"SMART" TECHNOLOGY USE IN AGRICULTURE

Drones, Smart Sprayers, Robotics–all are being promoted by their developers as being useful for applying materials to U.S. cropland. Following is a summary of what is now known about using "Smart" technology, and what the future may look like with forthcoming developments.

Drones are being promoted to apply pesticides and fertilizers to crops being grown in the U.S., as well as the seeding of cover crops. Benefits from using drones to make these applications include 1) applications can be made when field conditions are unsuitable for ground equipment, 2) detection devices on the drones can be used to detect the presence of a disease so that a fungicide is only applied where needed, and 3) drones can more effectively work in fields with uneven margins, and they can more easily avoid obstacles such as poles, power lines, and trees.

A source of information about using drones for spraying agriculture chemicals on crops is provided in an article titled Drones for spraying pesticides–Opportunities and Challenges from The Ohio State Univ.-Extension. This article provides a definition of the names and acronyms that are associated with drone technology, plus a history of drone usage and how drones can be used for aerial application of agricultural chemicals.

Drone research offers mixed findings. Work at Purdue Univ. indicates that spray coverage provided by drones can depend on carrier volume, adjuvants, drift reduction agents, distance from center of swath width, and deposition aids. Results from the research led the author to recommend 1) using a ground rig for broadcast herbicide applications, and 2) using drones for spot spraying and for spraying in small or hard-to-reach fields.

Spray drones make applications in difficult areas. This article highlights the use of drones by a Louisiana rice producer to apply fungicides to a field with overhead high-voltage power lines. The article also cites the use of drones by an LSU AgCenter Specialist to apply materials to research plots in order to improve worker safety and ensure timely application of treatments when soil conditions will not allow applications by ground equipment. Both the producer and Specialist agreed that more research needs to be done to document the effectiveness of drone-applied materials that are necessarily applied in low carrier volumes.

Rotor on a mission to top the high-capacity ag drone competition. Rotor Technologies is attempting to fill the high-capacity autonomous aerial agricultural application void by introducing a remotely-piloted helicopter aircraft that has a 30-ft. spray boom, a 110 gal. spray tank, and an estimated application rate of 240 acres/hr. This agricultural drone is equipped with a sophisticated camera system and a 30-gal. gas tank. Not having a pilot and some of the instrumentation of a piloted aircraft allows for the greater spraying capacity. Its estimated price tag likely means that it will only be purchased by a drone service that will contract with a producer to apply chemicals at a set cost per treated acre.

Can fungicide applications via drones effectively control soybean foliar diseases?. The contents of this article highlight the following details about and results from research conducted at Purdue Univ.

- The research was conducted to determine the effectiveness of using drones to apply foliar fungicides to manage soybean diseases.
- The research involved comparing fungicide applications by drones to those applied by traditional ground methods.
- Fungicides were applied at R3 and R5 soybean growth stages in carrier volumes of 2 and 5 gal./acre.
- After one year of this preliminary research, fungicide applications by drones performed as well at controlling targeted diseases as those applied by a ground rig.
- There were no yield differences between the types of application–i.e. drone or ground rig–or the carrier volumes.
- The authors pointed out that battery life, drone tank capacity, and licensing and certification

requirements that depend on the size of the drone are drawbacks to using drones for applications of agricultural materials to crops. A pesticide label may not specify that aerial application applies to drones.

Using Drones in Agriculture and Natural Resources. This April 2023 article provides details about how researchers and educators at land-grant universities in 20 U.S. states have worked together to increase drone use in agricultural settings. Specifically, work at Miss. State Univ. has dealt with creating new drone systems that monitor water quality and provide higher resolution data for the development of flood risk models and water resource management. This group's research and outreach have helped accelerate the use of drones in agriculture settings.

AI tool simplifies crop management. Information in this article highlights the use of a drone to scout a crop or crops in order to save time and labor. Combined with on-board **AI*** software, a summary of each scouted field along with recommendations for needed treatments will be provided to the producer after each scouting mission that is conducted by a drone. A major advantage of using this system is finding out what is happening in an entire field vs. only a few spots in a field that may be surveyed by walking.

