



# Variable Rate Technology

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“Variable rate technology refers to a system that varies the rate of agricultural inputs such as seed, fertilizer, and crop protection chemicals in response to changing local conditions.”

*National Research Council, 1997*

Variable rate technology represents “instrumentation such as a variable rate controller for varying the rates of application of fertilizer, pesticides and seed as one travels across a field.”

*Precision Farming Profitability, 2000*



## Variable Rate Technology

- **Variable Rate Applicators**
  - Seeding and planting material
  - Dry chemicals (granular fertilizer, pesticides, lime)
  - Liquid chemicals (liquid fertilizer and pesticides)
  - Gas fertilizer (anhydrous ammonia)
- **Variable Rate Irrigation**
- **Variable Tillage**



## Principle Components of VRT

- **Sensor** – device for measurement of physical phenomena (pressure, flow, speed, soil and plant properties, etc.)
- **Controller** – device for varying controlling signal according to input command and preprogrammed **algorithm**
- **Actuator** – device that responds to the controller's signal and changes equipment settings accordingly



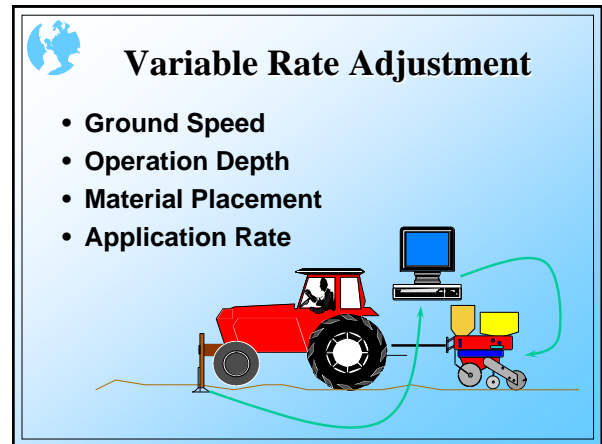
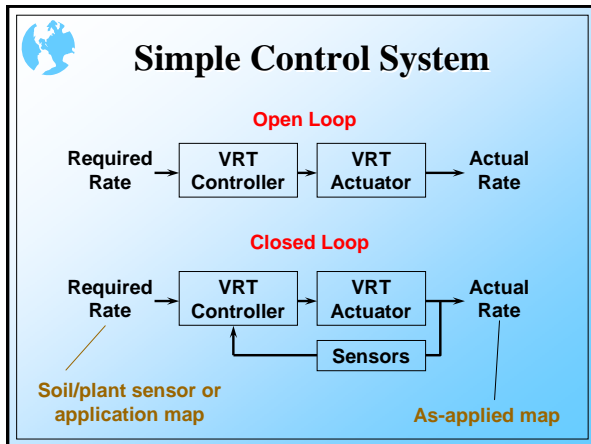
## Variable Rate Applicators

- | <b>Map-Based</b>    | <b>Sensor-Based</b> |
|---------------------|---------------------|
| • <b>Sensor</b>     | • <b>Sensor</b>     |
| – <b>Position</b>   | – <b>Soil/plant</b> |
| – Pressure/flow     | – Pressure/flow     |
| – Ground speed      | – Ground speed      |
| • <b>Controller</b> | • <b>Controller</b> |
| • <b>Actuator</b>   | • <b>Actuator</b>   |



## Sensor-Based VRT

- Anhydrous ammonia = f(soil type)
- Planting population = f(CEC, topsoil depth)
- Herbicide rates = f(Soil OM)
- Starter fertilizer = f(CEC)
- Nitrogen fertilizer at side-dress time = f(CEC, topsoil depth, soil nitrate level)
- Herbicide rates = f(weed population)



- ### Variable Rate Applicators
- **Seeding Equipment**
    - Speed of the seeding material drive
    - Seed variety
  - **Spinner Spreader**
    - Gate opening
    - Conveyor belt or chain speed
  - **Pneumatic Applicators**
    - Suspension rate
  - **Sprayers**
    - Operation pressure
    - Orifice size (multiple nozzles)
    - Chemical concentration
    - Nozzle timing

- ### Issues to Consider
- **Application rate uncertainty**
    - Calibration
    - Material quality
  - **Complex machinery (compatibility)**
  - **Spatial resolution**
    - Lateral
    - Longitudinal
  - **Recommendation algorithms**
    - Quality of input data
  - **Alternative practices and materials**

### Equipment

- Most major equipment manufacturers have some sort of VRT capability available today
- Utilization of CAN bus is expanding

Two photographs showing VRT control equipment on a tractor. The left photo shows a close-up of a control panel with a screen and buttons, labeled 'COMPUTER II'. The right photo shows a wider view of the tractor's rear section with the VRT applicator and control components.

A large, 3D-style green question mark graphic centered on the slide.

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