IMPROVING DECISION SUPPORT SYSTEMS WITH MACHINE LEARNING:

IDENTIFYING BARRIERS TO ADOPTION

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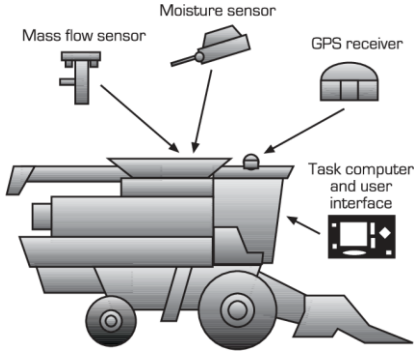
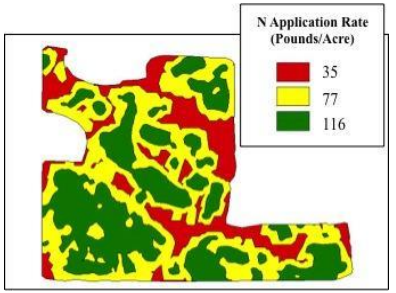
Precision Agriculture Solves Many Challenges

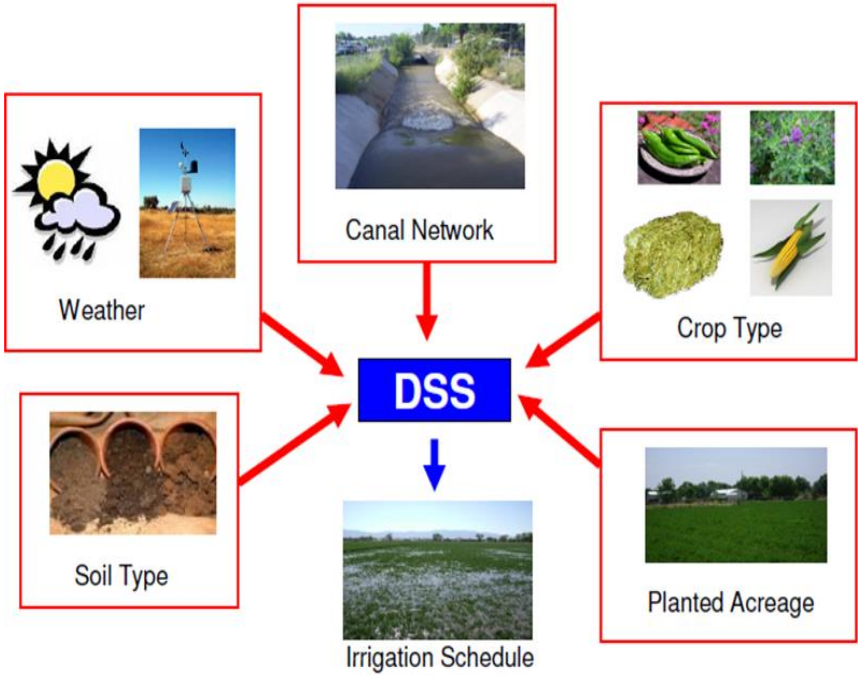
- UAVs can characterize a field to identify crop health stressors before yield/economic loss occurs

- The integration of sensors into harvesters provides precise yield data in which to make well-informed management decisions and yield goals



- The use of Variable Rate Fertilizer Technologies reduce cost of input and increase resource use efficiency



