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The Critical Assessment of Drone based Hyperspectral Imaging Technology for Sugarcane Cultivation

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Abstract

The second largest agriculture based industry in India is Sugar production. Sugar industry is one of the major source of income of not only for farmers but also for Indian economy. The yield of sugarcane in India is 50tons/hectare while in other countries it is upto 100 tons/ hectare.Therefore, the focus of the research has been over the years in improving the yield of sugarcane production and simplify its forward and backward linkage.

In Indian scenario, the challenges in sugarcane production has been due to the lack of financial support, skill, knowledge, technology, forward and backward linkage.In this article, the technological gray areas in sugarcane productivity is highlighted. Also, the article talks about the latest use of technology i.e. Hyperspectral Imaging by drones for yield enhancement.

Keywords: Hyperspectral, Imaging, Satellite.

Introduction

Sugar Industry is one of the most important agro-based industry in India. Sugar industry is seasonal in nature and its working period is only for 120 to 200 days in year. In India, sugar industry is the second largest industry after textiles. The country is the second largest sugar producer in the world. The sub-tropical region (Uttar Pradesh) contributes almost more than 50% of India's total sugar production, while the balance comes from the tropical region, mainly from Tamil Nadu, Karnataka, Maharashtra and Madhya Pradesh. The sugar industry is one of the world's major agro-based industries. Maximum global sugar production comes from the top 10 producers, of which the top three (Brazil, India and the European Union) contribute 40% of the total.

In India, so far, the agricultural research has focused on developing a high yield variety seeds since green revolution. The world is changing very fast in technology development for every field including farming as well. The modern farming should be aimed at making production efficient through precise usage of machinery and inputs. A lot of progress has been made in agriculture field monitoring dimension by using by drones for aerial survey and yield prediction. Therefore, we are yet to use the drones based agriculture field mapping technology and providing real time data analysis about crop yield prediction.

Figure 1

Onboard hyperspectral camera on Drone by Gamya

This technological analysis presents the novel concept of hyperspectral imaging based camera on drone platform used by the company Gamya. The CANEFIT is the product package for sugarcane crop monitoring and yield production based on onboard hyperspectral imaging sensor.

Aim of the Study

The article highlights the existing technological gaps in sugarcane production. Currently in India, the yield is almost half of the world average. Therefore, this article presents the application of hyperspectral imaging in yield enhancement as demonstrated by the start-up company Gamya. As the Indian govt aspires to doubles the income of farmers in 2022, keeping this view, here it is also brought out that this technology has potential in increasing the income of sugarcane farmers.

Dhrones Vs. Satellite Based Spectral Imagins

The drone based technology mapping is new comer in the area of crop mapping. Remote sensing satellite gives the satellite images of crop production but it doesn't specify physiology of crops. In drone based technology mixed with hyperspectral imaging camera having more than 40 bands spectrum and analytics tools for crop yield prediction as shown in the table-1. It gives high resolution hyperspectral images that can be analyzed for physiological changes.

Table 1

Satellite and Drone based imaging differences [1]

S. No.	Parameter	Satellite	Aircraft /Drone
1.	Scalable	No	Yes
2.	Spatial resolution	50cm-2m	Ultra-high
3.	Temporal resolution	Limited by the orbit coverage	Available on demand
4.	Spectral resolution	Up to 5 spectral bands	Hyperspectral imaging (Up to 41 bands)
5.	Accuracy	Low	High
6.	Minimum area reqd.	100 to 1000km	Not relevant

Figure 2: a) High Resolution Hyperspectral Image

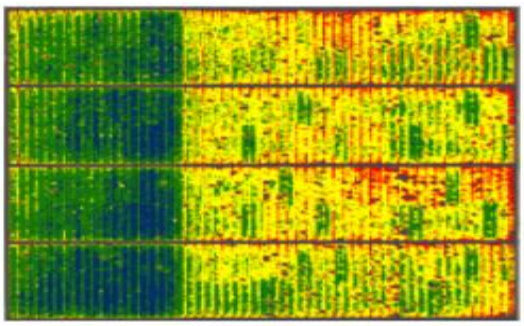


Figure 2: b). Satellite Image Multispectral Image

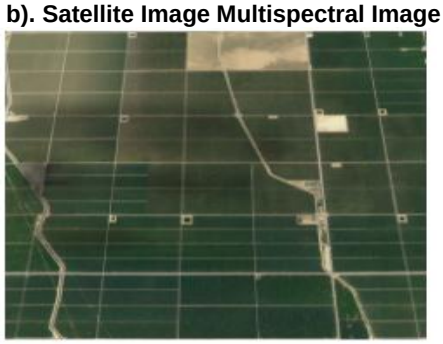


Table-1 shows the difference between satellite based and drones based imaging. The difference is coming due to multiband (more than 40 bands) hyperspectral camera i.e. capable of ultra-high special resolution w.r.t satellite imaging. The hyperspectral image as shown in fig.2, capable of producing physiological details of the agricultural produce.

Sugarcane Productivity Issues

There are many technical, political, administrative, and personal reasons to crop productivity losses. The major physiological issues that leads to crop yield reduction i.e.

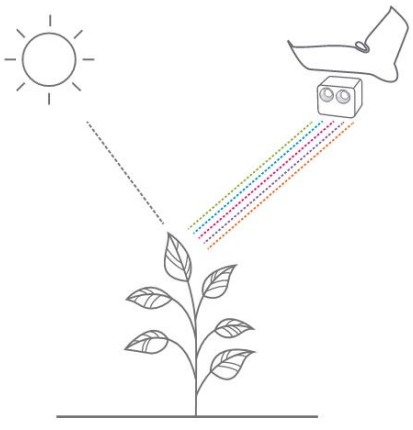
1. Lack of crop rotation, leads to reduction of nutrients in soils.
2. Lack of water availability for irrigation
3. Inadequate quality of seeds
4. Effect of rising temperature in productivity loss
5. Technological gap in detecting the nutrients in soil and crop.

