Maximizing the Probability of New Technology Adoption Success

John K. Schueller
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1934 (!!!) World's Fair

John K. Schueller

- Professor of Mechanical and Aerospace Engineering
- Affiliate Professor of Agricultural and Biological Engineering
- Chair, Mechanical Engineering Program Committee
- Director, Center for Manufacturing Innovation

- Editor-in-Chief, *Computers and Electronics in Agriculture*
- Fellow, Society of Automotive Engineers
- Fellow, American Society of Agricultural and Biological Engineers
- Fellow, International Academy of Agricultural and Biosystems Engineering
- Honorary Vice-President, International Commission of Agricultural and Biosystems Engineering
- Founder Member, European Society of Agricultural Engineers
- Management Committee, Club of Bologna
- Life Member, Indian Society of Agricultural Engineers
- Senior Member, Society of Manufacturing Engineers
- Member, American Society of Mechanical Engineers
- Member, Institute of Electrical and Electronics Engineers
- Member, American Society for Engineering Education

Generalist with wide exposure

- **> 40 countries visited**
- **> 400 graduate student supervisory committees in ten majors**
- **Worked at universities in Indiana, Texas, Germany, Japan, and Malaysia**
- **Worked for small, medium, and large (Caterpillar) companies**
- **Gets about 50 magazines/month**

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- **Old**

Difficult to predict best technology adoptions

- **Which** technologies to adopt
- **What** characteristics and parameters they should have
- **Who** should supply them to you
- **Where** they will be appropriate
- **When** they will make sense

www.npr.org

Can make a rough division into two major categories

- **"Systems"** technologies
- **"Drop-In"** technologies

Great differences in …

- Complexity of evaluation
- Rate of adoption

CEMA
EUROPEAN AGRICULTURAL MACHINERY

Agriculture 4.0 – the Challenges Ahead & What to Do About Them

Can make a rough division into two major categories

Great differences in …

- Complexity of evaluation
- Rate of adoption

- Systems technologies --- adoption of a technology will have impacts throughout the system
- Drop-In technologies --- adoption of a technology will only impact where it is dropped

Classic Agricultural Systems Technology --- Replace Horses and Mules with Tractors

- It took over <u>forty</u> years to have the needed manufacturing, distribution, dealer, fuel, service, implements, training, etc., systems throughout the USA

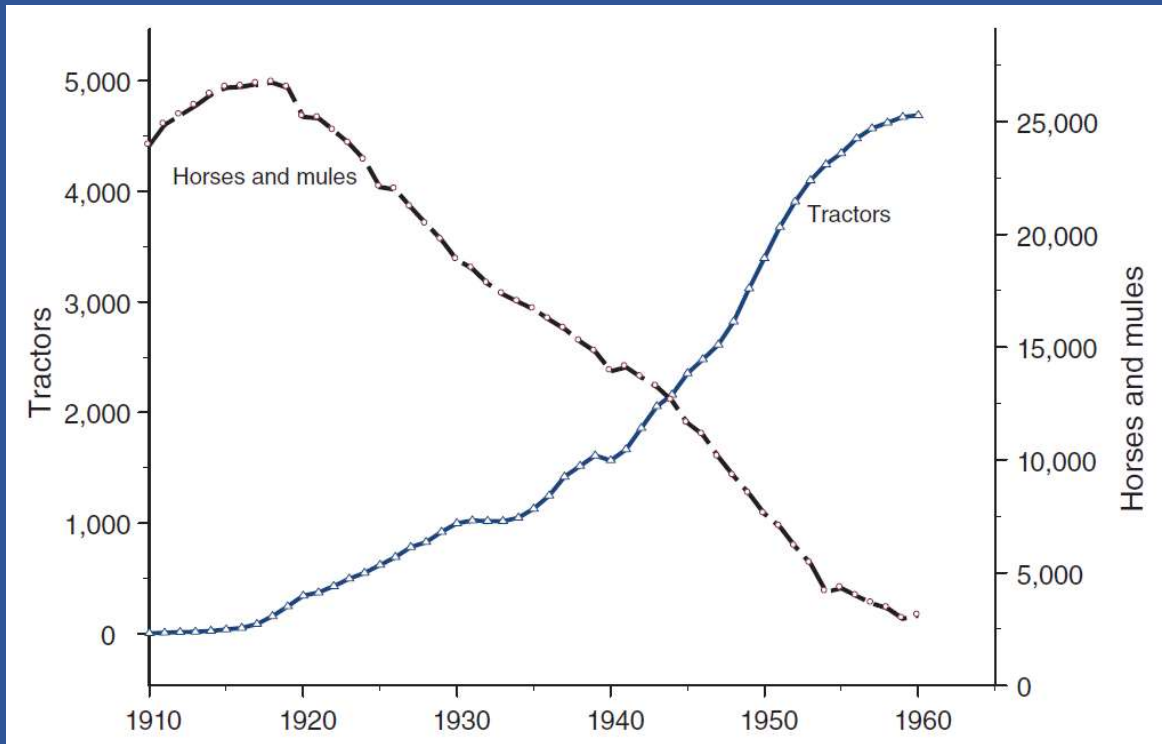


FIGURE 1. HORSES, MULES, AND TRACTORS IN FARMS: 1910–1960

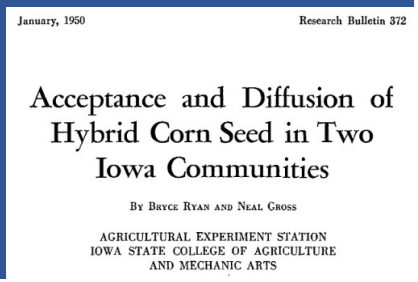
American Economic Review 2014, 104(4): 1368–1391

Classic Agricultural Drop-In Technology --- Hybrid Seed Corn

Note the rapid adoption because just put new seed into planter

Florida Example:
Sugar cane harvest: 30% mechanized in 1987
100% mechanized in 1993

(expedited by Simpson-Mazzoli Act)



January, 1950 Research Bulletin 372

Acceptance and Diffusion of Hybrid Corn Seed in Two Iowa Communities

By Bryce Ryan and Neal Gross

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

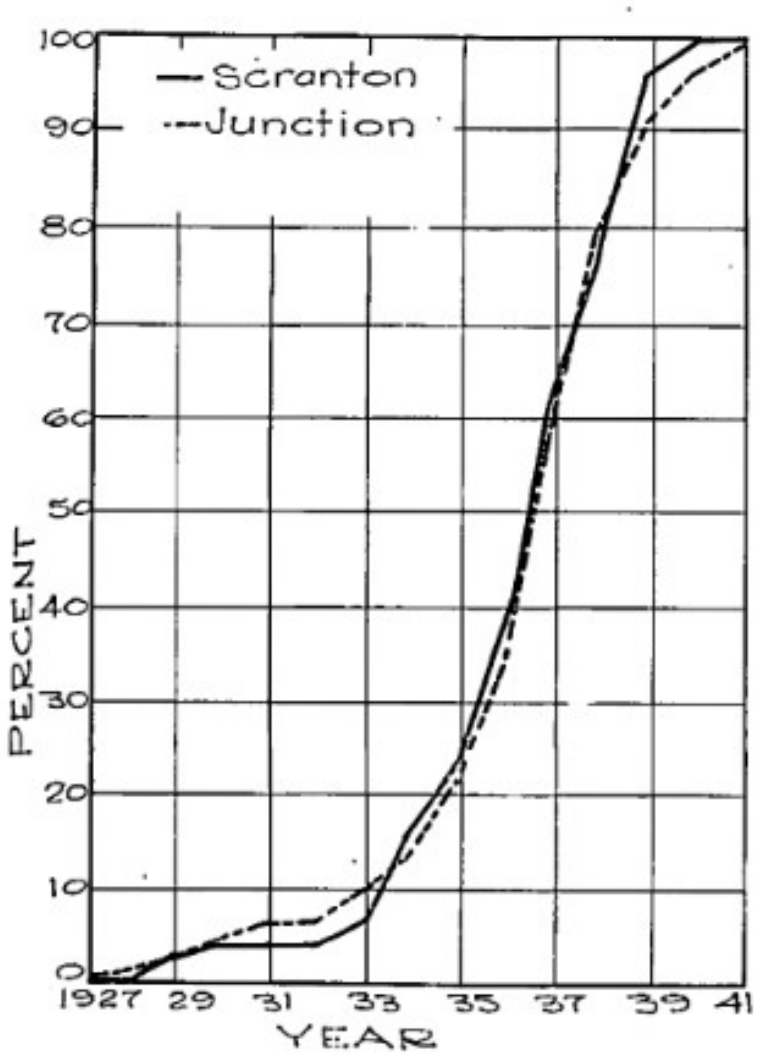


Fig. 1. Cumulative percentages of operators accepting hybrid seed in the two communities during each year of the diffusion process.

