



## UAV Technology for Precision Weed Detection and Management

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### Abstract

In India population increases rapidly day-by-day, therefore food demand also increases. Traditional farming is insufficient to meet these demands. Thus, Unmanned Aerial Vehicles (drones) were introduced, enabling Weed Management in less time, efficient use of herbicide and pesticide to bring sustainability to the environment and their resources. One of the most detrimental biotic variables in agriculture, weeds significantly reduces yields across the globe. Weed patches from crop fields can be identified by using drone sensors. Drone camera sensors can optimize weed in relation to leaf density, chlorophyll concentration and other plant canopy characteristics. The article emphasizes weed detection and management by the use of potential sensors of Unmanned Aerial Vehicles (drones) technology for better agriculture output.

**Keywords:** Sensors, UAVs, Weeds detection, Weed management

### Introduction

Weeds are the one most important factor among the biotic factors for crop growth. They provide competition with crops for different resources like space, nutrient, light and water. Also, weeds interact with other biological activities, acting as a host plant for pests (insects, fungi and bacteria). In every major crop grown worldwide, including rice (37%), potato (30%), soybean (37%), cotton (36%), wheat (23%) and maize (40%), weed competition significantly reduces production (Oerke, 2006). India relies heavily on agriculture, yet it still lags behind in adopting modern technology to create high-quality farms (Dutta and Goswami, 2020). Large crop regions can be monitored for weeds using UAV (drone) technology. Drone sensors can analyze data quickly, and by assessing the degree of crop-weed competition, potential solutions can be taken as soon as possible.

### Drone Sensors

In agriculture, drone technology camera sensors are mainly categorized in 3 classes.

#### RGB Sensors

RGB sensors are commonly available in the Indian market. Utilizing these sensors, vegetation indices like Greenness indices, Excessive Greenness indices, and Green/Red

Vegetation Index are calculated. Pre-flight planning and Dataset extrapolation are some of the things that are done in the typical way (Esposito *et al.*, 2021).

#### Multispectral Sensors

These camera sensors are used for the calculation of vegetation indices due to their ability to measure higher numbers of radiometric bands (Esposito *et al.*, 2021).

#### Hyperspectral Sensors

These sensors can capture 100-1000 of discard radiometric bands. Narrowband indices are computed using hyperspectral sensors, like- various vegetation and chlorophyll indices (Esposito *et al.*, 2021).

### UAVs Sensors-based Weed Detection and Management

In a crop field, there remain several weed patches with mixed communities of weed floras. These weed patches can be detected with precision by drone camera sensors in a short period. A detailed weed cover map showing the areas where herbicides are required can be produced using a drone that can gather photographs and information from the whole field. Three types (RGB, multispectral and hyperspectral) drone camera sensors are used for detecting weedy areas in crop fields. Hyperspectral images can identify glyphosate resistance of different weeds in crop fields (Dutta and

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Goswami, 2020). Different weed species can be classified by RGB camera sensors. Multispectral camera sensors provide more data than RGB by recording spectral bands which are invisible to the naked eye, like- vegetation indices, NIR data. Multispectral cameras can take pictures from 60-70 m height depending on crop types. After that, pictures will be analyzed using software to identify the precise location of the weedy areas.

UAVs remote sensing sensor technology is useful to detect and map weed patches (Figure 1), these sensors can identify differences between weeds and crops by spectral reflectance. Spectral and spatial resolutions of remote sensing are sufficient to identify weed differences (Rosle et al., 2022). The spectral signatures of particular plants can utilize the relationship between transmitted, interested and reflected energy. The majority of plants absorb red and blue light, reflect green light, and emit near-infrared light. Vegetation indices are used to compare various reflectance wavelength values. The NDVI (Normalized Difference Vegetative Index) is one of the vegetative indices that is used to analyze the vegetative growth of weeds and crops.

The NDVI equation is:  $NDVI = (NIR - R) / (NIR + R)$

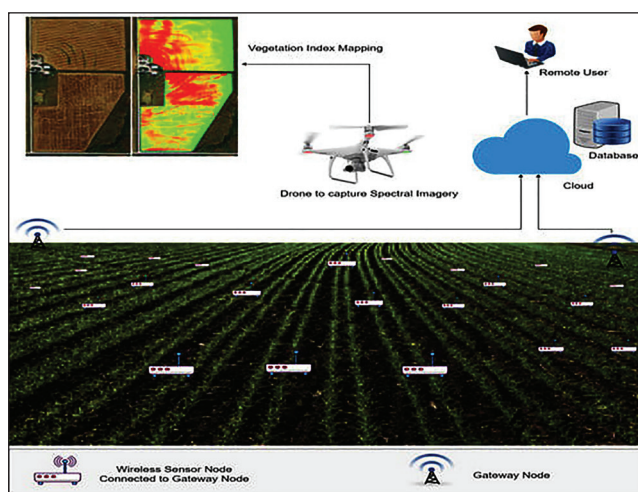


Figure 1: System architecture (Shafi et al., 2019)

NIR is the near-infrared band’s reflectance value, and R is the red band’s reflectance value. The NDVI ranges from +1.0 to -1.0.

