The Weather Company
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CIO Insights: The future of intelligent farming & food supply chain management

IBM

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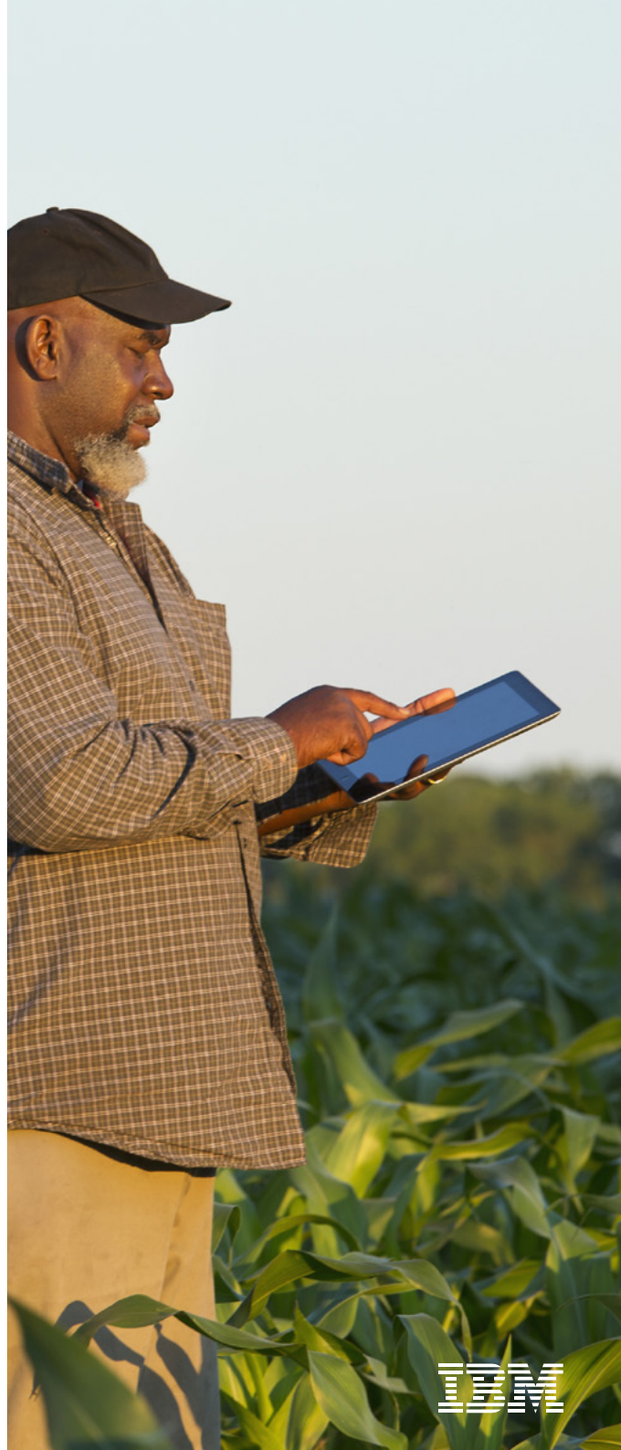


The business of agriculture may be more difficult today than ever.

This USD 5 trillion industry is currently undergoing massive disruptions and facing serious challenges, including:

- **Increasingly volatile weather**
  Rapid climate change is causing crop yields and farm operations to be more susceptible to lower margins. In fact, the U.S. Department of Agriculture estimates that 90 percent of crop losses are related to extreme weather.[1]

- **Growing environmental and regulatory pressures**
  Limited supplies of fresh water and arable land are requiring farmers and food producers to discover more efficient and innovative methods for increasing crop yields.

> *An estimated 600 million – almost 1 in 10 people in the world – become ill after eating contaminated food. 420,000 people die every year from food-related illness.[2]*

- **Greater demand for food quality and sustainability**
  An increase of food recalls and a growing population is leading to greater demand for quantity and quality. However, these goals must be achieved through sustainable practices that help protect and preserve the environment for future generations.

- **Fragmented global food chain**
  A complex industry network prevents the efficient transfer of useful information, hindering the ability to quickly identify and respond to changing consumer demand. Moreover, an imbalance in the distribution of consumer knowledge can weaken the position of growers, producers and processors during negotiations.

- **Proliferation of loss and waste**
  According to the Food and Agriculture Organization of the United Nations, an estimated one-third of all food produced globally is either lost or wasted due to factors such as pest infestations, harvest problems, or market and supply-chain inefficiencies.

To address these challenges and continue to feed a rapidly growing population, the agriculture industry must find new, more-sustainable strategies to increase both quantity and quality of crops.

