Cultivating Intelligence – AI-Powered Decision Science for Sustainable Agriculture

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AI that learns our way …

to grow more with less

The Agricultural Knowledge Ecosystem

Traditional Farmer

Learning Approach

- Seasonal observations
- Generational knowledge
- Community sharing
- Practical experimentation

Knowledge Strengths

Contextual	Adaptable
Practical	Intuitive

Agricultural Scientist

Learning Approach

- Scientific method
- Controlled experiments
- Statistical validation
- Peer-reviewed knowledge

Knowledge Strengths

Systematic	Validated
Replicable	Theoretical

Data Scientist for Ag

Learning Approach

- Multi-source data integration
- Model development
- Scientific method application
- AI system deployment

Knowledge Strengths

Scalable	Predictive
Integrative	Generalizable

Each knowledge system brings unique strengths and perspectives to agricultural practice

Human-AI Partnership: Augmenting Agricultural Capabilities

Human Abilities

Contextual Wisdom
Years of practical field experience and intuition

Judgment & Ethics
Values-based decisions considering local contexts

Adaptability
Creative problem-solving in novel situations

Trust Building
Community relationships and stakeholder engagement

Augmented Capabilities

- Enhanced decision speed with maintained quality
- Wider spatial and temporal monitoring scope
- More accurate field predictions and forecasts
- Adaptive management responsive to changing conditions
- Improved resource efficiency and sustainability

AI Capabilities

Massive Scale
Processing millions of data points across thousands of fields

Computational Speed
Near real-time analysis of complex agricultural systems

Pattern Detection
Identifying subtle correlations invisible to human observation

Predictive Power
Forecasting complex outcomes across multiple variables

Knowledge Integration & AI Development Cycle

Data Collection

- Structured experimental design
- Multi-modal sensor networks
- Integration of farmer observations

Pattern Analysis

- Descriptive models (what happened)
- Predictive models (what will happen)
- Prescriptive models (what should be done)

Intelligent Agriculture

Adaptive Learning

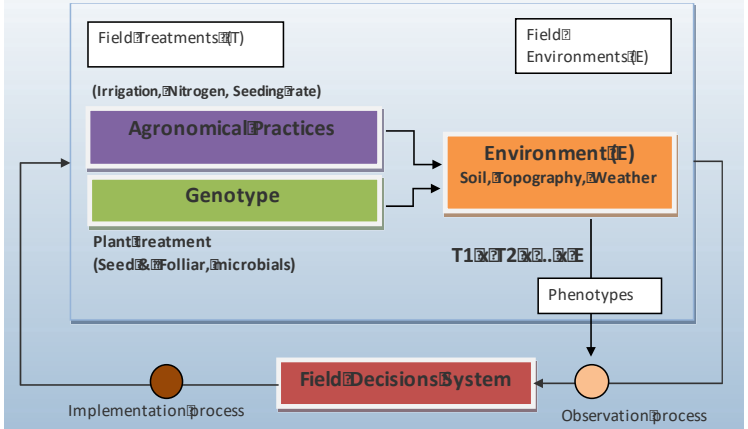
- Continuous improvement through feedback
- Integration of new knowledge sources
- Model refinement based on outcomes

Experience Design

- Narrative intelligence for insights
- Role-specific interfaces (farmer, scientist, etc.)
- Decision support visualization

AI systems for agriculture combine scientific rigor with practical wisdom, powered by technology to create scalable, adaptive intelligent agriculture

The Purpose of Learning in Agriculture



The G×E×M Interaction

Agricultural learning aims to understand the complex relationship between plant genetics, growing environment, and management practices.

Visualization of how different crop varieties respond to environmental conditions and management interventions

Optimizing Crop Phenotypes

The fundamental purpose of learning in agriculture is to design management practices that optimize crop phenotypes (such as yield, quality, and resilience) for specific genetic varieties grown in varying environments.

