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Subcommittee on General Farm Commodities and Risk Management

"Big Data and Agriculture: Innovation in the Air"
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Good morning and thank you Chairman Crawford, Ranking Member Walz, and members of the House Committee on Agriculture. I am honored to be here today and appreciate this opportunity to discuss the benefits of drones in agriculture and some of the challenges that impact its adoption and implementation.

My name is Robert Blair and I am a fourth generation north Idaho farmer raising wheat, barley, peas, lentils, and garbanzo beans on the rolling hills and canyon tops of the Palouse growing region. I am also the VP of Agriculture for Measure, the leading Drone as a Service® company that offers a drone flying service to agriculture and other industries. We put pilots and systems in place to collect data, do analytics, and return the data to the customer in a timely manner.

It is vital to the national security of the United States of America and to the rural communities throughout that agriculture remains strong and viable. Rural communities greatly depend upon the economic success of agriculture but it goes farther than that. All of America, along with those in many other countries, depends upon U.S. agriculture success as well. I truly believe that agriculture technology, especially the use of UAVs (unmanned aerial vehicles), sUAS (small unmanned aircraft systems), or drones, as many people call them, will pave the way from precision agriculture to surgical agriculture.

Agriculture has a tremendous challenge and responsibility of producing enough food to feed nine billion people by the year 2050 and doing so sustainably. Agriculture domestically and internationally is under increased pressure from many different sectors to reduce water use, reduce erosion, reduce pesticide use, and reduce nutrient applications while increasing crop quantity and quality. The agriculture industry cannot do this alone, but by utilizing precision agriculture technologies, especially UAVs, those working and managing the land can be successful in the mountainous challenge.

Agriculture Technology Background

The agriculture industry has always been on the leading edge of incorporating technology. From the beginning of time humans evolved from poking their finger in the ground to using a stick to plant seeds. The Industrial Revolution saw inventions like John Deere's plow, McCormick's reaper, and Eli Whitney's cotton gin help to increase productivity, increase quality, and to replace rural labor that was migrating to cities.

My Great, Great, Great Uncle started the farm in 1903, the same year Henry Ford started his company that gave us assembly lines, the same year the Wright Brothers had the first successful manned powered flight, and the same year of the first successful west to east radio signal transmission. These innovations are the corner stones for today's agriculture equipment and precision technologies.

I started my precision agriculture journey in 2003 by using a simple PDA (Personal Data Assistant) to do simple mapping. Holding the device, the stylus, and the GPS receiver brought about a challenge of needing a third hand which led me to creating my own innovation by riveting metal on the brim of my hat to affix the magnetic GPS receiver to so I could run the stylus and hold the device.

From that point on, I didn't look back. I incorporated a yield monitor, which led to saving 20-25% of nitrogen costs; autoboom, which has saved me between 10-15% on seed, fertilizer, and pesticides; and autosteering, which has reduced my overlap between 3-5%.

It was a very exciting time in 2004 learning about these technologies, incorporating them on my existing equipment, and trying to figure out how they could best serve me and my quest to be a better manager and steward of the land. It wasn't until I flew in a manned plane that summer that I realized aerial imagery was the missing piece to the precision agriculture puzzle.

Agriculture UAV Timeline

Being able to see crops growing from the air in 2004 provided a perspective I never had before. I could see areas in my crops that were doing very well and others that were falling down. When scouting a field, problem areas are hard to identify until I am in the middle of the worst part. Being able to see my fields from the air was an "ah ha" moment for me.

At the time I did not realize that the person I was working with was introducing me to remote sensing. He was using a modified camera with a filter to try to capture images to produce a Normalized Differential Vegetative Index (NDVI), a form of vegetation health analysis.

However, the crop "production line" does not shut off or get put on hold while aerial data is being captured and processed; the crops keep growing. I had to wait at least three weeks for the plane to come to my farm and then another three weeks to get the information that I was paying six dollars an acre for. Too much time had passed to where I could take action to address issues. The information needed to be timely. We have come a long way since I saw an ad for a UAV in 2006 but the need for timely information has not changed.

In the early days of experimenting with my UAV I discovered many shortcomings with the technology. Existing agriculture software was inadequate at utilizing UAV data, photo stitching software was practically non-existent, and analytical processing software was almost not even thought of. I was at the cusp of what this new technology could achieve.

