Improved Agricultural Productivity using Precision Drone Technology 2018 Final Report

Sponsored by Maryland Soybean Board

Carl Wise, Precision Ag Drone Technology LLC
Cdwise200@msn.com

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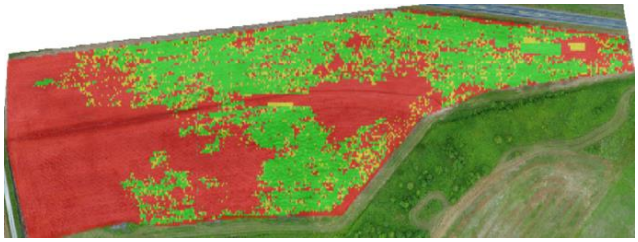
Abstract:

Agricultural Precision Drone Technology will have a significant impact on crop productivity (Yield- Input) over the next several years. Large investments are being made in mid-West farm belt to use drones for large farms with advanced capabilities. However, there are many Ag Drone capabilities that can be used on mid-size farms today to improve crop farming productivity. The objective of this 2018 Maryland Soybean Board Grant was to develop and demonstrate some of the near-term precision ag drone capabilities. The primary focus of this year's study was to use drone crop scouting to detect and identify the palmer amaranth and other aggressive weeds. This capability is the precursor to drone crop spraying which is expected to be available in the next several years. The study included crop scouting hand off to a simulated spray drone to determine potential accuracy of the spay drone. A second objective of the study was to evaluate crop damage and provide damage maps to support re-seeding.

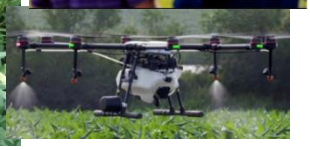
Available Today

Drone Crop Scouting – Test Case was 55% Crop Damage with Maps for Re-Seed



Available Next Several Years

Precision Drone Weed Detection & Spraying



1. Introduction

Agricultural Precision Drone Technology will have a significant impact on Crop Productivity (Yield- Input) over the next several years. There are many Ag drone capabilities that can be implemented today to improved Maryland Crop Farming Productivity.

This document summarizes the 2018 investigation into "Improved Agricultural Productivity using Precision Drone Technology" sponsored by the Maryland Soybean Board (MSB). The primary focus has been on the evolving precision (or spot) drone spraying technology. This new capability will reduce herbicide, fungicide and pesticide chemicals and therefore reduce cost and environmental impact. It is expected that drone spraying will be available within the next few years. This study focused on spraying for weed management but the new spray systems will have much broader crop agricultural applications.

A key part of this new capability will be to detect, identify and locate weed types such as Palmer Amaranth. Among many case studies, the investigation focused on weed detection and identification on a mature soybean field (August 11th). Testing was also done to simulate the handoff to a spray drone to evaluate accuracy using commercial GPS technology. Drone RTK mapping could provide much better accuracy but with increased cost.

Drone Spraying is currently being used in China, Japan, Australia and South America. The US government has not yet approved Drone Spray but licensing is expected by 2022.

A second area of investigation was to assess crop damage with maps for recommended re-planting.

Ag Drone Precision Spraying technology is expected to be available by 2022. This new capability will identify, locate and then Spot Spray different types of weeds including Palmer Amaranth with significant reduction in chemicals, crop damage and environmental Impact.

2. Background

For the past 3 years Precision Ag Drone Technology LLC has been working under a Maryland Soybean Board Grant with collaboration from University of Maryland Ag extension, and the USDA Agriculture Research Center. As of 2018, more than 40 drone flights have been made to evaluate different drone capabilities for improving crop productivity.

Carl Wise, Principle Investigator has led this project. Mr. Wise has BS and MS Degrees in Engineering from University of Maryland. He worked at Northrop Grumman for more than 30 years in remote sensing on Aircraft and Drones. For the past 3 years he has worked with Maryland Eastern shore Farmers to Explore Agricultural Drone capabilities.

