JUST AGRICULTURE
multidisciplinary e-Newsletter

Blue River Technology: Futuristic Approach of Precision Farming

Yeshe A.S.[1], Dr. Gourkhede P.H.[2] and Dr. Vaidya P.H.[3]
M.sc. (Ag)[1], Assistant Professor[2] and Professor[2]
Department of Soil Science and Agriculture Chemistry,
Vasant Rao Naik Marathwada Agriculture University, Parbhani, Maharastra

ARTICLE ID: 004

Abstract:

Increasing population and growing demand for chemical input i.e. Herbicide that's way needed to the precise application of herbicide are very important for saving the cost of cultivation. However, Blue river technology is the new approach to precision agriculture. It detects unwanted weed through computer vision and artificial intelligence and spraying the herbicide through robotic nozzles.

Introduction:

Blue River Technology is bringing machine learning to the field. Blue River Technology is a California-based machinery enterprise which is focusing on designing, producing, and selling computer-vision-based robotics that can be used to help the agriculture industry, specifically in cotton Weeding.

The company has created a machine called "See & Spray". The machine uses computer vision and artificial intelligence to detect, identify, and make management decisions about individual plants in the farmer's field so that plants that are essential to farmers and consumers are not unintentionally destroyed by the herbicide. The machine has robotic nozzles to ensure accurate spraying of herbicides. Furthermore, the machine sprays only the necessary weeds with herbicides in an attempt to curb weeds that are resistant to herbicides, as these are growing in number and could eventually greatly hinder farmers' produce and production capabilities.

This “See and Spray” technology can distinguish between wanted crops and unwanted pests to apply only pesticide where it is needed most, saving farmers money, improving yields, and helping the environment all at the same time.

It seems like everywhere we look machine learning and AI is becoming critical parts

JUST AGRICULTURE
multidisciplinary e-Newsletter

of companies' strategic growth plans. From self-driving cars to the smartest advertising consumers have ever seen, machine learning seems to be everywhere including places where you'd maybe least expect it – agriculture.

John Deere acquired Blue River Technology in 2017 for $305M, a significant premium over their most recent previous post-money valuation of $87M. Blue River Technology is using machine learning to build more intelligent farm machinery to help farmers make data-driven decisions in the field, improve their profitability, and respond to changing environmental and consumer trends. Their first product, the "See & Spray" technology, uses machine learning to more precisely apply pesticides to a field by using sensors, including cameras, to identify pests and target pesticides only to the areas that need it.

The agriculture industry is changing before our eyes as growers and manufacturers alike face unparalleled challenges. First and foremost, our population is growing, and arable land is shrinking. Climate change threatens this industry as precipitation patterns change, temperatures rise, and new pests and pathogens take root in the ecosystem. Further, as consumers care more about the environment and their health, they are putting pressure on companies to produce more organic food, use fewer pesticides and reduce their carbon footprint. And finally, with declining crop prices and increasing costs of inputs like seeds and pesticides, farmers are struggling to hold on to profitability in an already low-margin industry.

John's Deere's acquisition of Blue River was a direct response to this changing landscape. The opportunity that Blue River presents is obvious – if growers can run their operations more efficiently by using fewer inputs and increasing yields, not only will they improve their profitability but as a society, we will be better able to respond to the growing food security crisis. Further, more efficient application of inputs such as pesticides or water will help reduce the environmental strain that we are putting on a climate in crisis.

Blue River Technology's "See & Spray" technology works by using cameras to analyze each plant with machine learning supported by an expansive database of plant imagery to identify weeds and to only treat those weeds with pesticides. This approach allows farmers to use fewer pesticides, which is lower cost and preferred by consumers, as well as improve the yields of harvests. The machine learning platform behind "See & Spray" is

JUST AGRICULTURE
multidisciplinary e-Newsletter

PyTorch, an open-source machine-learning platform developed by Facebook.

While technology such as "See & Spray" seems like a no-brainer when considering the challenges in agriculture today, a challenge that Blue River faces is the adoption of their technology. Historically, growers have had some hesitancy to adopt the technology due to the investment it requires or concerns about data privacy. However, the adoption of technology in agriculture has been rising suggesting this might be less of a concern moving forward.

Fig. Blue River Technology, i.e. "See and Spray" Technology

How To "See And Spray To Work" Together:

See:

Two sets of cameras point to the difference between weed and crop and measurement. This is done about 20 times per second while the machine is operating at an average speed of 12 mph. As you go through those speeds, the technology identifies the plant so that it knows exactly what it is and how much it will cost. The technology has a database of more than 1,000,000 weed images.