Contemporary Drop-In Technology --- GPS Steering

When buying a new tractor, it is easy to buy one with GPS steering

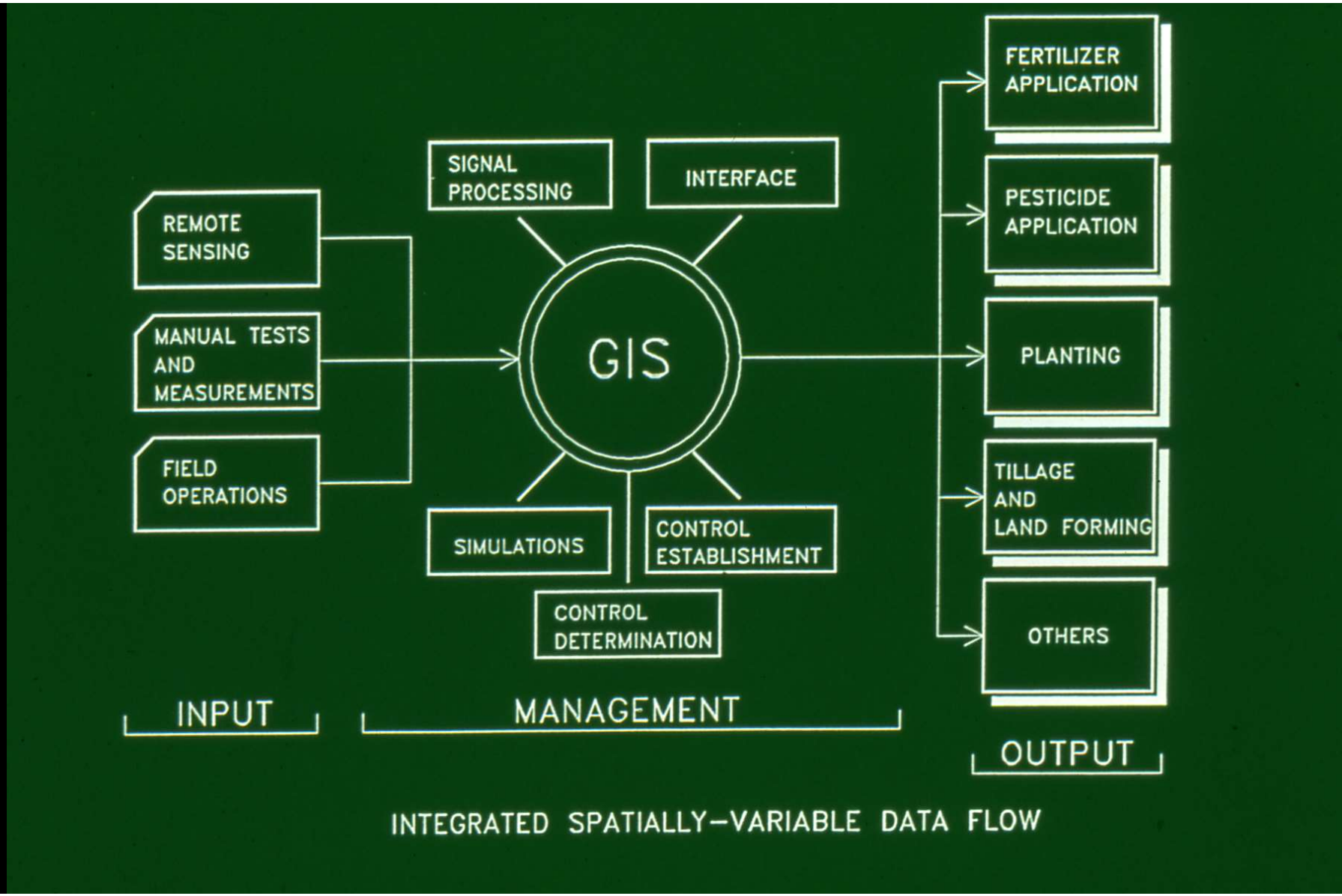
GPS STEERING THE FASTEST TECHNOLOGY ADOPTION IN HISTORY OF AGRICULTURE
May 5, 2008

American farmers have been very quick to adopt GPS steering technology over the past few years. According to a just-released industry study, GPS steering adoption rates may go down in history as the fastest ever. So concludes Caledonia Solutions, a business research and consulting firm in Minneapolis.

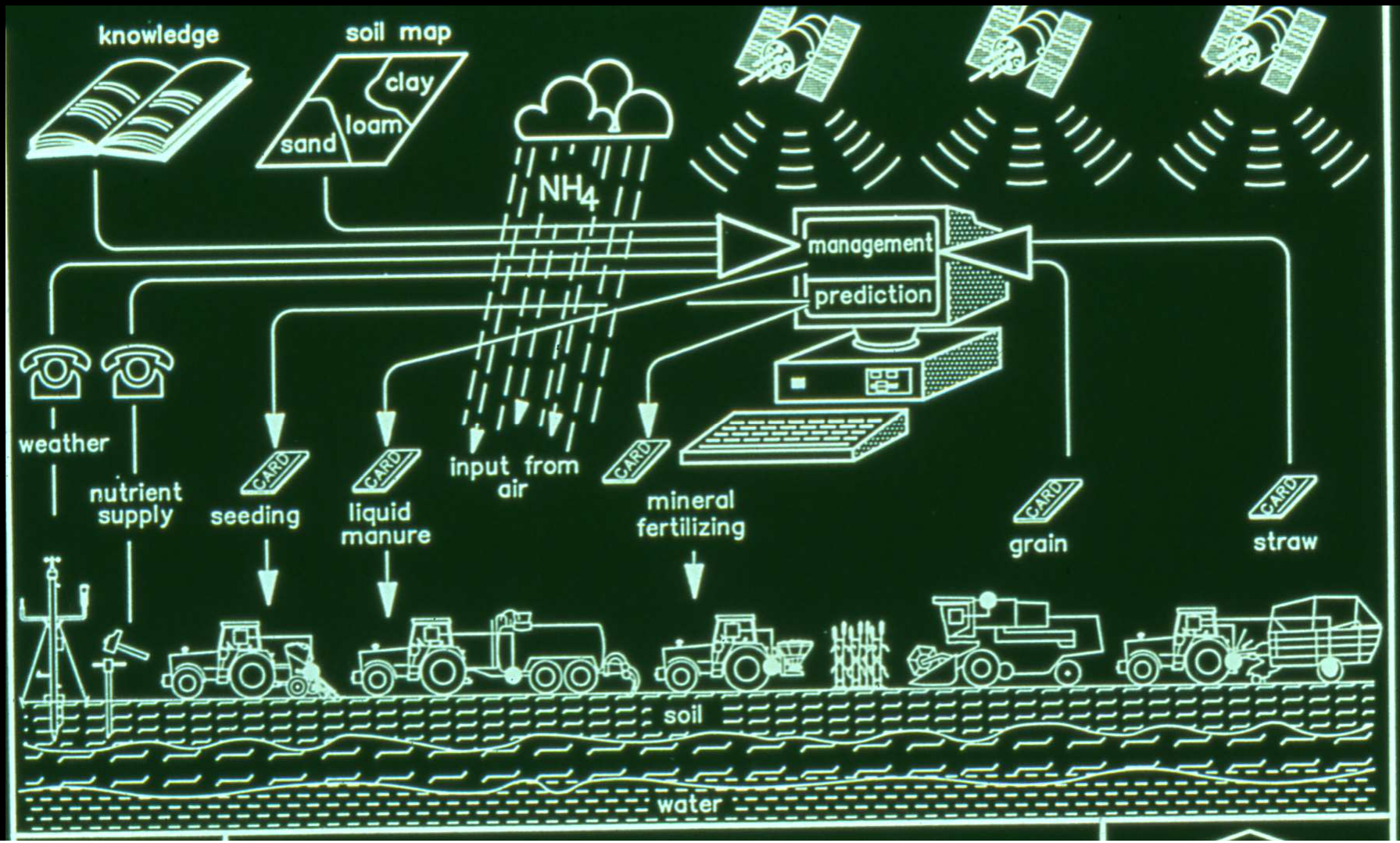
https://www.agrimarketing.com/s/49157

assets.cnhindustrial.com

Contemporary Systems Technology--- Precision Agriculture



Fertilizer Research 33:1-34



Auernhammer, H. and J.K. Schueller. 1999. Precision farming. In B.A. Stout and B. Cheze, eds., CIGR Handbook of Agricultural Engineering

An Example Technology Which Was NOT Successful

- Required extra effort at busy time
- Did not automatically integrate in production management system
- Economic value not completely obvious

Schueller, J.K., J.D. Whitney, T.A. Wheaton, W.M. Miller, and A. E. Turner. 1999. Low-cost automatic yield mapping in hand-harvested citrus. *Computers and Electronics in Agriculture*. 23(2): 145-153.

