**S 1069 Meeting Notes**

**Raleigh, NC**

**March 21 – 22, 2017**

**Participants:**

Cody Bagnall, TAMU Wesley Everman, NCSU  
Steven Thomson, USDA/NIFA Michael Buschermohle, Univ of TN  
Robert Austin, NCSU Joe Maja, Clemson  
Cully Hession, VA Tech Gary Roberson, NCSU  
Robert Freeland, NCSU Dharmendra Saraswat, Purdue  
Maria Balota, VA Tech Jeffrey White, NCSU  
Joseph Oakes, VA Tech Chinmay Prakash Soman, Univ of IL  
Joby Czarnecki, MS State Louis Wasson, MS State  
Steven Hall, NCSU Larry Purcell, Univ of AR  
Michael Sama, Univ of KY Christian Brodbeck, Auburn  
Terry Spurlock, Univ of AR Randy Price, LSU

Eric Young, SAAESD

**Objectives of Meeting:**  
1) Update on university and federal activities including current and future projects *(research, extension, and teaching activities)*2) Review project objectives  
3) Identify research needs, prioritize efforts, and identify teams   
3) Provide time for individualized discussion based on topic area  
4) Provide UAV demonstrations to facilitate platform/sensor/applications discussions   
3) Discuss next steps (collaborations, follow-ups, next meeting location/date,)

**Current Research Survey**

Here is the link to a Google Sheet to enter your information. I have entered mine for an example. Please feel free to insert additional lines for each category as you fill this out. Also note that there is a section for good and bad impressions for the various software you have used. If you have other fields you think are important for the group please feel free to enter them.

<https://docs.google.com/spreadsheets/d/1DXQygwE5QYCs3IX3eo-XC-yipNcEgTlluEaXn2SF67c/edit?usp=sharing>

**General Discussion**

Day 1

*Whole group discussion of objectives*

Do we need to select one problem or everyone do something different and use same methodology? Is there a low-hanging fruit project that demonstrates success to a grower? Can we do a simple project to show value? Of the objectives, there are pairs: 1 and 4, 2 and 3 – details in 2 and 3, methods in 1 and 4.

Visible camera is common thread that most people have. Can we base a project around visible? Perhaps NDVI standard. People like the ratio aspects. Could be tricky because NDVI differs. NDVI is just a measure of health, so how much does it matter? Bandwidth could be an ally here as it makes things less specific.

What IS the low-hanging fruit? Something a producer can use right now. Anomaly detection is the key. Must be anomalies the producer wasn’t aware of. Time series is more useful and we don’t always get a time series on damages. Must be some active way to factor in a priori knowledge of field. This data would improve usefulness of NDVI. Need to integrate more existing knowledge from producers.

Perhaps even an application that sorta works is better than nothing? For example, NDVI-led applications like fertilizer apps.

*Discussion of protocol development*

Protocol is important to all 4 groups. Perhaps it could focus on a list of things you have to gather vs. things you might also do and methods for how to do the required things. This would help with formatting the collected data to standardize the database. Facilitates inherent tasks in the database, such as unit conversions, etc.

This protocol would be released internally, not to the world, but we agree we should have some sort of protocol; general but with more detail for specific applications. Protocols would differ based on objectives, but we acknowledge there is some level of generalized data. Protocols would be for standard practices, and have more specific requirements for specific objectives would need some additional things. This seems like a lynchpin for our project.

Protocol development – start at the END. Protocol develops from purpose. Research to develop protocols versus applied research that uses protocols.

How do we design the database? How do we move into collaboration? How do collaborate in an unfunded environment?

*Other thoughts*

Researchers care about processing, farmers do not. Black box is cool so long as they can interpret it. Practical advice that is science based, but simple it the outcome.

Discussion about software. Open source, one-off solutions, etc. Pix4D popular option. Do we need to agree on a software and sensor for the protocol?

Proposal: same crop, same treatment, same sensors. Generate a protocol. Start by making a list of sensors and see where the overlap in resources is. Producing a document for reporting versus collecting.

Action items: Start making a database of skills, interests, and resources; Review protocols from each University group to see how different we are in terms of processing and collection.

*Next steps*

NIFA proposals due in a few months; can we write one proposal for each objective? Objectives versus focus areas for proposals. We need to identify funding opportunities. Other thoughts on how to move into grant development follow.

Perhaps a list of questions we want to answer. What are the priority questions?

How can we improve on previous approaches with other platforms? How can we be unbiased and make sure we’re not in this to sell UAVs? We need to make sure we are looking at sound science before we decide. Land grant mission is to add value to production; make sure we identify areas of value and also areas of non-value.

Maybe we should start small before collecting lots of data we don’t need. Stick with science, then advance. Start with detection and analysis best practices.

Ultimately we decide that we need surveys and baseline documents to start planning grant proposals.

*Extension Talk*

Demos are involve people wanting to see what you’re seeing with the drones and showing people how to set up the drones and flights.

Tend to use Phantoms because of safety amenities for demos. Easiest to fly in that it will hover on its own. Let visitors fly to see if they would enjoy it. This is why they come!

Range of people at these days means potential users, and very few high end users. People on low end of use continua. Lots of non-ag uses and are waiting to see if there will be any money-making uses in ag. Farmers who tinker, crop consultants. Mostly using to get a quick look.