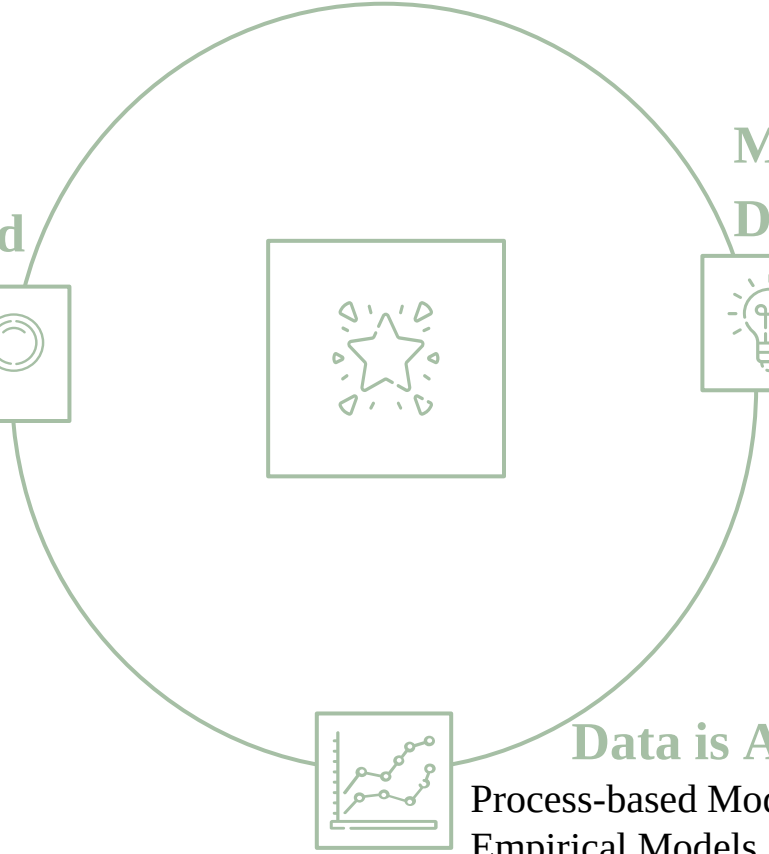


Decision Support Systems

Integrates collected data with modeling to produce actionable decisions

doi: 10.5772/16877

How DSSs Generally Work within Precision Ag



Data is Collected

Yield Monitor
UAV
Satellite imagery
Ground based Sensors

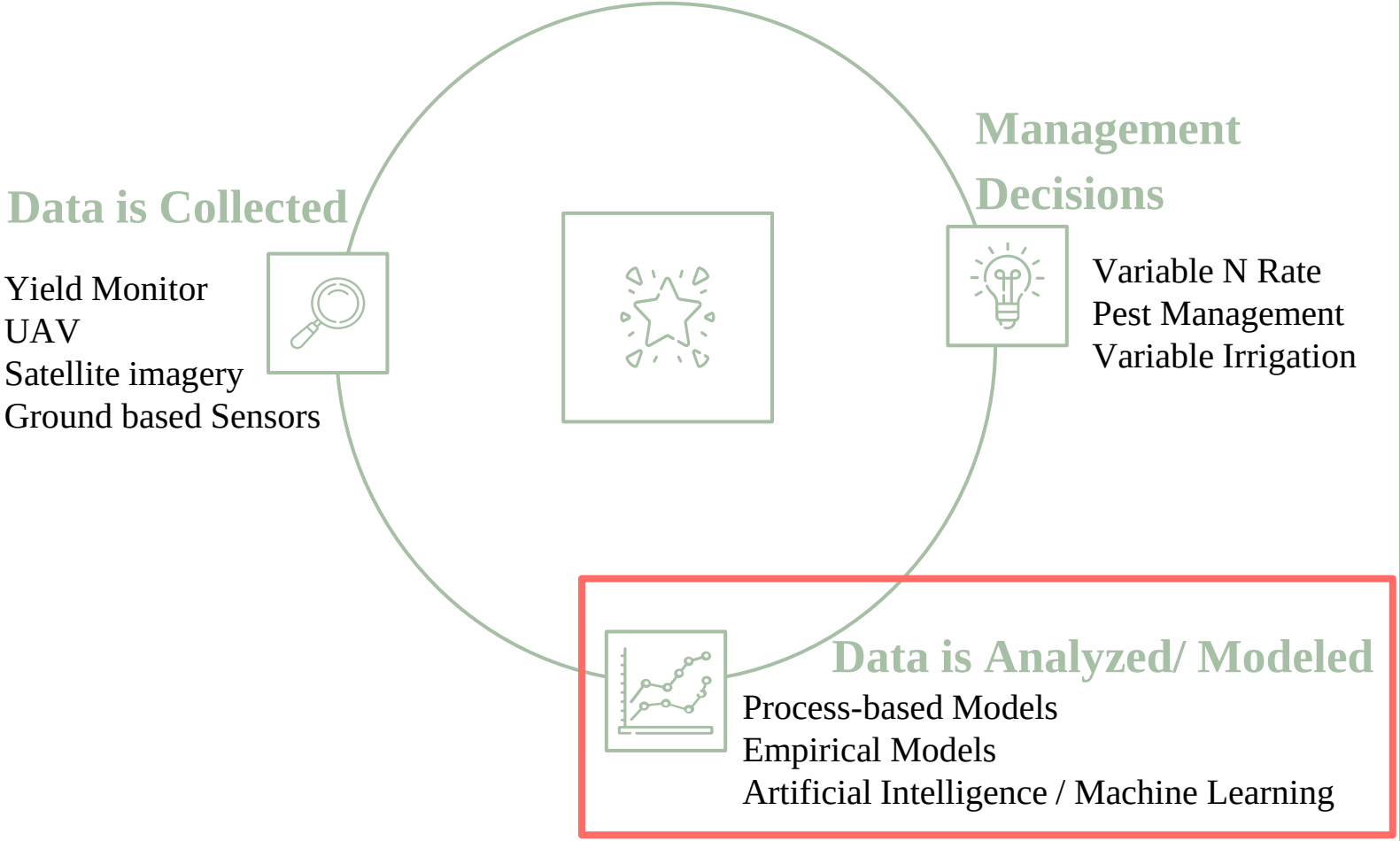
Management Decisions

Variable N Rate
Pest Management
Variable Irrigation

Data is Analyzed/ Modeled

Process-based Models
Empirical Models
Artificial Intelligence / Machine Learning

How DSSs Generally Work within Precision Ag



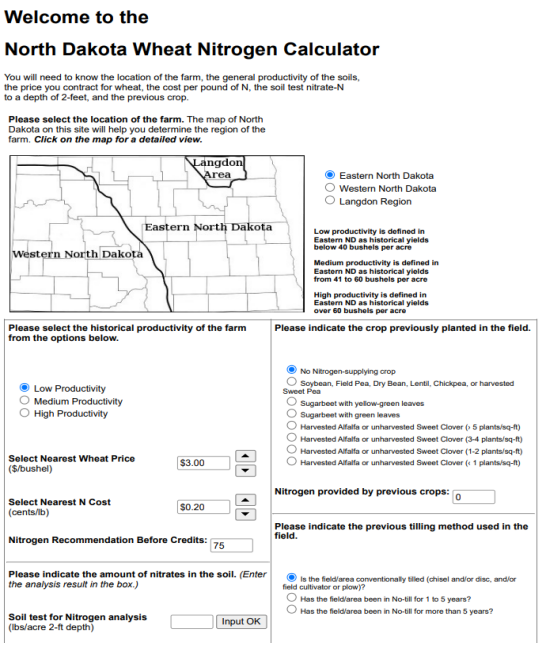
Modeling and Data Analysis to Make Decisions

