>60% of Ag Businesses that invest in Digital Agriculture do not see a positive Return on Investment

Source: McKinsey & Company, Creating value in digital-farming solutions, October 20, 2020
https://www.mckinsey.com/industries/agriculture/our-insights/creating-value-in-digital-farming-solutions

“It is not that easy”

Movie: FURY

Common attributes of successful adopters

Source: McKinsey & Company, Creating value in digital-farming solutions, October 20, 2020
https://www.mckinsey.com/industries/agriculture/our-insights/creating-value-in-digital-farming-solutions

High attention from CEO and top team

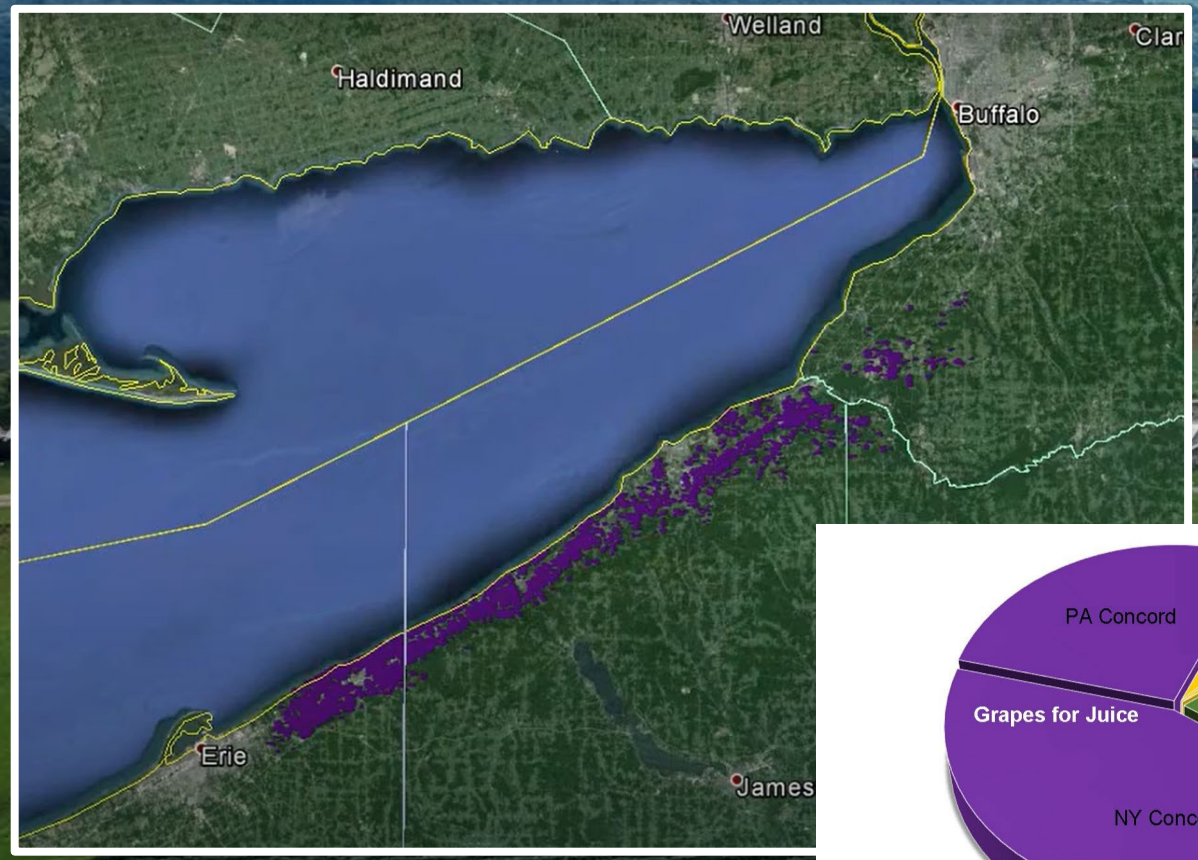
Decision makers see the potential value and are willing to become educated

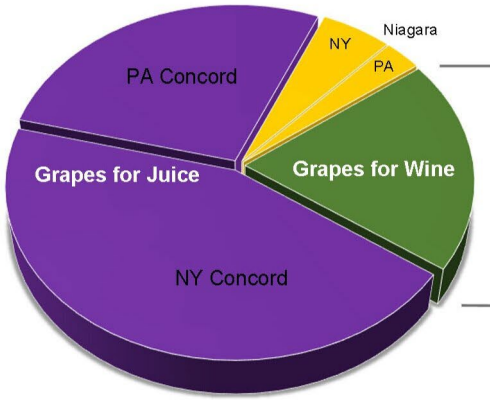
Clear strategy and business case linked to value creation

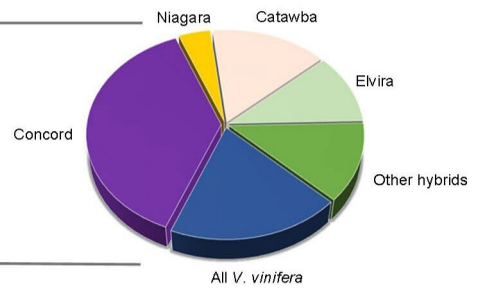
Don’t ask what it can be used for, tell me what you want to do

At-scale investment

Digital Ag Tech is scalable. Start small and work up.

