Smart Agriculture

The Needs, Challenges & Approaches

Qin Zhang
Washington State University

The Need of Agriculture

4-F,
bottom-line: provide human being the food needed for surviving!

A Few Examples of Agriculture

Cultivated Agriculture (Ag 1.0)

The Goal:

Produce sufficient food to feed human being.

The Approach:

- More farming land
- Better seeds/varieties
- Crop rotation
- Fertilizing
- Weed/pest control

Examples of Traditional Farming

Mechanized Agriculture (Ag 2.0)

The Goal:

Produce more food with less labor required
- *higher productivity*

The Approach:

- Mechanical & electrical power
- Mechanization (use of machines)
- Chemical fertilization & pest controls
- Irrigation
- Automation

Progress of Agricultural Mechanization

Precision Agriculture (Ag 3.0)

The Goal:

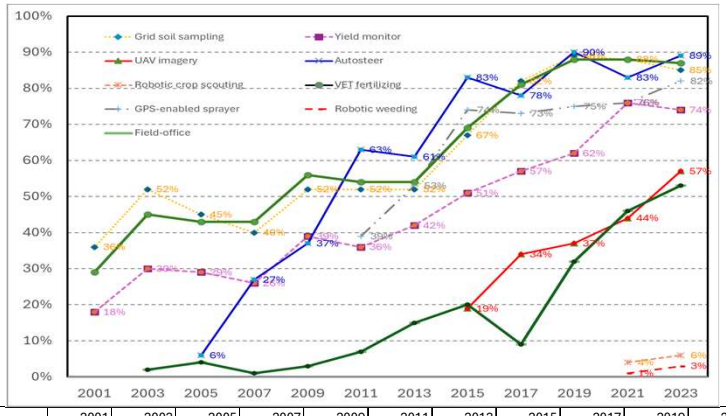
Productively produce more food with less resources
- *higher sustainability*

The Approach:

- Growth condition awareness
- Site-specific management & Prescription
- Variable rate applications
- Precise implementation

Examples of Precise Implementation

Farmer Adoption of PA Tech (USA)



	2001	2003	2005	2007	2009	2011	2013	2015	2017	2019	2021	2023
Grid soil sampling	36%	52%	45%	40%	52%	52%	52%	67%	82%	89%	88%	85%
Yield monitor	18%	30%	29%	26%	39%	36%	42%	51%	57%	62%	76%	74%
UAV imagery								19%	34%	37%	44%	57%
Autosteer			6%	27%	37%	63%	61%	83%	78%	90%	83%	89%
Robotic crop scouting											4%	6%
VET fertilizing	29%	45%	43%	43%	56%	54%	54%	69%	81%	88%	88%	87%
GPS-enabled sprayer						39%	53%	74%	73%	75%	76%	82%
Robotic weeding											1%	3%
Field-office		2%	4%	1%	3%	7%	15%	20%	9%	32%	46%	53%

Data Source: Erickson et al., 2023 (Purdue University)

Is It Enough?

Capable Equipment | **Precision Ag Technology** | **Service & Support**

Two Big Challenges

Millions of people in hunger, with a growing global population

About 1/3 of produces/foods being wasted

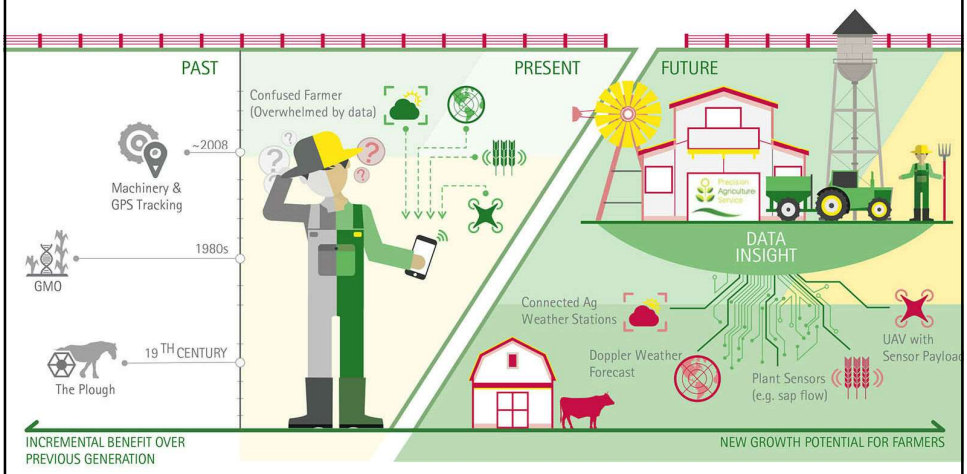
Farming Smartly Could Improve:

Harvesting right types of amount of produces to a market

Effectively reacting to varying farming condition for safe & efficient production

Adequate ways for safe & economic handling, storage & transporting

Evolute to Smart Agriculture



From old 4R to new 4R:

Right input, right amount, right place and right time for input management

→ Right consumer, right manner, right quality and right cost for output management

What is Smart Agriculture?