But Efforts for Technology Adoption Should Continue

Wild, K.M., T. Schmiedel, and J.K. Schueller. 2018. Measuring the sharpness of knives in agricultural machinery with a mobile device. ASABE 1801602

“Look before you leap”:

- What are the effects of the technology throughout the system?
  - Even “drop-in” can have system effect, especially on system reliability

“In the early 1960s, seed corn companies began to use male sterile cytoplasm so that they could eliminate the previous need for hand detassling to save both money and time. This seed was eventually bred into hybrid crops until there was an estimated 90% prevalence of Texas male sterile cytoplasm (Tcms) maize, vulnerable to the newly generated Race T. The disease, which first appeared in the United States in 1968, reached epidemic status in 1970 and destroyed about 15% of the corn belt's crop production that year. In 1970 the disease began in the southern United States and by mid-August had spread north to Minnesota and Maine. It is estimated that Illinois alone suffered a loss of 250 million bushels of corn to SCLB. The monetary value of the lost corn crop is estimated at one billion US dollars.” Wikipedia

“Look before you leap”:

- What are the effects of the technology throughout the system?
  - Even “drop-in” can have system effect, especially on system reliability
- What are the effects on sustainability?
  - Economic
  - Environmental
  - Social/Political (Will we have another “Simpson-Mazzoli”?)

www.caseih.com

www.deere.com

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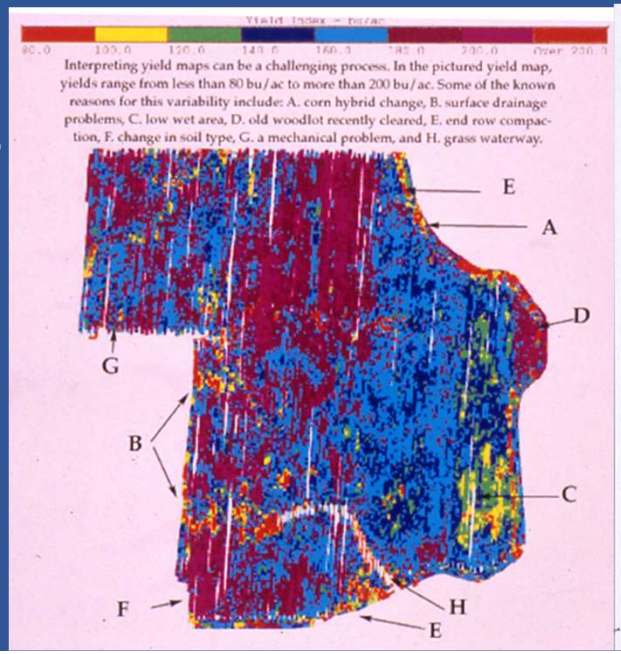
  - Economic
  - Environmental
  - Social/Political
- **Will system outputs be improved?**



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- What are the effects of the technology throughout the system?
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  - Economic
  - Environmental
  - Social/Political
- Will system outputs be improved?
- Can perturbations and local failures be tolerated?
  - Redundancies
  - “Limp-home” modes

“Limp Home Mode (LHM)

Limp home mode is a set of parameters the engine computer will use as a strategy to get you home without causing further damage to the drive-train of your car.

It means the computer noticed something wrong or lost contact with an important sensor that could ruin the engine or transmission and has de-rated the power so you can get home without the car stopping or damaging itself.” www.quora.com

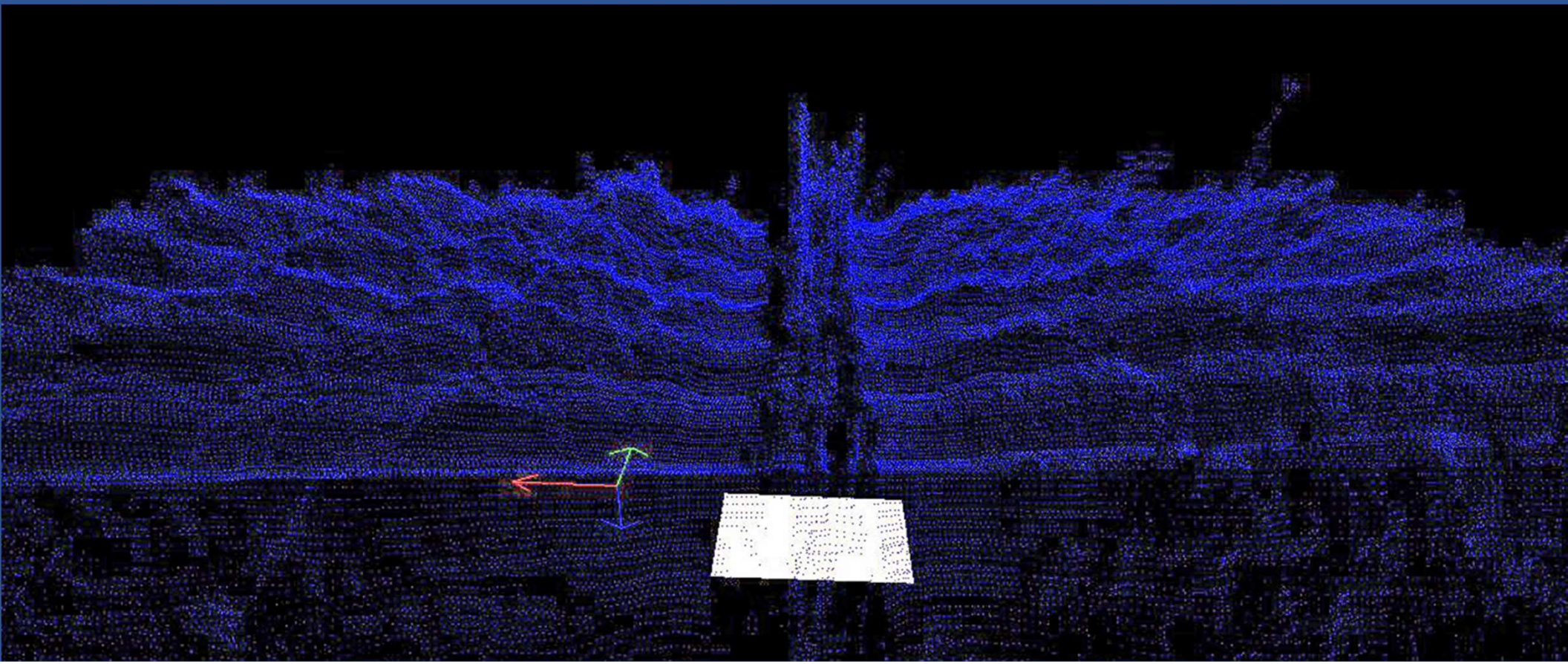
“Look before you leap”:

- What are the effects of the technology throughout the system?
  - Even “drop-in” can have system effect, especially on system reliability
- What are the effects on sustainability?
  - Economic
  - Environmental
  - Social/Political
- Will system outputs be improved?
- Can perturbations and local failures be tolerated?
  - Redundancies
  - “Limp-home” modes
- Is the technology mature enough for adoption?

In my opinion …

Biggest machinery engineering issue is accurate and reliable sensors

(Example: My unsuccessful attempt to use a laser scanner to find watermelon)

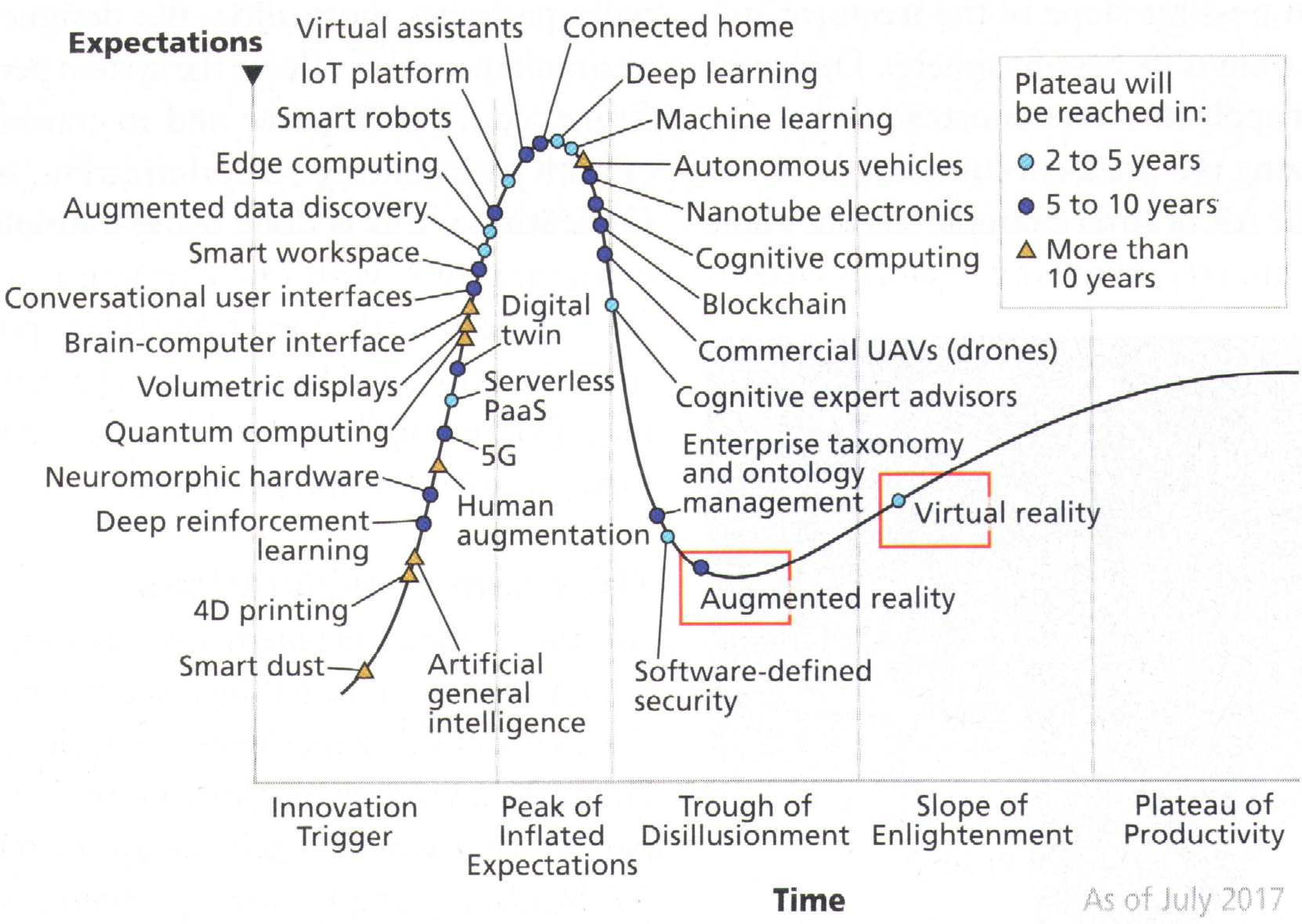


But there are real advances in such fields as…

- Computing speed
- Machine vision
- Spectral sensing
- Artificial intelligence
- Networking
- Datamining
- Autonomous vehicles
- Etc., etc.

