Smart Machines for Weed Control & Beyond

Using machine learning to optimize every plant

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Over 60 people, with deep experience in advanced technologies and agriculture

20
Experts in AI/ML, Software, Robotics

8
Hardware & mechanical engineers

8
Agriculture scientists & engineering support

Commercial & academic experience at key companies & institutions

A new era in Agriculture

Hand Tools

10,000 years

Mechanical

1900

Chemical

1950

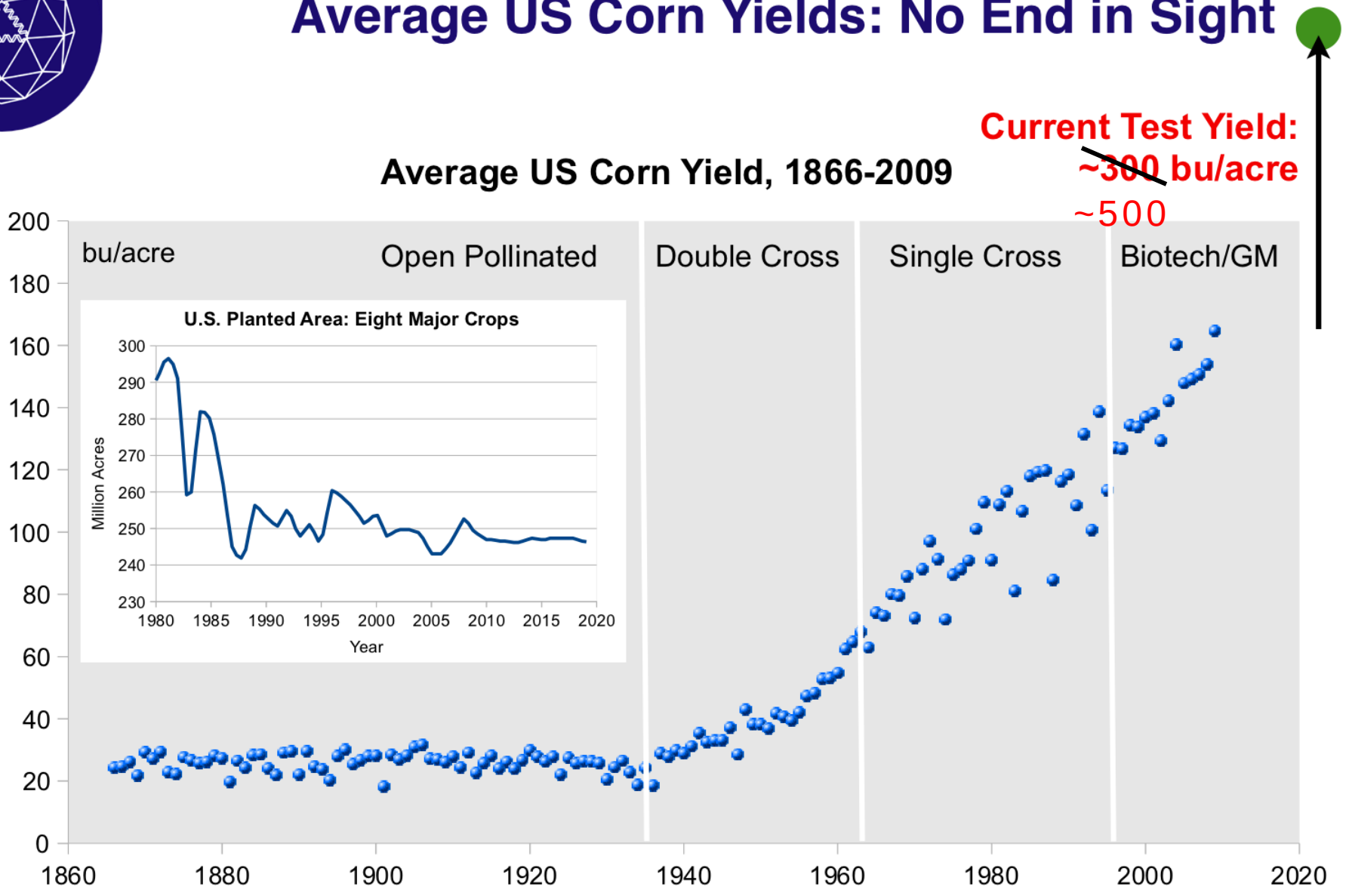
Biochemical

1990

Digital

NOW

Average US Corn Yields: No End in Sight



Sources: USDA-NASS; Troyer, *Crop Science* 46.2 (2006): 528; Pioneer (Rupert and Butzen, Crop Sci, 19(2))

