FARMING FROM OUTER-SPACE

MSU Next Generation Conference

Precision Agriculture
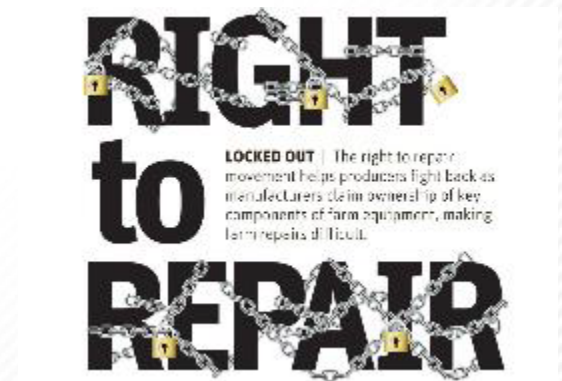
▸ **Precision agriculture** (PA) or **satellite farming** or **site specific crop management** (SSCM) is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. Crop variability typically has both a spatial and temporal component which makes statistical/computational treatments quite involved. (wikipedia)

▸ Doing the right thing in the right place, at the right time, in the right amount

▸ Maximizing margin (not necessarily yield)

▸ Easier said than done (but getting easier every day)

Topics of Discussion!

▸ **Current state of Precision Ag Technology**

▸ **What tools are FarmTech using?**

▸ **Where to Start**

▸ **FSA and Crop Insurance**

▸ **Right to Repair***

Right to Repair

▸ **At a crossroads with equipment manufacturers**

▸ **Equipment manufacturers are forcing farmers to pay their expensive tech fees for simple service like clearing an error code, or programming a valve controller that can easily be replaced, but not programmed, the list goes on and on**

▸ **AGCO has a decent diagnostic tool but not full tool**

▸ **Other companies are being taken to court**

- Class action lawsuit against JD right now

▸ **Getting attention at the Federal Level**

LOCKED OUT | The right to repair movement helps producers fight back as manufacturers claim ownership of key components of farm equipment, making farm repairs difficult.

What tools are available?

▸ **Seeding**

- Autosteer/Autoturn (5-10% savings)

- Variable Rate (Savings and increased yield)

- Section Control (5-10% savings)

- Auto Depth Control (Better emergence)

- Tractor data logging and servicing

- Population counting (Better plant spacing)

- Corn Planters have significantly more technology

- Acreage reporting (Auto submit to FSA)

What tools are available?

▸ **Crop Care**

- Autosteer/Autoturn (5-10% savings)

- Variable Rate (Savings and increased yield)

- Crop health scanning (identify problems)

- Individual nozzle control (3-15%)

- Boom Height Control (Better coverage)

- Drift Control (Better coverage)

- Timing of Nutrients

- Weather

- Scouting

What tools are available?

- **Harvest**

  - Autosteer (5-10%)

  - Yield mapping (key to variable rate)

  - Weighing (know what you got)

  - Task sharing (high quality yield maps)

 - Yield Reporting (Auto submit to Insurance)

Get in the Zone (soil)

Traditional: Understanding field level variability using historic data sets and current soil sampling data

Current: Understanding field level variability using a non invasive sensor to measure soil physical characteristics, independent of management or seasonal changes coupled with soil sampling data

Traditional Zoning

▸ **Create management zones using the best data available and best end user input.**

▸ **Sample each zone separately**

▸ **Create a rate of inputs for each zone based on soil analysis and yield goal. Best to use yield map driven yield goals instead of flat rate yield across the entire field.**

▸ **Load product maps up to display**

▸ **Go apply**

Soil Test Polygons
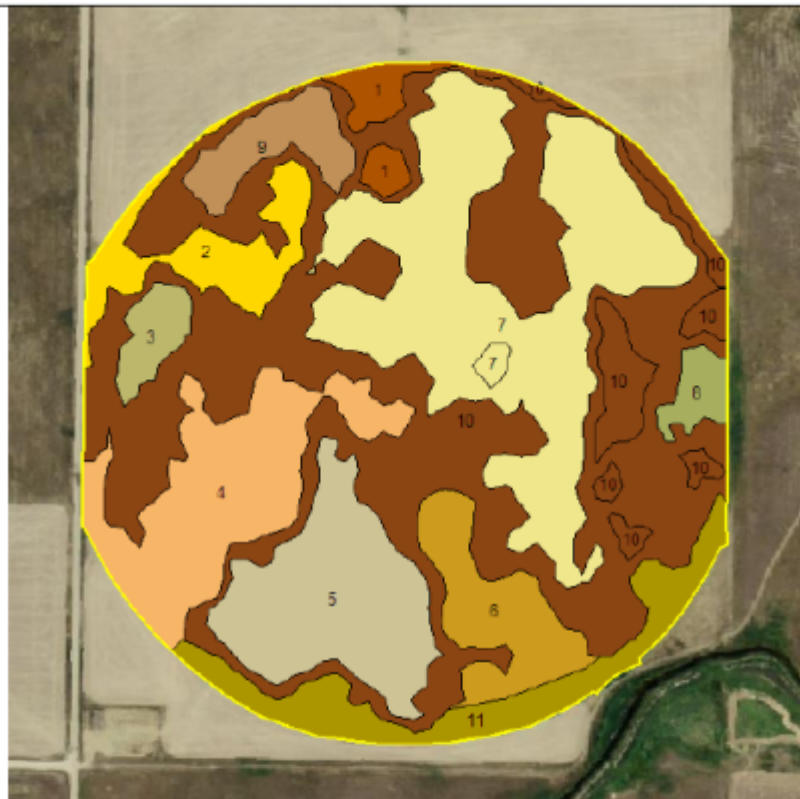
Grower: Weist Farms
Farm: Weist
Field: W01
Area: 128.79 ac
Event Date(s): 5/7/2014

One in = 481 feet
0   218   435   653   871   1088

Field Boundary
Soil Test Polygons
1 (2.0 ac) (1.6 %)
2 (5.1 ac) (3.9 %)
3 (1.9 ac) (1.5 %)
4 (12.2 ac) (9.5 %)
5 (11.5 ac) (8.9 %)
6 (6.0 ac) (4.6 %)
7 (26.0 ac) (20.2 %)
8 (1.5 ac) (1.2 %)
9 (3.5 ac) (2.7 %)
10 (51.8 ac) (40.2 %)
11 (7.3 ac) (5.6 %)

FarmTech

Soil Test Results

Grower: Weist Farms
Farm: Weist
Field: W01
Area: 128.79 ac
Event Date(s): 5/7/2014

	Soil pH	P	K	Om	CEC	Ca	Mg	B	Cu	Fe	S	Zn	NO3-N	Ca %	K %	Mg %	Na %
Min:	8.1	10	313	1.9	25.9	3,365	949	1.2	1.1	13.0	21.0	0.5	8.0	59.9	2.8	29.0	1.8
Max:	8.4	40	765	3.0	32.6	4,015	1,330	1.7	1.8	27.0	46.0	1.4	14.0	66.5	6.2	34.7	2.3
Avg:	8.2	19	469	2.5	30.6	3,788	1,200	1.5	1.5	18.6	32.2	0.7	11.1	62.0	3.9	32.6	2.2