In 2008, I filed the first petition for exemption to the U.S. Federal Aviation Administration (FAA) for commercial UAV use in agriculture, along with providing the FAA documentation on guidelines of how they should be used; many of my points are very similar to the current exemption rules. I also petitioned to try and obtain a seat at the FAA rulemaking table for agriculture. To this date agriculture still does not have a seat at the table.

Around the same time in 2008, many people outside of agriculture saw the possibilities of what this technology could do and companies sprang up overnight building less expensive UAVs and better software; technology that farmers could afford. I no longer needed to worry about building my own UAV, modifying cameras, cobbling software together or trying to understand hard to use autopilots and

flight software. It all comes down to being able to put UAV collected data into the cab of a tractor, applicator, or mobile device.

On June 18, 2014, the FAA defined what constituted as commercial versus hobby UAV operations. Since that time, I have not piloted a UAV over my own property; instead, I have complied with the rules and had certified pilots operating under FAA Section 333 exemptions to gather data over my farm. An example of the distinction made between commercial and hobby use is that while I can fly a UAV over my property and take all of the pictures and video I want, the moment I use that information to make management decisions, I am a commercial UAV operator.

Over the years I have been asked many times "Who will be flying UAVs, the farmer or a service provider?" With my experience in this industry, I see a future of service providers flying for agriculture. Farmers, ranchers, crop advisors, and agronomists have enough on their plate let alone becoming an aviation expert, remote sensing expert, software expert, and/or geographic information systems (GIS) expert. Instead, UAV service providers like Measure can collect the data to make the jobs of those with boots on the ground easier. A crop advisor friend stated, "I am currently managing 20,000 acres and with your service I could double the acres along with having better information for the farmer."

Part 107 was announced on Tuesday, June 21, 2016. There are a couple of provisions beneficial for agriculture such as obtaining a remote pilot certificate instead of needing a full pilot's license and not being required to have a visual observer. Both of these provisions will save costs making it less expensive to conduct business.

However, I believe UAV service providers like Measure will still be needed due to the time required for flying, processing imagery, and trying to make the imagery into actionable information. Operating safely is a priority of Measure and we will use highly trained and certified pilots to carry out flights.

While Part 107 is a major milestone for the UAV industry there is still work that needs to be done. Beyond line of sight (BLOS) operation will be needed to cover the millions of agriculture acres in the United States in a timely manner. Rules to fly at night with thermal cameras can collect data with higher accuracy due to the cooler evening temperatures. Also, further clarification is needed to conduct aerial application of pesticides with UAVs.

UAV Benefits and Opportunities

Before I had even heard of a UAV I saw tremendous potential for aerial imagery that could help my farm and the agriculture industry. I asked myself questions such as: "Can I apply nitrogen as needed and where it's needed during the growing season with certainty," "Can I identify weed infestations and treat twenty percent of the field instead of one hundred percent," or "Where should I go to do a visual observation, take a soil sample, take a tissue sample, or do a combination of the three?"

I have been fortunate to speak domestically and internationally on the benefits of precision agriculture, remote sensing, and UAVs and listen to people's questions on how could this technology be used on their farming operation. I have also benefited from doing two different agriculture fellowships that allowed me to interact with thought leaders and technology adopters at all levels in South America and Europe. These experiences have provided me with a better understanding of what UAVs can do for agriculture.

Last year Measure did a high-level, two-part study on agriculture UAVs with many different industry partners as co-sponsors. The highlight for me was the part of agriculture crops that are lost to weather and management. Roughly twenty percent of a crop is lost and the report indicated that UAVs can help gain back one quarter of what is lost due to management. I believe there can be even larger gains because better management and direct application can lead to gains against weather.

My experiences helped me gain a unique understanding of how UAVs can help agriculture today and in the future. Below I will list and briefly describe where UAVs can be of service to agriculture.

- General Scouting – UAVs can assist farmers and agronomists/crop advisors with their scouting by covering the acres in advance of needing to put boots on the ground. Currently those in agriculture go into a field to find a problem. UAVs can scout ahead of time, locating specific areas that would need further inspection. Another scouting benefit of UAVs is the amount of area it can cover. A UAV can cover one hundred percent of a field, while the example included in the testimony only covered around five percent.

- Nutrient Management – Fertilizer is a major expense for most crops. UAVs can be used to identify and monitor production zones created for variable rate application of nitrogen. This type of application not only reduces costs for the farmer but also helps reduce impact on the environment by applying what is needed where it is needed.

