



# AI – Agricultural Interoperability: Evolving Data Standards in the Era of Artificial Intelligence

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- President Agricultural Data Coalition

ICPP HARVEST Workshop Sept. 25 San Diego, CA

# Farming today ?



1953 Tractor



2025 AgBot





# Ag Technology Milestones



1992

- Yield Monitor

1985

- SoilTek



Intel Processor Releases

80286	1982
80386	1985
80486	1989

2000

- Vantage Point



- Launched to “help farmers and their professional advisers manage the vast amounts of data they generate.”

2005

- AutoGuide
- iPhone



2014

- Climate Acquisition
- Drones

FORBES RESEARCH > TECHNOLOGY

Monsanto Buys Climate Corp For \$930 Million

By Bruce Upbin, Former Staff.

Published Oct 02, 2013, 09:13am EDT, Updated Oct 02, 2013, 10:25pm EDT



2022

- DOT/Raven/CNHi
- ChatGPT



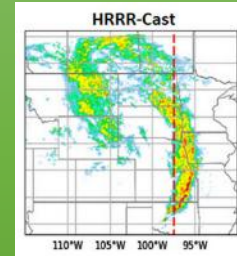
Targeted weeding



Monitor and control of animal facilities



Weather, Markets



Agronomic Recommendations

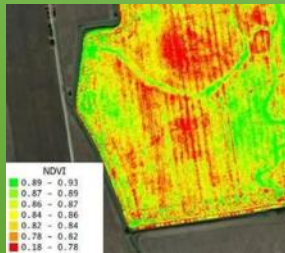
**Agronomy AI Arena**



Harvest machine optimization



IoT Sensors, Remote Imagery



Product Support



Digital Twin/Predictive maintenance



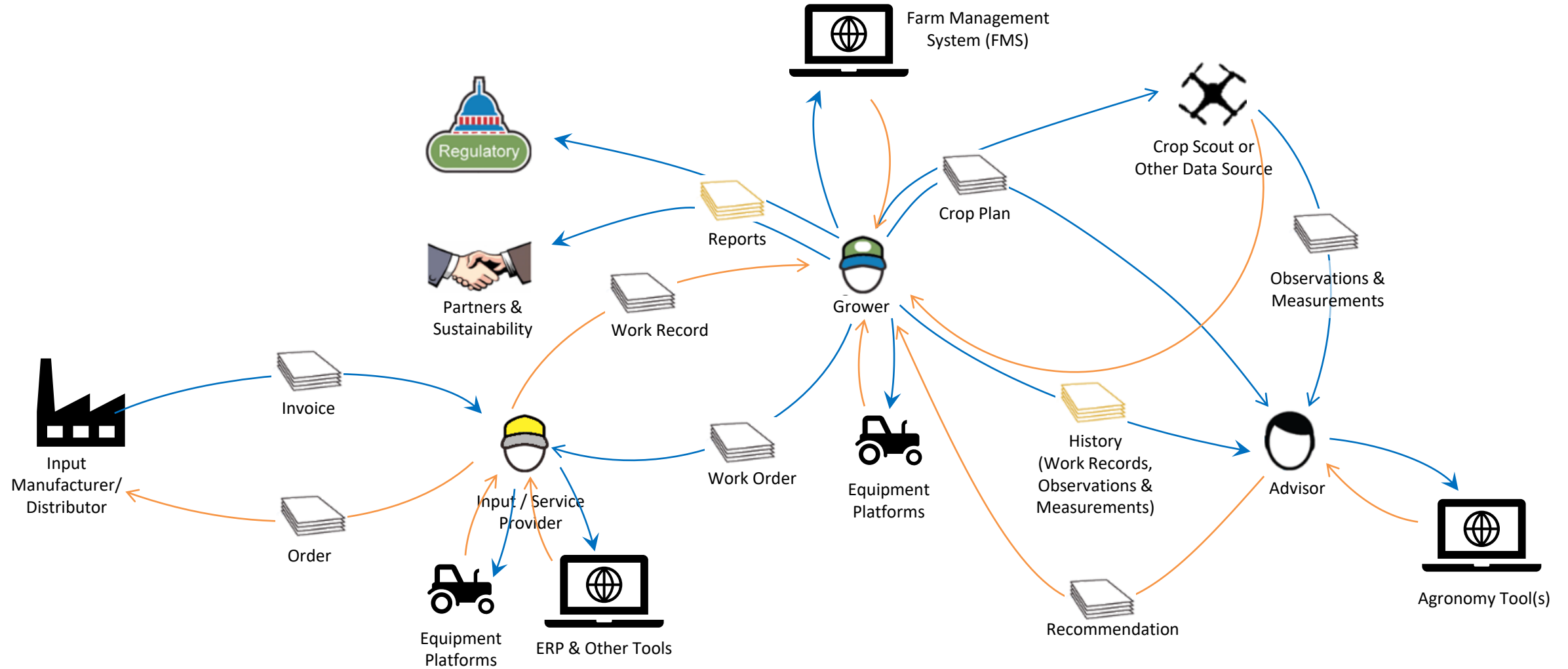
Smart Irrigation/Fertigation



Machine Guidance

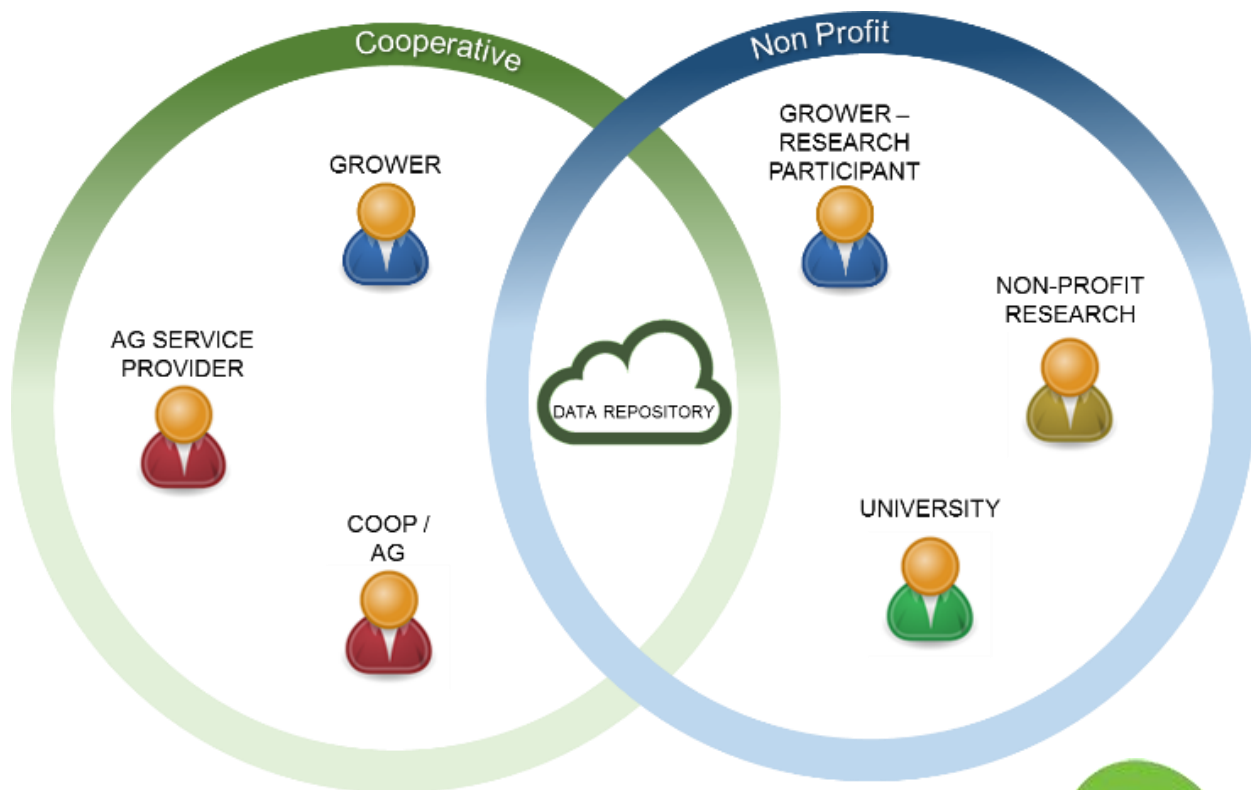


# Agricultural Information Flow





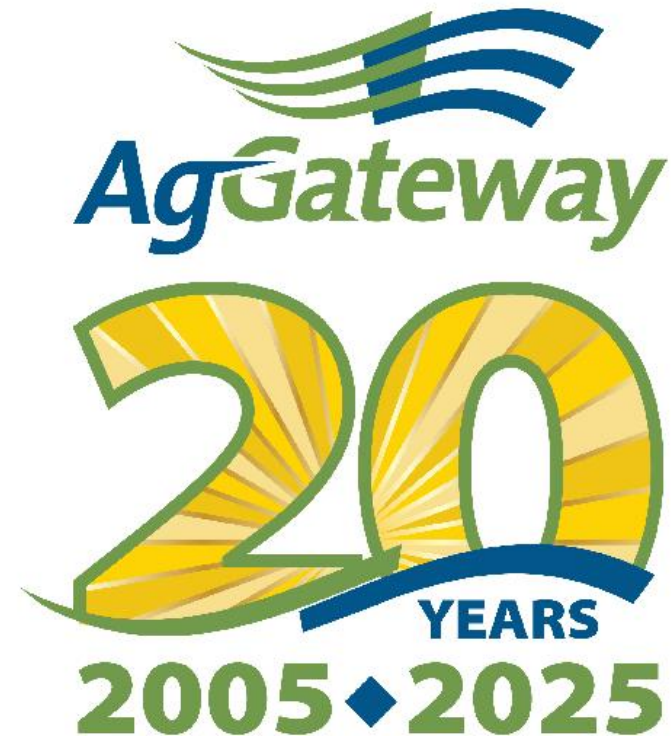
# Ag Data Coalition



# AgGateway

A non-profit member association leading the global transition to digital agriculture.

**Mission:** To develop the resources and relationships that drive digital connectivity in global agriculture and related industries.



# Some of our ~200 Member Organizations

WINFIELD  
UNITED

SSI  
SOFTWARE SOLUTIONS INTEGRATED, LLC

Keystone  
COOPERATIVE

CORTEVA<sup>™</sup>  
