SAAESD Artificial Intelligence Workshop

“Opportunities for Cross -Institutional Collaborations in Artificial Intelligence”

Wednesday, April 21 11:30-12:30 ET

UF | IFAS Research
UNIVERSITY of FLORIDA

AI Workshop Overview

1. **Speaker introductions and workshop objectives (5 minutes)**
2. **Panel presentations (30 minutes):**
   - *Why AI matters to experiment stations* (Katie Migliaccio – University of Florida)
   - *The funding landscape for AI research* (Steve Thomson – USDA-NIFA)
   - *Industry perspective on AI research opportunities* (Ed Barnes – Cotton Inc.)
3. **Overview of SAAESD AI survey results (5 minutes)**
4. **Discussion and action items (20 minutes)**

Discussion and Action Items

- Conference grant
- Faculty liaisons
- Collaboration activities and interest (e.g., multistate project)

AI overview – why AI matters to experiment stations

Kati Migliaccio

Professor & Chair Agricultural and Biological Engineering

SAAESD

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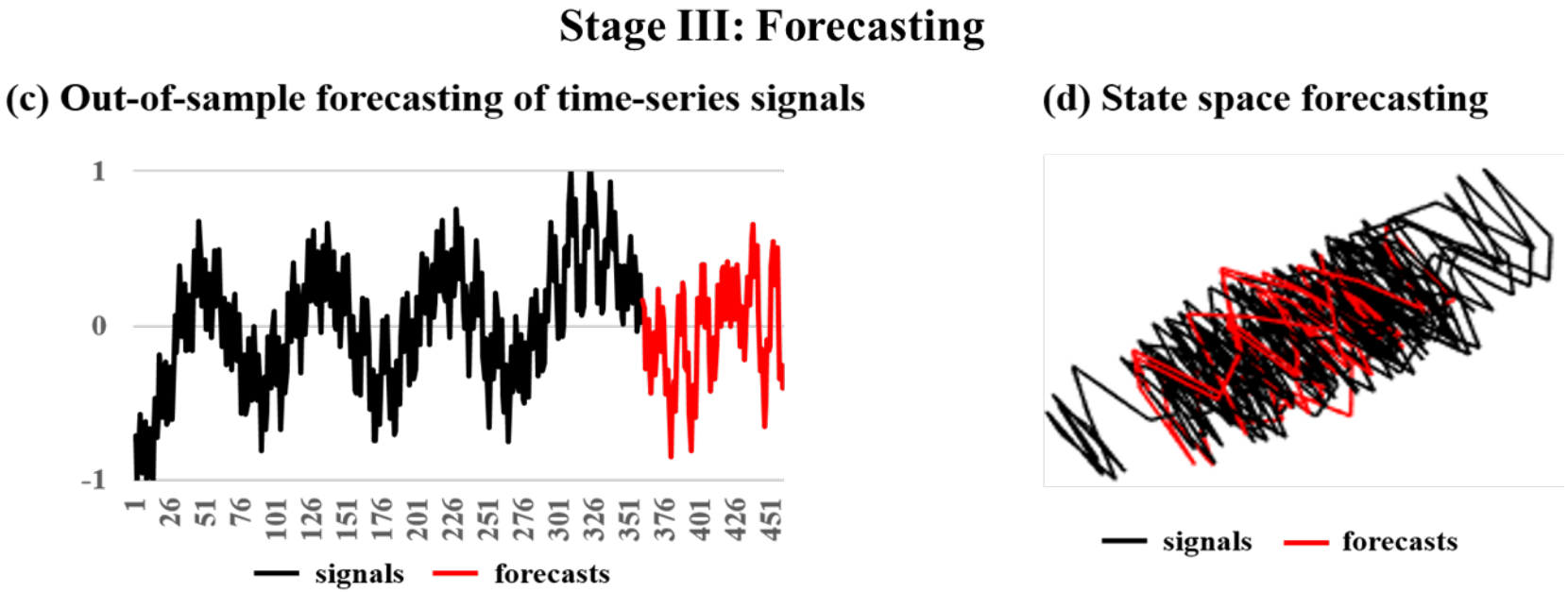
Artificial Intelligence in Agriculture

- Machine learning
  - Use data to better understand system dynamics and be able to use the 'learned' relationship to predict circumstances or needs and link to actionable tasks: irrigation, nutrient, pest, and disease management
  - Phenotyping to identify/develop stress-resistant varieties
- Computer vision
  - Use cameras to 'see' and use computers to process images into information for decision makers: plant stage, flowering, harvest planning, invasive species
- Machine vision
  - Use machine vision algorithms to operate/perform a function normally performed with human direction: plowing, planting, weeding, picking, sorting, packaging

