Dual function smart compost system: To monitor the quality as well as a home-made compost production system

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Why we need Compost and Problems faced by farmers?

1. Improves soil fertility & provides essential nutrients
2. Enhances soil structure and water retention
3. Promotes microbial activity & nutrient cycling
4. Reduces chemical fertilizer and pesticide use
5. Aids in waste management & carbon sequestration

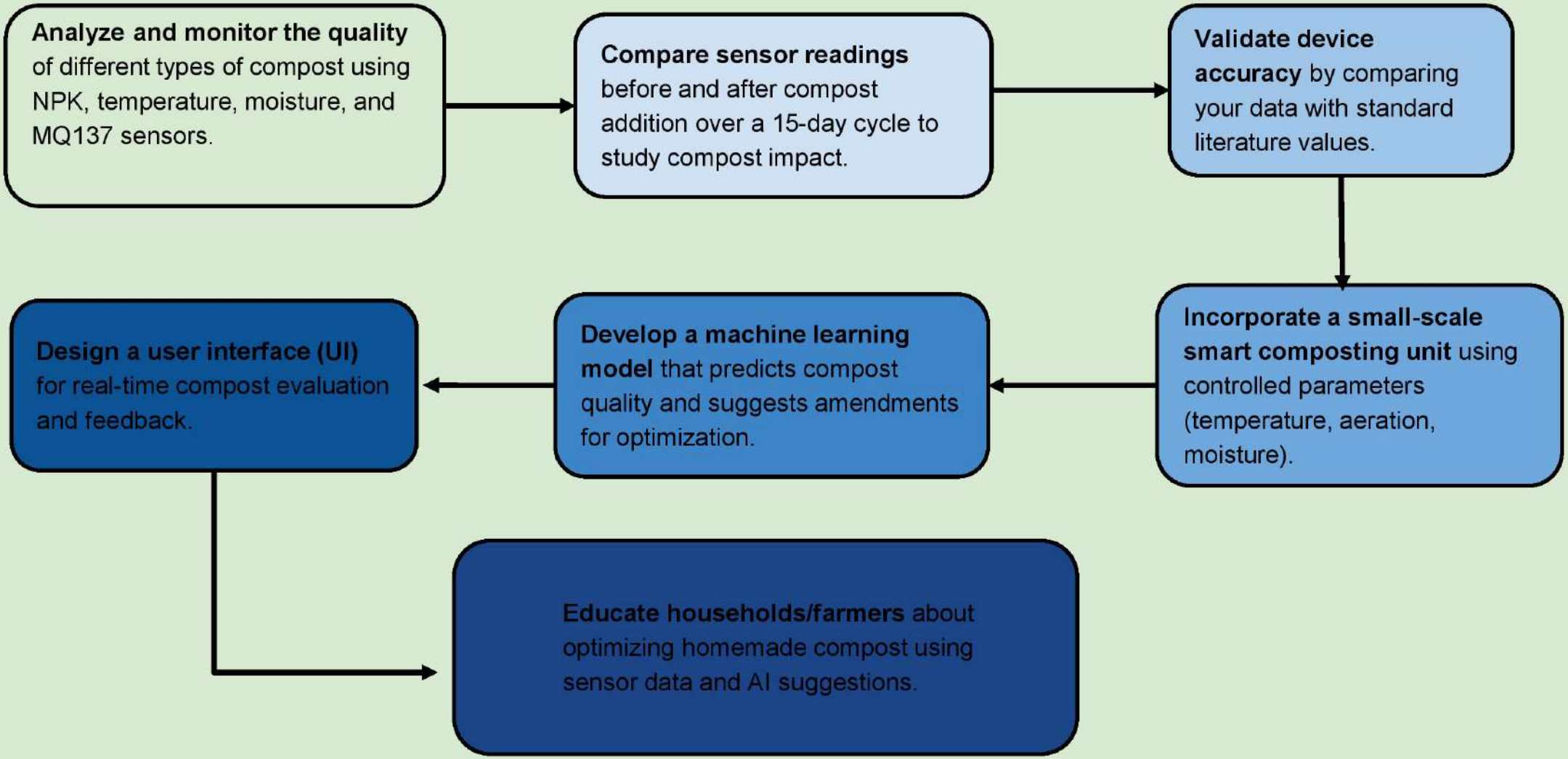
a. High production and transport cost
b. Low nutrient concentration vs. chemical fertilizers
c. Time-consuming composting process
d. Inconsistent quality and nutrient content
e. High initial investment for small farmers