1 Today's Extreme Winter Weather Can Impact Tomorrow's Crop Farming, Jim Foerster, Forbes, 15 February 2019
2 Food Safety, World Health Organization, 4 June 2019

AI can help create a brighter future for agriculture.

An explosion of farm data presents an opportunity to meet these challenges through focused and thoughtful applications of technology. For example, modern farming equipment can help enable precision agriculture by fine-tuning fertilizer and pesticide applications. Sensors embedded in the soil can help improve yields by transmitting information about moisture and nutrients to cloud platforms where that data is combined with high-definition satellite imagery and drone footage of fields.

The right combination of artificial intelligence (AI) and advanced analytics with this type of agricultural Internet of Things (IoT) data can help create actionable insights for driving quality, sustainability, output and profitability in farming. This may include creating more targeted irrigation strategies, identifying the optimal time to plant certain types of seeds and recommending actions to prevent crop loss due to pests and diseases.

But certain barriers have prevented the majority of the industry from realizing the potential value of digital transformation and precision agriculture, including:

- **Exponential data growth**
  Vast amounts of farm data are available, collected by sources ranging from equipment sensors to handwritten notes. But the process of analyzing this information is too cumbersome to be feasible, meaning most of the data goes unused.

> *The average farmer generates 500,000 data points every day. By 2036, this number is expected to increase by 800 percent, the growth being driven largely by the proliferation of sensors and other connected technologies.*[3]

- **Lack of reliable, accurate weather data**
  Most of the world does not have the specialized weather equipment necessary to create accurate forecasts that can effectively inform critical agriculture decisions.

- **Limited tech resources**
  While many farmers have invested in technology, they may not have the resources to pursue the upgrades and advancements needed to improve scalability and connectivity.

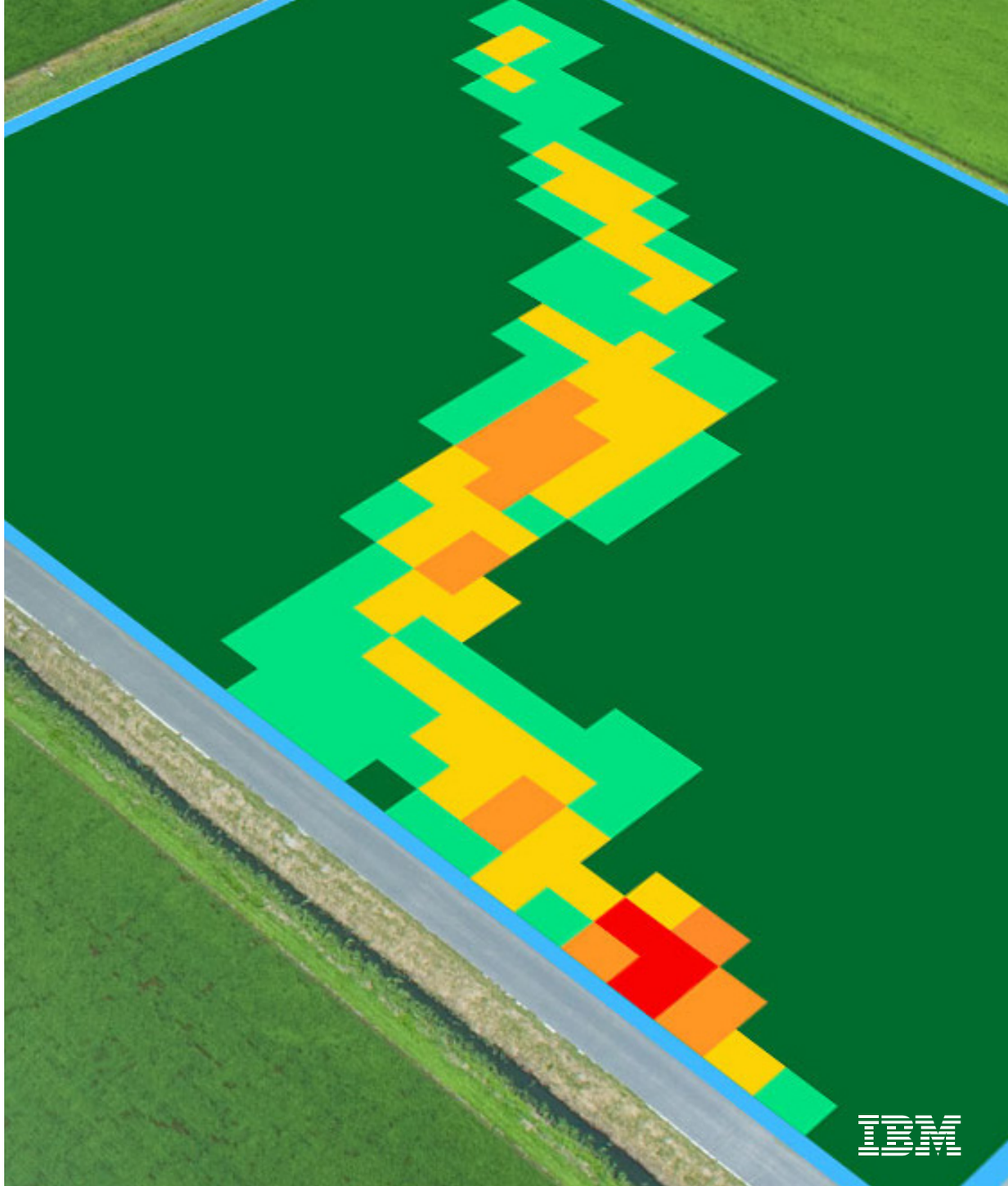
3 Why IoT, big data & smart farming are the future of agriculture; Andrew Meola; BI Intelligence, Business Insider's premium research service; 20 Dec 2016

