

AI for Earth Grantee Profile

Joshua Woodard

AI-driven yield and crop cover forecasting



Summary

Professor Joshua Woodard launched Ag-Analytics, a service integrated with the John Deere Operations Center that provides intelligent, easy-to-use tools to help farmers plan and monitor their crops. Ag-Analytics brings together data from farm machinery sensors with other datasets such as weather and satellite imagery to develop models for yield and crop cover forecasting. This information and more accurate forecasting can help shape policies to make it economically feasible (through insurance subsidies) for farmers to implement conservation practices.

Improving agriculture forecasting and conservation practices

Recently, the agricultural industry has shown increased interest in conservation and sustainable farming practices with regard for soil health and the surrounding environment and wildlife. Due to market pressures, agriculture in the modern era has relied widely on practices that maximize yield. Many fields are still extensively tilled for weed control. Additional fertilizers may be applied, and pesticides are used to prevent weeds and insects from competing with or harming the crops. However, these methods come with their own costs. Tilling

Common farming methods and climate change create more demand for cultivated land, posing a strong threat to biodiversity.

can cause severe erosion and soil crusting, which actually decreases fertility over time. While fertilizers like added nitrogen can benefit crops, the runoff can contribute to algae blooms in waterways, disturbing the ecosystem. And pesticide runoff can also cause harm if over-applied. Several major grower groups, including the [National Corn Growers Association](#), have launched a multitude of programs aimed at improving soil health and increasing adoption of conservation practices to promote better environmental outcomes.

Additionally, as the human population continues to soar, more land is cleared and dedicated to agriculture to meet the growing need to feed everyone. Climate change is compounding this push into the wilderness, as existing cultivated lands in some areas are increasingly subject to drought, flooding, or other damaging

weather. Combined with the common farming methods previously described, the demand for cultivated land poses a strong threat to biodiversity.

Conservation agriculture offers an alternative set of practices that promises not only to address these problems but also in time reduce costs while maintaining or even increasing yields. No-till farming preserves the natural organic soil layer, reducing erosion and runoff while allowing the soil to be productive for longer periods, and saves on the time and labor costs of tillage. Cover crops help further protect the fields from erosion between growing seasons and provide a ready-made layer of mulch to help fertilize the fields, as well as promoting the growth of organisms that create a healthy, permanent organic soil structure. Crop rotations help prevent weeds and insects from becoming established in the fields, acting as a natural pesticide, and offer disease control as well. Crop rotations and cover crops also help build rooting zones that allow for better water infiltration and improve the soil infrastructure.

Overcoming blocks to conservation

Some of these conservation practices, such as no-till farming, have already become more common. However, overall adoption of conservation practices has been slow, for several reasons. First, switching from conventional methods to conservation agriculture involves some up-front investment costs, such as purchasing new equipment to work with the new methods, and there is risk associated with adoption. Second, and relatedly,

For crop insurance to help, farmers must engage in some complex risk management planning, but need robust tools to provide them with useful insights.

conservation agriculture can take significant time to establish and reach yields matching, if not exceeding, those under the conventional methods. That can mean multi-year financial losses that many farmers could not afford. Without government policies—and financial subsidies to support them—many farmers lack economic incentives or ability to adopt some of these conservation practices, and extant market and policy structures simply do not support such adoption in many cases. Without strong data supporting the benefits, governments also lack incentives to promote conservation agriculture via the operation of major programs such as crop insurance—a market which insures \$100 billion a year in the US alone.

“Farmers are the original conservationists. They live and breathe it every day. Society should seek ways to enable growers and policy makers with technology and market structures to reach their conservation goals and improve profitability. This means providing solutions and policies that will promote market-based outcomes,” says Professor Joshua Woodard of Cornell University. Agriculture in the United States is subsidized through

crop insurance and has resulted in enormous positive benefits from a technology investment perspective. In exchange for annual premiums, crop insurance plans provide payments (known as indemnities) when yields or revenues fall below the covered amount. Crop insurance plans cover such contingencies as drought, hail, flood, insect damage, or even low prices. For crop insurance to help, farmers must engage in some complex risk management planning, accounting for a variety of factors from their planted acreage and crops to be insured to the harvesting methods and other aspects of the farm operations. Farmers have increasing access to large amounts of information they can use for this planning; particularly as newer farm equipment is more likely to incorporate sensors for collecting data. However, the farmers need robust analytical tools to digest all this data and provide them with useful insights. This is where [Ag-Analytics](#) comes in.

