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Anjugramam - Kanyakumari Main Road, Palkulam, Varyoor P.O. - 629 401, Kanyakumari District.

DEPARTMENT OF AGRICULTURAL ENGINEERING

AI3701 – REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM

UNIT 5 APPLICATION OF REMOTE SENSING AND GIS IN AGRICULTURE

5.2 PRECISION AGRICULTURE

PREPARED BY

MRS. NITHYA.K

ASSISTANT PROFESSOR/AGRI

OBSERVE OPTIMIZE OUTSPREAD

5.3 GIS Applications in Precision Agriculture, Including Soil and Crop Health Monitoring

Some key GIS applications in precision agriculture, especially focusing on soil and crop health monitoring, include:-

1. Soil Mapping and Analysis

Soil is a critical factor in agriculture, and its properties can vary significantly even within a single field. GIS enables farmers to:

- **Create soil maps** by collecting data from field samples or sensors that measure soil characteristics such as texture (sand, silt, clay), organic matter content, pH, electrical conductivity, and nutrient levels (nitrogen, phosphorus, potassium). These maps help visualize spatial variability in soil properties, allowing farmers to apply fertilizers and soil amendments (lime, organic matter, etc.) at variable rates, matching the needs of specific areas in the field.
- **Monitor soil erosion** by mapping terrain slope and runoff patterns. Over time, it can help track changes in soil health and predict areas prone to degradation, ensuring timely interventions to prevent soil loss.
- **Do precision tillage**, where GIS identifies zones with soil compaction, enabling targeted mechanical treatments that reduce compaction without over-tilling other areas.

2. Crop Health Monitoring

Using remote sensing (satellite, UAVs, or drones), GIS can capture detailed imagery of crop fields to monitor plant health. Key aspects include:

- **Vegetation Indices:** NDVI (Normalized Difference Vegetation Index) is widely used in crop health monitoring. It calculates plant health based on how vegetation reflects near-infrared (healthy vegetation reflects more) and visible red light. High NDVI values indicate healthy, photosynthetically active plants, while lower values suggest stress from drought, pests, disease, or nutrient deficiency.
- **Thermal Imaging:** GIS can integrate thermal data to detect hot spots or cold spots in a field. Plants under stress (e.g., drought or nutrient deficiencies) often exhibit changes in surface temperature that can be detected using thermal cameras on drones or satellites. This allows for quick identification of areas needing attention.

Farmers can use these insights to address problems early, applying water, nutrients, or pest control measures more efficiently.

3. Precision Irrigation Management

Water is a critical resource, and precision irrigation techniques help maximize its use. GIS can help farmers in different ways as described below:

- Map field moisture variations by integrating data from soil moisture sensors, weather stations, and remote sensing. With this spatial data, farmers can develop precise irrigation schedules tailored to the varying moisture needs of different parts of the field.
- GIS allows for the implementation of Variable Rate Irrigation (VRI), where irrigation systems apply water at different rates to different field zones based on soil moisture or crop requirements. This prevents overwatering (leading to nutrient leaching) or underwatering (leading to drought stress).
- Farmers can also use evapotranspiration (ET) models, combining GIS and climate data to estimate how much water crops lose through evaporation and transpiration. This information helps in scheduling irrigation more effectively.

4. Yield Mapping

Yield maps are created by using sensors mounted on harvesting equipment that track the crop yield as the harvester moves across the field. These are a few aspects of yield mapping:

- **Mapping spatial yield variation** across the field. Data from the yield monitors is combined with GPS data to show precisely where higher or lower yields occurred.
- By overlaying yield maps with other data (soil, topography, or management practices), farmers can identify **patterns and correlations** between yield and underlying factors like soil fertility, pest pressure, or water distribution.
- This helps in optimizing future inputs such as fertilizers or seeds and **enhances decision-making** for planting strategies, crop rotations, and field management practices.

5. Pest and Disease Management

Pests and diseases can spread rapidly, and early detection is key to managing outbreaks. GIS supports:

- **Spatial analysis of pest and disease occurrence** by monitoring the spread of pests, mapping hotspots, and understanding how environmental factors (temperature, humidity, wind) influence the movement of pests and pathogens.

- **Predict the spread of diseases or pest outbreaks** by overlaying pest data with climatic and field data. This helps in implementing targeted pest control measures (pesticides, biological controls, or traps) only where and when they are needed, reducing costs and environmental impact.
- **Early detection of signs of disease or pest stress** in crops through changes in vegetation reflectance using remote sensing data.

6. Climate and Weather Data Integration

Climate variability can have significant impacts on crop production. GIS allows farmers to integrate weather and climate data with field information to:

- **Predict extreme weather events** such as frost, drought, or heavy rainfall that can affect crops. For example, frost risk maps can be generated by combining weather forecasts with topographical data (cold air tends to accumulate in lower areas), helping farmers take protective measures such as irrigation or covering crops.
- **Monitor microclimates:** Within large fields, there can be variations in temperature, humidity, or wind exposure due to landscape features like hills, trees, or water bodies. GIS helps track these variations, enabling farmers to manage crops based on localized climate conditions.
- **Link historical climate data** with crop yield data to understand how climate variability affects production, allowing them to make better-informed decisions for the future.

CONCLUSION

In conclusion, GIS applications in precision agriculture have significantly transformed farming by enabling the integration of spatial data for more accurate decision-making. By using technologies like GPS, remote sensing, and satellite imagery, farmers can now monitor soil conditions, crop health, and weather patterns with great precision. This leads to more efficient use of inputs such as water, fertilizers, and pesticides, optimizing resources while minimizing environmental impacts. GIS also plays a crucial role in yield mapping, pest and disease management, and precision irrigation, ultimately contributing to enhanced crop yields and sustainable farming practices.