Process - Based

- Chemical, physical, or biological process
- (Yield Goal x 1)-N credits= N Rate

Empirical Model

- Statistical model based on observations among variables

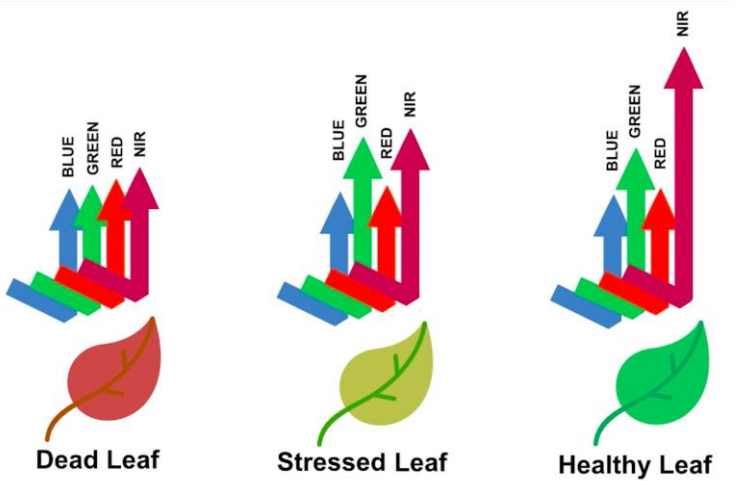


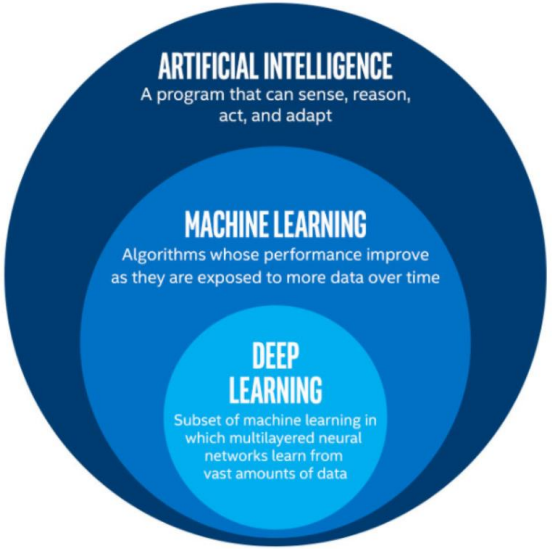
Machine Learning

- AI vs ML vs DL

- ML the model will identify new and complex patterns to update itself without human intervention (no feature selection required)

- Example: Vegetative indices to predict yield





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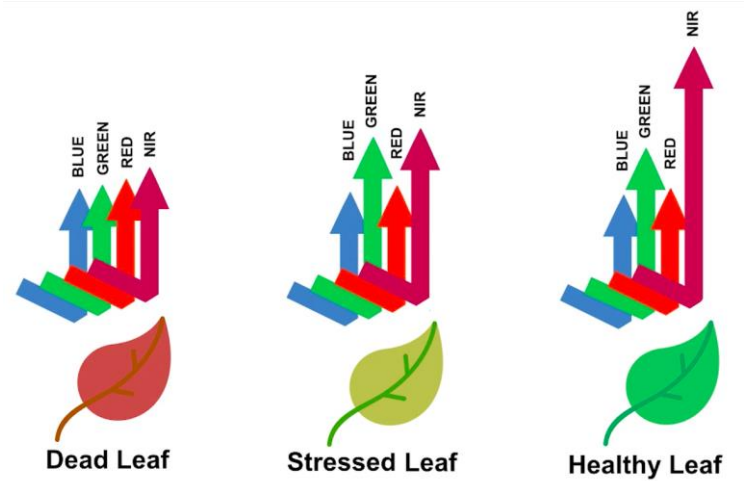
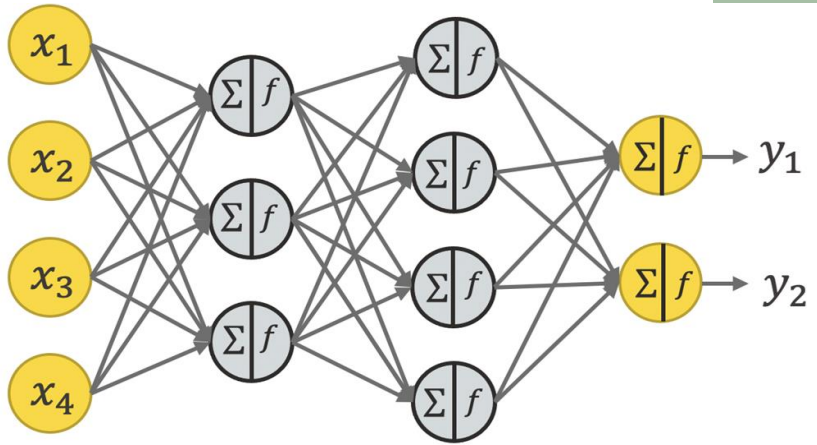
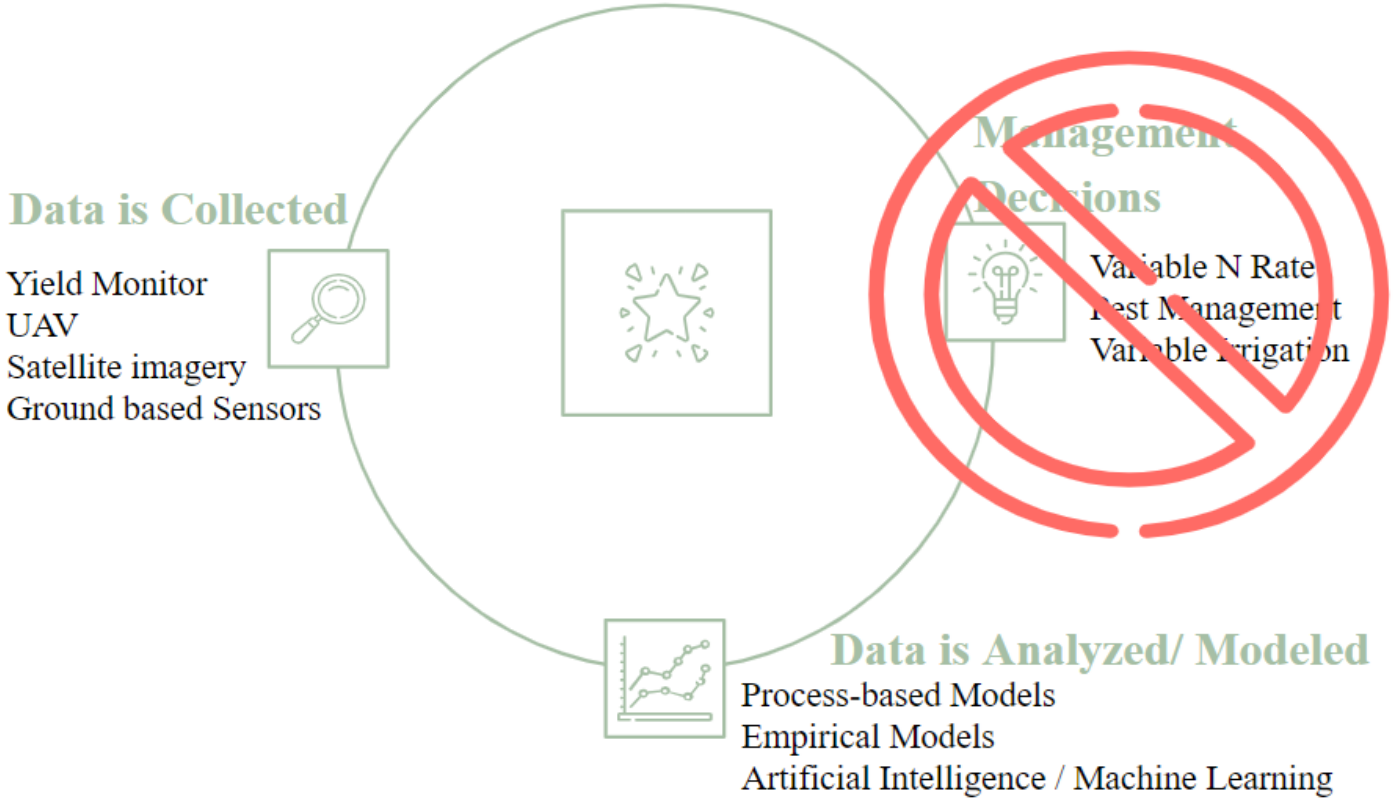