Spray:

After the spray has identified weeds, it will open a specific nozzle relative to the weed sprayer booms. The microphone will release a small amount of chemical growth that prevents other non-weed plants.

JUST AGRICULTURE
multidisciplinary e-Newsletter

Artificial intelligence:

John Deere See and Spray are different but what makes it so amazing is the ingenuity to be made inside the machine. In an article titled "Deere demonstrates a smart weed control system that relies on AI with Nvidia Chip" Matt Hamblen, delves deeper into the machine to give us an interior look.

"The clever secret behind See and Spray lies in the embedded Nvidia Jetson Xavier, a type of graphic processor in this field that is trained to detect weeds from the plant," Hamblen said.

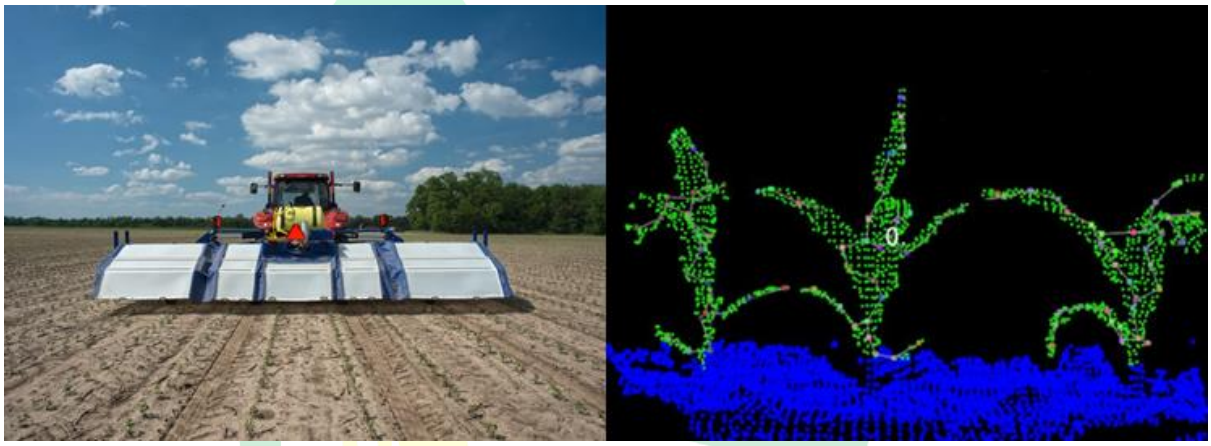


Fig. John Deer acquires Blue River Technology

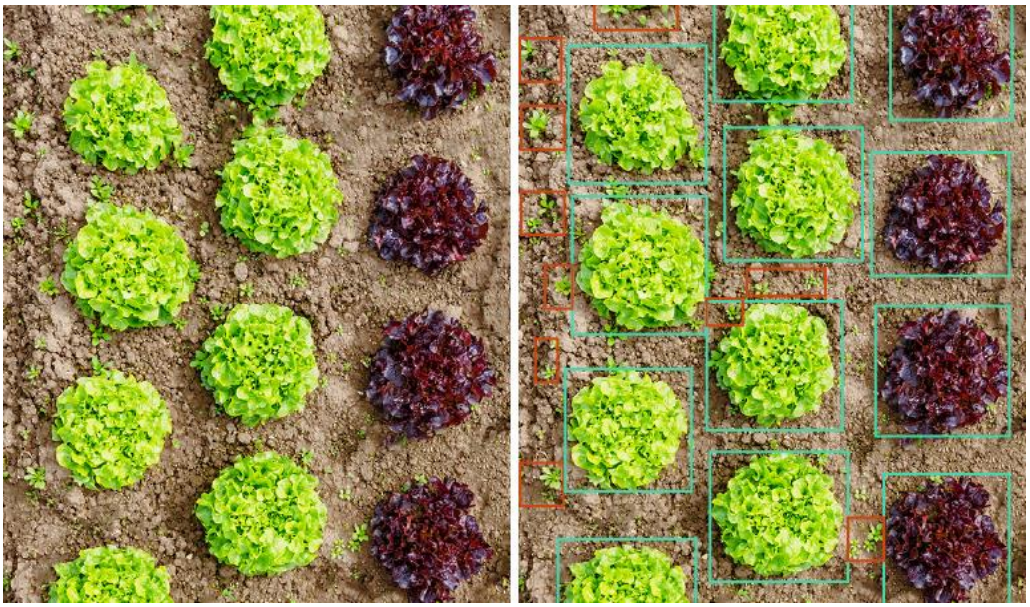
How smart spraying solutions work:

Computer vision and data analytics are at the heart of selective spraying in agriculture. These technologies help spraying equipment distinguish between types of foliage, recognize weeds, and provoke data-driven actions. Using AI and computer vision, the process of smart spraying consists of three main stages.

