



WATER INFRASTRUCTURE AND SUSTAINABLE ENERGY FUTURES

Address: Nelson Mandela Rd, Tengeru, P.O. BOX 9124, Nelson Mandela, Arusha, Tanzania. Web: www.wisefutures.ac.tz, email: wise.admin@nm-aist.ac.tz



Developing an AI-Based Crop Water Stress Monitoring tool for Climate-Resilient Small-Scale Agriculture

Musiige Denis

Supervisors 1. Prof. Hans C. Komakech 2. Dr. Chris de Bont

Background

- Smallholder farmers in Sub-Saharan Africa face climate-induced water stress.
- Over- or under-irrigation leads to reduced yields, diseases, and inefficient water use.
- There is a critical need for low-cost, intelligent irrigation decision-support tools.

Problem statement

- Smallholder farmers in sub-Saharan Africa struggle with low yields due to inefficient irrigation practices.
- AI tools for stress detection mostly target biotic factors like pests and diseases in commercial or cereal crops.
- Water stress detection in vegetables like cabbage remains underexplored.
- There's a need for lightweight, multimodal AI models and annotated datasets for smallholder systems.

Main objective

Develop and train an AI model that integrates field sensor data, imagery, and climate data to monitor crop water stress in cabbages in small-scale agriculture.

Specific objectives

- To evaluate and train ML model suitable for identifying water stress in cabbages using crop optical images.
- To evaluate the feasibility of utilizing environmental data (SM, T, EC, & pH) and crop imagery to train a ML algorithm for detecting water stress in cabbage crops.

Methodology

Experimental set up

Image based ML

Data collection

RGB and Thermal Images

Data preprocessing

70% Train, 15% Valid, 15% Test

Model development

AlexNet, GoogleNet, MobileNet V2, ResNet 50

Model evaluation

Accuracy, Precision, Recall, F1

Multi-Modal ML

Data collection

SM, T, EC, pH & Weather data

Model development

Best CNN Model+ Env'tal data

Model evaluation

Experimental layout

Green house

100% ETc (WW)	25% ETc (SS)	65% ETc (MS)
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Expected results

- The study is expected to yield a robust, lightweight AI model preferably MobileNetV2 or ResNet-50 with high accuracy and fast inference for water stress detection.
- The final model will be optimized and exported in mobile-compatible formats like TensorFlow Lite to support deployment in user-friendly irrigation advisory apps for smallholder farmers.

Fig. 1. Overview of multi-modal ML

