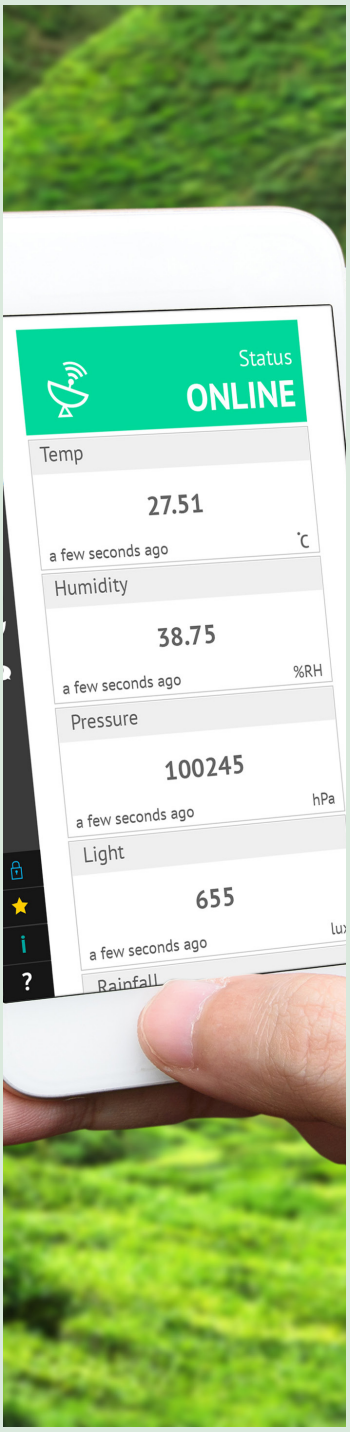
WHITE PAPER



ON-THE-GO PRECISION FARMING WITH NIRS IMAGING

Abstract

The seasonal nature of the agriculture industry puts significant pressure on farmers to consistently meet demand for high-quality produce. These days, precision agriculture is emerging as a way to help farmers make the right decisions about their crops. This is achieved by providing key insights into farm conditions and the supply lifecycle towards ensuring crop quality and quantity. This paper examines how near infra-red spectroscopy can help farmers implement precision agriculture to optimize input and neutralize environmental uncertainties, thereby improving agricultural yield.

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Introduction

As an industry, agriculture is vulnerable to a myriad of environmental and climactic conditions that can positively or negatively impact production. Along with experience and commitment, timely decision-making is a key success factor for agriculture. Thus, capabilities such as in-depth examination and analysis of commercial harvest along with its quality control have become increasingly important.

Advances in farming equipment are also helping agri-companies shift to cost-effective, easily available and manageable assets. One such technology – near-infrared spectroscopy (NIRS) – is a versatile and well-established technique for quantifying and qualifying analytics that is finding application in farming.

The principle behind NIRS is to obtain a spectral design from a particular material by casting light on a sample crop and measuring its spectral response. Pre-developed analysis models then analyze the spectral response. NIRS can provide instant and accurate data on multiple chemical and physical parameters and requires minimal preparation of sample types. In contrast to archaic chemical and conventional analysis methods, there is no waiting time to observe transformations in the sample.

NIRS can be leveraged in several domains including food quality control, pharmaceutical purity, oil and gas composition, and medical sample diagnostics, among others. It can also be used in farming to detect the crop characteristics such as moisture and nutrient content in different forage crops and silage.

Innovations driven by NIR

Near infra-red (NIR) is already a well-established technology with a proven performance track record for non-stationary equipment such as vehicles. It enables miniaturization to chip scale and uses semiconductor style wafers and etching techniques to achieve high production volumes, thereby making it cost-effective for companies to use it in a wide range of applications. This has unlocked opportunities in new and unexplored sectors including spectrometry and analysis. Today, NIR sensors are found in almost every mobile device.

NIR spectroscopy uses a technology called silicon micro optical systems technology (SiMOST) that replicates the properties of semiconductors for the photonics industry. This has made it possible to optimally design and fabricate optical and mechanical components on a single silicon chip, thereby reducing the size of the overall chip.

As a technology, NIR offers several advantages such as:

- NIR devices require only a single photo detector to capture optical power
- It allows simultaneous measurement of different materials with high accuracy
- It can measure samples of different forms including particles, flat surfaces and ground samples without the need for sample preparation
- It boosts efficiency, allowing companies to regularly monitor farm soil by continuously transmitting data
- It can detect unwanted chemicals and ingredients, thereby optimizing crop quality as well as quantity

Besides being cost-effective, NIR spectrometers can be used as an in-chip package, ushering technological innovation for the farming industry.