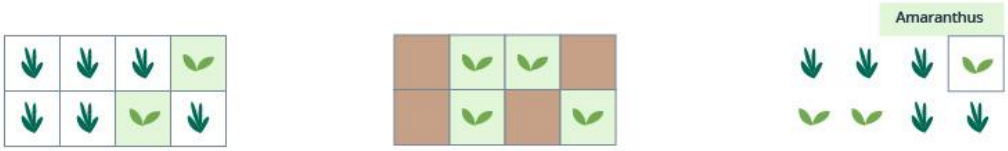
Stage 1 — Find and define

Sprayers equipped with cameras can capture real-time images of the spraying area in the field. Trained on input examples of what weeds look like, machine learning algorithms can identify weeds in images and label them as targets for spraying.

JUST AGRICULTURE
multidisciplinary e-Newsletter



In addition, farm spraying algorithms can distinguish between plants, excluding empty soil from the spraying range, and even label specific parameters of a weed-like its sort or canopy stage.



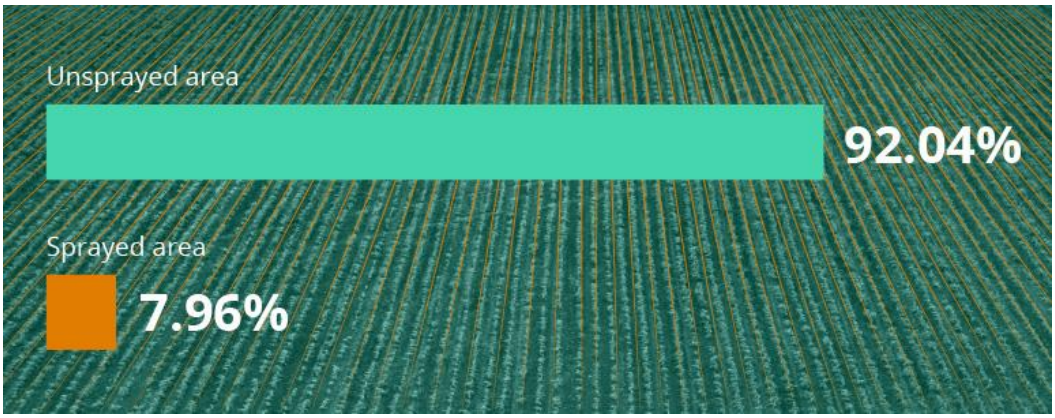
Stage 2 — Decide and act

As soon as a camera captures an image and AI analyzes it for the presence of weeds, robotic nozzles target those weeds with high precision and spray a herbicide dose that's adequate for the weed's size and age. Just as an inkjet printer applies ink only to targeted points and in specific colors while avoiding white spaces, farm spraying technology applies herbicides only to targeted plants with precise dosages and avoids areas of open soil.

JUST AGRICULTURE
multidisciplinary e-Newsletter

Stage 3 — Analyze and improve

Selective spraying can reduce the use of chemicals and potentially cut the global annual consumption of herbicides by up to 2.5 billion pounds. Analytics that complement smart spraying solutions can show farmers the exact amount of product used to calculate cost savings.



Smart spraying can lead to remarkable savings. The average annual savings for a farmer may range from $150,000 to $200,000 and pay off the cost of installation in two years for a 10,000-acre farm.

Notes from Artist:

Rivers Equipment Integrated Solutions Specialist Zach Carpenter has some insight into Bona and Spray. According to Zach, he says

"The reason why See and Spray are so important in Colorado and Wyoming agriculture is

JUST AGRICULTURE
multidisciplinary e-Newsletter

that this is the first technology designed for the planting practice we have here and it allows us to treat weeds without a ton of herbicides."

I kept asking him whether he would recommend what farmers do? It was a broad question but he just jumped with the answer.

"I think it is important for farmers who are interested in this new technology to do their research. Learn as much as you can about the system while searching and analyzing to make sure you will make the most of this technology, "said Zach.

