WATER REQUIREMENT CALCULATOR FOR AGRICULTURE

A PROJECT REPORT

Submitted by

LOGESH D (220701144)

in partial fulfillment for the course

OAI1903 - INTRODUCTION TO ROBOTIC PROCESS AUTOMATION

for the degree of

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE AND DESIGN

RAJALAKSHMI ENGINEERING COLLEGE
RAJALAKSHMI NAGAR THANDALAM CHENNAI
– 602 105

NOVEMBER 2024

BONAFIDE CERTIFICATE

Certified that this project report **"Water Requirement Calculator For Agriculture"** is the bonafide work of **"LOGESH D (220701144)"** who carried out the project work for the subject OAI1903 - Introduction to Robotic Process Automation under my supervision.

SIGNATURE

Mrs. G. M. Sasikala, M.E.,
SUPERVISOR,
Assistant Professor, Department of Computer Science and Engineering,
Rajalakshmi Engineering College,
Rajalakshmi Nagar,
Thandalam,
Chennai- 602105.

Submitted to Project and Viva Voce Examination for the subject OAI1903 - Introduction to Robotic Process Automation held on ___________.

Internal Examiner **External Examiner**

ABSTRACT

This project aims to automate the calculation of water requirements for agricultural crops using real-time weather data in a UiPath workflow. The water requirement for crops is a crucial factor in sustainable agricultural practices, directly impacting irrigation scheduling and water resource management. The key objective is to integrate weather information—such as temperature, humidity, and crop-specific coefficients—into a system that calculates the daily water needs of crops.

The methodology involves using a simplified version of the Penman-Monteith equation to estimate the reference evapotranspiration (ETo), a key factor in determining crop water needs. The ETo is calculated using weather parameters like temperature and humidity, and a crop coefficient (Kc) is applied to adjust the values for different crop types and growth stages. The water requirement is then derived by multiplying ETo with Kc. This process is fully automated within a UiPath workflow that retrieves weather data from an API, processes it, and outputs the water requirement.

The project utilizes several steps, including data acquisition through HTTP requests, JSON deserialization, and mathematical computations. The output is displayed in a user-friendly format, allowing farmers and agricultural experts to make informed irrigation decisions based on current weather conditions. This tool can be expanded to incorporate additional factors such as soil moisture, wind speed, and solar radiation for more accurate predictions.

The expected outcome is to provide an efficient and automated solution for calculating crop water needs, promoting water conservation and optimizing irrigation practices in agriculture.

ACKNOWLEDGEMENT

I express my sincere thanks to my beloved and honourable chairman MR.S.MEGANATHAN and the chairperson DR.M.THANGAM MEGANATHAN for their timely support and encouragement.

I am greatly indebted to my respected and honourable principal Dr. S.N.MURUGESAN for his able support and guidance.

No words of gratitude will suffice for the unquestioning support extended to us by my head of the department Dr. P. KUMAR for being ever supporting force during my project work.

I also extend my sincere and hearty thanks to my internal guide Mrs. G. M. SASIKALA for her valuable guidance and motivation during the completion of this project.

My sincere thanks to my family members, friends and other staff members of Computer Science and Engineering.

Logesh D (220701144)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABBREVIATION	ACCRONYM
RPA	Robotic Process Automation
AI	Artificial Intelligence
API	Application Programming Interface
CV	Computer Vision
OCR	Optical Character Recognition

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The "Agricultural Water Requirement Calculation Bot" is a cutting-edge solution leveraging Robotic Process Automation (RPA) to address the critical challenge of optimizing irrigation in agriculture. With the increasing demand for sustainable farming practices and efficient water management, accurate calculation of crop water requirements is paramount. This bot, developed on the UiPath platform, automates the process of calculating daily water needs for crops based on real-time weather data, enabling farmers to make informed decisions about irrigation scheduling.

In modern agriculture, water management has become a key factor influencing crop yield and resource conservation. However, calculating the precise water requirements for different crops, considering the variability in weather conditions, crop types, and growth stages, can be a complex and time-consuming task. This bot simplifies and automates this process, using weather data inputs such as temperature, humidity, and other relevant parameters, to calculate reference evapotranspiration (ETo) and determine the water requirement using crop-specific coefficients (Kc). By automating these calculations, the bot not only saves valuable time but also ensures accuracy and consistency in water management.

UiPath is a leading provider of Robotic Process Automation (RPA) software that enables organizations to automate repetitive tasks and workflows. The platform combines artificial intelligence (AI) and computer vision to enable robots to interpret data from various sources, such as screens, documents, and web services. By integrating data from APIs, including weather data, UiPath's automation platform simplifies complex processes and offers scalable, efficient solutions for various industries. With UiPath’s built-in capabilities, such as Optical Character Recognition (OCR) and seamless integration with external data sources, this platform is ideally suited to automate tasks that require precise data extraction, transformation, and decision-making—such as calculating agricultural water requirements.

The "Agricultural Water Requirement Calculation Bot" serves as an innovative tool for farmers, agricultural consultants, and institutions, providing a reliable and automated solution for managing irrigation based on weather patterns. This bot plays a crucial role in promoting water conservation, optimizing irrigation practices, and contributing to more sustainable agricultural operations.

1.2 OBJECTIVE

The primary objective of the Agricultural Water Requirement Calculation Bot is to revolutionize the way irrigation management is handled in agriculture. By leveraging Robotic Process Automation (RPA), this bot aims to automate the calculation of crop water requirements based on real-time weather data, ultimately assisting farmers in making informed and timely irrigation decisions. The project seeks to offer agricultural professionals, farmers, and institutions an efficient and accurate solution for optimizing water usage and promoting sustainable farming practices. By automating these calculations, the bot aims to save time, enhance precision, and contribute to water conservation efforts in agriculture.