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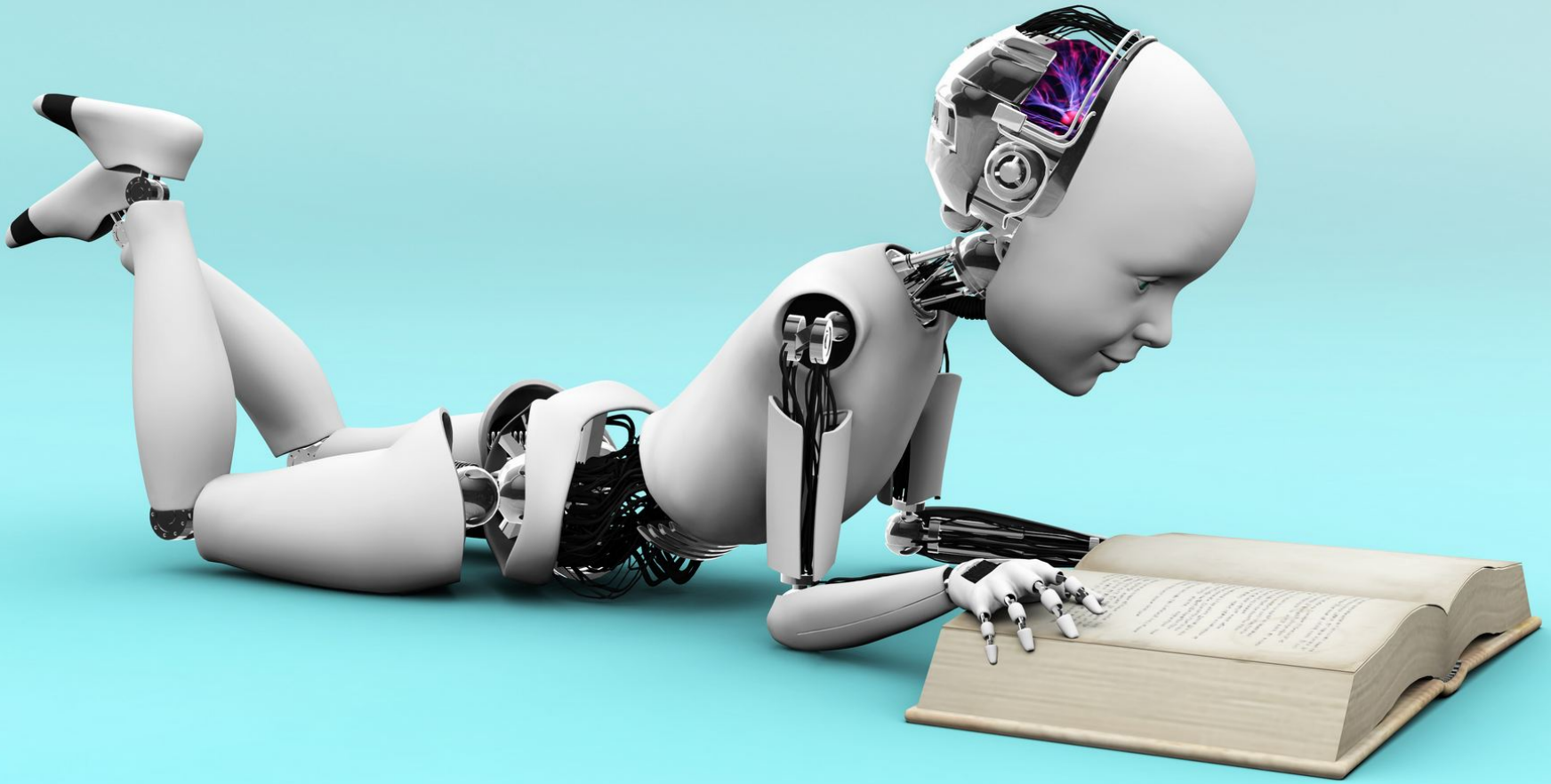
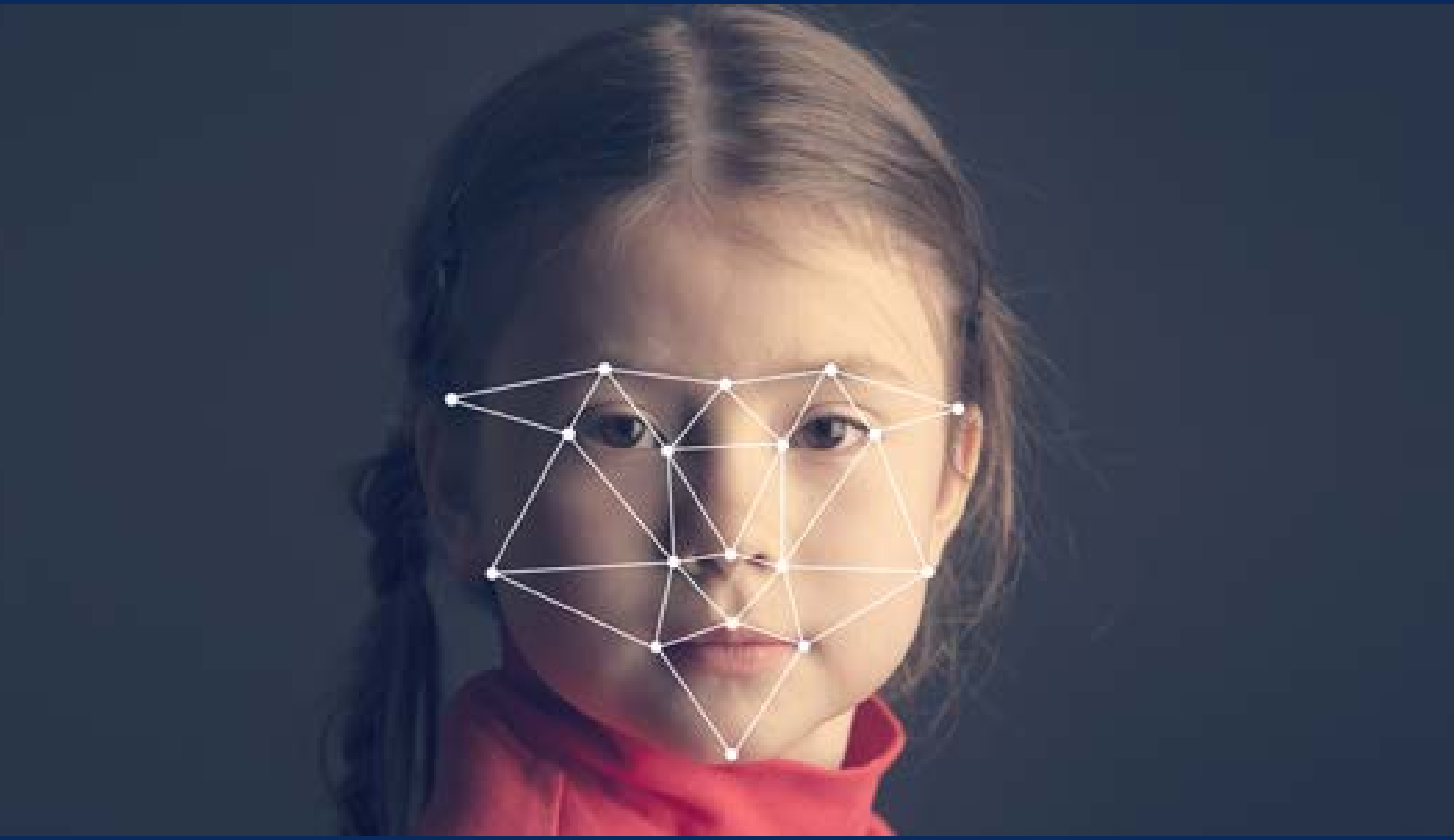
TREAT EVERY PLANT THE SAME.