agriscience

CHS<sup>™</sup>

VITA  
PLUS  
Employee-Owned

BAYER Bayer syngenta

AURORA  
COOPERATIVE

Mosaic<sup>®</sup>

FMC

Gowan  
The Go To Company

MFA  
INCORPORATED

CNH  
INDUSTRIAL

RDI  
Rosen's Diversified, Inc.

KEY  
COOPERATIVE  
your essential business partner

HELENA

BRANDT<sup>®</sup>  
Professional Agriculture<sup>®</sup>

AgVantage  
SOFTWARE

LAND O' LAKES, INC.

WILBUR-ELLIS<sup>™</sup>  
Ideas to Grow With<sup>™</sup>

AMVAC<sup>™</sup>

Simplot

GROWMARK

KOCH

Americot<sup>™</sup>  
cotton seed

GREENPOINT AG

Nufarm

TELUS<sup>®</sup>  
Agriculture

TOPCON  
Agriculture

Nutrien

KAHLER  
AUTOMATION

IRM  
INTERNATIONAL RAW MATERIALS LTD.

Ever.Ag

BECK AG  
Join the Conversation

ALBAUGH, LLC

RiceTec  
HYBRID RICE SEED

Tessenderlo  
KERLEY

BASF  
We create chemistry

JOHN DEERE

THE  
EQUITY

VAN DIEST  
SUPPLY COMPANY

SOUTHERN STATES  
Farmer owned since 1923.