Neglecting the Hype,

When Will They Be Productive?

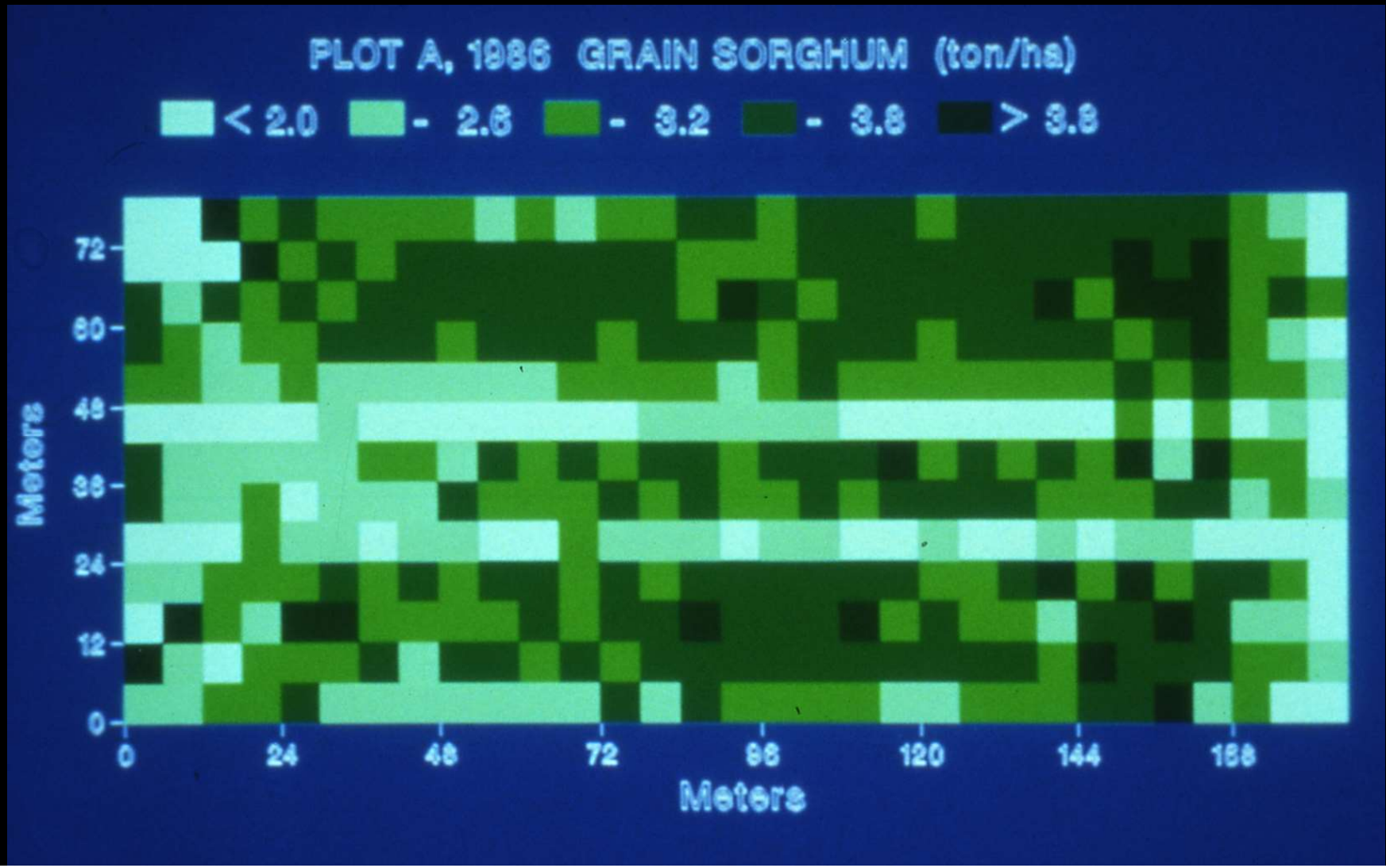


Gartner Hype Cycle

Gartner, Inc.

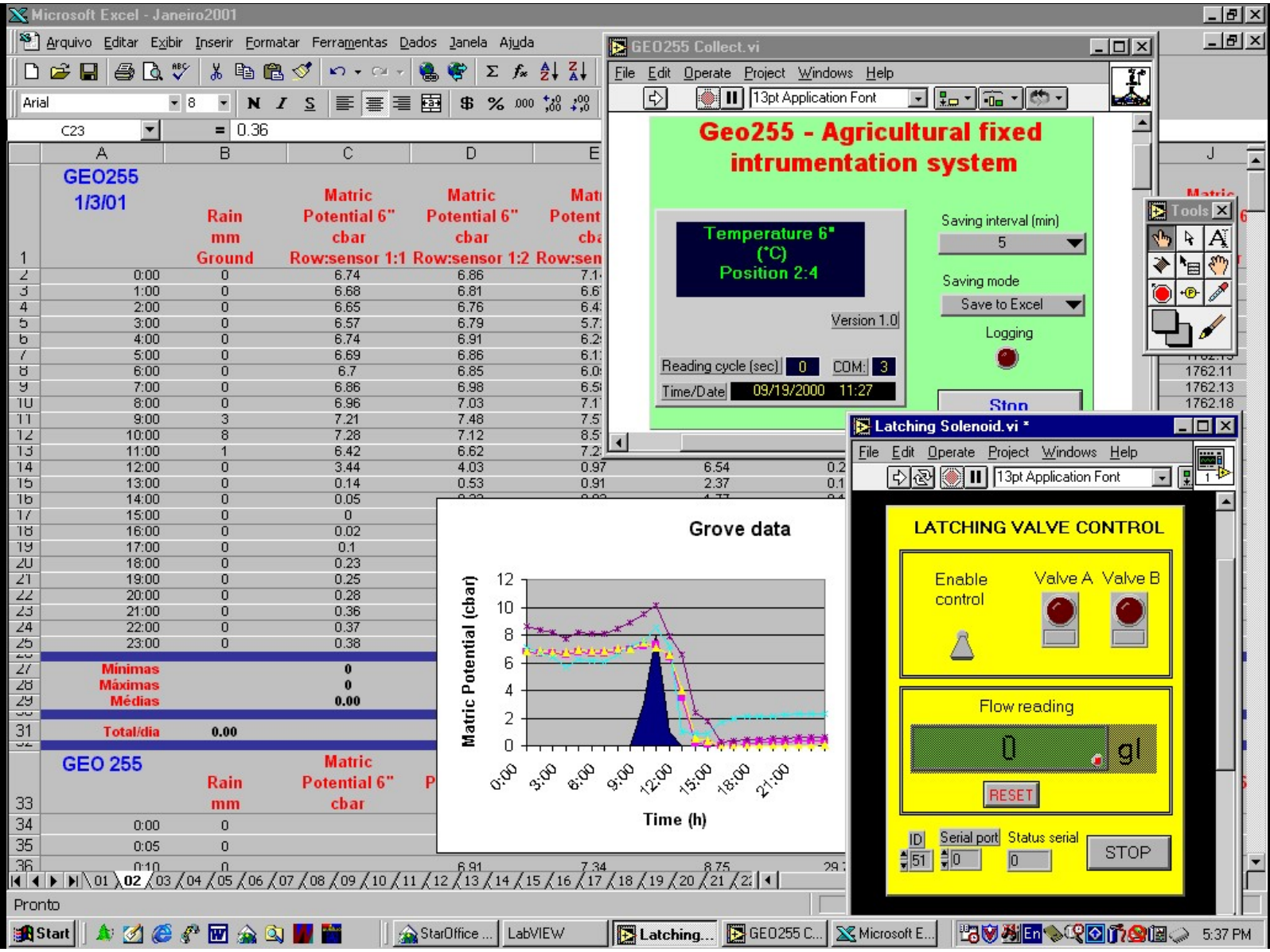
www.laserfocusworld.com

Research Often Takes Time to Widespread Commercial Adoption



MacArthur, D.K., J.K. Schueller, W.S. Lee, C.D. Crane, E.Z. MacArthur, and L.R. Parsons. 2006. Remotely-piloted helicopter citrus yield map estimation. ASABE Paper No. 063096.