Problems Faced Without Compost Addition

Problem Without Compost	Impact on Farmers	Statistical/Contextual Details
Soil degradation	Lower fertility, erosion	SOC <0.5% (Indian avg. 0.3%)12
Reduced crop yields	Lower income, food insecurity	Farms with SOC 0.51% see higher yields 1
Increased input costs	Higher debt, financial distress	50% + farmers debt-ridden (2019 NSS)1
Environmental/health risks	Pollution, health issues	Groundwater contamination, pesticide risks2
Shortage of biomass	Harder to adopt compost	Crop residues used for fodder/fuel5

1. **Use of Compost and Organic Practices**
    a. Vermicomposting adoption: Estimated 1.5 million farmers practice vermicomposting, but this is a small fraction of India's farming population.
    b. Barriers to adoption: Lack of awareness, high cost of organic inputs, and inadequate infrastructure.
2. **Cost Savings with Compost**
    a. Vermicompost application: Can reduce fertilizer cost by up to INR 4,000 per hectare and pesticide cost by 40% over 3–4 years.

Execution of the Project



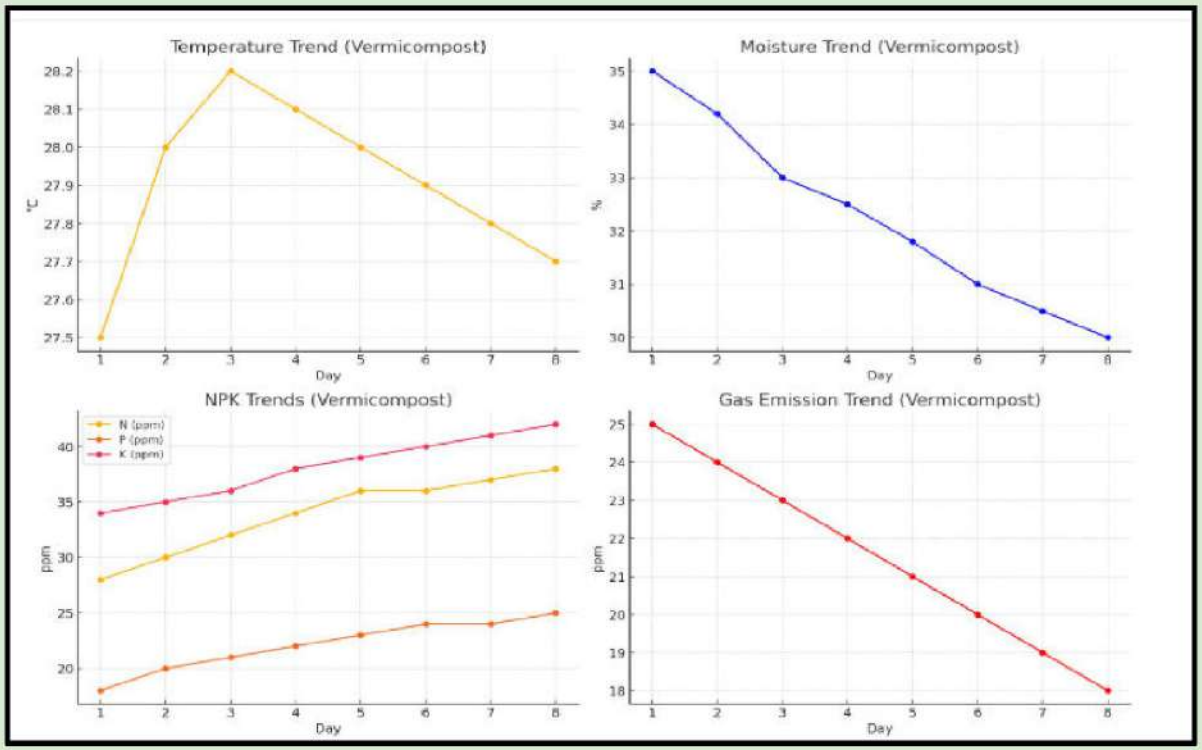
Compost preparation and data collection using the sensor's