Sampl ID	Soil pH	P	K	Om	CEC	Ca	Mg	B	Cu	Fe	S	Zn	NO3-N	Ca %	K %	Mg %	Na %
1	8.2	10	313	2.3	25.9	3,436	949	1.4	1.4	25.0	28.0	1.4	11.0	66.4	3.1	30.5	
1	8.2	10	313	2.3	25.9	3,436	949	1.4	1.4	25.0	28.0	1.4	11.0	66.4	3.1	30.5	
2	8.2	21	553	2.7	32.6	4,015	1,249	1.7	1.4	14.0	40.0	0.6	14.0	61.7	4.3	31.9	2.1
3	8.2	28	723	2.7	30.8	3,692	1,183	1.7	1.4	15.0	32.0	0.7	8.0	60.1	6.0	32.0	1.9
4	8.4	19	458	2.4	30.7	3,927	1,112	1.6	1.4	13.0	25.0	0.6	11.0	64.1	3.8	30.2	1.9
5	8.2	27	765	2.7	31.4	3,749	1,200	1.5	1.8	22.0	30.0	0.8	12.0	59.9	6.2	31.8	2.1
6	8.4	10	313	1.9	28.8	3,669	1,154	1.2	1.1	17.0	46.0	0.7	9.0	63.8	2.8	33.4	
7	8.1	40	559	3.0	27.9	3,365	1,161	1.6	1.4	17.0	36.0	1.0	10.0	60.2	5.1	34.7	
7	8.1	40	559	3.0	27.9	3,365	1,161	1.6	1.4	17.0	36.0	1.0	10.0	60.2	5.1	34.7	
8	8.2	13	509	2.5	28.8	3,827	1,003	1.4	1.4	27.0	21.0	0.6	8.0	66.5	4.5	29.0	
9	8.2	13	586	2.7	30.5	3,847	1,102	1.6	1.3	14.0	23.0	0.6	13.0	63.2	4.9	30.1	1.8
10	8.3	16	413	2.4	32.6	3,947	1,330	1.6	1.6	19.0	34.0	0.6	12.0	60.5	3.2	34.0	2.3
10	8.3	16	413	2.4	32.6	3,947	1,330	1.6	1.6	19.0	34.0	0.6	12.0	60.5	3.2	34.0	2.3
10	8.3	16	413	2.4	32.6	3,947	1,330	1.6	1.6	19.0	34.0	0.6	12.0	60.5	3.2	34.0	2.3
10	8.3	16	413	2.4	32.6	3,947	1,330	1.6	1.6	19.0	34.0	0.6	12.0	60.5	3.2	34.0	2.3
10	8.3	16	413	2.4	32.6	3,947	1,330	1.6	1.6	19.0	34.0	0.6	12.0	60.5	3.2	34.0	2.3
10	8.3	16	413	2.4	32.6	3,947	1,330	1.6	1.6	19.0	34.0	0.6	12.0	60.5	3.2	34.0	2.3
10	8.3	16	413	2.4	32.6	3,947	1,330	1.6	1.6	19.0	34.0	0.6	12.0	60.5	3.2	34.0	2.3
10	8.3	16	413	2.4	32.6	3,947	1,330	1.6	1.6	19.0	34.0	0.6	12.0	60.5	3.2	34.0	2.3
11	8.2	14	433	2.4	30.5	3,862	1,137	1.4	1.4	15.0	27.0	0.5	9.0	63.4	3.6	31.1	1.9

FarmTech

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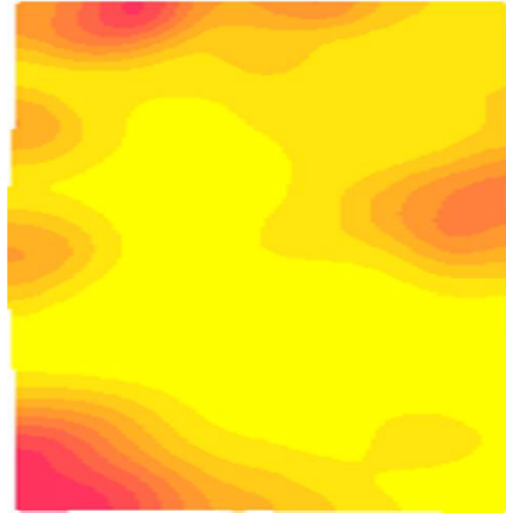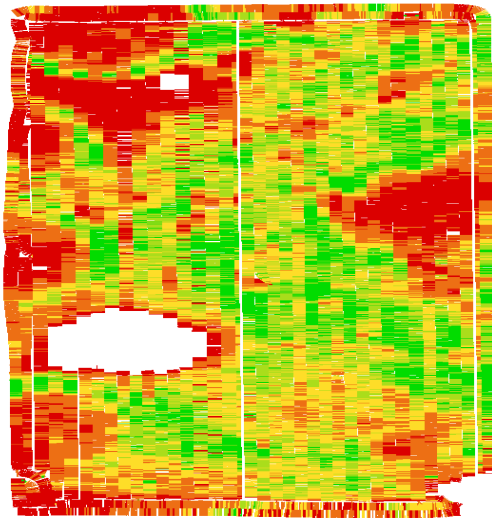# Current Zoneing Soil Optix Scanner

▸ **Non invasive**

▸ **Measures Gamma Radiation**

▸ **Independent of management**

▸ **One scan per 10 years**

▸ **Resample every 5**

▸ **Map of every nutrient sampled**

High Definition Mapping

25+ different property maps available
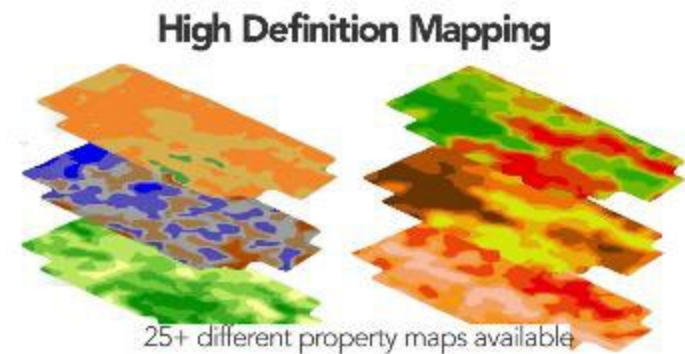
T07
Elevation

Client: Weist Farms
Farm: Truchot
Field: T07
Sample Year: 2021

Min: 3780.56
Max: 3808.25
Acres: 77.66

Range	Acres
3780.56 - 3783.63	31.38 ac
3783.63 - 3786.71	22.77 ac
3786.71 - 3789.79	8.35 ac
3789.79 - 3792.86	5.54 ac
3792.86 - 3795.94	3.74 ac
3795.94 - 3799.02	2.49 ac
3799.02 - 3802.09	1.18 ac
3802.09 - 3805.17	1.2 ac
3805.17 - 3808.25	1.22 ac

SOILOPTIX.
FIELD INTELLIGENCE

19
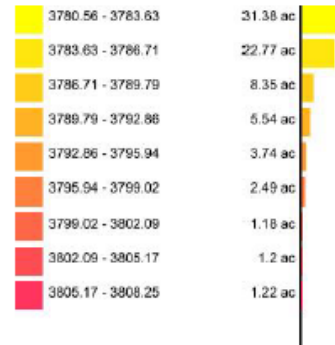
T07
pH
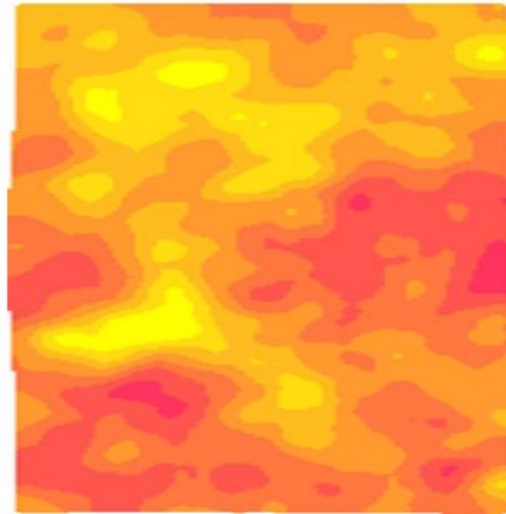
Client: Weist Farms
Farm: Truchot
Field: T07
Sample Year: 2021