- Irrigation Management – In irrigated crops water management is critical. UAVs can help identify zones to apply water at varying rates and identify irrigation equipment issues such as a plugged nozzle, a worn out nozzle, etc.

- Weed Identification – UAVs can obtain high enough resolution imagery that can show weeds between the rows before a crop canopies. The ability to use this data so a farmer can determine the threshold level on treating an area versus not applying can save thousands of dollars at the farm level.

- Insect & Disease Detection – While this is very similar to weed detection, it is more difficult to achieve in most cases. The creation of new sensors and a better understanding of where these pests show up on the spectrum chart are things the agriculture and UAV industry need to strive for.

- UAV Aerial Application – Japan has been doing aerial application of pesticides for almost thirty years. In the United States we are just getting started. These UAVs can be used to do spot applications in fields for small pest areas along with operating safely in difficult terrain such as pasture hillsides and grazing land. It could also operate safely over fields that are located within urban areas.

- Crop Insurance – Crop insurance is the cornerstone of risk management for farmers. UAVs could provide high resolution images to identify the area of a field that has been damaged by weather to assist the crop adjuster. Currently, the area designated for damage counts is identified with the toss of the farmer's or crop adjuster's hat. Where the hat lands is where crop inspection

begins. Using UAVs to determine the severity of weather damage would be an improvement upon this process.

- Crop Stand & Germination – UAV imagery can be used to detect how well a crop has been established and/or if there are germination issues so the farmer can determine if he/she should reseed. In the case of sugarcane, understanding what percentage of the sugarcane crop is viable at ratoon 2 or ratoon 3 is important so the farmer can determine if he can leave the existing crop in another year or if it should be worked up and planted to something else.

- Cattle – A thermal imaging camera could be used in a feedlot situation to detect sick animals along with detecting a cow in heat that is ready for artificial insemination. Furthermore, we can use thermal data to locate cattle on the range.

These are just a few innovative ways that UAVs can be used today. Just imagine what they could do tomorrow on farms and ranches to help American agriculturists compete on a global scale and ensure that food is continually on the dinner table. We need to look at ways this technology can also be used by the United States Department of Agriculture (USDA) to keep up with the rapidly evolving and tech savvy agriculture industry. I believe there are many uses that each department could take advantage of including:

- Risk Management Agency – Crop insurance claims, reporting and validation.

- Farm Service Agency – Crop reporting accuracy, especially with spring crops.

- Animal, Plant, & Health Inspection Service (APHIS) – I have had discussions with Undersecretary Osama El-Lissy about using UAVs to inspect cargo ships and containers to identify insect larvae and nests. Also, how UAVs can be used in the battle to eradicate the boll weevil by identifying host plants in non-cropped areas and then do an herbicide application by UAV instead of by foot.

- Natural Resource Conservation Service – Not only could UAVs be a program enhancement for the Environmental Quality Incentives Program (EQIP) or the Conservation Stewardship Program (CSP), it could help to better assess residue in fields instead of using a one hundred foot string line with markers on it.

While I could go on listing more departments and uses, I believe this paints a great picture of why UAVs need to be a more integral part of the next Farm Bill discussion. Everyone from Congress to the farmer and agriculture organizations to UAV companies need to start talking now on how this technology should be used and incorporated at all levels. This is a tremendous opportunity for all segments of agriculture.

Challenges

The future of UAVs in agriculture is here. As we watch the creation of a brand-new technology and industry unfold before our eyes, questions emerge: who should be working on this new technology, how should it look, what time frame is acceptable, and how can UAVs be used safely? None of these are easy

questions to answer, and in order to promote this technology for adoption, the following challenges must be addressed:

- Aging Agriculture – While I initially look at this as a benefit for using UAVs, it is also a major hurdle. The average age of a farmer and for the most part, those in supporting businesses, is between 57-59 years old. They are getting close to retiring and in most cases do not want to learn something new. My question to Congress, USDA, and the agriculture community is: "What can we do to incentivize the agriculture industry to adopt the use of this technology?" One thought is to provide a premium reduction on crop insurance for implementation of the technology that is reducing risk from weather.

- Local Expertise – In most instances there is not enough expertise to show farmers and ranchers the benefits of UAVs and how to use the data. Agriculture has relied upon universities and their Extension to be experts, but due to cuts in agriculture funding, that expertise has fallen behind. We need to act now to attract young people into agriculture and technology could be very attractive to a new generation of agriculturists.

