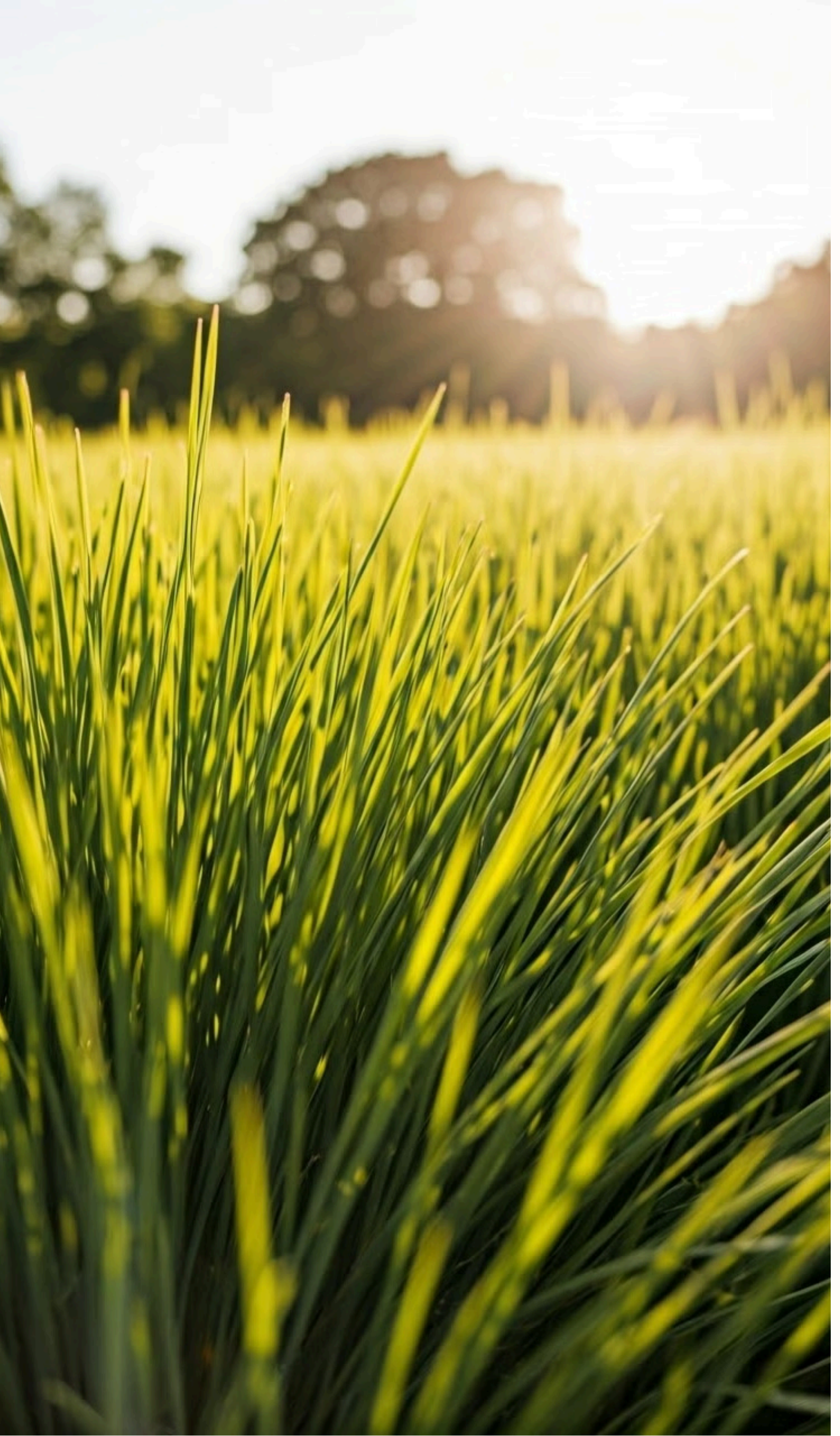


CAPSTONE PROJECT -2 EVALUATION

Predictive Soil Moisture Modeling

This presentation outlines a project aimed at developing a predictive model for soil moisture levels.

