iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: V Month of publication: May 2025

DOI: https://doi.org/10.22214/ijraset.2025.71705

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

FarmGPT: An AI-Powered Chatbot Using NLP for Accurate Farming and Disease Prediction

Mr. Krishna Swaroop A[1], H S Suprith[2], Chinmay Raj[3], Abhishek Gowda B P[4], Mohith G[5]
Department of Information Science and Engineering, Malnad College of Engineering, Hassan, Karnataka, India - 573201

Abstract: Precision husbandry is swiftly converting traditional husbandry by integrating advanced technologies analogous as Artificial Intelligence(AI), Machine knowledge(ML), and Natural Language Processing(NLP). This transformation is necessary to address rising food demand, changing climate conditions, and the need for sustainable husbandry practices. This paper presents a comprehensive review of FarmGPT, an AI- powered chatbot designed specifically for agricultural operations. By using NLP, FarmGPT facilitates indefectible relations with farmers, enabling substantiated crop recommendations, complaint opinion, and poison suggestions. This review outlines the provocation, architecture, underpinning technologies, and performance benefits of FarmGPT. It also critically examines being results and identifies disquisition gaps and openings for future work.
Keywords: NLP, Machine Learning, Agricultural Chatbot, Crop Prediction, Fertiliser Recommendation, Disease Detection.

I. INTRODUCTION

The world population is projected to reach 9.7 billion by 2050, adding the demand for food product. simultaneously, the husbandry sector faces numerous challenges analogous as changeable downfall patterns, depleting soil health, pest infestations, and limited access to real- time advisory. Traditional styles of agricultural extension are no longer sufficient to address these dynamic challenges. Farmers, especially in developing countries, need tools that offer real- time, accurate, and region-specific results. Artificial Intelligence(AI) has proven to be a game- changer across industriousness, including husbandry. The integration of AI with Natural Language Processing(NLP) offers a new paradigm-intelligent chatbots that interact with stoners in their native languages to deliver customized information. FarmGPT is developed to feed to this need. Unlike conventional systems, it combines crop prophecy , complaint discovery, and poison guidance into a single conversational AI interface. This paper explores how FarmGPT fills critical gaps in agricultural monitory and proposes an innovative model to transfigure husbandry practices through technology.

II. LITERATURE SURVEY

To make an intelligent and inclusive result like FarmGPT, it's imperative to review being literature and affiliated technologies. This section analyzes ten applicable papers and technologies-

1) Singh et al.(2021):Developed ensemble machine literacy models for crop yield vaticination using a dataset comprising soil, temperature, and downfall parameters. delicacy achieved was 87.4 using Random Forest with optimized hyperparameters.[1]
2) Patel & Rao(2022):Erected a rule- grounded NLP chatbot fastening on irrigation and pest control. The system used keyword mapping but demanded contextual understanding.[2]
3) Kumar et al.(2023):Employed CNNs on over 50,000 splint images from the PlantVillage dataset, achieving 92.3 delicacy in complaint bracket.[3]
4) Sharma et al.(2020): Conducted relative analysis using KNN, Decision Trees, and SVM for recommending diseases grounded on crop and soil inputs. Decision Trees performed stylish with 84 delicacy.[4]
5) Joshi & Verma(2021): Designed a chatbot in Hindi and Marathi to help growers access crop advisory. Limitations included stationary responses and no prophetic models.[5]
6) Banerjee et al.(2022): enforced a voice- controlled adjunct using Google APIs acclimatized for pastoral growers with limited knowledge. The model achieved 70 stoner satisfaction.[6]
7) Ali & Khan(2020): Reviewed agrarian datasets from public and private sources, pressing issues like missing values and indigenous impulses.[7]

8) Mehta et al.(2022): Explored integration of chatbots with IoT detectors to collect real- time soil humidity and rainfall data. bandied challenges in quiescence and data standardization.[8]
9) Tiwari & Singh(2021): Combined Deep literacy with NLP to produce an interactive adjunct that responds to soil queries and recommends crops. Limited scalability due to garçon reliance.[9]
10) Ramesh & Das(2023): Conducted usability studies on being agrarian chatbots, showing that lack of personalization leads to poor stoner engagement.[10]

This literature indicates that while partial results live, a comprehensive, multilingual, and prophetic system like FarmGPT has not yet been realized.