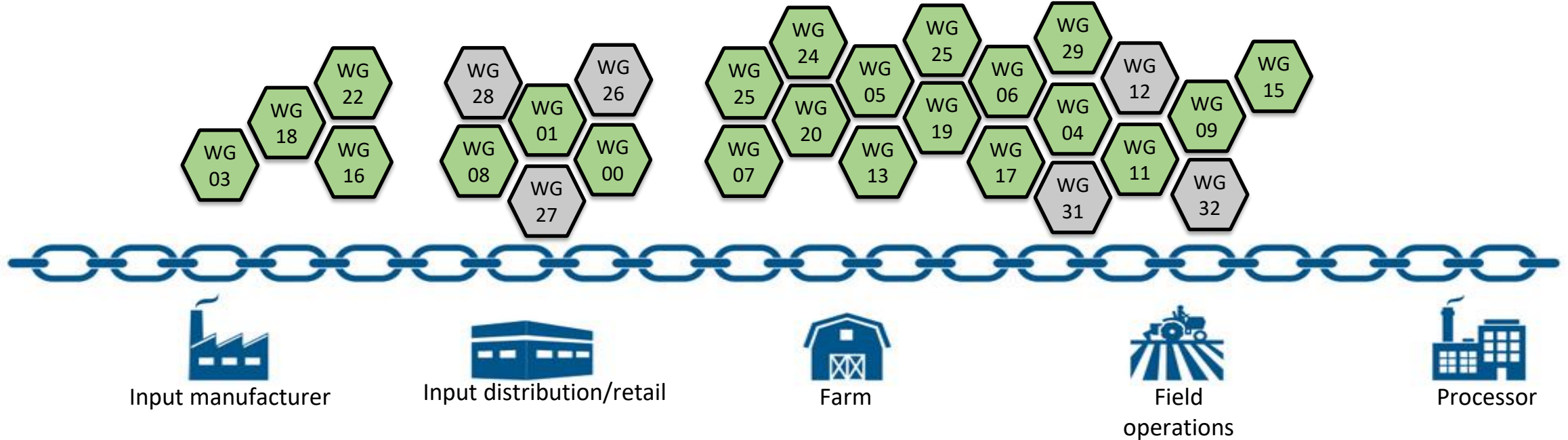
VALENT<sup>®</sup>

Arysta  
LifeScience

CFIndustries<sup>®</sup>



# Active & Completed Working Groups



- WG00 Agrisemantics PoC
- WG01 In-Field Product ID Seeding Pilot
- WG03 Product Catalog
- WG04 Ag Lab Data (Modus)
- WG05 Mix Ticket (dispensing Work Order/Record)
- WG06 Farm Inputs: Reference Data
- WG07 Farm Inputs: Work Order, Work Record
- WG08 In-Field Product ID ADAPT Plugin
- WG09 Linked Data (DatasetMetadata)

- WG11 LATAM Soil Data
- WG12 PAIL irrigation, Obs. & Meas. (ISO 7673)
- WG13 Closed Loop Spray
- WG15 Scale Ticket
- WG16 Crop Protection Product Guidelines
- WG17 Field Boundaries: Terms & Definitions
- WG18 Crop Nutrition 3<sup>rd</sup> Party Product Management
- WG19 ADAPT Serialization
- WG20 Traceability API

- WG22 Booking & Prepay Reporting
- WG24 Field Boundary: GNSS Accuracy
- WG25 Dairy Feed Data Standards Assessment
- WG26 Data Ethics and Stewardship
- WG27 Entity Identification Rules
- WG28 Modus: Plant Tissue Methods
- WG29 Dealer Lookup
- WG31 Field Operations Controlled Vocabulary
- WG32 Crop Protection Work Record Exchange