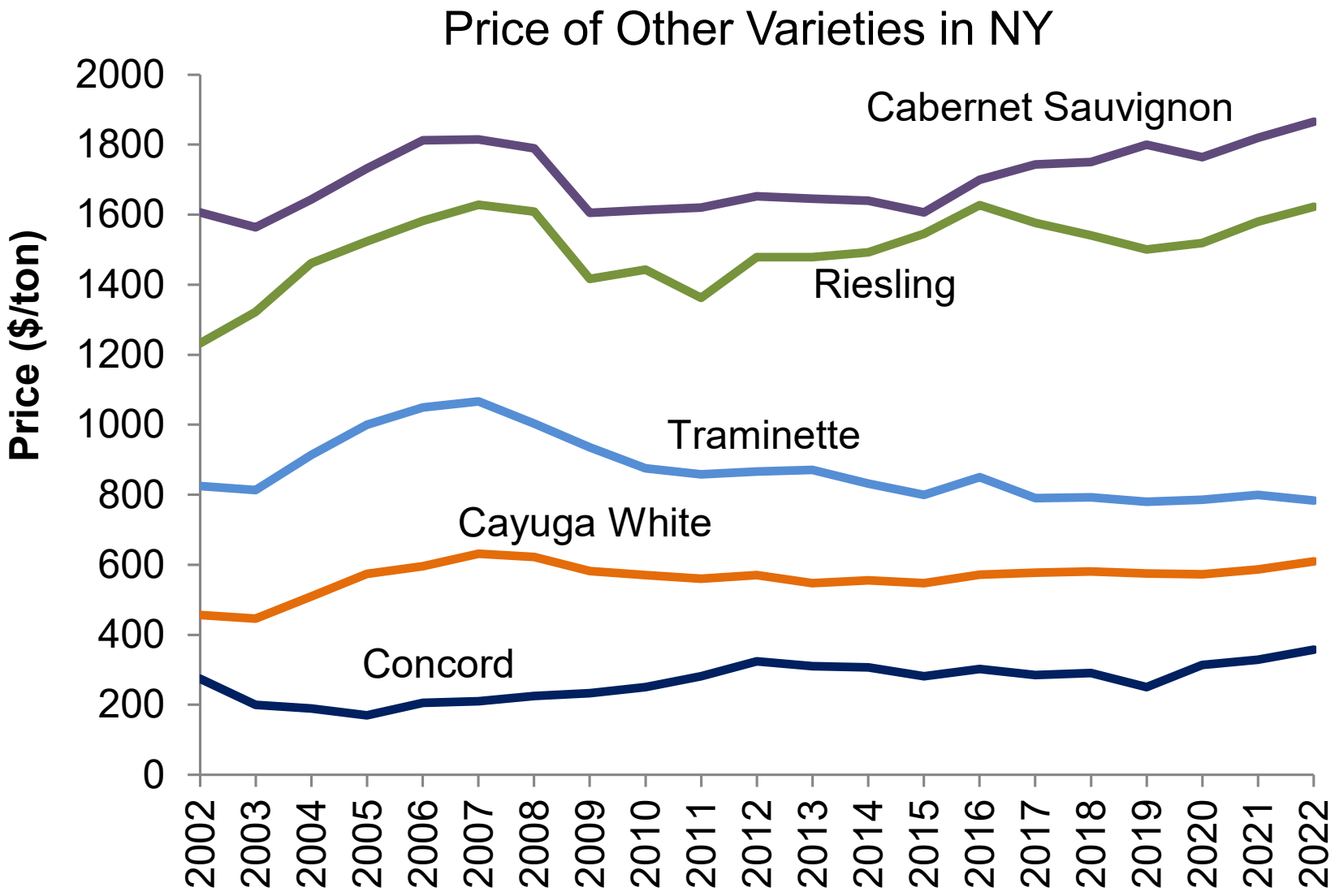


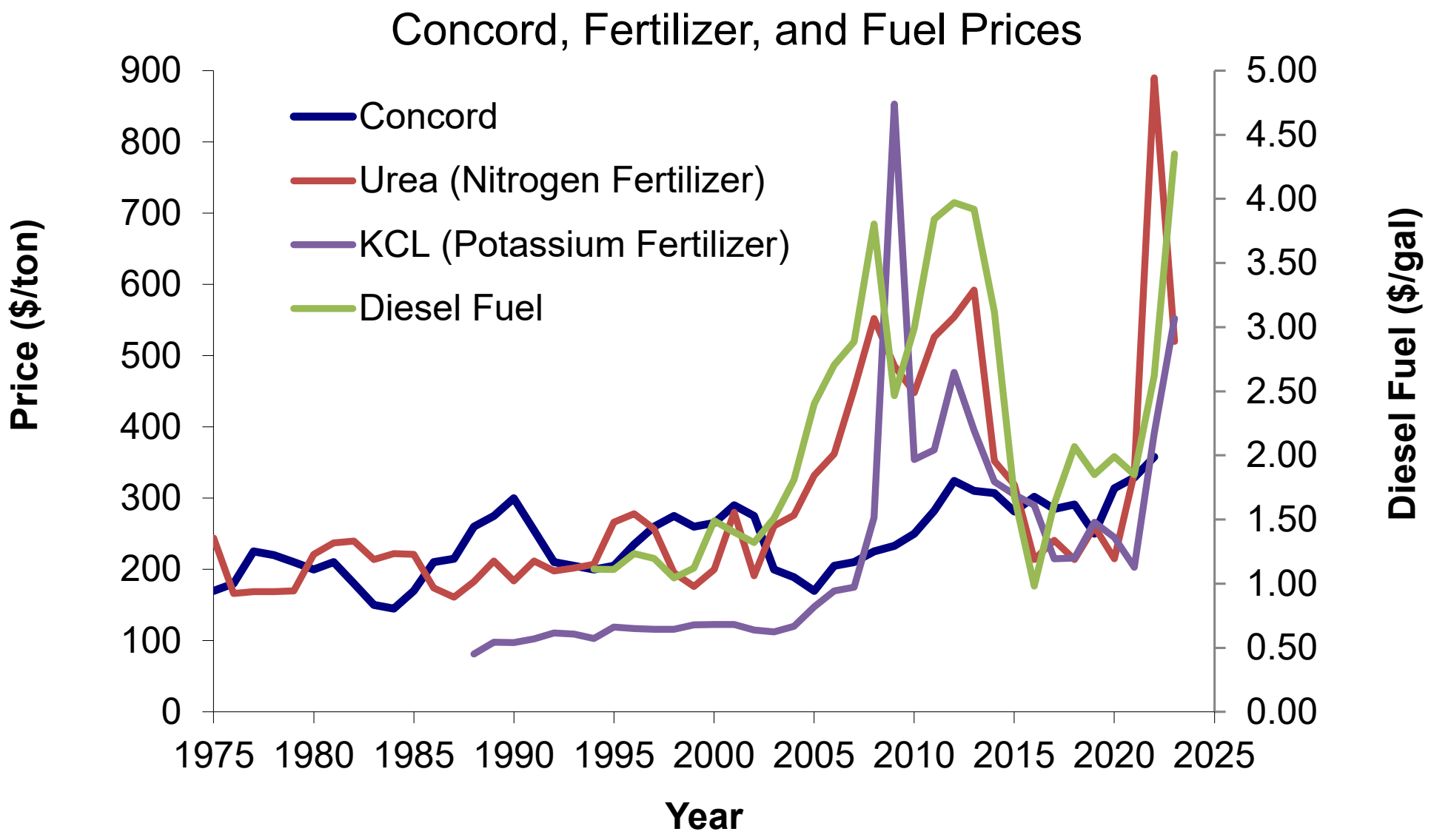




80% of grapes in NY and PA are grown for the juice market

Concord makes up 40% of the grapes grown for wine in NY and PA

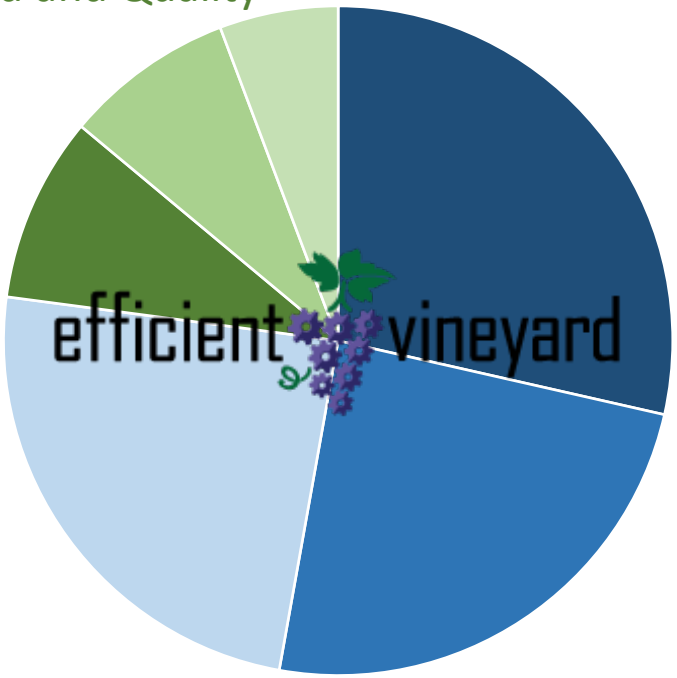

Price of Other Varieties in NY
Price ($/ton)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Cabernet Sauvignon
Riesling
Traminette
Cayuga White
Concord
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022


Concord, Fertilizer, and Fuel Prices
Concord
Urea (Nitrogen Fertilizer)
KCL (Potassium Fertilizer)
Diesel Fuel
Price ($/ton)
Diesel Fuel ($/gal)
Year
900
800
700
600
500
400
300
200
100
0
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

