Smart Machines for Weed Control & Beyond

Using artificial intelligence to manage every plant

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A new era in Agriculture

10,000 years
1900
1950
1990
NOW
Average US Corn Yields: No End in Sight

Average US Corn Yield, 1866-2009

Current Test Yield: ~300 bu/acre
~500


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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.
Machine learning
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
4. Protect
5. Harvest

Learn & Optimize for Next Cycle
“One weed is threatening to overtake farms”

*Bayer Crop Science*

Waterhemp is now resistant to five herbicide classes: ALS-inhibitors, Triazines, PPO-inhibitors, glyphosate & HPPD-inhibitors
# cases of weed resistance to glyphosate, dicamba or 2,4-D

Source: www.weedscience.org, Stratus 2012 farmer survey, USDA NASS
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
Ag machinery is specialized for each action

- Prepare soil
- Establish stand
- Fertilize
- Protect
- Harvest
Smart machines need to sense their surroundings

- Prepare soil
- Establish stand
- Fertilize
- Protect
- Harvest

Sense & Decide

Act
...and verify & learn from their actions
3 core elements required for smart machines

- Prepare soil
- Establish stand
- Fertilize
- Protect
- Harvest

Verify & Learn
Sense & Decide
Smart machines
Act
Blue River capabilities enable smart machines

- Sense & Decide
- Verify & Learn
- Act

Smart machines

- Computer vision
- Machine learning & deep learning
- Robotics
- Development & learning infrastructure
- Optimization
- On-board processing
- Spatio-temporal database and analysis
Proof of concept in California lettuce
5,000 decisions per minute with $\frac{1}{4}$-inch spray accuracy
After teaching our system to identify cotton and weeds, it performed better than our agronomist.

- Agronomist labels
- Deep learning labels

Weed missed by agronomist

Weed ID’d by deep learning
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%
See & Spray technology for cotton weeding

See & Spray
Spot spray herbicide only on weeds
July, 2017 near Lubbock, Texas
Use remote sensing to evaluate efficacy on each plant
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
See & Spray saves costs and fights weed resistance

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

**Phase 1:**
Lettuce Thinning
*Proof of concept*

**Phase 2:**
Cotton Weeding
*Full Commercialization*

**Phase 3:**
Weeding All Row Crops
*Showing Versatility*

**Phase 4:**
Full See & Spray
*Flexible spray tool*

**Timeline:**
2012 to 2016: Lettuce Thinning
2017: Phase 2
2018: Phase 3
2019: Phase 4
2020: Expand to soybeans, peanuts, corn, and others
2021+: Precise spot application of fertilizer, fungicide, growth regulator, etc.

**Features:**
- 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 to manage every plant
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