Drones improve efficiency; require special training. This article reminds drone users that adoption/use of drones requires mandated training and licensing in addition to the chemical applicator license that is required for those who normally apply pesticides. Many of the mandated training and licensing requirements require considerable study time. Also, a significant amount of time may be required for the approval to occur, so producers who contemplate using drones to apply materials to their crop site should account for this.

An article on this website titled Drone Use in Agriculture provides links to additional articles about drones and their potential/current use in agricultural settings. Information about who to contact in Mississippi regarding drone regulations in the state is contained in this article.

In the long term, research will be needed to confirm that using drones to scout crop fields and apply crop protection materials is practical, effective, and economically feasible under myriad conditions that will include amount of pressure of the target pest [to include application to a whole field vs. only targeted spots in a field], denseness of the soybean canopy, physical obstacles that only applications by a drone can overcome, and the spraying capacity and capabilities of the drone that is used. Plus, anyone who plans to operate a drone in any setting must be mindful of the training/certification requirement that is required to operate the chosen piece of equipment.

The Miss. Dept. of Agric. & Commerce is the agency that is responsible for regulating pesticides and pesticide applicators in Mississippi. For drone applications in the state, access the MDAC Drone FAQ UAV Pesticide Application portion of the website where the Fact Sheet titled Pesticide application using UAV's: What you need to know is located. This Fact Sheet provides information about who to contact regarding applications of pesticides, seed, and fertilizers using drones in Mississippi.

Smart Spraying Technology in Agriculture. This article defines smart spraying technology as a system that applies crop protection chemicals only where they are needed to control a targeted weed or pest. A smart spraying system is promoted to reduce spray drift and pesticide use while exhibiting the same level of pest and weed control as conventional spraying. Smart spraying involves 1) a sensing system [usually cameras] which scans and detects where a crop protection chemical should be applied, 2) a response function based on the system's software that determines what is to be done, and 3) spraying technology that responds to the demands for variable rate or spot spraying. The article also contains a video that describes the concept of intelligent spraying and the role that automation and **AI** play in agriculture. Smart spraying technology is being promoted to decrease environmental risks and reduce amount of herbicides and pesticides being sprayed.

Smart Spraying from AgriTechnica is an article that defines Smart Spraying as "the plot-specific and precisely targeted application of crop protection products". The article also states that "an important advantage of Smart Spraying is cost efficiency due to the savings in crop protection inputs" which should result in a significant reduction in the amount of these products that enter the environment since only affected areas of a field will be sprayed. Variable Rate Technology [VRT] will allow smart spraying systems to apply crop protection products only in an amount needed to control a targeted pest and/or weed in a particular area.

Verdant robotics upgrading its smart sprayer. Verdant Robotics is a company that is working to upgrade its Sharpshooter spraying system that uses a canopied spray boom equipped with lights, directional spray turrets, and cameras under the covered boom that work with its software to accurately identify weed presence and only spray where weeds are detected. Verdant plans to increase the groundspeed of the machine to 2 mph. The present system is promoted to treat small-acreage vegetable crops, but the technology will likely be adapted in the future to treat row crops such as soybeans.

8 Things to consider when buying a Smart Sprayer. Since a spraying system is an essential part of any farming operation, it is important that a producer consider the following when choosing a smart spraying system.

- Understand the basics of a smart spraying system, to include how it functions, the technology it employs to accomplish its intended goal, and the tangible benefits it will bring to the farming operation.
- Is the selected system user-friendly? Can it be operated and maintained without sophisticated outside help?
- Will it do the intended jobs with accuracy and precision, and will it do them correctly?
- Is the selected system the right size for the farming operation where it will be used?
- Is the up-front cost justified, and will the perceived savings be enough to justify its purchase by an individual over the long term?
- Will the selected system reduce the environmental footprint of the farming operation where it will be used?
- Is the safety net provided by after-purchase support and the warranty on the system sufficient to minimize unintended interruptions in the farming operation?
- Will the spray coverage and available nozzle choices be sufficient to accomplish all intended uses of the spraying system?