Stakeholders:

Our objective is to provide farmers, agronomists, and environmental scientists with actionable insights for informed decision-making in irrigation, crop selection, and land management.

By

NANDHAKUMAR C R

Problem Statement: Optimizing Water Usage & Crop Yield

1 **Soil Moisture Trends**

Analyze historical soil moisture data to identify patterns and trends over time, considering seasonal variations and other environmental factors.

2 **Soil Moisture Correlations**

Explore the relationship between soil moisture levels and key environmental factors like temperature, humidity, and precipitation to understand their influence on soil moisture fluctuations.

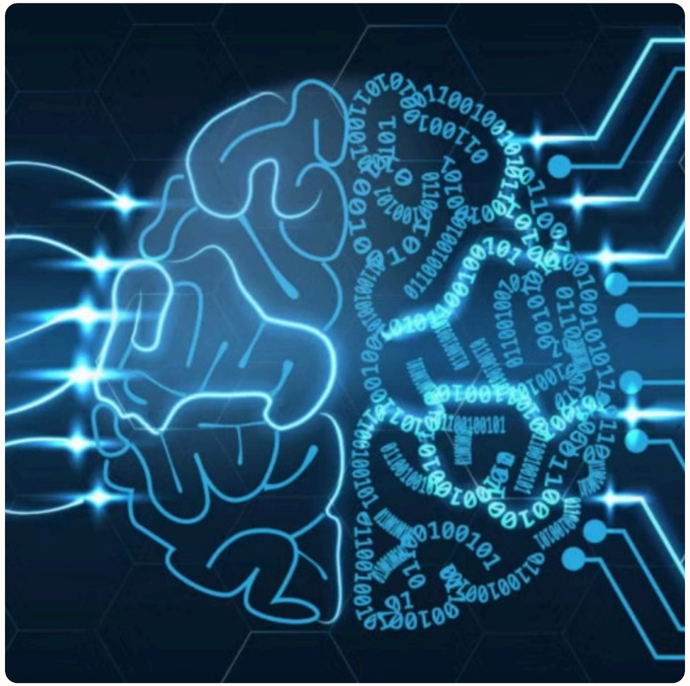
3 **Predictive Modeling**

Build a predictive model that leverages these correlations to forecast future soil moisture levels, enabling proactive management strategies.

4 **Data-Driven Decisions**

Provide farmers and agronomists with real-time insights to make informed decisions about irrigation, crop selection, and land management practices.

Model Development:



Model Architecture

Designing a suitable architecture that can effectively learn from sequential soil moisture data. This involves selecting the **number of layers, neurons, and other parameters** that optimize the model's ability to capture temporal dependencies.

Model Training

Training the model using the **preprocessed data,** allowing the **model to learn complex patterns and relationships within the dataset**. This training process involves adjusting the model's parameters iteratively to minimize prediction errors.

Model Evaluation & Validation

Evaluating the performance of the trained model using metrics such **R2 Score and mean absolute error.** Validating the model's accuracy on unseen data to ensure its ability to generalize and provide reliable predictions in real-world scenarios

Tools and Technologies: Enabling Predictive Accuracy

Category	Tools and Technologies
Model Development	ML, LSTM, Python, TensorFlow/Keras
Data Integration and Preprocessing	SQL, Python (Pandas, NumPy)
Data Visualization and Analysis	Python (Matplotlib, Seaborn)

Evaluation of Traditional Machine Learning Models

Linear Regression

Linear Regression attempts to find a linear relationship between soil moisture and predictor variables, but it may not capture complex patterns.

Decision Tree

Decision Trees make decisions based on a series of rules, but they can be prone to overfitting, especially with complex data.

Naive Bayes

Naive Bayes assumes independence of predictor variables, which may not hold true for soil moisture, leading to inaccurate predictions.