Lastly, as an integrated solution expert, you hope to see this come out here this year and make a huge difference in uncultivated (seasonal) lands where farmers should be aware of their weed control while preparing better.

Fig.John Deer New "See and Spray" technology: 4River equipment

Benefits of Blue River Technology:

Herbicide Spray 2.0:

As part of the John Deere tractor giant, Blue River remains committed to reducing herbicides. The company is busy with many pilots for its See & Spray clever agricultural technology.

Pulled behind a tractor, its See & Spray machine is 40 feet wide and covers 12 rows of plants. It has 30 built-in cameras to take pictures of plants every 50 milliseconds and process them using its top 25 modules in the Jetson AGX Xavier supercomputing.

JUST AGRICULTURE
multidisciplinary e-Newsletter

As the tractor pulls about 7 miles per hour, according to Blue River, Jetson Xavier modules that use Blue River image recognition algorithms need to determine whether images based on 30 cameras are weed or plant faster than the blink of an eye. That allows the See & Spray robot sprayer - with 200 accurate sprays - to spray each weed with an herbicide.

"We use Jetson to further the machine learning algorithms and to determine whether a plant is a plant or a weed, and then spray only weeds," said Heraud (CEO).

AgTech Fertility GPUs:

Blue River has trained its convolutional neural network in more than a million images and its See & Spray testing equipment continues to supply new data as it is used.

Capturing a wide variety of weeds at different stages of growth is crucial in training neural nets, processed in a "GPU server cabinet" and in the hundreds of GPUs in AWS, Heraud said.

Utilizing cloud GPU environments, Blue River has been able to train networks very quickly. “We were able to solve difficult problems and train them in minutes instead of hours. It's great to see what new opportunities are coming up, ”he said.

Among them, Jetson Xavier's integrated design has made Blue River move away from using PCs equipped with GPU tractors. John Deere has reinforced Jetson Xavier modules, providing some protection from heat and farm dust.

Business & Environment:

Herbicides are expensive. A farmer who spends a quarter of a million dollars a year buying pesticides has been able to reduce that cost by 80 percent, Heraud said.

Blue River’s See & Spray may replace conventional spraying, or in the air of weed killers, covering all plants with chemicals, something many countries are trying to reduce.

See & Spray could reduce land use of herbicides by about 2.5 billion pounds, a reduction of 80 percent, which could have significant environmental benefits.

“The number of chemicals has dropped dramatically. I think it goes very well with what customers want, ”said Heraud.

Technologies required building smart spraying solutions:

Apart from building market-ready solutions, companies who offer targeted AgriTech expertise can contribute to smart spraying technology in several ways:

JUST AGRICULTURE
multidisciplinary e-Newsletter

- **Structuring and processing field data** — as data flows increase year after year, farmers have a hard time dealing with all their data on their own. Farming software companies can simplify communication between different traditional and vertical farming systems by structuring data and preparing it for the specific task for which it will be used.
- **Designing and training AI algorithms** — Agriculture software companies can build machine learning models on extensive structured data sets, performing all the backstage work for spraying in agriculture. AI-based farming management systems can plan to spray at an optimal time when weeds are at the early stages of canopy development as well as quickly analyze new images to recognize weeds among other plants.
- **Mapping and tracking of spraying areas** — Agricultural machinery relies on GPS to complete most critical field tasks. For smart spraying, field maps are required to efficiently distribute workers and transport machinery to fields that need to be sprayed.
- **Integrating spraying with farm management systems** — Apart from direct factors influencing the spraying of weeds, important factors such as rain and landscape influence the way chemicals are spread in the environment. Integrating with systems that provide contextual data for weather analytics and determining terrain limitations for spraying can help smart spraying solutions avoid hidden risks.

Core Phases of Blue River Technology:

1. Green on brown:

Deere introduced this as the first phase of the "dark green" - you can see when there are weeds in the uncultivated field or before the burn / after harvest when there is no real harvest in the field. It. Worth noting, they can only go 12mph to get started - this is reduced from about ~ 16mph. Ideally, this speed reduction is done to reduce the filling of tanks, but it is something I can expect to see improvement over time.This first launch brings two benefits:

a. **Resistance control -** Using high doses of glyphosate or expensive tank-mixed with multiple groups across the field is inclusive. If you reduce the spray area by 70%, that makes a tank mix of 2 or 3 herbicide groups at higher prices more enjoyable for the farmer. This also reduces the chances of resistance occurring in the size system.

