Guest: Dr. Alison Thompson

Institution: USDA-ARS

Interview date: 05-15-2022

Background:

Dr. Alison Thompson is a Research Geneticist (USDA-ARS) stationed at the U.S. Arid Land Agricultural Research Center in Maricopa, AZ. She has been in her role the last 7 years. She was hired to ARS as a cotton breeder and leadership encouraged her to engage in high-throughput phenotyping (HTP). She describes his period as really the wild west in terms of innovation in this research area. During this period her research unit co-hosted workshops with U. of Arizona to demonstrate HTP approaches and share established protocols that others could follow. She acquired some experience with HTP during her training in graduate school at Washington State University.

She started using tractor based phenotyping system and then transitioned to using cart and unpiloted aerial systems (UAS) via collaborations. During this time period UAS were becoming more popular and were cheaper than other options. Folks wanted more information about UAS incorporated into their HTP workshops. She started using drones derived data into her program about 6 years ago, first through out-sourcing data collection to contractors that offer drone flights as a service for construction applications and golf courses. During this period she began to review and think through what successful data collection and storage protocols look like and collaborated to develop data extraction workflows from UAS data. There are lots of different drone and sensor types. Collaborators tried quite a few options and ended up purchasing quad-copter DJI with RGB camera when the cost of outsourcing data collection became prohibitive due to the number of flight missions performed each field season. ~~They next purchased a DJI rotocopter and used that until guidance from ARS demanded a search for alternatives.~~ I left Maricopa before an alternative could be identified

She values working in tandem with agricultural engineers. Working with them from the start has helped with guidance regarding the need for ground control points (GCPs), assessing the types of traits that can realistically be extracted from UAS data, and identifying the specifications for drones and sensors that can apply to their research questions. She has done some comparative studies for sensors looking at practicality on carts and tractors not UAS.

Her broad advice/thoughts are as follows:

Before you undertake this journey take some time to think and answer the following questions. What is it that you want from your study? What phenotypes or traits do you need to measure? If you can’t answer those two questions you probably won’t get what you want out of it.

HTP is something that everyone seems to be doing and nobody wants to be left behind. It is so easy to start just collecting images that many people don’t actually stop to think about what they are actually going to do with the data.

Ask yourself the following questions:

Is this practical? Is this useful? Can you manage a drone program? FAA regulations may change and make this process more cumbersome. Do you have someone to help manage the data? Do you have necessary storage resources?

Interview Questions:

*1.      What do you consider the biggest barriers to entry for implementing a UAS into a research program?*

Initial investment. Although the cost of drones, cameras, and other sensors have come down a lot folks hesitate over the question: “Is this really going to help my program?” UAS is a big black box for folks to understand realistically what I can get from the data that will help my program. How will it help? Is it worth the extra time and money investment?

Most people know at least someone that has implemented UAS. The need to see value for their application. Real world examples might be:

Breeder: How much did this technology improve genetic gain?

Agronomist: Decision support tools. Did the drone provide novel input or higher frequency input that can better inform decision support tools?

Crop Modeler: Does UAS help predict an outcome given certain parameters? Models are built on models, are built on models… Oftentimes very limited real-time data goes into these models, lots are based upon historical data and known facts. Her group has found that actually being able to feed modelers real-time data can achieve better outcomes.

Physiologist: Deeper understanding how things/parameters change over time.

*2.      What do you consider to be the most and least promising applications of UAS-based imaging for agricultural research?*

Folks have already demonstrated that UAS can be very helpful for decision support tools. Dr. Kelly Thorpe recently published a study demonstrating how UAS can be used to improve irrigation management: <https://elibrary.asabe.org/abstract.asp?aid=53019>

There are numbers in that manuscript that report how much it improved performance. This is mostly because it provides almost real-time feedback on crop growth. This is great for crop management and makes a good case for incorporation of UAS into precision agriculture.

She hasn’t seen such an obvious case for improvement in breeding. Usually the data is combined with other measurements in the context of genomic selection.

Bottom line is that there is still a lot to be determined on the utility of UAS in breeding and physiology.

*3.      What are some of the things you wish you had known before you began using a UAS for data collection?*

Ground control points are a must!

Don’t try to do it all yourself. It is good to have someone in charge of flights and drone maintenance. Generally, there is another person needed to process, analyze, and store/manage the resulting data. There are not many people who can do it all. Expecting someone to do that is unrealistic.

Build a strong support network from the get go. This is important for any HTP project. It is good to have cooperators in agricultural engineering and information technology.

Alison calls herself a luddite and stresses the importance of building a team.

*4.      What educational resources have you found most useful when developing your own skillset with UAS-based imaging?*

She has learned a lot about drone operation from Ag Engineer Kelly Thorp. HTP technician Matt Conley knows the ins and outs of just about everything. He spends a lot of time teaching people. Knows a ton about building and operation of ground based HTP carts.

She recommends reading the drone user manual. \*Can’t stress that enough!

Get to know other people who helped develop or deploy similar equipment.

In terms of data management and processing she recommends checking out the great learning resources on Coursera and LinkedIn. These can help identify some of the complexities faced when managing image data and can help conceptualize the how to process it.

Her preferred software for generating orthomosaics are Agrisoft Metashape and Open Drone Map.

She recommends learning Python. She likes using Python. Usually starts students off with tutorials in Coursera. She recommends trying out hands-on examples and attending workshops.

ALARC and U. Of Arizona used to host a NSF funded phenomics workshop. Her USDA-ARS unit partnered with Kansas State University and The University of Arizona to put the workshop on annually and they hosted the workshop as collaborators. Ultimately, they felt there wasn’t enough positive feedback for putting the time and effort to conduct the workshops. The NSF funds also ran out.

*5.      Are there other comments you believe would benefit an agricultural researcher considering implementation of a UAS into their research program?*

Alison on a soapbox:

“This is not a silver bullet. HTP (UAS), in some circles has been touted to be a silver bullet. It is not. Ultimately you need to apply tried and true scientific methods to learn from your experiments. You cannot fly with no objectives in mind. You need to have everything in place experimentally and logistically to make it work. You need to start with addressable questions and follow scientific methods and best practices. Use UAS/HTP as a tool. It will add more problems than you currently are dealing with otherwise.”

Make sure you are patient. Getting UAS to work efficiently within your program will not happen overnight. She mentions that even after 7 years her group still doesn’t have all the answers.

Generally, 4 ground control points at the corners of your experiment are good enough. Different folks give different answers. See publications from Kelly Thorp.

Choice of sensors really is depends upon the research question being asked.

Thermal will likely help with water use efficiency, stomatal conductance, and/or maybe some information about root architecture. Thermal images can appear pretty blurry (low resolution) and what you get out might not look a whole lot like your field. Lots of validation and ground truthing steps needed to be confident in the data.

RGB is great for phenology in cotton. Can see leaves, branches, etc. For phenology RGB does great.

Hyperspectral: A lot of unknowns as it relates to physiology. Quantification of chlorophyll content will likely work. Maybe can report on sugar content but would also require measurement of other lab procedures to ground truth.

Multispectral: Alison has less faith in multispectral. Mostly used to get NDVI. There are a lot of spectral indices and it is debatable how useful they are. Chlorophyll content prediction doesn’t seem to work in Arizona. No standards in the sensor market. For certain environments certain bands just seem to work better.

They’ve assessed chlorophyll content and compared with data from multispectral camera and didn’t see any correlation with SPAD meter.

Final advice in regards to setting up drone measurement program: “Stay the course. Until you’re sure it’s done.”