Artificial intelligence: machine learning

- Irrigation management (UF); using soil water data to develop a digita twin for forecasting



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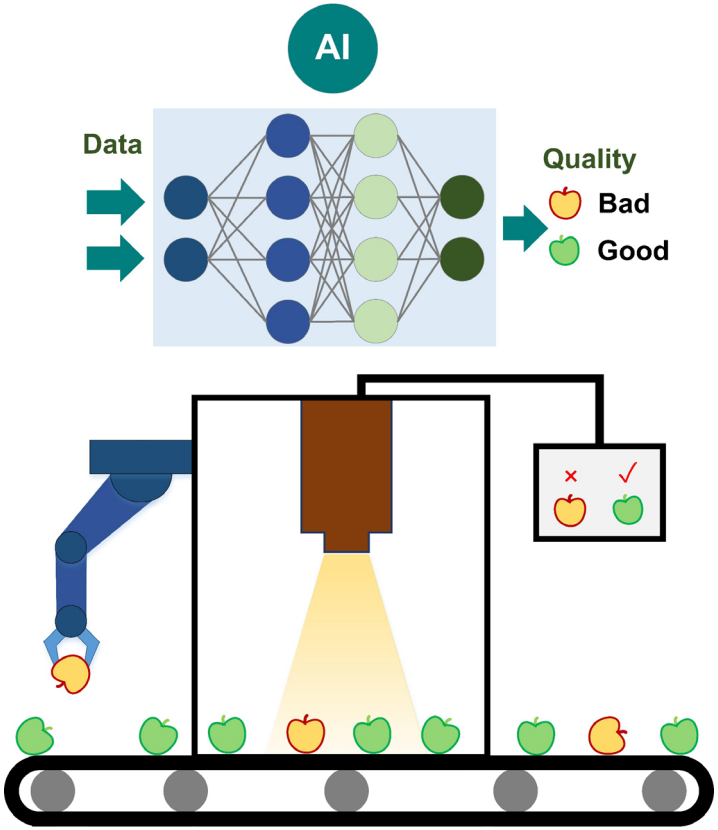
Artificial intelligence

- Texas A&M, plant identification

- Mississippi State University, fruit identification



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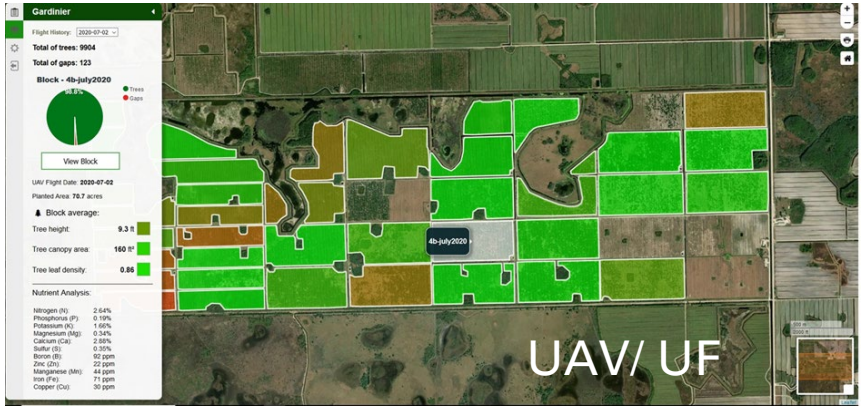
Artificial intelligence

- UF. Deep Learning Enhanced robotic visual detection and mapping of fruit positions in the canopy
- Improve detection rates of fruit under variable lighting conditions and with in fruit clusters
- Improve detection efficiency and reducing segmentation time

Where you might find AI

- Data management / data analytics
- Robotics and automation
- Precision/prescriptive agriculture
- Remote sensing / satellite / UAV
- High-throughput phenotyping technologies transitioned to production agriculture
- Sensor technology / data acquisition



Draft Vision for AI in Southeast

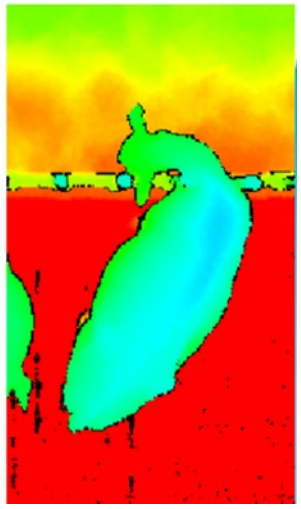
- Curate and share agricultural data
- Identify ways to integrate AI into agricultural systems of the Southeast through AI faculty partnerships with domain specialists
- Develop new AI products/tools that easily integrate into farming and food chain systems and can be commercialized for agriculture in the Southeast
- Support a resilient and viable food supply, work force, and environment

