POTENTIALS OF UNMANNED AERIAL VEHICLES (UAVs) IN THE NIGERIAN AGRICULTURE
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ABSTRACT

The continuous development of technology is driving the invention of new machineries such as the Unmanned Aerial Vehicles (UAVs), also known as "drones". The UAVs have become much more popular within the last decade for its significant roles in agriculture, among other industries, yet their applications in Nigeria are yet to be appreciated. Therefore, the present study reviewed the characteristics and multiple uses of UAVs in agriculture and their potentials for the Nigerian agriculture. Major applications of the agricultural UAVs for the Nigerian agriculture were identified to be soil analysis, crop disease detection and identification, pesticide application, yield and biomass predictions for large-scale farming, weed management including weed detection, weed monitoring and individual weed treatments. In terms of precision agriculture, crop stress assessment, irrigation scheduling, improved water-use efficiency for both surface and subsurface irrigation systems, and spatial variability assessments are inclusive. Further potentials include monitoring of plant growths based on its nutrient status, spatial variability in the nutrient's distribution across the fields and plant health monitoring. Agricultural UAVs were identified to have potentials in not only agriculture but also national security, in terms of nomads-farmers dispute resolution, through livestock monitoring and management. Challenges that may hinder the future use of the UAVs in the country as well as appropriate recommendations were also suggested for the effective use of agricultural UAVs in Nigeria.

Keywords: Agricultural UAVs; Agricultural Robotics; Precision Agriculture; Agricultural Mechanization; Agricultural Remote Sensing, Smart farming in Nigeria

INTRODUCTION

Specially designed machineries such as the Unmanned Aerial Vehicles (UAVs) also known as "Drones" are in place to foster for the 70% increase of Agricultural Food Production by the year 2050 projected by the FAO (McGill, 2009). UAVs were in use solely for military applications until lately. In 1921, the United States of America converted the abandoned military vehicles used for the World War I, technically categorized as Manned Aerial Vehicles (MAVs), for pesticide applications. It was until 1985 that the first UAV for pesticide spray and crop monitoring was developed by Yamaha, named "Rmax" (Chen et al., 2021; Giles & Billing, 2015; Lan & Chen, 2018). Yamaha was in continuous technological development, until 2007 when its UAVs production was stopped to protect its technology. UAVs net worth and value in agriculture is now predicted as the second to infrastructure (Mazur et al., 2016). According to the Association for Unmanned Vehicle Systems International (AUVSI) predicted the consumption of most (80%) civilian used UAVs by the agricultural sector in the near future (Lan & Chen, 2018). Agricultural UAVs have shown the competencies of being vigorous to weather conditions (Dandois et al., 2015). Their contribution to the smallholders is said to bring

climate-smart agriculture (CSA) and precision agriculture closer. Unfortunately, developing countries are yet to appreciate the use of such UAVs in the agricultural domain. Hence, this paper is an attempt to explore the major applications of these UAVs in Agriculture, its potentials, and the challenges to be faced for the Nigerian Agriculture.

APPLICATIONS OF UAVs IN AGRICULTURE

According to the literature surveyed from reliable internet resources, the use of agricultural UAVs varies significantly, with crop protection and plant growth and monitoring supposed as the major applications (Fig. 7). Crop protection also have four distinct branches, as in Fig. 8 below, with weed detection and management possessing the major use (40%).

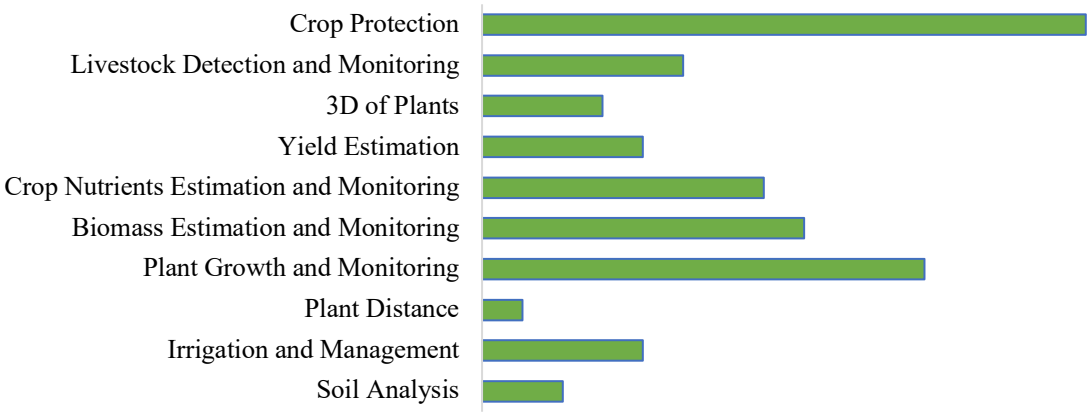

Fig. 7. Agricultural UAV Applications According to Literature Survey (2016-2021).

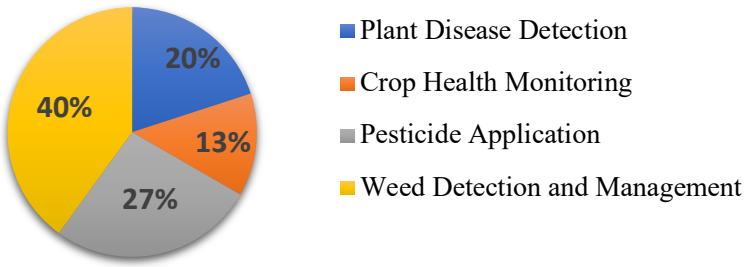

Fig. 8. UAV Applications in Crop Protection (2016-2021).

KEY REQUIREMENTS AND CHALLENGES

Regulation of usage

For the success of UAV adaptability and efficient use, its regulation is globally required. The Nigerian Civil Aviation Authority (NCAA) is the body responsible for UAVs regulation in the country for civilian use, agriculture inclusive. It permitted the use of UAVs in agriculture with concerns relevant for national security, user certification and authorization, user safety, public safety, and privacy. Despite the appreciable guidelines set by the body (NCAA, 2019), UAV regulations are still in its infancy stage, as it is the case for Africa in general (African Union & New Partnership for Africa's Development (NEPAD), 2018). Systematic review, update and enforcement of such regulations are critical for the sustainability of UAV applications in the country specifically and Africa in general (Ayamga et al., 2021).

Network availability

Configuring the UAV to acquire suitable images from the field, collecting the images, and most importantly, processing the images requires tremendous amount of data and viable internet connection. The widest available network in Nigeria is 3G, while 4G LTE is significantly spreading (Tugbiyele, 2019). Preparations for migration into 5G are yet to arrive. With such developments, the major challenge still in place include the costs (Osuagwu et al., 2013) and reliability on the network stability due to the problems associated with local internet service providers. Farmlands are usually in remote locations; therefore, the quality of internet services needs to be strengthened enough until a successful data acquisition and processing can be accomplished with the optimum efficiency and in the shortest possible time.

Import regulations for quality standardization

Nigeria is a developing country situated in the tropics. Most technological products are manufactured elsewhere and exported to the country. It is well known that designs and manufacturing of technological gadgets are affected by environmental conditions. Temperature, for e.g., was known to influence the chemical reactions in batteries in accordance with "Arrhenius equation" (Laidler, 1984) and the ionic conductivities of its electrons, thus generating heat and consequently tempering with the battery's quality. This implies a serious need for import standards of the UAV itself and its components, to suit the local conditions in terms of quality and reliability for data collection, processing, and results.

Intensive research and training

Nigerian agriculture is majorly a smallholder-based system. Thus, the incorporation of advanced agricultural mechanization technologies as well as the UAVs is a great task. For the UAV, specifically, researches proved its potential for use in smallholder agriculture (Kumi et al., 2021; Wahab et al., 2018) but with much more sophistication in the tech. Therefore, the modern agricultural sector if not provided with intensive training and research opportunities in Nigeria, the success of UAV applications might be daunting especially in the hands of the public sector.

RECOMMENDATIONS

Agricultural UAVs have been proved to be of optimum benefit to the Nigerian Agriculture. This is more specific to on-farm operations (from planting to harvest) and livestock production.

Recommendations for future dimensions are given as follows:

1. Improved agricultural technologies was set the topmost priority for the agricultural sector as part of the government's diversification plan (FGN, 2019). The stakeholders in the Nigerian agriculture should put up suitable policies for the success of UAVs use in agriculture. This should therefore include the UAVs and suitable policies in its regards should be made.
2. Agricultural UAVs are an advancement in agricultural mechanization technologies. Despite their versatility in terms of applications and qualitative results, their associated costs will be a huge setback for their success in Nigeria. Therefore, easy accessibility and lower costs could be achieved through government or custom hiring services. Government hiring services for agricultural mechanization, tractor in essence, have failed already (Kabir et al., 2019). An investigation into the future and success of UAV custom hiring services is therefore recommended.

3. Nigeria is a country situated in the tropics. Designs of UAVs could have potentialities in terms of using solar energy as power source. Thus, the potentialities and practicality of agricultural UAVs designed locally, and sustainability is highly recommended. Agricultural Engineers and students are recommended to apply the basic concepts for to achieve the optimum level of UAV utilization in the country.
4. Farmsteads are usually based in remote locations where viable internet connection may be difficult to obtain. It is recommended that portable and suitable internet connection facilities and network boosting tools should be developed. Research in this regard could be available; hence, their suitability for use in the Nigerian soil for its diversity should be ascertained.

CONCLUSION

UAVs or drones have been proved to have versatile applications in the agricultural industry. Nigeria, with its vast population and smallholder-dominated agriculture has the potentials of employing the UAVs for the future upgrade of the agricultural sector. In this regards, multiple literatures were reviewed to see the possible applications of UAVs in the Nigerian agriculture. Challenges to be encountered and possible solutions were recommended.

DECLARATION OF INTERESTS

The authors declare no conflict of interest.

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