1NF:-

Conditions for 1NF:

1. Ensure that each table has a primary key.
2. Each field contains only atomic (indivisible) values. No lists or sets are allowed in a single column.
3. No repeating groups or arrays.

Step 1: Apply 1NF (First Normal Form)

- Farmers table has contact detail.To normalize database to 1NF we need to ensure a single Value per Column,but contact detail can have multiple values as a single person can own multiple contact numbers. contact detail attributes can be taken out of farmers relation and new relation can be formed of contact detail

  Contact_Details (Contact_ID, Farmer_ID, Phone_Number, Email_Address ,Address)

  Primary Key: Contact_ID - Foreign Key: Farmer_ID (references Farmers)
- In table Farms , their is a attributed name Crop_Type and it should only have one type of crop per entry .if more crop_type for a single farm in the same field ,then this could be done by making it separate rows or a new table,but the point is we already have a crop table which has all this attributes so we can just put this crop type in crop table . And in case multiple crop are grown in a single farm then we can make a separate table to store farm_id with respective crop grown in them
- In table Farm_Activities we need to ensure that attribute Resource_Used should have single value ,but in case of multiple resources used in a single farm_activity ,we need to create separate rows or a new table

  Resoursces_used(Resource_ID ,resource_name) Modifying farm_activties:- Activity_ID, Farm_ID, Activity_Type, Date, Resource_ID, Time_Spent)

Here is the complete list of all tables in sustainable agriculture resource management system database, including their attributes after applying 1NF:

Table No	Table Name	Attributes
1	Farmers	Farmer_ID (PK), Farmer_Name, Age, Address
2	Crops	Crop_ID (PK), Crop_Type
3	Farm_Activities	Activity_ID (PK), Farm_ID (FK), Activity_Type
4	Resource_Usage	Resource_Usage_ID (PK), Activity_ID (FK), Resource_Type
5	Carbon_Tracking	Tracking_ID (PK), Farm_ID (FK), Total_Carbon_Emissions, Measurement_Period, Reduction_Strategies
6	Contact_Details	Contact_ID (PK), Farmer_ID (FK), Phone_Number, Email_Address, Address
7	Farm_Crops	Farm_Crop_ID (PK), Farm_ID (FK), Crop_ID (FK)
8	Weather_Data	Weather_ID (PK), Farm_ID (FK), Temperature, Rainfall, Humidity, Wind_Speed, Observation_Date
9	Sustainability_Measures	Measure_ID (PK), Farm_ID (FK), Sustainability_Type, Implementation_Date, Effectiveness

10	Researchers	Researcher_ID (PK), Researcher_Name, Institution
11	Research_Data	Research_ID (PK), Researcher_ID (FK), Farm_ID (FK), Carbon_Tracking_ID (FK), Research_Title, Findings, Date_Conducted
12	Policies	Policy_ID (PK), Policy_Name, Description, Effective_Date, Expiry_Date
13	Farm_Characteristics	Farm_Char_ID (PK), Farm_ID (FK), Farm_Size, Soil_Type, Irrigation_Method

2NF:-

Conditions for 2NF:

1. The table must be in 1NF.
2. Remove partial dependencies (non-key attributes should depend on the whole primary key, not just part of it).

Step 2: Apply 2NF (Second Normal Form)

1. Farmers Table

Attributes
Farmer_ID (PK), Farmer_Name, Age, Address

- Primary Key: `Farmer_ID`.

- Dependencies:
    - `Farmer_Name`, `Age`, and `Address` all depend fully on `Farmer_ID` (which is the primary key).
    - Since `Farmer_ID` is a single attribute (not a composite key), there is no possibility of partial dependency.

Conclusion: This table is in 2NF because all non-key attributes (`Farmer_Name`, `Age`, `Address`) depend on the entire primary key (`Farmer_ID`), and there is no partial dependency.

