Guest: Dr. Atena Haghighattalab

Institution: Independent Global Consultant

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Dr. Haghighattalab is an independent research consultant who has been applying UAS for plant breeding since 2014 but has been involved in remote-sensing for much of her professional career having been awarded a undergraduate degree in Geoimaging/Geographic Information Systems and a Master’s degree in Remote Sensing Engineering.

Her interest in agriculture began when she wanted to broaden her skills and utility. Ultimately, she wanted to identify ways to user her expertise in different areas.

Her graduate thesis advisors at Kansas State University were comprised of GIS and remote sensing scientists, plant breeders/geneticists, and one from private industry focused on robotics and image analysis. One of the most valuable experiences in her career was working at CIMMYT in Mexico. There she used both small sensors attached to Cessna planes and small drones (fixed wing and rotocopters) for the purpose of comparison. She has experience using a lot of different sensor types (RGB, multispectral, thermal, hyperspectral). She notes that payload size is an important consideration. You can put a lot on a drone but you can put a lot more different sensors on a Cessna.

As part of this research she had a lot of ground truth data (plant height, yield, NDVI) to compare the remote sensing measurements with and essentially all the data they examined was well correlated.

With so many different types of drones and sensors considering the application, what you want to get out of the measurements is important. If a drone and sensor combination works well for corn can we transfer this same technology to cotton?

She found that cotton was by far the hardest for breeding work. It was great to work at CIMMYT because you know the budget from the start of the project. It was clear to her she needed to keep costs low to deploy this technology more widely across multiple field sites so she developed a drone and camera combination that costed ~$700. The thought was that you don’t need extremely high spectral resolution to measure height, plant nutrient deficiency, or severe insect damage.

She notes that it isn’t usually wise to buy the most expensive drone first as technology changes rapidly. She recommends buying a drone and sensor combination that is well suited for your research question/application.

Good first steps are to develop a team and build the downstream data analysis pipelines. Once you collect data across several years you will find that in retrospect not all the data is collected perfectly. It is important to spend the time to learn to analyze the data you are collecting.

She notes that it’s no longer high-throughput phenotyping if you’re just simply moving time/effort from a research technician to a computer science student.

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

By far the biggest barriers are not having the platform and foundation of a multidisciplinary team. Many labs have a drone and they think that is the end of it. Truth is that just collecting the data isn’t enough.

That said, there are many details that are very important to collection of good quality data. Considerations include: time of day, sensor calibration, need to record and track metadata, environmental conditions during data collection. She emphasizes that time of day is key to consider/keep consistent. There should be a schedule for data collection.

If you have a group that has experience with these items the next challenge you will encounter will be how to store the data, because there will be a lot of it. You also need to know how to analyze the data. It requires specialized knowledge, skills, and abilities to analyze these datasets. Oftentimes there is a need for collaboration with folks outside of your discipline.

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

Most promising:

When she started in this field everyone was excited that measurement of plant height could be automated. Then they found out that they could measure a lot of other traits (lodging, ground coverage, etc.). Now they can build models to predict days until heading and days until maturity. The use/application of neural networks to model data is exciting.

Least promising:

Totally automated data collection and analysis has been oversold. This is probably not realistic but the technology is advancing. Some traits will be easier than others and it really depends upon the focus of the team. Results indicate it is definitely possible to predict yield and other features for some commodities.

Some folks in private industry over promise what they can deliver. Particularly what can be delivered on a timeline. Just because something are possible they are not always easy.

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

When she started she quickly realized that analysis of data from satellites and drones is quite different. She retrospectively wishes that she had better Python and R skills at the time. R is/was used a lot by plant breeders, whereas Python is good for cross domain work.

Mentioned that she has always had a good support team (plant breeders, IT support), meaning that she always been able to collect data and analyze it.

When she started this work they were sort of pioneers in a way. One of the first groups trying to connect phenotype, genotype and environment data. They made mistakes, failed on a few flights, and had to learn and improve from these experiences.

In subsequent years other folks starting doing it too and they could learn from each other’s experience.

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

It really depends on the individuals background of course. If you’re coming from a plant breeding/agriculture background she recommends:

Find collaborators that have an incentive to work with you. Find areas where unique skills apply to the same problem and how they can share knowledge. Learn from each other.

Going to the Phenome/North American Plant Phenotyping Network (NAPPN) conference. Most folks there have some computer science background and the focus is primarily about merging trans-disciplinary skills. The theme is high-throughput phenotyping, root imaging, data synergy.

She also mentions the Australian Plant Phenomics Group, International Plant Phenotyping Network and the Phenome Force workshop series as additional resources.

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

With any research subject, we tend to get more excited about the potential of a technology relative to what the technology actually does for us. Remember the application.

More work is needed on sensor development. She feels that we need more exploration of how narrow bands report on different features. One point of emphasis is that we need to make the effort to collect the best data possible (consistent time of day, weather, etc.) and do a better job at considering the effect of weather on what the sensor outputs. More work is needed on sensor technology.

When it comes to sensor choice think about your needs. A farmer needs to survey large areas of land and see affected areas. Can they tell if damage is due to hail or disease?

RGB can only tell if there is damage, multispectral may in some cases be able to discriminate between types of damage.

Hyperspectral and thermal imaging is a totally different story.

Thermal provides a direct measure of heat and nothing else. No other technology will give you this type of direct measurement.

She hasn’t worked much with hyperspectral data but recognizes the challenge of figuring out what wavelengths are useful and which are linked to a trait of interest. She wonders “Do we really need or want that much data?”

She believes hyperspectral technology is really good for discriminating between 2 different groups or categorize what is happening. Which bands are useful for what needs? Then these wavelengths can be used to develop multispectral cameras for specific applications. Unfortunately, there will be a lot of noise that can confound results that makes sifting through the data difficult.

Comparison of data across time and space is a challenge. Every pixel on the ground is relative. You collect the data today and you want to analyze data collected over several years. The computer only knows as much as you can tell it. The more data you have, the more you can use the computer to learn from it.

She gives the following example:

A single plot (let’s say plot #15) will be at slightly different coordinates within the image at a different date. Think of the orthomosaic as layers of data. Can layers go on top of each other? You will need to georeferenced to data to do this. This is very important for temporal analysis. Both spectral and temporal resolution are important for learning from data.

Final thoughts are: “It’s a process and we’ll figure it out. We need to listen to each other and learn from our experience. Collaborate, collaborate, collaborate.”