# Standards and AI

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# AI in Agriculture

You are  
here

## Gartner Hype Cycle

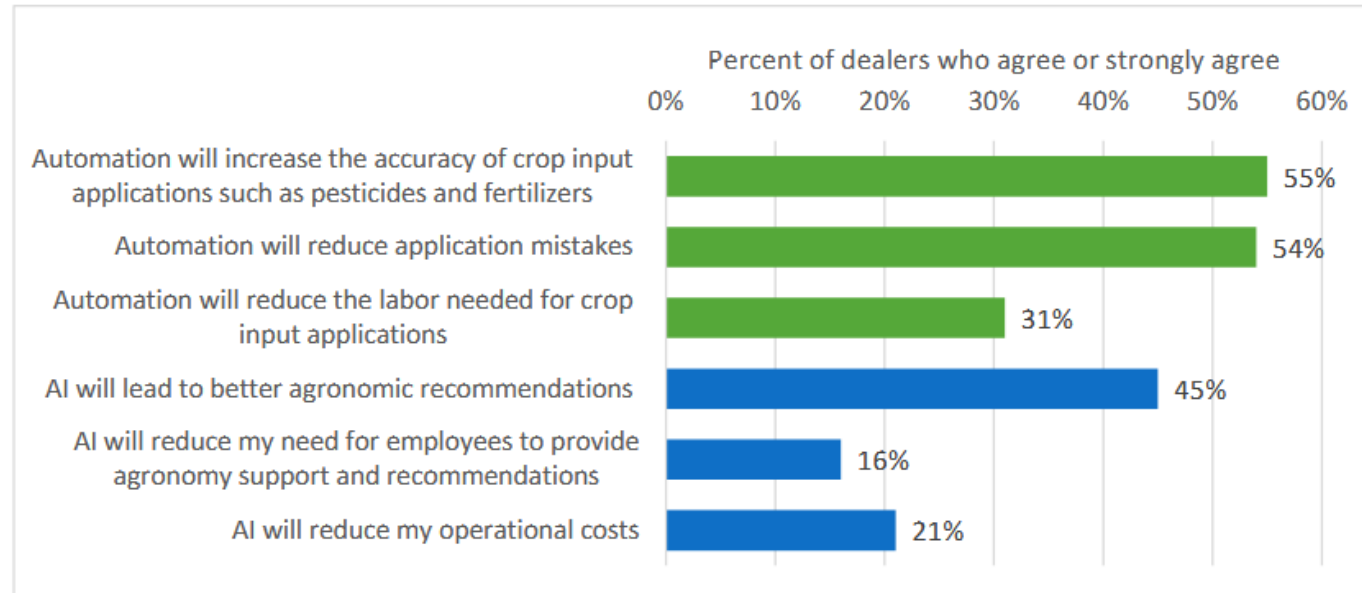
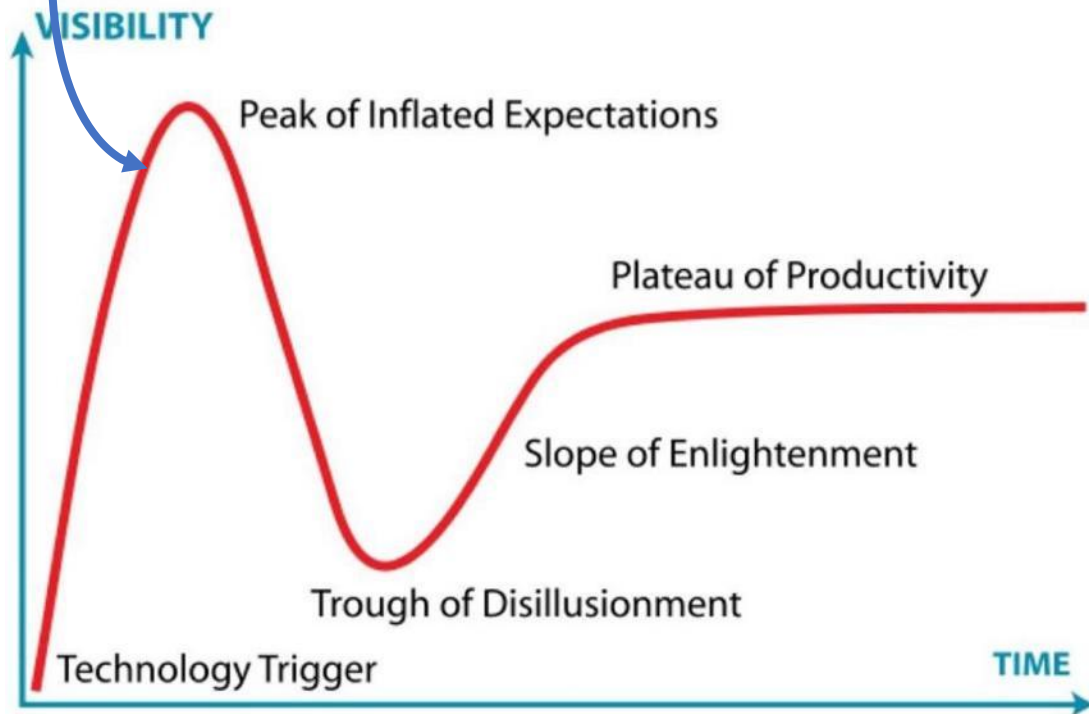
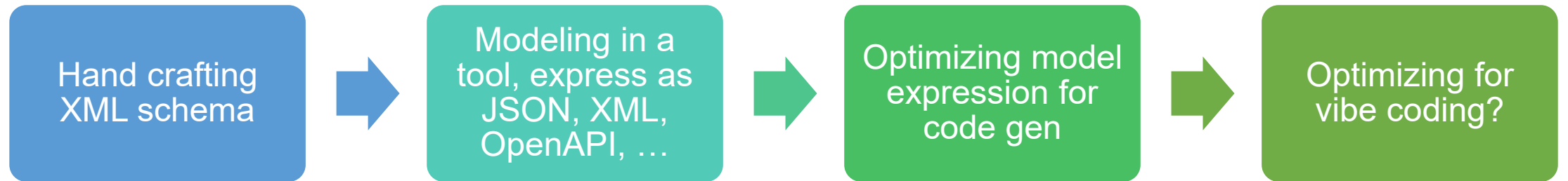