2. Crops Table

Attributes
Crop_ID (PK), Crop_Type

- Primary Key: `Crop_ID`.
- Dependencies:
    - `Crop_Type` fully depends on `Crop_ID`.
    - Again, since the primary key is a single attribute, there are no partial dependencies.

Conclusion: This table is in 2NF because all non-key attributes depend fully on the single primary key (`Crop_ID`).

3. Farm_Activities

Attributes
Activity_ID (PK), Farm_ID (FK), Activity_Type

- Primary Key: `Activity_ID`.
- Foreign Key: `Farm_ID`.
- Dependencies:
    - `Activity_Type` depends entirely on `Activity_ID`.
    - `Farm_ID` is a foreign key and does not cause any partial dependency.

Conclusion: This table is in 2NF because all non-key attributes (`Activity_Type`, `Farm_ID`) depend fully on the primary key (`Activity_ID`). There are no partial dependencies.

4. Resource_Usage Table

Attributes
Resource_Usage_ID (PK), Activity_ID (FK), Resource_Type

- Primary Key: `Resource_Usage_ID`.
- Foreign Key: `Activity_ID`.
- Dependencies:
    - `Resource_Type` depends fully on `Resource_Usage_ID`, the primary key.

Conclusion: This table is in 2NF because all non-key attributes (`Resource_Type`, `Activity_ID`) depend on the whole primary key, and there are no partial dependencies.

5. Carbon_Tracking Table

Attributes
Tracking_ID (PK), Farm_ID (FK), Total_Carbon_Emissions, Measurement_Period, Reduction_Strategies

- Primary Key: `Tracking_ID`.
- Foreign Key: `Farm_ID`.
- Dependencies:
    - `Total_Carbon_Emissions`, `Measurement_Period`, and `Reduction_Strategies` all depend fully on `Tracking_ID`.
    - There are no partial dependencies as `Tracking_ID` is a single primary key.

Conclusion: This table is in 2NF because there are no partial dependencies. All attributes depend fully on the primary key, `Tracking_ID`.

6. Contact_Details Table

Attributes
Contact_ID (PK), Farmer_ID (FK), Phone_Number, Email_Address, Address

- Primary Key: `Contact_ID`.
- Foreign Key: `Farmer_ID`.
- Dependencies:
    - `Phone_Number`, `Email_Address`, and `Address` depend fully on `Contact_ID`.
    - `Farmer_ID` is a foreign key and not part of the primary key. There are no partial dependencies here.

Conclusion: This table is in 2NF because all non-key attributes (`Phone_Number`, `Email_Address`, `Address`) depend fully on the primary key, `Contact_ID`.

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7. Farm_Crops Table

Attributes
Farm_Crop_ID (PK), Farm_ID (FK), Crop_ID (FK)

- Primary Key: `Farm_Crop_ID`.
- Foreign Keys: `Farm_ID`, `Crop_ID`.
- Dependencies:
    - `Farm_Crop_ID` is the only primary key, and no non-key attributes are dependent on only part of a composite key.
    - Both `Farm_ID` and `Crop_ID` are foreign keys that define the relationship between farms and crops.

Conclusion: This table is in 2NF because all non-key attributes (none in this case) depend fully on the primary key, `Farm_Crop_ID`. There are no partial dependencies.

8. Weather_Data Table

Attributes
Weather_ID (PK), Farm_ID (FK), Temperature, Rainfall, Humidity, Wind_Speed, Observation_Date

- Primary Key: `Weather_ID`.
- Foreign Key: `Farm_ID`.
- Dependencies:

    - Temperature, Rainfall, Humidity, Wind_Speed, and Observation_Date all depend fully on Weather_ID.

Conclusion: This table is in 2NF because all attributes depend fully on the primary key, Weather_ID. There are no partial dependencies.

