AGMATIX

DATA-DRIVEN SOLUTIONS TO UNLOCK TRUE VALUE FROM AGRONOMIC DATA

agmatix™

Contents:

Get To Know Agmatix

An agro informatics company that standardizes agronomic data and turns it into actionable insights.

We empower agriculture professionals to create new innovations and increase crop yield and quality while promoting sustainable agriculture. We combine agronomic data science with advanced AI technology to drive powerful decision-making at the field-level.

Founded by ICL in 2021

Data covers 150+ crops

50+ million digitized field measurements

Global reach of 4 million acres

Over 1 billion data points

>5,000 farmers worldwide

What We Do

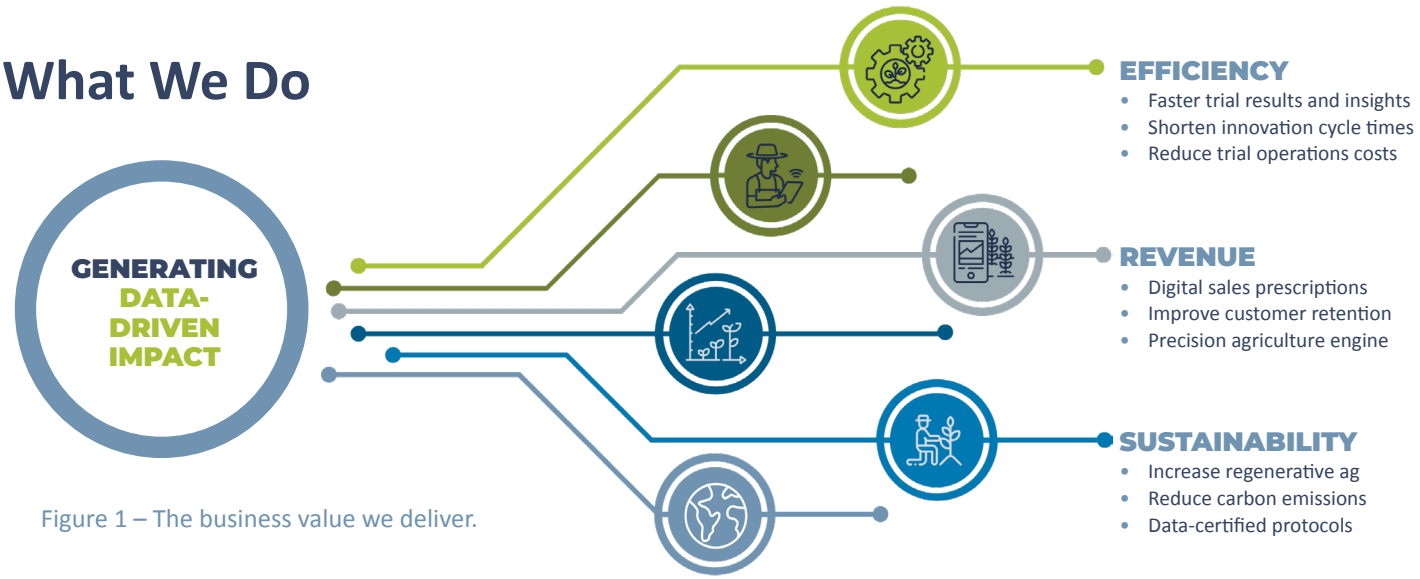

Figure 1 – The business value we deliver.

Capturing Data To Drive Impact

Digitizing Agronomic Trials & On-Farm Experiments

BUILDING SOLUTIONS BY
DIGITIZING FIELD TRIALS

AT THE CORE OF AGRONOMIC PRACTICES

COMPREHENSIVE COMPLETE DATA SETS

~150M CONDUCTED ANNUALLY

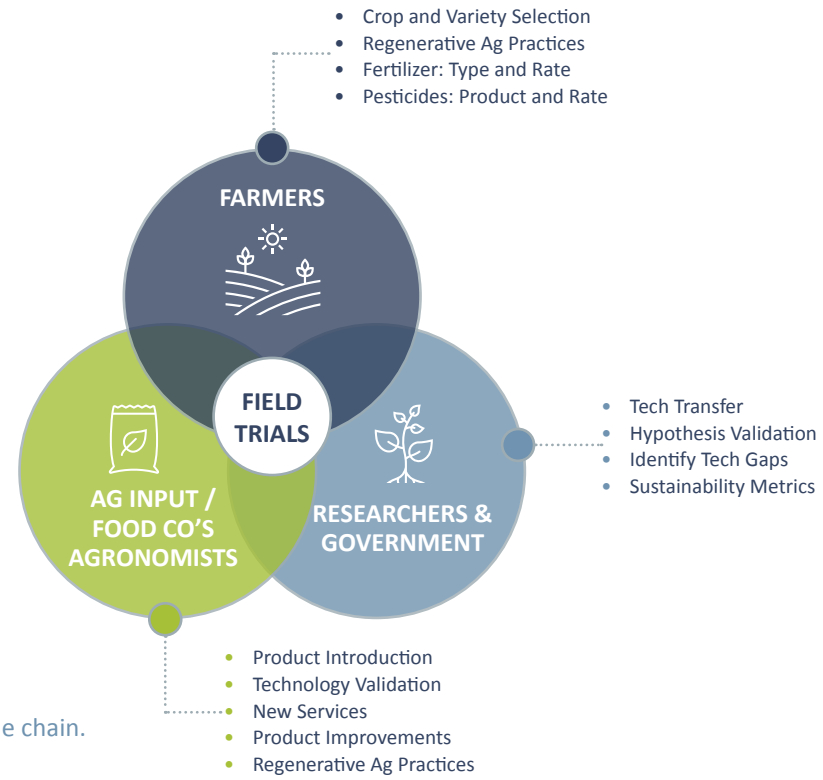

Figure 2 – Field trials intersect the entire value chain.