Southeast applications

- Monitor and predict spread of invasive species, spread of pest/disease
- Rovers/UAVs to monitor crop growth, flowers, disease, yield
- Rovers/robots to plant, plow, harvest, etc.
- Precision agriculture applications (water, nutrients, agrochemicals)
- Integration of weather and system information for planning a variety of actions
- Postharvest handling and packaging with machine and computer vision
- Protection of natural resources – identifying complex relations in ecosystem dynamics, analyzing large data sets with temporal and spatial components

Partnerships amongst SAAESD institutions

- Commodity based
- Technology based
- Resource meshing
- Complementary expertise/knowledge



Individual feed intake, breeding

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Organized efforts

- USDA NIFA
  - Draft title: Agriculture's future with AI: envisioning 2050 in the Southeast
  - Collaboration across SAAESD
  - Auburn, Mississippi State, U of Florida, U of Georgia have discussed
  - Presentations, panels, break outs, report back
- Multistate project
  - AI focus
  - Proposed by UF (Daniel (Won Suk) Lee leading effort) and Gary Thompson

AI matters…

- Leading edge of technology change and the opportunities it brings
- Student training and employment
- Food supply and resource use

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AI- related programs at USDA-NIFA

Steven J. Thomson, National Program Leader

APRIL 21, 2021

United States Department of Agriculture
National Institute of Food and Agriculture

Background

- Ph.D. University of Florida – Bio. And Ag. Engineering.
  - Sensing systems, water balance and crop modeling, electronic systems, DSS
- Assoc. professor at Virginia Tech (Research, Extension, Instruction)
  - BSE and Eng. Education Depts
  - DSS in Ag. Mgt (nutrient, water, ag. safety (CDC/NIOSH grant)
  - Instruction: Instrumentation and Controls, Engineering Fundamentals
- USDA ARS
  - Cotton ginning mech., aerial application, precision ag., remote sensing, statistics, irrigation. Mississippi Soybean Promotion Board (MSPB) grants; Lead SY on aerial application project (80%); Participating SY on water mgt. (20%)
- USDA NIFA
  - National Program Leader
    - Engineering programs; A1521, Cyber Physical Systems, Robotics, SiTs, AI Institutes
    - Acting Division Director for Ag. Systems Division (9 months) – have retained budget authority.

Washington DC update

- Pending: Secretary of Agriculture, Tom Vilsack
  - Served under President Obama
  - Expect continuing interest and initiatives in rural broadband, precision agriculture, AI, climate-smart agriculture.
- NIFA Director, Dr. Carrie Castille
  - Ph.D. - Renewable Natural Resources (with emphasis on environmental and public policy) from LSU
  - Associate Commissioner and Science Advisor to the Commissioner for the Louisiana Department of Agriculture and Forestry
  - Extensive Extension background

How NIFA funds are provided

- Capacity grants - for land-grant institutions, schools of forestry, and schools of veterinary medicine to fund research and extension activities. The amount of funds provided to each institution is determined by a formula.
- Competitive grants - for fundamental and applied research, extension, and higher education activities, as well as for projects that integrate research, education, and extension functions. Individuals, institutions, or organizations may apply according to criteria listed in the Request For Applications (RFA).

AFRI Engineering for Agricultural Production Systems

Program Area Priority Code: A1521

Proposed Budget Requests: $650,000 total per project for project periods of 3-4 years

Project Types: Research Projects or Integrated (research, and education and/or extension) Projects

Grant Types: Standard, Conference with LOI, and FASE (Strengthening Standard, New Investigator, Strengthening Conference, Seed, Equipment, and Sabbatical) Grants only

Application Deadline: July 15, 2021 (5:00 pm ET)

Contact: Steven Thomson, steven.j.thomson@usda.gov

Ganesh Bora co-lead, ganesh.Bora@usda.gov

Bradley Rein co-lead, brein@usda.gov

Olivia Moreno, Program Specialist, olivia.moreno@usda.gov

- **National Robotics Initiative (NSF paneled/NIFA funded):** development of scalable robotic technologies and coordinated multi-agent teams that focus on labor-intensive tasks, improved efficiency, inspection and monitoring, coupled UGVs and UAVs for on-farm management, others.
  - Total funding: 5M. 1.2M/grant. **Deadline: May 3, 2021.**