3. Current Weed Management

Weed Management is critical for productive Crop farming. Current practices begin with ground scouting over large fields to identify weed types and locations. When there are extensive weed problems over large areas, Aircraft Spraying could be used at significant cost and environmental impact. Mechanized ground spraying is also used. Both Area weed Treatments are expensive, damage the crops and have a big environmental impact.

Current wide area Spraying for Weed Management is Expensive and results in Crop Damage and Environmental impact.

4. Drone Spraying Technology

Drone Spraying Technology is currently being used in Japan, China, Australia and South America. Our government has not yet approved Drone Spraying. Licensing is expected in the next several years and will be similar to that required for spray aircraft.

Drone Spraying Could be offered to Maryland Crop Farming by 2022.

5. Weed Detection and Identification

The critical first step for Drone Spot Spraying is to identify and locate weeds on crop fields. One of the Case Studies from the 2018 MSB Grant showed that overhead weed detection and identification over mature Soybean fields is possible. On August 11th, a Soybean Field in Caroline County was used to evaluate overhead weed detection and identification.

Results are Encouraging for overhead weed detection and identification over mature Soybean Fields.

Caroline County, Md
August 11th, 2018

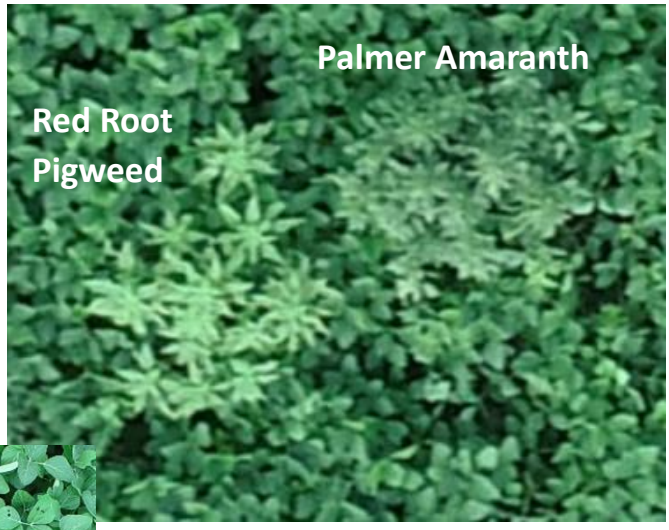
In one area of the Soybean field there were Palmer Amaranth and Redroot Pigweeds growing together. The test site picture shows Palmer and Redroot weeds growing about 4 feet apart. On the ground, the weeds are distinguishable by plant shape and leaf characteristic

Red Root Palmer

Palmer Amaranth and Redroot Pigweed are representative of Aggressive Weed Problems facing Soybean Growers.