Accuracy and precision are critical elements to get right to avoid wasting costly products. It is also imperative to achieve the right rate, at the right droplet size, to optimize each plant's performance and yield potential.



Citizens Bank Park
phillies.com
UNITED
#47 GIO GONZALEZ
EXTENSION 5.68 FEET
SPIN RATE 2881.55 RPM
VELOCITY 78.81 MPH
MLB.com
STATCAST
amazon
web services



With machine learning we can teach equipment to see and optimize every plant in the field

Plant-level crop management using intelligent machines can apply to the entire farming cycle

1 *Prepare Soil*

2 *Establish Stand*

3 *Fertilize & Irrigate*

4 *Protect*

5 *Harvest*

↻ *Learn & Optimize for Next Cycle*

Blue River Technology decided to start with crop protection

1 *Prepare Soil*

2 *Establish Stand*

3 *Fertilize & Irrigate*

BLUE RIVER TECHNOLOGY *starting point*

4 *Protect*

5 *Harvest*

↻ *Learn & Optimize for Next Cycle*

Ag machinery is specialized for each action

Prepare soil

Establish stand

Fertilize

Protect

Harvest

Act

Smart machines need to sense their surroundings

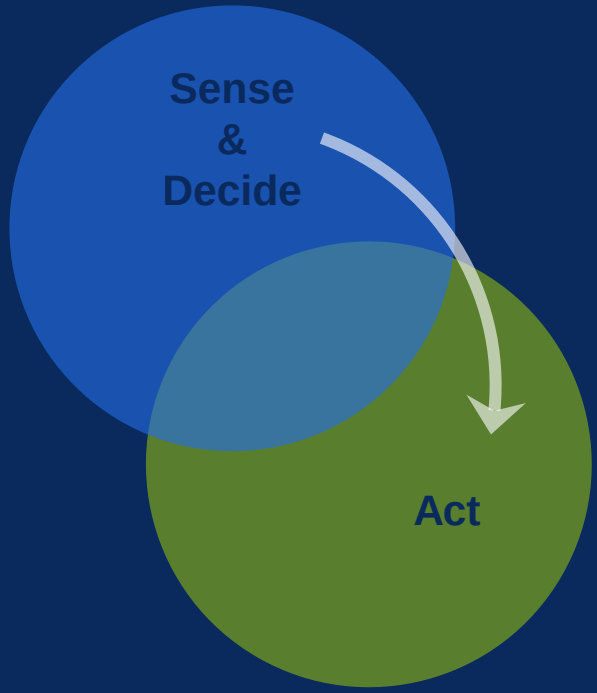
Prepare soil

Establish stand

Fertilize

Protect

Harvest



…and verify & learn from their actions

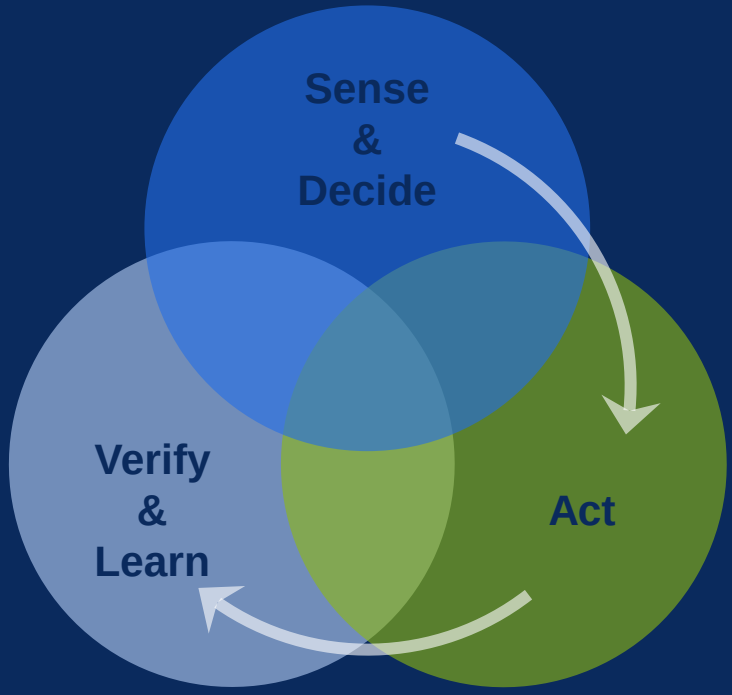
Prepare soil

Establish stand

Fertilize

Protect

Harvest



3 core elements required for smart machines

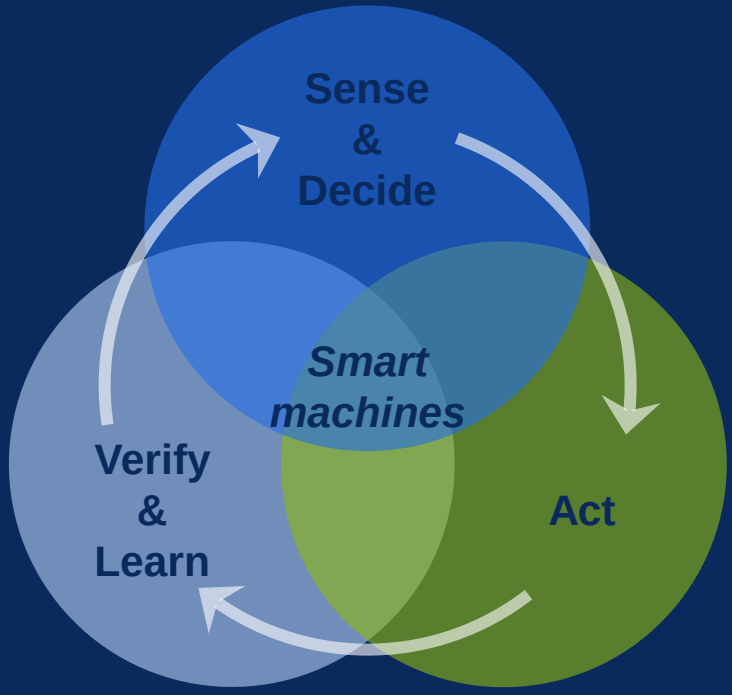
Prepare soil

Establish stand

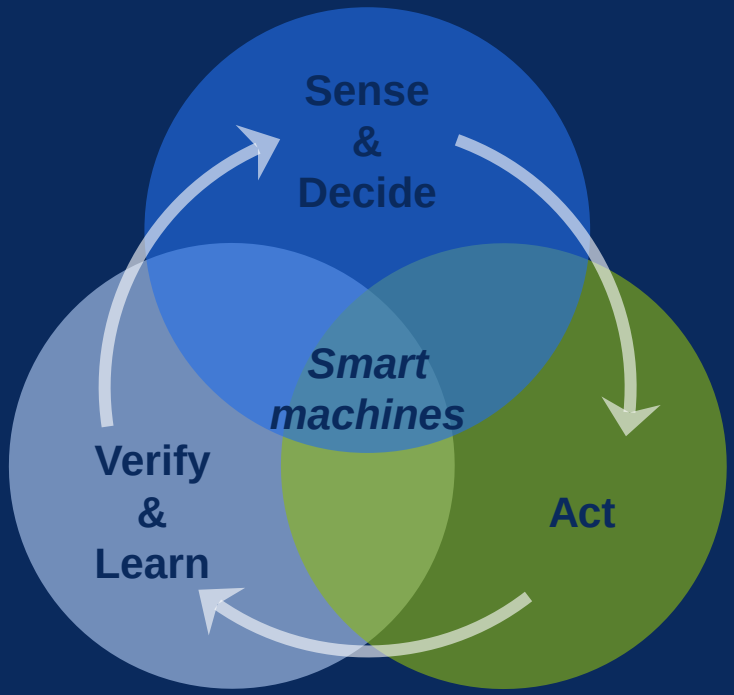
Fertilize

Protect

Harvest



Blue River capabilities enable smart machines



Computer vision	*Machine learning & deep learning*	*Robotics*

Development & learning infrastructure	*Optimization*	*On-board processing*	*Spatio-temporal database and analysis*

LettuceBot

5,000 plants cared for every minute

Blue River Technology - LettuceBot

https://youtu.be/jL4kcrumHA8

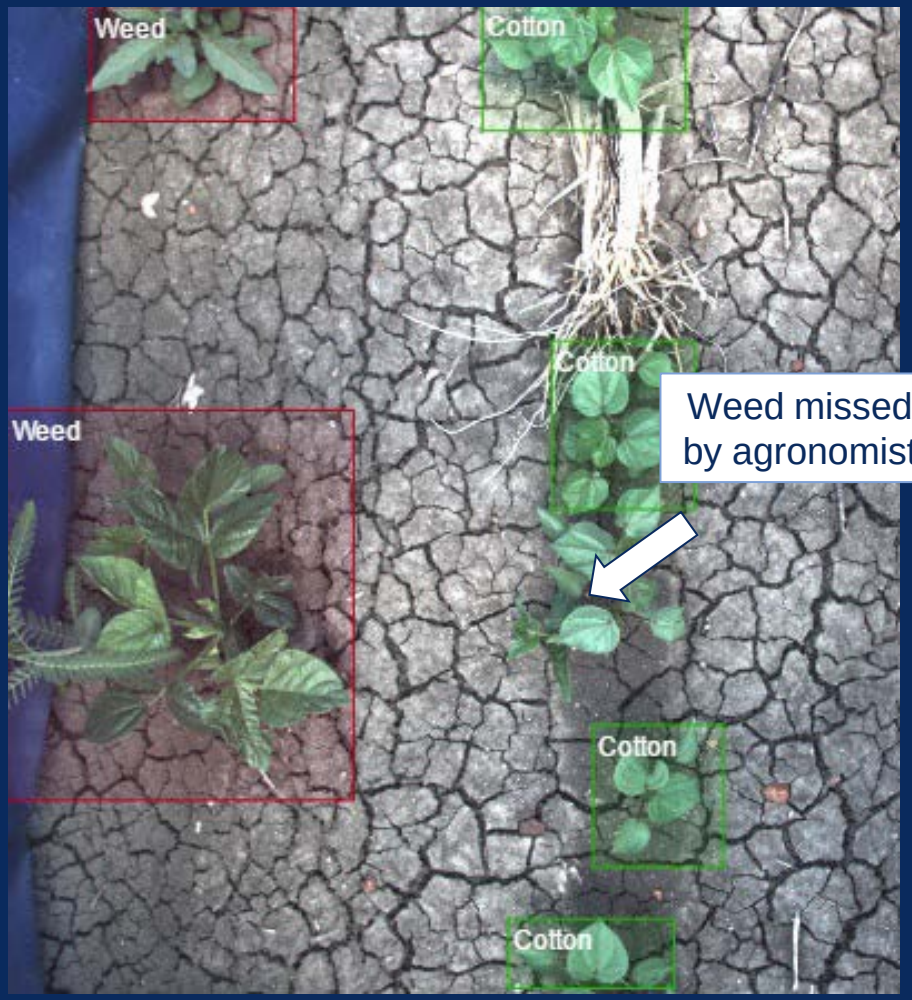
See & Spray technology for cotton weeding