Min: 5.95
Max: 8.11
Acres: 77.66

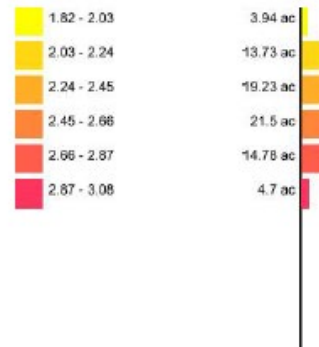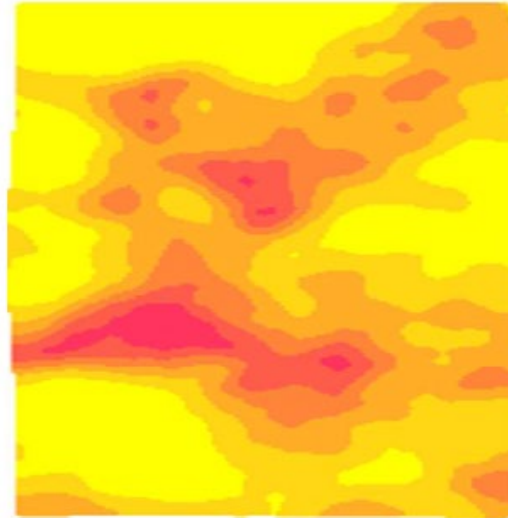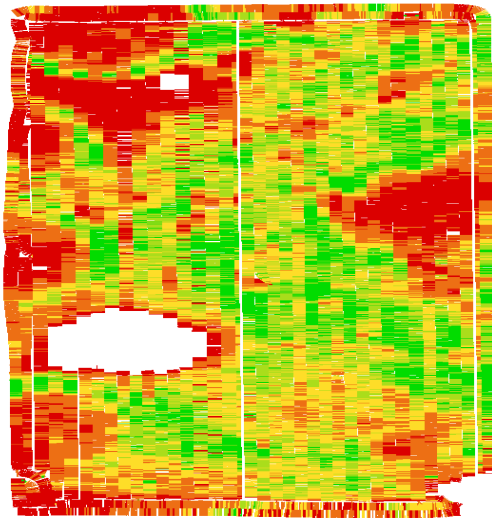| Color	pH Range	Acres
	5.95 - 6.25	2.08 ac
	6.25 - 6.56	7.86 ac
	6.56 - 6.87	15.79 ac
	6.87 - 7.18	20.67 ac
	7.18 - 7.49	18.85 ac
	7.49 - 7.8	11.47 ac
	7.8 - 8.11	1.18 ac

SOILOPTIX.
FIELD INTELLIGENCE

20
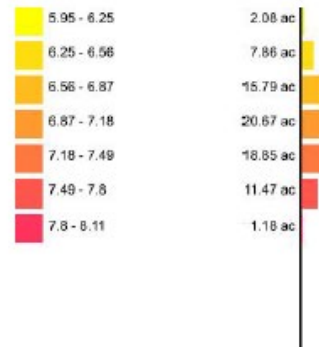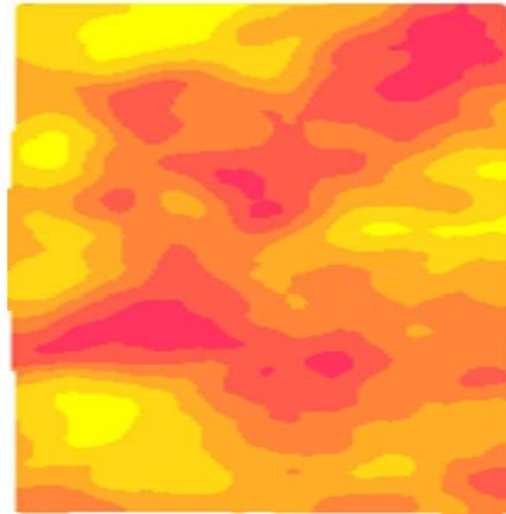
Client: Weist Farms
Farm: Truchot
Field: T07
Sample Year: 2021

Min: 1.82
Max: 3.08
Acres: 77.66

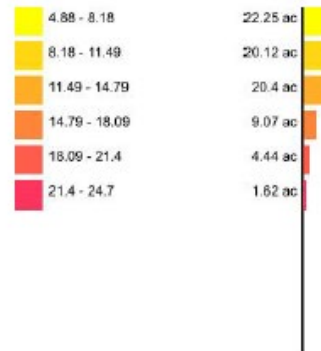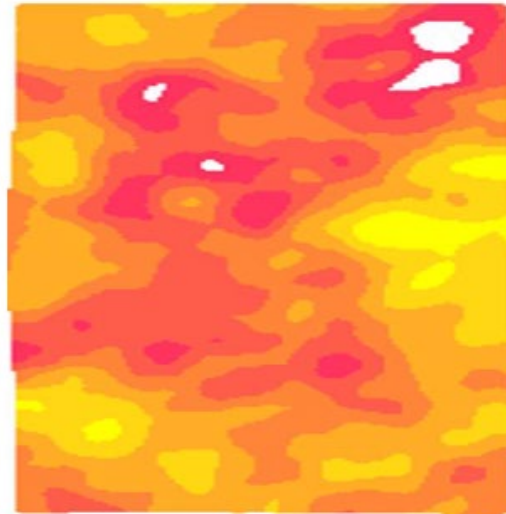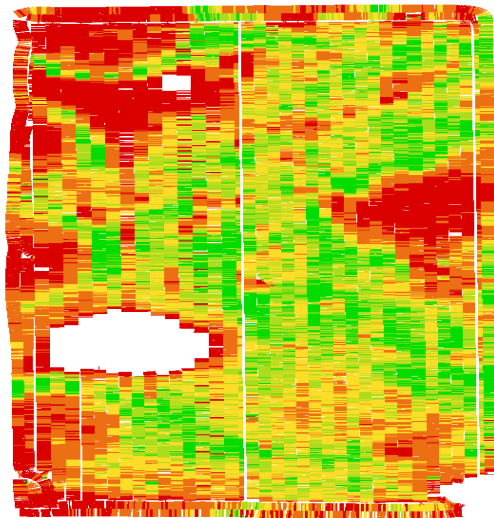|	Range	Acres
	1.82 - 2.03	3.94 ac
	2.03 - 2.24	13.73 ac
	2.24 - 2.45	19.23 ac
	2.45 - 2.66	21.5 ac
	2.66 - 2.87	14.78 ac
	2.87 - 3.08	4.7 ac

SOILOPTIX.
FIELD INTELLIGENCE

Client: Weist Farms
Farm: Truchot
Field: T07
Sample Year: 2021

Min: 4.88
Max: 24.7
Acres: 77.66

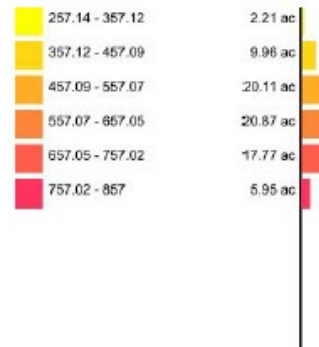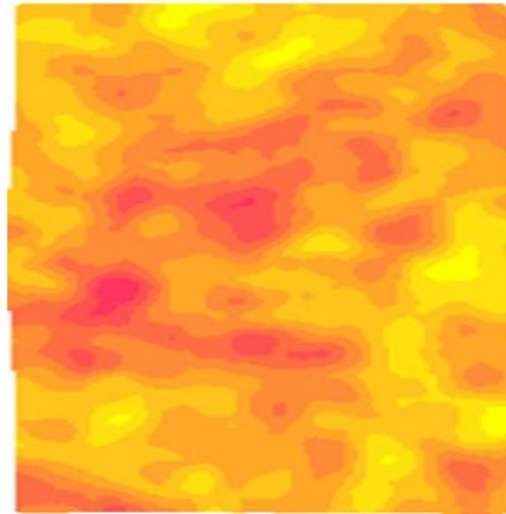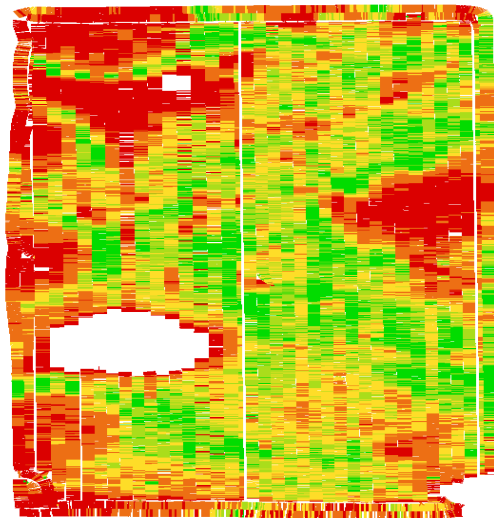| Range	Acres	
4.88 - 8.18	22.25 ac	
8.18 - 11.49	20.12 ac	
11.49 - 14.79	20.4 ac	
14.79 - 18.09	9.07 ac	
18.09 - 21.4	4.44 ac	
21.4 - 24.7	1.62 ac	