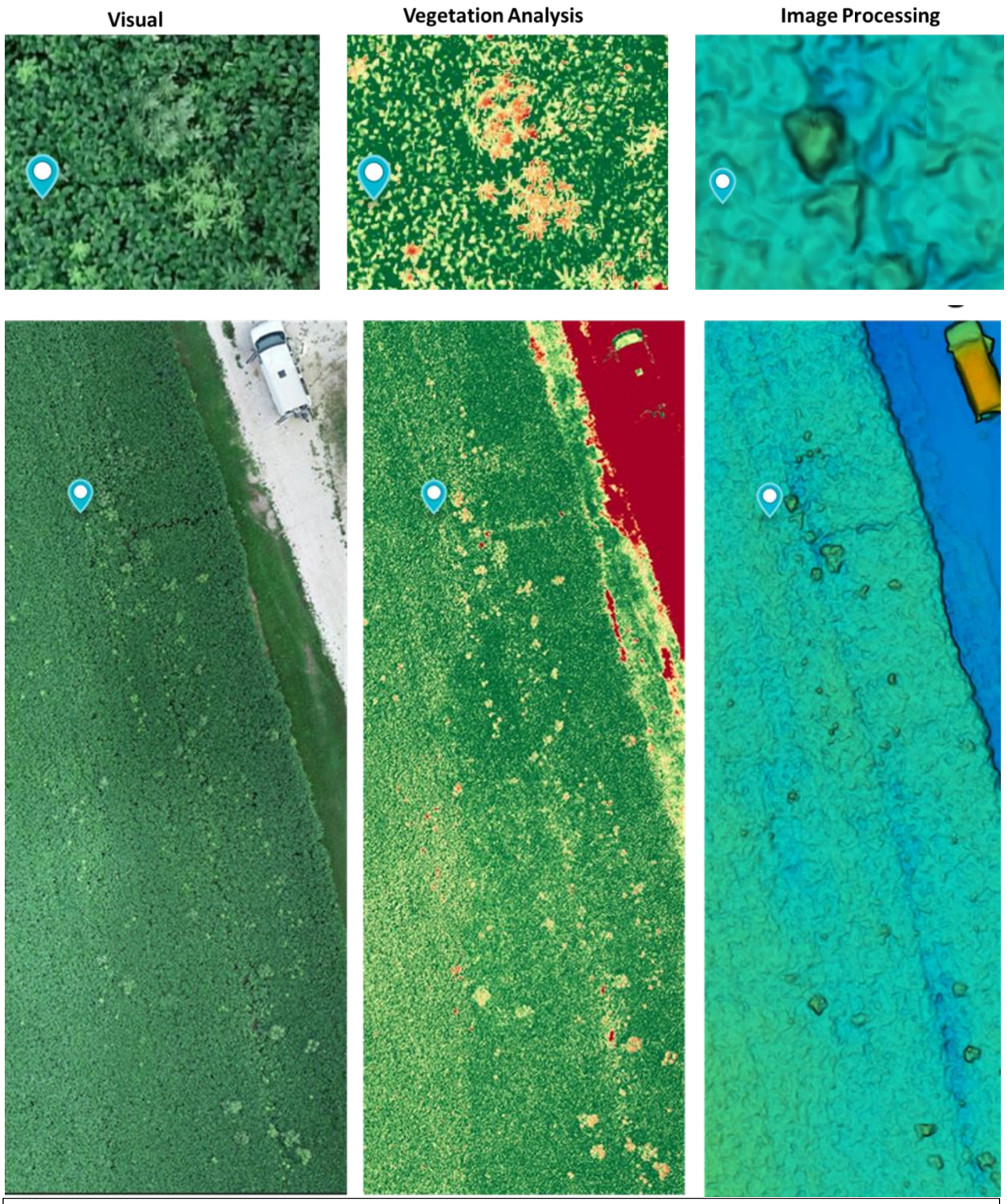
An Arial drone image from 125 ft altitude shows the Palmer Amaranth and Red Root Pig weeds imbedded in the soybean canopy. An expanded view of the weeds show that they are distinguishable by color, leaf pattern and other discriminators. A close-up at 25 foot helps to verify their distinguishing characteristics. Through various types of analysis, these types of weeds can be detected and, in some cases, identified. In the future, more advanced sensors and image processing will improve this capability.

The next page show field maps with various types of image analyses where weed types and locations have been identified. These locations would be handed off to a precision drone spraying system.



Expanded Overhead Mapping at 125 Feet Clearly Show Palmer and Red Root Weeds against the Soybean Canopy.