Random Forest Regressor and XGBoost Performance

1

Ensemble Methods

Random Forest and XGBoost are ensemble methods that combine multiple decision trees to improve accuracy and reduce overfitting.

2

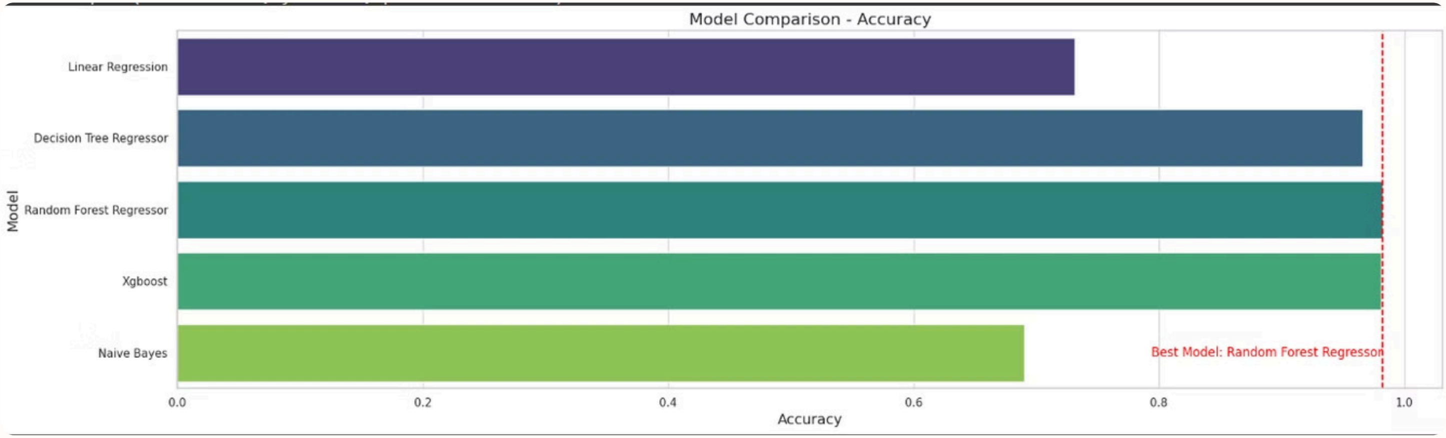
Feature Importance

These models provide insights into the relative importance of various predictor variables, allowing for informed feature selection.

3

High Accuracy

Random Forest and XGBoost demonstrated significantly higher R-squared values compared to other traditional models, indicating a better fit to the data.



Applying Regression Algorithms to Soil Moisture Modeling

Regression models can predict soil moisture based on environmental factors.

Input Variables

Weather data, soil properties, and topography.

1. pm2, pm2,pm3
2. am
3. Temperature
4. Humidity
5. Soil Type

Output Variable

Soil moisture content(SM)