Line of sight radio-modem
011010011


Microsoft Excel - Janeiro2001
Arquivo Editar Exibir Inserir Formatar Ferramentas Dados Janela Ajuda
GEO255 1/3/01
Rain mm Ground
Matric Potential 6" cbar Row:sensor 1:1
Matric Potential 6" cbar Row:sensor 1:2
Minimas
Máximas
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GEO 255
Matric Potential 6" cbar
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GEO255 Collect.vi
File Edit Operate Project Windows Help
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Version 1.0
Reading cycle (sec)
COM:
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Saving interval (min)
Saving mode
Save to Excel
Logging
Stop
Tools
Latching Solenoid.vi *
LATCHING VALVE CONTROL
Enable control
Valve A
Valve B
Flow reading
gl
RESET
ID
Serial port
Status serial
STOP
Grove data
Matric Potential (cbar)
Time (h)
Start
StarOffice ...
LabVIEW
Latching...
GEO255 C...
Microsoft E...
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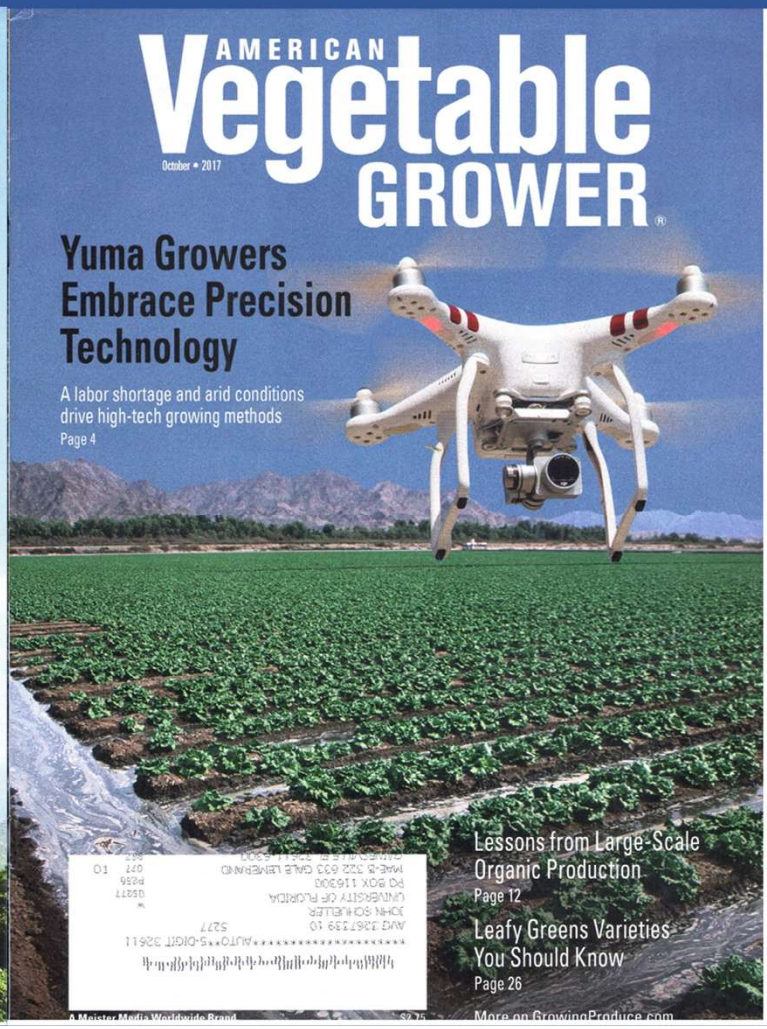
Risk is Reduced if There is a Critical Mass for Investment

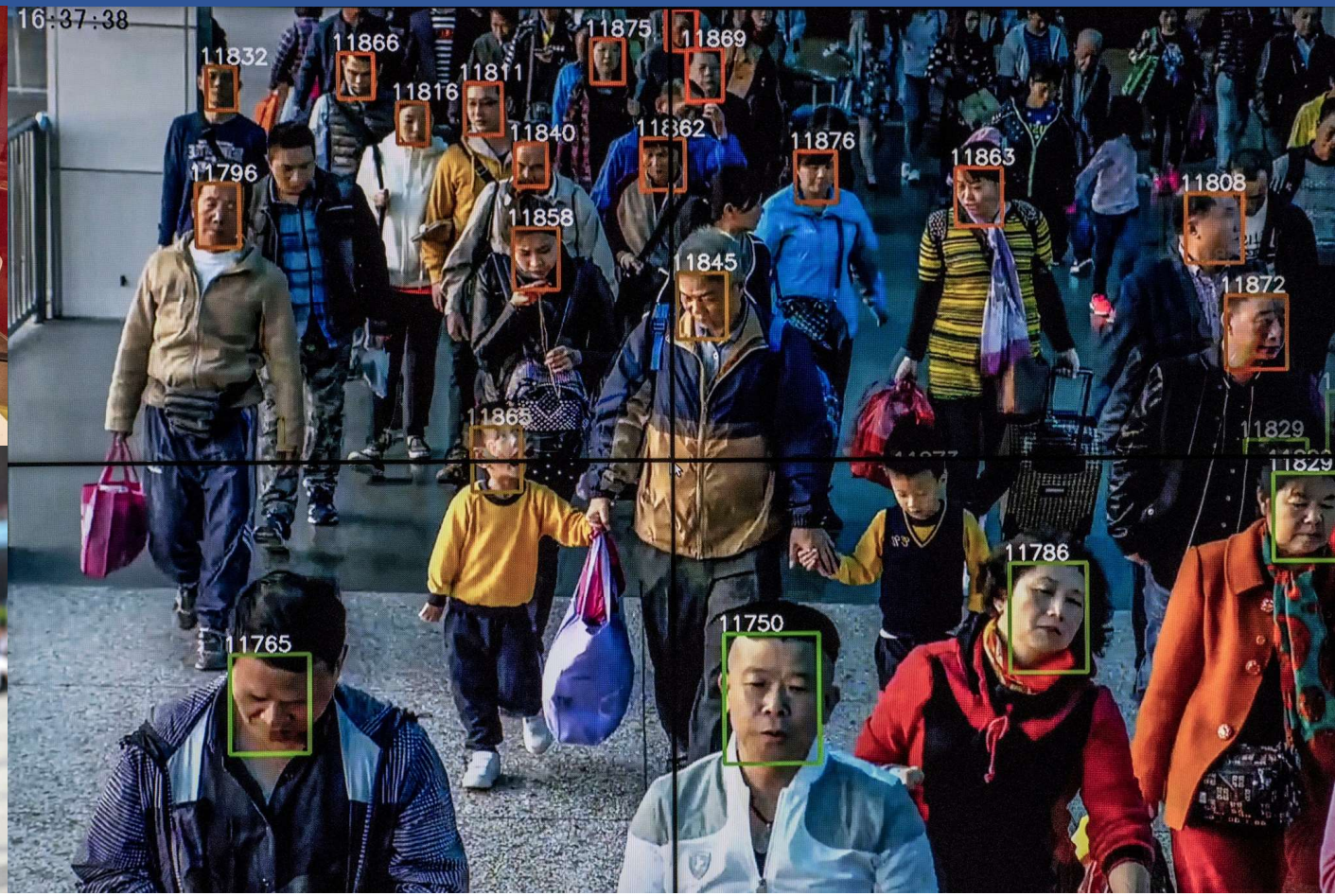
- Engineering
- Marketing



Agricultural Technologies Will Benefit If Parallel Work in Related Other Private and Public Sector Applications

Agricultural Technologies Will Benefit If Parallel Work in Related Other Private and Public Sector Applications