Concord Grape General Cost of Production

25% Crop Protection and Nutrition Materials

Improve Efficiency
for
Yield and Quality



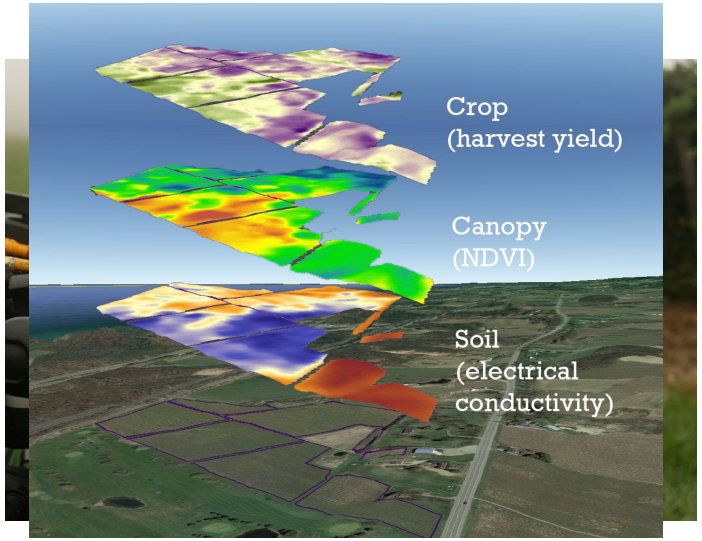
Reduce Labor
and
Production Costs

25% Vine and Trellis Maintenance

25% Harvest Operations and Trucking

25% Equipment Operation and Fuel

Concord Grape General Cost of Production



25% Crop Protection and Nutrition Materials

Improve Efficiency
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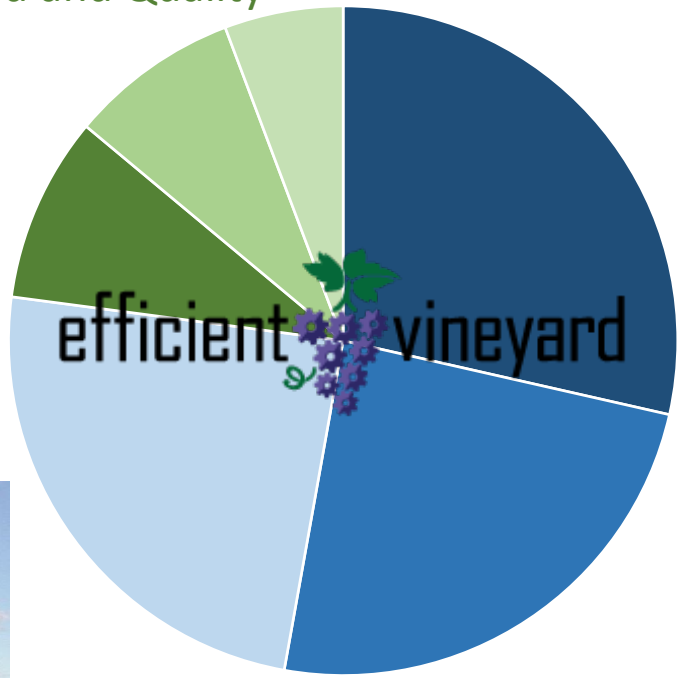


25% Vine and Trellis Maintenance

25% Harvest Operations and Trucking

Reduce Labor
and
Production Costs

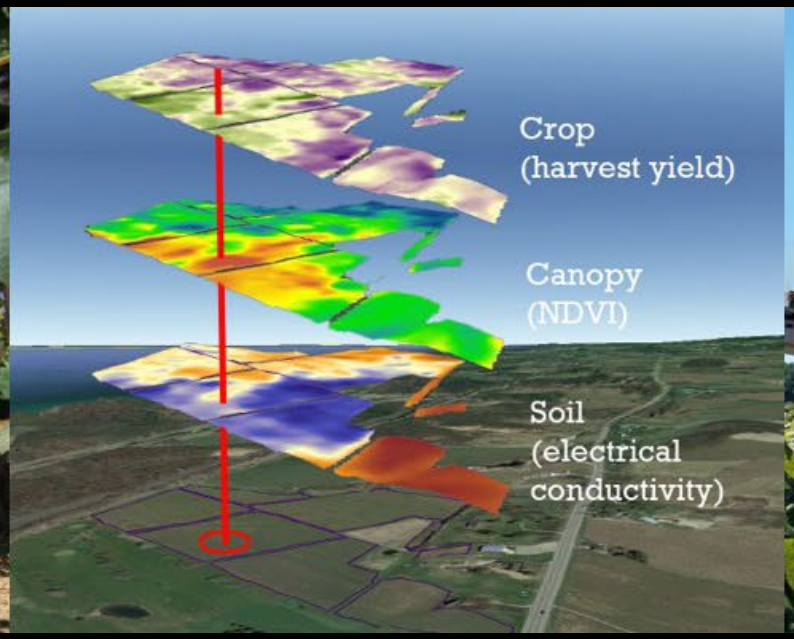
25% Equipment Operation and Fuel

The Efficient Vineyard Approach

Measure

Measure vineyard soil, canopy, and crop characteristics using mobile field sensors

Model

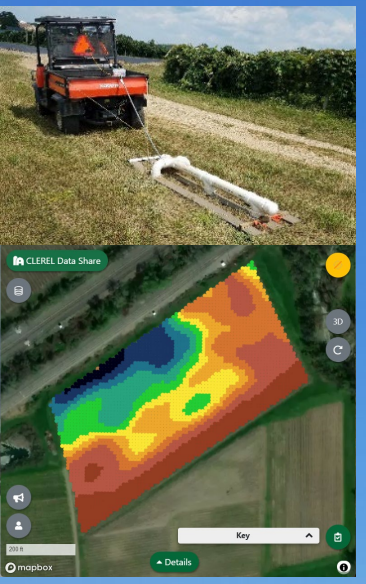
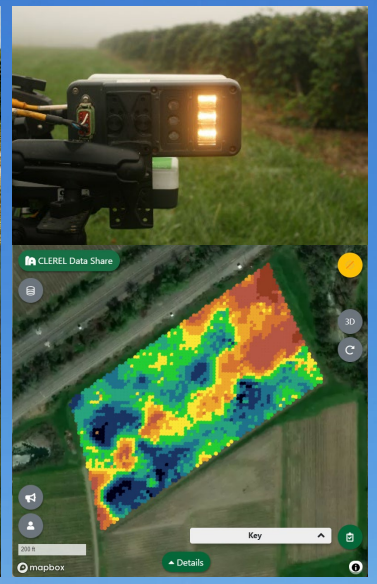
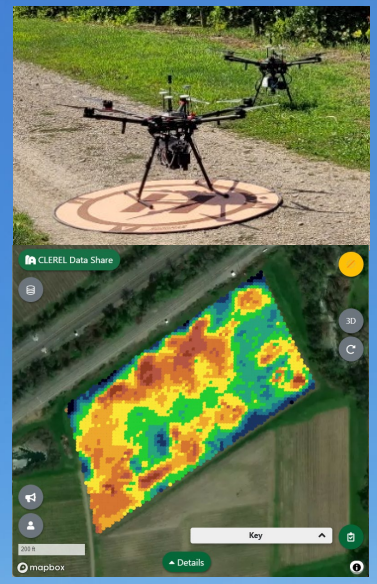
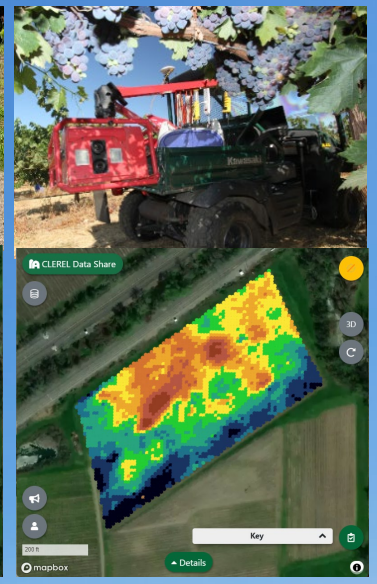
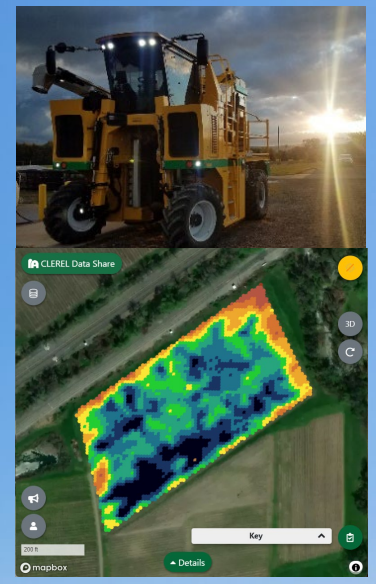


