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# DATA ACQUISITION TOOLS FOR VARIABLE RATE FERTILIZER APPLICATION TECHNOLOGY

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Variable rate technology is an advanced agricultural strategy favouring resource optimization through need specific application of chemical inputs. Variable rate technology comprises of three main stages, data acquisition, data processing and application. Data acquisition is the crucial and prime stage which has to be carried out in a suitable manner. The various data acquisition tools such as GreenSeeker®, SPAD meter, chlorophyll meter, spectral sensors, aerial imaging etc. are developed and available commercially. This chapter can give an overview on data acquisition tools available with their short description.

## INTRODUCTION

Variable rate technology (VRT) is an advanced farming practice that utilizes data-driven insights to optimize the application of inputs such as seeds, fertilizers, and pesticides. By leveraging GPS and various forms of field data, including soil properties, crop yield, and weather conditions, VRT enables farmers to adjust the quantity and timing of input applications precisely according to the needs of different areas within a field. This precision farming technique enhances crop productivity and resource efficiency while reducing environmental impact by minimizing overuse and runoff of agricultural chemicals. The implementation of VRT contributes to sustainable agriculture by promoting better crop management practices, improving economic returns for farmers, and ensuring long-term soil health.

Variable Rate Fertilizer Application Technology (VRFAT) is a specific application of variable rate technology that focuses on the precise distribution of fertilizers across a field. Using detailed field maps and real-time data from sensors and GPS, VRFAT allows farmers to tailor fertilizer application to the specific nutrient requirements of different zones within a field.

This technology can account for variations in soil fertility, crop growth stages, and environmental conditions, ensuring that each area receives the optimal amount of nutrients. The benefits of VRFAT include improved crop yields, reduced input costs, and minimized environmental impact through decreased fertilizer runoff and leaching. By applying fertilizers more efficiently and effectively, VRFAT supports sustainable farming practices, enhances nutrient use efficiency, and promotes healthier crop development.

## VARIABLE RATE APPLICATION PROCESS

Variable rate fertilizer application technology involves several key steps: data acquisition, data processing, and application. Data acquisition involves collecting detailed information about soil properties, crop health, and field variability using sensors, satellite imagery, and GPS. In the data processing step, this information is analyzed using software to create precise application maps and prescriptions. Finally, during the application phase, the variable rate applicators, guided by GPS and the processed data, distribute the fertilizers accurately according to the field's specific nutrient requirements.

Various data acquisition tools used for variable rate fertilizer application were discussed as follows.

### GreenSeeker®

A GreenSeeker® is a sensor that measures crop health and vigour by assessing the Normalized Difference Vegetation Index (NDVI) ranging from -1 to +1. It helps in determining the precise amount of fertilizer needed for different parts of the field (Mirzakhaninafchi et al., 2022). There are two types of GreenSeeker® - hand-held type (Fig.1) and mounted type. The hand held type may cost around a lakh and tractor mounted is around 4 lakhs rupees.


**Fig.1 Hand-held GreenSeeker®**

### Chlorophyll Meter

A device that measures the chlorophyll content in plant leaves, which is indicative of the plant's nitrogen status (Martins et al., 2020). This information guides the adjustment of nitrogen fertilizer rates. There are several models of chlorophyll meters available commercially and one of them was show in fig.2. The range of value (Chlorophyll Content Index) was between 0 and 100. The instrument provides average of a set of readings.

### Leaf Colour Chart (LCC)

A simple and inexpensive tool used to visually compare the colour of crop leaves with a standardized chart (Fig.3) to assess nitrogen levels and decide on fertilizer application rates. There are 7, 5, 4 etc., different shades of greenness printed on a plastic card. The cheapest tool is LCC at Rs.30 per card available with local government agricultural centres.