Are robotic sprayers here to stay?. This article cites the use of a robotic smart sprayer by an Indiana farmer. The article also contains a link to WHIN [Wabash Heartland Innovation Network], an organization that covers 10 Indiana counties. This organization was formed to facilitate relationships between its farmer members and industry partners such as Solinftec to bring new products such as the Solinftec robotic smart sprayer to market.

The above links are to example articles about the current state of technology in the spraying and application of materials in the agricultural sector; thus, this collection is not meant to be exclusive. Producers can search for and find information about other developments in this area that likely will provide similar results when they are used. Also, it is anticipated that industry and its cooperators will produce rapid advancements that will improve/enhance "smart" application systems.

Environmental concerns and a shortage of skilled labor will likely provide increased impetus for the adoption and use of smart spraying technology by crop producers. Hopefully, increased research with this technology and further development of autonomous application methods will lead to increased sustainability and profitability for all crop producers.

APRIL 2025 UPDATE

Drone Sprayers

Articles on this website titled Drone/UAV Use for Spraying Crops and Drones and Foliar Fungicide Application to Soybeans provide information about using drones to apply crop protection materials to a growing crop. Briefly, those articles provide the same basic information as contained in this White Paper–i.e. drones can effectively apply materials to a growing crop, but their capability depends on their payload capacity and air time capability between charges.

The below drone platforms offer promise for enhanced crop spraying.

- EAVision J100 from Agri Spray Drones is equipped with sensors that can detect small objects from 300 feet away. It comes with a 45-liter [~12 gallons] liquid tank, and has a dry tank accessory capable of holding 110 lb of granular material. According to company information, it can cover about 60 acres per hour when applying 2 gal/acre of liquid material.
- XAG P150 from HSE has a top speed of 40 mph and a 70-liter [~18.5-gallon] liquid tank. A dry tank accessory also allows spreading of granular materials.
- HYL-150 ARES from hylio has a payload capacity of 110 lb and can apply both liquid [13 gallons] and dry [20 gallons] materials. It can treat up to 70 acres/hr at a 2 gal/acre liquid rate and up to 120 acres/hr at a 20 lb/acre dry material rate.
- The SC1 from Guardian Agriculture has a 20-gal tank and an 18-ft spray boom. It has a 200-lb payload capacity, is fully electric with rapid plug-in recharging, and is designed and built in the U.S.

The price tag on sophisticated drone packages may render them prohibitively expensive for an individual producer to consider. However, their use through a drone service provider may make them available to producers who are willing to contract with such a vendor for a particular application at a set cost per treated acre that is deemed economical by the producer.

The Stratovation Group has launched a research study to determine how farmers perceive the use of drone technology in their operations. The purpose of the study is to capture farmers' perception of just how and when these devices are being or can be integrated into their operations to enhance crop scouting, cover crop seeding, and other tasks such as spraying that are deemed critical to their operations. The study is being conducted because of the rapid expansion of the availability of drones and drone services that can be used for agricultural applications. One of the frontline sponsors of the study is the National Corn Growers Association [NCGA], whose members comprise a large segment of U.S. crop producers. The survey results will hopefully guide future use and marketing and policy directions for drone technology that will benefit all U.S. crop producers.

Smart Sprayers

Targeted spray technology is touted to save on inputs. Click here for an article that provides information about precision spraying technology.

The technology behind each of the below "smart" sprayer products is similar–i.e. sensors are used to capture images which are analyzed by on-board computers to differentiate between a crop and weeds in order to direct nozzles to open and close in **Real Time****. All use **Artificial Intelligence [AI]** to perform functions that allow them to do things without on-the-spot human influence.