SOILOPTIX.
FIELD INTELLIGENCE

Client: Weist Farms
Farm: Truchot
Field: T07
Sample Year: 2021

Min: 257.14
Max: 857
Acres: 77.66

257.14 - 357.12	2.21 ac	
357.12 - 457.09	9.96 ac	
457.09 - 557.07	20.11 ac	
557.07 - 657.05	20.87 ac	
657.05 - 757.02	17.77 ac	
757.02 - 857	5.95 ac	

SOILOPTIX.
FIELD INTELLIGENCE

T07
Pbicarb

Client: Weist Farms
Farm: Truchot
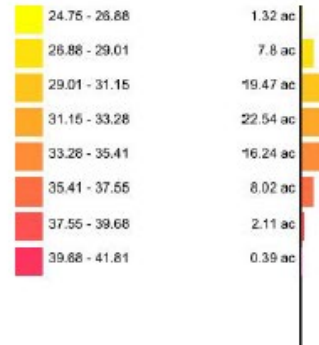Field: T07
Sample Year: 2021

Min: 24.75
Max: 41.81
Acres: 77.66

Range	Area
24.75 - 26.88	1.32 ac
26.88 - 29.01	7.8 ac
29.01 - 31.15	19.47 ac
31.15 - 33.28	22.54 ac
33.28 - 35.41	16.24 ac
35.41 - 37.55	8.02 ac
37.55 - 39.68	2.11 ac
39.68 - 41.81	0.39 ac

SOILOPTIX.
FIELD INTELLIGENCE

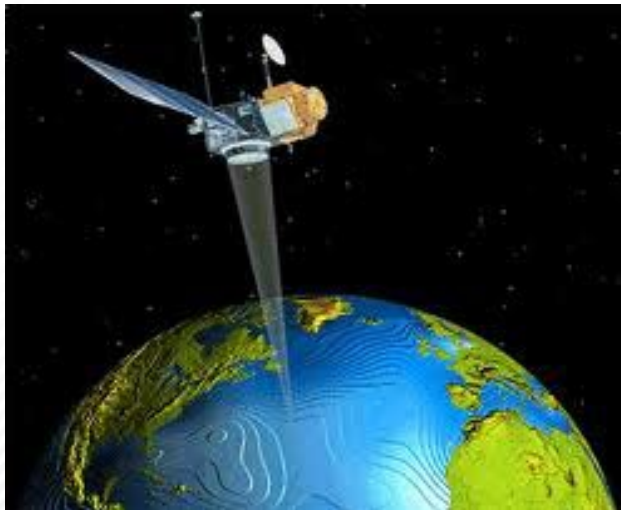# **Satellite vs Drone vs Tractor**

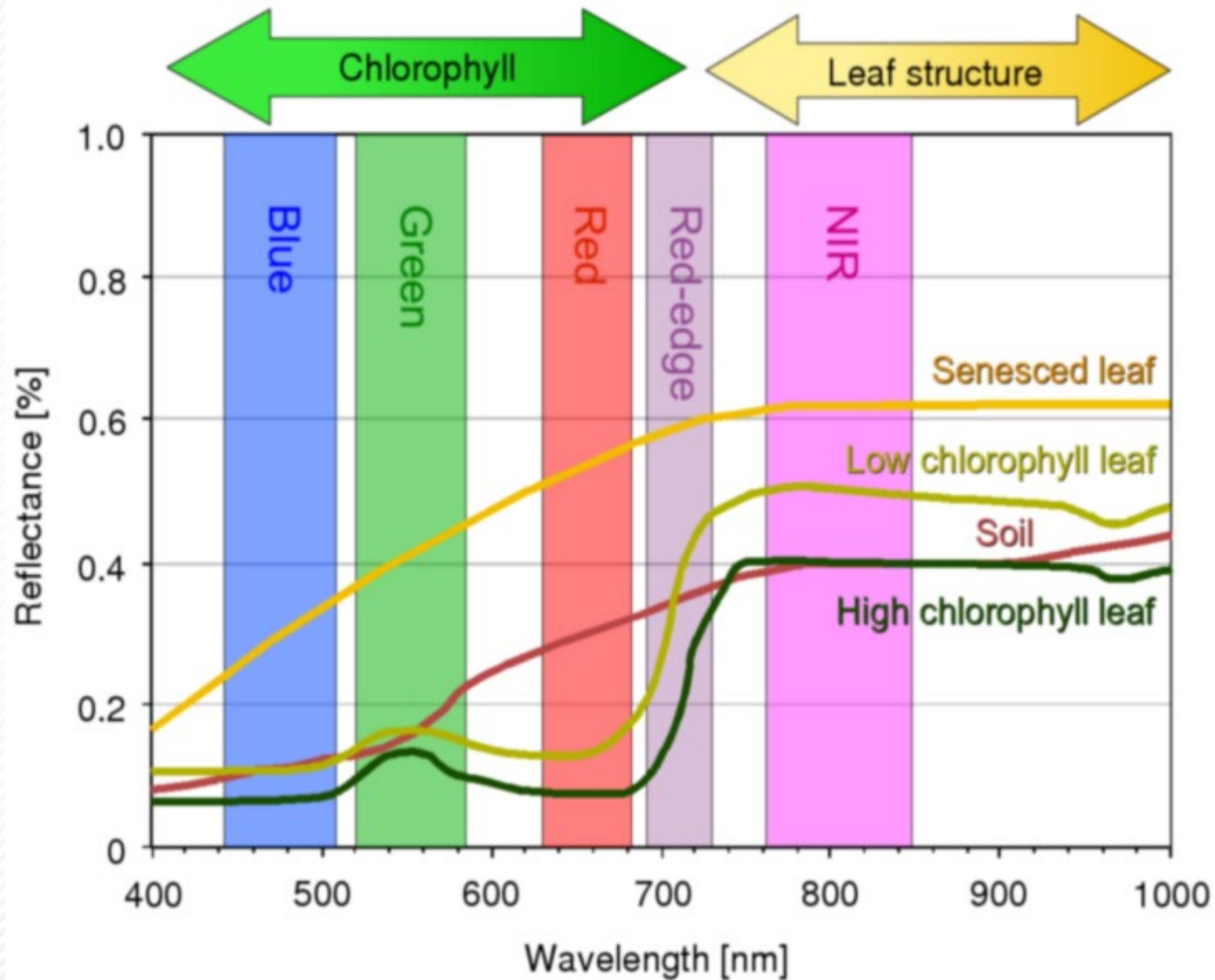Remote sensing from Earth to Space

Why Remote Sensing?

Diagnostic tool for in season assessment of crop health. Farmer still needs to make a decision from the data, not automated.