Blue River Technology's See & Spray - close up & slow mo

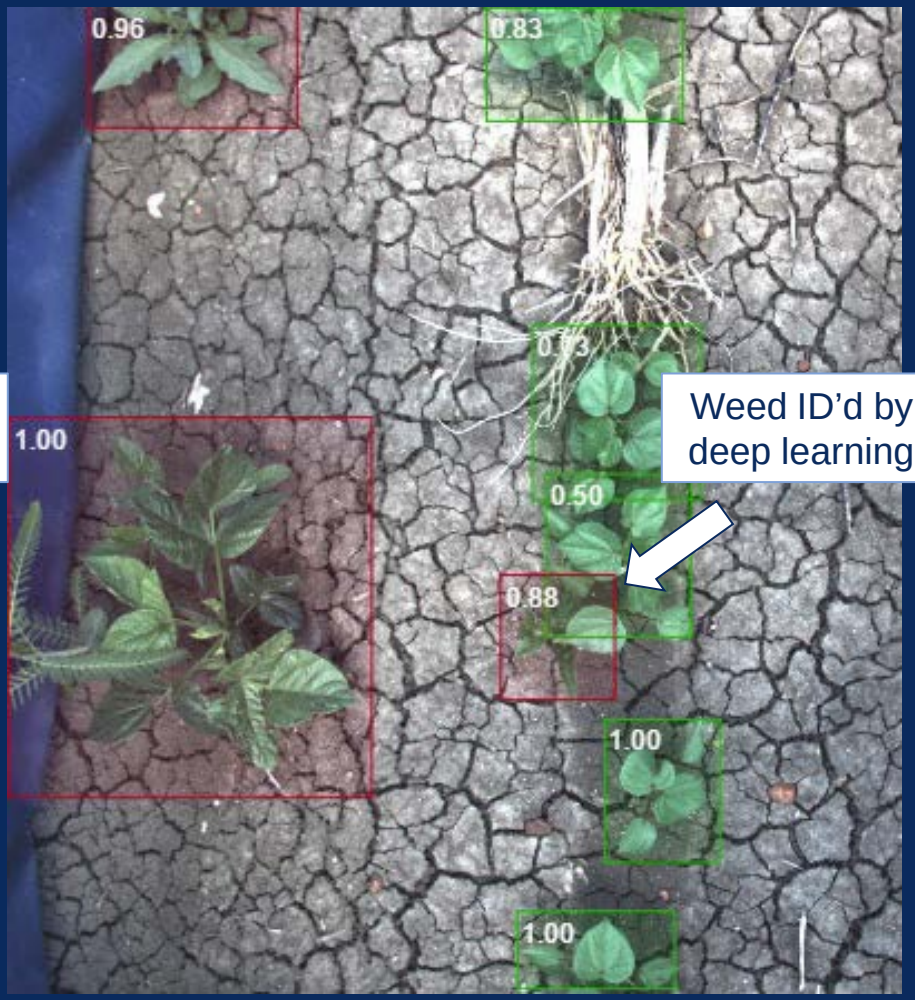
https://youtu.be/UXkGkAGIjMA

After teaching our system to identify cotton and weeds, it performed better than our agronomist

Agronomist labels



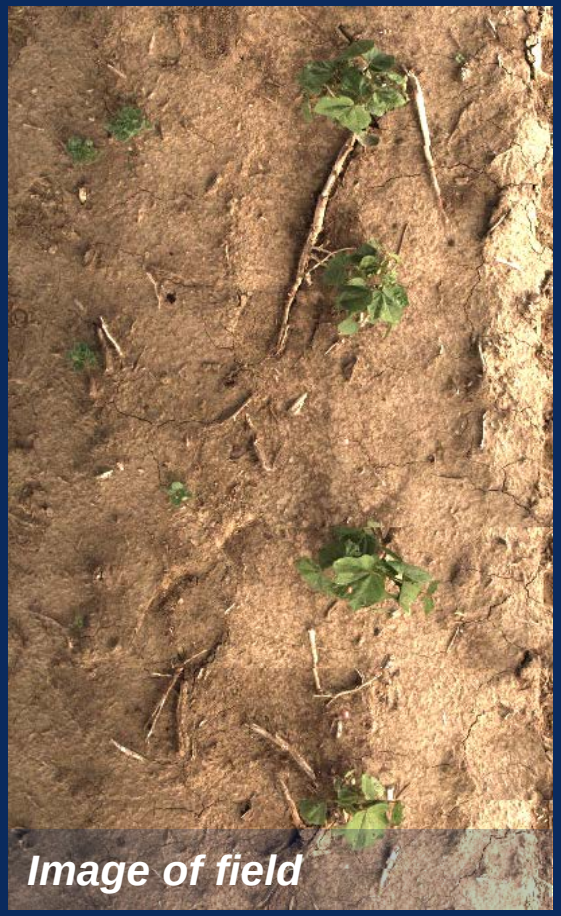
Deep learning labels



See & Spray uses artificial intelligence to identify and spray individual plants in milliseconds