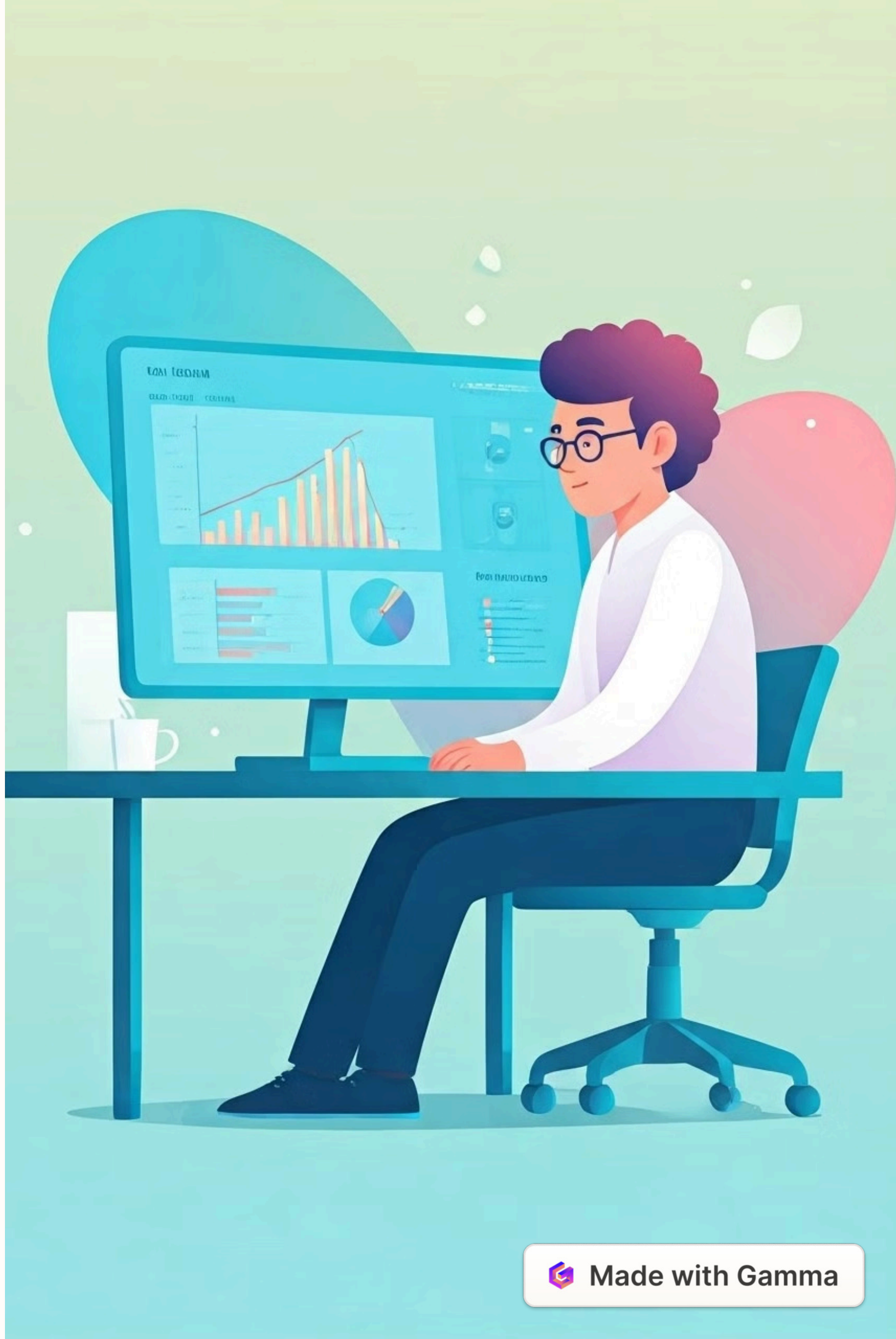
Model Training

Train regression models on historical data.

Evaluation Metrics and Methodology

Evaluate the performance of models using various metrics.

Metric	Description
Mean Absolute Error (MAE)	Average absolute difference between predicted and actual values.
Root Mean Squared Error (RMSE)	Measure of the overall prediction error.
R-squared	Percentage of variance in the target variable explained by the model.



