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Adoption and Utilization of Drones for Advanced Precision Farming: A Review

Aditya S. Natu
Dept. of E&TC
Government College of Engineering
Jalgaon, Maharashtra, India
e-mail: aditya2natu@gmail.com

Prof. S.C. Kulkarni
Dept. of E&TC
Government College of Engineering
Jalgaon, Maharashtra, India
e-mail: samadhankulkarni@yahoo.com

***Abstract*—** India is the considerable maker of agricultural products but has very low agricultural productivity. Productivity of farm needs to be improved in a way that farmers can earn more profit from the same piece of land with less labor. Advanced precision farming may able to do it. Advanced precision farming technologies include use of drones, unmanned aerial vehicles (UAV's), Airborne Digital Photography (ADP) etc. UAV's are controlled remotely by telemetry, where the operator keeps up visual contact with the aircraft using GPS and inertial guidance. The initial uses in agriculture have been for remote sensing, with a prominence on the visual investigation of crop yield or farm field conditions and for tracking resources like machinery, workers or product. This paper presents a review on utilization of precision farming using aerial based system such as drones or UAV's for sustainability farming.

Keywords- *Precision farming (PF), Unmanned aerial vehicles (UAV's), Drones*

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I. INTRODUCTION

The world-wide farming system faces tremendous challenges. The United Nations Food and Agriculture Organization (UN FAO) expects that food production must be raised by 70% throughout the following forty years to meet increasing demand due to rising economic welfare and population growth. The main challenge of global agriculture provides a food to growing population, which is predicted to increase from seven billion people today to approximately nine billion around the year 2050.[1]

Development in space technology and IT revolution changed Indian environment and also in addition to it created new scopes for sectors. So under this changed condition it is important to grasp the new innovative technologies in agriculture and subsequent modification according to the domestic conditions for proper digestion of Indian farm sectors. [2]

Therefore, the objective of this paper is to review the scope and future strategies for proper adoption and application of advanced Precision farming in Indian agriculture.

II. NEED OF ADVANCED TECHNOLOGIES IN PRECISION FARMING

India is categorized by small-scale farms. Furthermore 80% of total agriculture land in the country is divided into pieces of less than 5 acres. The majority of the crops are depends on rain, with just around 45% of the land irrigated. It determines that around 55% of total population of India depends on farming which is dependent on rain.

Due to poor availability of funds, agriculture inputs like fertilizers, irrigation, seeds and pesticides, no farm insurance, terrible support price structure for the mass-produce, most of the farming is un-remunerative and more than half of the farmers in India are in debt. This is the vital basis behind the more farmer suicides.

Again in some part of the country, due to intensive production and mechanization in the latter half of the last century it was not possible to take care of the within field spatial variability. So these developed areas require advanced PF technology to be applied.

Wealth and security of the nation come from its land and hence its need to be sustainable, innovative and high-productivity agriculture which will be profitable and provide both food and energy security for the country. Hence, it is believed that some advance farming technologies will help to promote the next green revolution to Indian agriculture. [3]

III. AGRICULTURE MANAGEMENT STRATEGY USING DRONES

According to the site conditions, the application of different inputs at a variable rate by which farmers are able to take large fields and manage them as a group of small fields. This reduces the misapplication of products and improves crop and farm productivity.[4]

The utilization of advanced technologies in farming will help the farmer to manage their farm field with ease and stress-free. As shown in figure 1 the management cycle has different steps which consist of monitoring, mapping, evaluation and application.[5] First, monitoring is done by the camera which is mounted on a drone; this camera will scan the whole farm field and generates a spatial map. The spatial map will manifest the condition of the field and by evaluating this spatial map farmer able to get how much and where to apply the agronomy inputs such as seed, fertilizers, pesticides etc over the field.

Fig 1. Management strategy

Evaluation step will show the actual amount of inputs to be applied according to site conditions and requirement. The application of different inputs is done by using drones such as an application of irrigation, fertilizer or pesticides at a variable rate. [6]

IV. ADOPTION STRATEGY FOR ADVANCED TECHNOLOGIES OF PF

The major problem of mechanized farming is, the machinery required for farming is very expensive and few farmers are able to afford them. However, one way might be to install agri machinery leasing agencies in rural areas. These agencies can lease the mechanized machinery such as drip irrigation setup, cultivating tractor, seeders to the farmers as well as provide skilled manpower to operate these machines. Such agencies previously exist on a limited scale in India. They demand money from farmers on a per hour basis. So, with less labor, it is attractive and less expensive idea for many agronomists. [7]

Another economical way is utilizes a drone for one village and uses it for farming the farms available in that village. One drone is sufficient for many farms in one village, as soil and yield are remained constant in one growing season. So, the farmer can use it once before starting of the growing season. Once farmer gets the composition of their soil so they can apply the correct amount of seeds, fertilizers, and irrigation to each section of their field in that growing season without labors. Therefore, it is proposed for developing Drones for Advance farming technologies for sustainability**,** which able to do multiple tasks of farming such as monitoring spatio-temporal variability, variable rate application, application of irrigation and fertilizers etc. The advantage of a drone is enabling monitoring of large portions of farmland in a simple, quick and cost-effective manner, providing high value insight that speeds up decision-making.