**Fig.2 Opti-Sciences Chlorophyll meter (CCM 200 Plus)**

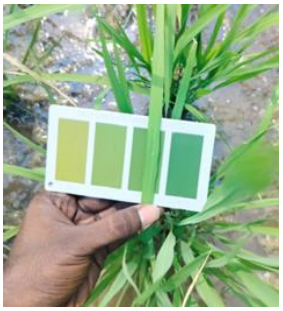

**Fig.3 LCC measurement**

**SPAD Meter**

SPAD (Soil Plant Analysis Development) is a portable device that quantifies the chlorophyll content in leaves, providing an indirect measure of nitrogen concentration (Atik & Akdemir, 2022). SPAD readings help in fine-tuning nitrogen fertilizer applications. SPAD value ranges from 0 to 50 and SPAD 502 model was shown in fig.4. Also, this instrument facilitates average reading after a set of consecutive reading.

**Fig.4 SPAD 502 (Konica Minolta)**

**Spectral sensors**

Spectral sensors assists in variable rate technology (Sozzi et al., 2020) by detecting and analyzing light reflectance from crops and soil, providing real-time data on plant health, biomass, and nutrient status. This information enhances the precision of data acquisition and processing, allowing for even more accurate and efficient application of fertilizers and other inputs. The spectral sensors are available in various price ranges suitable to hand held instrumentation, tractor mountable, drone mountable etc.

**Soil Sensors**

Sensors placed in the soil that measure various parameters like moisture levels, temperature, and nutrient content. These sensors provide real-time data that assists in the precise application of fertilizers.

**Aerial Imagery**

Drones or satellites equipped with multispectral or hyperspectral cameras capture detailed images of the field. These images help in assessing crop health and variability, informing variable rate fertilizer applications. Multispectral drone may starts from a price range of Rs.7 lakhs and Hyperspectral at more than 50 lakhs rupees. And notable issue is that, after acquiring the images, they have to be processed in a suitable software like Pix4D, Agi Soft etc., for practical utility.

**Fig.5 Multispectral imaging drone (DJI Phantom 4)**

**Yield Monitors**

Devices mounted on harvesters that measure and record crop yield and moisture levels in real-time. This data is used to create yield maps, which help in identifying areas of the field that may require different fertilizer rates (Zhang et al., 2020). These maps can be used to build stacked maps with other N availability, NDVI maps etc.

These tools collectively enable precise and efficient fertilizer application, enhancing crop yield, resource use efficiency, and environmental sustainability.

**CONCLUSION**

Various data acquisition tools were discussed for variable rate fertilizer application technology. Selection of a suitable tool among those depends on the field nature, crop, season, location, costliness and availability. By leveraging these tools, farmers can optimize fertilizer application based on real-time insights into soil conditions, crop health, and environmental factors, thereby enhancing agricultural productivity and sustainability.

**REFERENCES**

Atik, M., & Akdemir, B. (2022). Spatial Variability of NDVI and SPAD for Variable-and Fixed-Rate Fertilization in Olive Orchards. Erwerbs-Obstbau, 64(4), 647-655.

Martins, R. N., Pinto, F. D. A. D. C., Moura, A. D. D., Siqueira, W. D. C., & Villar, F. M. D. M. (2020). Nitrogen variable rate fertilization in corn crop prescribed by optical sensor. Journal of plant nutrition, 43(11), 1681-1688.

Mirzakhaninafchi, H., Singh, M., Dixit, A. K., Prakash, A., Sharda, S., Kaur, J., & Nafchi, A. M. (2022). Performance assessment of a sensor-based variable-rate real-time fertilizer applicator for rice crop. Sustainability, 14(18), 11209.

Sozzi, M., Bernardi, E., Kayad, A., Marinello, F., Boscaro, D., Cogato, A., ... & Tomasi, D. (2020). On-the-go variable rate fertilizer application on vineyard using a proximal spectral sensor. In 2020 IEEE International Workshop on Metrology for Agriculture and Forestry (MetroAgriFor) (pp. 343-347). IEEE.

Zhang, M., Zhou, J., Sudduth, K. A., & Kitchen, N. R. (2020). Estimation of maize yield and effects of variable-rate nitrogen application using UAV-based RGB imagery. biosystems engineering, 189, 24-35.