The Pharma Innovation Journal 2020; SP-9(9): 166-168

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2020; SP-9(9): 166-168

www.thepharmajournal.com
Received: 16-07-2020
Accepted: 20-08-2020

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# Variable rate application technology in India

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**Abstract**
Climate, soil and water are one of the basic inputs for successful crop production. Efficient utilization of these along with other (viz. fertilizers, pesticides etc.) is must for fetching higher monetary returns and input use efficiency. In spite of continuous progress in agricultural management practices/technology from last few decades, India still rely on those practices whose efficiency is very low and it opens a scope for transformation of technology. Variable rate technology (VRT) can be a boon for developing country like India; however some interventions and land consolidation practices needs to be adopted at farmers field level. Here an attempt has been made for giving a brief views on variable rate technology and its scope in India.

**Keywords:** Efficiency, VRT, consolidation

## Introduction
Transformation in agriculture sector is need of the hour to meet out the increasing food demands of the ever-growing global population. Over dependence on existing limited resources is resulting in overexploitation of these resources which is triggered by use of these limited resources in a non judicious manner. In modern agriculture, over the years many new technologies have been developed to cater the food requirements of global population viz. mechanization (First phase) followed by green revolution (Green revolution) and precision agriculture (Third phase). In developing countries like India, first two phases led to a tremendous increase in productivity of crops. However, at present situation there is a decreasing trend in Partial factor productivity for most of the crops which means that the response of crops towards more and more application of input is decreasing. Further in conventional agriculture system inputs viz. fertilizers, pesticides, irrigation etc are applied without considering spatial variability of the field which leads to decrease in productivity (due to over and under use of inputs) of crop/system and increase in environmental pollution and soil degradation (overuse of inputs like fertilizers/chemicals). Precision agriculture the third phase of modern agriculture revolution is popular in most of the developed countries where operational land holdings are large and now those countries are working on Agriculture 5.0 i.e. Robotics and Artificial Intelligence (Rubio and Mas, 2020) [3]. In Indian scenario Agriculture 4.0 (Digital Farming, Smart Farming, VRT) still holds a very small place owing to small and fragmented landholdings of the farmers. In India, introduction of precision agriculture techniques that suits the farmers need and condition is necessary to counter the ill-effects of conventional agriculture and for increasing farmers' profitability. Variable Rate Technology (VRT) is one of the main components of precision agriculture where inputs are applied according to the need of the crop with the help of GPS, GIS, remote sensing, plant/soil sensors, automatic controller etc. In VRT inputs are applied at right time & right site and in right amount & right manner by using the field variability. VRT implies any technology which provides economic benefits to farmers by reducing inputs and using precision agriculture tools to adjust rate of application of inputs as per crop requirements. For application of VRT variability (spatial/temporal) should be present in field. In absences of variability one cannot think of using variable rate techniques, however, variability is always present in farmers' field which opens the scope of this techniques. Variability in field can be due to nutrient status, soil texture, soil depth, crop management practice (s) etc. Variability can also be due to local climatic conditions like drought, rain etc. The first step in any VRAT (Variable Rate Application Technology) is to assess the variability which can be assessed by different techniques depending upon the type of variability and nature of work.

**Components of Variable Rate Technology (VRT)**

The major components of VRT (Figure 1). are RS (Remote Sensing), GIS (Geographical Information System), GPS/DGPS (Differential Global positioning system), computer, software etc (Sharma *et al*., 2014) [4]. According to Aggarwal (2003) [1], Remote sensing is a technique to observe the earth surface or the atmosphere from out of space using satellites (space borne) or from the air using aircrafts (airborne). Spatial data generated through remote sensing can be used in variable rate technology. GIS is a computer-based system that provides the following four sets of capabilities to handle geo-referenced data: a) Input, b) data management (data storage and retrieval), c) manipulation and analysis, and d) output. (Aronoff, 1989) [2]. GIS helps in projection of spatial data in the form of map using systems (software) like Quantum GIS, Arc GIS and many more. GPS helps in getting accurate position in field for application of VRT and helps in ensuring 4 R (Right Manner, Right Place, Right time and Right thing). Other components viz. computer, software (Q GIS, SAGA GIS, Arc GIS etc), Controller etc have their own importance/purpose in running any variable rate technology.

