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Variable-Rate Technology: A Smart Farming Technique

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Precision farming refers to the precise application of agricultural inputs for soil, and crop needs to improve productivity, quality, and profitability in agriculture. It uses spatial and temporal information of crops to perform site-specific management. It delivers customized inputs based on geo-referenced crop information and the partition of fields into zones with particular treatment requirements. Hence precision agriculture is about doing the right thing, in the right place, in the right way at the right time. Sensors & remote sensing, high precision positioning systems, geomapping, automated steering systems, variable rate technology, and integrated electronic communication are the main components of precision agriculture.

Variable-Rate Technology (VRT)

It describes any technology that enables the variable application of inputs. It attempts to site-specifically manage field variability. Farm inputs like fertilizers, lime, agrochemicals, irrigation water can be applied at different rates across a field, without manually changing rate settings on equipment or having to make multiple passes over an area. It can match changes in crop yield potential with specific input rates resulting in a more efficient system.

Why VRT?

Farmers apply various agricultural inputs like seeds, fertilizers, weedicides, pesticides, and water, based on recommendations emanating from research and field trials under specific agro-climatic conditions, which have been extrapolated to a regional level. Since soil types, soil nutrient status, weeds density, pest infestations, and soil water vary not only between regions and between farms but also from plot to plot and within a field or plot, hence, there is a need to take into account such variability while going to cultivate a particular crop. So the goal of VRT is to obtain more efficient use of applied inputs to improve economics to reduce any excess application that might cause environmental pollution. By utilizing tools like **Geographic Information System** and **Global Positioning System** to manage existing field variability, variable-rate technology (VRT) has been evolved. VRT helps to increase the input efficiency, minimize over-application of inputs, reduce the risk of pesticide and fertilizer runoff or leaching into water sources, and also reduce application in environmentally sensitive areas. Thus it helps to improve the crop yield through optimal use of inputs. In map-based VRT, a prescription map is generated based on soil analyses or other available information and then used by the VRT to control the desired application rate. Maps are generated using agricultural GIS software packages. Sensor-based VRT, utilizes sensors to assess crop or field conditions to provide real-time variable rate application (VRA) of inputs. Sensors are devices that transmit an impulse in response to a physical stimulus such as heat, light, magnetism, motion, pressure, and sound. It can be contact or remote, ground-based or space-based, and direct or indirect. Among these, the sensors are critical to success in the development of a VRT since sensors can sample at very small scales of space and time, have fixed costs, and facilitate repeated measures.

Geographic Information System (GIS) and Variable Rate technology

GIS forms an ideal platform for the storage and management of model input data and the presentation of model results which the process model provides. Modern GIS technologies use digital information, for which various digitized data creation methods are used. GIS accuracy depends upon source data, and how it is encoded to be data referenced. It allows complex data collection, which in turn are processed and interpreted for the benefit of the farmer. The GIS database must consist of many layers of spatial data, each of which has precise control of ground position in the field. Among the layers are physically measured inputs such as field boundaries, slope, and aspect of the terrain, water content, particle size distribution, rooting volume, and drainage. While some of these inputs can be interpreted from soil maps and conventional soil survey maps, they may not be accurate enough for precision farming, thus requiring intensive soil sampling and soil map generation for each field to be managed. Layers with chemical inputs such as nutrient levels, cation exchange capacity, pH, salinity, pollution potential, and plant tissue element levels are also collected. Measured biological data may include layers of yield quantity, yield quality, disease distribution, insect distribution, weed distribution, and organic matter content. The precise positioning of the data layers allows an analyst using GIS to determine locational coincidence among the yield rates and the various fertility and pest-control inputs.

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