Compost preparation with five types of readily available compost.

1. Vermicompost Powder
2. Liquid Fermented Organic Manure
3. Premium Spray
4. Fermented Organic Soil Material
5. Nano Silicon

Data collection for the **15 days** to get the reliable data of the nutrition form each type of the compost.

Data trend of the standard compost and comparison with the literature nutrition value



Graph shows the data collection by the sensor of standard compost follow the usual pattern when mixed with the soil.

1. The **15-day test** concluded that the sensor values collected for the standard compost, when compared with the literature values for the corresponding compost **NPK values, showed a difference of only ±10%.**

1. This demonstrates the accuracy of the sensor in measuring values close to the standard. Therefore, if a device for compost quality monitoring is developed using this sensor, the values can be considered reliable.

Working system of the Organic compost making device

Food waste from the home added to the device

sensors start taking the reading from the waste

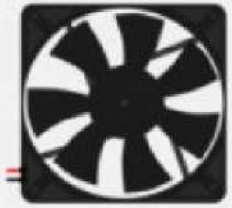
DHT11 Sensor Module

MQ137

NPK Soil Sensor

DS18B20 Digital Temperature Sensor

Soil Moisture Sensor



Fan

The Fan turns ON at regular intervals to exhaust ammonia gas

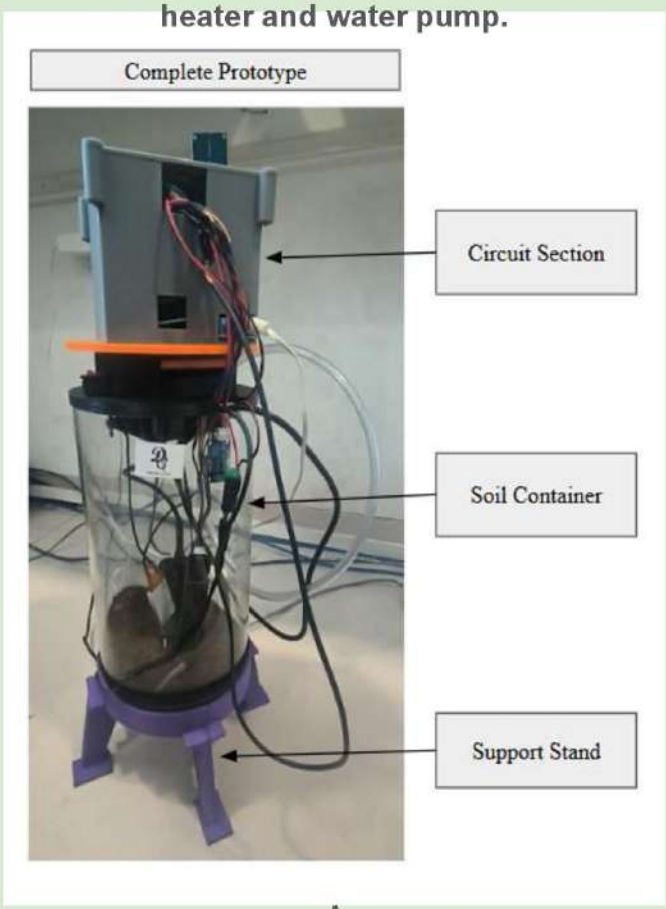
If moisture drops by 60% water pump will on