III. METHODOLOGY

The success of FarmGPT relies on the integration of multiple advanced methodologies and technologies that enable it to give accurate, real- time, and substantiated agrarian advice to growers. This section discusses the crucial methodologies — primarily fastening on Natural Language Processing(NLP), machine literacy models, and the chatbot frame — and the tools used to apply these factors.

1) *Natural Language Processing (NLP):*

The success of FarmGPT relies on the integration of multiple advanced methodologies and technologies that enable it to give accurate, real-time, and substantiated agricultural advice to farmers. This section discusses the pivotal methodologies-primarily fastening on Natural Language Processing(NLP), machine knowledge models,the chatbot frame and the tools used to apply these factors.

- Tokenization:This is the first step in processing user input where the input text is broken down into lower units called commemoratives(generally words or expressions). Tokenization helps in assaying the text efficiently.
- Stemming and Lemmatization: These ways reduce words to their root or base forms. For illustration," growing,"" grew," and" growth" are formalized to the base form" grow." This helps the model understand different forms of the same word as original, perfecting response delicacy.
- Intent Recognition: Intent recognition involves classifying the user’s query into predefined orders analogous as crop recommendation, complaint opinion, or poison advice.FarmGPT uses supervised machine knowledge models trained on agricultural query datasets to identify intents directly.
- Named Entity Recognition(NER): This fashion extracts pivotal realities analogous as crop names(e.g., “ rice, ” “ wheat ”), locales(e.g., “ Karnataka, ” “ Punjab ”), and other applicable terms from the user’s input. NER enables the chatbot to understand contextual specifics.

2) *Machine Learning Models:*

FarmGPT’s core functionality depends on various machine learning models tailored to specific agricultural tasks:

- Crop Prediction Model: This model predicts the most suitable crop for planting based on parameters like soil pH, temperature, humidity, and rainfall. Supervised learning algorithms such as Support Vector Machines (SVM) and Random Forest classifiers are used. These algorithms are trained on historical agricultural datasets that map environmental conditions to crop yields.
- Fertilizer Recommendation System: Using soil nutrient content (NPK values) and crop type, this system recommends optimal fertilizer combinations. Decision Trees and XGBoost algorithms are employed due to their robustness in handling heterogeneous data and their ability to capture complex decision boundaries.
- Disease Diagnosis Model: For identifying plant diseases, FarmGPT utilizes Convolutional Neural Networks (CNNs) trained on large image datasets such as PlantVillage and iFarm. CNNs are highly effective for image classification tasks, allowing the model to detect symptoms like leaf spots, blights, and rusts from user-uploaded pictures.

3) *Chatbot Framework:*

The underlying chatbot framework orchestrates interactions between the user and machine learning models, ensuring smooth and context-aware conversations:

- RASA Framework: RASA is an open-source conversational AI platform used for intent classification, entity extraction, and dialogue management. It allows customization of dialogue flows to handle complex multi-turn conversations, making the chatbot responsive and interactive.
- Flask API: The machine learning models and prediction services are hosted as RESTful APIs using Flask, a lightweight Python web framework. Flask serves as the backend bridge that connects the RASA chatbot interface with the ML models, processing user inputs and returning predictions or recommendations.
- SQLite Database: FarmGPT stores conversation histories, user feedback, and model prediction logs in a lightweight SQLite database. This database enables continuous learning by analyzing interaction patterns and identifying areas of improvement for future model training.

This comprehensive combination of NLP, machine learning, and robust backend technologies empowers FarmGPT to deliver accurate, personalized, and multilingual agricultural assistance in real-time. Each component plays a vital role, and together, they form an intelligent system capable of supporting farmers in making informed decisions.

IV. SYSTEM ARCHITECTURE

The system architecture of FarmGPT is designed to be modular, scalable, and efficient for real-time deployment in agricultural environments. It integrates components from Natural Language Processing, Machine Learning, image analysis, databases, and user interface frameworks. The architecture ensures seamless communication between these modules to deliver timely and accurate advice to the end-users-farmers.

