More advanced remote-sensing technology needed for weed detection, management

December 9 2019, by Kay Ledbetter

Remote sensing is a useful tool in detecting weeds and identifying them, which can help producers manage them better. Credit: Texas A&M AgriLife photo

Remote sensing provides an alternative to ground-based manual scouting for weeds in agriculture fields. And, while many advances have been made, many are still needed in the area of weed detection and differentiation, according to Texas A&M AgriLife researchers.

Muthu Bagavathiannan, Ph.D., Texas A&M AgriLife Research weed scientist, College Station, and a team of Texas A&M researchers recently published "Unmanned aircraft systems for precision weed detection and management: Prospects and challenges" in *Advances in Agronomy*.

Vijay Singh, Ph.D., an assistant research scientist with Bagavathiannan during the research who is now an assistant professor of weed science at Virginia Tech, is the lead author on the paper. Other Texas A&M authors were Nithya Rajan, Ph.D., Department of Soil and Crop Sciences; Michael Bishop, Ph.D., and Anthony Filippi, Ph.D., Department of Geography; and Dale Cope, Ph.D., Department of Mechanical Engineering.

The team spent the past four years utilizing remote-sensing technology for weed detection and management.

"We are excited about the potential for remote sensing to facilitate precise and timely data collection regarding weeds, which can help producers and crop advisors make appropriate management decisions," Bagavathiannan said. "We believe its inclusion in an integrated weed management approach can help optimize herbicide use and, perhaps, address some of the herbicide-resistant weed issues we currently face."

Their paper outlines what they have learned and what technological advances they believe still need to be made to make the system more reliable and efficient.

Effective crop management decisions and optimizations such as irrigation, fertilizer application and insect pest management already benefit from unmanned aircraft systems, or UAS, based remote sensing and advancements related to aircraft technology, sensor systems, information processing and data management capabilities.

The paper concludes these advancements in UAS-based tools and geospatial information technology create enormous opportunities for efficient and economical assessment of weed infestations as well as site-specific weed management.

"We believe the UAS-based technologies for weed management applications is in its infancy," Singh said. "While there has been rapid growth in terms of aerial data acquisition and analysis, challenges still exist with platform reliability, sensor capability and integration, image pre-processing, quantitative assessment and prediction, and final product development and delivery."

Their review summarizes current knowledge on the utility of UAS platforms, and examines potential opportunities and limitations to current technologies, based on the lessons learned from UAS-based weed detection and management research conducted at Texas A&M.

The authors outlined the "things we know":

- Remote sensing of agricultural environments has been conducted traditionally using satellite and manned aircraft platforms, often with multispectral imaging sensors to map crops and characterize their biophysical parameters.
- With moderate spatial, spectral and radiometric resolution of acquired imagery, research efforts were primarily focused on the development and evaluation of vegetation indices for empirical quantitative prediction of vegetation conditions.

- This research is advancing given the availability of new airborne platforms and sensors for large-scale agricultural applications.

And they listed the "things we need:"—Resolution of hardware engineering challenges regarding UAS platform navigation capabilities, sensor miniaturization, sensor integration and payload problems, and data acquisition strategies.

- Image preprocessing improvements with respect to the accuracy associated with radiometric calibration, geometric correction and image mosaicking.
- Information extraction from images to include spectral, spatial and temporal analysis strategies and the need for new algorithms and processing workflows.
- Effective methods for dissemination of information products.

"Perhaps our biggest challenge is the need to establish a framework for information synthesis and robust decision-support capabilities that account for uncertainty and risk," Bagavathiannan said. "With respect to weed characterization, we require precise identification and mapping of a weed species embedded within a mixture of other weed or crop species."

Similarly, not much work has been done on weed management with UAS-based spray applications, Singh said. The majority of UAS spray units commercially available in the market don't have site-specific application capabilities, which is one of the drawbacks in developing autonomous systems for weed detection and management.

Various platform-sensor combinations are being designed, optimized and evaluated by multiple research groups to generate quantitative and thematic information on weeds and crops. Continued improvements in sensor technologies and UAS payload capacities will facilitate more

efficient data collection strategies across large agricultural fields.

"Integrating more than one form of information is absolutely essential," Bagavathiannan said.

This will most likely require sufficient consideration of species properties based on spectral, spatial, textural, temporal and other information to support precise weed identification and differentiation.

"There is also a critical need for the development of databases and libraries that can be used as a reference to support characterization of plant species across various agricultural conditions."

Such advancements in image data acquisition, preprocessing, analysis and decision-support will require the establishment of data science frameworks and strong multi-disciplinary collaboration among pertinent scientists and engineers.

More information: Unmanned aircraft systems for precision weed detection and management: Prospects and challenges. *Advances in Agronomy*, doi.org/10.1016/bs.agron.2019.08.004

Provided by Texas A&M University