Remote Sensing

Tools for identifying variability

Reflectance

# RapidEye's 5 satellites orbit once around the Earth in 90 minutes

Satellite constellation

> **5 satellites**

> **5 day revisit possible. Considering cloud cover, this will result in a useful image every 2-3 weeks**

> **6.5 ground sampling distance**

> **4 million km2 acquisition capacity per day**

DRONES
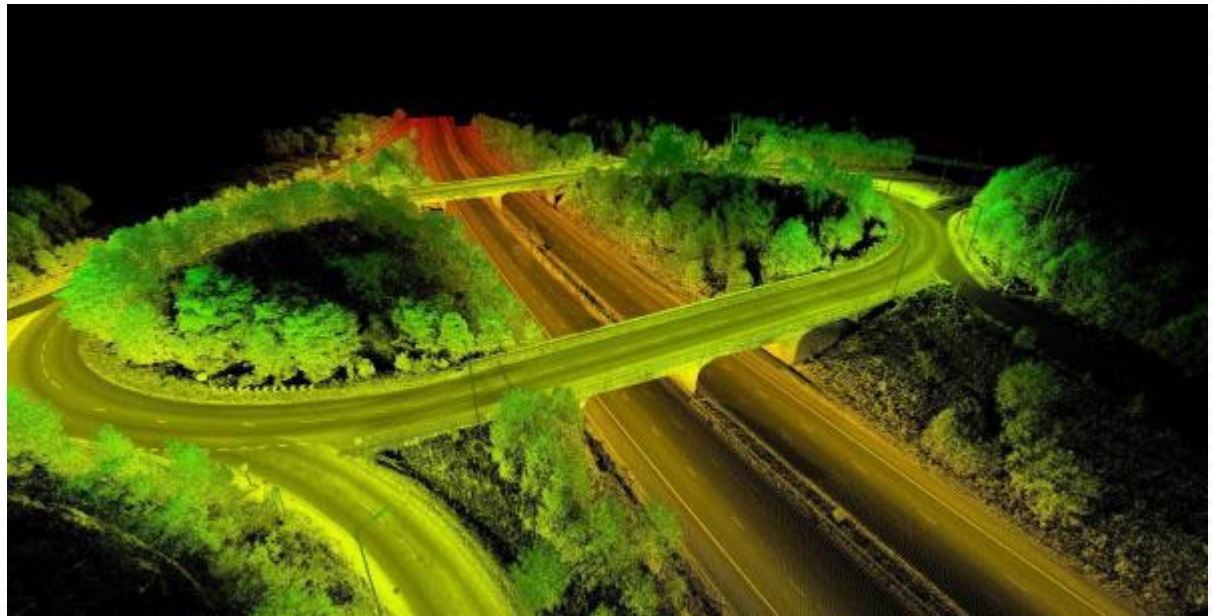
- **Unmanned Aircraft Vehicle (UAV)**

- **Unmanned Aircraft System (UAS)**

- **Unpiloted Aerial Vehicle (UAV)**

- **Remotely Piloted Aircraft (RPA)**

- **Big Brother**

- **Data Collector**
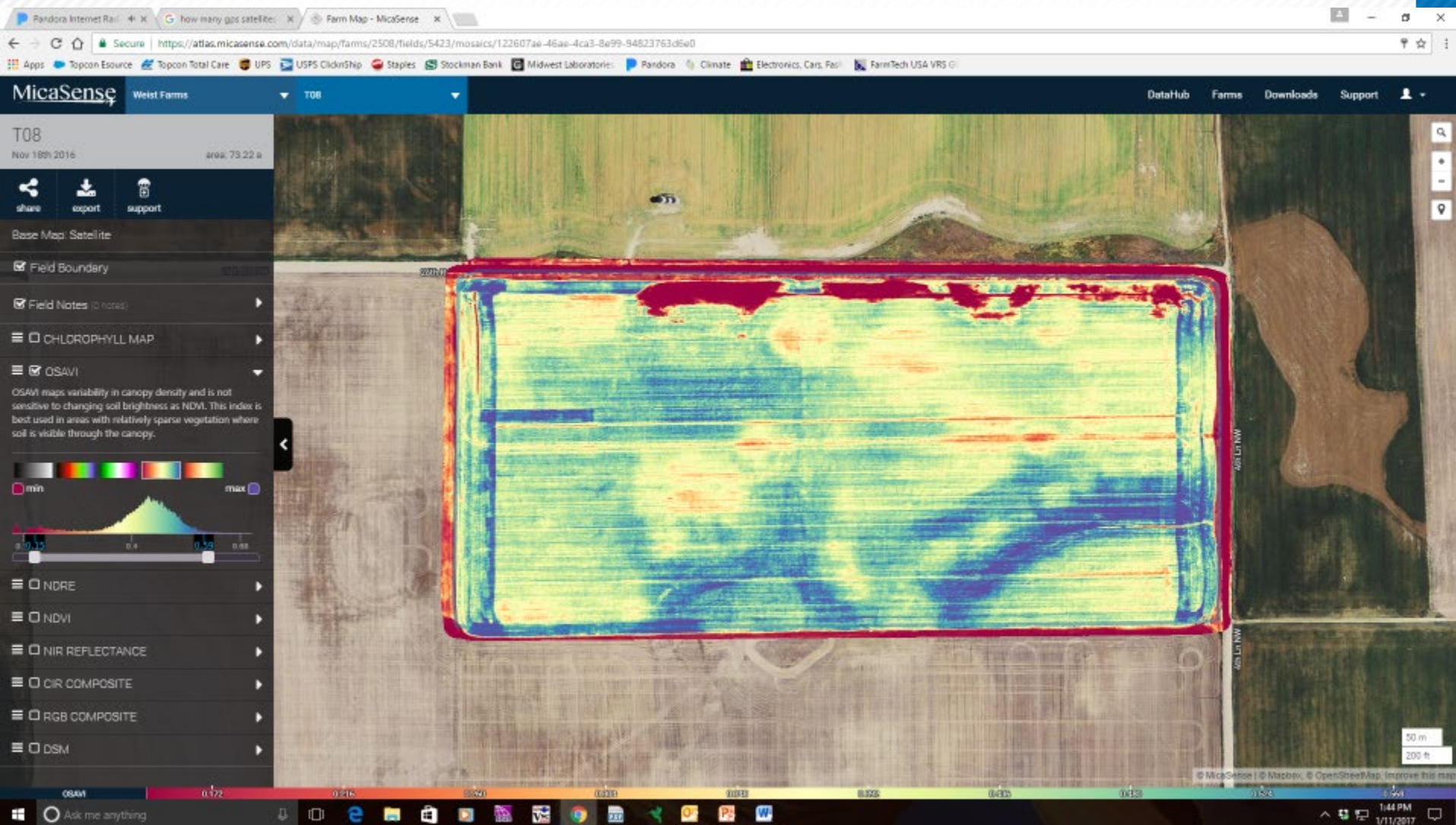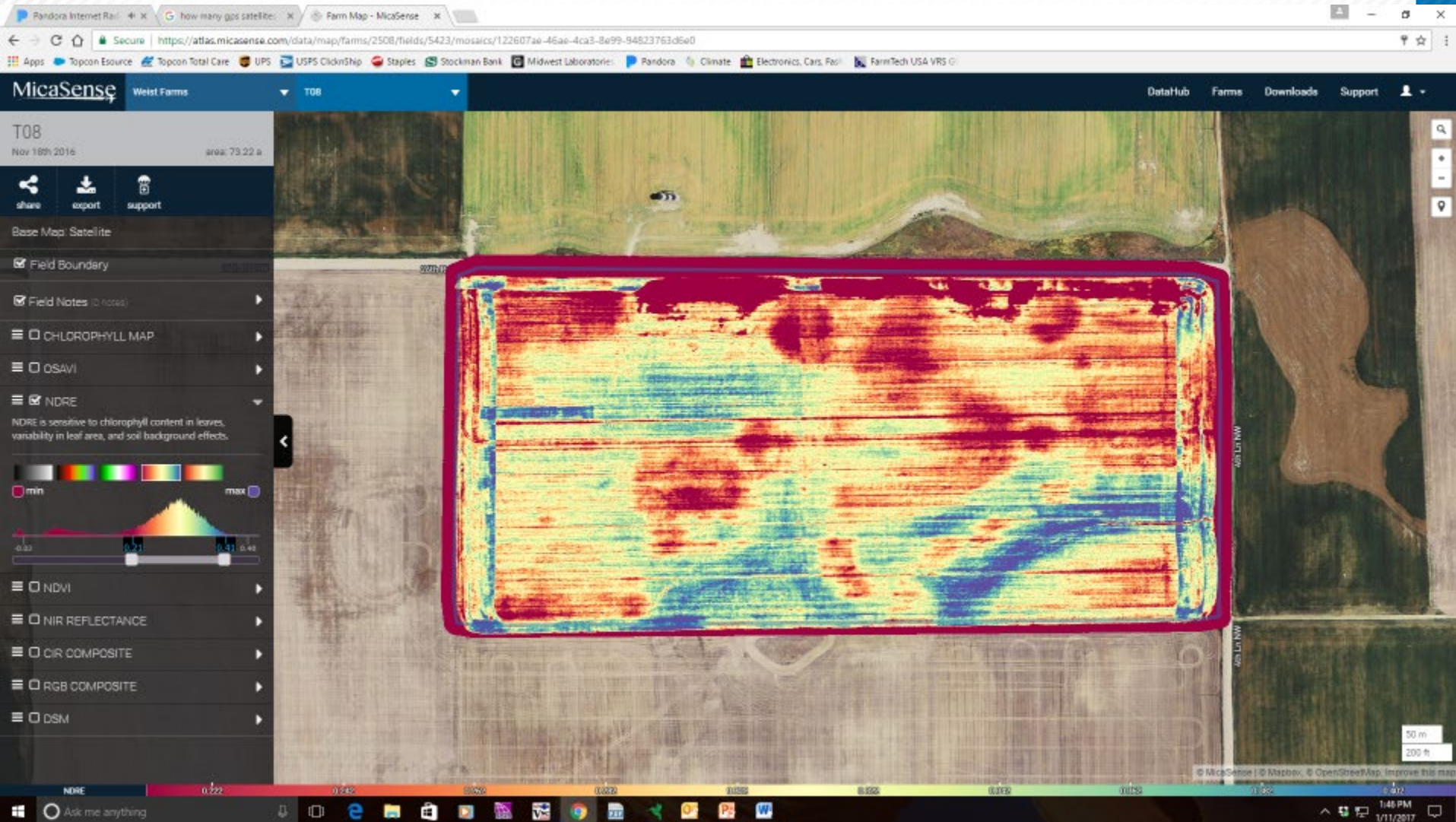
Unmanned Aircraft Systems (UAS)
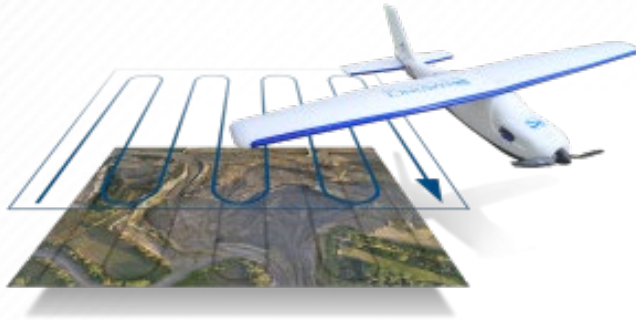
Sensor Platforms

