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Group Number: **3A**

Mentor – Dr. Niranjan Deshpande

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Links to Codebases

- Yashodip More: [GitHub link – To be added]
- Komal Kumavat: [GitHub link – To be added]
- S.M. Sakthivel: [GitHub link – To be added]
- Barun Saha: [GitHub link – To be added]
- Bibaswan Das: [GitHub link – To be added]

Selected Domain & Problem Statement:

Domain: Agriculture & Environment

Problem Statement:

"AgriWaste2Fuel - Smart Waste Converter with GHG & Carbon Credit Tracking"

To build an AI-powered platform that helps farmers **detect and classify farm waste**, guides them in **converting it into compost or biogas**, and **estimates the environmental benefits** in terms of greenhouse gas (GHG) emission savings and **carbon credits** turning farm waste into both **sustainable energy and income**.

Module 1: Farm Waste Detection & Classification

Goal:
Identify the type of farm waste using either **image-based AI detection** or **manual text input**, to determine whether it should be composted or processed for biogas.

Option 1: Image-Based Detection

1. **Farmer uploads a photo** of the waste using a smartphone or device.
2. **YOLOv8 model** detects and classifies waste into types like:
    - Cow dung
    - Paddy straw
    - Vegetable/kitchen scraps
    - Leaf litter, etc.
3. Model also estimates **waste quantity** based on image reference or asks the farmer to enter it.

Option 2: Manual Input

1. **Farmer types the name** of the waste (e.g., "cow dung", "banana peels", "sugarcane bagasse").
2. System **maps it to a known waste category** using a backend dictionary or NLP-based keyword matcher.
3. The input is validated for **spelling & matching category** (basic NLP or regex).

Output of This Module:

- Waste Type (image/manual)
- Quantity (auto-estimated or manually entered)
- Confidence score (if image-based)
- Waste classification label → passed to recommendation engine

Technologies Used:

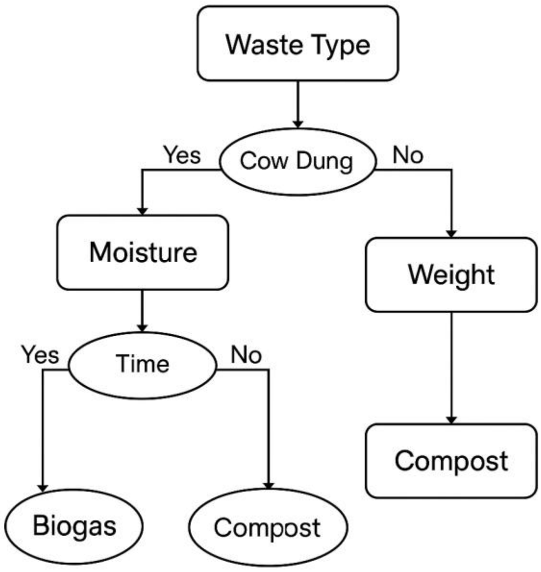
- **YOLOv8** (for object detection from images)
- **Python FastAPI** (backend logic)
- **NLP tools** (for validating manual input)
- **Frontend**: Form inputs + image upload (React/Flutter)

Module 2: Biogas or Compost Recommendation Engine

Goal:
Recommend the most suitable waste conversion process: **biogas generation** or **composting**, based on waste characteristics and quantity.

1. Decision tree logic evaluates:
   - High-moisture organic waste (e.g., cow dung + wet food waste) → Biogas
   - Dry waste (e.g., crop residues + leaf litter) → Compost
2. Output includes:
   - Suggested method (biogas or compost)
   - Steps to process it
   - Tools/materials required
   - Expected output (biogas in m^3 or compost in kg)

Example:



Module 3: GHG Savings Prediction

Goal:

Estimate how much CO_2e emissions are avoided by converting waste instead of burning it.

Procedure:

1. Use the classified waste type and approximate weight.
2. Refer to standard emission factors (e.g., from IPCC, FAO).
3. Apply a simple formula: GHG saved = weight × (EF_burning − EF_conversion)
4. Output the GHG savings in tons of CO_2e. E_F-Emission Factor

Module 4: Carbon Credit Estimation

Goal:

Convert GHG savings into carbon credits and show the farmer how much they can potentially earn.

Procedure:

1. 1 ton of CO_2e saved = 1 carbon credit.
2. Multiply credits by market rate.
3. Show credits earned and estimated income.
4. Optionally generate a digital certificate and connect with verified platforms for credit sale.

Detailed Tech Stack

1. Frontend (User Interface)

Component	**Tech**
Mobile/Web App	**Flutter** (cross-platform) OR **ReactJS**
Form Inputs	Image upload, text fields
Display	Result Dashboard (waste type, GHG saved, credits)

2. Backend (Logic + APIs)

Component	**Tech**
API Framework	**FastAPI** (Python, async-ready)
Image Handling	**OpenCV**, **Pillow**
Waste Matching (Manual)	**NLTK** or regex + dictionary
Rule-based Engine	Custom logic or **Decision Trees**
GHG Calculator	Python logic using IPCC data
Credit Estimator	Python calculator module

3. AI/ML Models

Purpose	**Tool/Framework**
Waste Detection	**YOLOv8** (Ultralytics, PyTorch)
Waste Type Classifier	Fine-tuned if needed
Model Hosting	**TorchServe**, Flask API, or FastAPI route

4. Database

Data Type	**DB Engine**
Waste & GHG Factors	**PostgreSQL / SQLite**
Carbon Credit Prices	API or local JSON DB
User Profiles, Input History	Firebase / Supabase / MongoDB

5. Deployment & Infra

Purpose	Tool
Cloud Hosting	**Render, Railway, Vercel, Heroku** (dev)
Production Backend	**AWS EC2 / Azure App Service**
Model Storage	GitHub, HuggingFace, S3
Certificates & Emails	SMTP + **PDFkit** / **ReportLab** (Python)

Weekly Activities & Progress Summary

Team Participation & Approach

- The team started by discussing the **real on-ground issues** faced by farmers in Maharashtra regarding waste handling.
- We explored multiple ideas, but concluded that the **main value is in fuel (biogas) and compost generation**, and designed our system around that.

Technical Work Done

- Created the **initial architecture and flowchart** for biogas/compost decision engine.
- Designed a **decision tree** model to determine best treatment method.
- Identified features for **yield prediction models** (waste type, quantity, temperature, moisture).
- Explored dataset sources: ICAR, MNRE, TERI, research papers.
- Created image-based decision tree diagrams and project visual flow.
- Discussed integrating GFG guidelines and carbon offset tracker as **additional layers**.

Obstacles Faced

- Finding real, open-source datasets on compost/biogas yield was challenging.
- Defining a clear balance between **core functionality** (waste to fuel) and **add-ons** (carbon tracking, government guidelines).
- Aligning the team around a **focused direction**, especially after adding multiple modules.

Guidance from Mentor

- Mentor helped us **re-center our focus** on the core problem of fuel/compost generation, not just data dashboards.
- Suggested to **prioritize farmer usability and real-world application** over just ML for the sake of ML.
- Guided us in structuring the problem clearly and recommended looking into **simple regression models** for early yield estimation.