Genetics (G)

Crop varieties with specific traits, yield potential, and stress resistance

Environment (E)

Abiotic: Soil, topography, weather, climate
Biotic: Pests, diseases, beneficial organisms

Management (M)

Planting, irrigation, fertilization, crop protection, harvest timing

Growing More With Less

Economic Benefits

- Increased yields per input unit
- Higher profit margins
- Reduced operational costs
- Risk mitigation
- Improved product quality

Environmental Sustainability

- Less land requirement
- Reduced water usage
- Lower fertilizer application
- Minimized chemical runoff
- Decreased carbon footprint

The roots of AI for Ag:
scalable, reliable, interpretable data

Data foundations for AI in Agriculture (powered by AI)

Remote Sensing

Multi-source smart data collection

Satellites | Drones | Ground Sensors

Satellite

- Broad coverage
- Regular intervals
- NDVI, EVI metrics

UAV/Drones

- High resolution
- On-demand capture
- Thermal imaging

IoT Sensors

- Soil moisture
- Real-time data
- Micro-climate tracking

Ground Stations

- Weather monitoring
- Disease forecasting
- Data calibration

Data Fusion

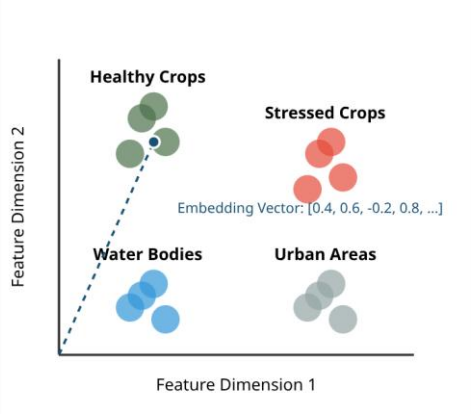
Multiple sources for insights

Planet Fusion | Weather Data

Feature Embedding

Unified information representations

AlphaEarth | Foundation Models



The stem of AI for Ag:

Actionable Insights

Actionable Insights grown from the stories our fields reveal

Actionable Analytics

Descriptive/Predictive/Prescriptive

Yield Prediction | Optimization

Narrative Intelligence

Data to natural language

Bayer's E.L.Y. | Gen AI

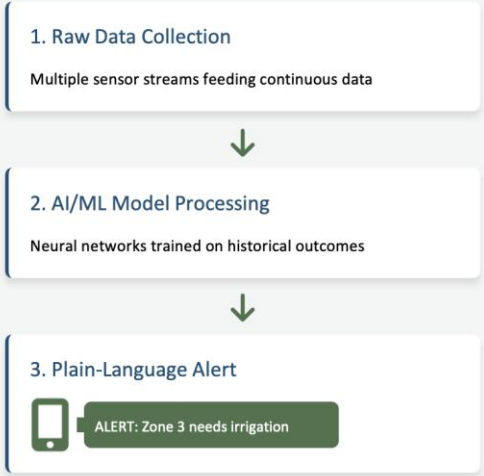
Moisture-Stress Forecast

Inputs:

- Soil moisture probe readings (5cm, 15cm, 30cm)
- 5-day weather forecast (precipitation, temp, wind)
- Historical crop water usage patterns

Advisory Output:

"Zone 3 soil moisture ↓ 12%; irrigate within 48h to avoid yield impact"



E.L.Y. Conversation Example

Farmer:

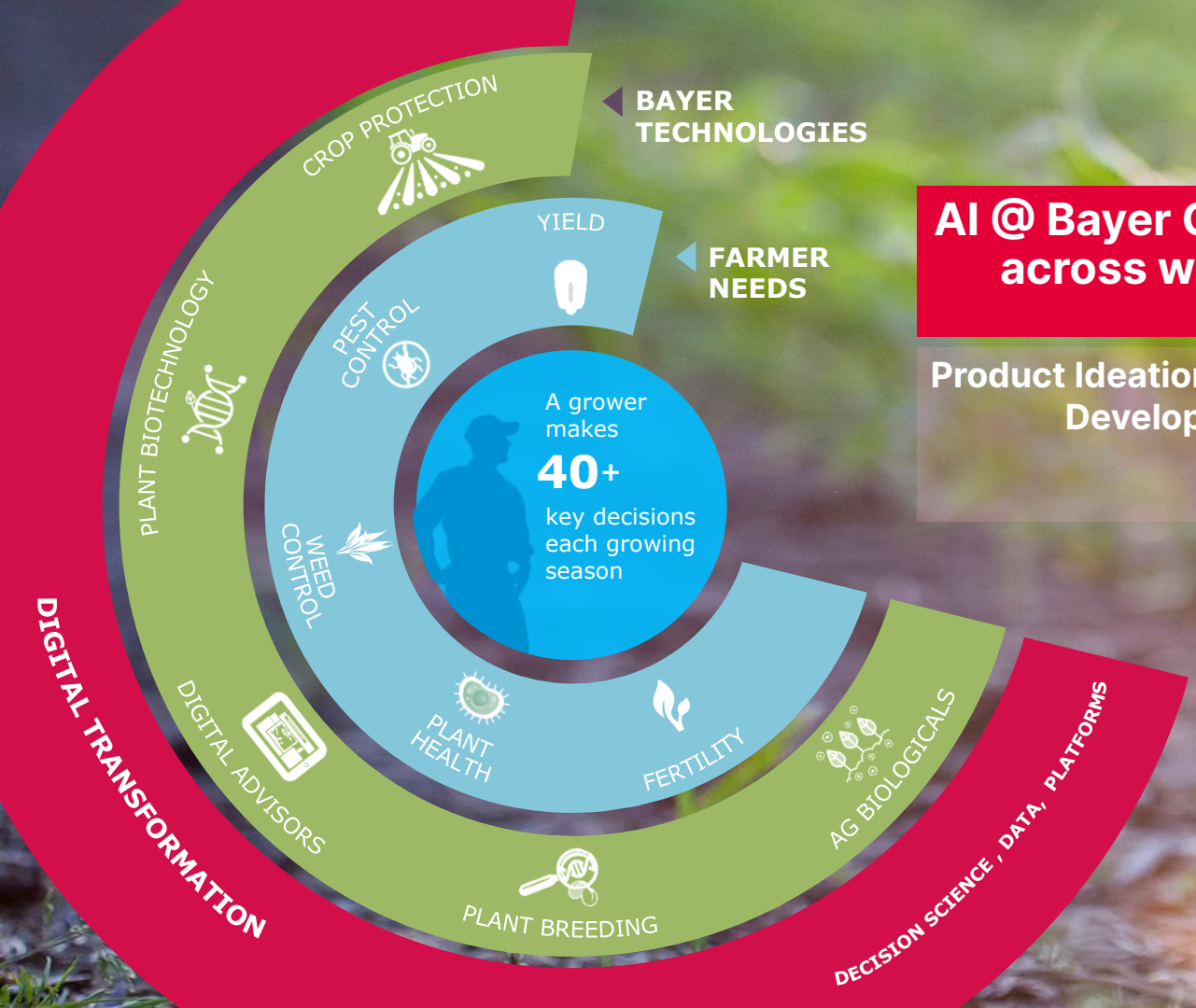
I'm seeing yellowing on my corn leaves after last week's heavy rain. What could be causing this?

E.L.Y.:

Based on the recent heavy rainfall in your region and the yellowing pattern you describe, this is likely nitrogen deficiency from leaching. I recommend soil testing to confirm. For immediate action, consider a foliar application of 28-0-0 at 2-3 gallons per acre. Our local trial data shows this approach recovered 85% of yield potential when applied within 10 days of symptom appearance.