1.3 EXISTING SYSTEM

In the current agricultural landscape, managing water resources efficiently is a major challenge. Farmers often rely on manual methods or basic weather-based models to estimate crop water requirements. These traditional approaches can be time-consuming, inaccurate, and inefficient, especially when farmers have to account for multiple factors such as temperature, humidity, soil type, and crop stage. Additionally, weather patterns are dynamic, and manual recalculations can often lead to delays in irrigation decisions. This results in either over-irrigation, leading to water wastage, or under-irrigation, which affects crop yields. Therefore, there is a pressing need for an automated, reliable, and accurate system to calculate crop water requirements, particularly in the face of changing climate conditions.

1.4 PROPOSED SYSTEM

The Agricultural Water Requirement Calculation Bot is envisioned as a transformative solution to the current challenges in agricultural water management. By utilizing UiPath's RPA capabilities, the bot will automate the process of calculating daily water needs for crops based on live weather data. The bot will integrate with weather APIs to gather relevant data such as temperature, humidity, and other environmental factors, which will be used to estimate Reference Evapotranspiration (ETo). This data will be further refined by applying crop-specific Crop Coefficients (Kc), ensuring that the water requirements are tailored to the specific crop and its growth stage.

The proposed system aims to significantly reduce the time and effort required for manual water requirement calculations. It will ensure that farmers receive accurate and up-to-date information about irrigation needs, allowing for more efficient water use and contributing to overall water conservation. The bot will generate detailed reports, including daily water requirements (in mm/day) for each crop, based on weather data and crop parameters. These reports can be used to guide irrigation schedules, optimize water usage, and ultimately improve crop yield and resource management. By automating this process, the system will help reduce labor costs, enhance the precision of irrigation practices, and promote sustainable agricultural practices.

CHAPTER 2

LITERATURE REVIEW

2.1 Agricultural Water Management and Water Requirements

Water is an essential resource for crop growth, and managing its usage effectively is vital for improving agricultural productivity. The Evapotranspiration (ET) process, which includes both evaporation from soil and transpiration from plants, is a key factor in determining water requirements. Reference Evapotranspiration (ETo) is widely recognized as the standard for calculating the water requirements of crops under optimal conditions (Allen et al., 1998). Various methods exist for estimating ETo, ranging from simple temperature-based models to complex methods that incorporate multiple weather parameters such as humidity, wind speed, and solar radiation (Penman-Monteith, 1948).

The Penman-Monteith equation, developed in the 1940s, is considered the most accurate method for calculating ETo, and it has become the standard method recommended by the Food and Agriculture Organization (FAO). However, more recent research has shown that simplifications and approximations of this equation can still provide reliable results when fewer data points are available (Jensen, 2007). These models often incorporate local environmental conditions, such as temperature, humidity, and wind speed, to estimate the evapotranspiration rates and, by extension, crop water requirements.

In the context of crop-specific water requirements, the Crop Coefficient (Kc) is applied to adjust the ETo calculation to account for the specific needs of different crops, growth stages, and environmental factors (Doorenbos & Kassam, 1979). The variability in Kc values between different crops and growth stages demonstrates the need for personalized and dynamic irrigation models to optimize water usage.

2.2 The Role of Technology in Agricultural Water Management

The integration of technology in agricultural water management has the potential to revolutionize how irrigation decisions are made. In recent years, advances in remote sensing, Internet of Things (IoT) devices, and weather forecasting have provided farmers with real-time data to better manage irrigation (Tian et al., 2016). Remote sensing technologies, such as satellites and drones, are increasingly used to monitor crop health, soil moisture, and other variables that impact water usage. These tools allow for precision irrigation, where water is applied based on the specific needs of different regions within a field, rather than uniformly over the entire area.

A key aspect of these technologies is their ability to integrate weather data. Weather forecasts and historical climate data play a pivotal role in predicting evapotranspiration rates and determining when and how much water should be applied. Weather-based irrigation scheduling systems use data from meteorological stations to optimize irrigation schedules based on real-time weather data (Bos et al., 2009).

2.3 Robotic Process Automation (RPA) in Agriculture

Robotic Process Automation (RPA) has gained significant traction across various industries, including agriculture, as a tool for automating repetitive tasks and enhancing operational efficiency. In agriculture, RPA can automate several processes such as crop monitoring, data collection, and decision-making (Ray & Popp, 2020). UiPath, one of the leading platforms for RPA, has been increasingly applied to automate workflows in industries ranging from finance to healthcare, and its potential in agriculture is being explored as well.

RPA systems in agriculture can integrate with external data sources, including weather APIs, IoT devices, and crop management systems, to perform automated calculations and provide real-time recommendations (Yu et al., 2020). For example, RPA can be used to automate the calculation of water requirements for crops based on real-time weather data, reducing the manual effort involved and ensuring that decisions are made based on accurate and up-to-date information. In addition, RPA can be used to generate reports, monitor irrigation systems, and alert farmers about potential issues, such as water shortages or over-irrigation.

2.4 Automation of Irrigation and Crop Water Requirements

Several studies have focused on automating the calculation of crop water requirements and improving irrigation efficiency through automated systems. Wang et al. (2017) developed a system that integrates weather data with soil moisture sensors to automate irrigation decisions. The system, which uses machine learning algorithms to predict water requirements, has been shown to optimize water usage and improve crop yields in various agricultural settings.

Similarly, Zhang et al. (2019) explored the use of automation and real-time weather data to develop an intelligent irrigation system that adjusts irrigation schedules based on weather forecasts, soil moisture levels, and crop needs. Their findings demonstrated significant improvements in water conservation and crop yield, emphasizing the importance of dynamic irrigation models that are responsive to changing environmental conditions.

