Part 2: *Practical Implementation*

Task 2: *AI-Driven IoT Concept*

1. Required Sensors for Data Collection

The simulation needs data to model the farm environment accurately. The following sensors are essential:

- ★ **Environmental & Weather Data:**
  - **Air Temperature and Humidity:** For calculating evapotranspiration and assessing plant stress.
  - **Ambient Light/Solar Radiation:** Crucial for modelling photosynthetic activity.
  - **Rain Gauge/Precipitation:** To track water input.
  - **Wind Speed and Direction:** For modelling microclimate and chemical drift.
- ★ **Soil Data:**
  - **Soil Moisture Content:** To determine irrigation needs.
  - **Soil Temperature:** Affects seed germination and root growth.
  - **Soil pH Sensor:** Indicates nutrient availability.
  - **Electrical Conductivity (EC):** Measures soil salinity and nutrient concentration.
- ★ **Plant & Imaging Data:**
  - **NDVI (Normalised Difference Vegetation Index) Camera/Sensor (e.g., Drone/Satellite Imagery):** For assessing plant health, vigour, and biomass.
  - **Leaf Temperature Sensor:** Used to calculate water stress.

2. Proposed AI Model for Crop Yield Prediction

A robust **Recurrent Neural Network (RNN) with Long Short-Term Memory (LSTM) units** is highly suitable for predicting crop yield.

★ **Why LSTM?**

- **Time-Series Data:** Crop growth is a **time-dependent process**, influenced by a sequence of environmental factors over the entire season (e.g., initial planting conditions, followed by weeks of weather, and then fertilisation events). LSTMs excel at learning patterns and dependencies in sequential data.
- **Long-Term Dependencies:** LSTMs overcome the **vanishing gradient problem** that standard RNNs face. This allows the model to remember and utilise influential data points from the **beginning** of the growing season (like planting date, initial soil pH when making a prediction **later** in the season (close to harvest).

★ **Model Inputs**

The model would be trained on historical data, with each data point being a sequence of daily or weekly readings for a specific growing season:

- **Lagged Sensor Data:** Time series of air temperature, soil moisture, NDVI values, and precipitation.
- **Static Data:** Soil type, crop variety, initial pH, and planting density.
- **Management Data:** Dates and amounts of irrigation, fertilisation, and pesticide application.

★ **Model Output**

- **Predicted Crop Yield** (e.g., metric tons per hectare).

3. Data Flow Diagram Sketch

★ **Data Acquisition: IoT Sensors** (Soil Moisture, Temp, NDVI Camera) collect raw, real-time data from the field.

★ **Data Aggregation:** A **Local IoT Gateway** (e.g., a field-based microcontroller) collects data from various sensors, performs initial filtering/cleaning, and aggregates it.

★ **Data Transmission:** The data is securely transmitted (e.g., via LoRa, NB-IoT, or Wi-Fi) to a **Cloud Server or Central Database**.

★ **Data Pre-processing:** The server cleans the data (handles missing values, corrects sensor errors) and transforms it into the format required by the AI model. This is where features for the **LSTM model** are engineered.

★ **AI Processing:** The **LSTM Model** runs on the processed data to generate **Predictions** (e.g., estimated yield, likelihood of pest outbreak) and **Recommendations** (e.g., 'Soil Moisture below threshold - recommend 1 hour of irrigation').

★ **User Interface & Actuation:**

- The **Prediction/Recommendation** is displayed on a **User Interface (Dashboard)** for the farmer.
- In a real-world system (not just a simulation), the recommendation can also trigger an **Actuator** (e.g., turning on an irrigation pump) to close the control loop.