We recognized that agronomic field trials and on-farm experiments conducted by ag input companies, food and beverage companies, universities, government institutes, and startups result in vast amounts of statistically verified data. On an annual basis, farmers and agriculture professionals conduct around 150 million field trials. Field trial data is essential to addressing the core challenges facing the agriculture industry. Standardizing this data will unlock a wealth of invaluable information for professionals in agriculture.

How We Do This: The Axiom Platform

To standardize the vast amount of data from these field trials, we developed the Axiom platform, an agronomic modeling technology. Axiom ingests, aggregates, standardizes and enriches agronomic data from multiple sources, including APIs, remote sensors and data repositories. This data is then leveraged by in-house ontologies with multiple sources to standardize, harmonize and facilitate agronomic predictive modeling, research and field trials. The current global challenges in agriculture clearly require the entire ecosystem to collaborate, and in a reality where data is siloed with limited standardization – a technology like Axiom, that makes agronomic field data available, interconnected and usable by agriculture professionals is an absolute must.

This novel technology is what turns big data into powerful and actionable insights, resulting in advanced digital solutions for agriculture professionals.

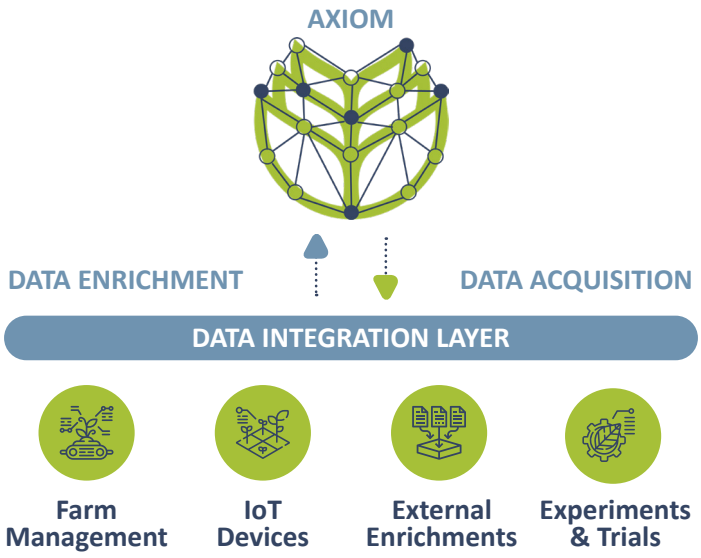

Figure 3 – Agronomic Data Pipelines: The Agmatix platform ingests, enriches, and standardizes data from any source or type via the Axiom engine.

BUILT ON GUARDS

The Axiom technology leverages its own Growing Universal Agronomic Data Standards (GUARDS) data protocol. GUARDS aims to translate the unique way each researcher preserves raw agronomic data into one common standardized language that can be understood by any researcher in the world. It is based on the FAIR data principles, which ensure data is Findable, Accessible, Interpretable and Reusable.

AUTOMATIC DATA INGESTION

Axiom automatically ingests agronomic data from multiple sources and in the highest integrity. This automatic ingestion uses agronomic big data and the latest technologies to enable agronomic predictive modeling, ontology repositories, and statistical analysis in agriculture. We then use our advanced analytics software to take standardized and analyzed data and generate machine learning-based predictive models for agricultural solutions, analytics, APIs, and data service digital solutions. With Agmatix, agriculture professionals can finally focus on molding insights instead of spending 80% of their time gaining access to clean ag data, significantly reducing the time to market new innovations in the industry.

How Axiom Works: A Step-By-Step Process

01 **Data Ingestion**

Data is ingested into the platform from legacy and ongoing research, as well as APIs, IoT sensors and data repositories.

02 **GUARDS Protocol**

The data then goes through our GUARDS protocol, which consists of **three engines**:

03 **Data-Driven Insights & Solutions**

After the data has been standardized, Axiom uses ML to generate insights and models, which are then used for analytics, APIs and data service solutions for field-level application.

BOTTOM-UP ONTOLOGY

We create standardized definitions with a unique bottom-up approach derived from the data itself. Every new piece of data that enters into the system is tested to see if it fits an existing ontology. If it doesn't, a new ontology will be developed. Agmatix's ontologies are built by leading experts with deep know-how in ontology creation.

ANOMALY DETECTION & INTEGRITY

Axiom proactively monitors data integrity and quality by leveraging ML capabilities. The system identifies abnormal items and data in comparison to other relevant agriculture data sets and alerts when needed.

(Reference Figure 4 on page 6)

UNIT CONVERSION

Axiom converts different measurement units into one and standardizes the data values accordingly, enabling customization of databases and values.