UiPath's role in agricultural automation, particularly through RPA, has been highlighted in multiple case studies where automation platforms are employed to streamline and optimize farm operations. In particular, the integration of weather APIs with RPA platforms like UiPath can automate the process of calculating water requirements, thus providing farmers with a seamless and efficient tool to optimize irrigation and reduce water wastage.

2.5 Gaps in Existing Systems

While there have been significant advancements in agricultural water management through technology, many existing systems still face challenges in fully automating the water requirement calculation process. Existing systems may lack integration between weather data and irrigation management tools, or they may not account for the full range of factors affecting crop water needs, such as soil type, crop-specific coefficients, and growth stages. Moreover, many systems remain complex and require significant input from farmers, leading to potential inefficiencies.

The integration of RPA with weather data APIs and irrigation management systems presents an opportunity to bridge these gaps. By automating the entire process—from gathering weather data to calculating water requirements and generating irrigation schedules—the proposed system aims to simplify irrigation decision-making and make water management more precise, efficient, and scalable.

CHAPTER 3

SYSTEM DESIGN

3.1 SYSTEM FLOW DIAGRAM

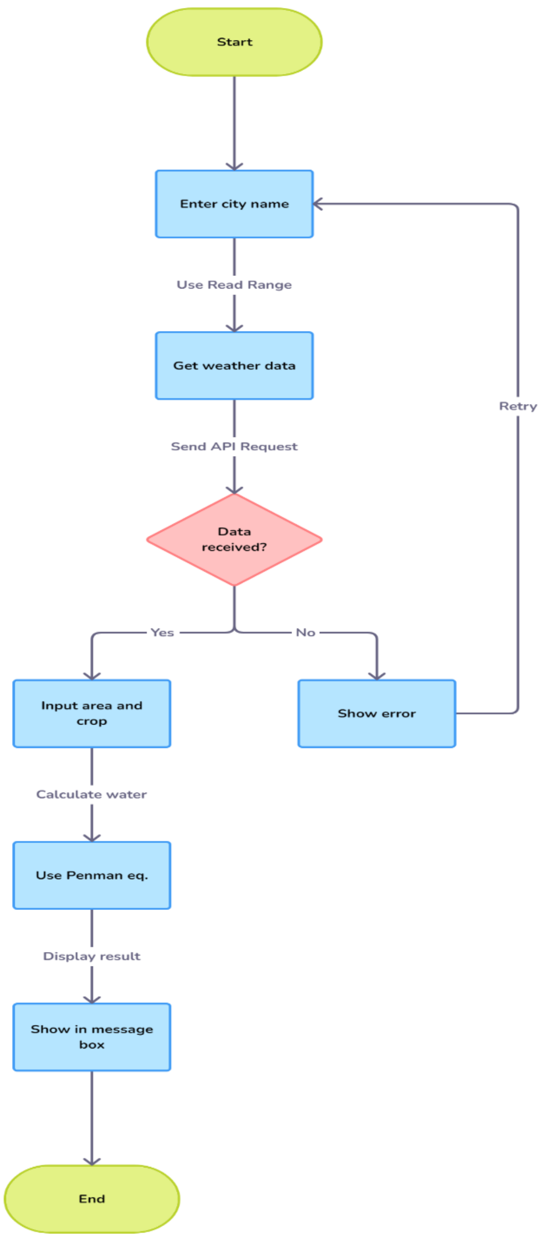


Fig 3.1 System Flow Diagram

3.2 ARCHITECTURE DIAGRAM

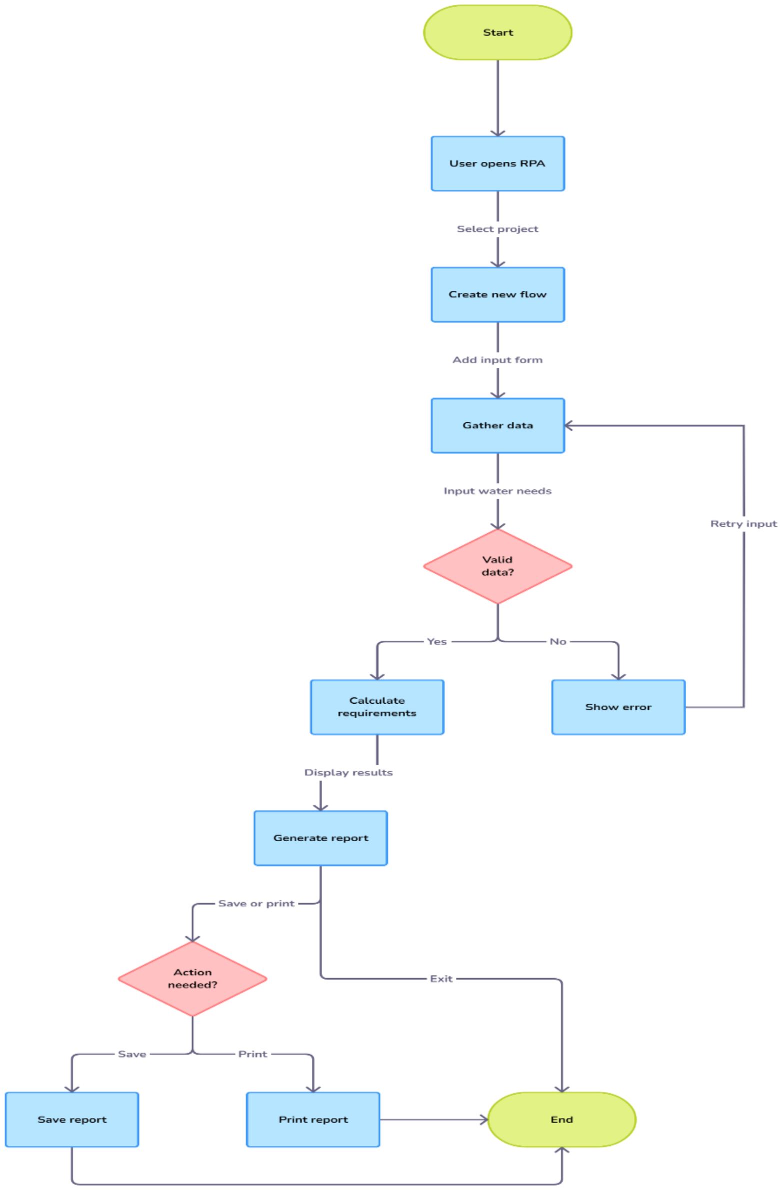


Fig3.1Architecture Diagram

3.3 SEQUENCE DIAGRAM

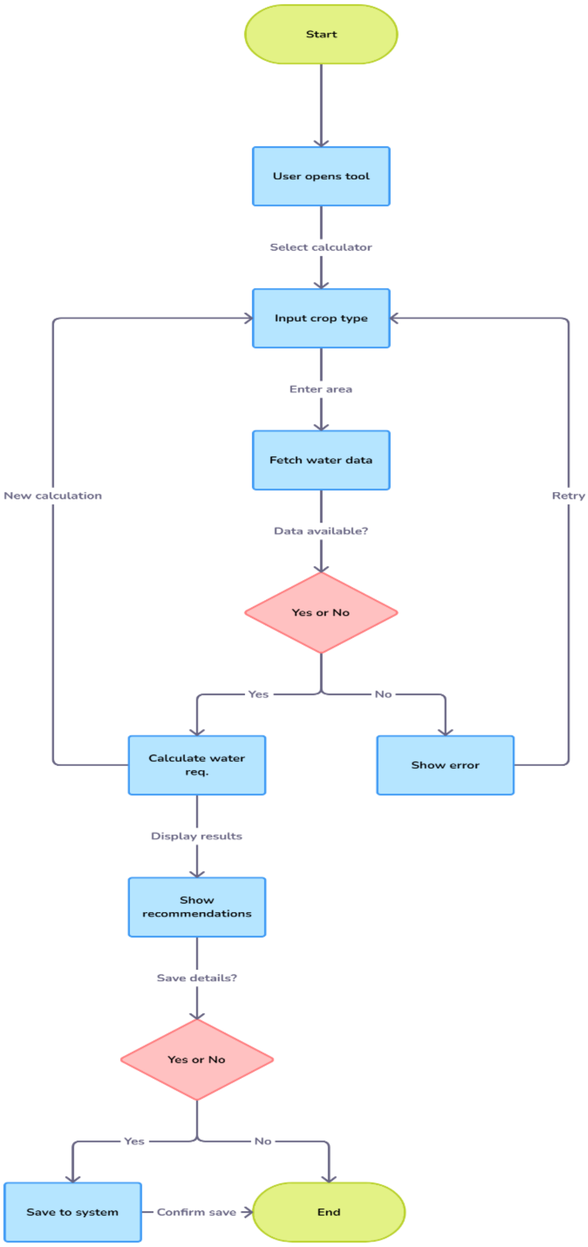


Fig 3.3 Sequence Diagram

CHAPTER 4

PROJECT DESCRIPTION

The Agricultural Water Requirement Calculation Bot is a Robotic Process Automation (RPA) solution designed to optimize irrigation management in agriculture. By leveraging real-time weather data, the bot automates the process of calculating crop water requirements based on the principles of evapotranspiration (ETo) and crop coefficients (Kc). This tool aims to assist farmers, agricultural consultants, and institutions by providing accurate, timely, and automated recommendations for irrigation scheduling, ultimately improving water use efficiency and promoting sustainable farming practices.

