

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 risks 2
Shortage of biomass	Harder to adopt compost	Crop residues used for fodder/fuel 5

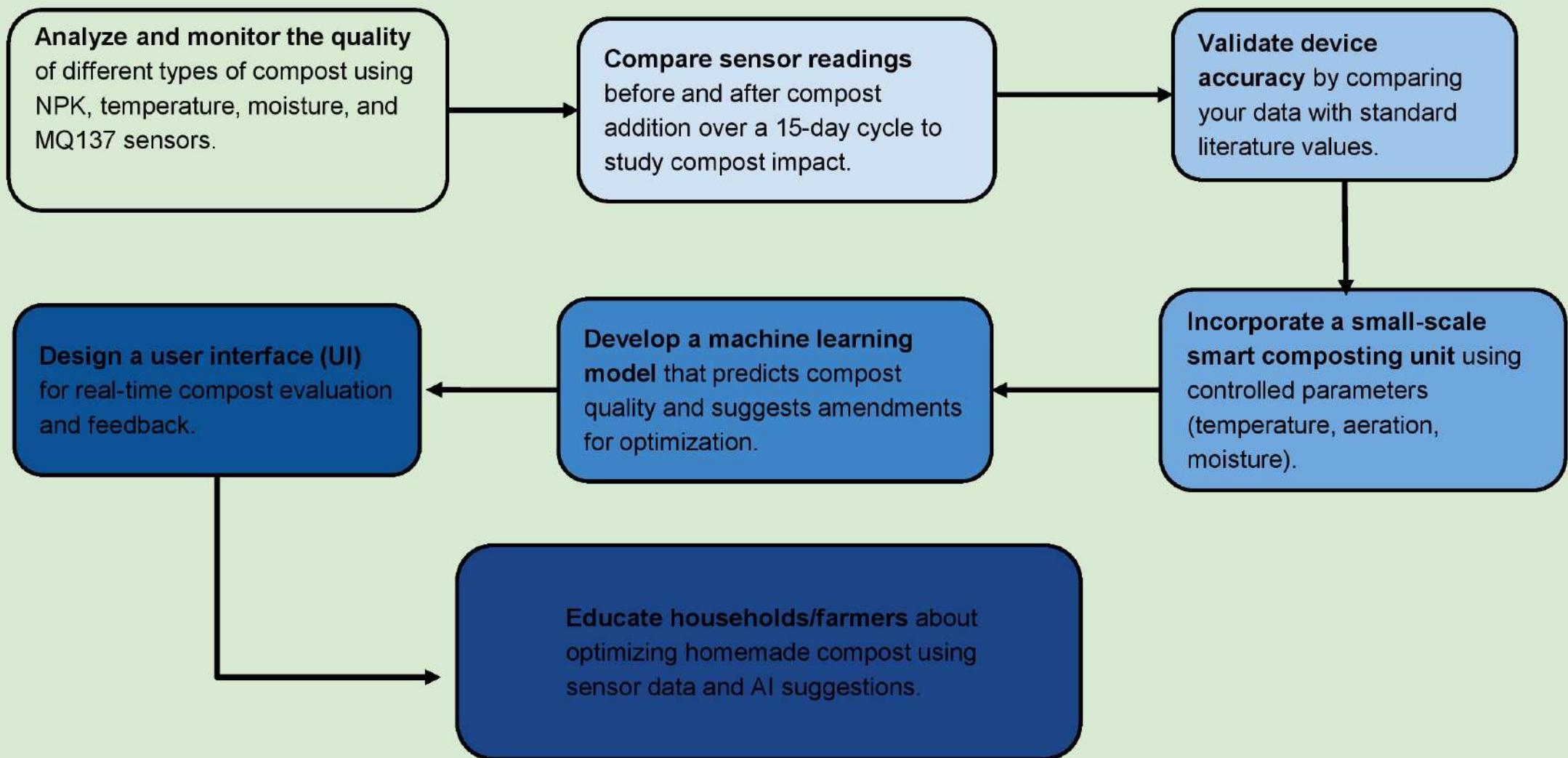
1. Use of Compost and Organic Practices

- 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.

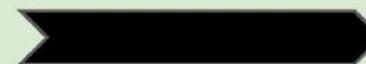
2. Cost Savings with Compost

- 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

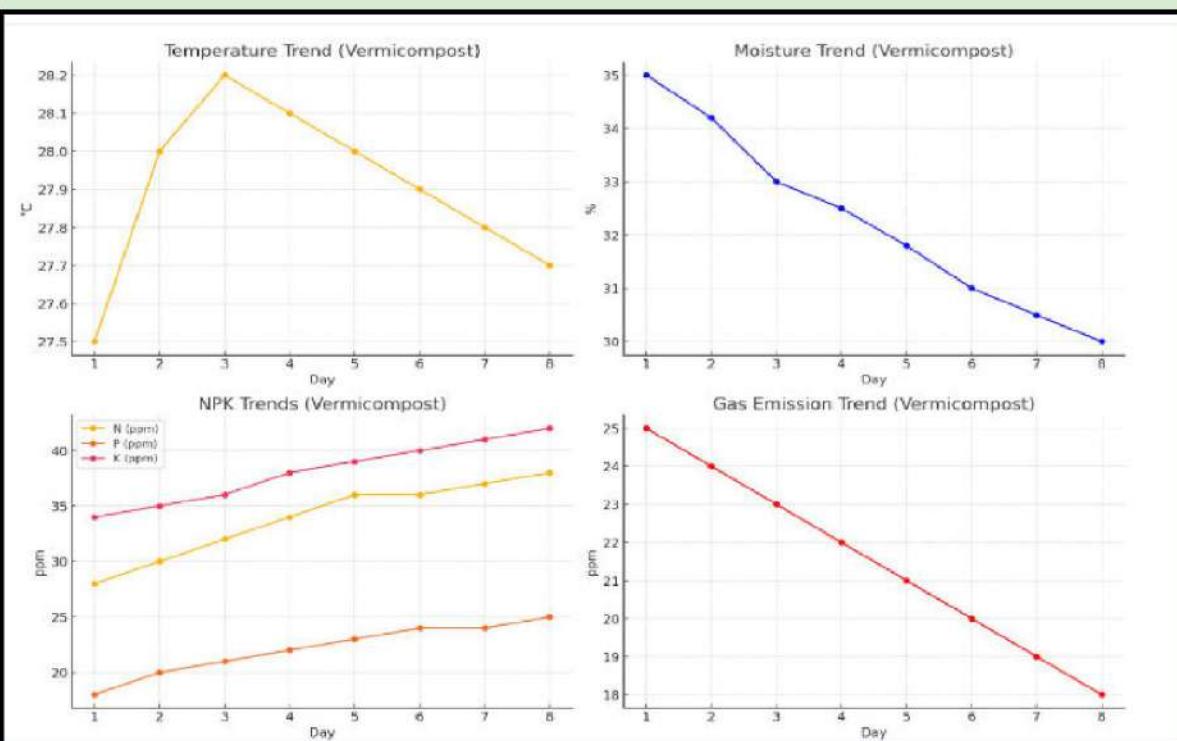


Compost preparation with five types of readily available compost.

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

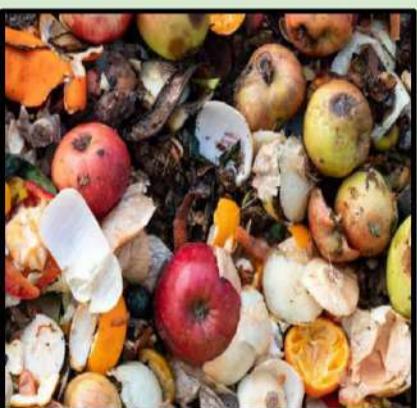


Graph shows the data collection by the sensor of standard compost follow the usual pattern when mixed with the soil.

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 $\pm 10\%$.**

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



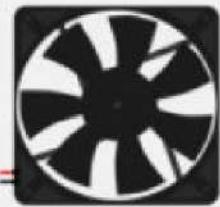
NPK Soil
Sensor



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



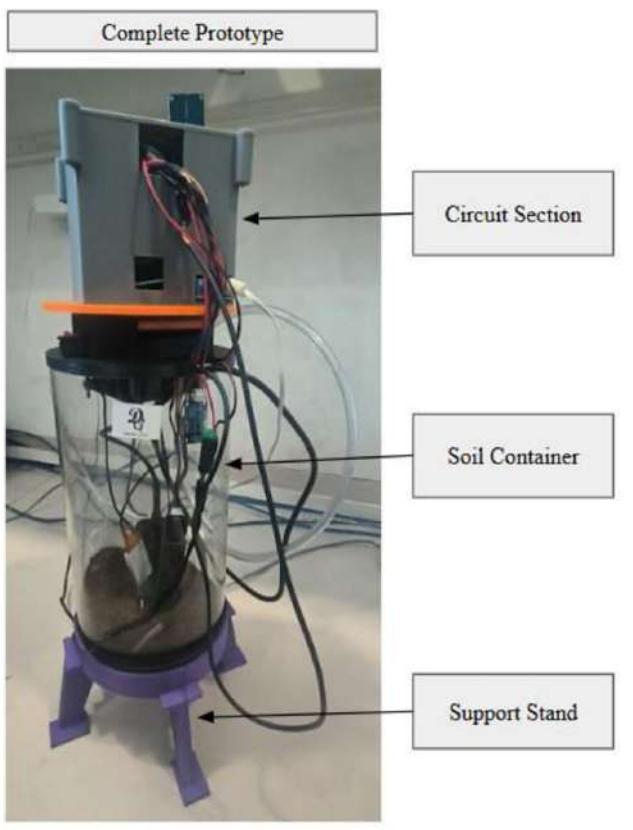
5v mini water pump



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.



A screenshot of a web-based application titled 'Compost Quality Score Evaluator'. The interface includes a sidebar for selecting compost types and a main form for entering spray readings. The sidebar shows the following options:

- Vermicompost
- Liquid Fermented Organic
- Manure
- Premium Spray (selected)
- Fermented Organic Soil
- Material
- Nano Silicon

The main form is titled 'Enter Premium Spray Readings' and contains fields for 'Dry' (set to 5), 'Temperature (°C)' (set to 30.00), 'Moisture (%)' (set to 40.00), and nutrient levels: Nitrogen (300.00 ppm), Phosphorus (150.00 ppm), Potassium (200.00 ppm), and Gas (300.00 ppm). An 'Evaluate' button is at the bottom.



Dashboard to Calculate and evaluate the compost requirement

Testing performed in the field with crop soil

Dashboard for compost quality monitoring

The screenshot shows a web browser window titled "Compost Quality Checker" at the URL "localhost:8501". The main content area is titled "Compost Quality Score Evaluator" and features a sub-section for "Enter Liquid Fermented Organic Manure Readings". On the left, there is a sidebar titled "Choose Compost Type" with a list of composting methods: Vermicompost, Liquid Fermented Organic Manure (which is selected), Premium Spray, Fermented Organic Soil Material, and Nano Silicon.

Compost Quality Score Evaluator

Enter Liquid Fermented Organic Manure Readings

Parameter	Value	Unit
Day	5	
Nitrogen (ppm)	300.00	ppm
Temperature (°C)	30.00	°C
Phosphorus (ppm)	150.00	ppm
Moisture (%)	40.00	%
Potassium (ppm)	200.00	ppm
Gas (ppm)	300.00	ppm

Evaluate

Dashboard for compost quality monitoring

Choose Compost Type

Select a composting method:

- Vermicompost
- Liquid Fermented Organic Manure
- Premium Spray
- Fermented Organic Soil Material
- Nano Silicon

Enter Vermicompost Readings

Day: 5 | Nitrogen (ppm): 1000.00 | Temperature (°C): 30 | Phosphorus (ppm): 150.00 | Moisture (%): 60.00 | Potassium (ppm): 200.00 | Gas (ppm): 300.00

Press Enter to submit form

Evaluate

Final Compost Quality Score

Calculated Score: 47.58/100

Compost quality score

Compost needs improvement. See suggestions below.

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

Suggestions to Improve

- Keep compost in a warmer spot or add fresh material.

Suggestion for the improvement

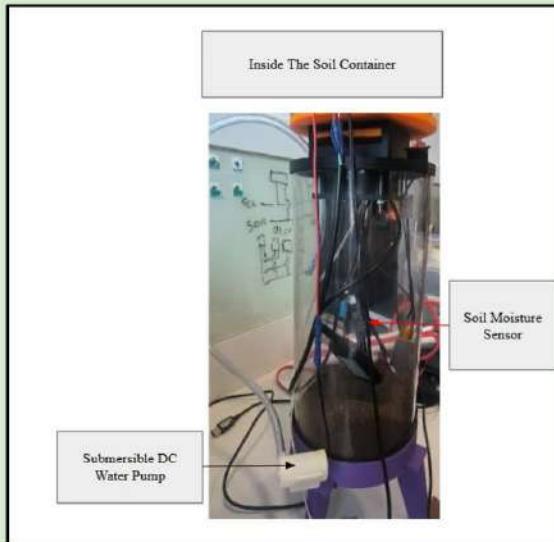
Closest Similar Record from Dataset

Compost Type	Day	Temp (°C)	Moisture (%)	N (ppm)	P (ppm)	K (ppm)	Gas (ppm)	Quality_Score
29 Vermicompost	26	48.3	61.4	1911	970	1456	97	87.68

