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Unmanned Aerial Systems (UAS) in Agriculture

Many people think of drones as weapons of war or high-tech toys. However, Unmanned Aerial Systems (UAS) offer realistic, economic, and ready-to-go solutions for agronomy with the potential to address climate change. UAS can be effectively used in some applications instead of tractors and other heavy farm equipment powered by fossil fuels. They can quickly and efficiently generate data to encourage farming practices that reduce carbon emissions. These data can be merged with different data sets to gain real-time knowledge for decision-making. The speed of information acquisition means more facts can be gathered sooner, along with pictures that provide essential detailed guidance. UAS can reduce the total amount of toxic chemicals used for crop production and worker exposure. More efficient use of chemicals will reduce the effects of climate change. More targeted usage of farm labor and heavy equipment reduces costs. This technology allows for the development of accurate historical records, which may improve predictions, serve as control data in before and after situations, and serve as a benchmark for documenting crop damage. UAS can help increase crop yields by assisting the natural process of pollination. UAS is another aspect of the movement toward "smart farms, " including other high-tech equipment that will become more prevalent in the future.

Early uses of UAS in agriculture included aerial mapping and photography of farmland. This information was used to plan future development and provide more detailed information to prospective buyers. It was also used by land owners for the location of septic fields or outbuildings. This information provided a greater understanding of farm boundaries and the topography of the land. Erosion control practices rely on accurate information about the angle of the slope. High-resolution imaging helps farmers understand crop cover, the amount of tillable soil, or the extent of soil erosion. UAS maps creek beds, water drainage, and flood areas. Aerial color photography, and more recently, multispectral imaging has been used to determine the extent of crop damage due to insects, fungal infestations, and water damage. Imaging is also important to document evidence of crop damage for insurance claims. Modern “smart farms” are beginning to use aerial imaging for decisions about the timing of planting and harvesting. It also helps farmers understand which crops will thrive in certain areas and where the highest yields can be achieved[1]. Multi-spectral UAS technology can be used to analyze soils to understand nutrient availability for management of better plant growth and optimization of external chemical applications[2]. Proper use of imaging can yield important data for farmers before permanent leaf damage occurs.

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[1] Simelli, Ioanna and Apostolos Tsagaris. “The Use of Unmanned Aerial Systems (UAS) in Agriculture.” HAICTA 2015: 7th International Conference on Information and Communication Technologies in Agriculture, Food and Environment. http://ceur-ws.org/Vol-1498/HAICTA_2015_paper83.pdf accessed 29 July 2022.

[2] Debangshi, Udit. “Drones – Applications in Agriculture.” Chronicle of Bioresource Management. 2021, 5(3):115-120. file:///C:/Users/16052/Downloads/DRONESANDITSSUSTAINABLEAPPLICATION_DEBANGSHI_OCT_2021%20(2).pdf accessed 29 July 2022.

Every time a tractor or other heavy equipment move across a field, some compaction of the soil profile and plant damage occur. Farm equipment is generally dependent on fossil fuels that are costly and contribute to global warming. UAS can reduce the amount of heavy equipment needed for the application of potentially toxic chemicals. Chemicals can be applied to fields by UAS instead of driving a heavy tractor with spray apparatus attached. This saves time and fuel costs and reduces soil compaction. UAS spraying devices can apply pesticides to very targeted areas with a high level of precision and accuracy. Trace nutrients and other fertilizers may be applied to specific areas of the fields instead of a huge broadcast application with a tractor or a crop-dusting aircraft. More efficient use of chemicals is better for the planet because it avoids waste. It also reduces occupational exposure which reduces potential health impacts. Targeted usage of chemicals results in less pesticide residue in the soil and food chain.

UAS thermal imaging along with high-resolution photography may be used to monitor livestock. Farmers with large herds or large acreage have the difficult task of checking the daily health and welfare of their animals. UAS allows a farmer to track the movement of their herds and the welfare of individual animals. This is particularly important during birthing season. UAS allows monitoring of grazing lands for plant health to prevent over-grazing. It helps ensure an adequate food supply for the herd. The farmer may see in real-time any problems related to the amount of food, water, or fencing and eliminate unnecessary trips. UAS is also used for wildlife conservation. It can be used for determining the amount and type of wildlife in a given geographic area. Predator species can be identified and remedial actions are taken, if necessary. It can also be used to monitor the health of tree stands and the progress of new seedling development which may be difficult to see from the ground.

Global warming and colony collapse disorder threaten pollination pivotal for food production. Multi-copter drones can be utilized to fly low and slow over crops at the peak time of crop pollination to augment the fertilization process. The downward force of the airflow from the drone's propellers increases the mixing of air and the movement of plants so that pollen can spread more easily from one plant to another. This is particularly important due to the stress climate change places on birds, bees, and insects who are the primary natural pollinators. Considerable resources can be wasted growing a plant to maturity if poor pollination prohibits that plant from bearing fruit which is the ultimate food source for humans and animals. Additionally, more novel use of UAS involves importing insects, bacteria, or fungi into a particular geographic area for integrated pest management (IPM). IPM capitalizes on natural predator/prey or disease/host relationships. If an insect or a disease begins to damage a crop, the natural enemy of that insect or disease vector can be introduced into a geographic area to eradicate the problem pest or disease. Drones can also be used to spread seed when conditions are too wet for tractors to enter the field. These especially wet periods may favor seed germination.

UAS is an immensely powerful tool for the rapid development of high-quality data. These data can be used to build an information database for a given geographic area. Accurate historical information can be used to improve predictions for decisions that impact the economic and long-term health of an ecological system. These data can be shared across regions, academic research, or governmental jurisdictions or used by a single farmer for his or her farm. Once the data set is developed, it can be merged with other data sets enhancing the power of the entire database and the robustness of any subsequent decision-making.

Drone usage is still in its infancy. Current FAA regulations limit drone weight to 55lbs under 14 CFR Part 107. It is likely the industry will press for the development of larger UAS to carry heavier payloads. With increased drone size comes greater risks of collisions and property damage. As the size and weight of UAS increase, so will the likely skill requirements for the licensing of pilots. It is also likely that the same type of medical and drug testing requirements will be imposed as on commercial airline pilots.

Expected regulatory changes from the FAA to UAS specifications in September of 2023 will result in remote identification of drones. This will allow FAA to identify the location and operator of every drone flying. This direct attribution to the operator means that drones operating illegally can be quickly found. Enforcement actions may be taken against an operator for improper or dangerous practices. This regulation needs to be in effect to protect public safety and allow UAS technology to progress. As drones increase in sophistication, more training will be required of UAS operators to understand the technology in meaningful applications for agriculture and other uses. However, future agricultural usage may be hampered in very rural areas when the remote ID requirement becomes effective because it is internet dependent. Many isolated areas in the Dakotas lack cellphone coverage and internet access. For UAS technology to be successful in rural agriculture, it will require better broadband and Wi-Fi coverage. More satellite internet will likely solve this problem. The future of UAS usage is strong and likely to become a highly skilled occupation, particularly in agriculture.

UAS is no longer a novelty. Instead, it is a powerful scientific weapon to combat global warming. It is a valuable tool for farmers who need economically attractive farming practices to increase food production while minimizing the negative impact of agricultural methods on the environment. Any technology that reduces the combustion of fossil fuels reduces carbon dioxide which increases the temperature of the planet. Improved pollination and reduced use of chemicals are just two of the hundreds of important uses of UAS in agriculture.

References:

1. Debangshi, Udit. "Drones – Applications in Agriculture." Chronicle of Bioresource Management. 2021, 5(3):115-120. file:///C:/Users/16052/Downloads/DRONESANDITSSUSTAINABLEAPPLICATION_DEBANGSHI_OCT_2021%20(2).pdf Accessed 29 July 2022.
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