4.1. MODULES:

Module 4.1.1: Input Module (Excel Data Reading and User Input)

Objective:
This module handles the input from the user, including reading the list of cities from the Excel file, reading the farming area (in hectares or acres), and selecting the crop type.

Activities Involved:

- Read Range (Excel):
  - Read city names from the Excel sheet.
  - For each city, the weather data will be fetched via API.

- User Input:
    - The user will enter the area of farming (in hectares or acres).
    - The user will select the crop type (e.g., wheat, maize, rice), which will determine the crop coefficient (Kc).

UiPath Activities:

- Excel → Read Range: To read the list of cities.
- Input Dialog: To prompt the user for input such as area of farming and crop type.

Module 4.1.2: Weather Data Retrieval Module (API Integration)

Objective:
This module retrieves real-time weather data (temperature, humidity, etc.) for each city from an external weather API (e.g., Open Weather Map, AccuWeather).

Activities Involved:

- HTTP Request:
    - Make an API request to get weather data for each city.
    - You'll need to integrate the API and pass the city name as a parameter.
- Deserialize JSON Response:

- Once the API returns the weather data in JSON format, deserialize it into a structured format that can be used for further calculations (e.g., temperature, humidity, wind speed, etc.).

UiPath Activities:

- HTTP Request: To retrieve weather data.
- Deserialize JSON: To process the weather data returned from the API.
- Assign: To extract individual weather parameters (temperature, humidity, etc.) from the JSON response.

Module 4.1.3: ETo Calculation Module (Penman Equation)

Objective:
This module calculates the Reference Evapotranspiration (ETo) based on the Penman-Monteith equation, using weather data (e.g., temperature, humidity, wind speed) retrieved from the API.