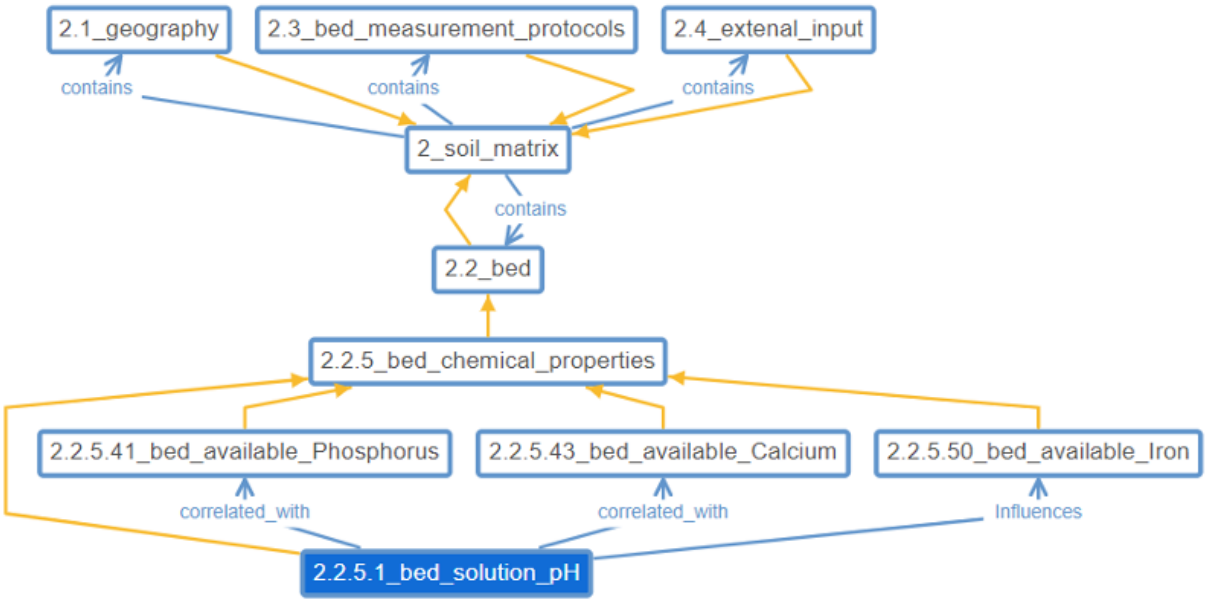

Figure 4 – Relations diagram between different entities from different domains. Yellow arrows represent 'child-parent' relationships, and other arrows have a description written in the diagram. Ontology example GUARDS concept 2.2.5.1_bed_solution_pH and (some of) its relations to other entities in the domain 2_soil_matrix.

Axiom Technology

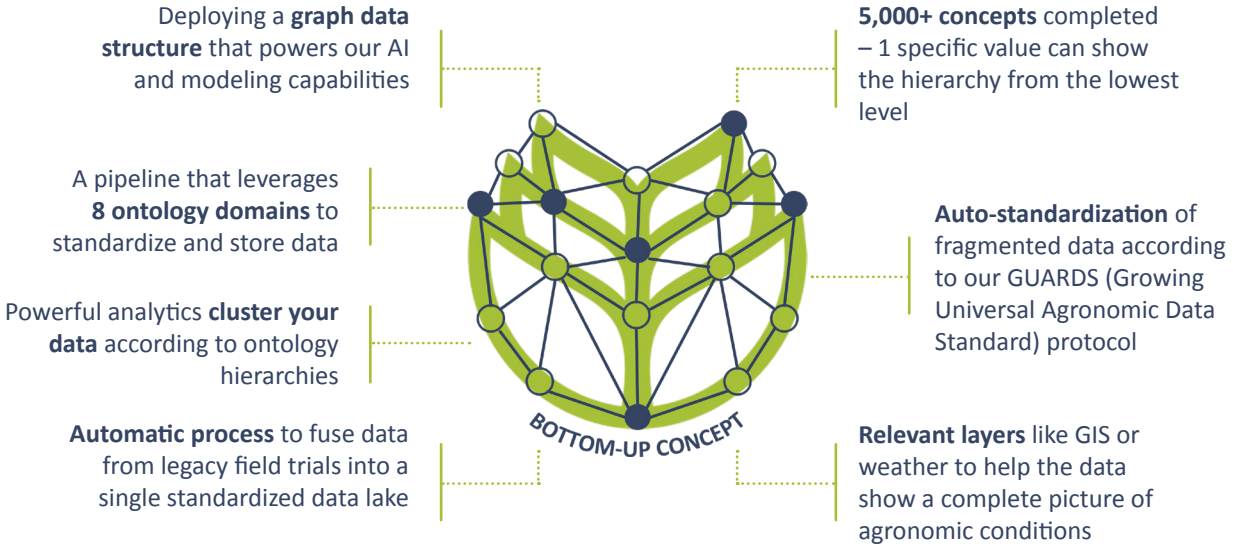

Figure 5 – Axiom is an ontology-based engine that drives innovation.

Novel Solutions for Agriculture Professionals

Empowered by the Axiom platform, our solutions help agriculture professionals collect data, share it and find unique insights they can take action on.

Agronomic Trial Management: Run and analyze field trials with full visibility and control.

Insights & Models: Run analysis, generate crop models and other discoveries.

Agmatix Mobile App: Accurate data collection. Easily run on-farm experiments in just a few clicks.

Digital Crop Advisor: Increase yield, boost sales and quantify sustainability.

Legacy Data Fusion: Use data standardization and enrichment to integrate and cross-analyze your data.

Agronomic Trial Management

Our powerful agronomic trial management system makes administering experiments easy and accessible, giving agriculture professionals end-to-end capabilities. Plan, operate, analyze and manage all agronomic field trials in one central place.

Insights and Models

Get a deeper understanding of the results of agronomic trials with our agronomic analysis tool. Insights & Models analyzes aggregated and standardized data from field trials, converting it into deeper insights and dynamic crop models.

Digital Crop Advisor

Our scientific-based crop nutrient decision support system lets agriculture professionals optimize their crop nutrient plans so they can increase profits while lowering their environmental footprint.

Agronomic Trial Management

One-Stop Shop For R&D

Agmatix's Agronomic Trial Management solution is an end-to-end field trial management program that allows researchers to plan their field trials, execute them with standardized protocols and data collection, and analyze the results. All in one digital, centralized location.

START WITH TRIAL DESIGN

Using Agronomic Trial Management's drag and drop features, researchers can map their trial layouts from a field-level view and create hundreds of customizable treatment combinations.

Figure 6 – Trial management mobile interface and trial mapping layout.

GET REAL-TIME VISIBILITY THROUGHOUT EACH TRIAL'S EXECUTION

Executives and researchers have full visibility and real-time status updates of all experiments from the platform's dashboard. Multiple people can access the interface, improving communication between researchers, trial operators, field technicians and CROs. The task assignment feature ensures field work is completed and as directed.

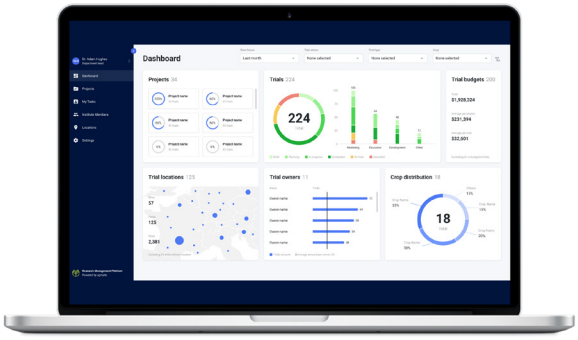

Figure 7 – Executive dashboard for visibility and control of all trial operations.

With Agronomic Trial Management's extended mobile capabilities, data collection has never been easier. Researchers can receive status updates, review data and assign tasks to others, whether they're at their desk or in the field. The executive dashboard helps them to better manage budgets and resources, as well as view other key elements that impact trial performance.

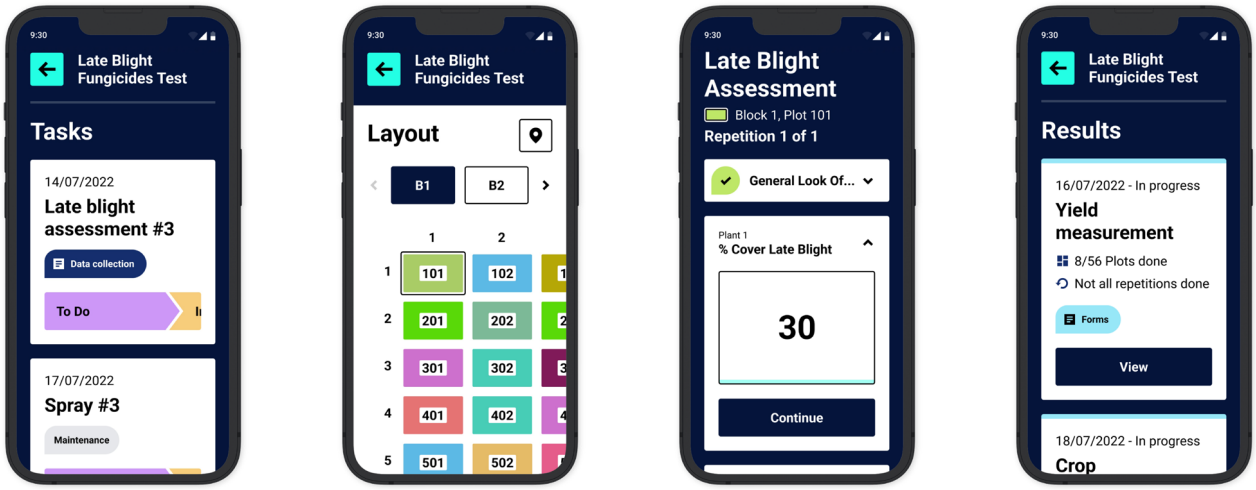

Figure 8 – Extend your trial operations from your desk to the field with the flexibility of Agmatix mobile.

UNIFY DATA COLLECTION AND SIMPLIFY SHARING

With full operational visibility of the trial, researchers can ensure they're collecting the information they need with the solution's customizable data entry form. This allows the team to easily collect a multitude of observations and sample data right from the field. Researchers can then view data results instantly to monitor outliers and validate the course of the trial.

Once the trial is complete, the data can be easily exported to .csv and .xls, along with chart images and operational insights, for fast and accurate reporting and sharing with stakeholders.

KEY BENEFITS:

1. Field-Level Trial Design
2. Task Assignment Tool
3. Standardized Protocols And Data Collection
4. Real-Time Visibility
5. Compatible With Desktop And Mobile Devices

USE CASE: Innovation Center Digitalization

IMPROVE TRIAL OPERATION EFFICIENCIES

CHALLENGE

Following a successful merger, a Brazilian fertilizers company's management began perusing how to **digitize their R&D processes and improve trial operations efficiencies at their innovation center**.

The companies are conducting hundreds of trials (screening, prototyping, comparisons, demos, etc.) for a diverse set of crops and looking to e**xtract more insights while reducing the cost per trial**.

APPROACH

Define comprehensive protocols and workflows to ensure data completeness in order to allow future advances analysis.

Deployed the **Agmatix Trial Management** solution for the field and greenhouse research teams, including an executive dashboard to increase visibility and control over their operations.

RESULTS

Improved R&D cycle times, gained visibility, and reduced their time to analysis.

Extracted 12x more parameters enabling more **data-driven insights**.

Unified their data preservation to optimize **recommendations for marketing & sales purposes**.

USE CASE: Optimize Data Pipelines R&D To Commercial

DATA FUSION FROM TRIALS TO BOOST PRODUCT DEVELOPMENT

CHALLENGE

A crop protection producer sought to standardize insecticide trials globally. The company received **data from 10 years of trials in various languages and formats** (ARM, PDF, excels, etc.).

The company sought to **improve its data analysis capabilities, optimize R&D processes, and provide better commercial recommendations** as part of its strategic digital transformation.

APPROACH

Harmonized trials' datasets and enriched the company's data with external data layers.

Deployed the **Agmatix Insights** solution for the global product development team, enabling cross-analysis and more efficient operations.

RESULTS

ML modeling insights allowed them to improve protocols, add parameters, and initiate a digital trials management program.

The product development team can easily access a **globally harmonized data lake** for statistical cross-analysis.

Data-driven recommendations to **support the formulation and commercial divisions**.

Insights And Models

Discover the Hidden Value in Your Data

Why do we need data? To gain knowledge about what's going on in the field so we can make better decisions. But that only happens if we have a comprehensive understanding of what the data is telling us. The Insights & Models solution makes this a reality by analyzing aggregated and standardized data from field trials, so agriculture professionals can uncover actionable insights.

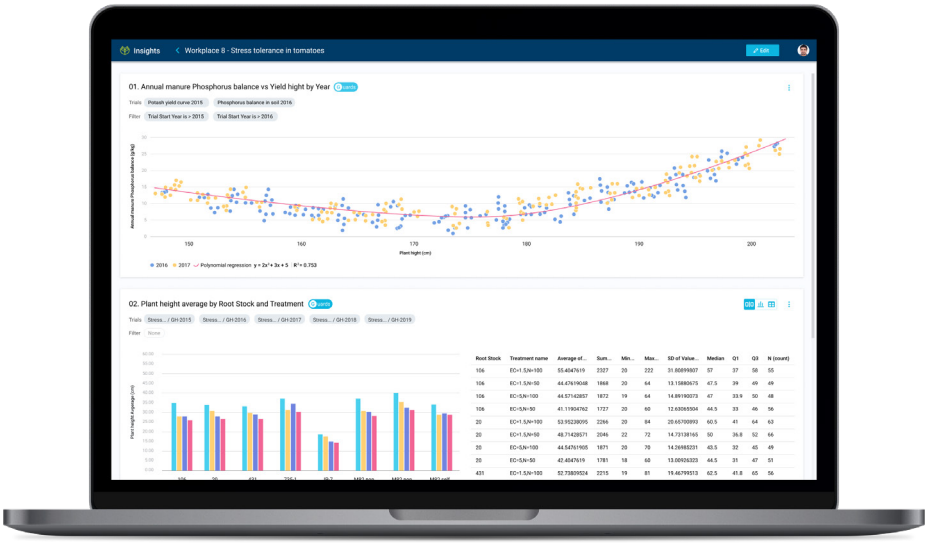

Figure 9 – Choose from 14 pre-built analytical widgets for analysis.

ALL YOUR DATA IN ONE PLACE

The first step to unlocking the true value of data is to have it all standardized and in one location. With Insights & Models, data from every field trial a research team has conducted anywhere is housed under one unified platform. Our Axiom technology ingests and fuses legacy trial data to harmonize all datasets, so agriculture professionals can easily uncover new information through cross-trial analysis. And by integrating and standardizing legacy trial data via Agmatix's GUARDS ontologies, data can be easily searched, accessed, queried and consumed.

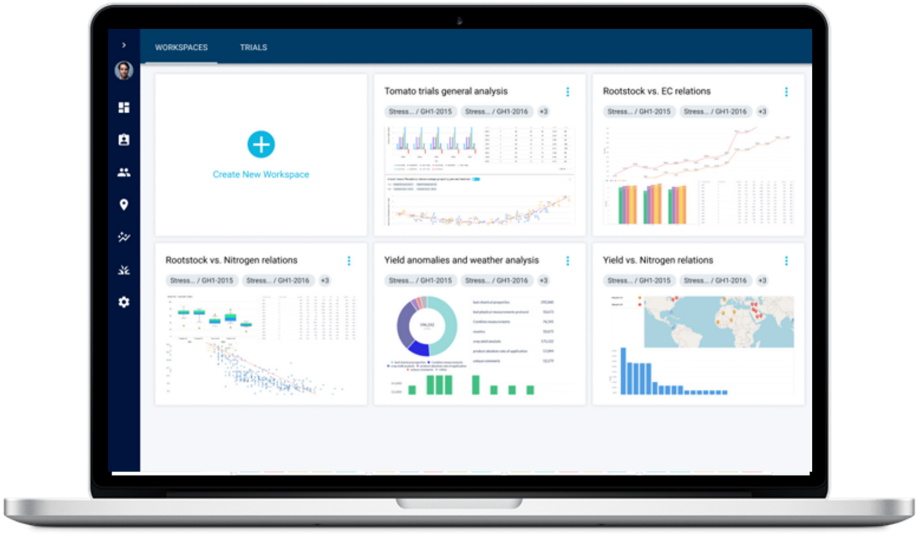

Figure 10 – Utilize customizable workspaces for quick analysis and easy collaboration.

UNDERSTAND THE DATA

With datasets standardized and harmonized, agriculture professionals can begin generating powerful insights and models from the data in just a few clicks. Insights & Models has 14 pre-built statistical tools that improve data quality and statistical analysis. From there the solution's multi-step approach allows agriculture professionals to create custom reports that summarize the data, visualize it and compare parameters.

MAKE POWERFUL DATA-DRIVEN DECISIONS

After the data has been processed and insights have been made, agriculture professionals can use the agronomic analysis tool to better understand what's happening in the field. And the agronomic modeling tool can provide deeper insights into advanced farming practices. Agriculture professionals can calibrate and verify statistical ML models to better identify the best way to increase yields, maximize water and fertilizer use efficiency, and achieve superior performance.

KEY BENEFITS:

1. Leverage 14 statistically pre-built widgets
2. Calibrate and verify statistical ML models
3. Harmonize legacy trial data
4. Conduct cross-trial analysis
5. Create custom reports

CASE STUDY: Predicting Corn Yields Across Different Environments

To demonstrate the potential for modeling in the Insights & Models solution, we'll go through an example of using datasets from corn experiments to predict corn yield in different environments.

DATA COLLECTION AND MODEL CALIBRATION

First we gathered a small subset of data from more than 7,500 corn experiments. These experiments came from:

- Replicated university experiments, from two universities
- Unreplicated demo plots
- Data from farm management software

Geographically, the data ranged from China to the U.S. Midwest and Mid-Atlantic Regions.

To calibrate the model, we implemented the XGBoost (decision tree ensembles) algorithm in R, based on 80% of the data. The remaining 20% of the data was kept for validation.

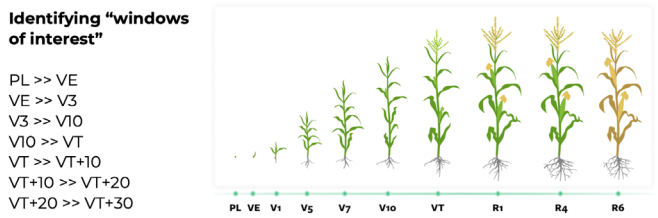

Figure 11 – Corn growth stages. For each stage, models were used to calculate the rainfall and GDD which were subsequently used as site specific explanatory features for the yield prediction model.

ACCURATE PREDICTIONS AND FURTHER REFINEMENTS

The data was enriched with site-specific weather parameters, such as precipitation and GDD, calculated for different growth stages in each experiment. The model was able to predict corn yields across different environments with an adequate efficiency and relatively low mean prediction error of 10%.

Similar approaches could be used to predict other parameters, such as grain quality, crop diseases and phenological stages.

With the constant stream of new data into the Axiom database, it is constantly refining models. And in turn, those refined model predictions are used to refine decision support systems.

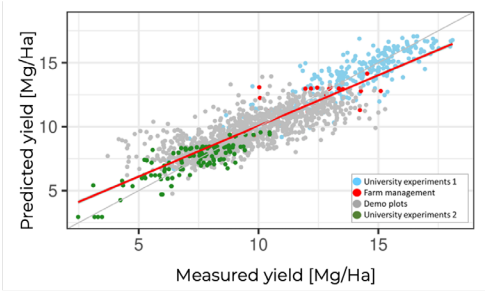

Figure 12 – Test data -predicted versus measured corn yield in 1,542 independent yield measurements not used for the calibration. RMSE – 1.22 Mg/Ha; mean average prediction error – 10.0%; Adjusted R2 – 0.80, p< 0.01.

Digital Crop Advisor

Building Data-Driven Crop Nutrient Recommendation Plans

Developing a fertilizer plan has never been one-size-fits-all. In addition to understanding a specific crop's nutrient needs, agronomists and crop consultants need to consider the soil and its properties, the grower's crop rotation, weather and environmental conditions, as well as the farmer's budget, labor and equipment capacities. Without data, farmers and their consultants are at risk of making decisions based on gut feelings and bad assumptions.

Figure 13 – Executive dashboard visibility into ag input sales, crop nutrient needs and sustainability metrics of nutrient plans.

START WITH SCIENCE-BACKED NUTRIENT PLANS

Digital Crop Advisor removes the guesswork and tediousness agronomists encounter in trying to ensure each crop they work with is getting its nutritional needs. Built on 12 scientifically proven crop nutrient data profiles, agronomists can create unique nutrient plans, including controlled release fertilizers, for over 150 different crops. It can also verify fully customized crop nutrient protocols.

EVALUATE EACH PLAN'S SUSTAINABILITY

Growers are faced with the unique challenge of trying to maximize crop yield and production while lowering their impact on the environment. With Digital Crop Advisor, agronomists can have confidence their recommended crop nutrient plans will meet their farmers' sustainability goals. Each plan quantifies sustainability KPIs, such as carbon footprint and susceptibility to nitrogen leaching, and offers recommendations for improving sustainability. Agronomists can also work with their farmers to run various simulations and understand the trade-off between higher yields and impact on the environment.

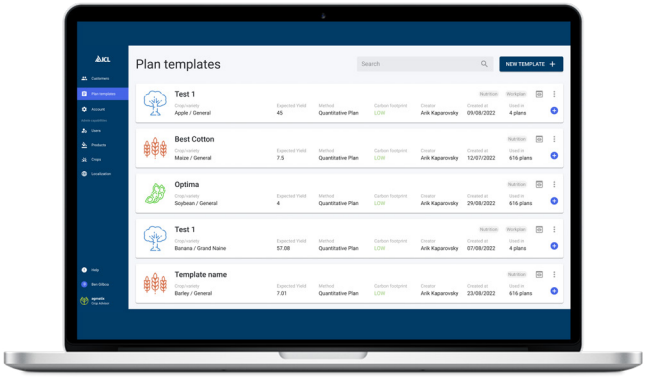

Figure 14 – Customize nutrient plan templates based on each location, crop type and agronomic input needs.

BUILDING TRUST TO DRIVE BUSINESS

Accessible in both the office and the field, agronomists can build plans with Digital Crop Advisor right on their clients' farms. Growers can see why their agronomists are recommending specific input products and together create a nutrient strategy that fits their crop needs and budget. Farmers can feel confident the plans they've developed with their agronomist are based on data and have their best interests in mind.

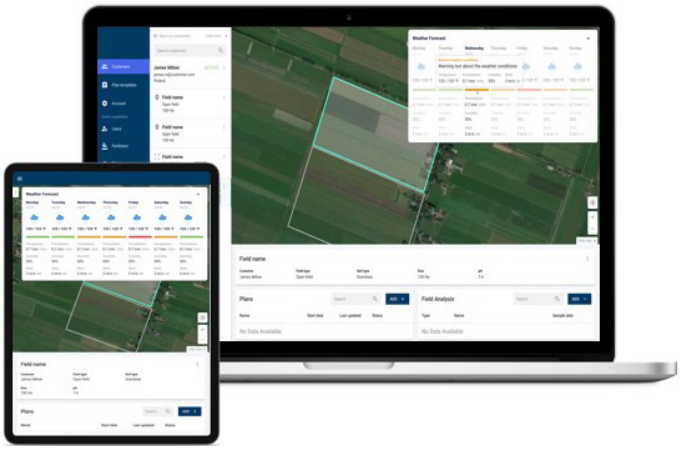

Figure 15 – Leverage real-time weather and critical events alerts to impact agronomic decisions at field-level.

KEY BENEFITS:

1. Leverage 12 scientifically proven crop nutrient data profiles for 150+ crops
2. Accounts for all nutrient inputs including controlled release fertilizers
3. Detailed weather forecast and critical event alerts
4. Visualize nutritional distribution along each phenological stage
5. Quantifies sustainability of nutrient plans

The Agmatix Platform In Action

CASE STUDY: Finding the Optimal Nitrogen Level for Pomegranates

To demonstrate an application of Digital Crop Advisor, we tested the tool's nitrogen recommendation rate. We used experimental results from a study that examined the optimized nitrogen application for the growth and productivity of pomegranates [Lazare et. al. 2020]. The study was conducted in large pots filled with perlite and we rescaled calculations to kilograms per hectare (kg/ha), assuming 450 trees per hectare.

As you can see in the graph below, pomegranate yield (blue line) first increased sharply as the nitrogen application rate increased. But it quickly reached its maximum yield potential before a nitrogen rate of 250 kg/ha. After that, as nitrogen increased, yield began to drop.

The green line represents the Digital Crop Advisor's Nitrogen Response, which predicts nitrogen leaching. Loss is minimal as yield increases due to rapid nitrogen uptake. But after yield reaches its max, we see the risk of nitrogen loss continue to increase, as the crop no longer takes up nitrogen.

Digital Crop Advisor recommends a nitrogen application rate of 220 kg/ha, as indicated by the red dot. Based on the experimental results, this confirms the recommendation is close to the maximal yield achieved.

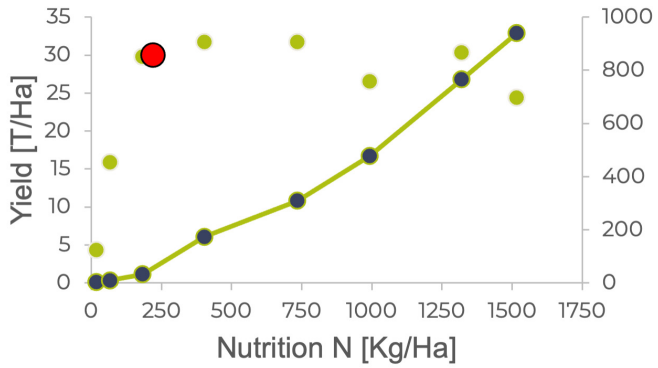

Figure 16 – Yield response of Pomegranate crop to different level of N fertilizer loading (blue lines), measured leaching losses (green lines), and the Digital Crop Advisor's N recommendation (red dot).

As the nitrogen application rate increases, we see yield (blue line) increase sharply and reach maximum production just before 250 kg/ha. The green line shows the risk of nitrogen leaching, which we see drastically rises after pomegranates reach their maximum yield potential. The red dot indicates the Digital Crop Advisor's recommendation of applying 220 kg/ha nitrogen.