Limitations of Traditional Models

Static Relationships

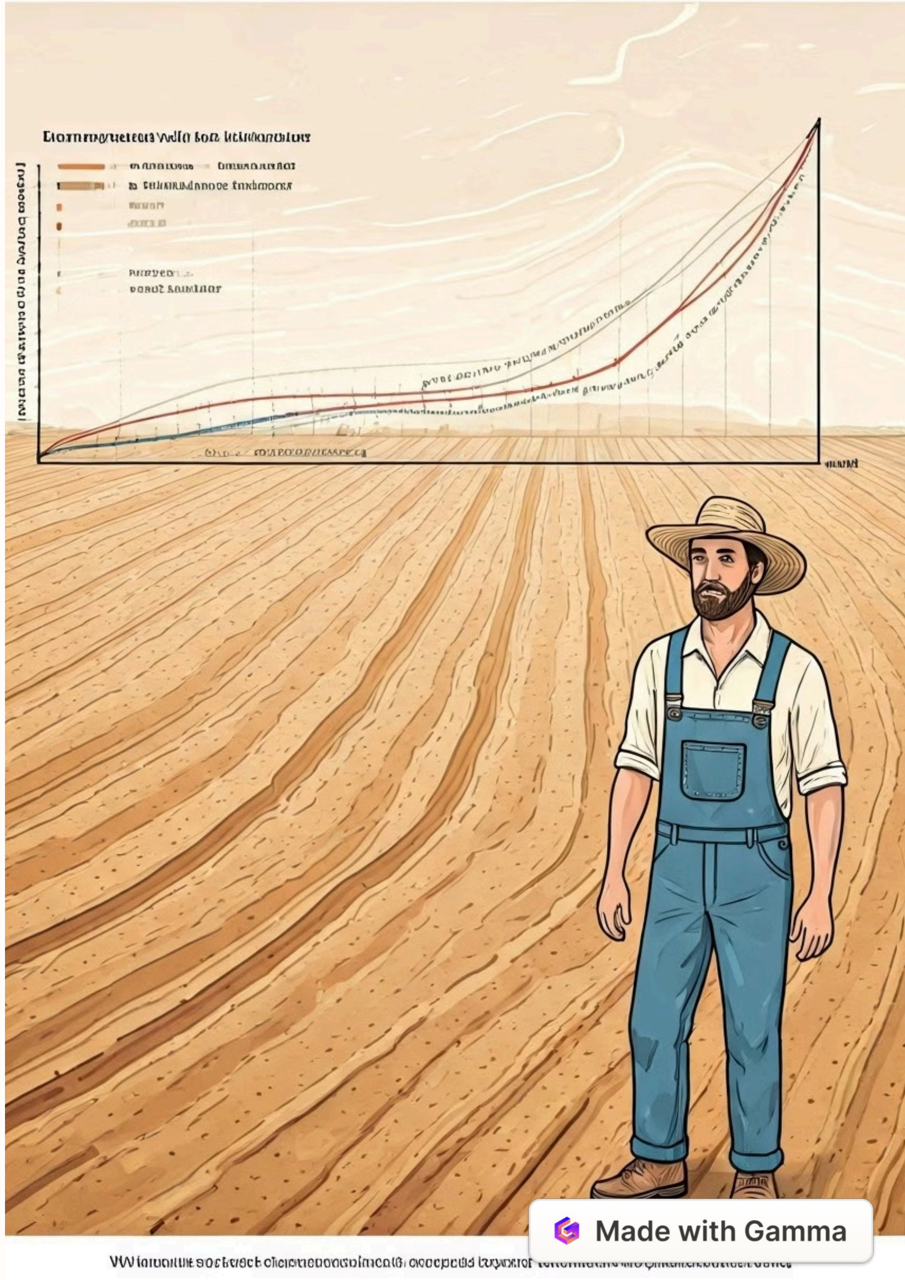
Traditional models assume static relationships between soil moisture and predictor variables, ignoring the dynamic nature of soil moisture over time.

Limited Temporal Information

These models often struggle to capture the temporal dependencies and trends inherent in soil moisture time series data.

Non-Linear Patterns

Soil moisture can exhibit complex non-linear relationships with environmental factors, which traditional models may not fully capture.



Time Series Prediction with LSTM and RAR

1

LSTM Networks

LSTM (Long Short-Term Memory) networks are specialized recurrent neural networks that excel at learning temporal dependencies in time series data.