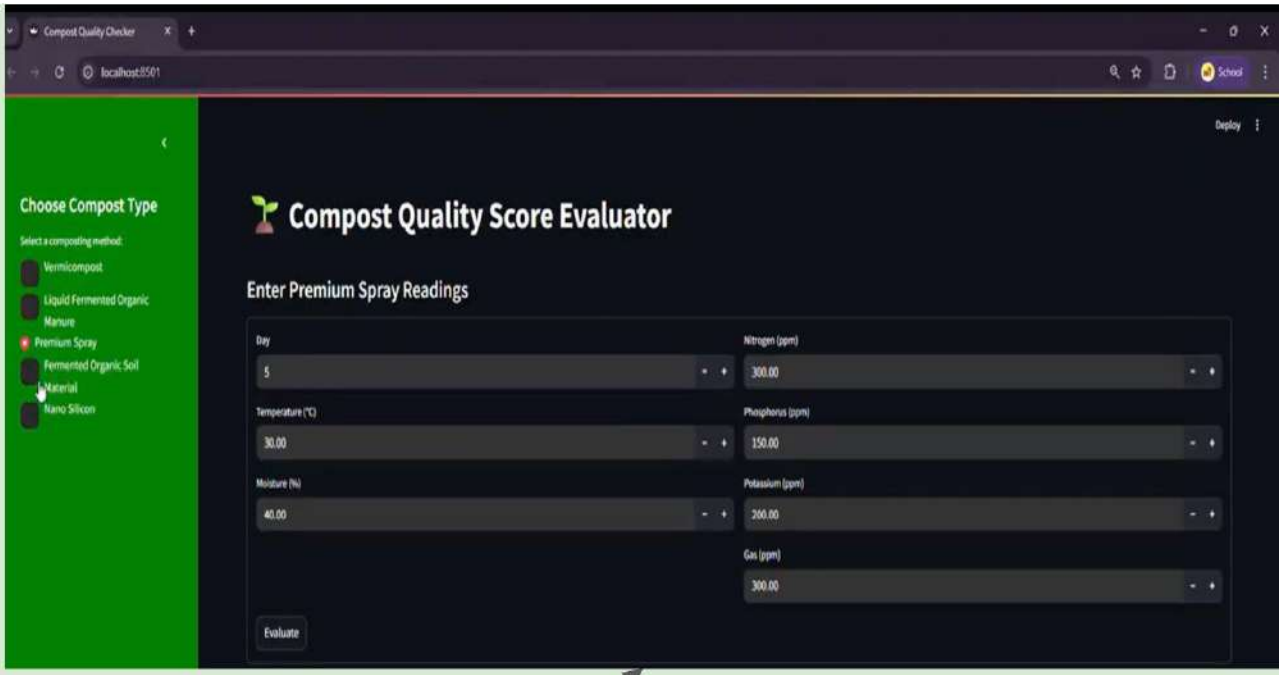
5v mini water pump

The displayed data should be added to the dashboard to **compare the compost quality with the standard compost values.** Based on this comparison, suggestions can be generated to **improve the compost quality further.**

Actual Workflow

Prototype equipped with all the sensors, heater and water pump.