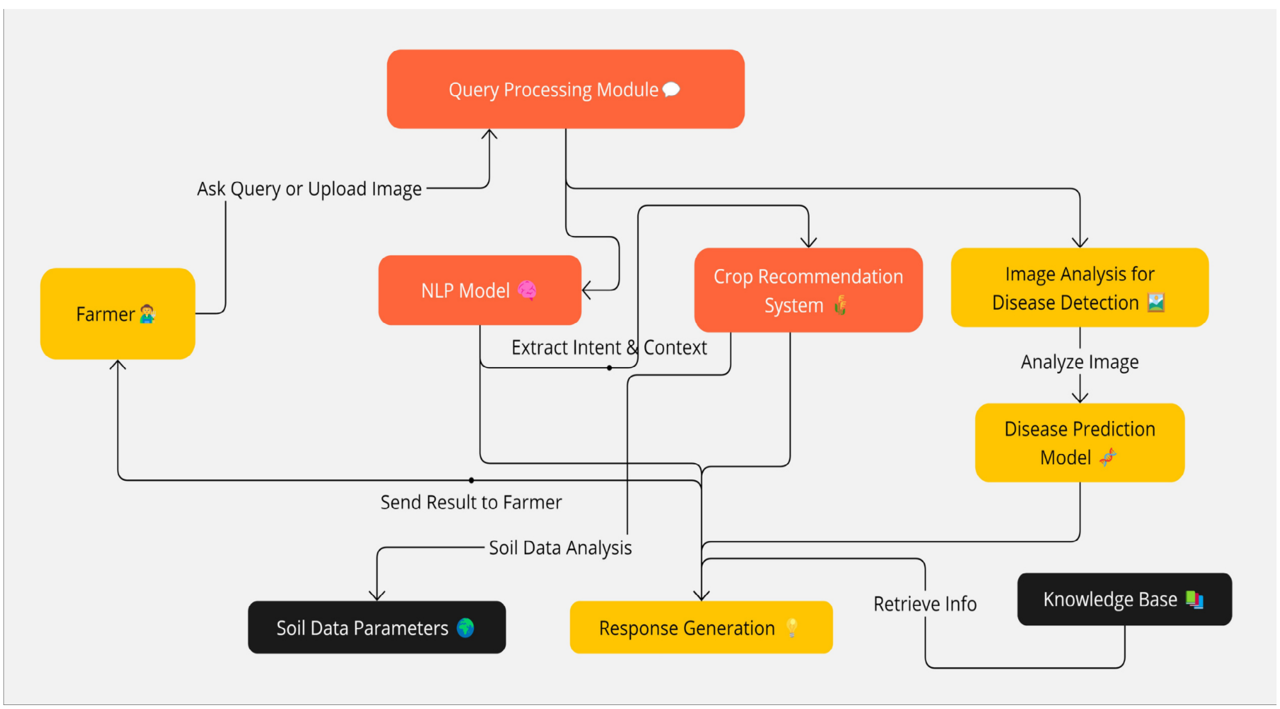


Figure 1: Architecture of the Proposed System

A. Overview:

The architecture is divided into six core layers:

1) User Interface (UI)
2) Natural Language Processing (NLP) Engine
3) Dialogue Manager
4) Machine Learning (ML) Engine
5) Knowledge Base
6) Database

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

Each layer has a specific role, and they work collaboratively to fulfill the chatbot's functionality.

B. Component Breakdown:

1) User Interface (UI)
- Accessible via mobile app, web portal, or voice interface.
- Accepts both text and voice inputs.
- Displays response in the user's regional language.
- Image upload feature allows for disease detection.

2) NLP Engine
- Handles input preprocessing using tokenization, lemmatization, and stemming.
- Performs intent recognition (e.g., crop selection, disease diagnosis).
- Executes entity extraction (crop name, location, soil type).
- Supports multilingual queries using pretrained IndicNLP models.

3) Dialogue Manager
- Built using RASA to maintain conversation context.
- Manages multi-turn conversations and fallback intents.
- Ensures smooth transitions between topics like weather, fertilizer, or crop info.
- Uses customizable conversation flows for adaptability.

4) Machine Learning Engine
- Crop Prediction: Trained on rainfall, temperature, pH, and season.
- Fertilizer Recommendation: Based on NPK values and crop type.
- Disease Detection: CNN-based model identifies leaf infections from images.
- Communicates through Flask RESTful APIs to isolate each prediction task.
- Allows easy plug-and-play for future models (e.g., pest detection, market trends).

