UAS Assisted Framework for the Selection of High Yielding Cultivars

Jinha Jung ¹,*, Anjin Chang ¹, Juan Landivar ², Murilo Maeda ², Ruizhi Chen ¹, Tianxing Chu ¹, Juan Enciso ³, Chenghai Yang ⁴

¹) Texas A&M University – Corpus Christi
²) Texas A&M AgriLife Research Extension Service – Corpus Christi
³) Texas A&M AgriLife Research Extension Service – Weslaco
⁴) USDA-ARS
*) Presenter
1. Unmanned Aerial Systems (UAS)

Why do we need UAS for PA?
Safety
Non-destructive measurements
Seamless Measurements
Can we identify high yielding cotton cultivars based on cotton boll count analysis applied to UAS data?
2.

DOW Cotton Trial

@ Texas A&M AgriLife – Corpus Christi
DOW (Phytogen) Cotton Cultivar Trial

- Planted on **March 27\(^{th}\)**, 2015
- Randomized complete block design
- **48** entries, replicated **3** times
- 2 rows by 30 ft plots, spaced at 38 inch
- 5 seed/ft plant density
- Harvested on **August 10\(^{th}\)**, 2015
UAS Data Acquisition

- Altitude: **30 m** (above ground)
- Programmed mission using Pix4D capture app
- Processed with Agisoft Photoscan Pro → Orthomosaic & 3D point cloud data
- Resulting spatial resolution: 8 mm
3. Cotton Boll Count Analysis

High Throughput Phenotyping
Orthomosaic Image

Binary Classification

Classified Map (cotton boll vs. background)

Connected Component Labeling

Cotton Boll Patch Map

Patch Size Analysis

Cotton Boll Statistics

- Number of bolls
- Average Boll diameter
- Average Boll area
- Perimeter to Area Ratio
- ....
By number of boll
By average boll area

11.9 24.3 (cm²)
By total boll area

By total boll area

3,638 19,331 (cm²)
By average boll diameter

<table>
<thead>
<tr>
<th></th>
<th>3.8</th>
<th>5.2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cm²</td>
<td>cm²</td>
</tr>
</tbody>
</table>

(cm²)
### Stepwise Cultivar Selection

<table>
<thead>
<tr>
<th>Sel. Cycle</th>
<th>Selection Description</th>
<th># entries</th>
<th># entries removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original</td>
<td>Original population</td>
<td>144</td>
<td>28</td>
</tr>
<tr>
<td>sel1</td>
<td>removed lower 28 entries based on eqdia mean</td>
<td>116</td>
<td>28</td>
</tr>
<tr>
<td>sel2</td>
<td>removed lower 28 entries based on peri mean</td>
<td>88</td>
<td>28</td>
</tr>
<tr>
<td>sel3</td>
<td>removed lower 28 entries based on area mean</td>
<td>60</td>
<td>28</td>
</tr>
<tr>
<td>sel4</td>
<td>removed lower 28 entries based on number of bolls</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>
144 original population
32 cultivars selected based on 1) machine harvested yield vs. 2) open boll count analysis

24 / 32
Cultivars selected by both 2) and 1)

75%
Success rate without harvesting!
Web Application
Conclusion

- Huge potential in UAS based High Throughput Phenotyping (HTP) system
- Feasibility of breeding selection based on cotton boll count analysis
- More to come in 2016
  - Plant height and canopy cover development rate
  - Water/Heat stress
  - Canopy health via NDVI (multispectral sensor)
  - LiDAR
  ...

Acknowledgement

Special thanks to all the people who supported and contributed to this project:

- **Texas A&M AgriLife Research Extension Center**
  - Dr. Juan Landivar
  - Dr. Juan Enciso
  - Dr. Murilo Maeda
  - Ms. Andrea Maeda

- **Texas A&M University – Corpus Christi**
  - Dr. Anjin Chang
  - Dr. Ruizhi Chen
  - Dr. Tianxing Chu
  - Mr. Daniel Gonzales

- **USDA – ARS: Dr. Chenghai Yang**

- **TAMU-CC, Research Enhancement Grant**
Thanks!

Any questions?