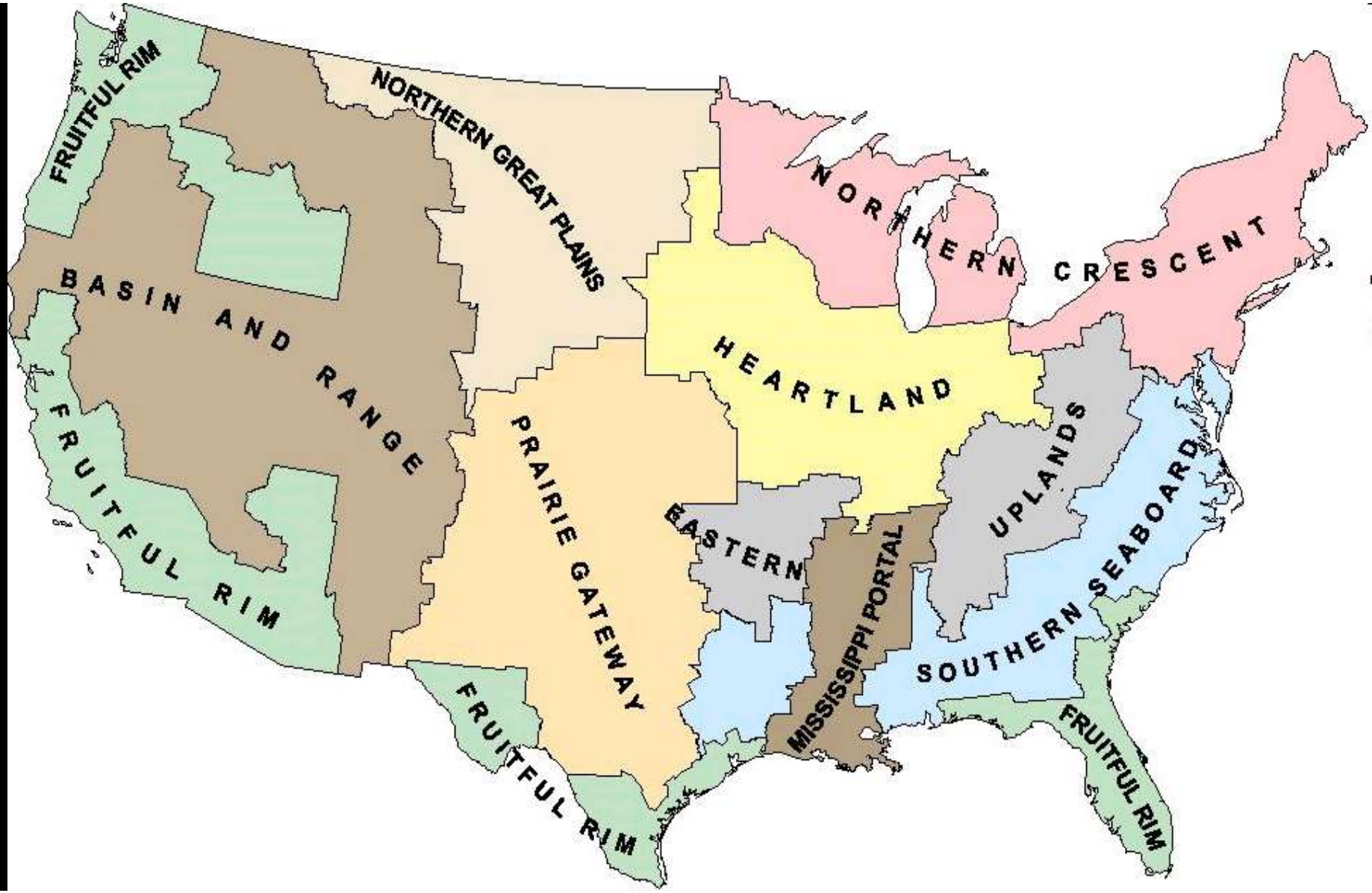
Megvii



Example Application of Machine Vision and Artificial Intelligence

But we in Florida agriculture have a problem…

Technology development and largest markets are in Heartland and California



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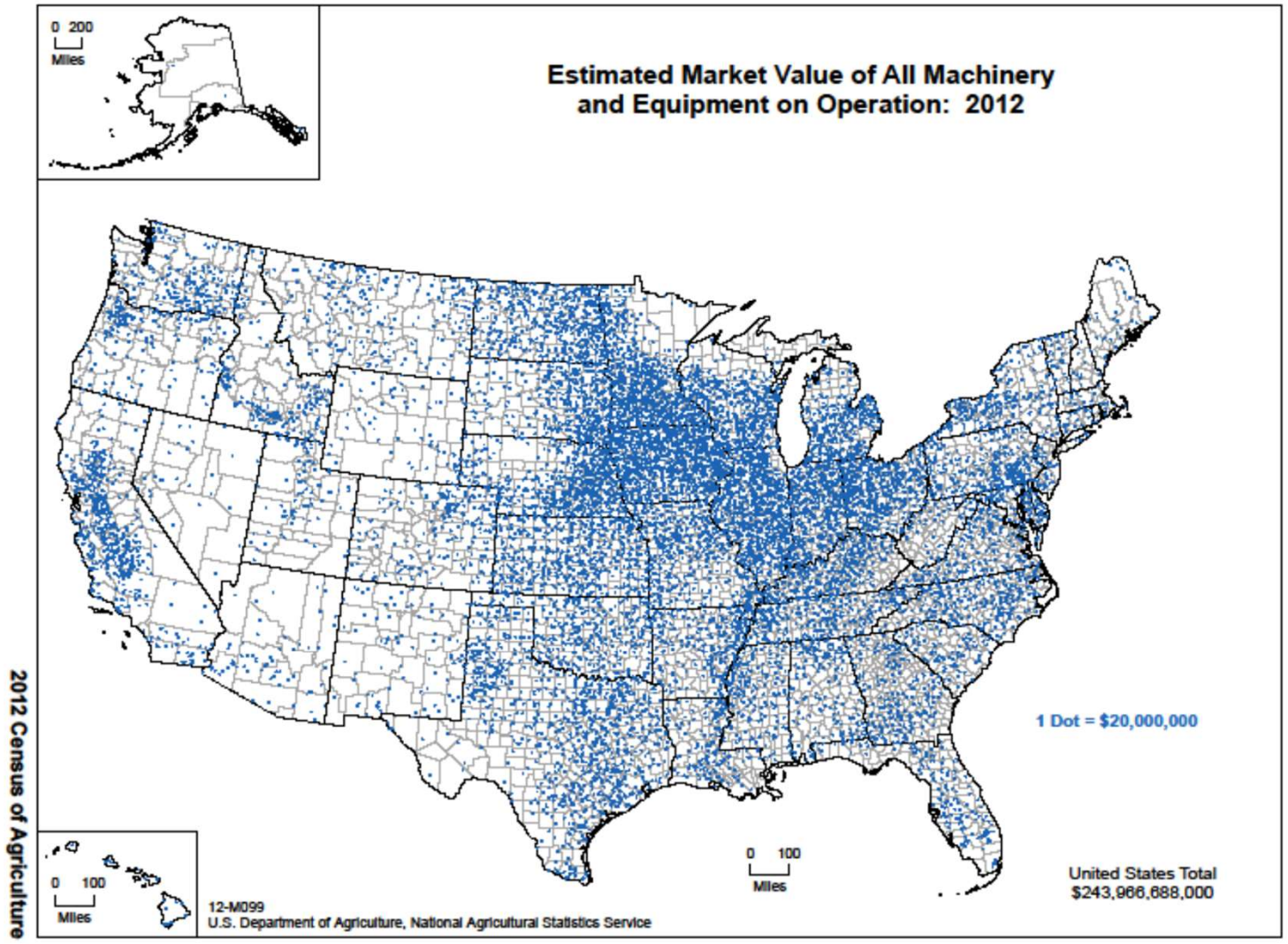


Need to understand whether technologies can be transferred from

- Other industries
- Other commodities
- Other locations

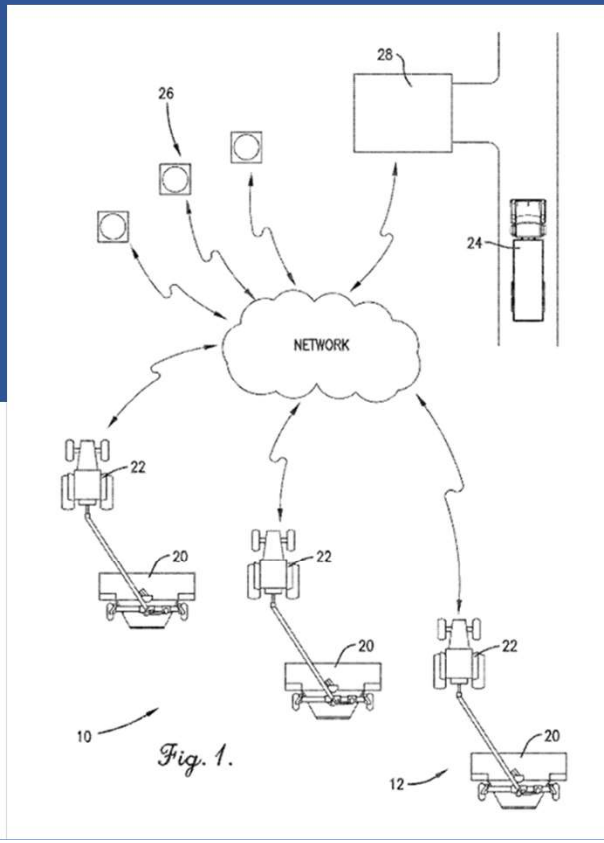


Fig. 1.

(19) **United States**

(12) **Patent Application Publication**

Schmidt et al.