Drone Inspection at 25 feet Give strong verification of Weed Type



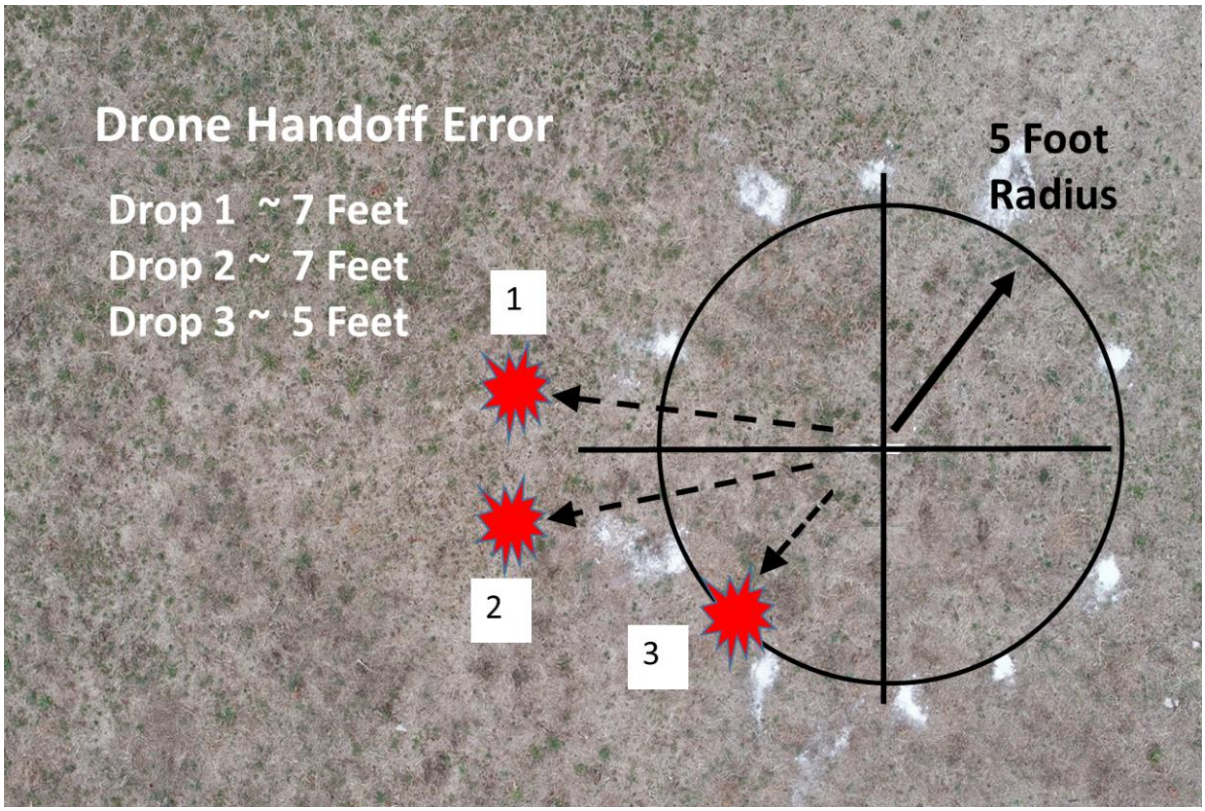
Soybean Testing on August 11th 2018 show Excellent potential for Drone based Weed Detection and Identification for Precision Spraying.

6. Simulated Spot Spray Testing

Drone drop testing was used to simulate precision spraying accuracy. An initial scout drone was used to locate several test targets. The coordinates for the targets were then given to a second drone that hovered at 50 feet over each target and took pictures to designate where a spot spray discharge would have hit the ground. The target error of the simulated spray drone to the scout drone location was less than 7 feet. Better calibration between the two drones might provide 4-foot accuracy. However, wind and other conditions most likely will be the limiting factor for spot spray accuracy.

The simulated spot spray target testing was conducted at Kinder Park in Severna Park Maryland on January 10th, 2019. The diagrams show the test target and drop errors. Because the errors seem to be biased in one general direction, calibration should reduce the error. If needed Ground Control Points (GCP) or RTK techniques could be used to improve drop accuracy. Further investigation needs to be done between weed detection and Spray accuracy

Spray Accuracy was ~ 5 to 7 foot using Commercial GPS positioning. With Calibration, 4 foot accuracy may be possible.