Formula (Penman-Monteith):

ETo=0.0023×(T+17.8)×(T−Tmin)×0.5ETo = 0.0023 \times (T + 17.8) \times (T - T_{min}) \times 0.5ETo=0.0023×(T+17.8)×(T−Tmin)×0.5

Where:

- T = Average daily temperature (°C)
- T_min = Minimum temperature (°C)

- 0.5 is a constant based on environmental conditions.

Activities Involved:

- Use the Assign activity to apply the Penman-Monteith equation.
- Perform the calculation for ETo for each city based on the weather data received from the API.

UiPath Activities:

- Assign: To apply the Penman-Monteith formula to calculate ETo.
- If: To ensure that the data is valid (e.g., if temperatures are available).

Module 4.1.4: Water Requirement Calculation Module

Objective:
This module calculates the water requirement for the selected crop, adjusted by the crop coefficient (Kc).

Formula:

Water Requirement (mm/day)=ETo×Kc\text{Water Requirement (mm/day)} = ETo \times KcWater Requirement (mm/day)=ETo×Kc

Where:

- ETo: Reference evapotranspiration (calculated in the previous module).

- Kc: Crop coefficient, which varies depending on the crop type and growth stage (this is provided as user input).

Activities Involved:

- The user will input the crop type, and based on this, the crop coefficient (Kc) will be assigned. For example:
  - Wheat: Kc = 0.8
  - Rice: Kc = 1.2
- Area of farming will also be entered by the user (in hectares or acres).
- Convert the crop's water requirement from mm/day to litres based on the farming area (i.e., multiply the crop water requirement by the area).

UiPath Activities:

- Assign: To calculate the water requirement using the formula.
- Assign: Convert the water requirement from mm/day to litres using the area of farming.
  - Conversion example:
    - 1 mm of water on 1 m^2 = 1 litre of water.
    - Water in litres = Water Requirement (mm/day) × Area (m^2)

Module 4.1.5: Output and Display Module (Message Box)

Objective:
This module displays the calculated water requirement in litres in a Message Box to the user.

Activities Involved:

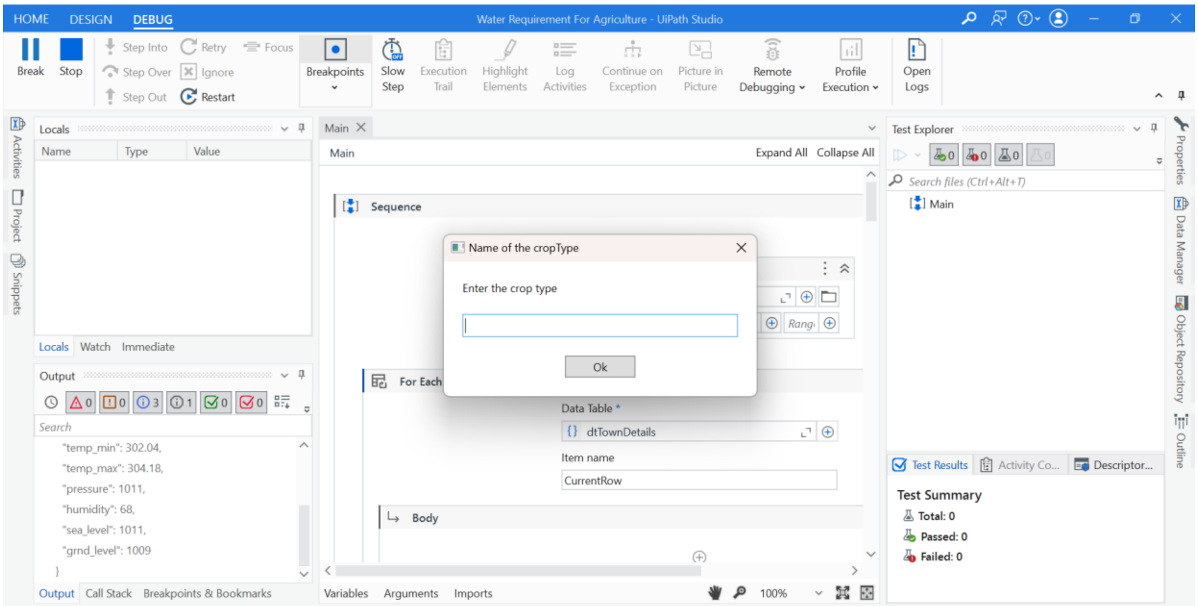
- Message Box:
  - Show the final water requirement for the selected crop, displayed in litres for the area specified by the user.

UiPath Activities:

- Message Box: To display the final result, showing the calculated water requirement in litres.