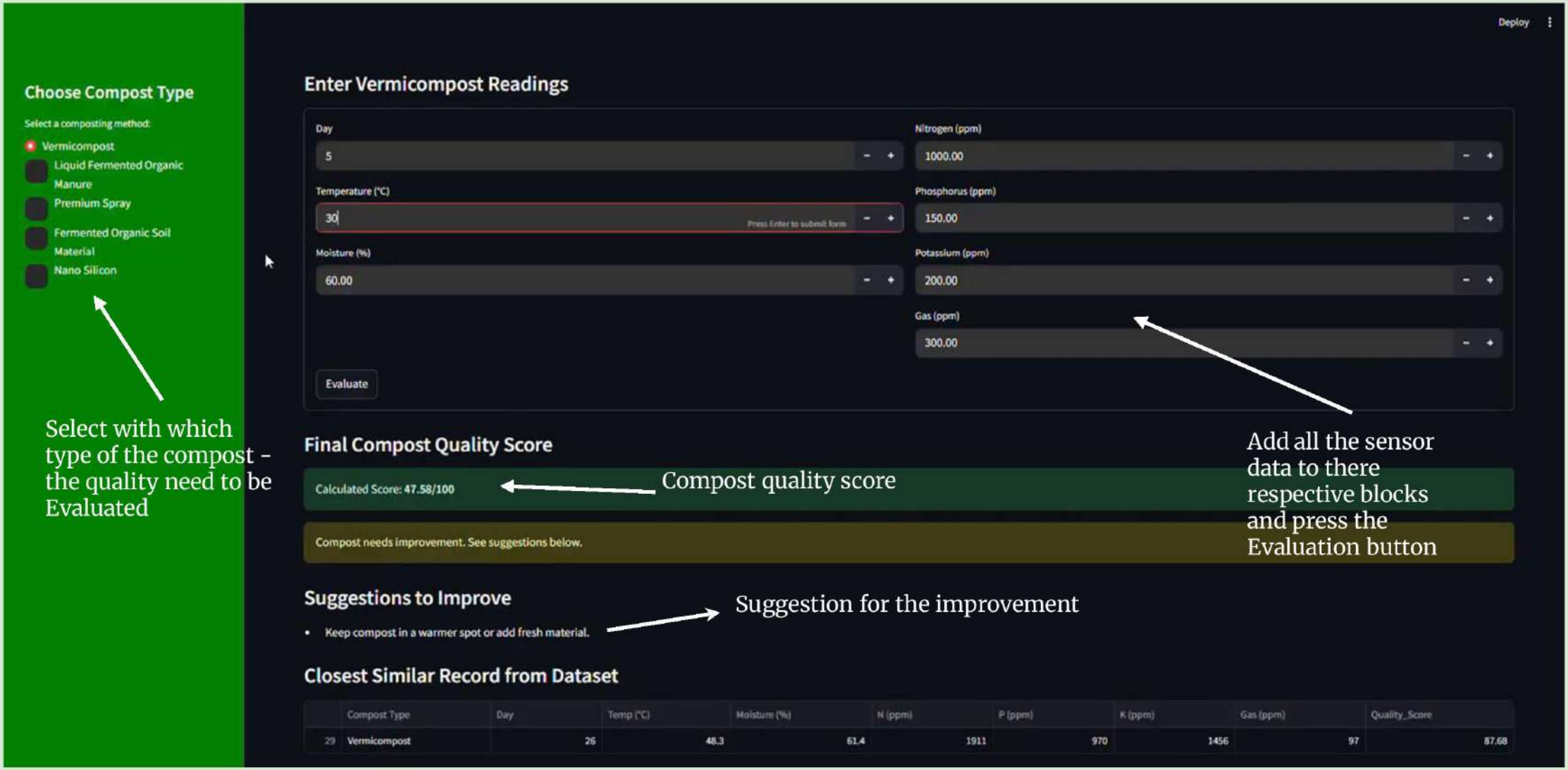


Dashboard to Calculate and evaluate the compost requirement

Testing performed in the field with crop soil

Dashboard for compost quality monitoring

Dashboard for compost quality monitoring



Select with which type of the compost - the quality need to be Evaluated

Compost quality score

Add all the sensor data to there respective blocks and press the Evaluation button