Sense & Decide: Blue River's artificial intelligence identifies subtle differences between crops (green) and weeds (red)

Act: Only weeds are sprayed, reducing chemicals by >90%

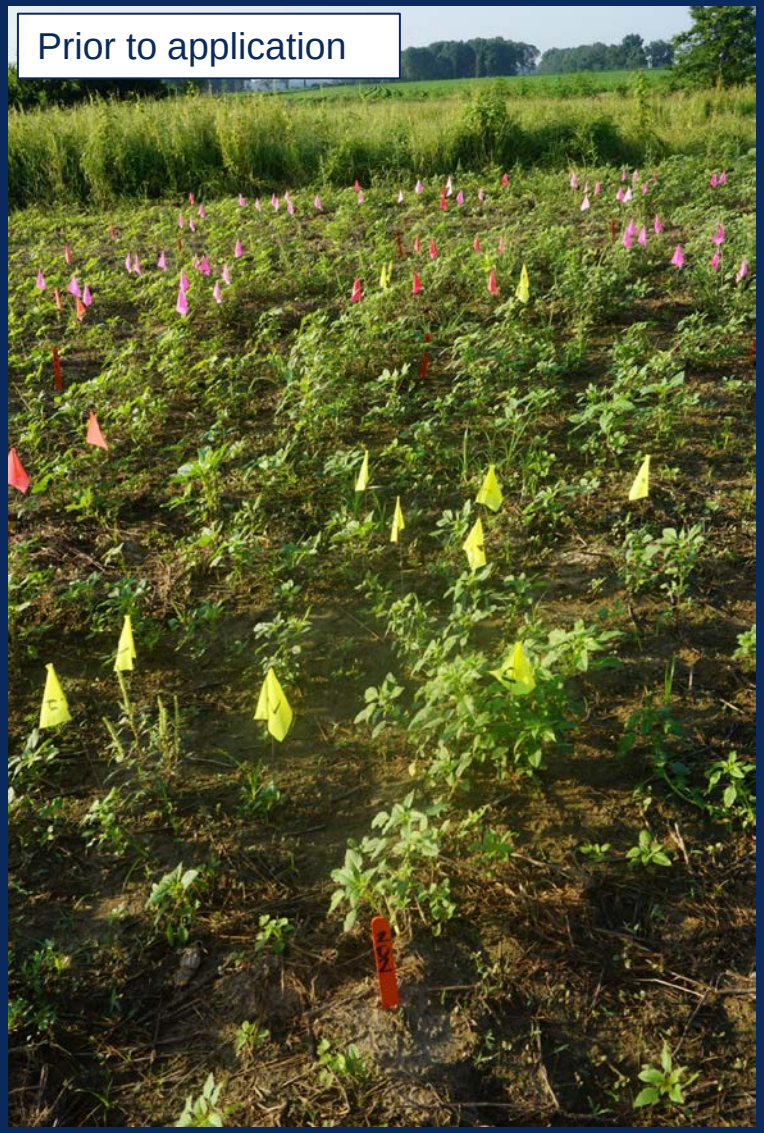


Lettuce
Peppers
Soybeans
Cotton
Corn
Chickpeas

Lettuce
Peppers
Soybeans
Cotton
Corn
Chickpeas

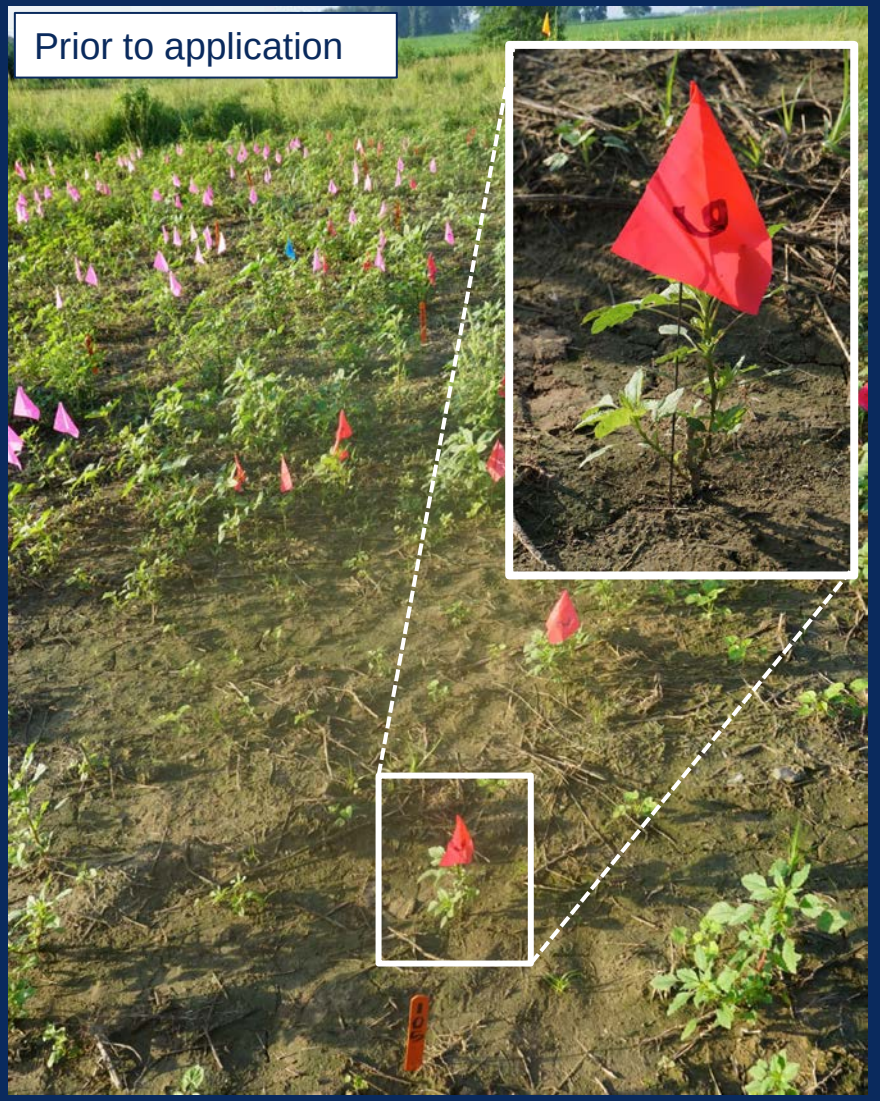
Liberty (glufosinate) failed to control large pigweed