2

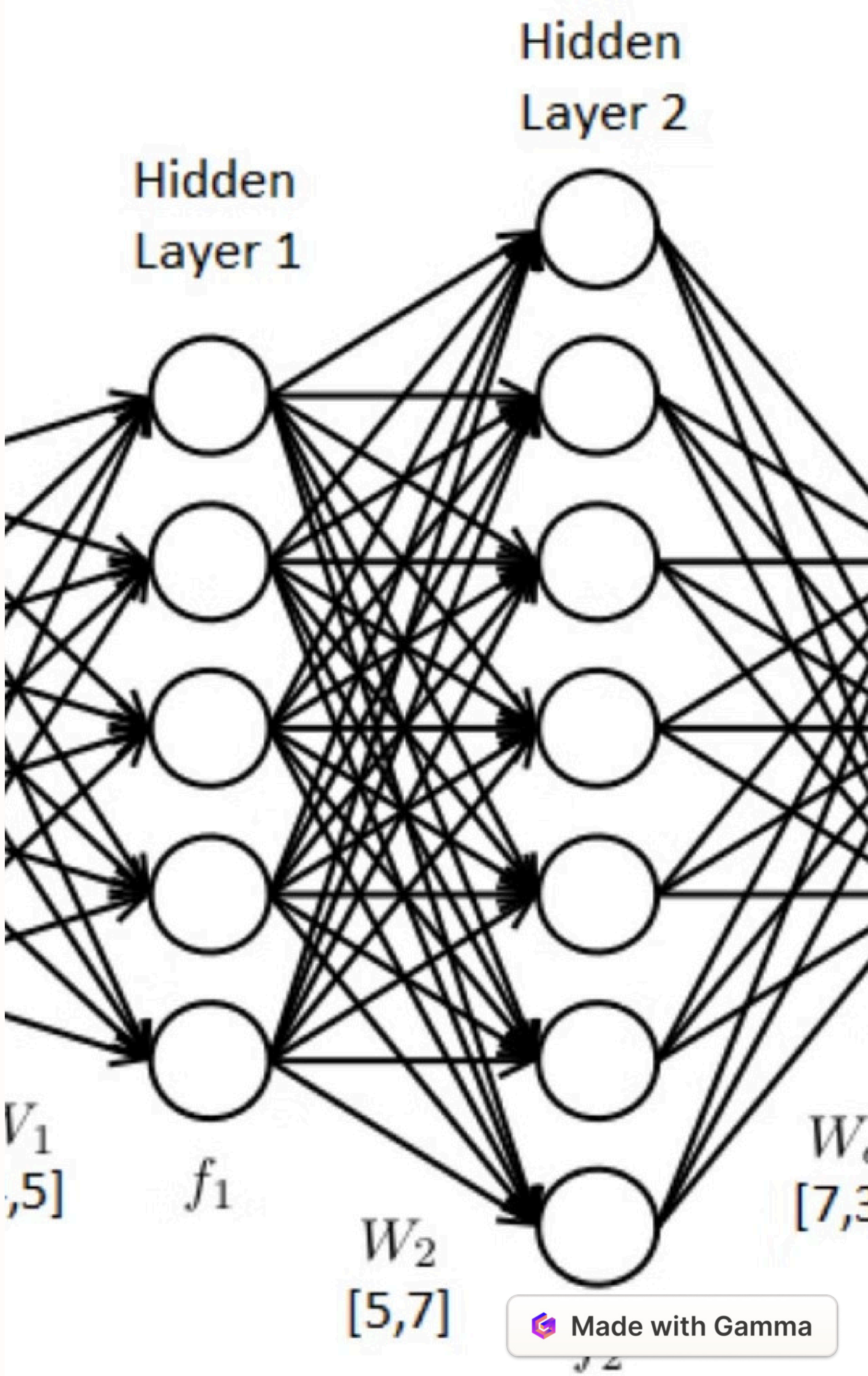
Linear AR Model

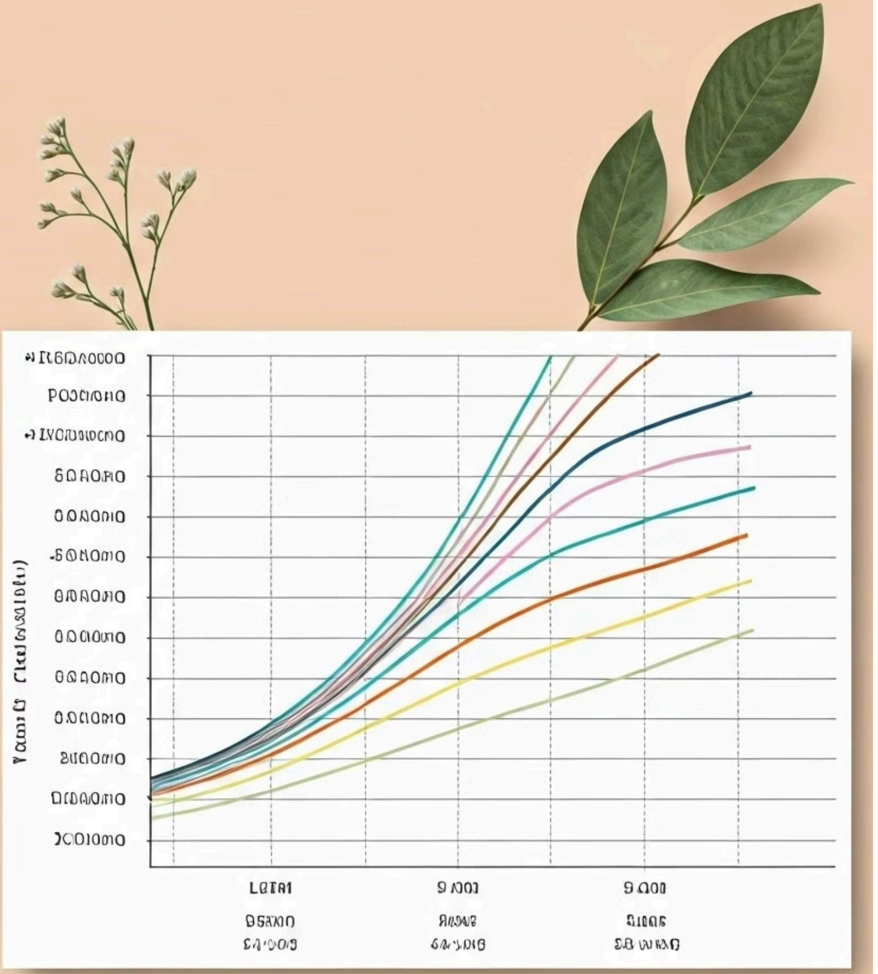
The Linear Autoregressive model uses a recursive approach to predict soil moisture, capturing the temporal dependencies and trends in the data.

3

Dynamic Modeling

These models account for the dynamic nature of soil moisture and can effectively predict future values based on past trends and patterns.





Comparison of Model Accuracies

Model	R-squared
LSTM	0.95
Linaer AR	0.86
Random Forest	0.98
XGBoost	0.98

Conclusion and Future Directions

Predictive soil moisture modeling plays a crucial role in sustainable agriculture.

Improved Modeling

Further development of LSTM models.

Data Acquisition

Expand datasets for better model training.

Global Applications

Deploy models to various regions worldwide.

Automation

Integrate models with automated irrigation systems.

Conclusion and Future Directions

Based on the analysis of the soil moisture dataset, several machine learning models were evaluated for their ability to predict soil moisture.

The Random Forest Regressor and XGBoost exhibited the highest accuracy (R-squared) among traditional machine learning models, surpassing other models like Linear Regression, Decision Tree, and Naive Bayes.

However, for **time series prediction of soil moisture,** the **LSTM and Linear AR models** showed promising results in terms of their prediction capabilities, with the LSTM achieving a high R-squared score and a low Mean Squared Error.

The comparison of LSTM and Linear AR models demonstrated that **LSTM generally outperformed Linear AR in terms of accuracy and error.** Overall, while Random Forest Regressor and XGBoost are suitable for predicting soil moisture with high accuracy in a non-time series context, LSTM and Linear AR models are more appropriate for time-dependent predictions, where past soil moisture values are crucial for forecasting future values.

The choice of the best model depends on the specific needs and constraints of the application, whether it requires a snapshot prediction, or a time series forecast.