稲作水田灌漑に地理地形情報とデータ分析を統合する用水管理
Integration of Geoinformatics and Data Analytics in Rice Irrigation Water Management

○ムトミ　ケルビン キマスィ*,**，鈴木　純*
○Kelvin Kimathi Muthomi*,**，SUZUKI, Jun*

1. Introduction

In Kenya and sub-Saharan Africa, poor rice irrigation water management has been spelling doom to food security. Old irrigation methods, earthen canals, silted canals, rusted gates, and low-level practicality in water management are menace. As a result, low rice production and overreliance on imports and relief food are the new norms.

A study is currently being conducted to develop a centralized system that offers near real-time information on paddy field performance and water accountability. This system considers water availability, soil parameters, weather, and satellite monitoring to determine water supply.

Rice is central in the global agricultural landscape, with approximately 900 million impoverished individuals relying on it as producers or consumers. (Childs & Kiawu, 2009). Water resources become scarcer as the world faces climate change, conflicts, and diseases. Additionally, with the easing of COVID-19 restrictions, there has been a notable increase in global rice demand. This surge in demand has led to a sharp rise in rice prices, reaching $650 per metric ton. (Samsul Said, 2023). It puts absolute pressure on the farmers.

Governments and experts aim to address food security, but a gap exists between SDG policies and implementation. Rice cultivation, predominantly in flooded paddies, requires substantial water, with 1432 liters needed for 1 kilogram (Bouman, 2009).

Many farmers rely on outdated manual gate methods, especially in developing countries with deteriorating canal infrastructure.

Many satellite crop monitoring studies lack proactive measures and merely observe crop conditions, relying on farmers' decisions. Despite gathering multiple datasets, these studies often fail to take preemptive action.Photos illustrate these challenges.

Figure 1 United Nations SDGs summit

2. Materials and Methods

2.1 Study site

The study focuses on two paddy fields owned by Shinshu University, as depicted on the map. Parcel 1 covers an area of 0.23 acres, while Parcel 2 spans 0.23 acres.

The **RICEFARM** application, developed for this project using Microsoft Power Platform, provides data analytics and water request functionality. It is housed on a secure platform that is accessible at *https://www.ricefarm .powerappsportals.com*.

This platform is now accessible worldwide and provides access to farmers and any

*信州大学農学部 Faculty of Agriculture, Shinshu University, **National Irrigation Authority Kenya
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anonymous user, provided they have a Gmail account. However, there is a limitation to access exclusively for farmers within the system.

Terminologies:**PowerBi** uses business intelligence techniques to assess soil, weather, water requirements, and farmers' water use.

PowerAutomate initiates and conducts cloud flows, alleviating human interaction.

Dataverse provides storage for all records in the cloud except user passwords. Google caters to user identification.

Farmo is a Japanese company that offers gate automation solutions for the actuation of the process.

2.2 Methodology

i) Soil samples from land parcels are taken in four phases: pre-planting, planting, crop development, and maturity, considering hydraulic conductivity, bulk density, porosity, and moisture content. ii) Water canal parameters such as crosssections, slope, and freeboard are taken into account to determine discharge. iii) A weather station is installed in the field to provide precise evapotranspiration, addressing satellites' limitations such as cloud coverage and resolution. iv)Formulae such as the Green-Ampt equation are applied to determine the ponding time and a constant ponding depth. v)Satellite resources such as WapoR are employed to monitor Gross Biomass, Light use efficiency, Net Primary productivity, and NDVI for the farmland within the season.

Figure 2 Reality on the ground: Failed Canal system in Burundi

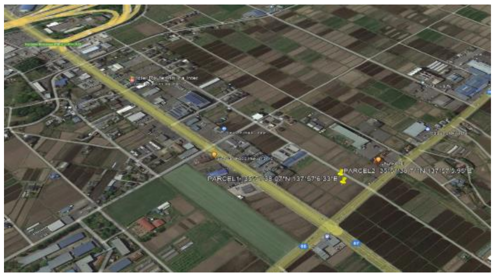

Figure 4 Study Location

2.2.1 System Functionality:

1) Farmer Login and registration, 2)If registered, the farmer can just press the button to request for water, 3) In the request page, the farmer provides the parcel number, rice variant, and the current canal discharge, 4) On submission, the system applies the Green-Ampt model and the FAO Penman-Monteith equation to determine the water supplied at a given time. 5) The farmer presses start on the **FARMO APP** and stops once the time is over. The gates Automatically open and close within the stipulated time, 6) PowerBI automatically fetches the data stored through Power Automate and provides farmers and relevant users with near-real-time data.

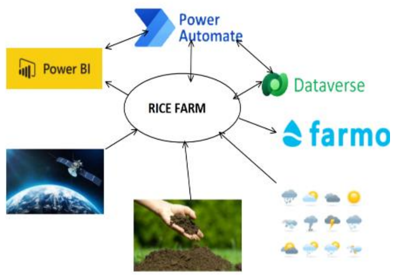

Figure 5 flow chart

3. Conclusion

Upon completion, the research will transform the management of rice irrigation water, promoting equity and a more stable food supply for all. African and international rice cultivation will benefit greatly from the technological transfer provided by Japanese innovations like automatic gates and standardized concrete canals, which will promote responsible water usage and accountability.