CHAPTER 5

OUTPUT SCREENSHOTS



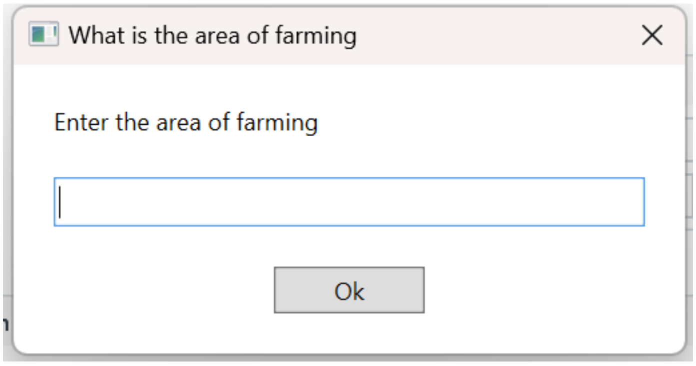


Fig 5.1 – Input Dialog

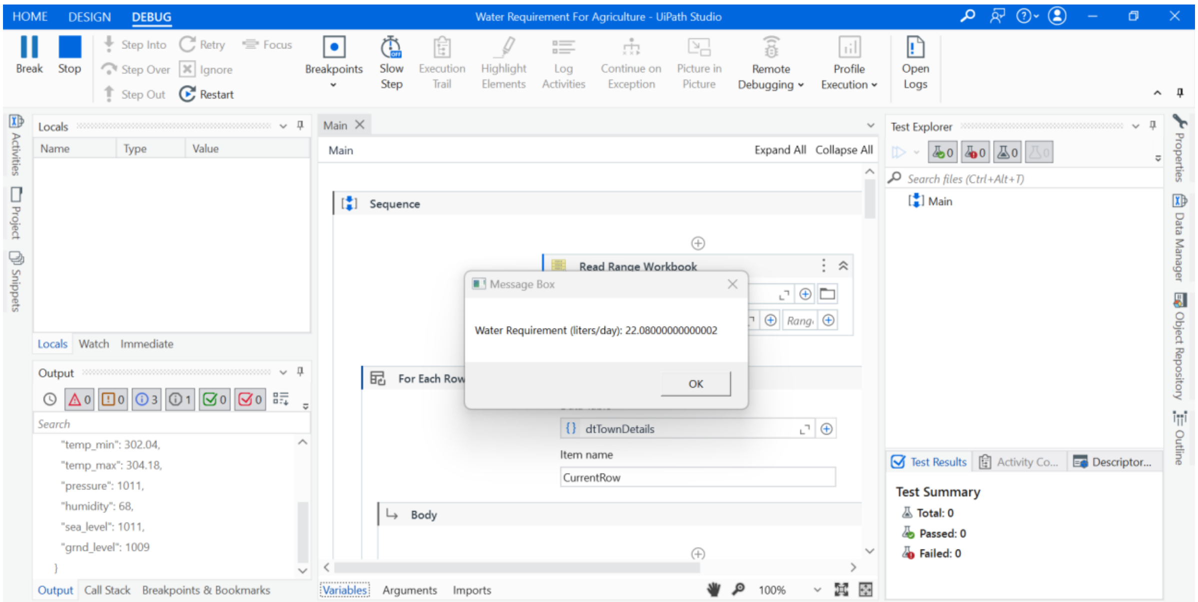


Fig 5.2 – Message Box Output

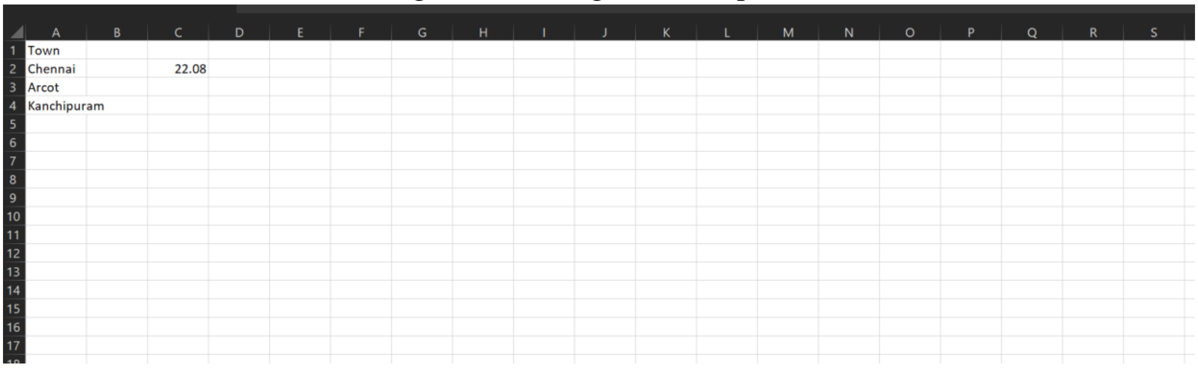


Fig 5.3 - Output Stored in Excel

CHAPTER 6

CONCLUSION

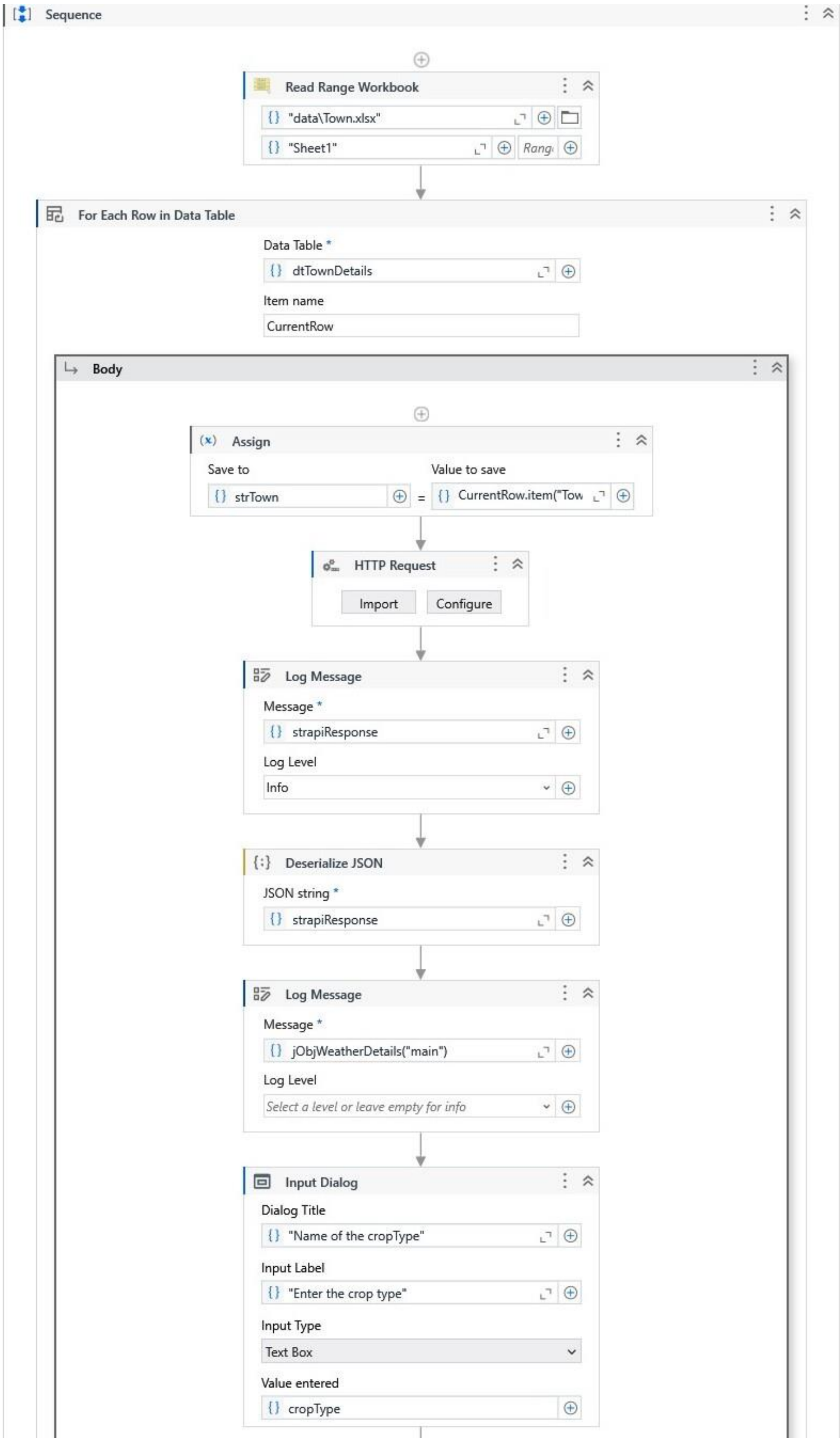
The **Agricultural Water Requirement Calculator** developed using Robotic Process Automation (RPA) and UiPath Studio offers an innovative and efficient solution for modern irrigation management. By automating the process of calculating crop water requirements based on real-time weather data and specific crop factors, this tool not only simplifies the task of irrigation scheduling but also ensures precision in managing water resources. The integration of weather data through API requests, combined with the use of the Penman-Monteith equation for estimating **Reference Evapotranspiration (ETo)**, ensures that the calculations are based on the most up-to-date and accurate climatic conditions. This is crucial for optimizing water usage in agricultural practices, especially in regions where water resources are limited or need to be managed sustainably.

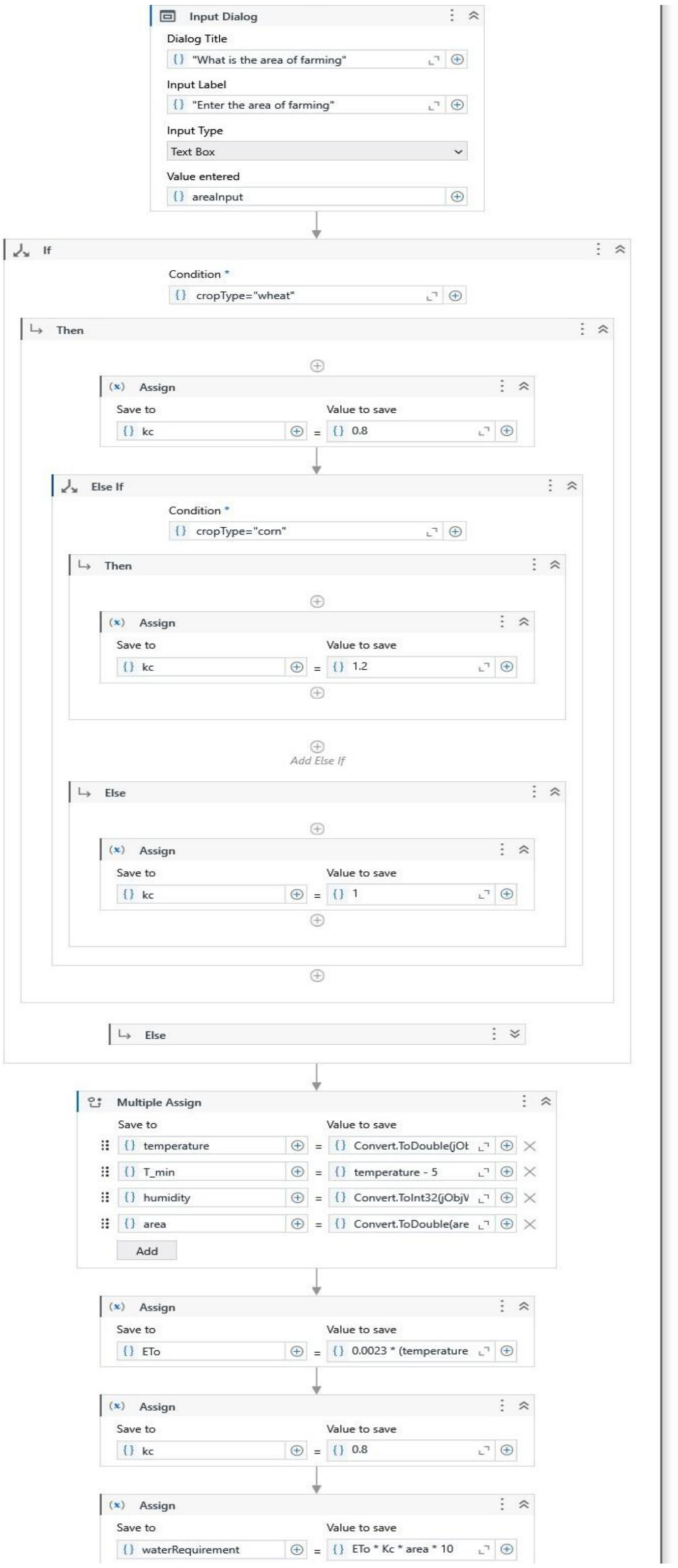
Overall, the **Agricultural Water Requirement Calculator** represents a significant step toward promoting **sustainable agricultural practices**. By leveraging the power of automation and real-time data, it contributes to more efficient water management in agriculture, ultimately helping farmers optimize their irrigation practices, reduce costs, and promote environmental sustainability. The project also lays the groundwork for further enhancements, such as integrating soil moisture sensors or forecasting weather patterns for even more precise water requirement predictions.

