

# IQ-FARM: Smart Agricultural Recommendation System

A technical report

## 1. Introduction

IQ-FARM is a Smart Agricultural Recommendation System designed to assist Iraqi farmers in selecting the most suitable crops for their specific soil conditions and geographical region. Implemented as a Telegram bot, IQ-FARM leverages Python and a rule-based expert system to provide actionable insights. This report details the system's architecture, features, and limitations, as well as potential avenues for future development. The goal is to provide a professional yet accessible overview of the project's current state and potential for expansion.

## 2. Methods

IQ-FARM was developed using Python, leveraging the `python-telegram-bot` library for its Telegram interface. A rule-based expert system forms the core of its recommendation engine. The system operates without machine learning, relying instead on hard-coded knowledge of crop requirements and regional characteristics.

## 3. System Architecture

### 3.1 User Interface (UI)

- Telegram chat
- Slash commands
- Inline buttons

The system utilizes a Telegram bot interface. Users interact with the bot via slash commands and inline buttons, allowing for easy navigation and data input.

### 3.2 Processing Layer

- Python handlers
- pH, N, P, K, moisture
- Percentage scores

The processing layer consists of Python handlers that normalize soil data (pH, Nitrogen, Phosphorus, Potassium, and moisture) into percentage scores. This normalization allows for a consistent comparison against ideal crop requirements.

### 3.3 Knowledge Base

- Hard-coded tables
- Crops and regions

The knowledge base is currently implemented as hard-coded tables within the Python code. These tables contain information about crop requirements and regional characteristics within Iraq. This is a limitation of the current implementation.

### 3.4 Recommendation Engine

- Compares user soil data
- Computes suitability
- Returns ranked crops

The recommendation engine compares user-provided soil data to the ideal ranges stored in the knowledge base. It then computes a suitability score for each crop and returns a ranked list of recommendations, accompanied by justifications for each choice.

## 4. Results / Features

### 4.1 Data Visualization

- Matplotlib
- Radar and bar charts
- Arabic interface

IQ-FARM generates visual representations of the soil data and crop suitability using Matplotlib. Radar and bar charts are created and sent as images within the Telegram bot. The interface is localized to Arabic, utilizing `\text{}` for right-to-left text rendering.

### 4.2 Key Features

- Region/custom data
- Rule-based recommendations
- Auto-generated charts
- Arabic explanations
- No database
- Python dicts

Key features include the ability to select a region or input custom soil data, rule-based recommendations, automatically generated charts, and explanations in Arabic. The system currently operates without a database, storing configuration data in Python dictionaries.

## 5. Discussion

IQ-FARM provides a valuable tool for Iraqi farmers, offering data-driven insights into crop selection. The Telegram bot interface makes the system easily accessible, while the Arabic localization ensures usability for a wide audience. The use of rule-based expert system allows for explainable AI, where the user can get an explanation for each of the results that the system suggests.

## 6. Limitations and Future Work

The current implementation of IQ-FARM has several limitations that offer opportunities for future development:

- **No Machine Learning:** The system relies on a rule-based expert system, limiting its ability to adapt to new data and improve its recommendations over time.
- **Manual Knowledge Base Updates:** The knowledge base is currently hard-coded, requiring manual updates to add new crops, regions, or refine existing data.
- **Limited Scope:** The system currently supports a limited number of crops and regions within Iraq.
- **No Persistent Logging:** User interactions and system performance are not currently logged, making it difficult to track usage patterns and identify areas for improvement.

Future work will focus on addressing these limitations by:

- **Integrating a Database:** Implementing a database will allow for more efficient storage and retrieval of crop and regional data.
- **Collecting Real-World Data:** Gathering real-world data on crop yields and soil conditions will enable the development of more accurate and data-driven recommendations.
- **Training a Machine Learning Model:** Training a machine learning model will enable the system to learn from data, improve its recommendations over time, and potentially identify new crop-soil relationships. Keeping the rule-based expert system as an explainable AI layer.

## 7. Conclusion

IQ-FARM represents a promising solution for supporting Iraqi farmers in making informed crop selection decisions. By leveraging a Telegram bot interface, rule-based expert system, and data visualization techniques, the system provides accessible and actionable insights. While the current implementation has limitations, future extensions involving database integration, real-world data collection, and machine learning integration have the potential to significantly enhance the system's accuracy, adaptability, and overall usefulness.