The Flower/Fruit of AI for Ag:

Measurable outcomes

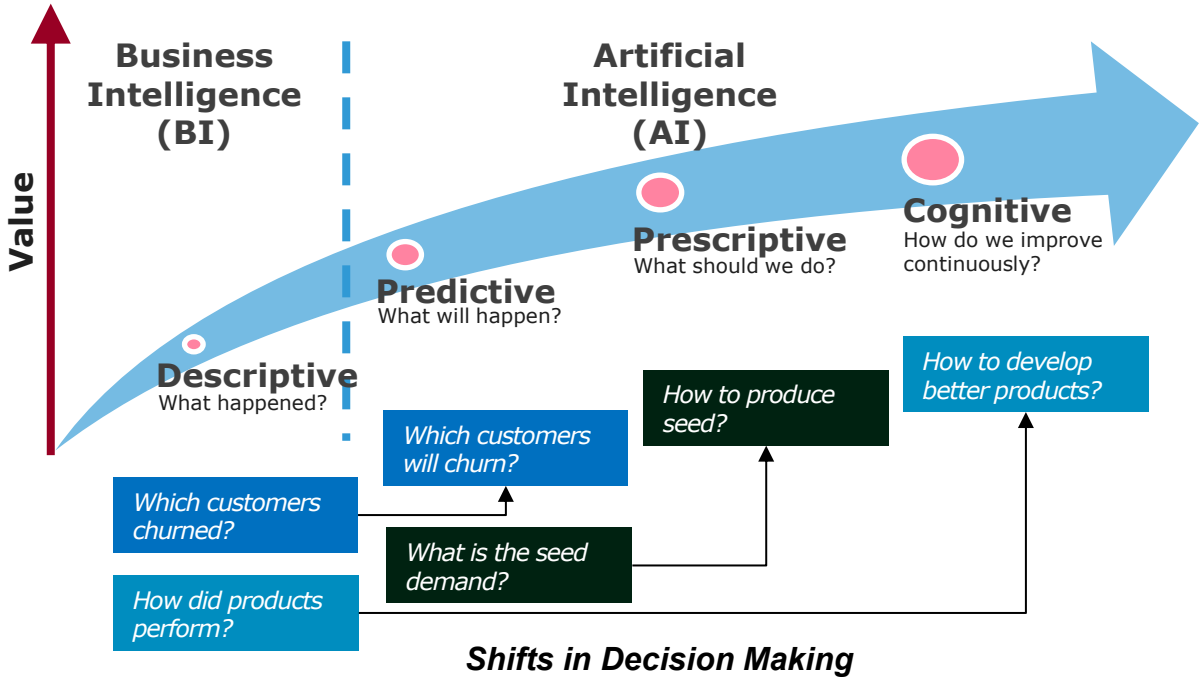


AI @ Bayer CS is impacting decisions across whole product life cycle

Product Ideation
Development
Manufacturing
Commercialization

DEVELOPING SOLUTIONS FOR FARMERS

Our Decision Science maturation has been enabled by people, process, technology, and innovation



Technology
Platforms
Best practices

Process
Alignment
Value measurement

People
Learning
Hiring & retaining

~700 personnel globally → >450 models improving decisions → Delivered value for Crop Science

Examples of Business Decisions impacted via Actionable Analytics

R&D

- What products (insect, chemistry, seed) to develop?
- What products to advance in pipeline?
- How to route combines to maximize data collection?
- What equipment will fail in labs?
- What is the environmental impact of products?
- How to design breeding pipelines?
- How to design and operate seed processing facilities?
- Where to test products?
- What is the food/feed safety of products?
- How to impute high-density, high-quality genotypic data?
- What field data should be collected from product trials?

Product Supply

- What is the seed demand?
- How much safety stock is needed?
- How to spread crop production?
- What's the optimal time to plant, detassel, harvest, etc.?
- What is the in-season product supply?
- How to route trucks to reduce seed loss?
- How to optimize Glyphosate production?
- What is the optimal policy for seed treatment applications?
- How to operate seed processing facilities?
- How to improve customer service?
- How to design seed distribution network?
- How much raw material to source for herbicide production?
- What is the seed quality?
- What will be the seed size?