(10) **Pub. No.: US 2017/0083026 A1**

(43) **Pub. Date: Mar. 23, 2017**

(54) **ISOBUS WIRELESS NETWORKING OF AGRICULTURAL MACHINES IN A COLLABORATIVE AGRICULTURAL PROCESS**

(71) Applicant: **AGCO Corporation**, Hesston, KS (US)

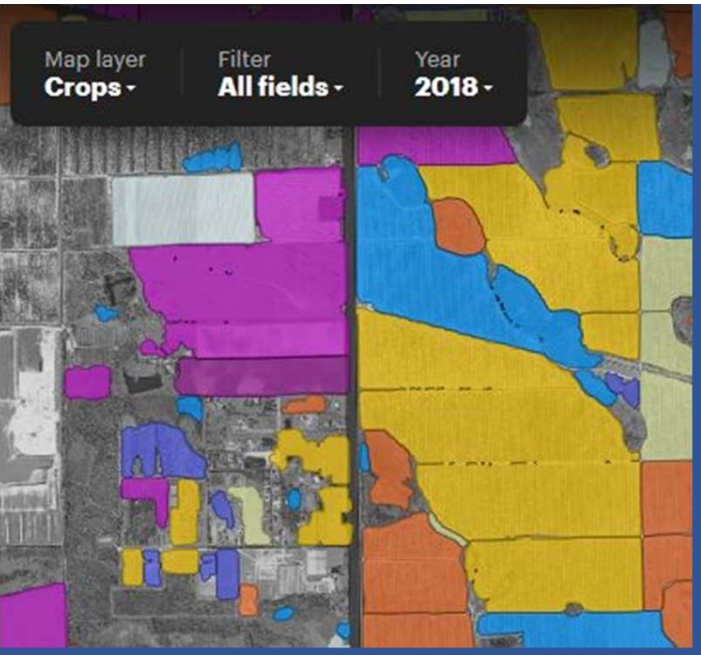
(52) **U.S. Cl.**

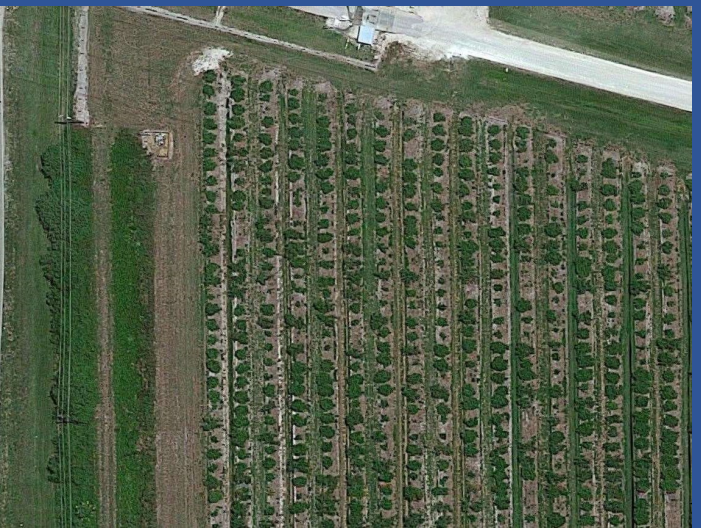
CPC ***G05D 1/0297*** (2013.01); ***H04L 67/12*** (2013.01); ***H04L 12/66*** (2013.01); ***G05D 1/0022*** (2013.01); ***G05D 1/0027*** (2013.01); *H04W 84/18* (2013.01)

OneSoil (https://onesoil.ai/en/) uses satellite imagery and machine learning algorithms to classify fields around the world