Barriers to Adoption of these Management Tools



Barriers to Adoption of these Management Tools

- Some Precision Ag Technologies are more prevalent than others suggesting there are barriers to the adoption of some of these tools

More Yield Monitors

Less Variable Rate Technology

Barriers Identified Through Survey

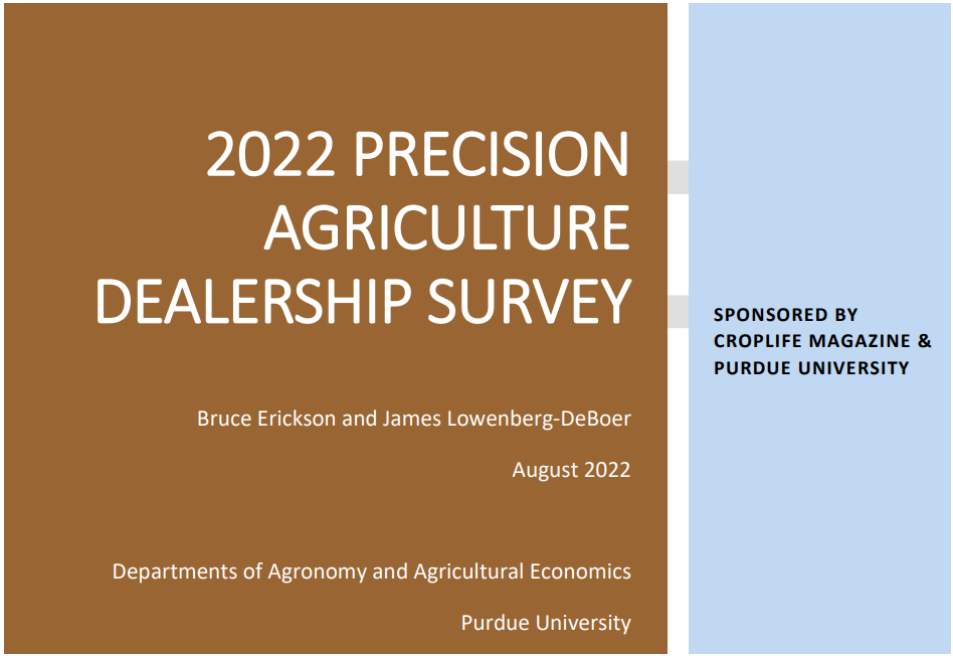
Agricultural retailers have been surveyed about producer attitudes every other year since the mid-1990s to give insights (Erickson & Lowenberg-Deboer, 2022)

#1 Economic Limitations

#2 Trust Concerns

#3 Data Privacy

#4 Workforce Availability



https://ag.purdue.edu/digitalag/_media/ croplife-report-2022.pdf

Financial Barrier

Financial Barriers

Crop prices have been observed to dictate how much of a barrier

Return on Investment

Smaller farms have a more difficult time making a return on investment which deters farmers from taking these economic chances

Ashworth et al., (2018) discussed that the cost of the equipment per hectare decreases with increasing farm size

Two Farmers Want to Use Variable Rate Application

Farmer 1:

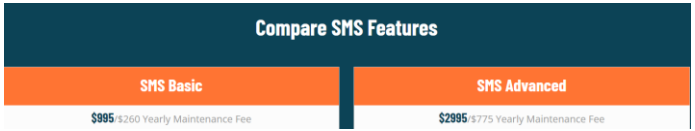
Farm size: 100 ha

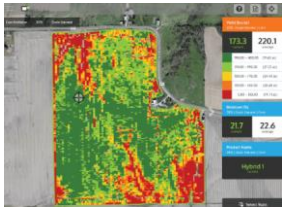
Farmer 2:

Farm size: 1000 ha

Two Farmers Want to Use Variable Rate Application

Mapping Software: $3,000





Applicator: $100,000

Total: $103,000

Farmer 1:

Farm size: 100 ha

Cost /ha : $1,030

Farmer 2:

Farm size: 1000 ha

Cost /ha : $103

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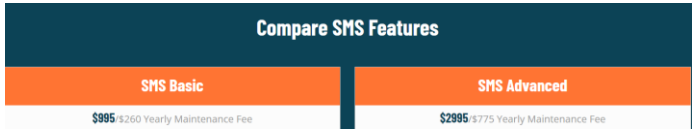

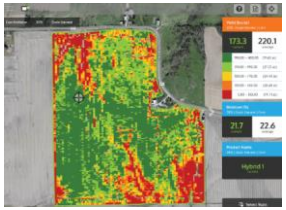

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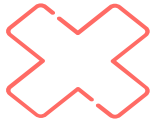


Farmer 2:

Farm size: 1000 ha

Cost /ha : $103

Considerations: Potential Solutions

Collecting data (yield, soil, remote sensing imagery, etc) will provide **no economic impact until a decision is made** that drives an increase in revenue.

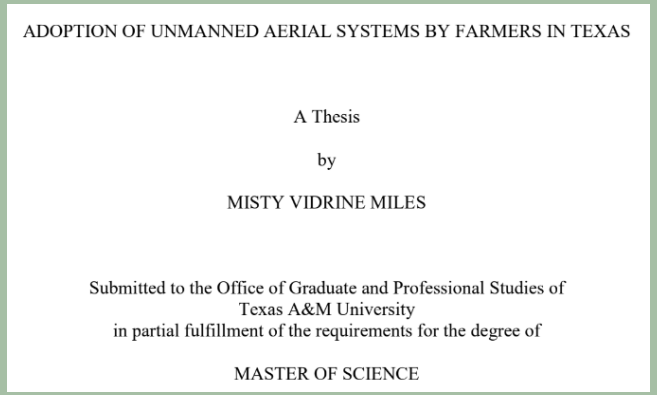
- Studies have observed significant advantages in which PA does save 20-30% in input costs (Winstead & Fulton, 2010)
- A farmer with 100 ha may not use PA technology the same way as one with 1,000 ha.
- University extensions can guide you to the right farm technology.

Industry-Driven Solutions

- Industry paying farmers and creating a market for crops produced with PA technology

Trust Concerns

Farmer Opinions on UAVs (Miles, 2019)



ADOPTION OF UNMANNED AERIAL SYSTEMS BY FARMERS IN TEXAS

A Thesis

by

MISTY VIDRINE MILES

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

High-Tech Enthusiasts: Embrace UAVs for advanced data and innovation.

Purposeful/Selective Users: Value UAVs but use them strategically.

Conventional/Selective Skeptics: Prefer traditional methods, showing cautious adoption.

Key Takeaway:

Trust and Expectations: Varying levels of trust in technology influence adoption, driven by differing expectations of UAV benefits.