Arkansas herbicide trial, August 2016, day of spraying and after 12 days



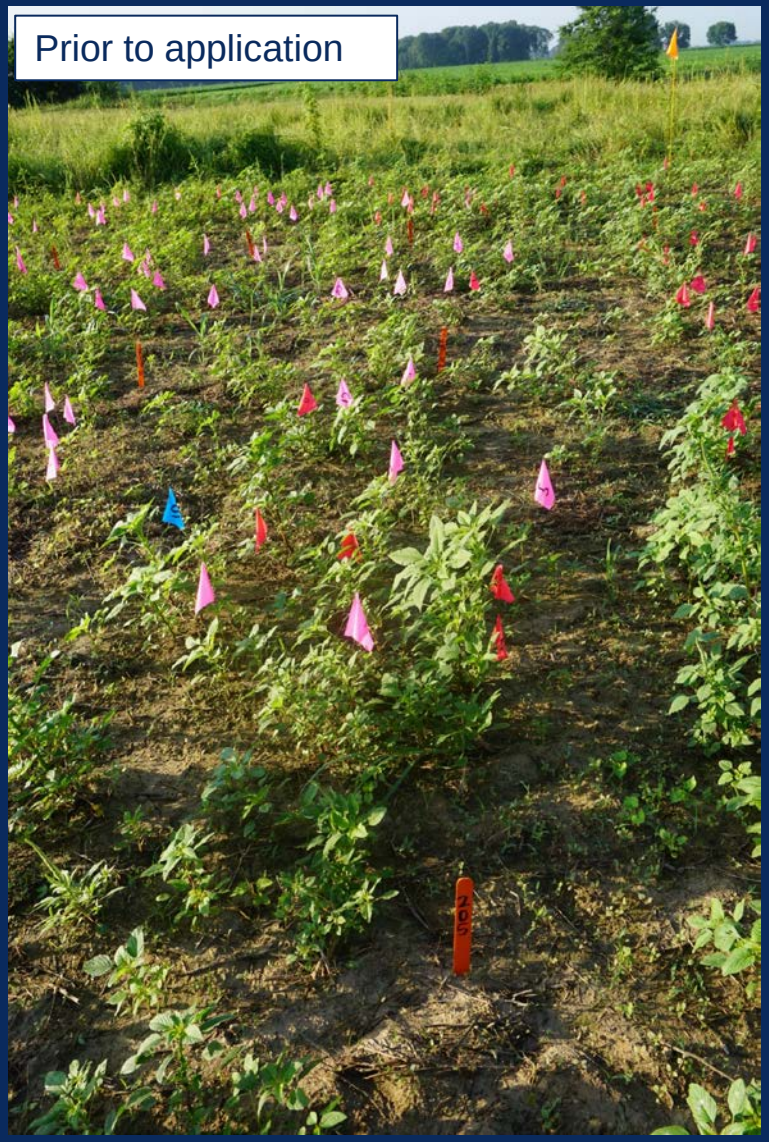
Dicamba failed to control pigweed >6”

Arkansas herbicide trial, August 2016, day of spraying and after 12 days



Paraquat + Caparol controlled pigweed of all sizes

Arkansas herbicide trial, August 2016, day of spraying and after 12 days



Testing Blue River Technology Nozzle Design

Objective
- Compare Blue River Technology nozzle designs with current application technologies (e.g. air-induction broadcast nozzles)

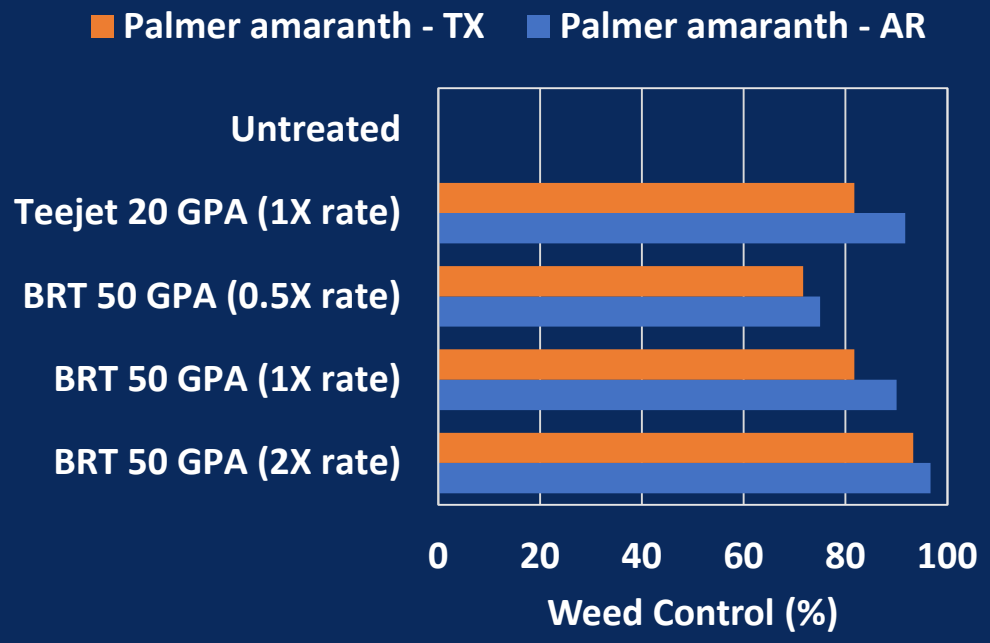
Equipment
- Blue River Technology nozzle manifold (40” width) was attached to a pushcart with all nozzles open during application