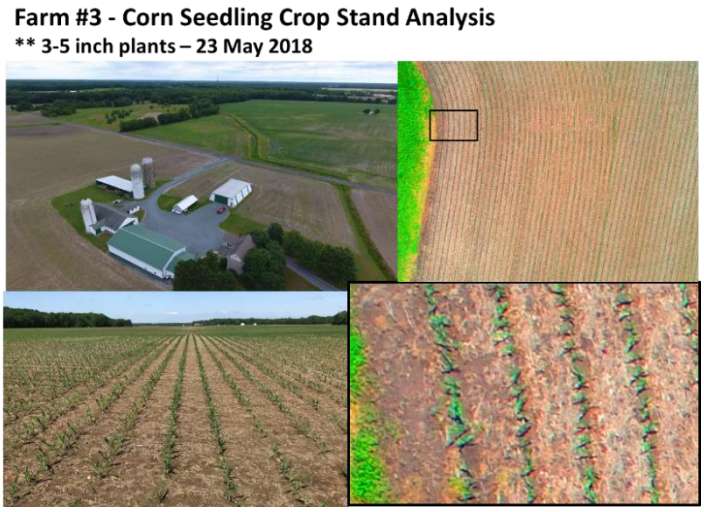
7. Yield Estimates and Crop Damage Support

A second objective for this project was to evaluate drone seedling emergence and its potential applications. Drone analysis can evaluate seedling emergence maps. For corn this provides an early estimate of yield. There are several techniques for this with varying degree of accuracy and cost. Two applications were investigated. The first was a strong, health corn field with an estimated 97% emergence.

In spring of 2018 many farms had severe seedling damage due to heavy rain. A second field with severe crop damage was evaluated.
Damage assessment and recommended re-seed maps were provided. The damaged field was re-seeded with a strong recovery. This type of analysis should be of value to both farmers and insurance companies.

- **Healthy Corn Yield Estimate – Baseline Capability**.

On May 23rd drone measurements were made on “Field #3 Corn” which had a strong seedling germination. The resulting maps showed almost uniform emergence with an estimated 29,760 plants per acre. The crop stand maps showed several small areas that had missing plants and others where there was no emergence. This strong field was used as a baseline drone analysis which showed a crop stand of ~98% over the 10 acres tested.



Crop Stand Analysis Indicates Strong Harvest

10 Acre Corn Plant Count Analysis Shows Strong, Uniform Crop Stand

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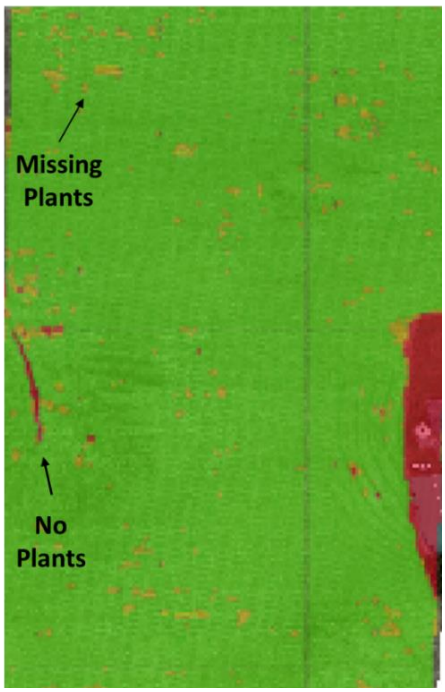
29,760 plants per acre