- ▸ **High Definition True color**

- ▸ **Near InfraRed and Red Edge**

- ▸ **Hyperspectral**

- ▸ **LiDar**

- ▸ **Thermal**

MicaSense Red Edge – Ground Cover

MicaSense Red Edge - NDRE

Unmanned Aircraft Systems (UAS)

► **If providing a service**

- Special Airworthiness Certificate

- Cannot transport people or property for compensation or hire

- Can conduct research, development, training and sale of data

- Below 400 feet

- Away from airports and air traffic

- Operator remains in sight of the UAS

► **If doing it on your own farm (not selling the data)**

- Below 400 feet

- Away from airports and air traffic

- Operator remains in sight of the UAS

CropSpec^{TM} – specifications

Environment	IP 67 compliant
Laser safety	Class 1 or Class 1M
Physical Dimensions	200 mm x 80 mm x 80 mm
Mounting height	2 - 4 meters
Viewing angle	45°- 55°
Temperature	0 - 60°Celsius
Operational wavebands	735nm and 808 nm +/- 3nm
Supply voltage	10-32 VDC
Supply current	1 A

Crop Specs in Montana

Spray Controller

1

11.2 gal/ac

9.6 gal/ac

35.04 gal/min

[−] [+]

VRC | 5.0 gal/ac | 7.5 gal/ac

Universal Terminal

```
Average Reading        25.9
Prescription           10.6 gal/a
Output                       c
Left reading           25.9
Right Reading          25.7
```