Weed Pressure Algorithm examines high-resolution drone data to create a weed pressure map that provides farmers with a weed pressure index (range from 0 to 20) and the proportion of weeds that are scattered throughout the entire survey area.

In the above mentioned figure 2, a) Weed mapping and target area (blue line) identification were accomplished by supervised picture classification; (b) An application map with particular flight patterns (yellow line) was created after determining target locations; (c) Following application, UAV photos were gathered to map and detect herbicide-applied areas based on the chlorosis and necrosis of target weeds and (off target) sod; (d) and (e) areas might be classified as true negatives, true positives, false negatives, or false



Figure 2: UAVs for weed mapping and herbicide application (Hunter et al., 2020); (a) Weed mapping and target area identification; (b) An application map with particular flight patterns; (c) Herbicide-Sprayed area; (d) Mapping of confusion matrix categories; (e) Confusion Matrix

positives by superimposing the (a) weed detection and (b) spray maps. Effectiveness, Precision, and accuracy of the applications were evaluated using these classifications (Hunter et al., 2020).

UAVs technology helps to identify and manage weeds before they harm crops (Figure 3). With drone technology 83L glyphosate solutions are sprayed, 29L glyphosate were present in solution. The amount of glyphosate used was reduced by 67.78% compared to a tractor’s blanket application, which would have consumed a total of 90L, saving farmers 14.57 euro hectare<sup>-1</sup> (Anonymous, 2022). Important crops like Sugar beet, maize, wheat and barley have served as the primary testing grounds for UAVs. These crops are among the most widely grown in the world, and they are particularly vulnerable to weed competition during

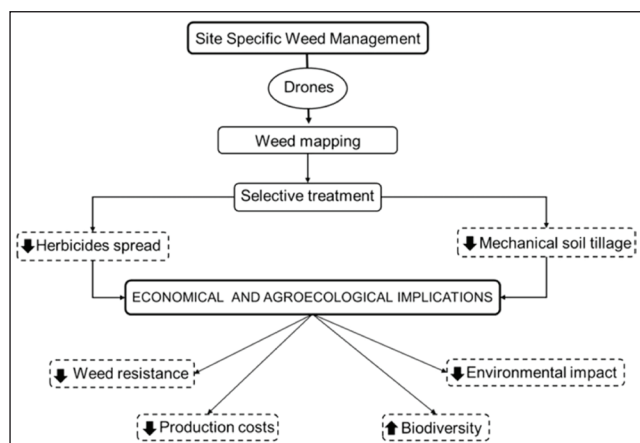


Figure 3: Site-specific weed management by drones (Esposito *et al.*, 2021)

the early phenological stages. These crops contained a number of dicotyledonous weeds, including as *Amaranthus palmeri*, *Cirsium arvense*, and *Chenopodium album*.

Graphs in figure 4, are from maize fields which after 8 days treatment (SPLIT = cyprosulfamide seed treatment and isoxaflutole spray, COMB = cyprosulfamide and isoxaflutole combined spray application, control = no application) and data collected from multispectral pictures at the wavelength of 550, 660, 735 and 790 nm (Mink *et al.*, 2019).

According to the American Farm Bureau Federation, farmers those used agricultural drones might realize returns for soybeans and wheat is \$2-3 acre<sup>-1</sup> and for corn is \$12 acre<sup>-1</sup>. According to research published in October 2022 in partnership with the Adani Group, with UAVs technology, agrochemical spraying can enhance crop productivity while reducing input costs by 25-90%. Through its Rythu Bharosa Kendra, the state of Andhra Pradesh has created a strategy to deploy 10,000 drones gradually. State agriculture institutes, farmers’ organizations, and drone manufacturers are reportedly collaborating with states including Uttar Pradesh, Punjab, Haryana, Karnataka, and Tamil Nadu to introduce drones.

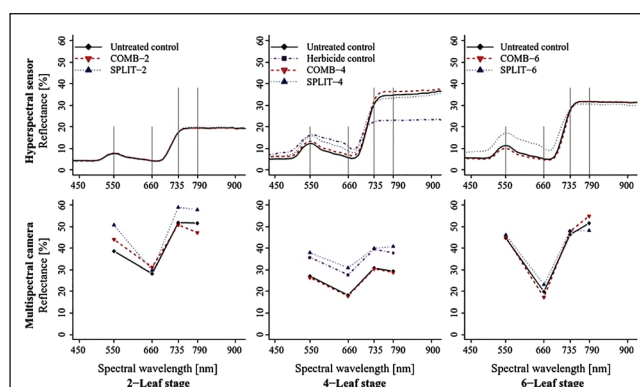


Figure 4: Graph of a sprayed maize field (Mink *et al.*, 2019)

### Conclusion

Drone technology has a great potential to identify crop weeds and site-specific management. It has immense potential to revolutionize the weed control approaches in

Indian agriculture. UAVs can effectively identify the weed patches and herbicide resistant weeds in crop fields and accordingly management approaches can be triggered at the earliest. Also drones are very helpful to maintain the sustainability of environment and ecology by reducing the use of herbicides and pesticides. Future weed detection and management techniques for big fields using drones may make them an integral element of agriculture. Therefore it will certainly help the Indian farmers to maintain their fields with less farm resources and also boost the profitability.

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