

Секция «Модели и методы управления организационными социально-экономическими системами»

ANALYSIS OF MODERN TECHNOLOGIES FOR MONITORING CROP FARMS

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As the world population rises, so does the global food demand. This makes it necessary to have an efficient method of monitoring crop health to improve efficiency, crop yields and resource management as agriculture is the main source of food. This is addressed by modern technologies such as drones, satellites and a new CubeSat design, which will be discussed in this article.

Firstly, drones in agriculture are unmanned aerial vehicles (UAVs) which are equipped with multispectral and thermal cameras that captures photos of crop plantations. They capture very high-resolution images that allow real-time and very accurate monitoring of the health of crops. With the aid of drones, farmers can detect pests and diseases, and also identify plantation portions that require attention.

The main advantages of drones are that they are cheaper compared to other types of technologies for monitoring crop farms like satellites. They can cover medium to large areas quickly. However, their operation range is limited to small areas, compared to satellites. For large scale plantations, a fleet of drones would be required which would make it more expensive.

Another technology used for monitoring crop farms is the use of satellites through remote sensing. Remote sensing refers to using satellites to collect information about Earth's surface without direct contact. Satellites equipped with optical instruments such as multispectral cameras and sensors are used for large scale or regional monitoring of farms. Some satellites such as Sentinel 2 have open-source data which can be used to monitor plantations and vegetation cover of any region in the world. The Sentinel 2 satellite visits the same region once every 4 to 5 days.

The main practical applications of using these technologies are:

1. Precise Crop Health monitoring: satellite and drone images can help detect stress from the crops through the use of vegetation indices.
2. Optimisation of resources: satellite images provide farmers with data which they can be able to use to better control the usage of resources which in turn reduces the production cost.
3. Yield prediction: satellite imagery mixed with machine learning can provide data which in turn can be used to analyse trends. These trends can be used by farmers to predict crop yields.

To monitor crop health, a variety of vegetational indices are use. The Normalize Difference Vegetation Index (NDVI) is used to measure the quality and quantity of the crops. This helps access the general health of the crops.

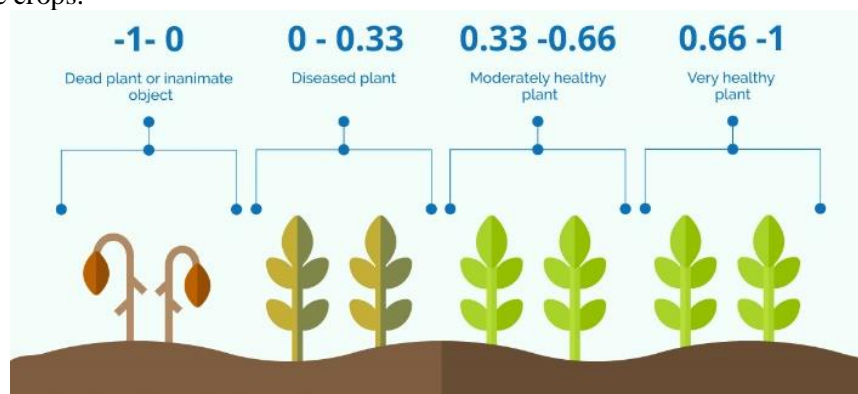


Figure 1. NDVI scale

Green Chlorophyll Index (GCI) is an index used to measure the content of chlorophyll in the leaves of the crops. It can be used to determine if the plants are in stress or healthy.