CASE STUDY: Boosting Sales, Customer Service And Sustainability In India And Brazil

Our Crop Advisor solution has generated true impact such as the case with the market in India, where we supported sales growth by enabling field agronomists to provide digital nutritional prescriptions for their farmers based on field trials data, soil and water testing, and a unique data technology used for rapid leaf testing. This allows field staff to provide accurate and customized prescriptions, and to quickly adjust to changes during the session.

BOOSTING SALES CUSTOMER SERVICE AND SUSTAINABILITY IN INDIA

DIGITAL PRESCRIPTIONS

AI-DRIVEN LEAF TESTING

1,460 FARMS

1,640 HECTARES

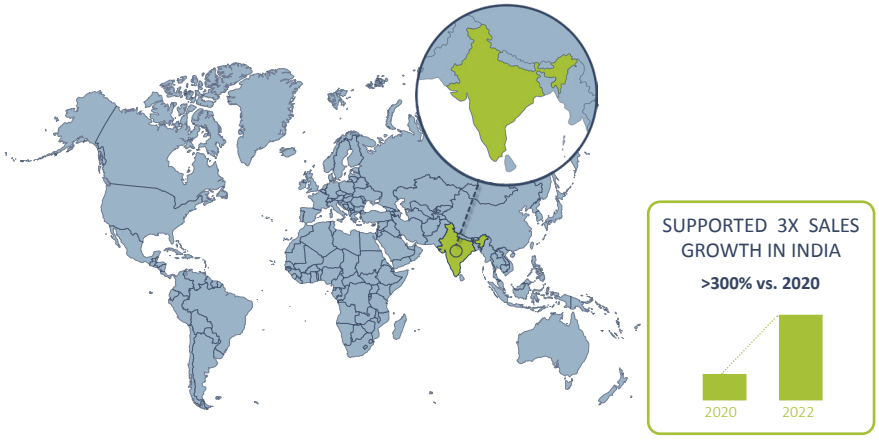

Figure 17 – Digital Crop Advisor boosted 3X sales growth in India.

Crop Advisor allows our customers to optimize fertilizer recommendations based on their carbon emissions, thereby reducing the carbon footprint of fertilizer use. Following our current deployment rate, we estimate that by 2027 we can reduce 140 KG of C02 per ton of yield.

DIGITAL CROP ADVISOR ENABLES CUSTOMERS TO:

DIGITAL PRESCRIPTIONS BASED ON BIG DATA

OPTIMIZE AG PRACTICES TO REDUCE CARBON FOOTPRINT

SAVE AN AVERAGE OF 140 KG PER TON OF YIELD

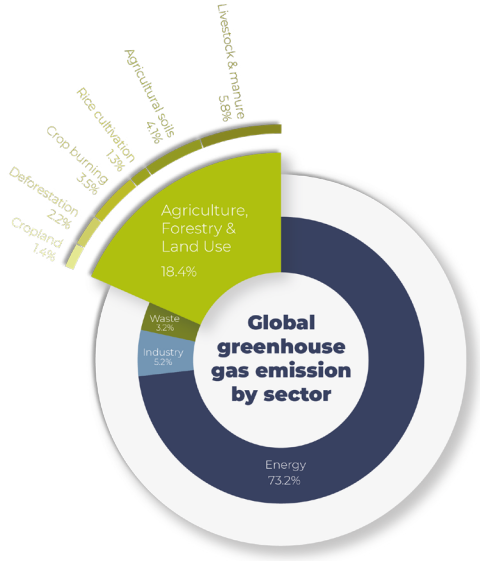

Figure 18 – Estimated global greenhouse gas emissions by sector.

CASE STUDY: Collaborative Data Open Research Platforms

We have opened one of the largest open data platforms for crop nutrient data. The data was donated by many organizations globally and consists of more than 2000 different data sets from more than 50 collaborating researchers and over 50 contributing countries. Together with our partners the International Fertilizers Association (IFA), Wageningen University & Research (WUR), African Plant Nutrition Institute (APNI), and Innovative Solutions for Decision Agriculture (ISDA). These collaborative and open databases are powered by the cutting-edge Agmatix platform, designed to aggregate, standardize, and harmonize agronomic data, Agmatix has also used its complex algorithms to enrich the datasets with site-specific data, such as weather and geospatial information on soils and crops. Agmatix's agronomic data solutions continue to revolutionize agro informatics and improve sustainable food production worldwide.

COLLABORATIVE DATA OPEN RESEARCH PLATFORMS

2,000+ DIFFERENT DATASETS

>50 COLLABORATING RESEARCHERS

53+ CONTRIBUTING COUNTRIES

> **These databases make it easier to create decision support systems to optimize crop production in a sustainable way.**
>
> - Achim Dobermann, IFA Chief Scientist

See How Agmatix Can Help Your Agribusiness

Agmatix is building a world where agronomic data is standardized and universally accessible, empowering agriculture professionals with unique insights that will help them optimize their R&D pipelines, advance crop yield, quality and sustainability. As our Axiom technology continues standardizing and harmonizing the vast wealth of statistically verified data available, it empowers the solutions that will allow agriculture professionals to make those advancements.

Whether you're trying to manage large field trial operations, increase your ag input sales, or just make better decisions at field-level, Agmatix's data-driven solutions can help you achieve your agronomic and business goals.

To see how our Axiom-empowered technology is helping clients solve their biggest data problems, visit: agmatix.com/resources.

Interested in working with us? Visit agmatix.com/contact-us/ to schedule a demo and get started in leveraging the power of your data.