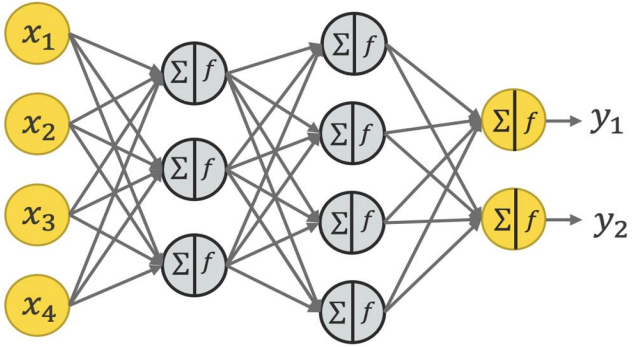
Sticking Points for DSS in Agriculture

#1 Model Explainability/Communication

#2 Clear Decision-Making Responsibility

#3 Fairness in Model Development

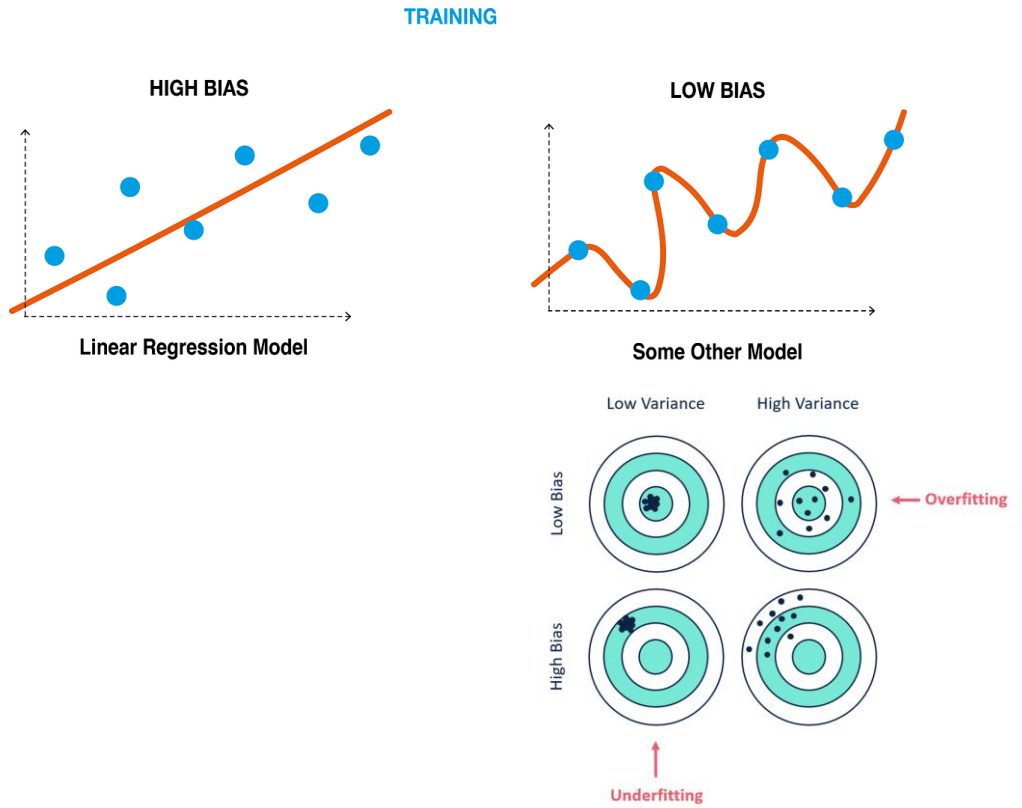
Deep Learning Model



DOI: https://doi.org/10.1002/agj2.21432

Bias from Training Models with Large Farm Data

- A lack of small farm data could create a data bias for future PA tools using ML and AI models



Examples of Cultivating Trust

- Building a tool that is not just easy to use but also **useful**
  - Vite.net: Vineyard Management using in field sensors
    - Identified specific issues for vineyards
    - Convey information easily and clearly
  - Pigs2Win: Swine Production DSS
    - Worked closely with farmers during design process, used excel, became familiar quickly

Data Ownership/ Privacy

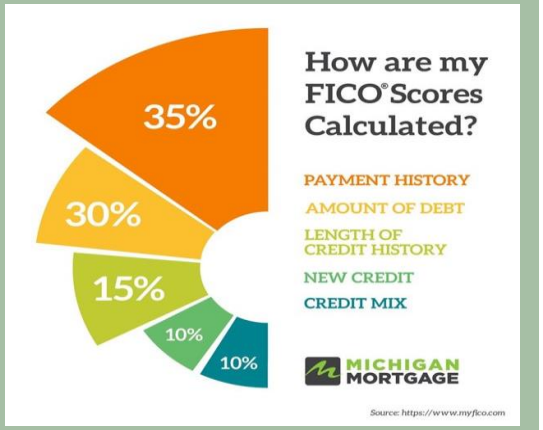
Legal Issues with Data

- Bushel of corn is **tangible** and **excludable**

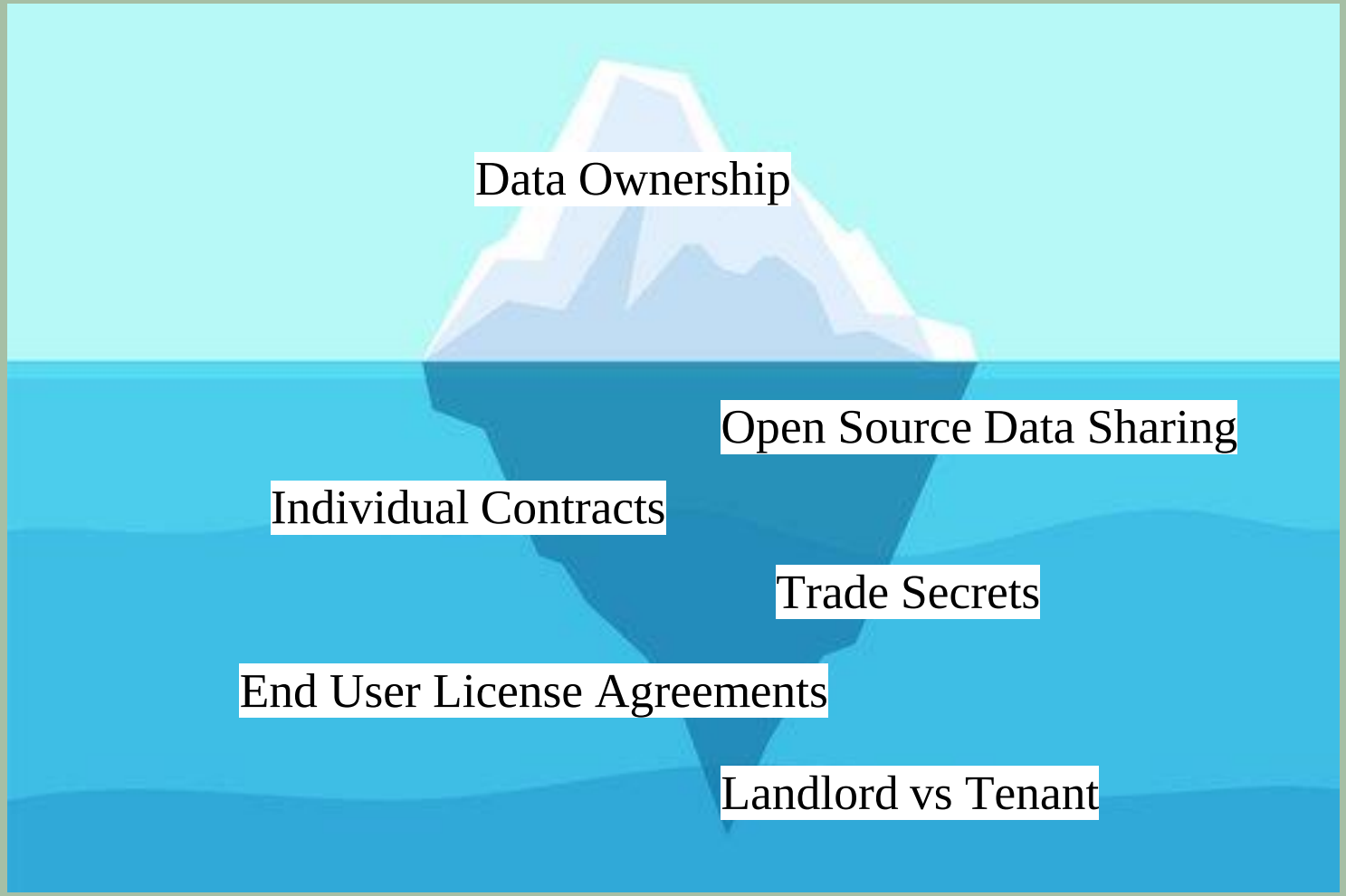
- Farm Data:

  Not Tangible

  Not Excludable



- Data ownership is similar to a credit score
- Who is profiting and what are they doing with it?
- ML motivates third parties to acquire and aggregate data


Data Ownership
Open Source Data Sharing
Individual Contracts
Trade Secrets
End User License Agreements
Landlord vs Tenant

Ag Data Transparent Certified Companies

https://www.agdatatransparent.com/

Leaf
Unified API for Agriculture

Ambrook, Inc.
Ambrook

AG Growth International
Ag Growth International

The Farmer's Business Network, Inc.
Farmers Business Network

EFC Systems by Ever.Ag
FieldAlytics

GiSC
Growers Information Services Cooperative

LogiAg
LogiAg System

Agi3 Ltd.
Agi3 Ltd.

Aleop Solution Inc.
Solution Aleop Inc.

Ecosystem Services Market Consortium
Eco-Harvest by ESMC

Combyne Ag
Combyne

Sollio Agriculture
AGCONNEXION

AgSights
bioTrack Plus

Carbon by Indigo
Carbon by Indigo

Beck's
FARMserver

Digital Grain Elevator
FOB Ag Logistics Platform

Ever.Ag Corporation
My Dairy Dashboard

Metos Canada Inc.
FieldClimate

John Deere
John Deere Operations Center

Simplot
Simplot Grower Solutions

Prospera
365, Insights, Scheduling, AgSense, Variable Rate Irrigation

Palliser Insurance Co. Ltd.
Palliser Direct Ltd.

FarmLink Marketing Solutions
GrainFox

CarbonTerra
CarbonTerra

The Climate Corporation
FieldView

Global Ag Risk Solutions
Global Ag Risk Solutions

Conservis LLC
Farm Management Software

GROWMARK
FS Advanced Information Services

Traction
Traction Ag Farm Management Software

Farm Credit Canada / Financement agricole Canada

WorkForce Availability

Knowledge, Skills, and Abilities in Precision Ag

- Long-term adoption requires skilled labor that is proficient in PA

  A 2015 survey (Erickson et al., 2018) Knowledge, skills, and abilities in the precision agriculture workforce

- Employees in PA meets or exceed education expectations

  - However -

  There is a shortage of employees capable of practical field applied skills:

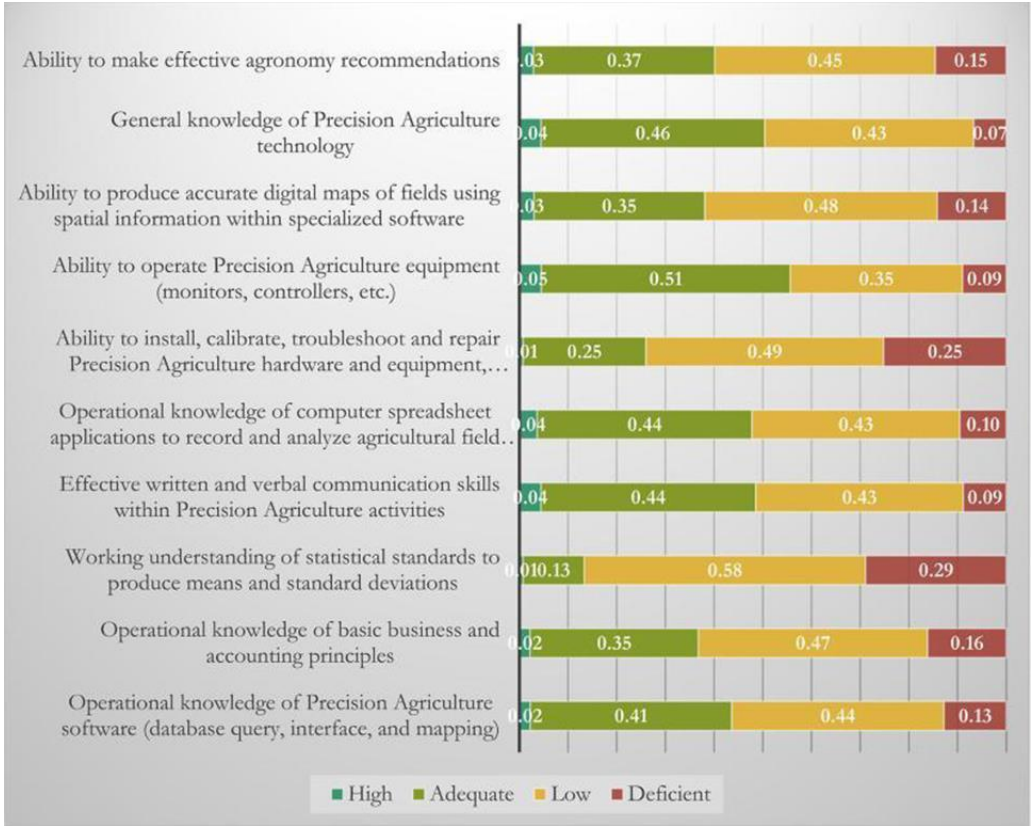
  Data-intensive thinking

  Understanding Statistical Standards

  Effectively design field trials for data

https://doi.org/10. 4195/nse2018.04.0010

Knowledge, Skills, and Abilities in Precision Ag



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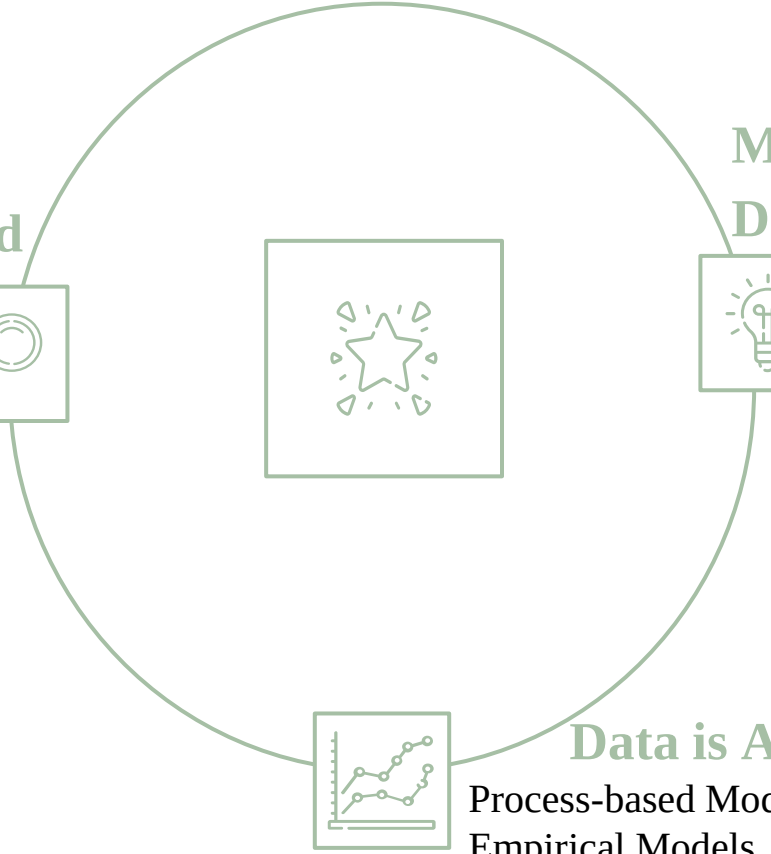
- Great Plains IDEA
    - Interactive Distance Education Alliance (IDEA) offers fully online programs and coursework
- Ag IDEA
    - A Tri-Societies affiliate offering courses in agriculture disciplines to close the gap in knowledge
- Offering Precision Agriculture Majors and Minors at Land Grant Universities
    - I encourage you to seek out classes involving: agriculture machinery and management, agronomy, and **data science**

Lowering Barriers Will Push Precision Ag Progress Forward



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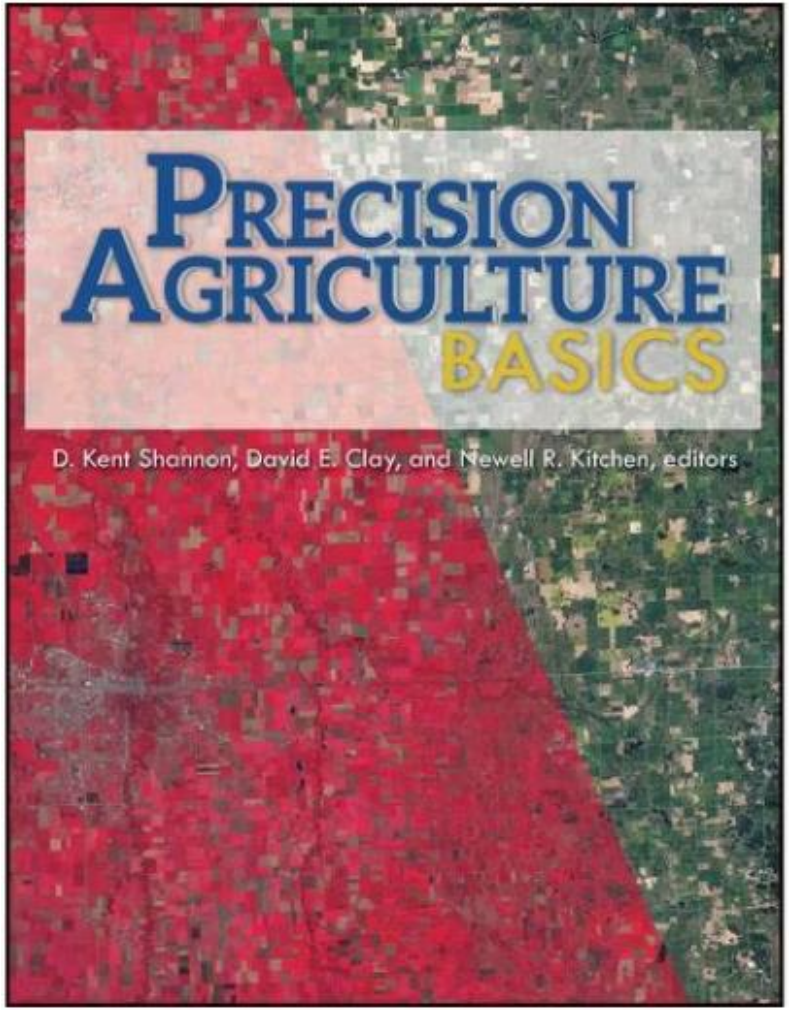

- Revision of PA Basics Book
- We are looking for students to review the updated and new chapters
- Certificate from ASA-CSA-SSSA to put on your resume

Questions?

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Office: Raven 105, please stop by anytime!