JUST AGRICULTURE
multidisciplinary e-Newsletter

b. **A total number of herbicides -** This is a reduction in the cost of inputs and may mean less water supply and time to fill the spray, reducing labor costs (* less speed may decrease some of these initially). This also plays into the latest carbon buzz and sustainability. Chemistry has a carbon footprint. This may be associated with carbon offsets in the future as well.

2. Green on green:

This initial launch is cool, but just the start. The real cool part is the next phase: deciphering weeds from crops.

This means in-crop herbicide applications a sprayer would only spray the weeds. This is where it is compelling. Now, you can manage resistance much better in-crop too. The first focus sounds like it will be cotton, corn, and soybean in North America. This has three benefits:

a. **Using less expensive herbicides in the crop at higher rates** - Not only can you use less herbicide, but now you can use less expensive herbicides (eg: 2,4-D) at rates that might injure the crop sprayed across the field. While this might not be the primary use case, I can see some of the applicability here.

b. **Managing resistance** - This is one of the biggest concerns for farmers. But now, being able to mix higher rates of products in the crop, or have separate small tanks with a direct-inject system on the sprayer for specifically hard weeds to kill with a specific active ingredient, could help alleviate many immediate resistance challenges. This could even change the economics and regulatory dynamics around current active ingredients in the pipeline or bring forth old active ingredients that were written off due to costs on a per-acre basis. This also may bring up opportunities for biopesticides. The cost to efficacy ratio may not be on par with synthetics, but if there are carbon offsets available + the ability to apply a higher rate only on a small portion of the field, then that fundamentally shifts the economics in a more favorable direction.

I'm getting ahead of myself on those latter examples, but when you bring in these capabilities the door opens for unique approaches, especially when considering other trends at play.

JUST AGRICULTURE
multidisciplinary e-Newsletter

c. **Less herbicide stress on the crop** - Herbicides are generally safe on the crop, no argument from me there. But they take energy and time to metabolize for a crop, most specifically for a crop that is under cold stress or drought stress for example. I associate it with humans and alcohol consumption: I can drink 5 shots of tequila and still function the next day, but I won't be as productive as if I drank zero. That's how I think about herbicides applied to crop. This has the potential to support better yields through less herbicide metabolism, and even quality in some instances for farmers.

3. Beyond Herbicides:

* None of the following was announced by John Deere, I just used the concept of "what's next" in their power.

Once you have sprayed the nerves, it just goes down to what you train those nerves to "see" next. Weeds are a natural entry point due to the instability of damaging profits. Many insects are too mobile to use them. However, diagnosing stress, nutrient deficiencies, disease decay, or even soil nutrient levels (perhaps carbon ?!) is a possibility. This may extend to the view of the treatment due to defects and be consistent with John Deere's view of "plant healing". There is also the importance of creating pre-maps and placing that data in predicting yields or quality skills or compiling tags by airplane.

I think John Deere will focus on finding the herbicide side first and most importantly however, what they have done is creating a "deadly app" for their sprays that can deliver unique information and enable better results for farmers.

A. Greener Future

A major side-effect of agriculture's reliance on (and less-than-judicious use of) weed-killer is one of the reasons innovations like Blue River Technology's have caught the eye of big farming companies.

Weeds are hardy plants, and they've developed resistance to commercial weed killers like Roundup at an alarming rate. According to Bloomberg, in 2008, there were 10 million acres of Roundup-resistant weeds. By 2012, there were 30 million, and today there are 70 million acres, an area about the size of Nevada. The $28 billion herbicide industry is unlikely to go down without a fight, but, perhaps surprisingly, even some of the biggest names in the

JUST AGRICULTURE
multidisciplinary e-Newsletter

business were early investors in Blue River Technology, including Monsanto Growth Ventures and Syngenta Ventures.

The first See & Spray bots are expected to hit the US in 2020, with Europe following a year later. Reducing agriculture's reliance on haphazardly deployed toxic chemicals to thin crops and kill weeds will benefit our world in many ways. That includes a cleaner, less chemically tainted food supply, fewer toxins seeping into the world's waterways, and the preservation of aquatic and amphibious species.

As Heraud told Bloomberg, "Robots don't have to take us away from nature — they can help us restore it."