Commercial

- What customers are likely to churn?
- What is the customer loyalty?
- What are the expected seed returns?
- What is unconstrained seed demand?
- What is best product price?
- What is optimal market funding?
- What is the best product portfolio?
- What product systems should be tested?
- Where should products be tested?

Digital Farming

- What is the optimal seeding density?
- Where to place products?
- What are optimal agronomic (irrigation, Nitrogen, etc.) prescriptions?
- Which disease is affecting plants?
- What diseases will impact in future?
- What is the drift of herbicides?
- What is the predicted weather?
- What is the predicted crop growth?

HR

- What employees are at risk of attrition?
- What behaviors drive employee engagement?
- What behaviors make leaders effective?

Corporate Engagement

- How is Bayer's reputation being impacted?
- How to drive better public acceptance of our products?

Seed Manufacturing Operations at the Field Level relies on timely and orchestrated decisions in order to produce a bag of seeds

Simulation and analytical models are a step-changer for operations and cost management

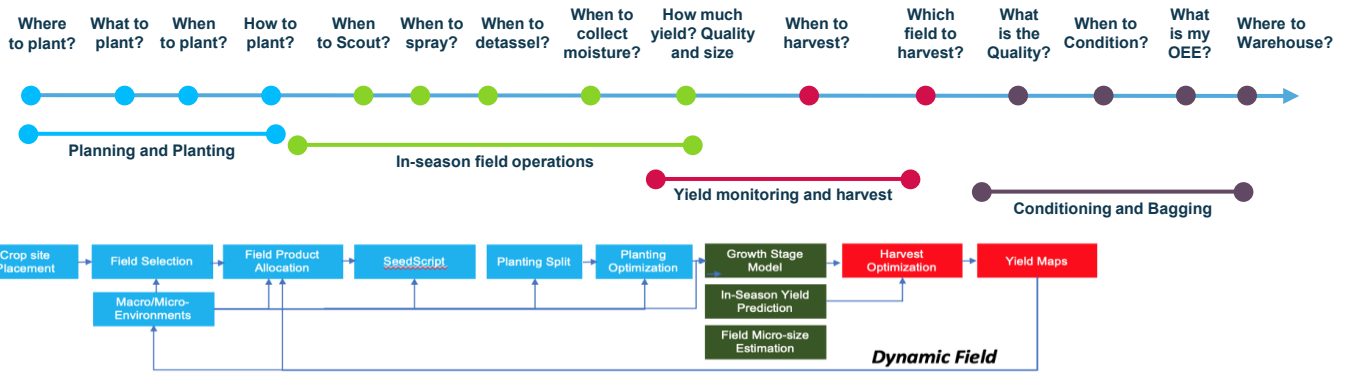
Advanced Analytic Program

Automating and virtually orchestrate decisions across fields all the way to facilities using advanced analytical (AI) models along with a digital transformation strategy

Key Achievements

- Contributed to significant yield increase and cost reductions across global operations

Models Processes Decisions



The Seed of AI for Ag:

Help nurture the change

Opportunities

Invest

- Fund rural broadband infrastructure in agricultural regions
- Support R&D for low-cost, appropriate-scale technologies
- Develop financial incentives for early adopters (tax credits, subsidies)

Regulate

- Advance clear data ownership and privacy frameworks
- Develop interoperability standards for ag-tech systems
- Require environmental stewardships for new technologies

Educate

- Fund extension services for digital agriculture training
- Create demonstration farms showcasing integrated technologies
- Develop farmer-to-farmer peer learning networks

Partner

- Facilitate public-private partnerships for technology development
- Create multi-stakeholder platforms for collaborative governance
- Support international knowledge exchange and capacity building

Thank you!

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