But imagine if stakeholders across agriculture could access a shared digital platform that provided:

- **A single source of truth** in which high quality, field-specific data sets were combined with AI and advanced analytics to drive actionable insights.
- **The most reliable, accurate forecast data** including historical, current, short-term and seasonal forecasts to support better decisions about weather's impact on crops.
- **A scalable, security-rich cloud-based platform** so stakeholders across the ecosystem could quickly access a unified set of relevant data and insights at a hyperlocal level.

To effectively transform agricultural data into useful insights, such a solution should be:

- **Science-backed** – Applies a principled and scientific methodology that combines machine learning with real-world factors such as weather, crop health and phenology
- **Analytics/AI-driven** –Creates a common domain representation layer in which relevant data is gathered to enable advanced querying and analysis
- **User-specific** – Provides customized applications that display the results of analysis and support key decisions
- **Contextual** – Captures relevant data in a structured manner to support effective analytical models
- **Engineered** – Considers the foundational aspects of data lifecycle management while remaining grounded in the realities of analytics and data science



The IBM® Watson® Decision Platform for Agriculture leverages Watson AI to transform data into predictive insights that help empower more informed, confident decisions.

The platform works with your existing IT, cloud and software-as-a-service (SaaS) infrastructure to create a security-rich digital replica of your farm and an electronic field record that is accessible for all authorized users. This record combines the world's most accurate weather forecasts with relevant agriculture IoT data, including:

- Soil conditions such as moisture, pH levels, protein content, nutrients, temperature and sucrose concentration
- Equipment data
- Farm management system data
- Agriculture practice and workflow data
- High-definition visual imagery from satellites, drones, and fixed-wing aircraft
- Genetic information about the seeds used in a particular field

The platform also leverages industry-leading geospatial analytics technology to transform geospatial-temporal information – such as maps, satellite, weather, drone footage and IoT data – into usable insights. Query and analytics services provide users with a search-friendly catalog of relevant information to help enable growers and other members of the ecosystem to ask questions and quickly find answers. The platform contains over 4 petabytes of data today and ingests terabytes of new data every day.

By applying AI, machine learning and advanced analytics to the electronic field record, the IBM Watson Decision Platform for Agriculture helps deliver value across the agriculture ecosystem.

The potential benefits include:

Optimized field output and forecasting
The platform analyzes relevant data and compares actual yield against benchmarks from similar fields to help growers identify the areas with the greatest potential for improvement. These capabilities help enable a clearer picture of agriculture at virtually all levels by generating:

- Field-level yield and quality forecasts that incorporate plant date, weather, imagery and growth stage to derive a projected yield amount and quality level for specific crops.

- National crop yield forecasts that apply machine learning to assumed crop mix, satellite imagery, historic data and forecasted weather. This forecast is adjusted using early, statistically-relevant harvest data from local fields to help improve accuracy and reduce bias.

Improved crop protection
The platform analyzes and identifies factors that may hinder a farmer or food producer's ability to optimize yields so that corrective actions can be taken. This includes:

- Crop health monitoring that leverages machine learning and hyperspectral satellite images to create a ground-level vegetation index with information about crop stress

- Field and soil health monitoring which combines data about soil types, altitude and weather forecasts to estimate moisture and temperatures at various depths

- Pest and disease prediction and identification by using Support Vector Machine Learning (SVM) and weather forecasts to determine the risk of near-future outbreaks of specific pests and diseases. Watson Visual Recognition also helps identify various pests and diseases from live or saved photos. These personalized, data-driven recommendations for pesticide application help farmers avoid the damages of overapplication to the field and surrounding environment.