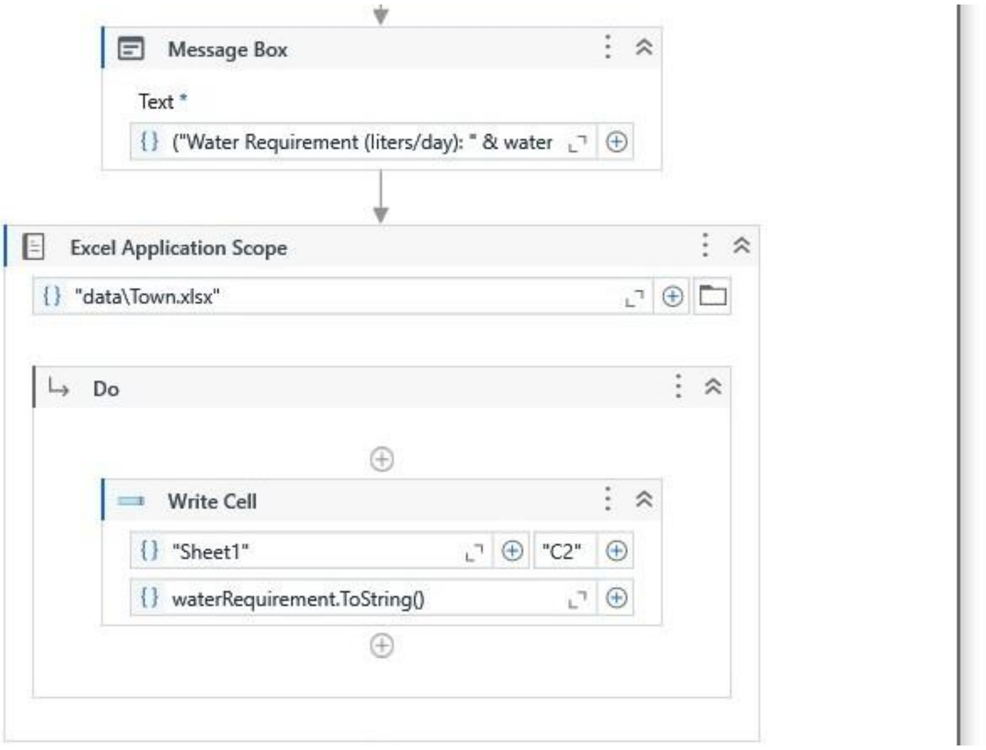
In conclusion, this project showcases the potential of RPA and advanced data analytics in transforming the way irrigation is managed in modern agriculture, making it a valuable tool for the future of farming.

APPENDIX

PROCESS WORK FLOW




Input Dialog
Dialog Title
"What is the area of farming"
Input Label
"Enter the area of farming"
Input Type
Text Box
Value entered
areaInput
If
Condition *
cropType="wheat"
Then
Assign
Save to
Value to save
kc
0.8
Else If
Condition *
cropType="corn"
Then
Assign
Save to
Value to save
kc
1.2
Add Else If
Else
Assign
Save to
Value to save
kc
1
Else
Multiple Assign
Save to
Value to save
temperature
Convert.ToDouble(jOb
T_min
temperature - 5
humidity
Convert.ToInt32(jObjV
area
Convert.ToDouble(are
Add
Assign
Save to
Value to save
ETo
0.0023 * (temperature
Assign
Save to
Value to save
kc
0.8
Assign
Save to
Value to save
waterRequirement
ETo * Kc * area * 10



REFERENCES

[1] **Allen, R.G., Pereira, L.S., Raes, D., & Smith, M. (1998).** *Crop evapotranspiration - Guidelines for computing crop water requirements*. FAO Irrigation and Drainage Paper No. 56. Food and Agriculture Organization of the United Nations (FAO).

[2] This foundational paper introduces the concept of reference evapotranspiration (ETo) and provides guidelines for calculating crop water requirements.

[3] **Penman, H.L. (1948).** *Natural evaporation from open water, bare soil, and grass*. Proceedings of the Royal Society of London. Series A, Mathematical and Physical Sciences, 193(1032), 120–145.

[4] **Jensen, M.E. (2007).** *Design and operation of farm irrigation systems*. ASAE.

[5] **Doorenbos, J., & Kassam, A.H. (1979).** *Yield response to water*. FAO Irrigation and Drainage Paper No. 33. Food and Agriculture Organization of the United Nations (FAO).

[6] □ "Estimation of actual crop evapotranspiration using artificial neural ...." 30 Jun. 2023, https://www.sciencedirect.com/science/article/pii/S0378377423001968.

[7] □ "Smart irrigation monitoring and control strategies for improving water ...." 01 Feb. 2022, https://www.sciencedirect.com/science/article/pii/S0378377421006016.