  POC: steven.j.thomson@usda.gov

  ganesh.bora@usda.gov

- **Cyber-Physical Systems (NSF paneled/NIFA funded):** engineered systems that are built from, and depend upon, the seamless integration of computation and physical components.
  - Agriculture topics address
    - Real-Time Agricultural Data Analytics and Control
    - Smart & Connected Communities (S&CC)
  - Total funding: 5M. 1.2M/grant, 400K additional Transition to Practice (TTP) option. ***No Deadline*** (accepted through Dec 31, 2021).
  - POC: steven.j.Thomson@usda.gov

- **AI Institutes (NSF paneled/NIFA funded):** Total funding: 20M. AI in Agriculture - involving core principles of AI; specifies stakeholder engagement. 4M/year and funded per year.
  - Previous Deadline: December 4, 2020.
  - RFA is being developed for 2022.
  - POCs: ann.stapleton@usda.gov; steven.j.thomson@usda.gov; jdonlon@nsf.gov.

Cross-cutting: Data Science for Food & Agricultural Systems (DSFAS)

Program Area Priority Code: A1541

Proposed Budget Requests: $650,000 total per project for project periods of 3-5 years; for coordination innovation networks priority only $1,000,000 total per project for project periods of up to five years

Project Types: Research Projects or Integrated (research, education and /or extension) Projects only

Grant Types: Standard, Conference, and FASE (Strengthening Standard New Investigator, Strengthening Conference, Seed, Equipment, and Sabbatical) Grants only

Requested Grant Types for Coordination Networks: Standard and FASE (Strengthening Standard) Grants only

Application Deadline: July 29, 2021 (5:00 pm ET)

Contact: Ann Stapleton, NIFA-DSFAS@usda.gov

Cross-cutting: Data Science for Food & Agricultural Systems (DSFAS)

Funding Priorities: data science to enable systems and communities to effectively utilize data, improve resource management, and integrate new technologies and approaches to further U.S. food and agriculture enterprises

The most competitive proposals will be equally well grounded in agricultural science and data science.

- Applications must address one or more of the following:
  - Analysis of Agricultural Data
  - Connect Multi-scale, Multi-domain or Multi-format Agricultural Data
  - Agricultural Applications and Human-Technology-Data Interactions

Cross-cutting: Inter-Disciplinary Engagement in Animal Systems (IDEAS)

Program Area Priority Code: A1261

Proposed Budget Requests: $1,000,000 total per project for 3-5 years

Project Types: Integrated Projects (Research and Extension or Education) only

Grant Types: Standard, Conference, and FASE (Strengthening Standard, New Investigator, Strengthening Conference, Seed, Equipment, and Sabbatical) Grants only

Application Deadline: July 15, 2021 (5:00 pm ET)

Contact: Steven Smith, steven.i.smith@usda.gov
Ganesh Bora, ganesh.bora@usda.gov
Andres Cibils, andres.cibils@usda.gov

Cross-cutting: Inter-Disciplinary Engagement in Animal Systems (IDEAS)

Funding Priorities:

- Precision animal management
- Environmental synergies of animal production
- Societal aspects of animal welfare

Cross-cutting: Critical Agricultural Research & Extension (CARE)

Program Area Priority Code: A1701

Proposed Budget Requests: $300,000 total per project for project periods of 1-3 years

Project Types: Integrated (research and extension) Projects only

Grant Types: Standard and FASE (Strengthening Standard and New Investigator) Grants only

Application Deadline: June 17, 2021 (5:00 pm ET)

Contact: James Dobrowolski, james.dobrowolski@usda.gov

Vijay Nandula, vijay.nandula@usda.gov

Andres Cibils, andres.cibils@usda.gov

Cross-cutting: Critical Agricultural Research & Extension (CARE)

Funding Priorities: Critical challenges and opportunities that research and extension, together, can addresses address to improve our nation's agricultural and food systems

- Projects should include:
  - Integrated activities based on rigorous **research combined with effective extension**
  - Involvement of stakeholders to develop and rapidly apply new knowledge or practices
  - Contribute to improved well-being of the people, communities, plants, and animals involved in, and affected by, agriculture and food-production systems.