Test Area

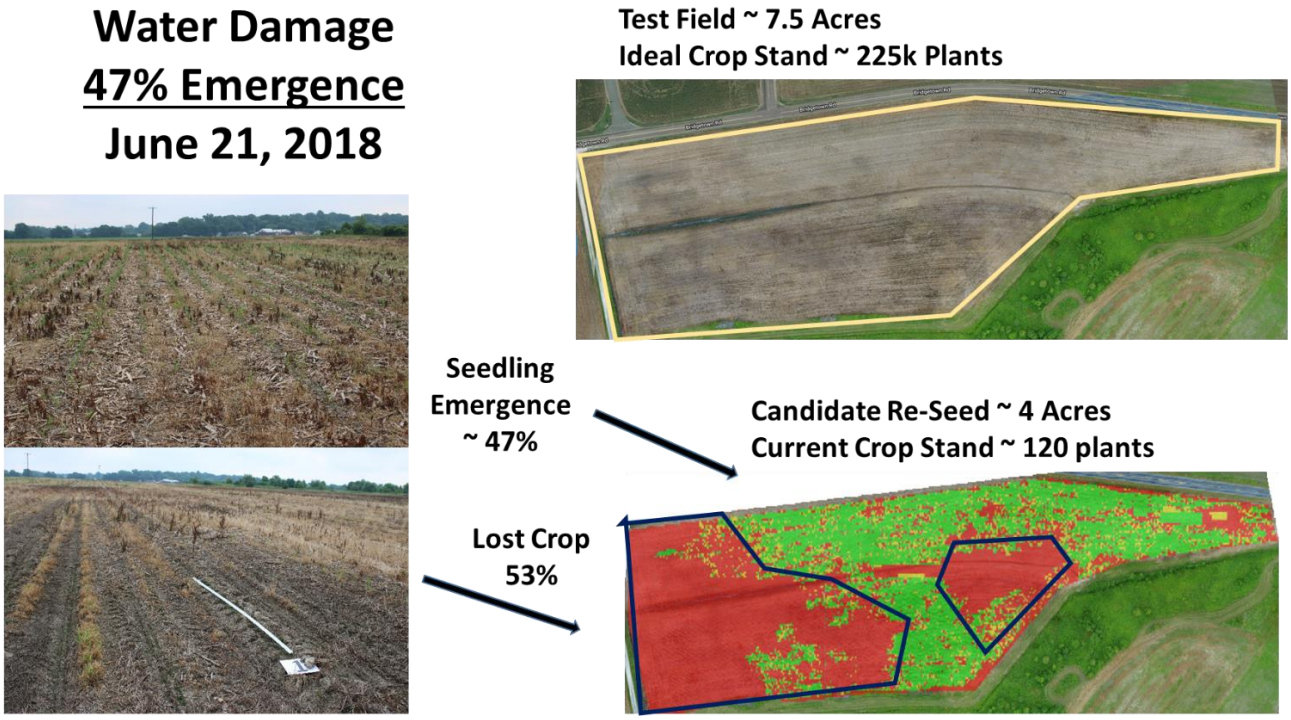
Overhead Visual Image

Plant Count Analysis Map



- **Crop Damage Assessment / Re-Seeding Map**

There was sever rain during the spring of 2018 and many freshly planted seeds were damaged. On June 21st Corn Field #11, drone measurement and analysis were done to assess the damage. The drone maps showed a seedling emergence of ~ 47% over the 7.5 acres tested. Drone maps were used to recommend a Re-seeding plan. On July 26th drone overhead and ground measurements showed that there had been a significant recovery in the crop stand after re-seeding.



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Successful Re- Seed - July 26, 2018

8. Conclusions and Recommendation.

Agricultural precision drone technology will have a significant impact on crop productivity (Yield- Input) over the next several years. Large investments are being made in the mid-West farm belt to support new drone-based precision farming capabilities. There are many Ag drone capabilities that can be implemented today to improved Maryland crop farming productivity.

Based on the 2018 Weed Investigation, drone based precision spraying appears to be viable and should be available to Maryland crop farmers by 2022. This new capability will reduce chemicals and crop damage while also reducing environmental impact.

Based on 2018 Investigation, Drone Based Seedling Emergence Analysis can be implemented today. It will be valuable to farmers in assessing crop yield. It can also be used to evaluate crop damage with recommended re-seeding maps.

A 2019 follow-on project is recommended that would further develop and demonstrate Drone based Precision/Spot Spraying and crop stand analysis for Maryland crop farmers as a near term capability. I look forward to working with the Maryland Soybean Board to study and develop these new Ag Drone based capabilities.