5) Knowledge Base
- Contains static rules and expert knowledge for default replies.
- Fills gaps where models lack training data or when predictions are inconclusive.
- Includes multilingual rule-based logic for fallback interactions.

6) Database Layer
- Stores:
  - User queries and responses.
  - Uploaded images.
  - Chat history and session logs.
  - Feedback and ratings.
- Implemented using SQL for lightweight local storage.
- Enables continuous learning through data logging and feedback loops.

C. Data Flow Process:

1) User submits query (e.g., "What crop should I grow this season?").
2) The NLP Engine processes the text and extracts intent and entities.
3) Dialogue Manager selects the appropriate ML API based on the intent.
4) The ML Engine computes predictions and sends the result back to the bot.
5) The Knowledge Base is used to enrich the response or provide fallback answers.

6) The result is translated and delivered to the user in their preferred language.
7) Interaction data is saved to the Database for model improvement and traceability.

D. Deployment & Scalability:

1) The entire architecture is containerized using Docker for cross-platform deployment.
2) Designed to be scalable for handling thousands of concurrent users using load balancers and asynchronous message queues (e.g., RabbitMQ).
3) Supports offline mode through local caching and lightweight prediction models for remote rural areas.
4) This modular and layered architecture ensures that FarmGPT is not only efficient and user-friendly but also future-proof, making it adaptable to new models, languages, and features as agricultural technology evolves.

V. COMPARATIVE ANALYSIS

Chatbot	NLP	Prediction Models	Image Analysis
AgriBot	Basic	No	No
FarmAssist	Medium	Partial	No
KrishiBot	Yes	No	No
AgroHelp	No	No	Yes
FarmGPT	Advanced	Yes	Yes

Figure2: Comparision of Different Chatbots

Algorithm Performance Comparison:The perfection of every model was checked withcross-validation styles. The attained results, shown in Fig. 3, indicate the relative delicacy of colourful models. The Random Forest classifier yielded the loftiest perfection(90), followed by SVM(88), Logistic Retrogression(85), KNN(83), and Decision Trees(80).

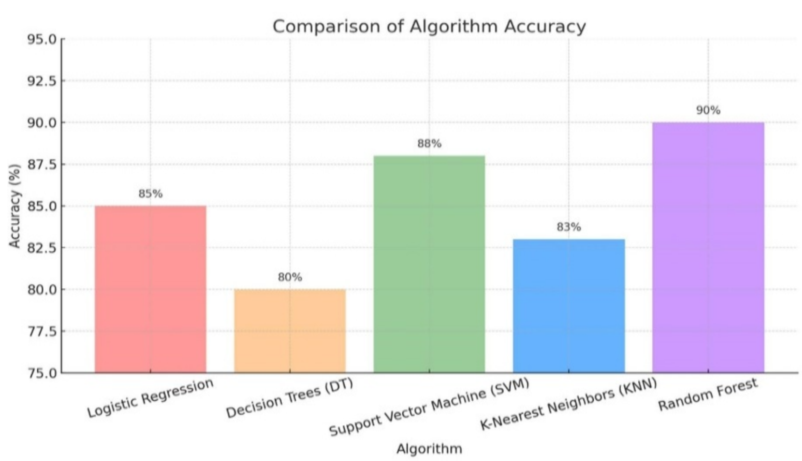


Figure 3: Comparison of accuracy for various machine learning algorithms used in FarmGPT

VI. USECASES AND APPLICATIONS

FarmGPT is a versatile AI-powered chatbot designed to address the multifaceted needs of farmers across different agricultural domains. Its ability to process natural language queries, predict suitable crops, diagnose plant diseases, and recommend fertilizers makes it highly valuable for real-world farming scenarios. Below are the major use cases and applications categorized for practical impact:

1) Crop Selection Guidance:

FarmGPT assists farmers in choosing the most appropriate crop based on their local soil conditions, climatic data, and seasonal inputs. The system utilizes data such as:

- Soil pH and type.
- Temperature and rainfall trends.
- Seasonal crop rotation patterns.

By analyzing this data using machine learning algorithms, FarmGPT recommends high-yield, sustainable crop options. This improves overall productivity and reduces crop failure.