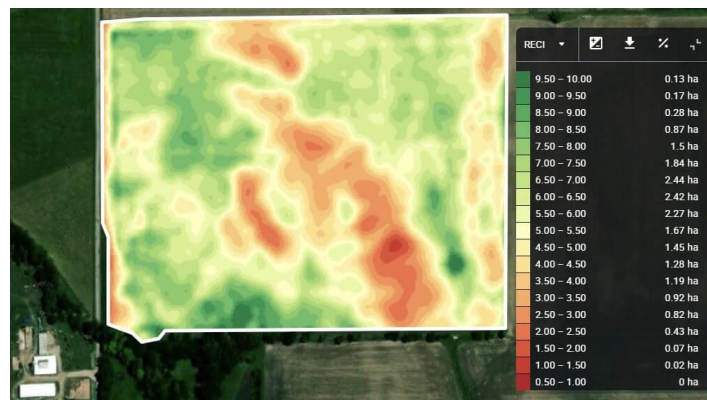


Figure 2. GCI scale

The Normalized Difference Water Index (NDWI) is an index use to monitor the changes of water on the leaves of plants. This is used to access the water stress on the crops.

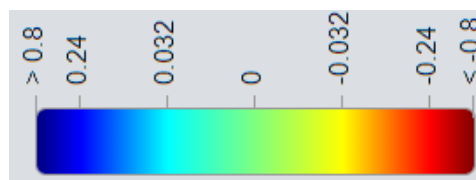


Figure 3. NDWI scale

These indices, gotten from the use of both drone and satellite imagery, are essential for making informed decisions about crop management.

Finally, to get a balance between cost, durability, efficiency and accuracy of images, a proposed nanosatellite technology (6U CubeSat) named South Sudan Satellite 1 (SSD-Sat 1) can cover the required tasks adequately. This satellite would be launched into the Low Earth Orbit (LEO) where it would orbit the earth in 94 minutes. It is sun-synchronised meaning that it passes through the same place at the exact same time everyday. For this case, in South Sudan, the SSD-Sat 1 will pass through it 2 times in a day. It has a 2 m resolution camera which is ideal for crop monitoring.

Table 1. Comparative Analysis of Drones, Sentinel 2, and SSD-Sat 1

| | Drones | Sentinel 2 | SSD-Sat 1 |
|----------------------|---------------|-------------------|------------------|
| Period | every 7 days | every 5 days | 2 times a day |
| Resolution, m | 0.05 | 20 | 2 |
| Cost, \$ | 100 000 | free | 250 000 |
| Life span | 2 years | 7 years | 5 years |

As shown in Table 1 above, SSD-Sat 1 has the best frequency, a balanced life span and resolution of the multispectral camera, compared to drones and the Sentine 2. However for the cost, is more expensive

compared to Sentinel 2, which is an open-source data collection hub. Drones can vastly vary depending on the quality and the number of drones in a single fleet.

In conclusion, while drones have a very accurate precision and detailed imaging, and Sentinel-2 offers cost-free large-scale data, SSD-Sat 1 provides a well balanced resolution, high revisit frequency, and scalability. For modern technologies of monitoring crop farms in large-scale agricultural operations, SSD-Sat 1 presents an important solution with timely, data-driven decisions for improved crop management and yields.

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CURRENT STATE OF AGRICULTURE IN UGANDA: PROBLEMS AND WAYS TO SOLVE THEM

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Agriculture simply means the practice of growing plants and raising animals to produce food, clothing, and other essential products [1]. It includes activities like farming crops, raising livestock, and sometimes fishing or forestry. Essentially, agriculture is how people use the land and natural resources to provide for their basic needs. This has become the backbone of Uganda's economy, contributing approximately 24% to the Gross Domestic Product (GDP) and employing over 70% of the population. 80% of the total land is arable, only 35% is being cultivated; its fertile agricultural land has the potential to feed 200 million people [2].

Uganda's advantages such as its endowment with fertile soils, favorable climatic conditions, and a wide range of crops, including coffee, bananas, maize, and tea, which are the country's key agricultural products has created great opportunities for its agricultural growth. Productivity is limited by reliance on natural weather conditions and the still widespread use of traditional methods and equipment. The Government is pushing for greater commercialization of agriculture by encouraging the use of irrigation and mechanized farming [2].

A research shows Uganda's economic structure with all its statistics below in (Figure 1) [2].