Food and Agriculture Science Enhancement (FASE), New Investigator, and Seed Grants

- New Rules and levels for Seed Grants
  - 300K for two years
  - New Investigators can now apply for Seed funding
    - First 5 years of first career-track position
    - Limited publication record
    - No previous Federal funding other than a pre- or postdoctoral fellowship or AFRI seed grant

Thank you!

steven.j.thomson@usda.gov

1. Desire to serve on Grant Panels? Send me an email and CV

2. Talk with appropriate program leader!

3. Find grant summaries:
   Go to Data Gateway or
   - Google or Bing - "USDA CRIS"
   - Go to "Assisted Search" at top left

Opportunities for Cross-Institutional Collaborations in Artificial Intelligence: **Industry Perspective**

Ed Barnes, **et al.**

Cotton Incorporated

SAAESD Artificial Intelligence Workshop

April 21, 2021

Partners

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Kater Hake
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Kansas State University

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NC State University

Mathew G. Pelletier,
John D. Wanjura
Greg A. Holt
USDA, ARS
Lubbock, TX

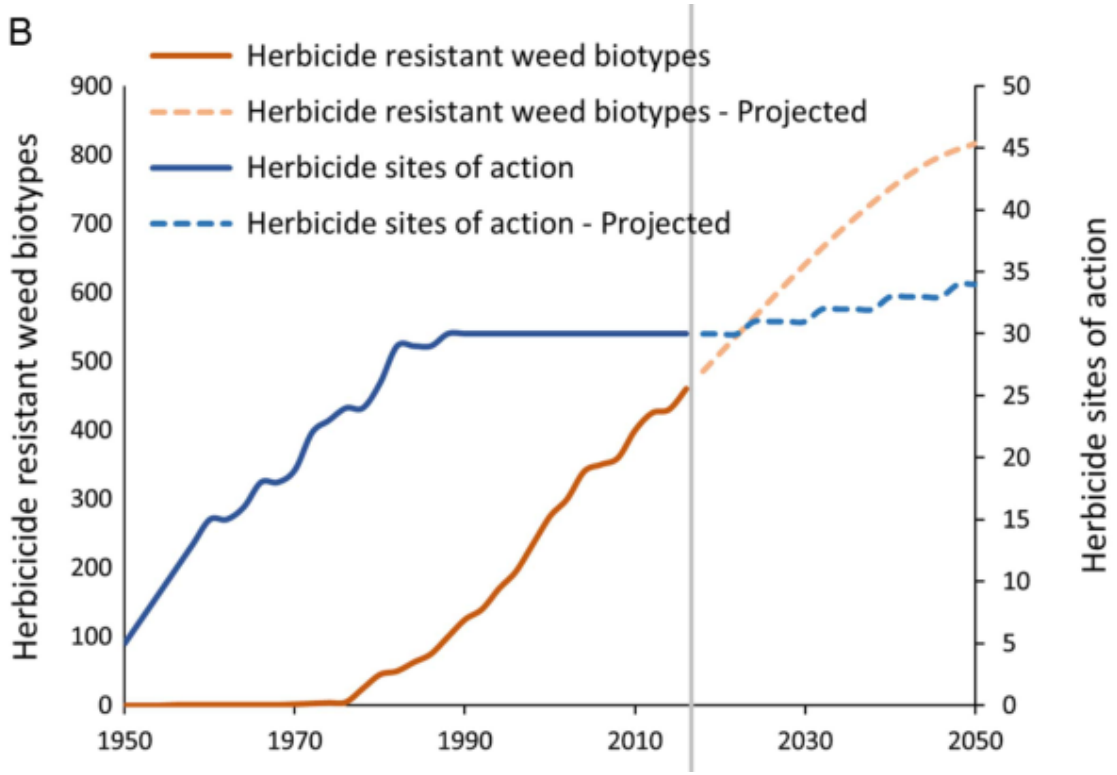
Overview

- Drivers behind agricultural AI
  - Herbicide Resistant Weeds
  - Labor
- Commercial Systems
- Machine Vision Needs
- Open-Source Opportunities

Joe Maja, Clemson

Glen Rains, UGA

Herbicide Resistance – Huge Threat



From Westwood, et al. (2018): Weed Management in 2050: Perspectives on the Future of Weed Science