- UAV Regulations – The FAA has the important responsibility and challenge to keep the sky safe while trying to incorporate UAVs into the most congested airspace in the world; no small task. I would like to pose some examples for the FAA to consider when it comes to how American farmers could benefit from using UAVs for agriculture:

    - Aerial Application – Japan has been using a helicopter UAV to apply pesticides for almost thirty years and that program is overseen by their Ministry of Agriculture, Forestry, and Fisheries. In the United States, UAVs are being flown under exemptions instead of permanent rules for pictures and video—not for pesticide application. I am hopeful that this week's announcement by the FAA accelerates this application.

    - Competing Countries – I spent six weeks on an Eisenhower Agriculture Fellowship studying precision agriculture, remote sensing, and UAVs in Argentina, Uruguay, and Brazil; countries that are direct competitors to U.S. farmers and commodities. Not only did I see the first UAV for agriculture fly in Uruguay at a field day in Rosario, but they streamed the video from the UAV to a large screen on a truck. I have never seen that level of technology used in a U.S. field day.

    - Timeliness for Agriculture – For two years I have been trying to fly over the test plots of one of the largest wheat breeding companies in the world with no success. The process to obtain permission to fly within restricted airspace in Walla Walla, Washington and other restricted airspace locations where agriculture is located could be better. The trials at Walla Walla were for drought tolerant varieties and the last time a drought was as severe as last year in the Pacific Northwest was in 1977. The lack of a timely process led to agriculture losing a generation's worth of data.

- Big Data – Ownership and integrity of the data Measure uses its UAVs to collect are very important and we work hard to make that a priority. However, with more technology evolution and use looming in the future, all segments in the agriculture chain need to make data security a priority.

- Rural Connectivity Infrastructure – Agriculture and natural resources are the major economic sectors that keep rural communities going. Many of America's farms and ranches are international companies that do business on the world market. At this early stage in agriculture UAVs, we are trying to put a firehose worth of data through a straw with Internet connection speeds on my farm at 5-8 Mbs down and less than 1 Mbs upload. America can and should do better.

- Agriculture Representation – Agriculture needs a seat at the FAA table to make sure rules that are proposed will work for our industry. The USDA motto of "Agriculture is the foundation of manufacture and commerce" is as true today as it was when it was first uttered, especially in ensuring the economic success of rural America.

- Safety – This is a critical challenge for not only agriculture UAVs but the entire UAV industry. Measure's mantra is "Safe, Legal, and Insured" and we try to live that and lead by example. Often, outsourcing to service providers whose responsibility is to fly within the current scope of unmanned regulations is the safest way to obtain aerial data. It is my hope that Measure and the agriculture UAV industry can help lead the way on this important issue.

- Investment – We are living in a time when the United States is putting less money into agriculture research when competing countries are increasing theirs. This trend needs to change for our national and global security. We are watching the birth of the UAV industry in agriculture; we must nurture it so it can mature successfully and become a benefit to American society.

Even though there are many more challenges that could be listed and that the growing UAV industry will be encountering, I am very optimistic that with good communication, increased understanding, and everyone working toward the same objective of safely incorporating UAVs into the National Airspace System (NAS) and the agriculture industry we truly will be successful.

Closing

Agriculture has evolved from poking fingers into the ground to using those fingers to select a specific spot on a screen to be captured by a UAV. Agriculturists have been doing remote sensing in shades of green since the beginning of time and now we need to help this new crop of agriculturists to see things in colors of not just green, but in red, yellow, blue and all shades in between.

The journey that UAVs have taken me on has brought me closer to my roots by looking at the technology used on my farm over five generations while at the same time making me ask more questions about the future. What will UAVs be doing besides pictures, videos, and aerial application in five years?

Again, agriculture cannot do all the lifting alone; we will need to work with industries, organizations, companies, and agencies we haven't had to work with before. However, agriculture does need a seat at the regulatory table for everyone involved to be successful.

I am hopeful that my testimony has planted one of many seeds on the road to the next Farm Bill. Congress and USDA will need to work with traditional agriculture organizations while expanding to those in the UAV industry to start laying the foundation of how this technology can be used and promoted.

However, without better connectivity and a stronger Internet infrastructure, rural America and all Americans will not benefit. Those utilizing precision agriculture and UAV data today are struggling greatly to deliver, in relative terms, this small amount of data today. America will need to invest into rural connectivity the same way America invested in a successful electrical infrastructure starting at the beginning of last century.