Compost made using the device



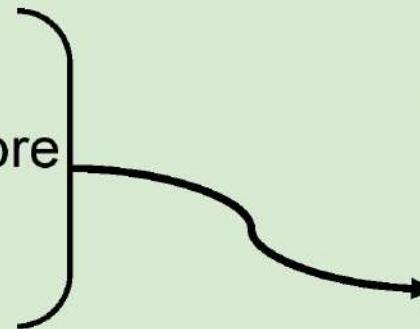
+



=



Garden waste as well as
fruit waste collated for more
than 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

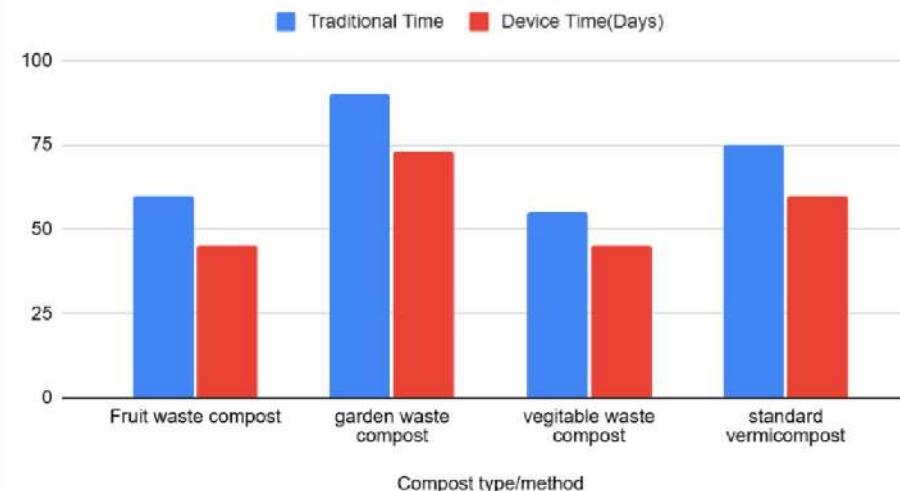
Results and Interpretation

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 (benchmark)	75	20	60	12

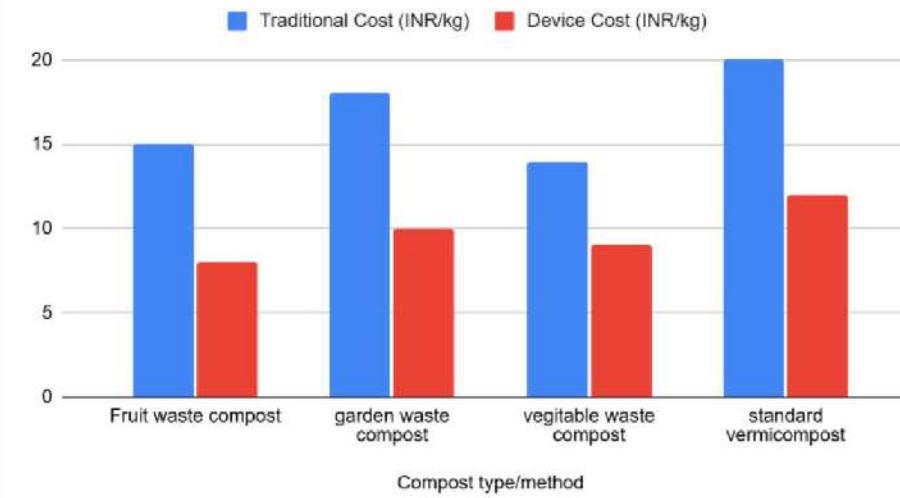
Interpretation :

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.

Traditional Time and Device Time(Days)



Traditional Cost (INR/kg) and Device Cost (INR/kg)



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

1. <https://www.abhijeetshirke.in/organic-waste-composting/>
2. <https://thewire.in/government/how-natural-farming-can-revive-indias-farmlands-and-ensure-sustainable-agriculture>
3. <https://agristudoc.com/problems-of-organic-farming-in-india/>