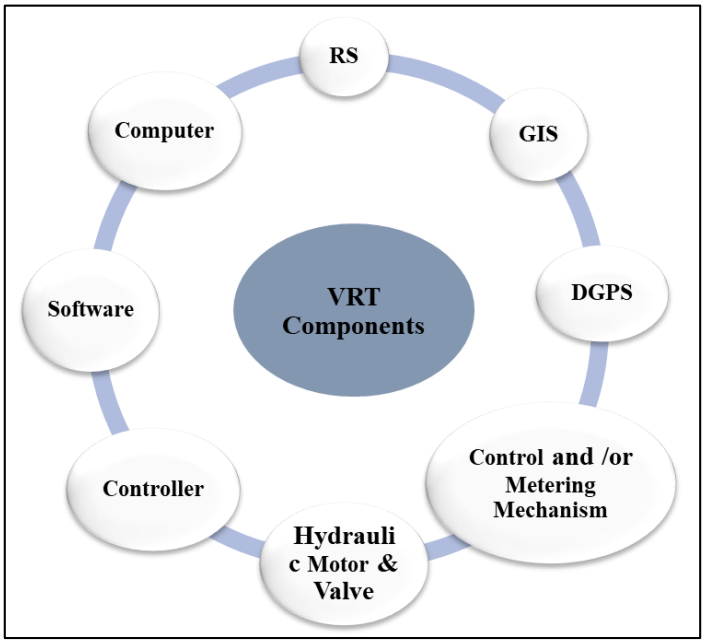


**Fig 1:** Components of Variable Rate Technology (Source: Sharma *et al*. 2014) [4]

The two basic technologies (approaches) for VRA are 1) Map-based VRA which adjust the application rate based on electronic map also known as prescription map and 2) Sensor-based VRA which requires no map or positioning system. Beside these two, manual approach can also be used. In manual approach, the rate of application is changed manually by the operator. For example in central pivot irrigation system, operator adjusts the speed and position of pivot for application of water in crops (Figure 2). Similarly for smaller area (less than that required for central pivot irrigation system), Raingun can be used for irrigation (Figure 3 and 4).


**Fig 2:** Central Pivot Irrigation System at Central State Farm-NSC, Sardargarh, Rajasthan.


**Fig 3, 4:** Irrigation through Raingun at Central State Farm-NSC, Sardargarh, Rajasthan

**Challenges and future strategies for VRT in India**

At present the major challenge for its adoption is small & scattered land holdings and diverse cropping pattern of farmers. Some other challenges which limit the use of VRT are high initial cost of machinery and its maintenance and running cost, lack of technical staff and poor network of providers for custom hiring purpose. However, proper strategies especially for land consolidation, custom hiring may help in application of VRT in agriculture sector. Besides development of VRT suiting the local conditions and needs of small and marginal farmers needs to be develop and promoted.

**Conclusion**

Due to high initial cost and complex machineries system it requires proper management, calibration and maintenance. However application of VRT reduces overall amount of inputs used improves crop yields through optimal use of inputs. Hence in future scope of variable rate technology in agriculture could be immense if land consolidation practices get a good rhythm in developing countries like India. Beside this some local interventions needs to be applied considering the local conditions to promote and use the VRT in an efficient and economic manner.

**Acknowledgement**

The authors are thankful to VCSG Uttarakhand University of Horticulture and Forestry and GKMS scheme funded by IMD, New Delhi and AICRPAM scheme funded by ICAR- CRIDA, Hyderabad for their help in publishing this paper.

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