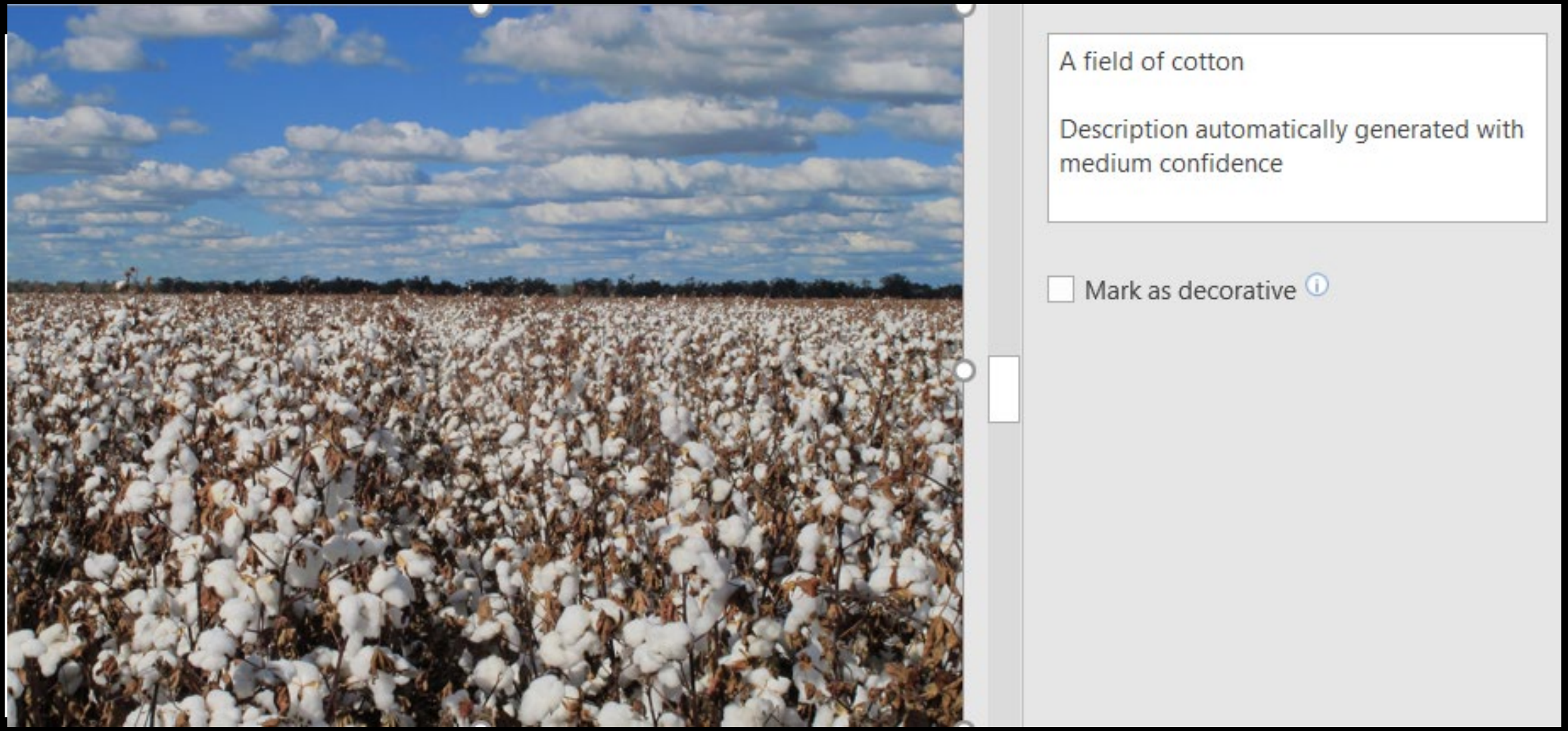
John Deere / Blue River

ecoRobotix

Commercial AI Weed Control Examples

Evidence of Labor Shortages

- $1,004,845 list price
- Only harvest Cotton, sits for 10 months
- Available 2008
- Now harvest > 50% U.S. crop
- → Labor 5 people to 1 person



Microsoft Office Auto-Captions

3-D Machine Vision System

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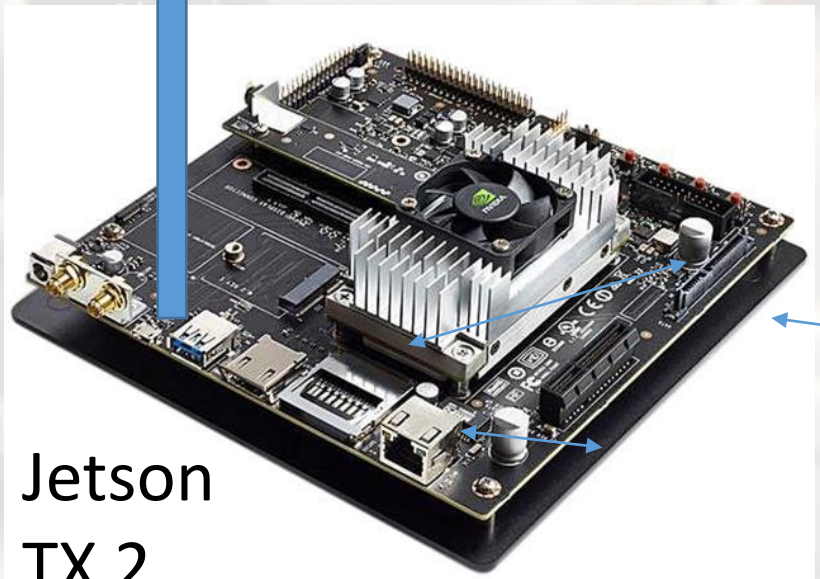
ZED Camera