Produce sufficient food?

- That's the purpose of cultivated agriculture

Produce food effectively?

- That's the purpose of mechanized agriculture

Produce food sustainably?

- That's the purpose of precision agriculture

A New Age of an Old Industry

Evolute to Smart Agriculture (Ag 4.0)

The Goal:

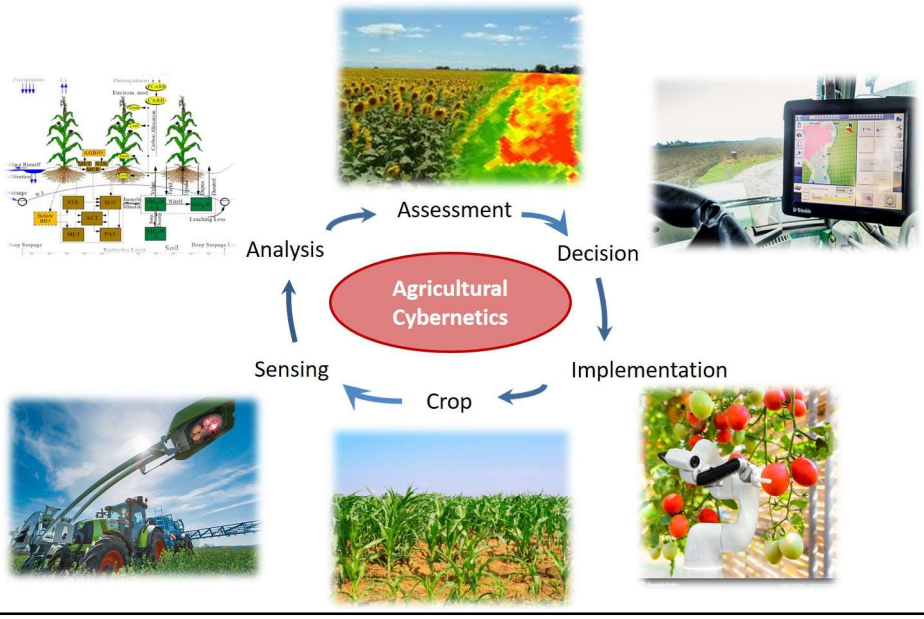
Sustainably produce differentiated quality food to meet the needs of different customers

- higher overall efficiency

The Approach:

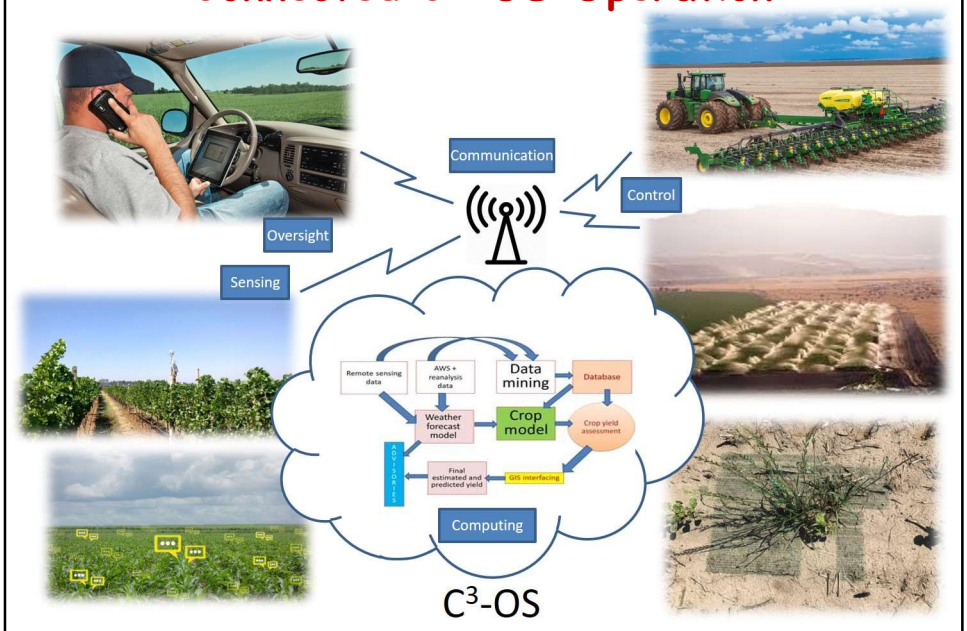
- System of agri-food systems
- Agricultural cybernetics
- Data-driven Ag-AI
- Customer-in-the-loop production

Cybernetics in Smart Agriculture



Data-Driven AI for Smart Farming

Connected C^3-OS Operation



Impact to Farming & Rural Community

New model of agriculture could bring changes in rural area by:

- Converting farmers to business managers
- Creating a new profession of high-tech/robotic farming services (a new high-pay job)
- Changing rural population demography
- Enriching rural economy
- Making rural area better place to live