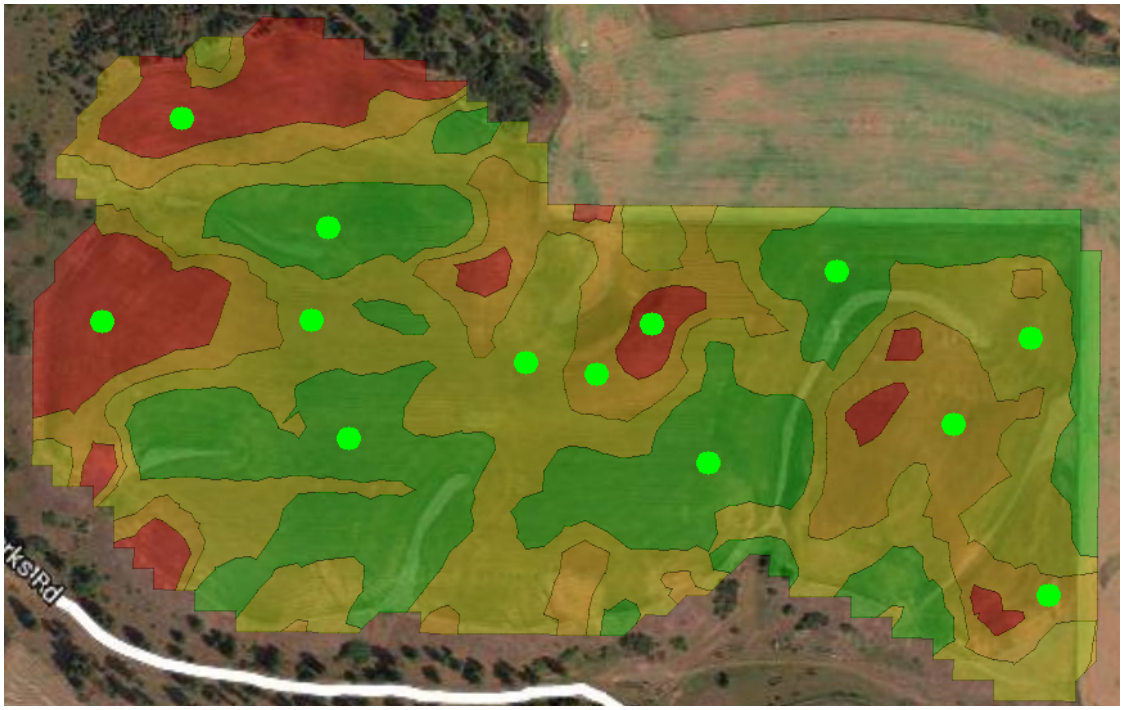
We are in the information age where timing of data is becoming more critical every day. We have larger tractors, combines, and implements that are equipped with the technology that can utilize the data collected from a UAV. I have been implementing these technologies on my farm for over a decade and I am very optimistic about the future of agriculture, because in America the sky truly is the limit. With today's low commodity prices and tighter margins, UAVs can help reduce costs while keeping farmers where they belong…on the farm.

Chairman Crawford, Ranking Member Walz, and members of the Subcommittee, thank you for the opportunity to testify before you this morning. I look forward to answering your questions.

Since the farm was started in 1903, five generations have been involved with major technology innovations in agriculture moving from horses to tractors to autosteering to unmanned air vehicles (UAV). This new generation of farmers and ranchers have grown up with computers and precision agriculture and we need to ensure today that there is a strong infrastructure in place for these leaders of tomorrow.

In 2006 I became the first farmer in the United States to own and use a UAV. My two sons, Dillon and Logan have learned what this technology can do and how it can be used for over a decade to take pictures. They will need additional rules in place for uses such as aerial application by UAVs.