TOPCON
Precision Agriculture

Auto Section Control

CONTROL MODE

9

BOUNDARY LIMIT
Field Boundary

ASC ON

---

5   44

B

A

---

1 | 11.2 gal/ac
391 gal
34.8 ac

17
0.2"
RTK

13.4 mph

1"
0°

−5
144.3 ac
37.1 ac

Spray Controller

1

16.0 gal/ac

10.6 gal/ac

9.05 gal/min

VRC

5.0 gal/ac

7.5 gal/ac

Universal Terminal

Average Reading 23.4

Prescription Output 10.6 gal/ac

Left reading 22.4

Right Reading 24.4

TOPCON
Precision Agriculture

Auto Section Control

CONTROL MODE

9

BOUNDARY LIMIT
Field Boundary

ASC ON

---

4 TANK1 15

B

A

---

1 14.2 gal/ac

385 gal
27.0 ac

17

0.2"
RTK

3.1 mph

0

0°

-5

145.0 ac
36.3 ac

Sources of Remote Sensing Data

- **Sensors mounted on your equipment**
  - $5,000 - $15,000 one time
  - Capable of real time applications
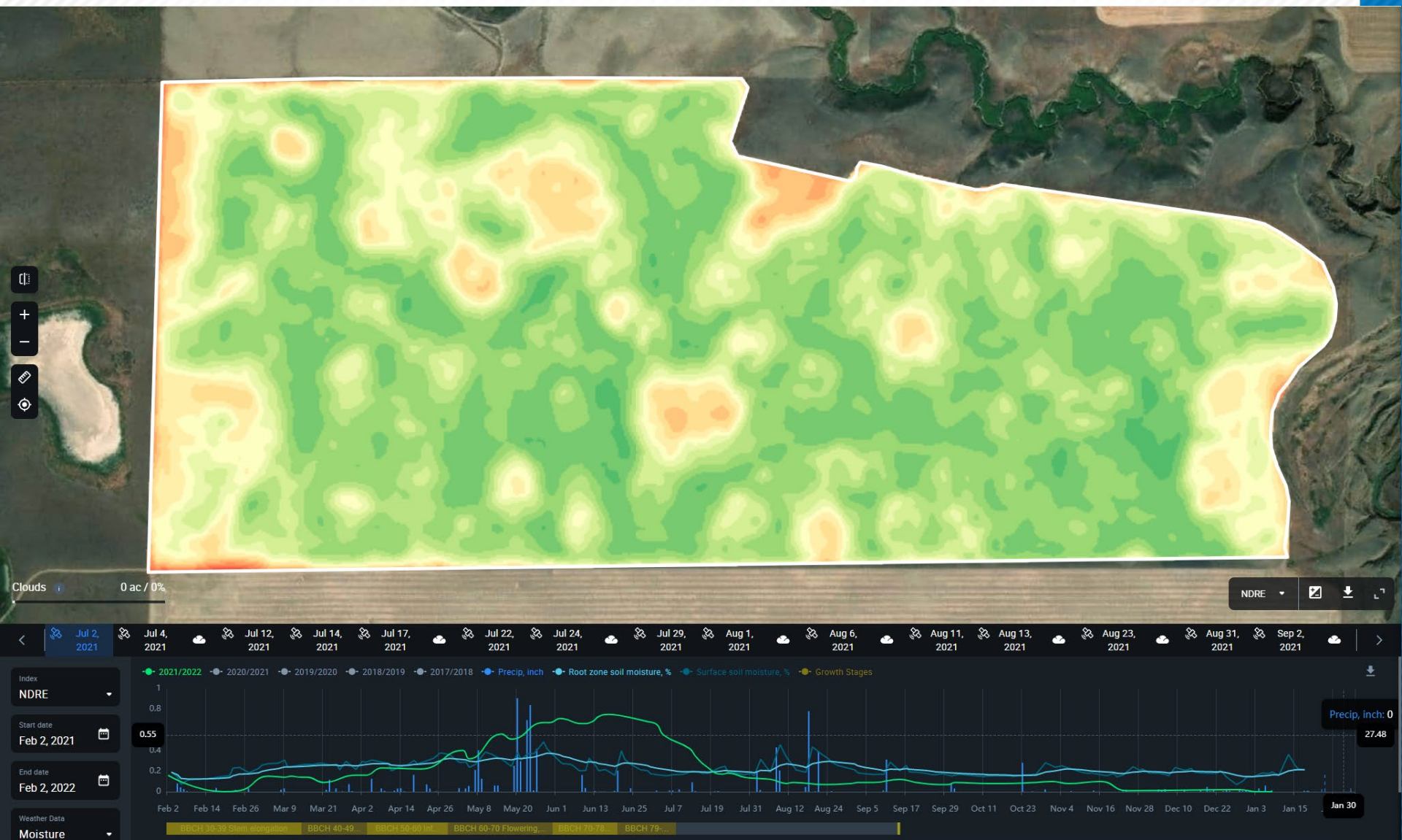- **Drone with special camera**
  - $5,000 - $50,000 for drone and camera
  - $300 monthly for Special imagery software
  - Can create simple prescriptions
  - Do you need 2-4" pixels?
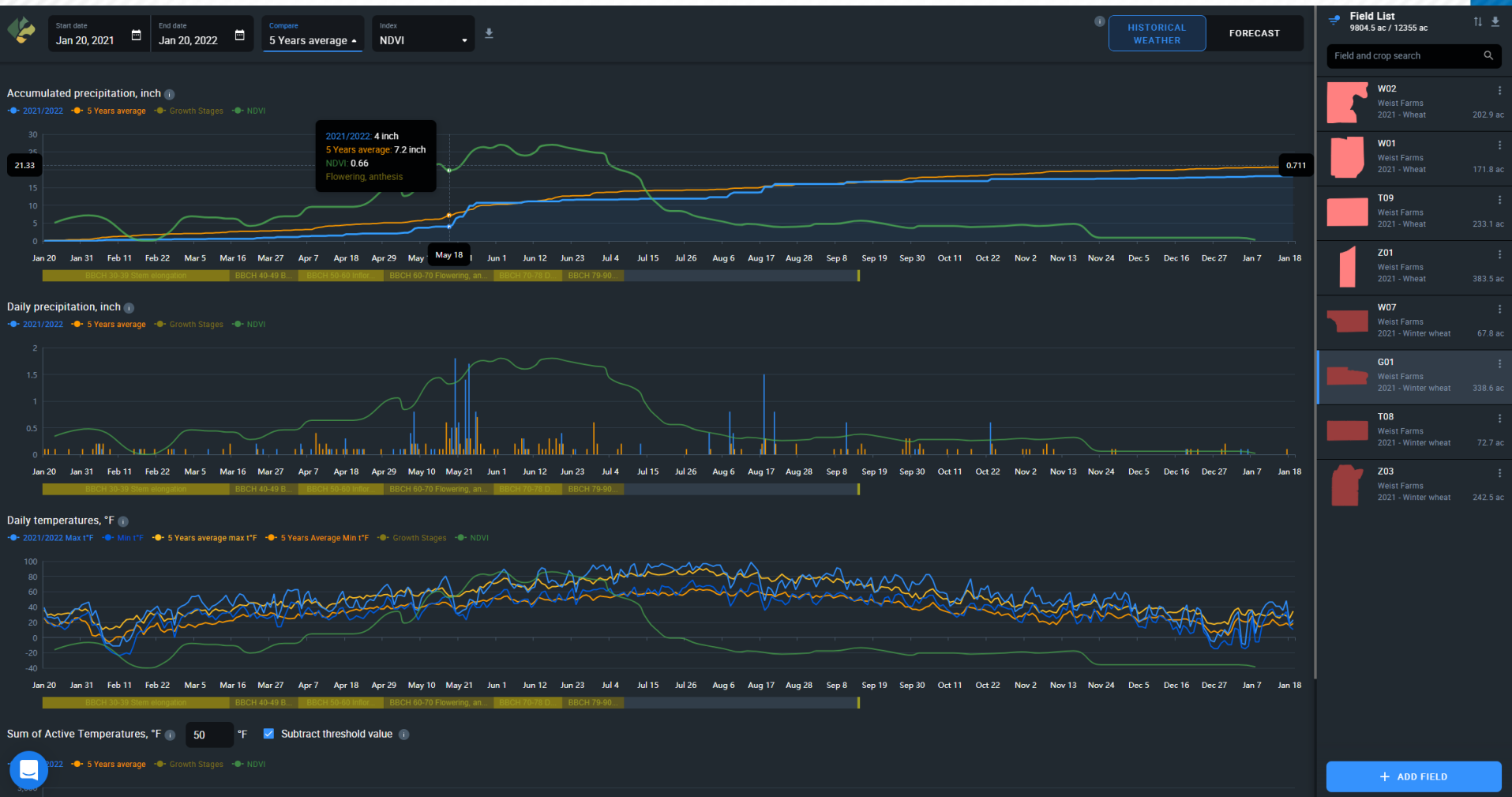
- **Satellite**
  - Many companies offering "free" Satellite imagery with cloud service
  - Other companies charge for imagery and create indexes and prescriptions
    - $1 - $5 per acre per year

EOS Remote Imagery and Weather

EOS Remote Imagery and Weather

Your Weather

▸ **Real time Soil sensors**

▸ **Many on the market**

- Mostly only do simple data collecting

▸ **Several that are highly advanced**

- Nutrient Levels

- Moisture levels

- Temperature and Humidity

- Irrigation scheduling

Harvest Smarter

▸ **Smart Cart**

- Automatic weight capture

- Automatic Upload to secure Cloud

- Can be uploaded to MyAgData Seamlessly

MyAgData

▸ **3rd Party to move data**

1. Farmer seeds his fields
2. Console uploads to Cloud
3. MyAgData gets data from Cloud
4. Creates FSA compatible data and wireless submits Acreage Report
5. Once harvested, yield data is used to generate yield maps and auto-report to insurance

▸ **Why is this good?**

• Accurate acreage reporting, seeded and prevent plant
• Typically a reduction in premium (more accurate acres)
• Quicker payments
• More accurate proven yields
• Reduces load on Farmer

Connectivity

slingshot

▶ **Topcon TAP**

▶ **Trimble Connected Farm**

▶ **AGCO FUSE**

▶ **JD Link**

▶ **Raven Slingshot**

▶ **Climate FieldView**

DATA OVERLOAD

DATA DATA and more DATA

All farming operations involve collecting data. Anything from the grey matter between Grandpas ears to highly sophisticated data warehouses with endless ways to find trends and solve problems

The Evolution of Mobile Data Transfer and Storage Technologies

EPROM	5.25 in. Floppy	3.5 in. Floppy	SD Card	USB	Cloud
1/1/1985	1/8/1990	1/1/1997	1/1/2003	1/1/2007	1/8/2012

1985 | 1985 | 1989 | 1993 | 1997 | 2001 | 2005 | 2009 | **2012**

Who owns what data???

