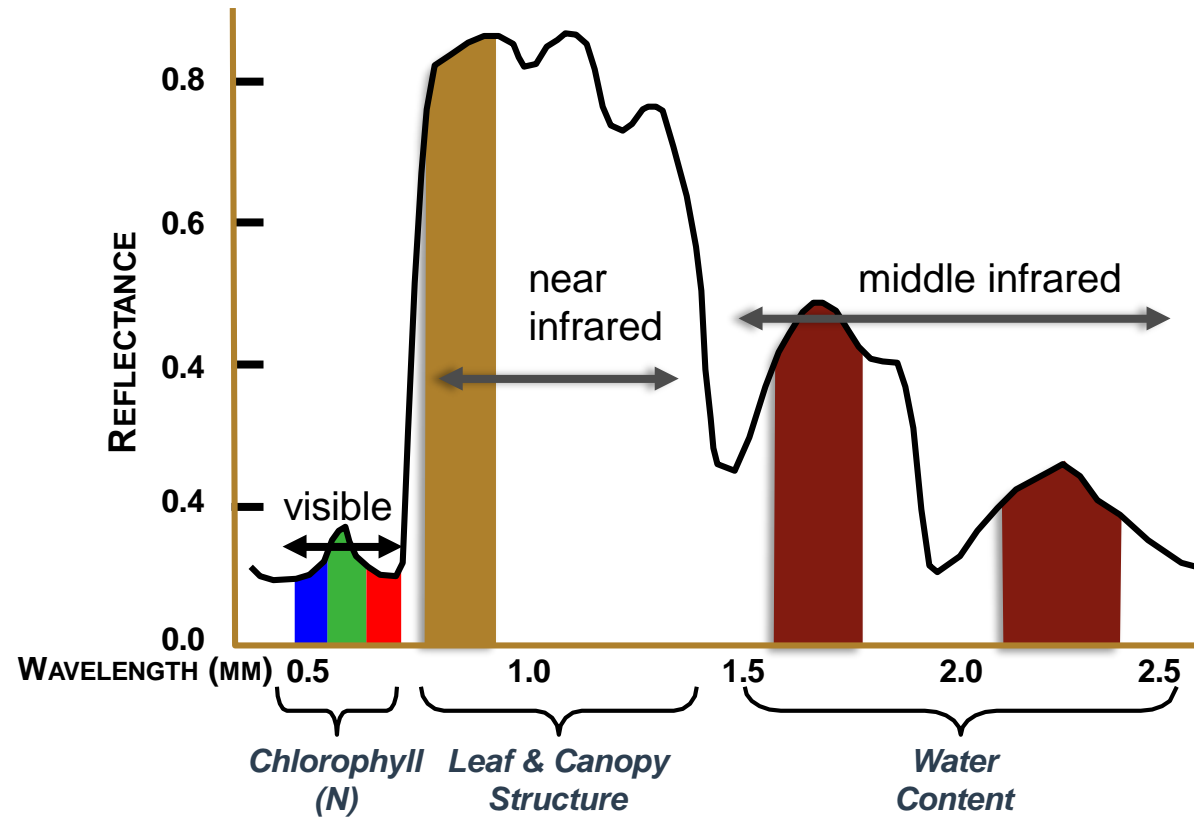
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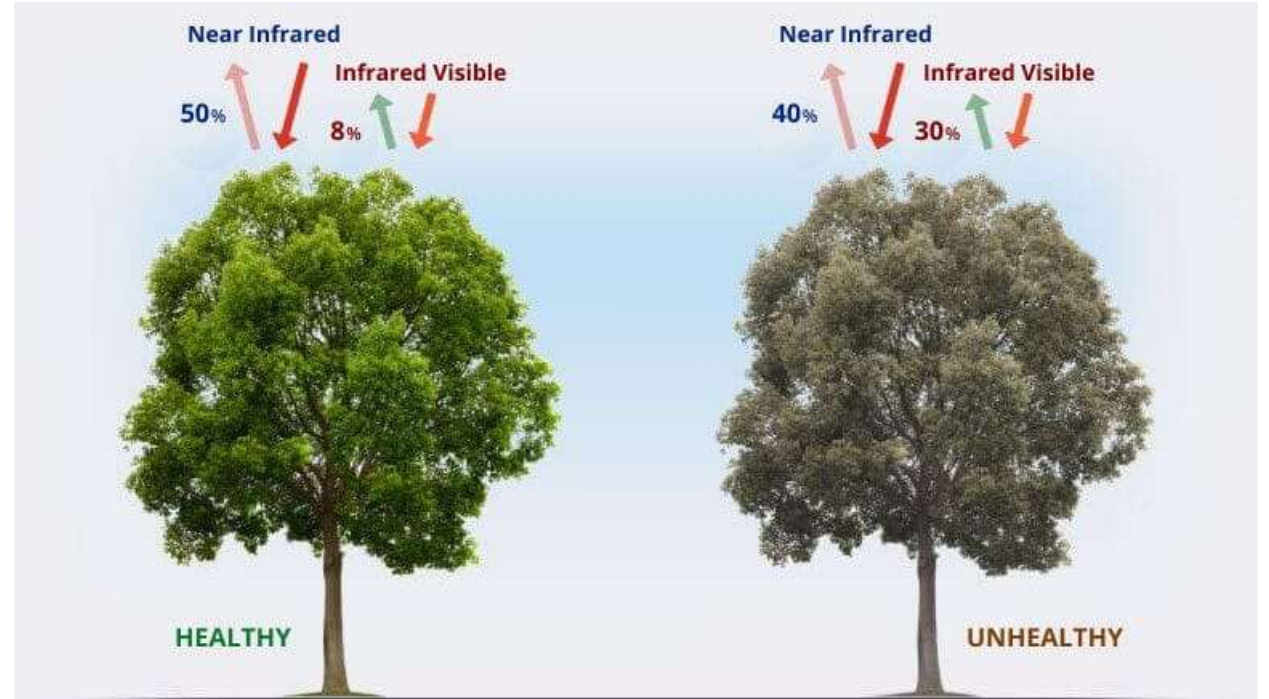
Light and Reflectance