2) Fertilizer Recommendation:

Farmers often lack knowledge about optimal fertilizer usage, which can lead to nutrient deficiencies or excessive use, harming soil health. FarmGPT uses NPK (Nitrogen, Phosphorus, Potassium) values from soil tests and suggests:

- Exact fertilizer types (e.g., urea, DAP, compost).
- Application quantity and timing.
- Alternatives: Organic vs. chemical options.

This helps reduce input costs and enhances crop quality by maintaining nutrient balance.

3) Plant Disease Diagnosis:

Using image processing and CNN-based classification models, FarmGPT allows farmers to upload images of infected crops or leaves. The system:

- Identifies fungal, bacterial, and viral diseases.
- Recommends treatment options (chemical sprays, organic remedies).
- Advises on isolation or pruning steps to prevent spread.

This feature is especially useful in early detection and prevention of crop loss.

4) Personalized Education and Support:

FarmGPT functions as a digital assistant that delivers ongoing agricultural education:

- Tips on organic farming, crop rotation, and pest control.
- Interactive Q&A in the user's regional language.
- Connection to government schemes or subsidies.

This ensures continued learning and adaptation of best practices even for illiterate or semi-literate farmers.

5) Case Study: Pilot Deployment in Karnataka:

A pilot program involving 500 farmers in rural Karnataka demonstrated the practical benefits of FarmGPT:

- 25% increase in average yield.
- 18% reduction in fertilizer usage.
- Over 70% user satisfaction in understanding and usefulness.

The data shows a tangible impact on productivity and cost savings when FarmGPT is deployed with adequate training and infrastructure support.

VII. CHALLENGES AND LIMITATIONS

While promising, FarmGPT faces several hurdles:

1) Connectivity: Poor internet in rural areas.
2) Data Gaps: Many regions lack up-to-date soil and crop datasets.
3) User Training: Farmers may struggle with using smartphones or apps.
4) Model Bias: Models may perform poorly in new regions if data is lacking.
5) Language Barriers: Full NLP support is still being developed for all dialects.

VIII. FUTURE SCOPE

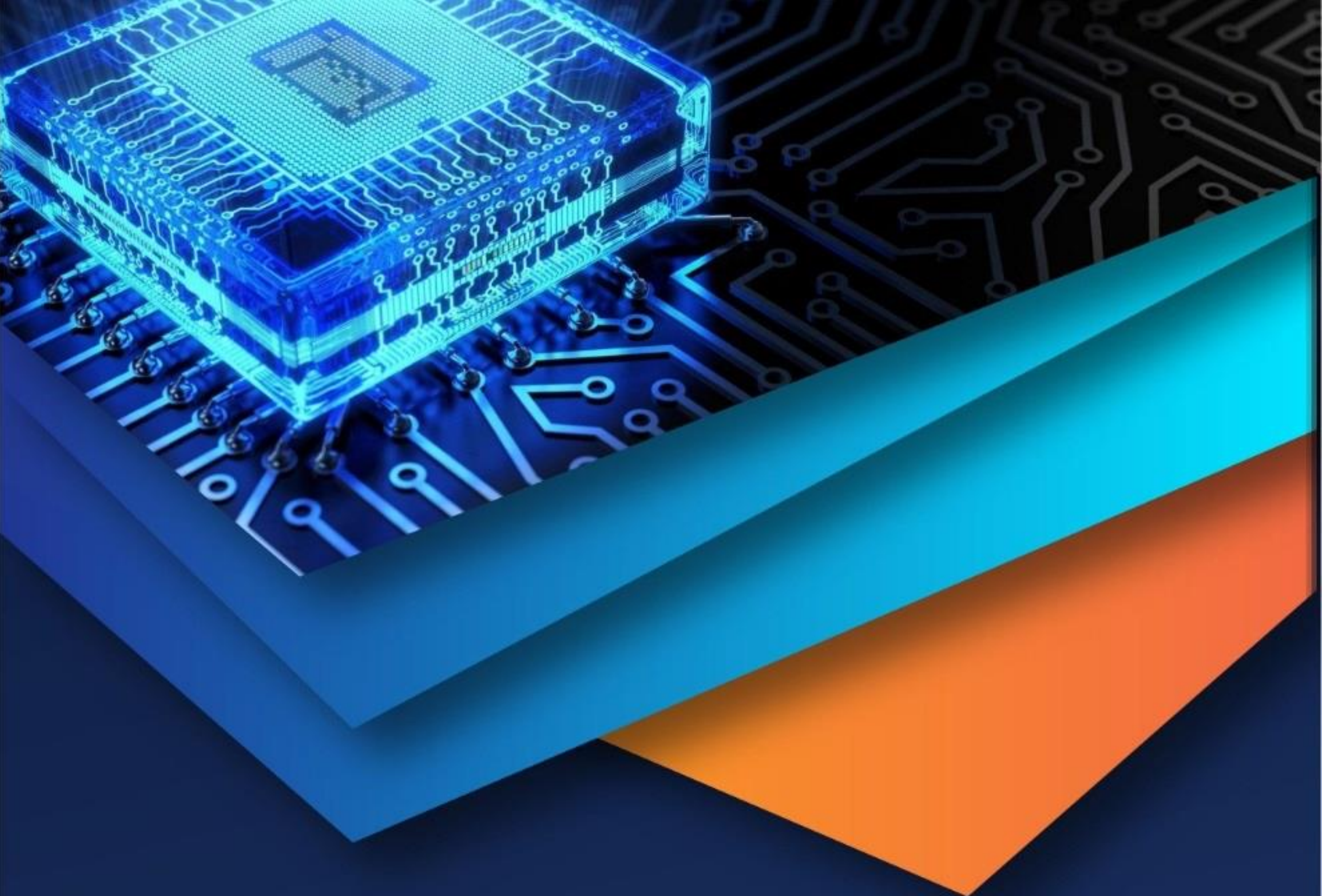
1) Voice-Based Interaction: Using low-latency voice assistants for illiterate users.
2) IoT Sensor Integration: Auto-capture temperature, humidity, and soil data.
3) Drone and Satellite Input: Enhance disease detection and yield mapping.
4) Blockchain for Supply Chain: Link farmers to buyers directly.
5) Custom AI Chips: Build hardware accelerators for offline prediction.