“Farmers are the original conservationists. They live and breathe it every day.”—Dr. Joshua Woodard

Founded by Dr. Woodard as an outgrowth of his work at Cornell University, Ag-Analytics offers a farm management platform and data analysis services to help farmers and growers make better management decisions, increase yield, and mitigate risks. Through its headline product, [FarmScope](#), the platform combines diverse sources of data including satellite, weather, soil, historical crop, and farm equipment to create a picture of the current state of a farm’s fields and forecast for future yield. Most recently, Ag-Analytics has launched its [ProfitLayers](#) tool, which pulls in as-seeded/harvested/applied operation files and combines them with a proprietary price database to easily create profit maps and summaries—which growers can then push back to the John Deere Operations Center, a data platform operated by the major agriculture equipment manufacturer John Deere. With such tools for data analysis and planning, farmers can gain the information they need to make the switch to conservation practices feasible and better track profitability.

Bringing big data tools to farm data

Ag-Analytics is developing a real-time high-resolution yield forecasting and crop cover model that utilizes the artificial intelligence (AI) and machine learning resources available through Microsoft Azure. Working with farmers, the company has collected precision data (at sub-meter resolution, including seeding, variety, application, and harvest yield information) that is representative of hundreds of millions of historically planted acres. Ag-Analytics has already integrated with the John Deere Operations Center to connect the sensors in John Deere machinery to the Ag-Analytics platform, allowing farmers to very securely and confidentially take advantage of their precision farming data with the Ag-Analytics system.

Ag-Analytics is applying Azure machine learning algorithms at scale to this precision agriculture data, as well as soil, weather, crop cover, and other remotely sensed data to generate high-resolution, nationwide yield, practice, crop condition, and crop cover estimates. The models will also condition on other external market data (such as ethanol plant placement, waterway routes, and prices) to further refine real-time planting and yield estimates. These models will then be available as APIs, allowing for extensive research, development, and use while protecting farmer privacy.

With improved accuracy, reliability, and timeliness of agricultural forecasts, farmers will have the resources they need to switch to conservation farming practices.

Ag-Analytics also houses a massive collection of public data such as soil and weather, which it makes available to researchers and analysts with the help of the Azure API Management service. With so much data to manage, on-premises database and processing infrastructure becomes a bottleneck—it's prohibitively expensive for most organizations to deploy and maintain enough hardware for that level of processing. Through the Microsoft Azure cloud platform, Ag-Analytics uses cluster-based configurations with Azure database resources that have the scalability and compute power to handle the work, while maintaining data security and privacy.

Going forward

Ag-Analytics' deep experience in crop insurance markets, government policy, advanced yield risk modeling, and other ag-finance related applications puts it in a league of its own in the farm management software space. [National Corn Growers Association and Ag-Analytics also recently announced](#) a data collection effort using the platform in order to develop a new Conservation Endorsement for Federal Crop Insurance. The endorsement would allow for better recognition by the Federal Crop Insurance program of the benefits of soil building conservation practices on reducing financial risk. Ag-Analytics currently has several other efforts underway from banking, to finance, to land management and investment applications. For example, the US Department of Agriculture (USDA) requires several months to publish its county-level yield estimates based on survey data. Ag-Analytics anticipates that by combining its nationwide models, with just 3 to 5 percent farmer participation within the greater corn belt, it will be able to easily surpass the accuracy—and frequency—of the periodic USDA forecasts. Ag-Analytics will also be able to tabulate and publish highly reliable end-of-season yield and production estimates—from nationwide down to field level—based on hard data and AI in the field in real time. With such accuracy, reliability, and timeliness, not only will farmers be better equipped to manage their existing farms, but also they will have the information and planning resources they need to consider switching over to more sustainable conservation agriculture practices in a profitable manner.

About Dr. Joshua Woodard

The founder of Ag-Analytics, Dr. Joshua Woodard is also an associate professor and the Zaitz Family Faculty Fellow of Agricultural Business and Finance at the Charles H. Dyson School of Applied Economics and Management at Cornell University. His work focuses primarily on risk and policy issues in agricultural finance including risk management, banking, and insurance, with special emphases on empirical applications, spatial data analysis, weather risk, and large-scale data analysis. He is an authorized expert reviewer for the Federal Crop Insurance Program. He also specializes in the design, analysis, and evaluation of insurance programs, and has extensive experience in partnering with crop insurance companies and grower groups to develop innovative crop insurance products currently sold in the market, such as Trend-APH, Dairy-RP, and many others.

Resources

Websites

[Ag-Analytics](#)

[Professor Woodard's](#) Cornell University faculty page

Press

Bonnie Lei. "Ag-Analytics helps farmers and researchers use AI to prepare for climate change." Microsoft on the Issues. July 23, 2019. <https://blogs.microsoft.com/on-the-issues/2019/07/23/ag-analytics-helps-farmers-and-researchers-use-ai-to-prepare-for-climate-change/>

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"Sign up for the National Corn Growers Association rating study." Illinois Corn Growers Association. December 21, 2018. <https://www.ilcorn.org/news-and-media/current-news/article/2018/12/sign-up-for-the-national-corn-growers-association-rating-study>

Documentation and background resources

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Max Roser and Hannah Ritchie. "[Yields and Land Use in Agriculture](#)". Our World in Data. 2018.

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