The Canefit Technology Overview for Smart Farming

It collects drone based hyperspectral imaging data with historical climate and weather records.Then uses comprehensive crop model and artificial intelligence to produce detailed crop physiological traits.Furthermore, it presents the deficiencies of nutrients, disease, weeds etc. and also recommend the optimum use of herbicide, pesticides and fertilizers.

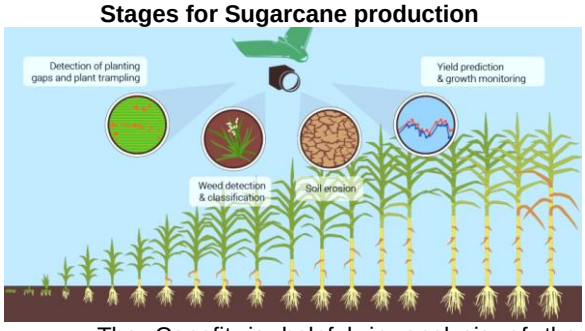
CANEFIT is a product by Gamya using the hyperspectral technology and its scenario is studied and optimized for sugarcane production.

Figure 3 Hyperspectral Imaging by Drone



Gamya has conducted a lot of research in collecting the historical data for sugarcane production to be used for developing a mathematical model. The model is correlated with field data and the product came in the market in the name of CANEFIT.

Figure 4
Stages for Sugarcane production



The Canefit is helpful in analysis of the following effects on sugarcane production.

1. Weed Detection and classification
2. Detection of planting errors and plant trampling
3. Soil Erosion
4. Biomass monitoring and Yield prediction
5. NPK Deficiency
6. Crop water stress
7. Pests and disease detection

Figure 5: a) Field overview

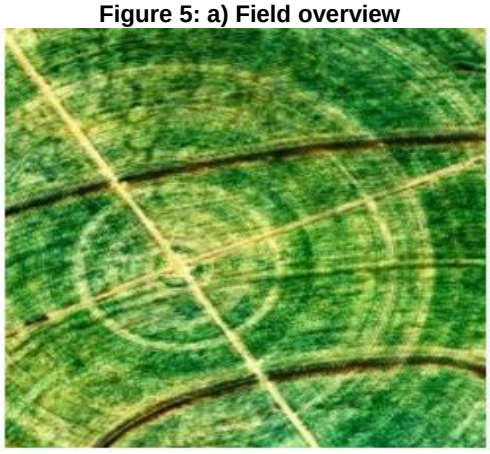


Figure 5: b). Weed detection maps by Canefit (Image source by Gamya)

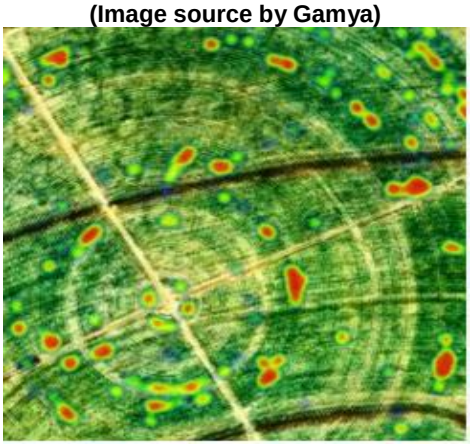


Figure 6: a) Status map

Figure 6: b). Detection of soil erosion (Image source by Gamya)

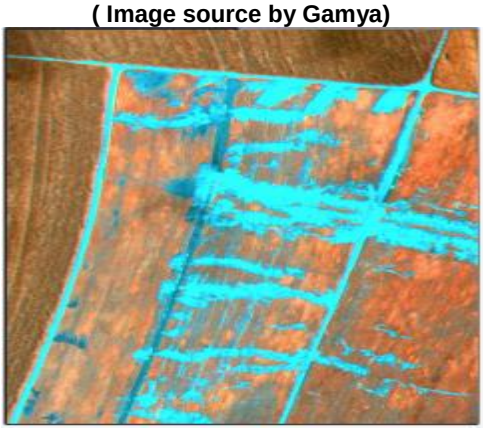


Fig. 5 and fig.6 shows the images of Canefit application in weed detection and soil erosion. Likewise, the analysis can be provided for the above list out other benefits. It also provides analysis report of the NPK deficiency of the field, wherein India can save a lot in fertilizers almost 30%(as claim by Gamya in sugarcane production).

Challenges in Technology Implementation

In India, the agriculture is considered as profitless occupation for survival only. Therefore, the state should focus on present technological innovations happing worldwide in the area of enhancing productivity. Although, some research has started in the core technology development for scientific farming, but more effort is needed in actual implementation. In India, only low cost product can survive or the state should sponsor hyperspectral scanning of poor farmers.

At present, the commercial use of the technology is costly, but in order to utilize the actual benefit of the technology is huge if the cost can be minimized. Therefore, research in lowering the cost of technology is imperative in Indian perspective.

Conclusion

The hyperspectral imaging based technologies are having potential in solving the India's growing problem of low agricultural productivity, low income of farmers and poor monitoring of fields. Canefit product by Gamya has demonstrated in Brazil for effective production and management of sugarcane production. Therefore, the government should focus in improving the accessibility of technology to farmers by research or government agency based imaging.

Therefore, the above technology is one of the commercially available technology having potential for India's farming technology needs. A well planned effective measure is expected from the government agencies and research institutes for integrated farming and management. It is also critically analyzed that the technology can save huge resources in weed suppression, soil erosion, fertilizer reduction, crop water usage etc

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