**Prediction of crop yields using location and weather-based automatic systems of IoT**

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This chapter provides an overview of the importance of yield prediction in agriculture and the pivotal role played by location and weather in the prediction process. With the objective of accurate yield forecasts for crop planning, management and for the cultivation practices. The chapter covers key topics such as climate and weather patterns, geographic factors influencing crop suitability, remote sensing and GIS technologies, crop modelling techniques, integration of weather data along with a case study, future trends, challenges and recommendations in brief showing location and weather-based automatic systems of internet of things (IoT)

1. **Introduction**

Location and weather are critical factors that significantly influence crop growth and productivity. The spatial variability in soil properties, topography, and land use patterns across different regions can lead to variations in agricultural productivity. Moreover, weather conditions, including temperature, precipitation, solar radiation, and wind patterns, directly impact plant growth, photosynthesis, and yield formation. Therefore, integrating location-specific information and weather data into yield prediction models can provide a more comprehensive understanding of crop performance and enhance the accuracy of yield forecasts. The several key climate variables such as; temperature, precipitation, humidity, solar radiation, wind and seasonality affect crop yields and play a critical role in determining the success and productivity of agricultural systems. Understanding and managing these variables is crucial for ensuring optimal crop growth and maximizing yields. These factors influence the weather patterns and determine their impact on crop growth. Key points related to weather patterns and their impact on crop growth are; heatwaves, droughts, heavy rainfall and flooding, frost and freezing temperatures, storms and hailstorms, El Niño and La Niña. There are several data sources and collection methods for climate and weather data such as: meteorological stations, satellites, weather models, remote sensing, climate data archives etc.

1. **Role and integration of Remote Sensing and Geographic Information Systems (GIS) in yield prediction**

Remote Sensing and Geographic Information Systems (GIS) are powerful tools when it comes to location and weather-based prediction for crop yields. They provide valuable insights and enable more accurate and efficient yield forecasting and management in agriculture. Remote sensing involves the use of sensors and satellites to collect data about the Earth's surface, including vegetation health, land cover, and weather patterns. This data can be used to assess crop conditions, monitor changes in vegetation, and identify factors that affect yield potential. Remote sensing data, such as satellite imagery and spectral measurements, can be processed and analyzed to extract valuable information about crop health, biomass, and growth stages. GIS, on the other hand, is a computer-based system that integrates and analyzes geospatial data. It enables the spatial analysis and visualization of data, allowing for the identification of patterns, relationships, and trends related to crop yields. By combining remote sensing data with other geospatial information, such as soil characteristics, topography, and weather data, GIS provides a comprehensive framework for location-based analysis and prediction of crop yields.Using remote sensing and GIS, farmers and researchers can analyze historical yield data along with spatial data layers such as soil types, weather conditions, and land cover to develop predictive models. These models can then be used to estimate yields for specific locations and make informed decisions regarding crop selection, planting schedules, and resource allocation.

The integration of remote sensing and GIS technologies offers powerful capabilities for yield forecasting. Remote sensing data, such as satellite imagery, can be processed and analyzed using GIS tools to extract crop-related information. By combining this information with other geospatial data, such as soil characteristics and weather patterns, comprehensive models for yield forecasting can be developed. The integration of remote sensing and GIS technologies enhances the accuracy and spatial resolution of yield forecasting, enabling targeted decision-making in agriculture.

1. **Crop Modelling and Yield Prediction**

Crop modelling and yield prediction involve the use of a combination of biophysical models, statistical models, and machine learning approaches. By leveraging these tools, researchers and practitioners can gain valuable insights into crop growth dynamics, estimate future yields, and make data-driven decisions to optimize agricultural practices.

**3.1 Machine learning approaches for yield forecasting**

Machine learning approaches have gained popularity in recent years for yield forecasting due to their ability to handle complex datasets and capture non-linear relationships. These models learn from historical data to identify patterns and make predictions based on input variables. Machine learning algorithms, such as random forests, support vector machines, and neural networks, can be trained using historical yield data along with a range of predictors such as weather variables, soil characteristics, and crop management practices. Machine learning approaches offer the potential for improved accuracy and flexibility in yield prediction, particularly when dealing with large and diverse datasets.