Suggestion for the improvement

Compost made using the device

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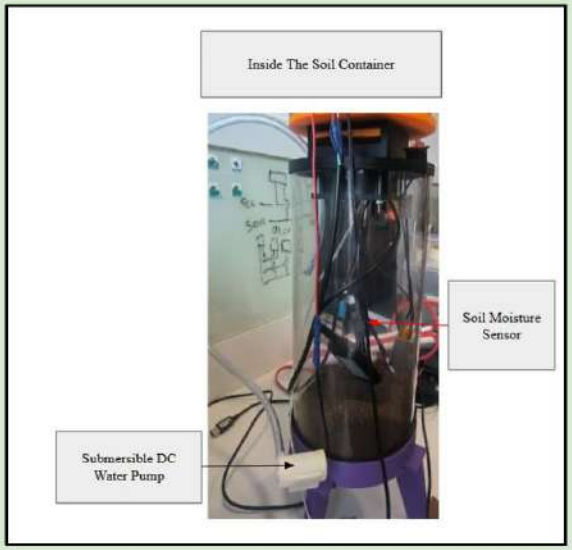

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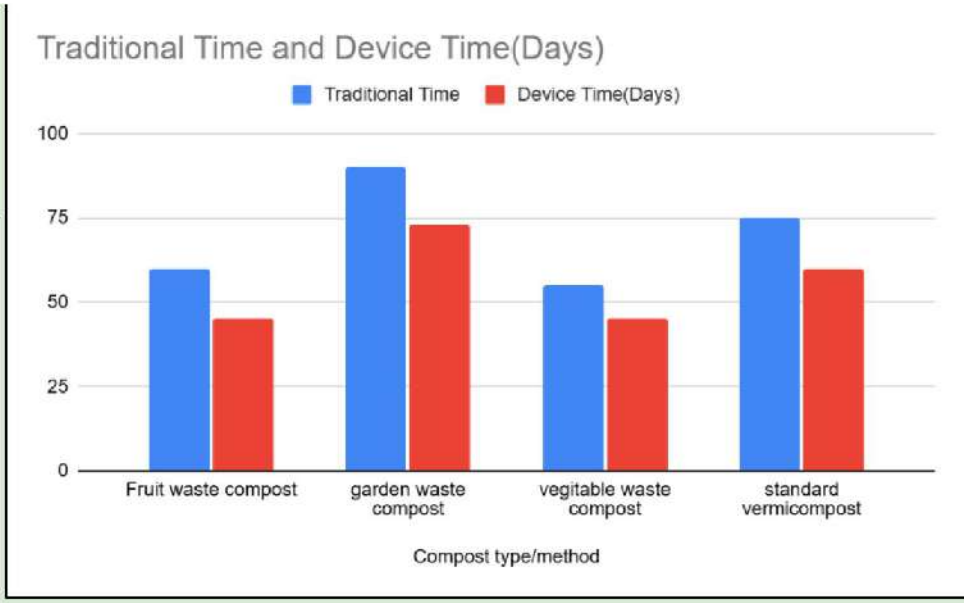
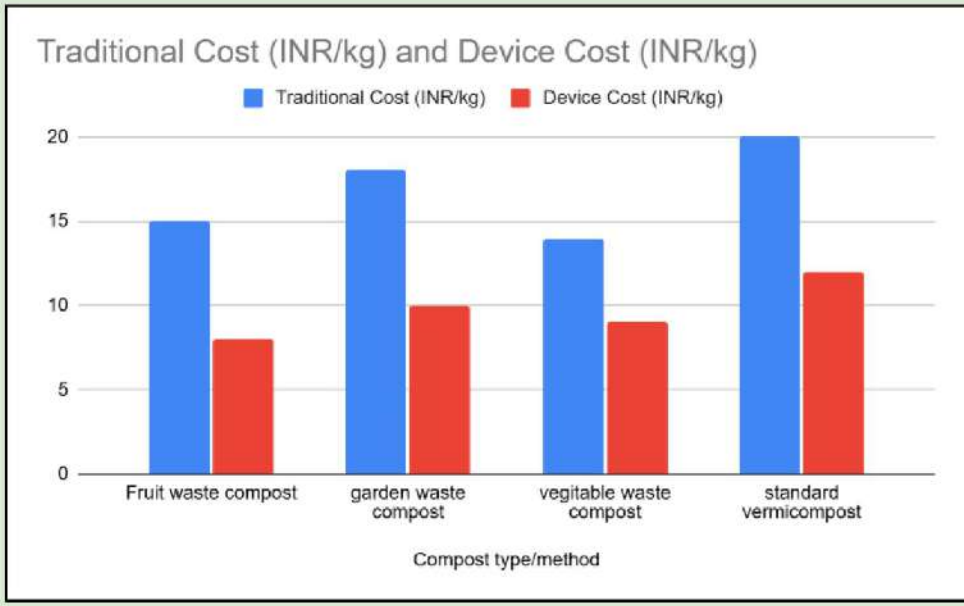
Garden waste as well as fruit waste collated for more then 9 days

1. Vegetable waste based compost after **45 days**
2. Garden waste based compost after **73 days**
3. Fruit based compost after **56 days**

Results and Interpretation

Compost Type / Method	Traditional Time (Days)	Traditional Cost (INR/kg)	Device Time (Days)	Device Cost (INR/kg)
Fruit Waste Compost	60	15	45	8
Garden Waste Compost	90	18	73	10
Vegetable Waste Compost	55	14	45	9
Standard Vermicompost (benchm	75	20	60	12





Interpretation :

1. Device reduces composting time by **~20–25%.**
2. Production cost drops by **40–50% per kg**, making it more affordable.
3. Consistent quality assured through sensor monitoring → increases reliability.

Monitor + Produce

Ingredient	Quantity for 1 kg Compost	Why It's Good	Best For Which Compost Type
Vegetable Peels	300-400g	High in Nitrogen, moisture	All types - especially Liquid Organic Manure
Fruit Waste	200-300g	Rich in sugars, feeds microbes	Fermented Organic Material, Liquid Manure
Rice (cooked leftover)	100-150g	Carbohydrates, attracts beneficial bacteria	Fermented Organic Soil Material
Tea Leaves/Coffee Grounds	50-100g	Nitrogen-rich, acidic	Vermicompost, Premium Spray
Eggshells (crushed)	30-50g	Calcium, balances pH	All types

Table 1: Top Ingredients to Add (Easily Available at Home)

Turn your daily kitchen waste into high-quality compost in 25-35 days (instead of 60+ days) - saving money, reducing garbage, and getting free fertilizer for your plants.

Home Compost Mix

Category	Ingredients	Quantity (for 1kg batch)	Purpose
Green (Nitrogen)	Vegetable peels, fruit waste, tea leaves	600g (60%)	Provides nitrogen, moisture
Brown (Carbon)	Dried leaves, paper, cardboard	300g (30%)	Absorbs moisture, structure
Accelerator	Cow dung or old compost	100g (10%)	Speeds up decomposition
Moisture	Water spray	Maintain 60%	Critical for microbes
Air	Turn/mix	Every 3 days	Prevents bad smell

Conclusion & Future Scope

1. Smart compost system reduced **composting time by ~20–25%**.
2. Lowered **production cost by 40–50% per kg**, making it affordable.
3. Ensured **consistent compost quality** through real-time sensor monitoring.
4. Dual-function design (monitoring + production) increases **trust and adoption** among farmers and households.

1. **Scalability:** From household units → community compost hubs → large farms.
2. **Integration:** Solar-powered operation for rural/off-grid use.
3. **Advanced AI:** Larger datasets to improve accuracy and predictive insights.
4. **Waste Management Expansion:** Adapt system for **municipal organic waste** processing.
5. **Commercialization:** Develop a **low-cost IoT compost kit** with mobile app for global use.

References

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