Herbicide Program
- Dicamba (Engenia) plus glyphosate (1X rate = 560 g ae/ha + 870 g ae/ha)
- Adjuvants were Reign at 1.0% (v/v) and Induce at 0.5% (v/v)

Locations
- Marianna, AR
- Lubbock, TX

Weeds
- Palmer amaranth

Results
- Herbicide applications through Blue River Technology nozzles were equivalent to current broadcast nozzles (e.g. Teejet AI) when comparing 1X rates



Arkansas – Dicamba Program

Dicamba + Glyphosate
20 GPA with Teejet nozzles

Dicamba + Glyphosate
50 GPA with BRT nozzles

Marianna, AR
Pictures taken 14 days after treatment

* Teejet AI110015 nozzles at 40 PSI

Texas – Dicamba Program

Dicamba + Glyphosate
20 GPA with Teejet nozzles*

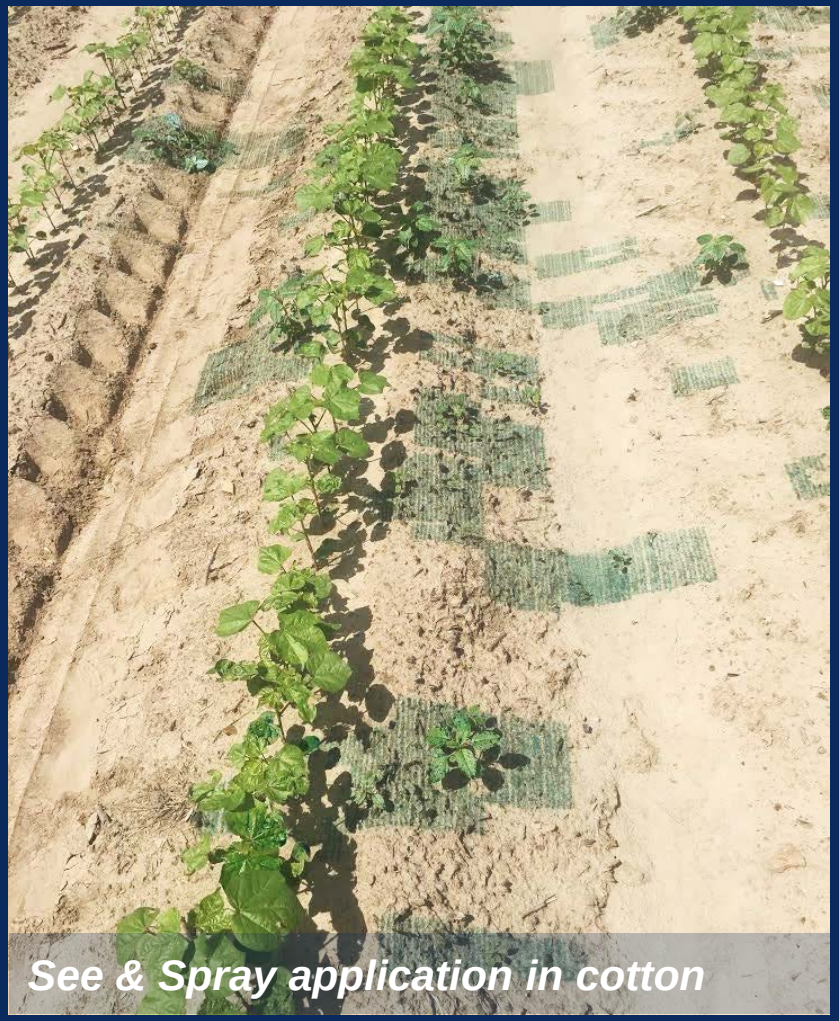
Dicamba + Glyphosate
50 GPA with BRT nozzles

Lubbock, TX
Pictures taken 15 days after treatment

* Teejet AI110015 nozzles at 40 PSI

BLUE RIVER

See & Spray saves costs and fights weed resistance



See & Spray application in cotton

-90%

Reduction in post-emergence herbicide costs by switching from blanket spray to spot spray

-50%

Reduction in seed costs by switching from GMO to conventional seeds

Increased ability to fight resistant weeds using an unlocked toolkit of herbicide options

See & Spray will see limited commercial release in 2018 for cotton, then expand to other row crops

NOW

2012 to 2016 | 2017 | 2018 | 2019 | 2020 | 2021+

Phase 1:	**Phase 2:**	Phase 3:	Phase 4:
Lettuce Thinning	**Cotton Weeding**	**Weeding All Row Crops**	**Full See & Spray**
Proof of concept	*Full Commercialization*	*Showing Versatility*	*Flexible spray tool*

Self-sustaining R&D operations

Begin cotton machine delivery

Expand to soybeans, peanuts, corn, and others

Precise spot application of fertilizer, fungicide, growth regulator, etc

See & Spray - Blue River Technology's precision weed control machine

https://youtu.be/-YCa8RntsRE

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