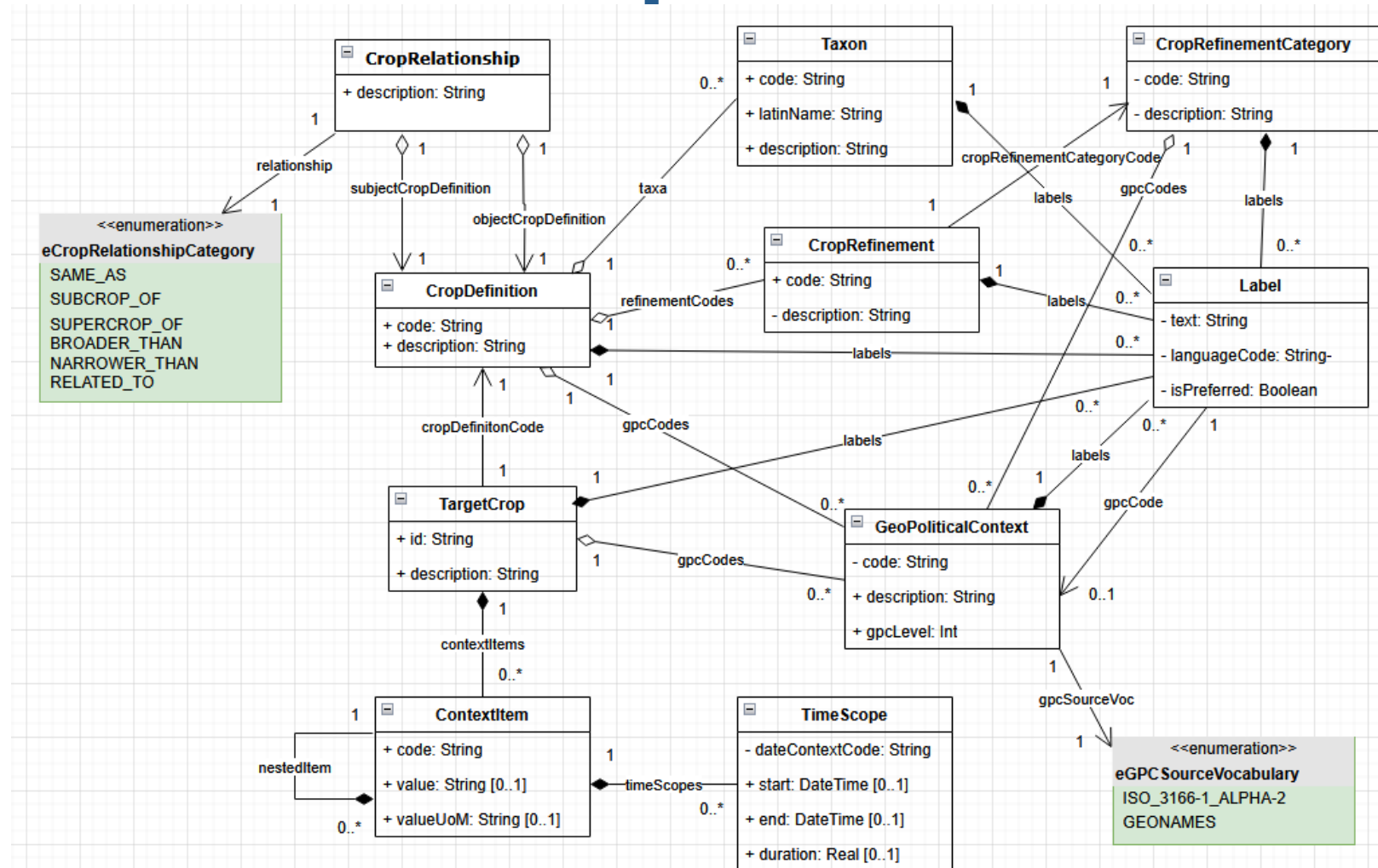
Figure 13, from 2024: Dealer attitudes about automation (green bars) and artificial intelligence (blue bars).

# Schema Development Changes





# Semantics – Crop Definition Example



# Ontologies

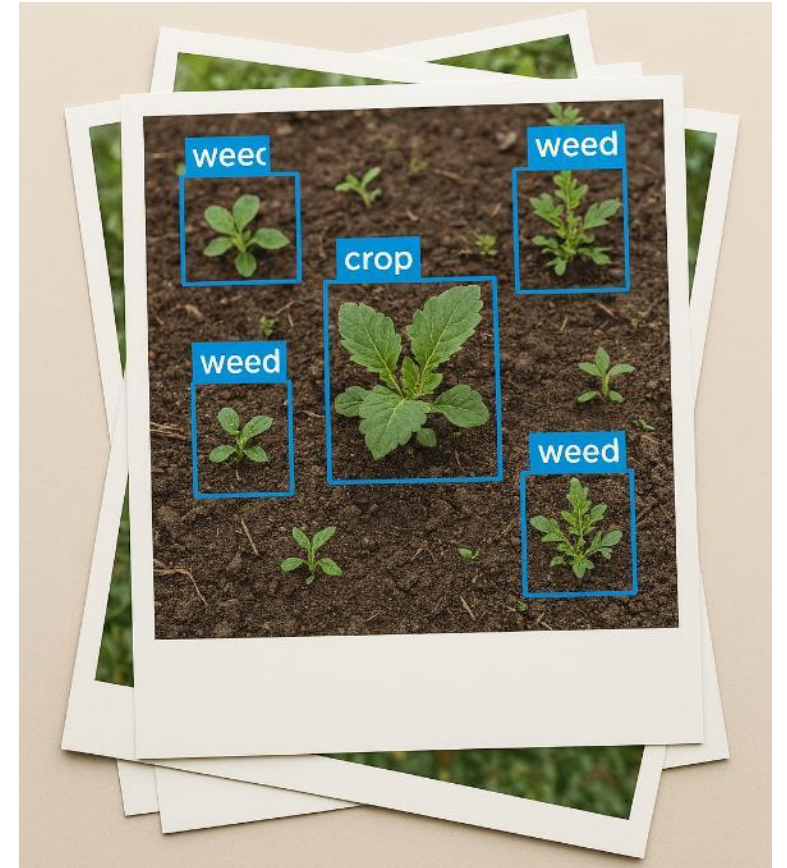
- Almost a bad word a few years ago – to academic to have practical applications
- Now comes up in conversations regularly
- Next ?