What is precision agriculture?

Precision agriculture (PA) is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. The goal of precision agriculture research is to define a decision support system (DSS) for the entire farm management to optimize returns while preserving resources.

Precision farming takes into account faltering requirements like quality and productivity. It has the capability to store imperative real-time information about the optimal amount of nutrients needed during harvest. This increases the quality and quantity of produce, thereby benefitting farmers. It provide insights regarding critical nutrients and minerals for fodder plants such as grass, corn and clover, thereby improving the quality of subsequent silage processes. Additionally, mapping farms and scanning seeds helps accurately predict the selling prices.

Thus, precision agriculture can help farmers meet the demand for high produce quality and quantity through the judicious use of the right technologies.

Applications of NIRS in precision agriculture

As the physical nature of soil changes every few meters, tracking soil constituents can be difficult. NIRS can be used on agricultural equipment like tractors and harvesters to create an integrated system of mobile harvesting machines. As a mobile solutions, NIRS can provide real-time data about the condition of the soil across entire fields. Enabling the Internet-of-Things (IoT) on NIRS sensors allows data to be securely stored on cloud servers while big data and AI technologies can be used to analyze this data to gain insights for every square meter of field area.

Key benefits

The combination of precision agriculture and NIRS delivers significant benefits such as:

- Enhanced quality through real-time and continuous mapping of fields for soil, nutrients, moisture, etc., with nearly 4000 readings per second
- Improved monitoring through immediate results, allowing farmers to take frequent and more representative samples instead of relying on non-representative samples measured through wet-chemistry analysis
- Optimized field usage by increasing the quality and quantity of produce per square meter
- Real-time insights allowing farmers to make the right decisions to meet fiber requirements
- Higher feed quality as operators can view constituent measurements while harvesting and quickly make on-the-go adjustments
- Improved livestock health and feed rationing by monitoring livestock feed components

These improvements in quality and quantity slash cost and boost business profitability for farmers.

An example of NIRS

Harvest Lab 3000 is an example of precision farming using NIR spectroscopy. Harvest Lab 3000 is developed by an American corporation that manufactures agricultural, construction and forestry machinery, diesel engines, drivetrains for heavy equipment, and lawn care equipment. It can be fixed onto mobile equipment like harvesters or tractors in order to gather different types of data. For instance, when in motion, it can collect harvest data about soil. In stationary mode, it collects information about feed given to livestock.

Harvest Lab 3000 uses NIRS to analyze the characteristics of the harvest or the feed such as the nutrients, moisture, protein, starch, and acid levels. It can measure up to 10 nutrient values in a steady and continuous stream of real-time data. Admin users can monitor the data anytime and anywhere, even at the time of harvesting, and can easily make changes in inputs like fertilizers and pesticides to maximize quality.

The data gathered from Harvest Lab 3000 during stationary mode can be used by admin users to understand feed constituents like protein, fiber and other characteristics. This is then used to adjust rations for optimal nutrition and reduce feed variability. Moreover, a variety of feed can be monitored and measured as often as required. These measurements enable precise feed tracking and ensure quality of the feed given to the livestock. Through these capabilities, Harvest Lab 3000 helps farm owners make proactive decisions about their yield, cost, quality, and pricing, thereby improving profitability.

Conclusion

The use of near infra-red spectroscopy has important value for precision agriculture by providing a robust and unique solution for farm management to maximize agricultural yield, optimize input, manage soil contents (nutrients, minerals, acids), and neutralize environmental impact. It can handle a variety of farming challenges and simplifies the process of sampling and tracking field-related parameters. When integrated with strong data analytics and even Azure solutions, it can help farmers get relevant insights that drive timely decision-making to enhance quality and boost quantity of produce, thereby delivering significant financial benefits to farmers and agri-businesses.

About the author

Varun Rathore is a Lead Developer with Infosys. He has around 10 years of experience in the IT industry. He is associated with the Infosys IoT practice and focuses on digital transformation for multiple clients. As a certified agile practitioner, Varun has rich experience across engineering, automotive and health domains. His functional expertise ranges from digital transformation to IoT and agile coaching. You can connect with him at varun_rathore01@infosys.com or https://www.linkedin.com/in/varun-rathore-15218530/

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