Challenges:

1. One big challenge is the adoption of technology and machine. While the machine will help farmers save money on herbicides and pesticides, the machine may require a significant upfront investment, including machinery purchase and infrastructure. In addition, the common stereotypical portrayal of a farmer is that they are not tech-savvy and open to innovation. While this stereotype may not be true, John Deere should look for early adopters in the industry and showcase the efficacy and value of its products to the broader customer segment.
2. .The second challenge is the unpredictability of the farming environment. Because agriculture is largely an outdoor application, there's no enclosed, central onsite facility where one can implement a server and a communications network. To overcome the shortcoming, John Deere implemented edge computing, with processing onboard the machines doing the work. However, edge computing and network have to be customized for each different farming environment, slowing the adoption and scaling. Since data collection on multiple parameters including the image of weeds, weather conditions, soil conditions, not only for the current product but also for future development, John Deere should select representative areas for unique conditions and experiment with the product extensively to acquire data. As a result, John Deere would be able to accelerate the customization process and scale faster.
3. You have to manage the psychology of farmers - Change brings uncertainty and that uncertainty needs to be reduced. Farmers today know when their spray brings

JUST AGRICULTURE
multidisciplinary e-Newsletter

pesticides - everywhere! Visually and emotionally it will take time to instill confidence as there are intangible dynamics around technology. Even once there is confidence: Will it work the way I expect it to? What happens when the weeds run away? Whose fault is that? Operators? Chemistry Company? John Deere? How will the farmer buy the inputs? They know they have 300 hectares of spraying, but how much spray is needed (I think this is an evolutionary opportunity for the business model of plant and vegetable producers…)? These are just the beginning.

4. Recovery - There are advanced savings on weed control. The initial cost of this supplement to the sprayer can be significant although initially, in the green-brown phase, it is very important for most farmers. These pieces of equipment are one of the most expensive on many farms and farmers do not hesitate to spend a lot of money on something unless they see reasonable savings or profits. I think this will come, but the first introduction of brown is very important for farmers, especially those who are not on the big side of things.

I think the potential benefit to the farmer if this technology works as it is in place, and changes from brown to green has the potential to bring great value to farmers as an auto steer, by resisting management as just one route. In western Canada alone, research shows that resistance costs farmers $ 1.5 Billion a year. Combine this with potential input savings and better effect with improved management (crop quality) and check more boxes.

Conclusion:

Plant protection practices are the most important activities during crop production. Progress in spraying technology has been increased in the recent past. Robotics and automation spraying technologies like a variable-rate sprayer, UAV sprayer, and electrostatic sprayer have gained more attention to enhance. These advanced spraying technologies not only reduce the labor cost but are also effective in environmental protection. John Deere and Blue River Technology are excited to release this new technology to farmers with dreams of it making life a little easier. Blue River Technology i.e. "See and Spray" technology is a new way of farming Precision. Agricultural robots offer the opportunity to increase productivity, improve agricultural sustainability, be more timely and less expensive, and move new technologies and technologies to new areas.This technology is one of the stock solutions for the effective use of herbicides and the protection of excess weeds, ultimately increasing indirectly increasing global food security.

JUST AGRICULTURE
multidisciplinary e-Newsletter

References:

- Blue River Technology, https://golden.com/wiki/Blue_River_Technology-DBER5JP
- AFN, #Foodtech#Agtech, John Deers Acquires ' See And Spray' Robotics Startup Blur River Technology for $350m , September 6, 2017, Louisa Bourwood- Tylor, https://agfundernews.com/breaking-exclusive-john-deere-acquires-see-spray-robotics-startup-blue-river-technology-305m.html
- Goodwill Farming: Startup Harvest AI to Reduce Reduce Herbicide, John Deere-owned Blue River is in widespread testing of its AI- driven system, May 2, 2019by Scott Martin,https://blogs.nvidia.com/blog/2019/05/02/blue-river-john-deere-reduce-herbicide/
- https://www.demandtalk.com/tag/blue-river-technology/ (Image)
- Up Stream Ag Insights , See and Spray technology Implication in Agribusiness, Shane Thomas , March 7 2021, https://upstreamaginsights.substack.com/p/see-and-spray-technology-implications
- John Deere , 4Rivers Equipment, John Deers New See and Spray Technology, 22 April 2021, https://www.4riversequipment.com/john-deere-new-see-and-spray-technology/
- Jama Software , This AI Crop Spraying System Can tell Plant And Weed Apart, By Jama Software , February 22, 208, https://www.jamasoftware.com/blog/this-ai-crop-spraying-system-can-tell-plants-and-weeds-apart/
- Intellias, Intelligent software Engineering, Smart Spraying Technology in Agriculture for Precise Herbicide Application, (BLOG), https://intellias.com/smart-spraying-technology-in-agriculture-for-precise-herbicide-application/