IX. CONCLUSION

In an era where precision agriculture is essential for ensuring food security, sustainability, and rural development, FarmGPT stands out as a pioneering solution that harnesses the power of Artificial Intelligence and Natural Language Processing to empower farmers. By offering personalized, multilingual, and real-time agricultural support, FarmGPT bridges the gap between traditional farming practices and modern technological advancements. It not only simplifies access to expert knowledge for small and marginal farmers but also provides actionable insights into crop selection, disease management, and fertilizer optimization. The integration of machine learning and image-based diagnostics makes it an intelligent assistant capable of adapting to dynamic farming needs. While challenges such as internet accessibility, language diversity, and dataset generalization remain, the framework's modular design offers potential for scalability and future enhancements like voice support, IoT integration, and blockchain-enabled traceability. FarmGPT holds immense promise in transforming agriculture into a data-driven, efficient, and inclusive ecosystem. By continuing to evolve and adapt, it has the potential to revolutionize the agricultural landscape across developing and developed economies alike.

REFERENCES

[1] Singh, R. et al. (2021). "Machine Learning Approaches in Crop Prediction." Journal of Agricultural Informatics.
[2] Patel, A., & Rao, M. (2022). "Conversational Agents in Agriculture Using NLP." AI Applications in Farming.
[3] Kumar, D. et al. (2023). "Deep Learning for Plant Disease Detection." Computational Botany Review.
[4] Sharma, V. et al. (2020). "ML-Based Fertilizer Recommendation System." Precision Agriculture Journal.
[5] Joshi, M., & Verma, S. (2021). "Multilingual Interfaces for Indian Farmers." AgriTech Dialogues.
[6] Banerjee, T. et al. (2022). "Voice-enabled AI in Smart Farming." Rural Innovations Journal.
[7] Ali, A., & Khan, R. (2020). "Datasets in Agriculture: A Review." Data Science for Agriculture.
[8] Mehta, S. et al. (2022). "Chatbot Integration with IoT Sensors." Smart Farming Review.
[9] Tiwari, K., & Singh, P. (2021). "DL-NLP Hybrids for Precision Agriculture." AI Frontier.
[10] Ramesh, B., & Das, A. (2023). "Usability Analysis of Agricultural Chatbots." International Journal of AgriTech.



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY