Soil Classification & Smart Agriculture System - Database Design Documentat

1. Entity-Relationship Diagram (ERD)

The ERD represents the main entities and their relationships in the system. It includes:

- Farmers: Tracks users of the system.
- Soil: Stores soil properties.
- Crops: Defines suitable crops for soil types.
- Weather: Records environmental data.
- Recommendations: AI-based crop & soil recommendations.
- Smart Irrigation: Automated irrigation tracking.

2. Logical Schema

The database consists of six main tables with defined relationships:

Table: Farmers

```
CREATE TABLE Farmers (
    farmer_id SERIAL PRIMARY KEY,
    name VARCHAR(100) NOT NULL,
    location VARCHAR(255),
    phone VARCHAR(15),
    email VARCHAR(100) UNIQUE
);
```

Table: Soil

```
CREATE TABLE Soil (
    soil_id SERIAL PRIMARY KEY,
    type VARCHAR(50) NOT NULL,
    moisture_level FLOAT,
    pH_level FLOAT,
    nitrogen FLOAT,
    phosphorus FLOAT,
    potassium FLOAT
);
```

Table: Crops

```
CREATE TABLE Crops (
    crop_id SERIAL PRIMARY KEY,
    name VARCHAR(100) NOT NULL,
    suitable_soil_id INT REFERENCES Soil(soil_id),
    water_requirement FLOAT,
    temperature_range VARCHAR(50)
);
```

Table: Weather Data

```
CREATE TABLE Weather (
    weather_id SERIAL PRIMARY KEY,
    location VARCHAR(255) NOT NULL,
    temperature FLOAT,
    humidity FLOAT,
    rainfall FLOAT,
    recorded_at TIMESTAMP DEFAULT CURRENT_TIMESTAMP
);
```

Table: Recommendations

```
CREATE TABLE Recommendations (
    recommendation_id SERIAL PRIMARY KEY,
    farmer_id INT REFERENCES Farmers(farmer_id),
    soil_id INT REFERENCES Soil(soil_id),
    crop_id INT REFERENCES Crops(crop_id),
    recommendation_text TEXT,
    created_at TIMESTAMP DEFAULT CURRENT_TIMESTAMP
);
```

Table: Smart Irrigation

```
CREATE TABLE SmartIrrigation (
    irrigation_id SERIAL PRIMARY KEY,
    farmer_id INT REFERENCES Farmers(farmer_id),
    soil_id INT REFERENCES Soil(soil_id),
    weather_id INT REFERENCES Weather(weather_id),
    irrigation_status VARCHAR(50),
    water_used FLOAT,
    timestamp TIMESTAMP DEFAULT CURRENT_TIMESTAMP
);
```

3. Optimization & Indexing

To improve query performance, indexing is applied:

- Index on soil type for faster lookup.
- Index on farmer email to prevent duplicate entries and quick retrieval.

```
CREATE INDEX idx_soil_type ON Soil(type);
CREATE INDEX idx_farmers_email ON Farmers(email);
```

4. Sample Queries

To retrieve useful insights from the database, sample queries include:

- Retrieve all farmers with their recommendations:

```
  SELECT Farmers.name, Recommendations.recommendation_text
  FROM Farmers
  JOIN Recommendations ON Farmers.farmer_id = Recommendations.farmer_id;
```

5. Data Integrity Constraints

To maintain consistency and prevent errors:

- Foreign key constraints are enforced.
- Preventing deletion of referenced data.

6. Future Considerations

Potential enhancements to improve the system:

- Adding more weather parameters for better predictions.
- Improving irrigation efficiency tracking using additional data sources.