3-D Position

Depth



Jetson
TX 2

NVIDIA
CUDA

ubuntu

OpenCV

ROS.org

Image-Data Sets Available Now

Datasets	Modality	Platform	Format	Number	Annotation
CWFI (2015)	RGB+NIR	Ground vehicle	.png	60	Pixel level
Carrot-Weed (2017)	RGB	Hand-held	.jpg	39	Pixel level
Plant seedlings (2017)	RGB	Ground fixed platform	.png	407	Image level
Grass-Broadleaf (2017)	RGB	UAV	.tif	15,336	Patch level
Sugar Beets 2016 (2017)	Multimodal	Ground vehicle	.png	12,340	Image level
Synthetic SugarBeet Weeds (2017)	RGB	No imaging platform	.png	8,518	Pixel level
weedNet (2017)	RGB+NIR	UAV	.png	840	Image level
Joint stem detection (2018)	RGB+NIR	Ground vehicle + UAV	.png	1,321	Pixel level
Leaf counting (2018)	RGB	Hand-held	.png	9,372	Image level
Weed Map (2018)	RGB+NIR	UAV	.png, .tif	10,196	Pixel level
DeepWeeds (2019)	RGB	Ground vehicle	.jpg	17,509	Image level
Crop weed discrimination (2020)	RGB+NIR	Ground vehicle	.png	40	Pixel level
Early crop weed (2020)	RGB	Hand-held	.jpg	508	Image level
Ladybird Cobbitty Brassica (2020)	Multimodal	Ground vehicle	Multple	NA (~3 T)	No annotations

Sierra Young & Yuzhen Lu

Biological & Agricultural Engineering, North Carolina State University

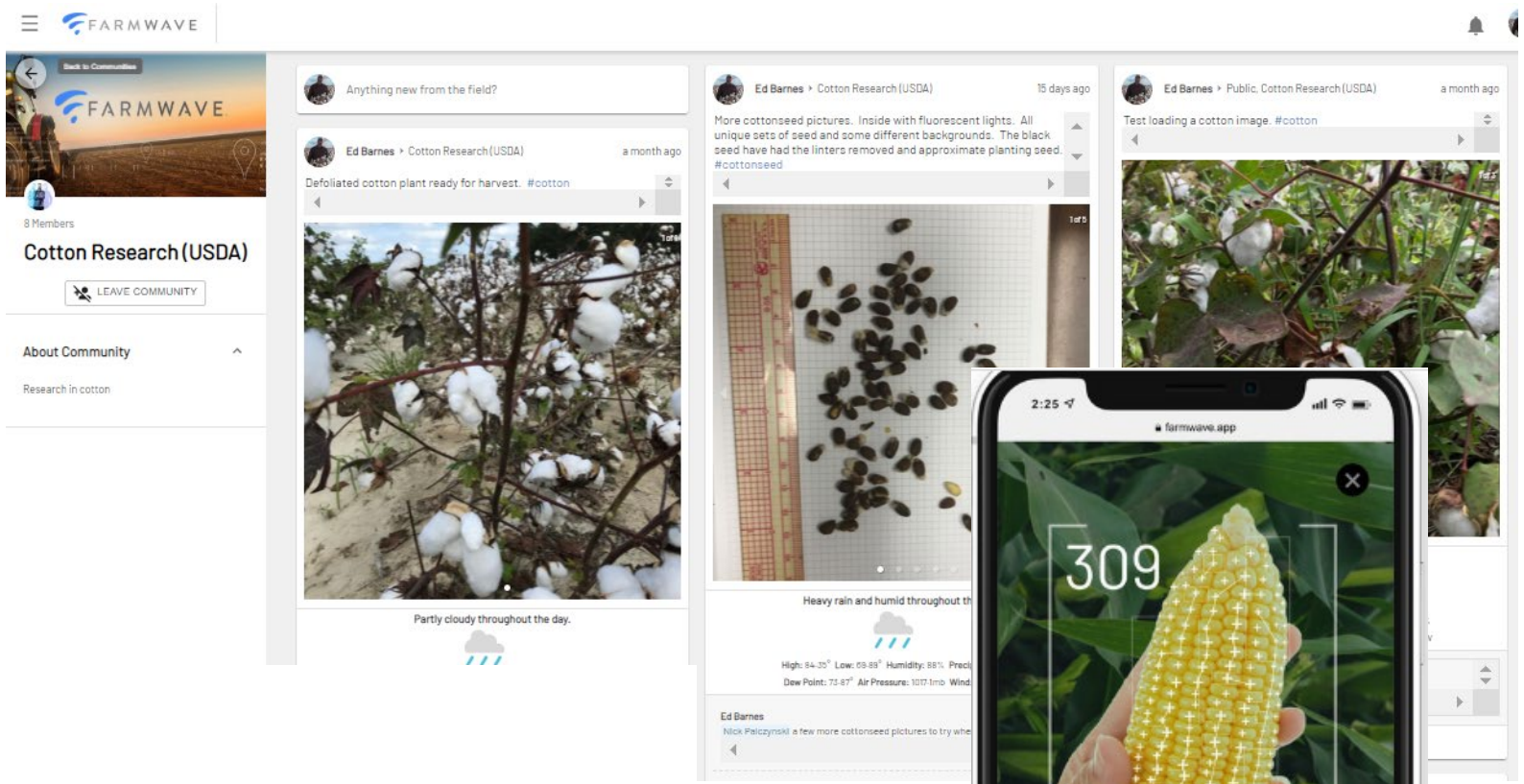
Published in Computers & Electronics in Ag, Nov. 2020