V. APPLICATIONS OF DRONES IN FARMING

Regarding applications for precision farming, remote sensing, exploration, surveillance and mapping are some of the important tasks, since a smart remote sensor may be capable to obtain information from various angles and follow predefined tracks in remote areas that are troublesome access for human being [14, 15]. In future each of the workable uses for these drones will be delivered by the industries. For farming purpose some applications that are already being implemented are as follows.

A. Crop Health Monitoring

By now the capability to observing growing crops with Normalized Difference Vegetative Index (NDVI) or near-infrared (NIR) sensors is the first usage of drones in agriculture. Conventionally it has been carried out by physically inspecting areas of concern like walking on farm field with notebook in hand. But now drones such as SenseFly'seBee Ag is able to cover up to hundreds of hectares/acres in a single flight, also it helps the acquiring of data that unable to perceive by the human eye using NDVI. Furthermore, it eliminates considerable human error with respect to conventional scouting.[9]

B. Irrigation Equipment Monitoring

Drones becoming a water saving tool for agriculture. Managing multiple irrigation pivots is a complicated task, particularly to substantial growers that have numerous fields outspread across a county. When crops such as sorghum or jowar, corn start arriving at certain heights, mid-season observation of the nozzles and sprinklers for watering system supplies turns into a critical task. Drone technologies could potentially provide very valuable information about when and where to apply precise quantities of water to the crop if it can be made affordable. Farmers with the right irrigation technology could use this information to precisely apply irrigation water at different rates throughout the field instead of the same rate everywhere, which can cause waste.[10]

C. Mid-Field Weed Identification

Historically, until harvest time many farmers haven't aware how prominent their weed issue was. Creating a weed map by employing NDVI sensor data and image processing, farmers and their agronomists can easily distinguish region of high-intensity weed growth from the healthy crops growing right alongwith them. [11]

D. Variable-Rate Fertility

Although ground-based or satellite imagery are more practical for the purpose of refining variable rate applications like Nitrogen, Phosphorus and Potassium in agriculture, drones do have their place. By using NDVI maps to direct in-season fertilizer applications on corn and other crops are done by Agribotix, which is CO-based ag drone service startup. With the help of drone-generated variable-rate application (VRA) maps to decide the strength of nutrient uptake within a single field. The farmer can apply 60 pounds of fertilizer to the struggling areas, 50 pounds to the medium areas, and 40 pounds to the healthy areas by using drones results in decreasing fertilizer costs and increasing yields.[12]

E. Cattle Herd Monitoring

In the late-90s during the days of low commodity rate many growers made the call to diversify their farms by adding cattle employment. Drones are one of the best choice for monitoring or inspecting herds from high to tracking the amount and activity of animals. Also they are particularly useful for night-time monitoring because of the human eye's inability thus far to evolve to the point of seeing in the dark.

VI. ETHICAL AND SOCIAL IMPLICATIONS

With the help of drones farmers can make crops with minimum waste. The drones can reduces waste of water by detecting water requirement of specific plant. Also these drones could limit the amount of pesticides being used causing less chemicals to be unleashed into the environment. These drones would have a large impact on the current social trends of becoming environmentally friendly and saving the environment. These drones are ethical, as they are used for their predetermined motive, and are not used to cause any kind of harm to the plants and animals they are inspecting.[13]

VII. CONCLUSION

Over the past decade there have been a growing number of examples of applications of UAV'S or drones in environmental monitoring and precision farming. However, there are still some crucial limitations related to drones including high initial costs, platform reliability, sensor capability, and lack of standardized procedure to process large volumes of data. Moreover, strict aviation regulations and simple lack of interest from the farmers may impede adoption of drones. Hence it is clear that the application of Drones in precision farming is still in its early stage and maybe there is a considerable amount of room for further development concerned to both the technology and the various applications. Providentially, it is expected that with the development of UAV'S technology, improved image processing techniques, lower costs, new camera designs and a significant number of experimental studies of UAV'S based remote sensing for farming application, it will be a more prominent advantages of these systems in precision farming and environmental monitoring.

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