One Smart Spray. This link is to information about a system that is a product from a joint venture between Bosch and BASF. This system uses camera-based weed detection to offer farmers a precise solution for directed weed control by integrating hardware and software with agronomic intelligence.

Intellisense Sprayer Automation is a system designed for New Holland's Guardian front-boom sprayer. It offers both variable rate and selective spray opportunities. The company states that the front-boom location allows for it to be run closer to the ground to reduce herbicide drift.

See & Spray from John Deere uses 36 cameras across the spray boom, and coupled with AI, targets individual weeds in real time. It is available either as a factory-installed unit or as a precision upgrade for an existing sprayer.

Greeneye Technology offers a Selective Spraying system that allows seamless transition of any sprayer into a smart machine. Their technology enables farmers to simultaneously spray contact herbicides on targeted weeds and residual herbicides on a broadcast basis. Their goal is to lead a shift from recommendation-based to decision-based solutions.

Weed-It Quadro is a precision spraying system that can be retrofitted to sprayers that are on hand. At traveling speeds up to 15 mph, it uses chlorophyll flourescence properties to detect weeds as small as 1cm^2 so they can be sprayed.

Amaspot by Amazone is a system that uses a sensor-controlled nozzle system and fluorescence sensors to target living weeds. The flourescence measurement is tolerant to different light conditions and thus ensures reliable plant detection.

The Solix Robotic Sprayer from Solinftec is powered by onboard solar panels, and uses a suite of integrated sensors to scan plants as it passes through a field. If the onboard AI system determines that a plant is a weed, the autonomous sprayer will apply herbicide to it. According to the developer, the sprayer can manage up to 100 acres per day and can operate 24 hours a day with minimal soil compaction.

ARA Field Sprayer from Ecorobotix is a boxed/shielded system that can be operated with minimal manual intervention to achieve reduced labor costs and a reduction in product usage. A machine that can be used on corn and soybeans should be forthcoming.

Augmenta field analyzer from Raven uses Computer Vision and Machine Learning technology to translate camera images from a maximum 138-ft field of view into agronomic insights that can be used to fine-tune prescriptions and implement variable rate application in real time. The equipment can be installed on most common tractor and sprayer platforms. It should be especially useful for applications of burndown herbicides.

Agco Systems PTx technologies allow farmers to retrofit virtually any brand of sprayer equipment so that it can be used for more accurate spraying of crop protection products.

AiCPlus camera system from Agrifac uses an algorithm which gathers data, then sorts and labels it. Cameras are fitted on the sprayer boom and nozzles open and shut according to when a weed is sensed. It likely will work best where targeted weeds are sparse.

Ecopatch from DAT is a sensor system that can be mounted directly on existing sprayers. A computer analyzes images in **real time**** and decides whether or not to spray. The system can be adjusted to spray at different thresholds based on the crop and field conditions.

SprAI by DeepAgro is a weed detection system that can be installed on any sprayer to open and close nozzles automatically in real time.

Use of any of these systems should result in a more productive, profitable, and sustainable level of weed control in crops. At the very least, using a smart sprayer should result in less pesticide being loaded into the environment as a result of broadcast-spraying of crop protection materials regardless of weed presence. Producers are encouraged to access the information contained in the above links to determine if a particular item can increase efficiency of their farming operation.

***Artificial Intelligence [AI]** is defined as the capacity of a computer or other programmed device to perform functions that are analogous to learning and decision making in humans. **AI** refers to systems that are capable of performing tasks that are typically performed by humans. **AI** encompasses a set of technologies that enable a computer to perform a variety of advanced functions that include analyzing data and making decisions based on that data analysis. The core principle of **AI** revolves around using data analysis to identify patterns and relationships that humans may miss.*

******Real Time*** *is defined as occurring instantaneously or at once. With Smart Sprayers,* ***Real Time*** *refers to the actual time elapsed in the performance of a computation by a computer in order for a process–in this case identifying the presence of weeds–to continue–i.e. the actual time during which a process takes place.*

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