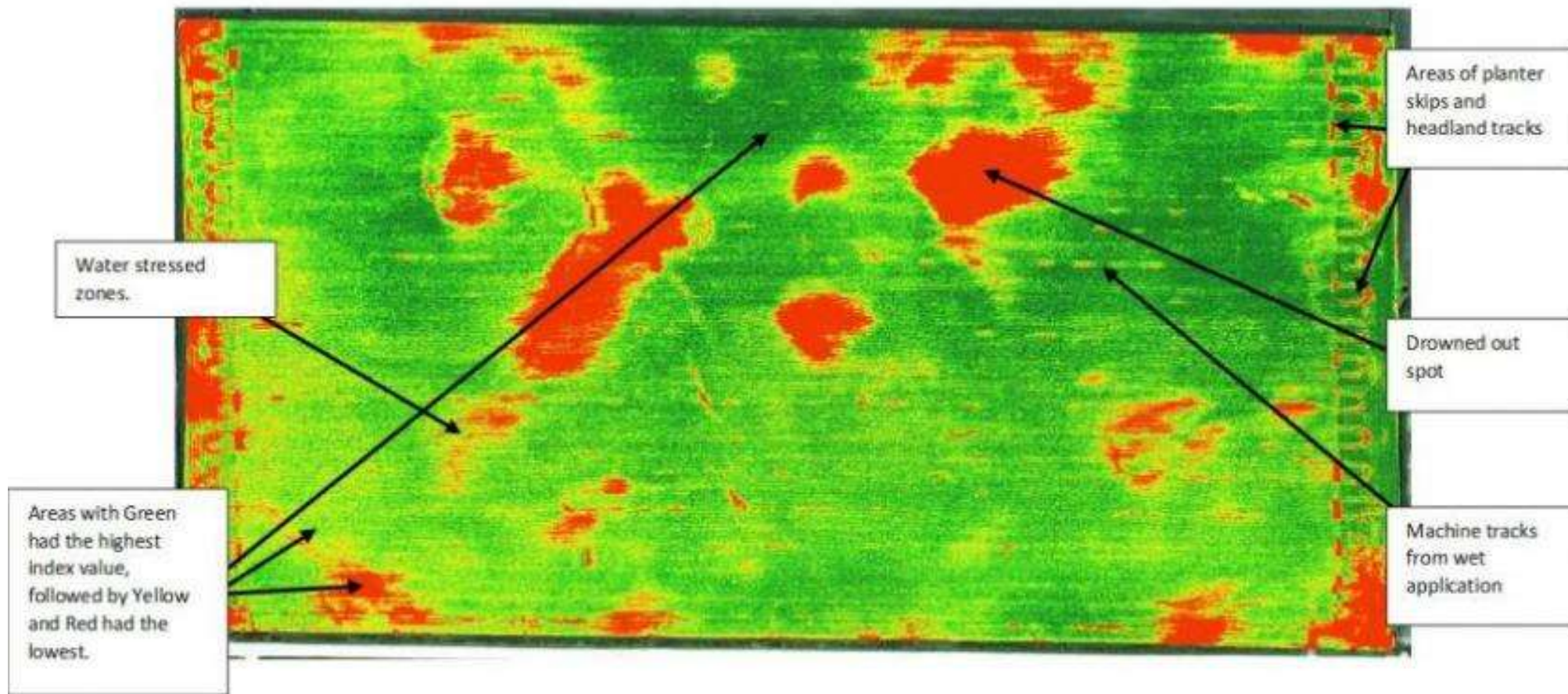
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Normalized Difference Vegetation Index

$$\text{NDVI} = \frac{(\text{NIR} - \text{RED})}{(\text{NIR} + \text{RED})}$$



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- <https://croplandcros.scinet.usda.gov/>

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