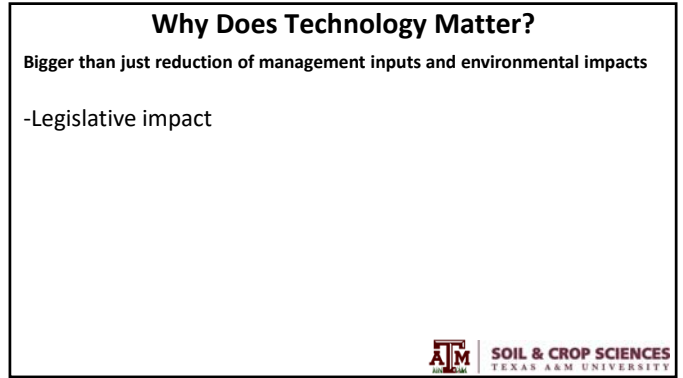
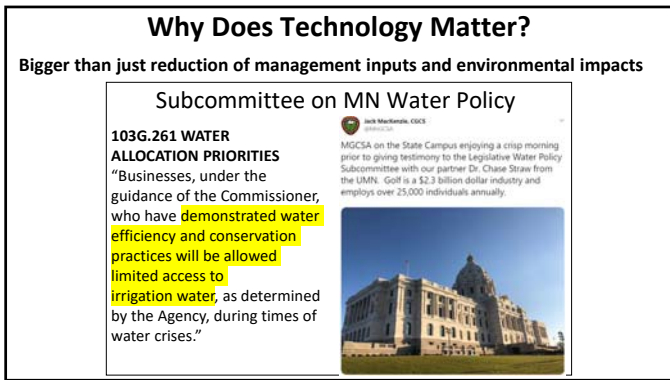




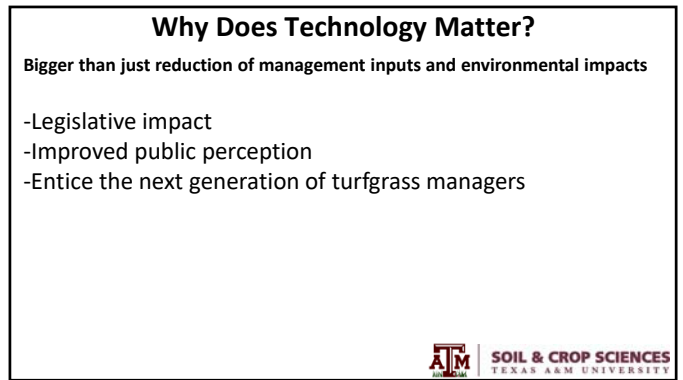
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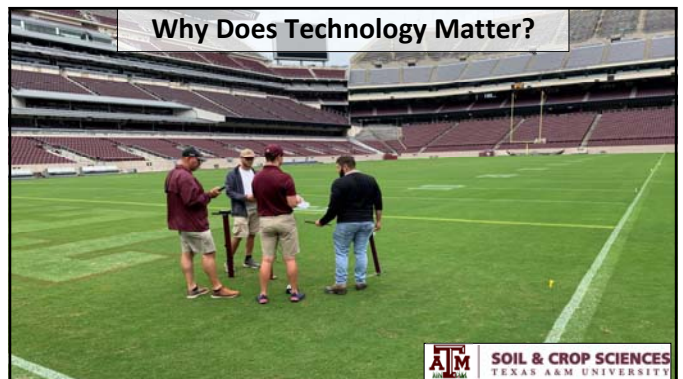
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Outline

Topics discussed:


- Painters
- Mowers
- Sprayers/spreaders
- Soil moisture sensors
- Drones



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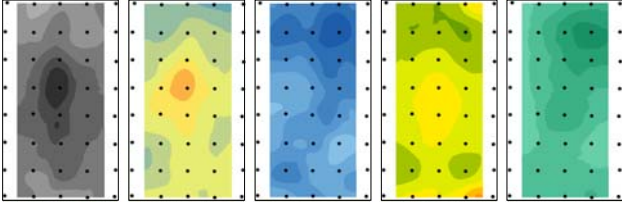
Global Navigation Satellite System (GNSS)



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Mapping Within-Field Variability

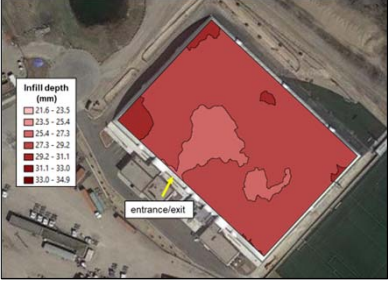


● Irrigation head

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Within-Field Variability – Artificial Turf



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GNSS Technology

VT Grounds Crew @VT_groundscrew · May 24, 2021
Big Poppy, our @Turf_Tank robotic painter, is working hard this afternoon to paint the Steve Johnson Practice field



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GNSS Technology

Latest turf news: Autonomous mowers help cut costs, improve conditions at NorCal courses divr.it/R4P41L



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GNSS Technology

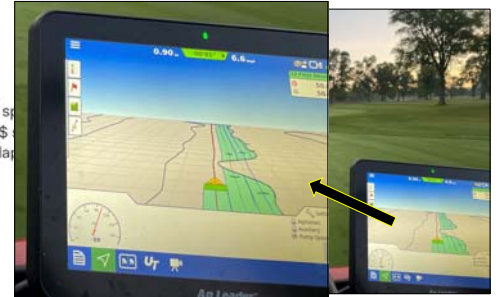


Kyle Foreman @LoneStarTTC · 46m
Good news, pre-emergent worked, bad news, we missed a spot.



13

GNSS Technology



Kurt Sams, CGCS @idycc

The dreaded weekend spot... Didn't expect to see \$\$\$ yesterday so had to adapt to overcome.



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GNSS Technology



Tom Kaplun @nhccsuper

Still fine tuning the geofences but the technology is amazing and 90% of the stakes, ropes and cart signs will go goodbye! #lessclutter 🙌. A win/win for all.

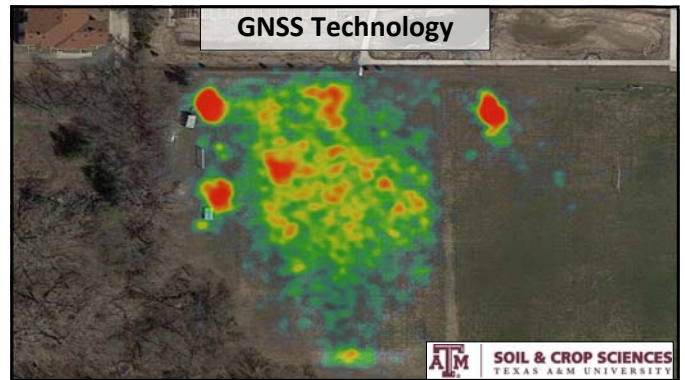


2:43 PM - 4/5/22 · Twitter for iPhone



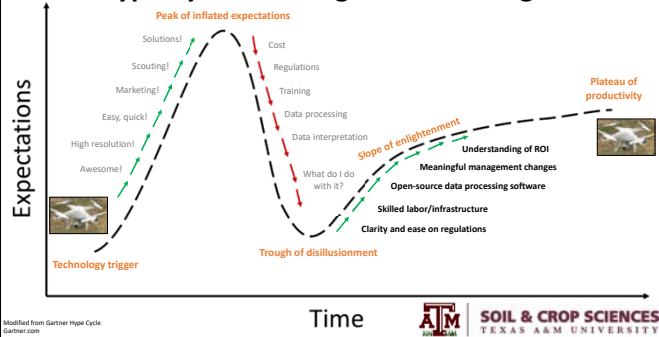
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GNSS Technology



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Hype Cycle for Turfgrass Technologies



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Painters



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Painters

Considerations:

- Accuracy
- Tank size
- Weight
- Battery life




Tragology @tragology075
Perfect over marking w GPS. Make the switch to efficient field marking. Learn more at tragology-rs.com, [@digitalurTexas](https://twitter.com/digitalurTexas) @LunenandScott @BakerVehicle @Surfwerkinc




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Mowers



Husqvarna




Toro




TM-2000

ECHO



Greenworks



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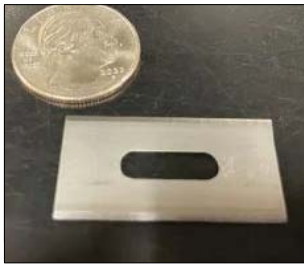


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Mowers

Considerations:

- Regulations/safety
- Time/battery life
- Quality of cut
- Maintenance
- Supervision
- Mowing pattern




GCM




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Mowers



Graze Mower



TURFLYNX



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GPS Sprayers

- Individual nozzle control
- Minimizes overlapping
- Sprays within boundaries
- Variable-rate applications



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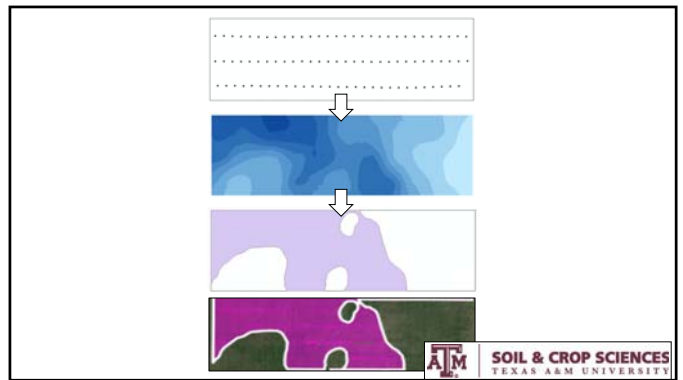
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On-Going TAMU GPS Sprayer Study

As the level of precision increases, how does this affect the number of applications?

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GPS Spreaders



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GPS Spreaders

- Works only with hydraulic controlled spreaders
- Precise spinner speed control of swath width
- Precise belt speed for automatic rate control

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Soil Moisture/Salinity Sensors



Credit: Spectrum Technologies, POGO, and Campbell Scientific

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In-Ground Soil Moisture/Salinity Sensors



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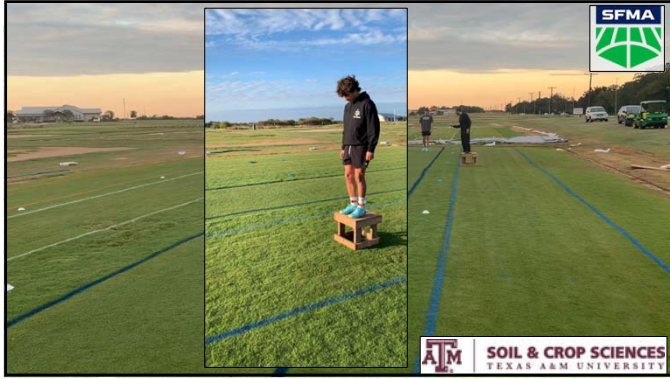
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Soil Moisture

- A lot can go wrong in the construction phase
- Native soils high in silt and clay = higher VWC and slower infiltration rates
- Soil moisture + traffic strongly effects turfgrass cover, surface hardness, and shear strength over time (Dickson et al., 2018)
- Soil moisture variability can impact athlete- and ball-surface interactions (Straw et al.)

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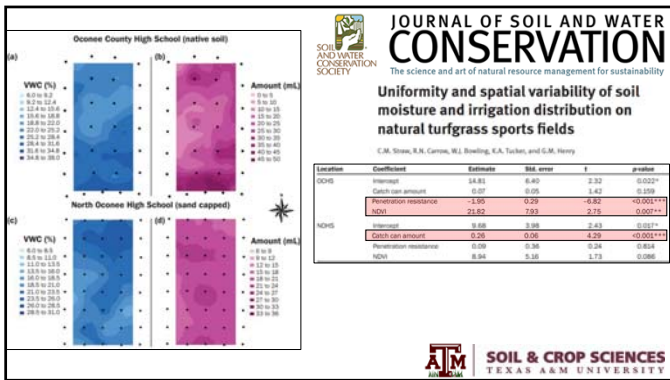
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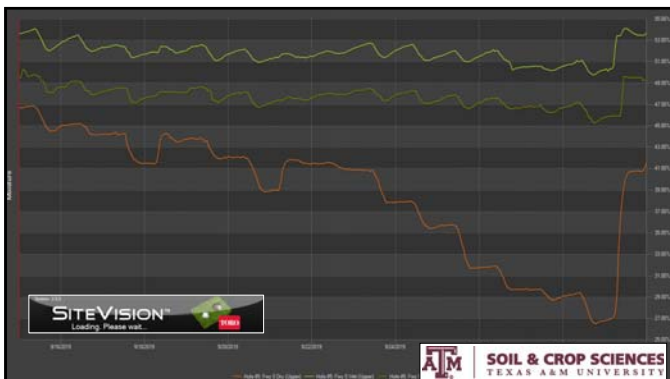
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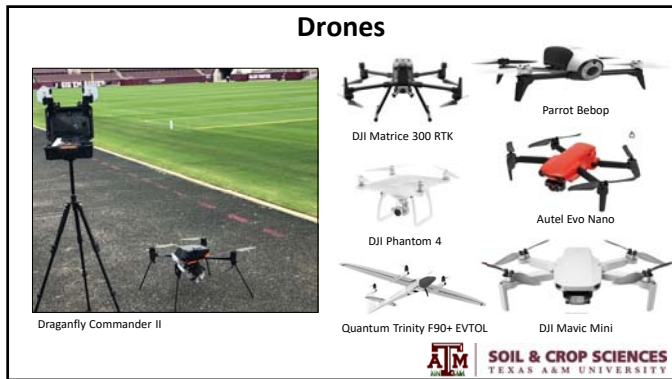
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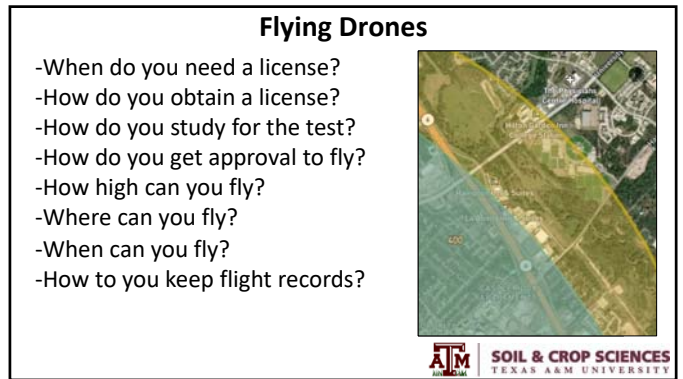
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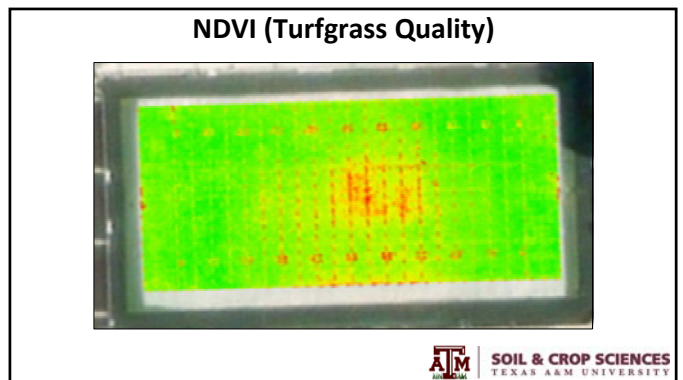
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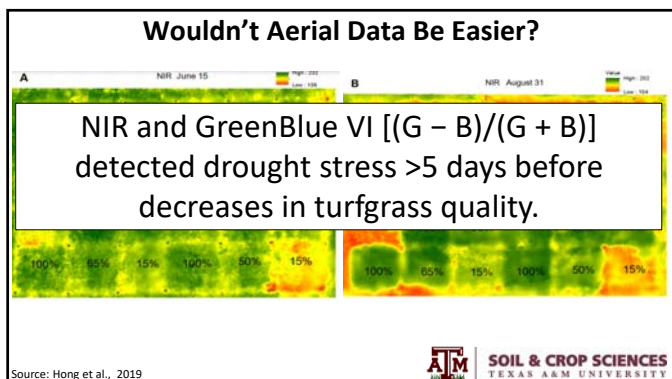
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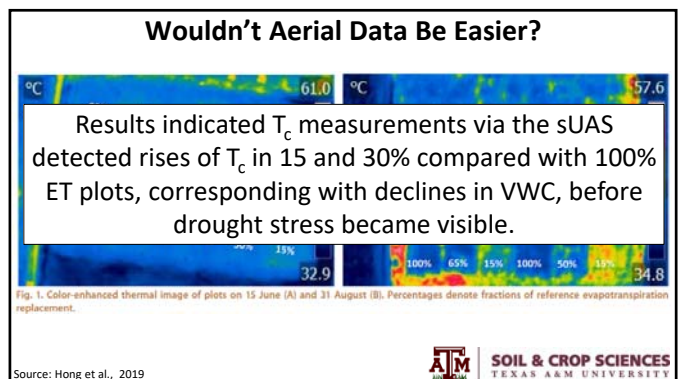
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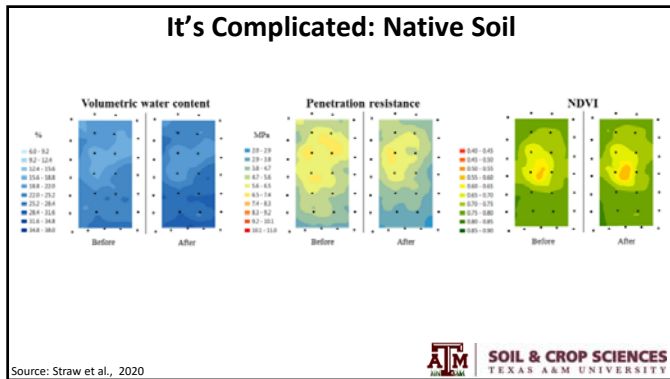
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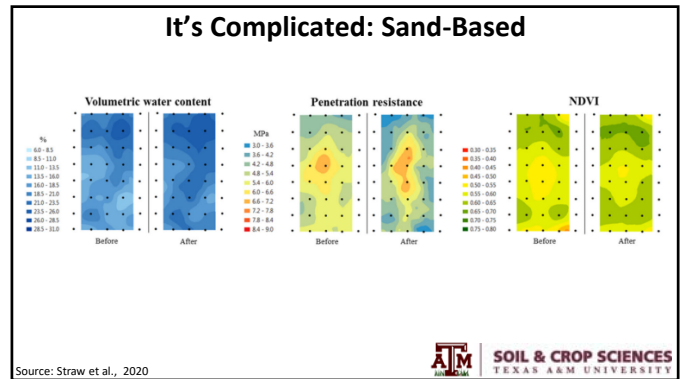
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The future of soil moisture sensing for golf course and turfgrass management.

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Variable-Rate N Fertilization

“UAV imagery can adequately assess the N status of turfgrass and its spatial variability within a species, so for large areas, such as golf courses,..., UAV acquired data can optimize turf management.”

Fig 6. Relationships between the clippings nitrogen content and NDVI data measured with the UAV on *Cynodon dactylon x transvaalensis*, *Paspalum vaginatum* and *Zoysia matrella*. In each species values are means of 4 replications.

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Variable-Rate N Fertilization

“The GeoEye-1 satellite can adequately assess the N status of different turfgrass species and its spatial variability within a field...”

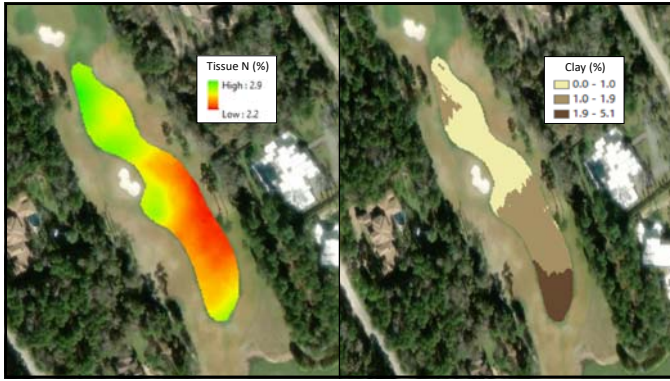
Source: Caugelli et al. 2015. GeoEye-1 satellite versus ground-based multispectral data for estimating nitrogen status of turfgrasses. *International Journal of Remote Sensing*, 36(8), 2235-2251.

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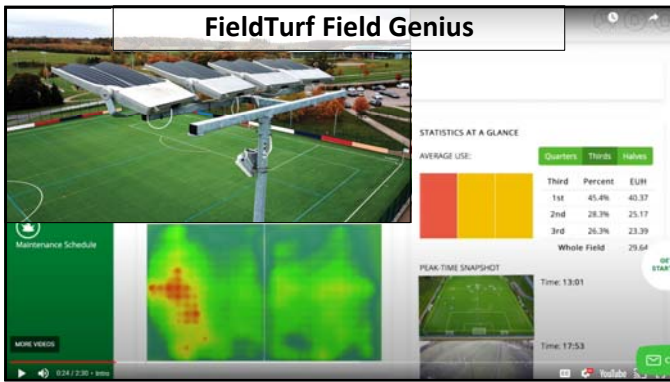
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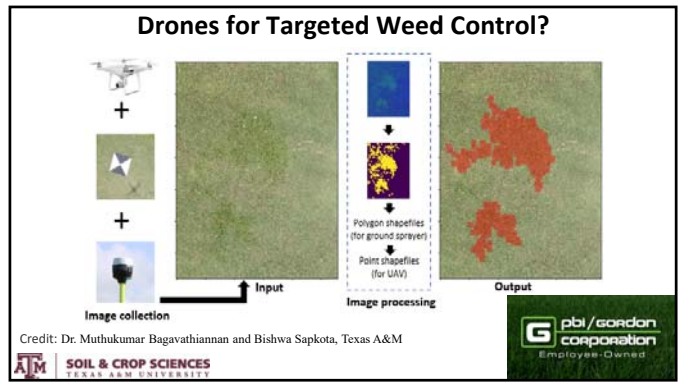
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Potential Challenges of RPAAS in Turfgrass

- Cost
- Urban areas
- Connectivity
- Objects
- Drift
- Efficacy
- Adoption

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Final Thoughts


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Thank You!

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