Show a range of drone options. Show them potential photos they can get with the products. Tell them they need more steps to do specific applications. Other issues worth showing. Oblique views versus nadir views. Edge of field view versus interior of field.

Videos are often good enough to tell *a* story, maybe not a research story, but an extension story.

Lots of choices for a grower in the marketplace. Must be able to answer questions for the growers about how to make these choices.

Remember the workflow to use begins with getting people LEGAL.

Data quality and safety are important. Participation in an FAA pathfinder project to increase airspace safety by some groups to test LATAS.

Day 2

Action items: Please send presentations to Eric.

Database – already moving forward on. Please fill in survey if you have not.

Submit protocols from each University for pre-flights – Dharmendra will handle

Still don’t know how we form proposal teams. Research buckets for proposal development. Cross disciplines by crop versus area of detection? Short versus long term? By topics? Sensors, phenotyping, stresses, data utilization analysis. Seems like THE missing step is the so what? The relationship between image and field action.

Perhaps we need statisticians, biometrics, and machine vision faculty to move us forward.

Pick an important problem and build a team. Sensor expert to pick sensor, research experts to do field work, extension team to move up to applied system.

It turns out for a bunch of smart people, we don’t really know where to go from here. There’s a lot to do, but no one is sure where we start. We have many needs – lots of data, lots of statistics, repeatability, reliability, transferability, long-term vision.

Host location for next year. Perhaps TAMU. Will have to discuss with Alex. Need to pick dates. Perhaps a bit earlier next year – early March. Subsequent to the meeting, Alex agreed to host the next meeting in Texas sometime in early March.

**Objective 1 Notes**

*Phenotyping vs Non-Phenotyping*

Soybean plots, damage (20%, 40%, etc.), take an image from the field, spatial and spectral characteristics. Should we have a common protocol for how to collect data across the group? Every sensor is different. Every objective is different.

Objectives are usually more general. Can we set up a general methodology that is common across the group? It may be difficult given the wide range of projects and backgrounds.

Is the emphasis on to specify the sensor/platform or the biology? Sensor characterization using remote sensing protocols across different geographical areas.

Simple questions: how often and when can I detect a particular parameter?

Coming up with data management standards.

Anomaly detection. Determining physiology and what sensors are useful for detection.

Sensor range is limited on UAS-deployed applications as compared to larger systems.

There is not a large enough dataset to support commercial products.

Metadata standard? Maybe not follow a collection protocol but certain information must be provided with a dataset so that data can be compared.

Finding manuscript reviews can be challenging in this area.

What sensor did you use, what wavelengths, where did you use it? We need to come up with core set of things you need to document across different sensors.

Environmental considerations: cloud coverage, wind, temperature, etc?

Find out where problems in the data collection/processing chain occur. Documentation at certain steps helps.

Develop a form that users can check off or fill in items.

MODRAN can be used to correcting cloud effects of satellite data.

*Summary*

The group coalesced around the idea that we need to develop simple tools for documenting data collection methods so that the resulting data is useable across individual investigators and projects. Part of the data aggregation and standardization process should be to define what metadata is required for S1069 related projects.

How should we go about setting up the online database? Are there existing resources or do we need to secure funding to support this objective?

**Objective 2 Notes**

* To start out there was a good bit of discussion over what the grower needs and what kind of actionable information we can provide.
* It was discussed that currently about 85% of growers are interested only in simple observational data (something like live video stream) while the remaining 15% are the high-tech growers who want to know everything
* It was further discussed that it is important to teach people what the rules are and how to go about getting a FAA license and registration. However, it was decided that this was probably a better fit under Objective 4.
* The following Sub-Objectives were developed:
  + Development of Calibration Procedures
    - There needs to be a calibration procedure developed that growers are collecting good quality data. This procedure needs to be a simple, turn-key solution that allows for image calibration and data use (such as using a nitrogen rich strip in a field).
    - Additionally a second calibration procedure needs to be developed that researchers can use so that consistent calibration procedures are used across all UAV data collection. This calibration procedure should be such that it can be referenced when developing an article for peer-review publication.
  + Development of Appropriate Platform Recommendation
    - Many times the question is what should we purchase? A set of guidelines needs to be generated to help determine a suitable platform that includes questions such as scale of area to be flown, type of data to be collected, and who the user is (researcher or grower).
  + Data Management
    - This is a sub-objective that crosses all objectives, but becomes a more apparent issue as the scale becomes larger.
    - One solution to helping with data management is using cloud-based systems, so it would be good to test numerous cloud-based image processing companies to develop a set of pros and cons depending on the application
    - Second, developing a set of pros and cons for in-house processing software’s that growers and researchers can look at make educated decisions.
  + Data Utilization (Value Added)
    - The discussion here was can we conduct a case study across the multi-state region that uses the low hanging fruit to demonstrate the capabilities and usefulness of UAV technology?
    - Also, it would be beneficial to put out a bulletin that addresses what can currently be done with the technology and some speculation as to what we believe the technology will be able to do in the near future.
    - As part of the data utilization, it would be good to generate a work flow/solution on to plan, fly, collect, download, process, and use UAV data.

**Objective 4 Notes:**

* Not enough practical information for Extension to work with.  A grower may ask, “What can I do with $300 imagery?”
* Simple use questions and standards for outreach.  Newsletters for example
* Standardized outreach information for county agents.
* More information on FAA Part 107 for growers and agents.
* Training for growers and agents on how to use UAS imagery data.