The screenshot displays the Protégé ontology editor interface. The top navigation bar includes tabs for 'Active ontology', 'Entities', 'Individuals by class', and 'DL Query'. Below this, a horizontal menu shows 'Classes', 'Object properties', 'Data properties', 'Annotation properties', 'Datatypes', and 'Individuals'. The 'Classes' tab is active, showing a 'Class hierarchy: entity' tree. The tree starts with 'owl:Thing' and branches into 'entity' (highlighted), 'continuant', and 'occurrent'. 'entity' further branches into 'generically dependent continuant', 'independent continuant', 'immaterial entity', 'material entity', 'specifically dependent continuant', 'quality', and 'realizable entity'. 'occurrent' branches into 'process', 'history', 'process profile', 'process boundary', 'spatiotemporal region', 'temporal region', 'one-dimensional temporal region', and 'zero-dimensional temporal region'. On the right, the 'Annotations' tab is selected for the 'entity' class. It shows several annotations: 'rdfs:label' with the value 'entity' (language: en), 'rdfs:isDefinedBy' with the URL 'http://purl.obolibrary.org/obo/bfo.owl', 'BFO CLIF specification label' with the value 'Entity', and 'BFO OWL specification label'. Below the annotations, a 'Description: entity' section lists various logical relationships with expandable icons: 'Equivalent To', 'SubClass Of', 'General class axioms', 'SubClass Of (Anonymous Ancestor)', 'Instances', 'Target for Key', 'Disjoint With', and 'Disjoint Union Of'.



# WG Proposal: Imagery Annotation

- Standardized basic set of metadata tags
- Make imagery/video training datasets interoperable
- Weed recognition algorithms primary use case



# Data Ethics

## Data Ethics White Paper

*"The rapid advancement of data-driven technologies in agriculture offers immense potential to enhance productivity, sustainability, and economic resilience. However, this increasing reliance on data also brings ethical, legal, and stewardship challenges that must be addressed to ensure responsible use and equitable benefits for all stakeholders. The Data Ethics White Paper explores key principles of data ethics and stewardship within agriculture, emphasizing the importance of privacy, ownership, transparency, fairness, and responsible governance in agricultural data management."*

The above passage is from the introduction to **AgGateway's Data Ethics and Stewardship White Paper**; a long-standing document that underwent an extensive review and revision over nearly two years and is now complete. We're excited and proud of the work and commitment of volunteer members and staff to update and improve this document, and we are now sharing it with the agriculture community at large.

[CLICK HERE TO DOWNLOAD THE WHITE PAPER](#)

- New White Paper
- Not AI specific, but a major motivator

<https://aggateway.org/News/CommunicationsKit/DataEthicsWhitePaper.aspx>



# Questions?

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# Appendix

AgGateway resources

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# ADAPT Standard Principles

- **Data Transfer:** The purpose of the ADAPT Standard is to facilitate data transfer between systems.
- **Field-Centric:** The ADAPT Standard is a data representation for agricultural information centered on the field/production space.
- **No Flexibility in How to Model.** The ADAPT Standard seeks to avoid the data consumer needing to handle conditionality for multiple data producers.
- **Flexibility in What is Modeled.** The ADAPT Standard will allow serialization of subsets of the data model.
- **No Software Dependencies.** The ADAPT Standard is an open format and not platform dependent. All data authorization, encryption, etc. is external to the standard itself.
- **Burden on Data Producer:** It presumes that the data producer has sufficient interest in the consumer being able to correctly interpret the data to put forward the effort to accurately transform data into the model.