1. **Experimental Case Studies**

**4.1 Weather-Based Yield Prediction in Corn Farming**

Researchers developed a weather-based yield prediction model for corn farming, using historical weather and yield data. The model utilized multiple regression analysis with temperature, precipitation, and solar radiation as predictor variables. Temperature had a positive correlation with corn yield, while precipitation and solar radiation showed varying effects based on crop development stage. The model demonstrated high accuracy in predicting corn yield and helped farmers optimize planting schedules, irrigation management, and fertilizer application for improved crop productivity and resource utilization.

**4.2 Location-Based Crop Suitability Analysis**

Researchers conducted a location-based crop suitability analysis by integrating GIS, soil data, climate data, and crop requirements. They collected soil and climate data, along with information on crop requirements. Using GIS software, they overlaid the data and generated suitability maps for different crops. The maps identified areas where soil type, climate conditions, and crop requirements aligned, indicating high suitability. The analysis provided insights for farmers to make informed decisions on crop selection and land use planning.

**4.3 Successful Implementation of Remote Sensing and GIS for Yield Prediction**

Researchers implemented remote sensing and GIS technologies for yield prediction in a large-scale agricultural setting, using satellite imagery and vegetation indices. They integrated this data with field-specific information and employed GIS techniques to generate crop health and biomass maps. By combining this data with historical yield data, they developed an accurate predictive model. The implementation allowed farmers to identify low productivity areas and improve crop performance through targeted management strategies. These case studies demonstrate the benefits of data-driven approaches and advanced technologies in optimizing agriculture.

1. **Future Trends and Innovations in Automation and IoT -**

Advancements in weather data collection and processing are expected to revolutionize yield prediction in the future. With the increasing availability of weather sensors, satellite imagery, and remote sensing technologies, there will be a significant improvement in the quantity and quality of weather data. Advanced data collection methods, such as high-resolution weather monitoring networks and drones, will provide more localized and precise weather information. Furthermore, advancements in data processing techniques, including machine learning algorithms and artificial intelligence, will enable more accurate and real-time analysis of weather data for yield prediction models. Several emerging technologies hold promise for improving yield prediction. These include; crop sensors, unmanned aerial vehicles (UAVs) and Internet of Things (IoT)

**5.1 Integration of Artificial Intelligence and Big Data Analytics in Yield Forecasting**

The integration of artificial intelligence (AI) and big data analytics is poised to revolutionize yield forecasting. AI algorithms can analyze large volumes of data, including weather patterns, soil characteristics, crop genetics, and management practices, to identify complex relationships and patterns. By leveraging big data analytics, these algorithms can generate more accurate yield predictions, identify optimal crop management strategies, and improve decision-making processes. AI and big data analytics can also facilitate real-time monitoring, enabling farmers to respond promptly to changing conditions and optimize crop yields. Looking ahead, there are several exciting avenues for further research and development in location and weather-based yield prediction; integration of multi-scale data, fusion of remote sensing and weather data, real-time and near-real-time monitoring, climate change adaptation, adoption of open data and open-source tools

**6. Conclusion and Recommendations**

Finally, it can be ascertained that; farmers should consider incorporating weather-based yield prediction models into their decision-making processes. By utilizing available weather data and predictive models, they can optimize resource allocation, plan planting schedules, and mitigate risks. Researchers should continue to advance the development of location and weather-based yield prediction models. This includes improving data quality, refining crop models, exploring new machine learning algorithms, and integrating multi-source data for more accurate predictions. Policymakers should recognize the importance of accurate yield prediction for supporting sustainable agriculture and food security. They should invest in data infrastructure, promote data sharing and collaboration, and develop policies that incentivize the adoption of predictive models by farmers.

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