Model multi-layer spatial data needed for perennial cropping systems

Manage

Manage vineyards by integrating spatial information with variable-rate technology

Measure: Collecting and Validating Spatial Observations in the Vineyard

Soil ECa	Canopy Reflectance (NDVI)	Nutrient and Disease Detection	Image Analysis	Yield Monitoring	Fruit Quality	Grower Observations
						

Sensor Validation is Important…

…to translate spatial sensor data into horticultural information

Model: Viticulture is a Multi-Layer Decision Making Process

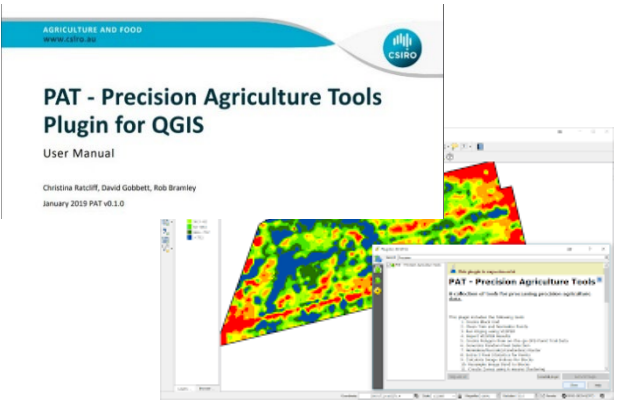
CHO CONSIDERATIONS
CHO Gradient between Shoots, Canes, & Arms
Net Production of CHO
CHO Reserves
Amount of Leaf Area
Net Assimilation Rate
Chlorophyll
Leaf Environment
Light Intensity
2000 ft-c
Weeds (Tall)
Leaf Temp.
Day
Night
Leaf Soundness or Freedom from Injury by:
Pests
Pesticides
Fungicides
Insecticides
Herbicides
Heat
Growth Reg.
Frost
Hail
Pollutants (Ozone)
Mineral Deficiency
Shade
Anti-senescence Agent
5 Sugar Concentration in Berry
1 Ft. Row/ Acre
6 Crop Wt. of "Count" Nodes/ Acre
Wt. S.S. per Acre
Acre
Grape Crop/Acre
1 Ft. of Functioning
Completeness of Trellis Fill
Row Spacing
2 Vine Size (Cane Wt./Ft. canopy)
Nodes/Ft. of Canopy
3 Pruning Severity
Shoot Production
Shoot Maturation
Shoot size
Shoot No.
Roots
Root No.
Root Production
CHO
Soil Vol.
Net Product-ion
Translo-cation
Root Destruction
Ageing
Nematodes
Mech.
Phylloxera
Resist. Rootstock
Vine Resist.
Growth Reg.
Root Environment
N
Weeds
eration
re Training Restriction
re Collection
re Transport
re Detachment
re Conveyance
ds/Ft. of Row
6 Pounds/Foot of Canopy
nt" Nodes
from shoots Arising from "Non-count" Nodes
Variety
from Basal Nodes
as Sprouts
4 Pounds/Node
Shoots/Node
Pruning Severity
Polarity
Cane Maturation
CHO
Local
Vine Reserves
Crop/Shoot
Clusters/Shoot
Cluster Primordia Initiation
Weight/Cluster
Berry Size
CHO
Water
Growth Reg.
Applied GA
Seed
No.
Size
Pollen Quality
Pollen Source
CHO
B
Production
Shoot Elongation Rate
Pruning Severity
Temperature
Growth Retardants

