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Drones for Crop Monitoring: A Farmer's Guide to Aerial Phenotyping

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What is drone-based crop monitoring?

Flying a drone equipped with cameras or sensors above the crop canopy provides vital aerial information regarding crop conditions. Hence, drones allow growers to perform a quick and informative field scan above the crop. Recently, drone-based crop monitoring has become a popular method to evaluate crop performance by assessing growth and development. A drone is like an eye in the sky that captures pictures or crop information reflected in sensor readings, which can be used to study plant traits and yield. This technology can provide detailed insights into plant health, phenotypic characteristics, and canopy color throughout the field. Farmers and researchers can make an informed decision by analyzing aerial images and identifying problems earlier than their visibility to the naked eyes.

Benefits of drone-based crop monitoring

Drone-based images show the variability in the field by analyzing the color of different bands reflected from the crop canopy, providing vital information about the field and crop conditions. The application of drones in monitoring crops provides several benefits to farmers:

Early detection of the problems:
Aerial images can visualize several crop stresses caused by pests, diseases, weeds, drought, or nutrient deficiencies before they are noticeable to human eyes. For instance, even in stressed conditions, fields look green to the naked eye, but multi-band images generated by drones can reveal hidden stress levels. This early detection of abnormal crop conditions enables timely field interventions such as site-specific spraying, nutrient application or irrigation before they significantly impact yield.

Assess growth and yield factors:
Drones can capture images from early emergence to physiological maturity, providing critical stage-specific information. This helps to track growth and development across different periods more easily. Aerial photos can be analyzed to estimate important plant traits like height, canopy cover, plant number, and leaf nitrogen content across the field. Continuous variations in crop growth can be recorded using drone data, which can also be valuable in predicting yield. The comparison between a drone-derived field map showing crop health and a yield map can provide clear site-specific insights into yield performance.

Site-specific resources management and yield improvements:
Drone-based images use the frequency of reflected and absorbed light to provide information on plant health across the field. The high-resolution field map showing detailed crop conditions helps growers apply inputs (water, fertilizers, pesticides, herbicides, etc.) in the right amount using the right tool at the right time and in the right location. For instance, a NDVI map showing patches of different colors representing different crop conditions, suggests the need for targeted farm interventions like additional inputs or weed control in specific areas.

Provides huge information quickly:
Manual field monitoring requires multiple hours to days to acquire crop growth and development status, whereas drones can scan entire fields in minutes. The images acquired from drones clearly show crop growth patterns and plant health status compared to traditional manual scouting. Drones enable identification of most appropriate crop monitoring stage and the most affected areas to make crop monitoring more efficient rather than repeatedly visiting the entire field.

Documentation and field planning:
Field documentation is valuable for analyzing the farming practices and planning the next cropping cycle. Aerial photos can document information about the field and crop conditions throughout the season. Some natural events, like drought, storm, or hail, might damage crops, and drone images can be vital records that can be used for insurance claims. Similarly, reviewing the images helps us understand what management practices produced the best crops and what went wrong in the field. This information allows growers to plan for the upcoming cropping cycle.

Figure 1: RGB Ortho mosaic showing field condition.

How does drone imagery work?

Drones carry various cameras/sensors that capture multiple images of the field from numerous angles. Those images provide different information about the standing crop and field conditions.

RGB camera:
The RGB camera captures what regular cell phone cameras capture and what our eyes see. Normal cameras and naked eyes can visualize obvious issues in the field, like moisture condition, disease and pest damage, but some stresses are not visible in RGB images until they become severe. However, several indices can be derived using multiple band information (Red, Green, Blue) in the RGB images which can provide crop health status. RGB cameras are the most affordable and easy to process for field scouting. Moreover, those indices can also help visualize and quantify stress across the field.

Figure 2: Field patches indicating stress.

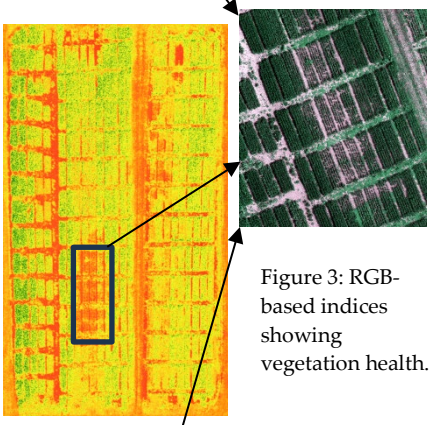

Figure 3: RGB-based indices showing vegetation health.

Multispectral sensor:
Multispectral sensors capture images that our regular camera and naked eyes cannot see (usually red-edge wavelength and near-infrared). The vegetation index map is generated using the amount of light absorbed or reflected in a particular bandwidth by the plants. Normalized Difference Vegetation Index (NDVI) is the most popular to visualize crop health status. Generally, healthy crops reflect NIR light, giving higher NDVI values (closer to 1), whereas stressed crops reflect less, giving lower NDVI values (Burgman & Murphy, 2021). The NDVI map generally represents higher NDVI in greener colors; lower values are shown in yellow to red. Farmers can detect early stress from nutrients, pests, and weeds using such indices maps.

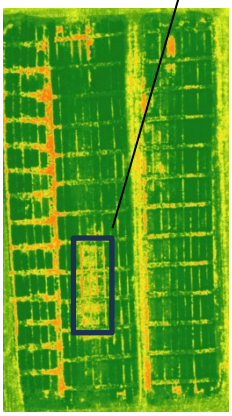

Figure 4: NDVI generated using multispectral sensor showing crop growth status.

Thermal Camera:
A thermal camera on a drone can capture the temperature difference across the field. In the field, some areas with less water have stressed plants with warmer canopies because the cooling effect through evaporation is reduced compared to healthy, well-watered plants (Thompson et al., 2018). Using this information, a drone can help locate drought-prone and disease and insect infested areas. Farmers can use a field map derived from a thermal camera for appropriate field intervention.

LiDAR:
LiDAR is the most advanced and expensive sensor that provides an accurate vertical crop structure. It is most helpful in studying plant height, biomass, and terrain variations (Pun Magar et al., 2025). However, it is a complex technology and requires high storage capacity and expertise to handle the huge volume of datasets.

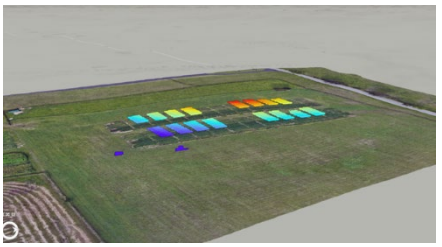

Figure 5: LiDAR point clouds above the field are useful for providing information about field elevation and crop height.

References

Crop Scouting with Aerial Imagery – Choosing the Right Source | Integrated Crop Management. (2021). Retrieved April 29, 2025, from https://crops.extension.iastate.edu/post/crop-scouting-aerial-imagery-choosing-right-source.

Getting Started with Drones in Agriculture, NebGuide Nebraska Extension. (2017).

Pun Magar, L., Sandifer, J., Khatri, D., Poudel, S., KC, S., Gyawali, B., Gebremedhin, M., & Chiluwal, A. (2025). Plant height measurement using UAV-based aerial RGB and LiDAR images in soybean. Frontiers in Plant Science, 16. https://doi.org/10.3389/fpls.2025.1488760