- Extreme weather warnings that include the anticipated amount of damage to crops. The platform provides advanced notifications of severe weather and makes recommendations to help mitigate damages such as covering crops or preparing to drain rainwater for plots not yet harvested.

(Benefits continued)

Increased trust and transparency
The platform's combination of rich agriculture data, AI and cloud technologies are designed to provide more control around provisioning access to electronic field records and increased visibility into how the insights are being used across the ecosystem.

Higher food quality through traceability
Recent outbreaks of E. coli in beef and romaine lettuce are leading to increasing consumers' demand for quality and sustainability in farming practices. Powered by the IBM Blockchain platform, the Food Trust network supports visibility across virtually the entire agriculture ecosystem, driving accountability and traceability for every step of the food journey.

More accurate field, crop and area identification
Enterprises can gain a clearer understanding of boundaries and crop types for specific fields by applying machine learning to satellite and drone imagery as well as GPS data. These capabilities are designed to support not only better field-specific decisions for yield forecasting, crop health and food quality, but also to assist in evaluating regulatory compliance and validating insurance claims.

Greater sustainability
The platform supports responsible farming by identifying and expanding best practices for water and soil management. This includes the impacts of weather, crops and livestock on a field. Recommendations are created to help growers optimize operations such as irrigation and drainage, improving quality and sustainability while better managing costs.

Use case

E. & J. Gallo Winery

E. & J. Gallo Winery makes better wine with less water.

With more than 80 years of experience farming in California, E. & J. Gallo Winery understands the importance of water efficiency. The winery recently discovered that specific areas of its vineyard needed more water than others. But the existing irrigation system could not target sections smaller than 10 acres and manual watering required too much work to be feasible.

To help improve water efficiency, E. & J. Gallo Winery implemented a solution that ingests data from weather forecasts, satellite imagery and water lines wrapped with sensors that measure environmental conditions and vine stress.

This data is collected and analyzed in the IBM Cloud™ to uncover insights into the effects of atmospheric changes on sections of the vineyard and create recommended watering instructions based on the needs of each vine. Next, water is delivered through a new, more-targeted irrigation system to help grapes ripen in sync and with improved quality.

Since implementation, E. & J. Gallo Winery has increased yields by 26 percent, improved grape quality by 50 percent and reduced water usage for crop irrigation by 16 percent.

Use case

Yara International

Fertilizer maker Yara International and IBM are helping the agriculture industry feed a growing population by launching a global digital platform that will apply AI, machine learning and in-field data to unlock new insights for all aspects of agriculture.

By merging analytical insights from IBM Watson Studio, IBM Physical Analytics Integration Data Repository and Services (PAIRS) technology, The Weather Company® and other services with Yara's unrivaled crop knowledge and modelling capabilities, the platform will play a key role in sustainably optimizing crop yields.

The project aspires to provide coverage for 100 million hectares of farmland worldwide. Participating farmers will receive not only hyperlocal weather forecasts but also actionable recommendations in near real-time that are tailored to the specific needs of individual fields and crops.

Use case

Bunge

As a leading global agribusiness and food company with a complex supply, Bunge wanted to gain deeper insight into determining what crops were planted in a given area, the historical yields for that location and the weather variables that might impact production.

Bunge implemented IBM PAIRS to gain the data and computing power needed to build advanced statistical models that help the company better understand crop production and land utilization. This includes granular resolution of historical weather and satellite data that is accurate within 250 meters (273 yards).

The new solution also enables Bunge to optimize larger data sets than previously possible, gathering and applying machine learning to massive amounts of proprietary and public information. This allows the company to run sophisticated analysis and queries to improve activities such as crop forecasting.

IBM is helping the agriculture industry continue to feed the world through the power of data and AI.

Our solutions are designed to support precision agriculture and sustainable practices by providing:

- **Unique breadth and quality of data**
  Leverage The Weather Company's industry-leading forecast data and analytics to gain weather-based insights on a field-by-field or zone-by-zone basis. Growers and advisors can take advantage of these packages quickly by accessing the weather data APIs via the cloud.

- **Market-leading technology**
  Combine security-rich cloud solutions with AI to empower agriculture stakeholders across functions with timely, relevant insights that help drive more-profitable decisions.

- **A trusted partner**
  IBM has over 100 years of experience in delivering client-first, security-rich innovations that help businesses around the world solve the problems that matter most.

Are you ready to get started?
Visit ibm.biz/agriculture to explore IBM solutions for agriculture and request a demonstration.

The Weather Company, an IBM Business, is the world's largest private weather enterprise, delivering up to 26 billion forecasts daily and among the most accurate, personalized, and actionable weather data and insights. It helps millions of consumers and businesses make better decisions via its enterprise and consumer products from The Weather Channel and Weather Underground.