Tools for Working with Spatial Observations

1000

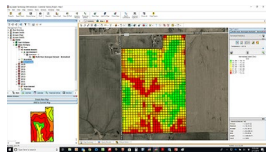
ArcGIS® ESRI

QGIS



100

Ag Leader® Trimble® John Deere Operations Center



SMS

Ag Software

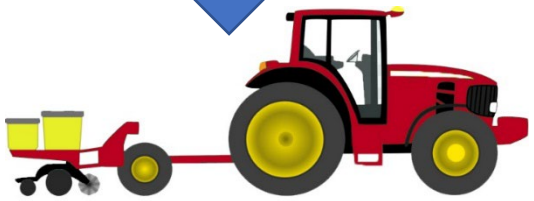
Operations Center

InCommand

GFX

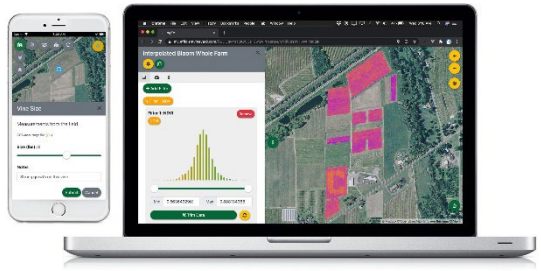
4640 Display

Rate/Flow Control Mechanism

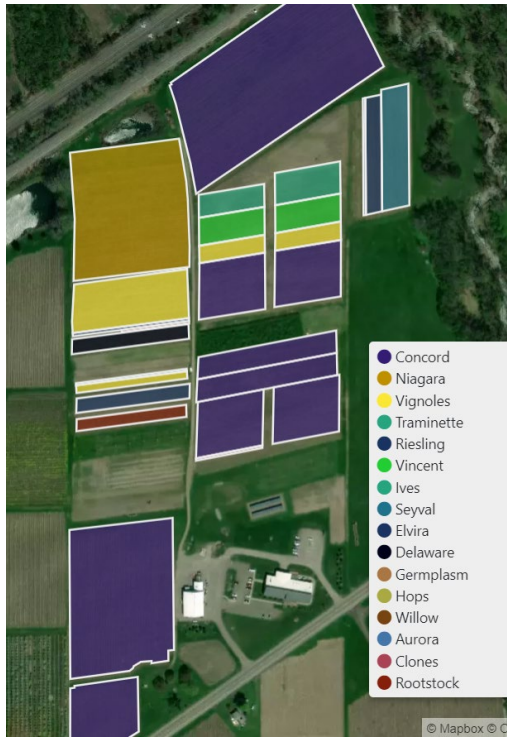


10

MyEV Tool

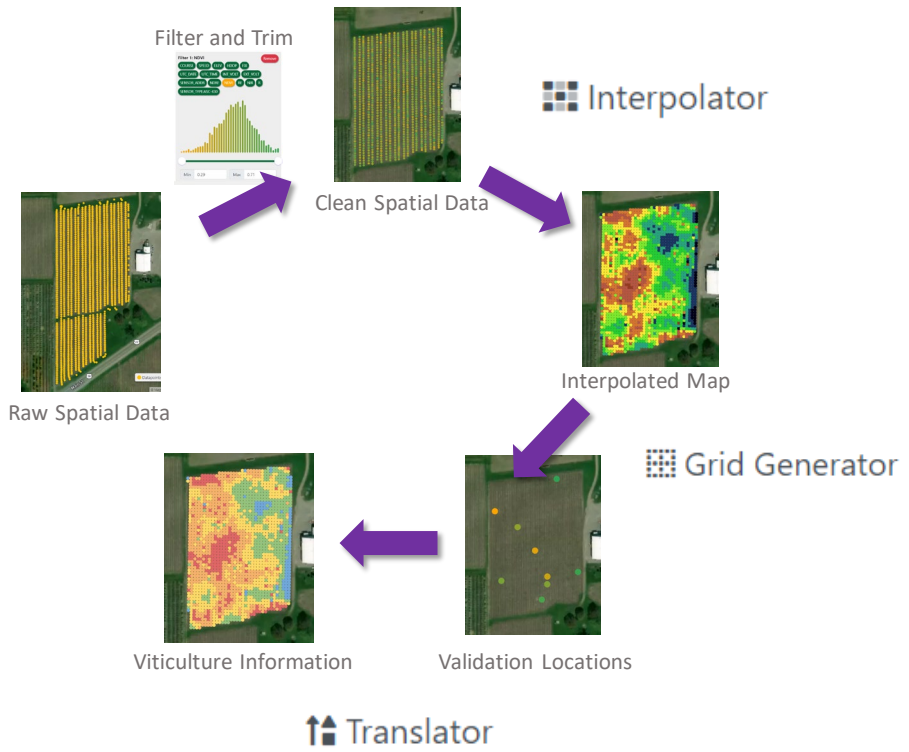


More Basic

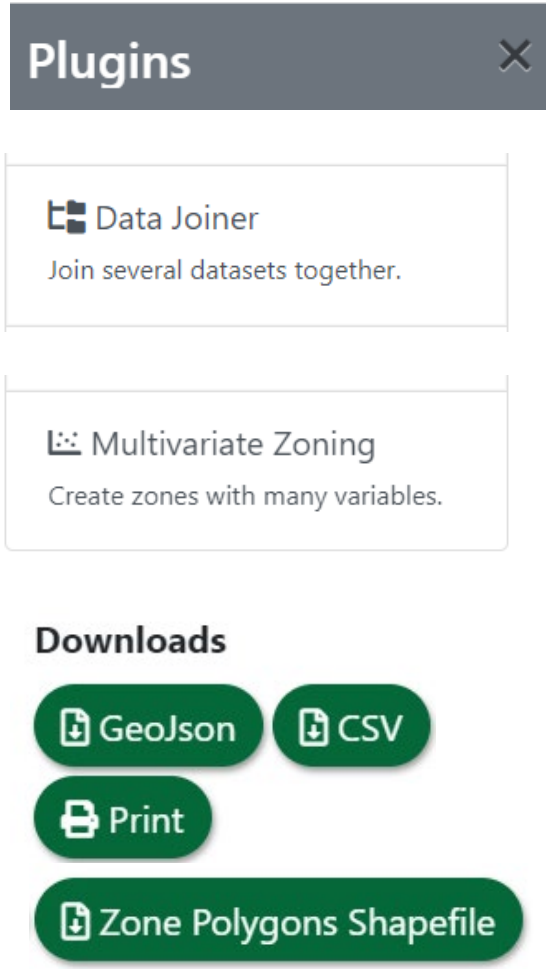


Farm and Block Level Data Management

Primary MyEV Function



More Advanced



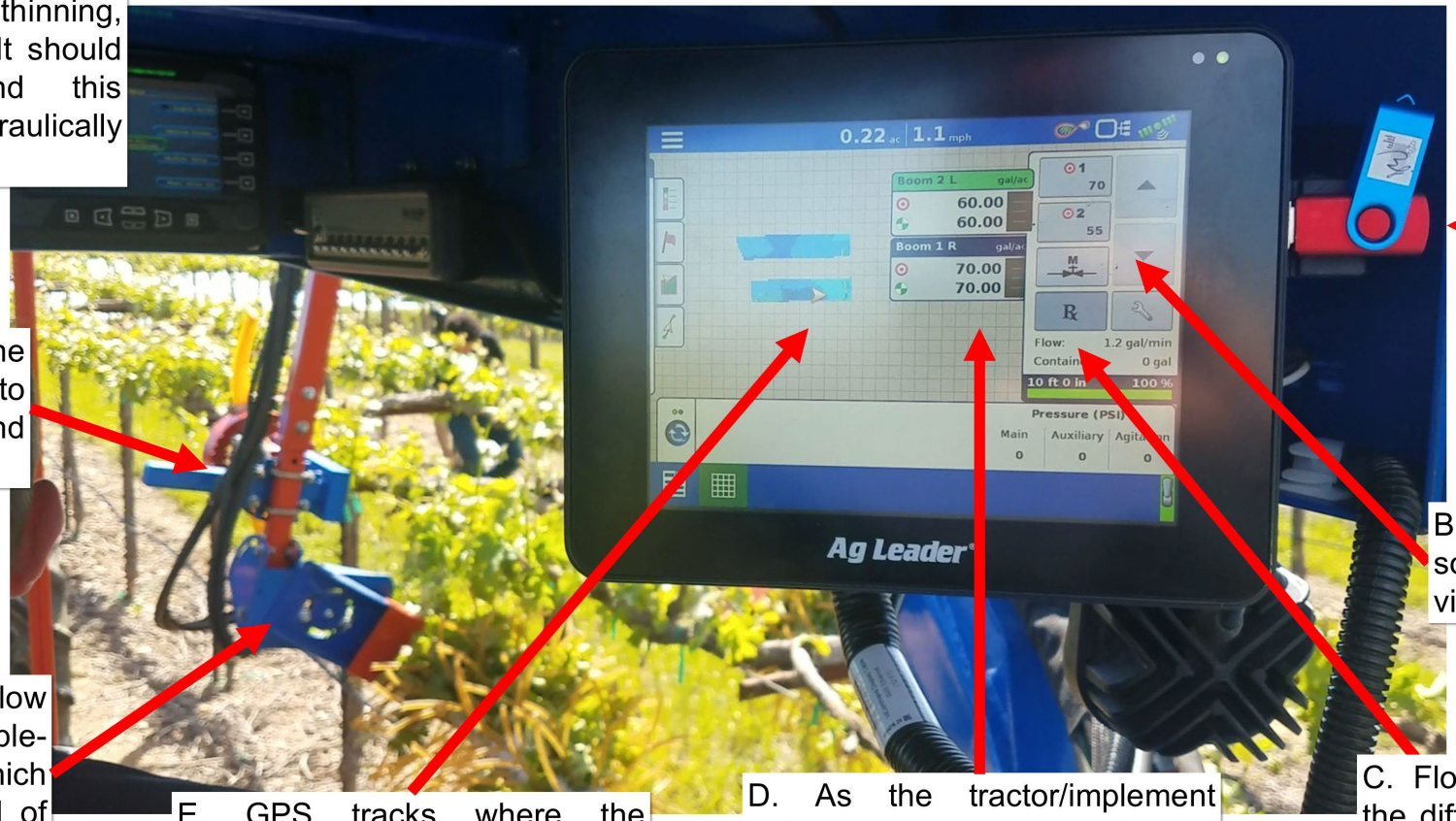
www.efficientvineyard.com

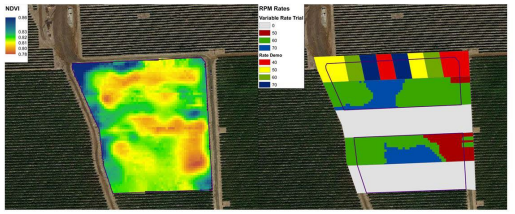
Anatomy of Variable-Rate Vineyard Mechanization



Vineyard machines apply a uniform treatment to a non-uniform system. Integrating spatial data and decision support with precision agriculture technology and vineyard mechanization can lead to mechanized variable-rate applications.

H. This method has been used for VR shoot thinning, fruit thinning, and fertilizer applications. It should be possible to extend this technology to any hydraulically controlled implement.





A. Spatial data are used to generate in-field rate trials and variable-rate prescription maps

G. A speed sensor on the thinning head allows us to translate flow rate to RPMs and shoot thinning rate.

B. AgLeader hardware and software are used to import and visualize prescription maps.

F. The signal from the liquid flow controller is sent to a variable-rate hydraulic valve, which controls the rotational speed of the shoot thinning head .