Machine Vision Libraries & Simulated Environments

Mathew Pelletier, USDA-ARS, Lubbock, TX

Farm Wave

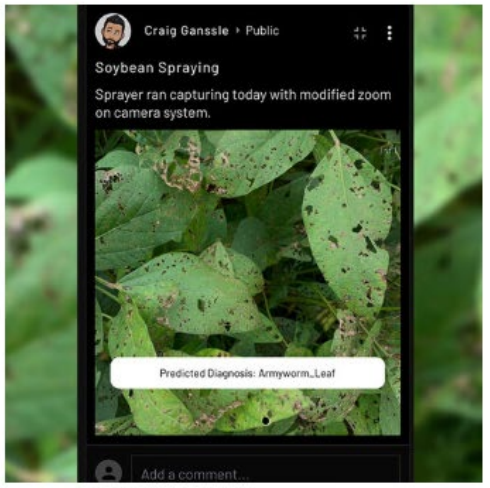
- Farmwave.io
- FarmWave.app



Real Time Results

Farmwave Sprayer Vision

Image captured on 1 meter soybeans at 27km per hour.

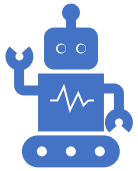


That same image pushed through Farmwave CORE to identify the pest issue in real-time.

Intellectual Property Strategy

Get as much as possible in the public domain so we have multiple companies offering harvest solutions.

Achieve this by funding proof of concept research projects with university partners.



Open source robotics.

ROS Agriculture

open robotics

https://www.openrobotics.org/

ROS
(Robot Operating System)
For Agriculture

http://wiki.ros.org/agriculture

Thanks!

ebarnes@cottoninc.com

Survey Results of Artificial Intelligence Activities at SAAESD Institutions

- Preliminary Report -

AI is a major focus area eliciting excitement and broad interest across the Southern region.

Cross-institutional awareness is low and uncoordinated

Hiring AI-experienced faculty is one of many diverse needs and bottlenecks to fully engage in AI research.

Coordinated approaches to reduce barriers & costs and inform more effective approaches to data management strategies

Many universities have core competencies in AI application domains and express a desire to grow cross-university collaborations.

Articulating core competency domains can lead to improved collaboration and avoid redundancy across the system

Few institutions have partnerships; however, some respondents indicated AI research projects are in place with industry or other universities.

Enhance public-private and multi-university partnerships

Many universities are developing AI curricula within and outside colleges of agriculture.

Awareness of what others are doing and best practices in AI education

The funding landscape is a concern, including the amount of funds, focus of programs, and understanding of the funding landscape.

Work with funding agencies to increase awareness of funding opportunities