- ► **End users**

- ► **Custom Applicators**

- ► **USDA**

- ► **Grain buyers**

- ► **Machinery Dealers**

- ► **Service Providers**

- ► **Private Companies**

- ► **Insurance**

- ► **Foreign Governments**

Big Data and little Data

- ► **Big Data needs little data**

- ► **Little data needs to be accurate and very well defined in order for BIG DATA to gain any benefits**

- ► **Farmers Business Network**

- ► **John Deere**

- ► **SST Software**

- ► **Walmart**

Money Ball

- ▸ **Use large sets of data**

- ▸ **Use advanced analytics to find advantages**

- ▸ **Oakland A's 2002 and 2003 run proves this**

- ▸ **No difference in Agriculture**

- ▸ **Data itself is worth almost nothing, but high level analytics and products of the data are priceless and can have profound results**

Knowledge vs Data

Old farmers might not be able to tell you what they had for breakfast, but they can all tell you how a field performed 30 years ago and why.

The best current data sets do not have knowledge, only data. The need for local knowledge is critical to the success of a precision ag program. Every farming operation is different, every field is different, treat them accordingly.
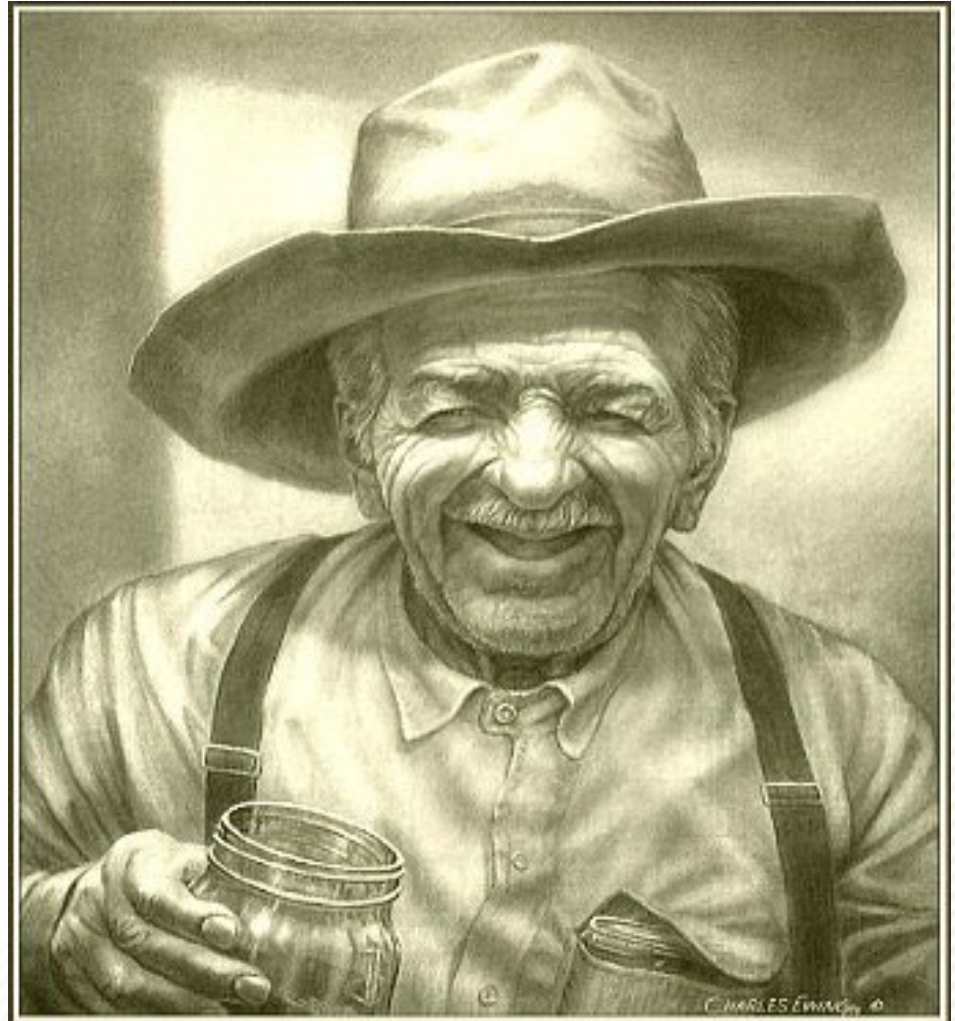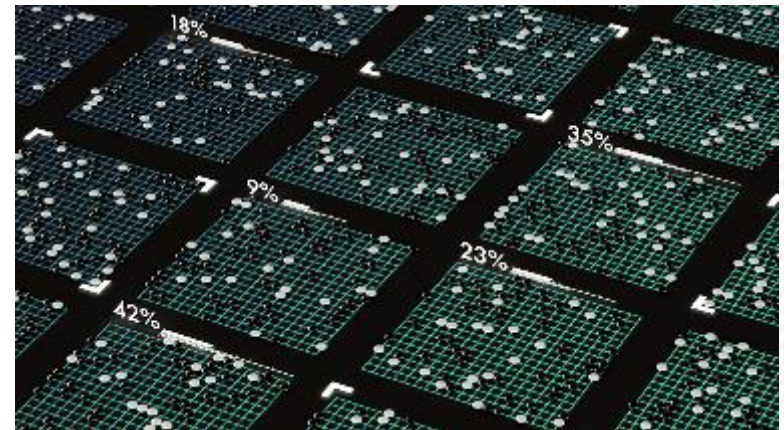
Artificial Intelligence

▶ **Weather**

- Satellites

  - Precipitation

  - Growing Degree Days

  - Compare to previous 5 years

▶ **AlphaGo**

- First AI to learn how to play Go

- Beat 10+ time world champion 4-1 in 2021

- Was expected to take another decade of research to complete

All these tools, now what?

1. **Take inventory on what equipment you have and its capabilities**
   - A lot of seeders are now VRC capable
   - Most sprayers are VRC capable
   - A lot of combines have yield monitors
   - Can retrofit older equipment to make as smart as new

2. **Start with the quick pay back technologies and passive data collectors**
   - AutoSteer/AutoTurn/BoundaryAutoturn
   - Auto Section Control
   - Yield Mapping
   - Smart Grain Cart
   - Crop Health Monitoring
   - Cloud Platform

3. **Variable Rate Macro then micro nutrients and possibly seed**
   - Some sort of zoning tool
   - Vary NPK through seeder
   - Vary N and micros through sprayer

4. **Look at other technologies and see if they make sense**
   - Individual nozzle control
   - Sub inch GPS
   - Boom Height Control
   - Seeder/Plow Height Control
   - Controlled Traffic
   - Autonomous tractor

Golden Rule..........Start with Seeding

▸ **Nothing else matters if you don't get the seed in the ground precisely correct.**

▸ **Some of the oldest drills still provide good stands**

▸ **Get the crop started well first, you have the highest yield potential the day you plant the seed**

▸ **All the tools used after seeding are to fix any potential problems**

▸ **Get your seed in the ground at the right depth, the right rate and the right time.......precision agriculture**

▸ **All the tools and tech in the world cannot fix poor seeding and emergence performance.**

Farm Tech Approaches

- **Implement Autosteer and Auto-section Technologies**

- **Control implements with precision**

- **Collect Data….. applications, yield, weights, images, etc.**

- **Soil Optix Scanning**

- **Remote Sensing**

- **Elevation Data**

- **Harry Eyeball**

NO Fear!

▸ **Analysis Paralysis**

▸ **If you do what you've always done, you'll get what you've always got**

▸ **The definition of insanity is doing the same thing, expecting different results**

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