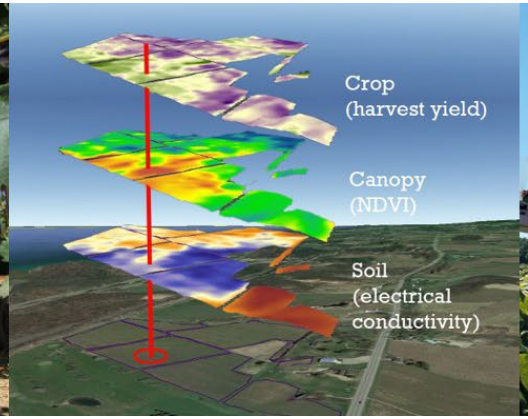
E. GPS tracks where the implement is in the vineyard and on the prescription map.

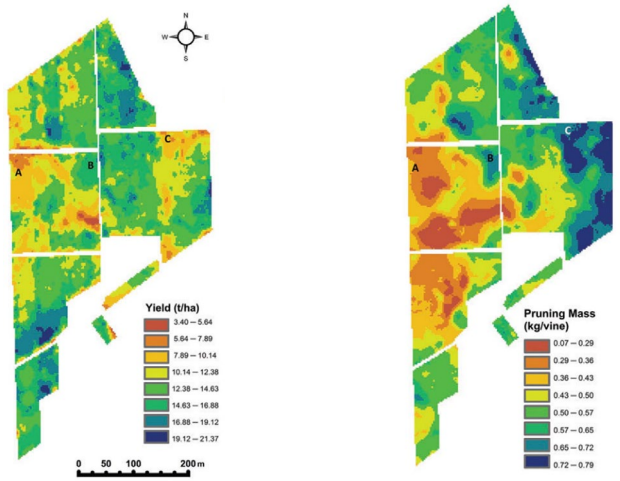
D. As the tractor/implement enters a new management zone, the signal to the liquid flow controller changes.

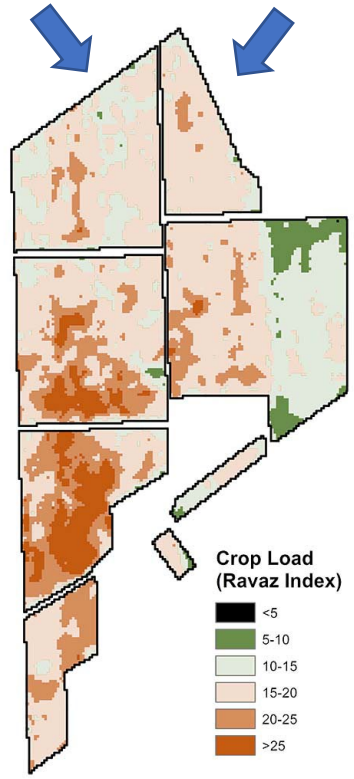
C. Flow rates are assigned to the different treatment zones on the prescription map.

Potential Practical Benefits of Precision Viticulture

- Improve production through soil and vine size mapping
- Optimize fruit quality through crop load (Ravaz Index mapping)
- Efficient use of soil amendments and fertilizers
- Labor Efficiency through VR Mechanization
- Business analysis through revenue (yield, Brix, and market) mapping
- Leveraging Local Viticulture Knowledge





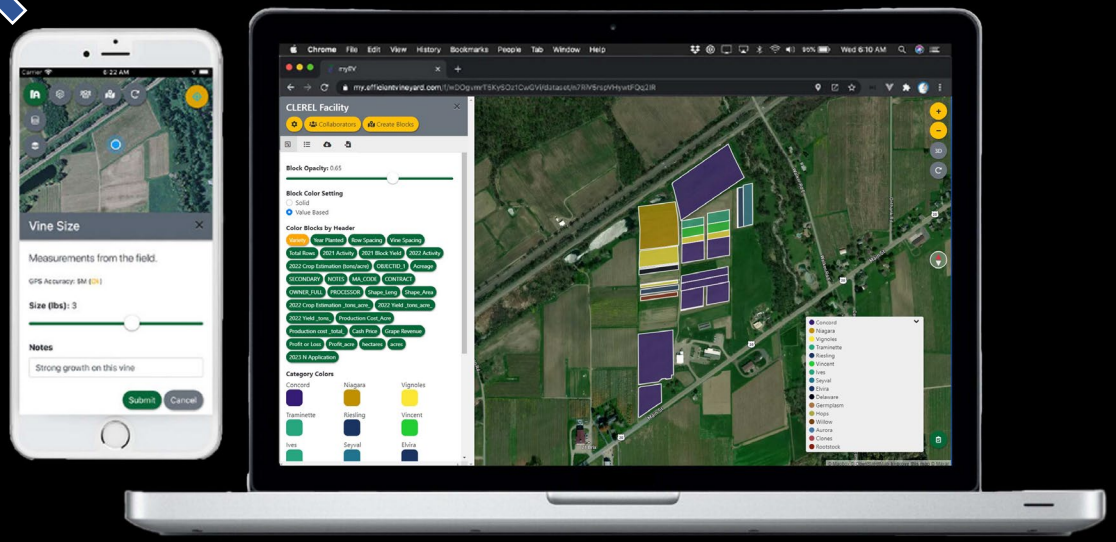


efficient vineyard

MyEV Tool

CLEREL | The Efficient Vineyard Project | Vit Blog

myEV Documentation



Cornell AgriTech New York State Agricultural Experiment Station

Efficient Vineyard

It is not just a project. It is our mission.

Dr. Terry Bates, CLEREL Director (cv)

As a proud member of Cornell AgriTech, our lab


Education
Business Purpose
At-scale Investment