

## **CONCEPT NOTE & PROJECT PROPOSAL**

**Submission to:** WRRIC Mini-Hackathon

**Theme:** Youth-Led Grassroots Solutions

**Date:** February 19, 2026

**Project Title: Ghala-Smart (Autonomous Off-Grid Grain Preservation System)**

**Developed by:** Sericsoft Innovations Ltd. (Kisii University Team)

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### **1. Executive Summary & Problem Statement**

Small-scale farmers in rural Kenya consistently lose up to 30% of their harvested maize to post-harvest rot, moisture damage, and aflatoxin contamination. Traditional storage methods (like standard sacks or basic metal silos) offer no early warning systems. By the time a farmer realizes their grain is spoiling, the financial loss and health risks are already irreversible. There is a critical need for a low-cost, automated intervention system that operates independently of internet access and reliable electricity.

### **2. The Grassroots Solution: Ghala-Smart**

Ghala-Smart is a youth-led engineering solution designed specifically for rural agriculture. It is an intelligent, off-grid IoT monitoring and active-ventilation system that upgrades any standard grain silo into a "smart storage" unit. The system continuously monitors the internal microclimate of the silo and automatically intervenes to prevent grain spoilage before it happens, while keeping the farmer informed via basic SMS.

### **3. Technical Architecture & Hardware**

The system is built on a robust, locally serviceable hardware stack:

- **Sensors (The Senses):** A **DHT22** sensor monitors internal temperature and humidity, while an **MQ-135** gas sensor detects early signs of fermentation and spoilage gases (ammonia/carbon dioxide). An **HC-SR04** ultrasonic sensor acts as a digital dipstick to measure grain inventory levels.
- **Processing (The Brain):** An **ESP32** microcontroller processes the sensor data locally in real-time.
- **Actuation (The Muscle):** If internal humidity or gas levels breach safe thresholds, the ESP32 triggers a **5V Relay**, immediately turning on an active ventilation fan to aerate the

grain and expel moisture. If the system detects external rain (rapidly rising outside humidity), it locks the silo to prevent drawing in wet air.

- **Offline Communication (The Voice):** Recognizing that rural farmers often lack smartphones or Wi-Fi, the system uses a **SIM800L GSM Module** to send direct SMS alerts to the farmer's feature phone (e.g., "Alert: High Humidity detected. Fan activated.").
- **Green Energy & Scalable Power (Off-Grid Capability):** The system operates entirely off-grid via a scalable solar architecture. Our current proof-of-concept prototype utilizes a compact 10,000mAh lithium-ion system with a TP4056 charge controller for micro-ventilation. For commercial deployment in large-scale silos requiring high-draw industrial fans, the power architecture seamlessly scales to 12V/24V deep-cycle solar batteries and heavy-duty inverters, ensuring 100% autonomy in remote villages.

#### 4. Community Impact & Scalability

Ghala-Smart transitions farmers from passive storage to active preservation. By preventing a 30% harvest loss, the system acts as an insurance policy that pays for itself in a single season. Furthermore, the modular design allows it to scale from a single village-level silo to large-scale cooperative warehouses simply by upgrading the size of the exhaust fan.

#### 5. Team Members & University Registration

We are a dedicated team of students from Kisii University, combining skills in hardware engineering, software development, and project management.

- **Gideon Mwiti** – IN13/00052/23
- **Ezekiel Ayuoyi** – IN17/00145/24
- **Annastacia Mueni** – IN17/00025/24
- **Lencer Odhiambo** – CB21/00204/23

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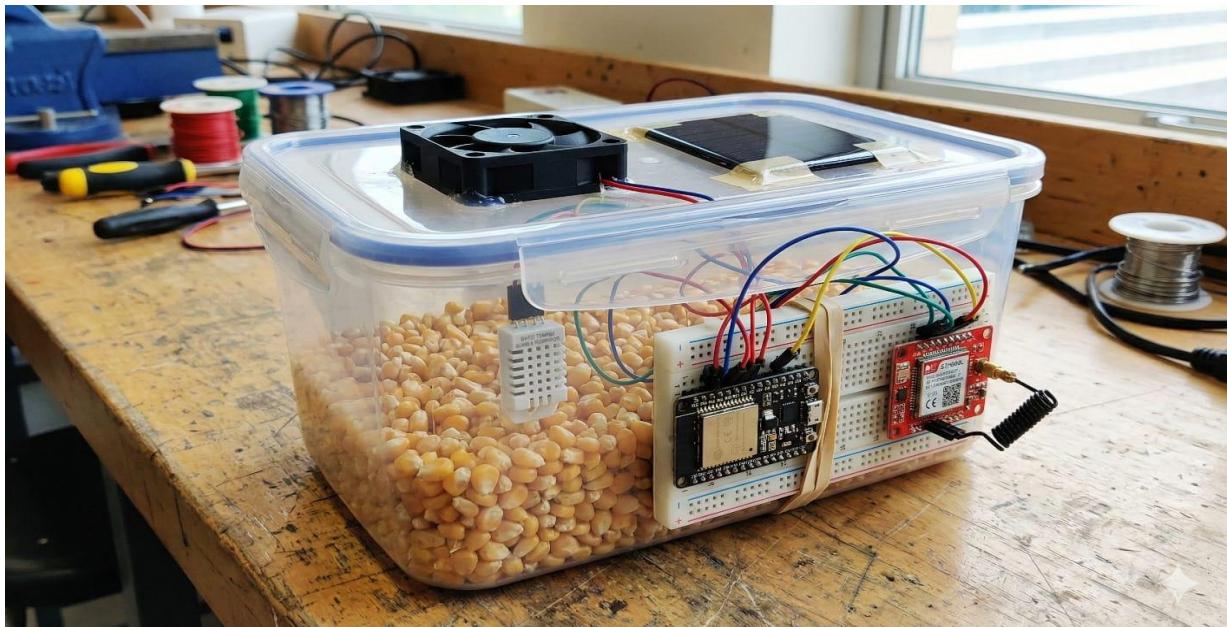
#### Contact Information:

**Email:** [ghalasmart@sericsoft.com](mailto:ghalasmart@sericsoft.com)

**Phone:** +254 799 987 409

**Institution:** Kisii University

## 6. Appendix: Phase 1 Hardware Prototype



**Figure 1:** Our current working prototype demonstrating the ESP32 integration, SIM800L GSM module, active ventilation fan, and internal DHT22 sensor tracking grain microclimate.