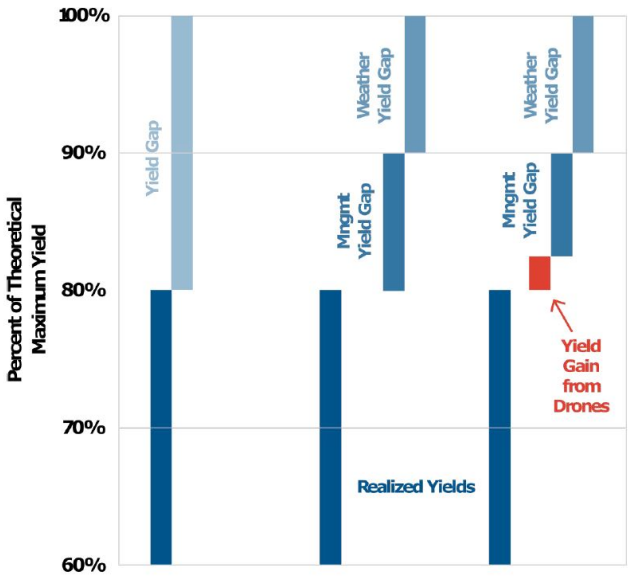
Scouting is traditionally done by sitting on a 4-wheeler and driving through a field to find problems. This is inefficient, time consuming, and does not see all of the acres. Above, the green line is twenty feet wide and follows the tracks of the 4-wheeler. The twenty feet represents being able to see into the canopy ten feet on each side of center which is less than five percent of the field.



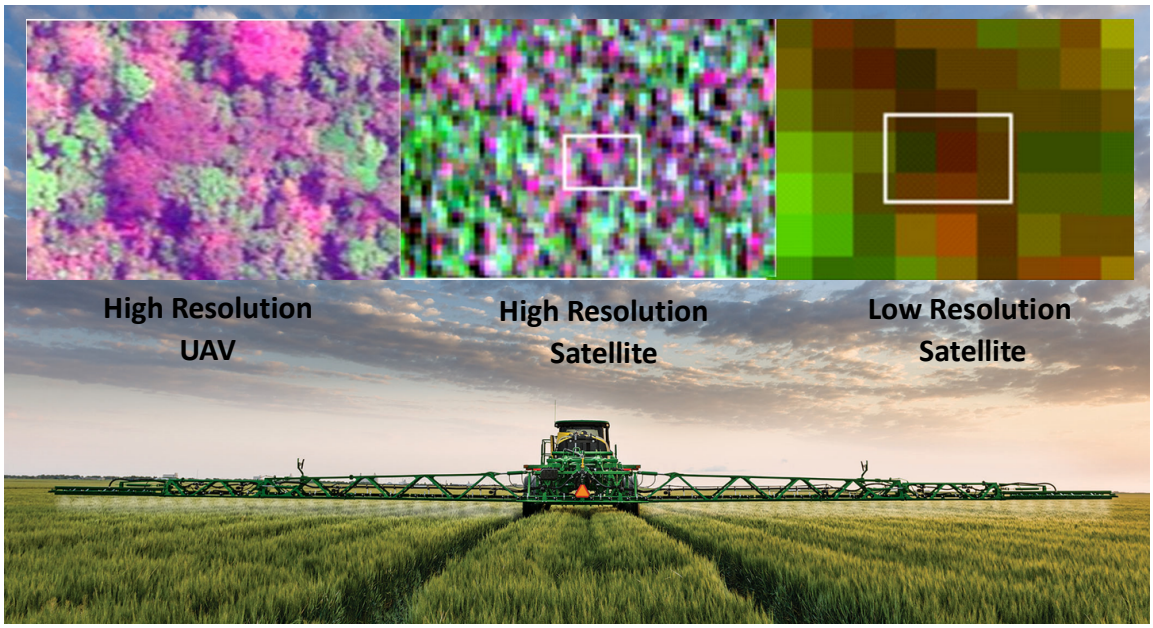
Incorporating a UAV to detect problem areas, farmers can place markers on the field like the ones in green to scout to, instead of hoping to see problems just driving or walking through a field. We can also create management zones and adjust inputs based upon productivity potential.

Estimated Yield Increases

- Closing the yield gaps
    - Estimated yield gaps range from 15% to 30%.
    - Approximately 50% of gap is due to weather.
        - ❖ Remainder due to sub-optimal management and information.
- Based on research and interviews, drones are estimated to reduce management yield gap by 25%.



In a 2015 study conducted by Informa for Measure and sponsoring agriculture partners it highlighted that UAVs could recover 25% of the yield lost by improper management. I believe that utilizing UAVs during the growing season reductions in yield lost by weather can also be gained by increasing test weights, reducing shrunken and broken kernels, and increasing overall quality.



Images captured by UAVs have greater resolution that can show more issues to address in a crop. Solutions for treatment can be incorporated into the cab of a tractor or applicator for precise placement reducing costs and impacts on the environment.