My parents' former farm in Wisconsin is fairly well classified

Just east of the SWFREC, it is a different story…



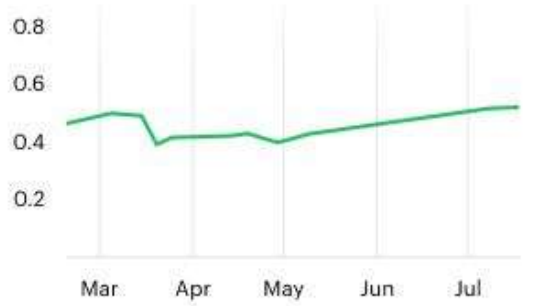


Crop
Maize

Field size
138.5 ha

Field score
0.47

Field development by NDVI



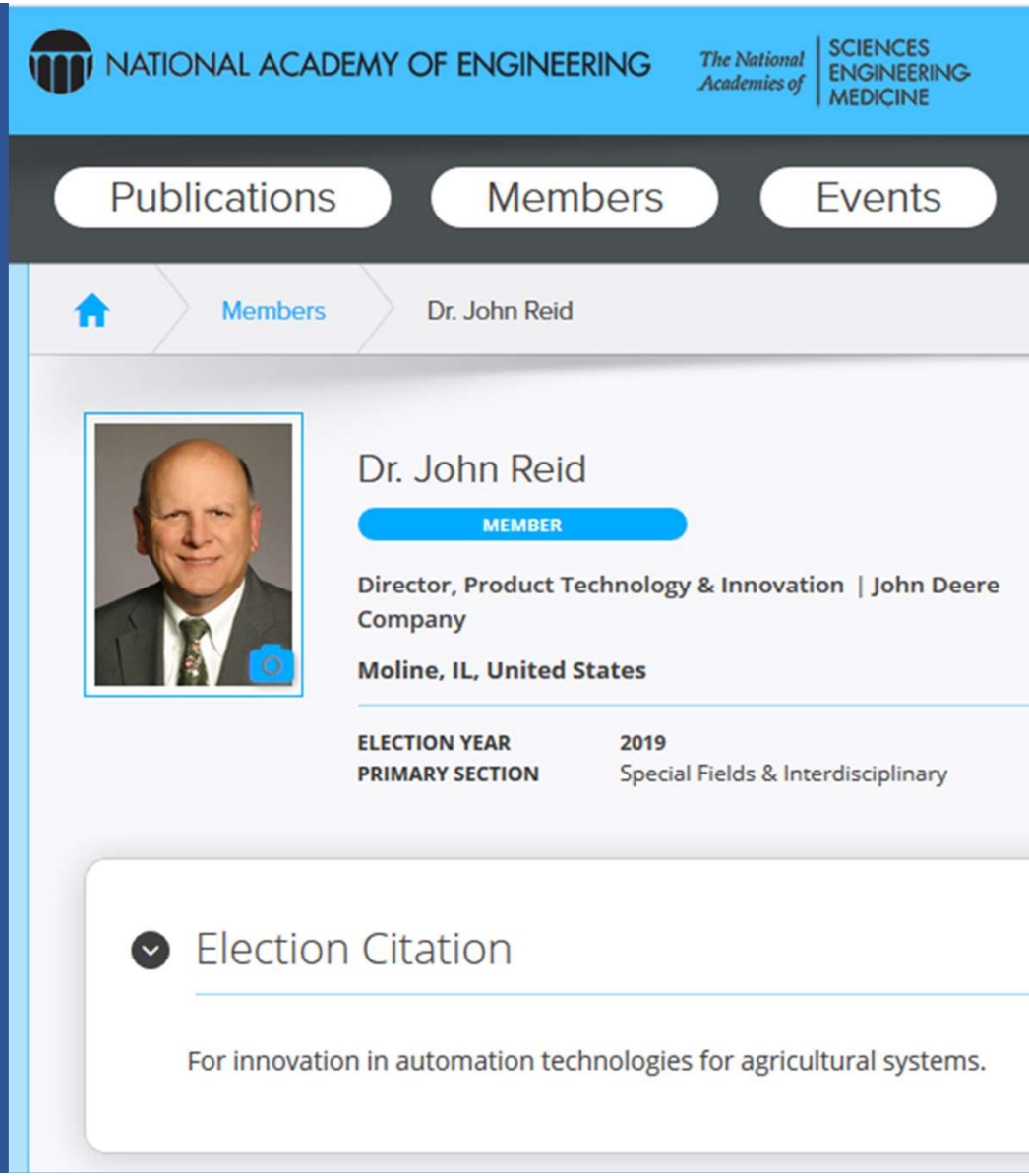
Go to OneSoil Platform →

Wrong field boundaries? Inform us
Wrong crop? Inform us

Some technologies don't succeed, but many eventually become useful

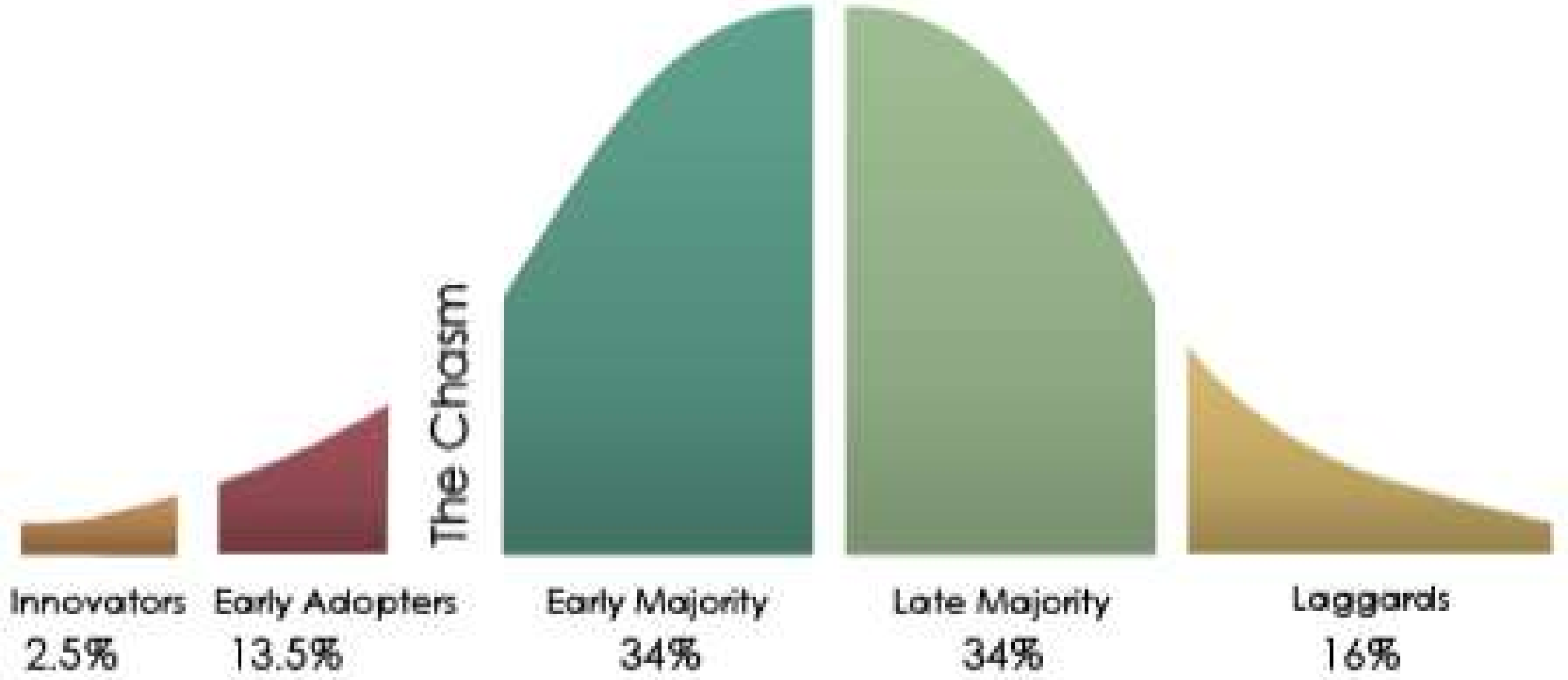
Timing is everything

Example:
Technologies from John Reid's 1986 pathbreaking dissertation implemented in 2016 ---30 years later!



Adoption Comes at Different Times to Different People

Rodgers Innovation Diffusion Curve www.cisco.com



Some Things I Think Will Come Fast

Some Things May Take Longer…

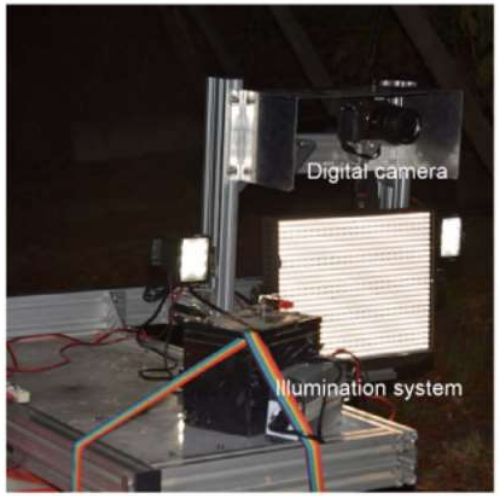
KOREAN STORE UNVEILS 'GENIUS' BANANA PACKAGING TO AVOID OVERRIPE FRUIT

www.independent.co.uk

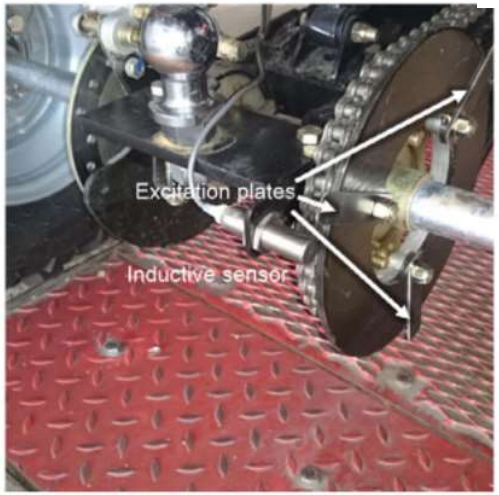
Automated early yield prediction in vineyards from on-the-go image acquisition

Computers and Electronics in Agriculture 144 (2018) 26–36

Arturo Aquino, Borja Millan, Maria-Paz Diago, Javier Tardaguila



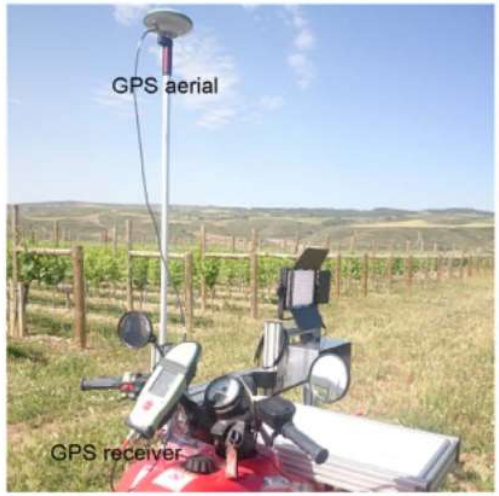
(a)



(b)

(a)

(b)



(c)

(d)

(c)

(d)

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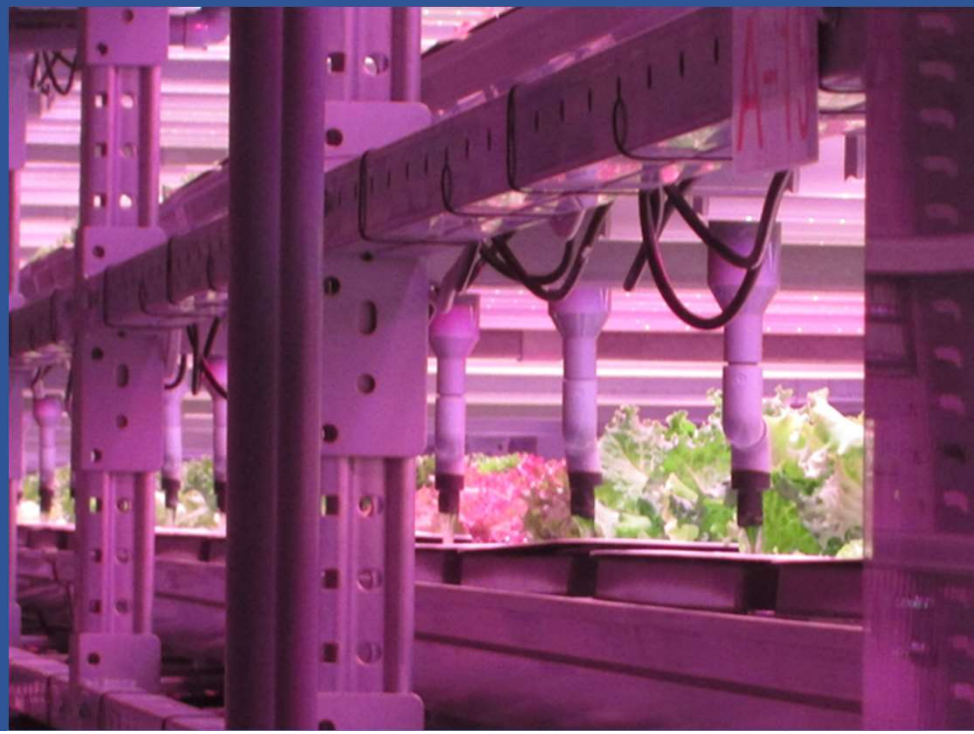
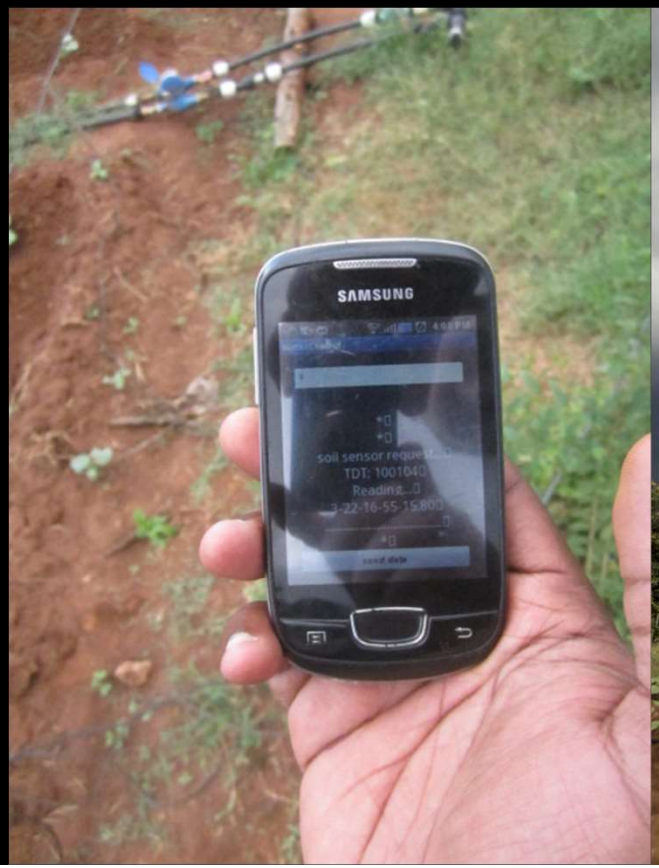


Inside Japanese plant factory

But Technologies Are Coming…

Cell Phone Controlled Vegetable Irrigation in Tanzania



But Technologies Are Coming…
And Many Are Great Improvements

Minimize Risk:

- Consider Entire System
- Evaluate Carefully
- Learn From Past
- Think Globally/Act Locally

Maximizing the Probability of New Technology Adoption Success

John K. Schueller
University of Florida
schuejk@ufl.edu

1934 (!!!) World's Fair