# ADAPT Resources

Resource	Location
ADAPT Homepage	<a href="https://AdaptFramework.org">https://AdaptFramework.org</a>
ADAPT Standard Homepage	<a href="https://AdaptStandard.org">https://AdaptStandard.org</a>
ADAPT Framework Repo	<a href="https://github.com/ADAPT/ADAPT">https://github.com/ADAPT/ADAPT</a>
ADAPT ISO Plugin Repo	<a href="https://github.com/ADAPT/ISOv4Plugin">https://github.com/ADAPT/ISOv4Plugin</a>
ADAPT Standard Plugin	<a href="https://github.com/adapt/StandardPlugin">https://github.com/adapt/StandardPlugin</a>
ADM (ADAPT Data Model) Plugin Repo	<a href="https://github.com/ADAPT/ADMPlugin">https://github.com/ADAPT/ADMPlugin</a>
ADAPT Visualizer Repo	<a href="https://github.com/ADAPT/ADAPT-Visualizer">https://github.com/ADAPT/ADAPT-Visualizer</a>
ADAPT Standard Issue Board	<a href="https://github.com/ADAPT/Standard/projects/1">https://github.com/ADAPT/Standard/projects/1</a>
ADAPT NuGet Packages	<a href="https://www.nuget.org/profiles/AgGateway">https://www.nuget.org/profiles/AgGateway</a>



# Where to find Completed WG Digital Resources

WG/Resource	Location
WG01 In-Field Product ID Seeding Pilot(ShippedItemInstance)	Private GitHub Repo (AgGateway members only) <a href="https://github.com/AgGateway/In-FieldProductID">https://github.com/AgGateway/In-FieldProductID</a>
WG03 Product Catalog	Private GitHub Repo (AgGateway members only) <a href="https://github.com/AgGateway/ProductCatalog">https://github.com/AgGateway/ProductCatalog</a>
WG04 Ag Lab Data (Modus) WG11 LATAM Soil Testing Data	Public GitHub repo <a href="https://ModusStandard.org">https://ModusStandard.org</a> , <a href="https://github.com/AgGateway/Modus">https://github.com/AgGateway/Modus</a>
WG05 Mix Ticket	Public GitHub Repo <a href="https://github.com/AgGateway/Dispensing">https://github.com/AgGateway/Dispensing</a>
WG06 Farm Inputs: Reference Data	AgGateway Confluence (Wiki) <a href="https://aggateway.atlassian.net/l/cp/zPjh3HqN">https://aggateway.atlassian.net/l/cp/zPjh3HqN</a>
WG07 Farm Inputs: Work Order, Work Record	AgGateway Confluence (Wiki) <a href="https://aggateway.atlassian.net/l/cp/oGiWwmD5">https://aggateway.atlassian.net/l/cp/oGiWwmD5</a>
WG08 In-Field Product ID ADAPT Plugin	Public GitHub Repo <a href="https://github.com/ADAPT/ShippedItemInstancePlugin">https://github.com/ADAPT/ShippedItemInstancePlugin</a>
WG09 Linked Data (DatasetMetadata)	Private GitHub Repo (AgGateway members only) <a href="https://github.com/AgGateway/DatasetMetadata">https://github.com/AgGateway/DatasetMetadata</a>

# Where to find Completed WG Digital Resources

WG/Resource	Location
WG13 Closed Loop Spray	AgGateway Confluence (Wiki)
WG15 Scale Ticket	Private GitHub Repo (AgGateway members only) <a href="https://github.com/AgGateway/ScaleTicket">https://github.com/AgGateway/ScaleTicket</a>
WG16 Crop Protection Product Guidelines	Wiki pages, publication in process
WG17 Field Boundaries: Terms and Definitions	Added ADAPT Standard <a href="https://github.com/ADAPT/Standard/issues/97">https://github.com/ADAPT/Standard/issues/97</a>
WG18 Crop Nutrition 3 <sup>rd</sup> Party Product Management	XSLM file
WG19 ADAPT Serialization	Implemented in ADAPT Standard <a href="https://ADAPTStandard.org">https://ADAPTStandard.org</a> , <a href="https://github.com/ADAPT/Standard">https://github.com/ADAPT/Standard</a>
WG20 Traceability API	Public GitHub Repo <a href="https://github.com/AgGateway/TraceabilityAPI">https://github.com/AgGateway/TraceabilityAPI</a>
WG22 Booking & Prepay Reporting	Implemented in Ag eStandards <a href="https://www.aggateway.org/GetConnected/Messaging.aspx">https://www.aggateway.org/GetConnected/Messaging.aspx</a>