9. Sustainability_Measures Table

Attributes
Measure_ID (PK), Farm_ID (FK), Sustainability_Type, Implementation_Date, Effectiveness

- Primary Key: Measure_ID.
- Foreign Key: Farm_ID.
- Dependencies:
    - Sustainability_Type, Implementation_Date, and Effectiveness all depend fully on Measure_ID.

Conclusion: This table is in 2NF because all non-key attributes (Sustainability_Type, Implementation_Date, Effectiveness) depend fully on the primary key, Measure_ID.

10. Researchers Table

Attributes
Researcher_ID (PK), Researcher_Name, Institution

- Primary Key: Researcher_ID.
- Dependencies:

    - Researcher_Name and Institution both depend fully on Researcher_ID.

Conclusion: This table is in 2NF because all attributes depend fully on the primary key, Researcher_ID.

11. Research_Data Table

Attributes
Research_ID (PK), Researcher_ID (FK), Farm_ID (FK), Carbon_Tracking_ID (FK), Research_Title, Findings, Date_Conducted

- Primary Key: Research_ID.
- Foreign Keys: Researcher_ID, Farm_ID, Carbon_Tracking_ID.
- Dependencies:
    - Research_Title, Findings, and Date_Conducted depend fully on Research_ID.

Conclusion: This table is in 2NF because all attributes depend fully on the primary key (Research_ID), and there are no partial dependencies.

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12. Policies Table

Attributes
Policy_ID (PK), Policy_Name, Description, Effective_Date, Expiry_Date

- Primary Key: Policy_ID.
- Dependencies:
    - Policy_Name, Description, Effective_Date, and Expiry_Date depend fully on Policy_ID.

Conclusion: This table is in 2NF because all non-key attributes depend on the entire primary key (`Policy_ID`).

13. Farm_Characteristics Table

Attributes
Farm_Char_ID (PK), Farm_ID (FK), Farm_Size, Soil_Type, Irrigation_Method

- Primary Key: `Farm_Char_ID`.
- Foreign Key: `Farm_ID`.
- Dependencies:
    - `Farm_Size`, `Soil_Type`, and `Irrigation_Method` depend fully on `Farm_Char_ID`.

Conclusion: This table is in 2NF because all non-key attributes depend fully on the primary key, `Farm_Char_ID`.

3NF:

Conditions for 3NF:

1. The table must be in 2NF.
2. Remove transitive dependencies (non-key attributes should depend only on the primary key, not on other non-key attributes).

1. Farmers Table

Attributes

Farmer_ID (PK), Farmer_Name, Age, Address

- Primary Key: Farmer_ID.
- There are no transitive dependencies since Farmer_Name, Age, and Address all depend directly on Farmer_ID.

2. Crops Table

Attributes
Crop_ID (PK), Crop_Type

- Primary Key: Crop_ID.
- There are no transitive dependencies since `Crop_Type` depends directly on Crop_ID.

3. Farm_Activities Table

Attributes

Activity_ID (PK), Farm_ID (FK), Activity_Type

- Primary Key: Activity_ID.
- There are no transitive dependencies as `Activity_Type` depends directly on `Activity_ID` and not on any non-key attribute.

4. Resource_Usage Table

Attributes
Resource_Usage_ID (PK), Activity_ID (FK), Resource_Type

-Primary Key: Resource_Usage_ID.
- No transitive dependencies exist since `Resource_Type` depends directly on `Resource_Usage_ID`.

5. Carbon_Tracking Table

Attributes
Tracking_ID (PK), Farm_ID (FK), Total_Carbon_Emissions, Measurement_Period, Reduction_Strategies

- Primary Key: Tracking_ID.

- There are no transitive dependencies here. All non-key attributes (Total_Carbon_Emissions, Measurement_Period, Reduction_Strategies) depend only on the primary key (Tracking_ID).

6. Contact_Details Table

Attributes
Contact_ID (PK), Farmer_ID (FK), Phone_Number, Email_Address, Address

-Primary Key: Contact_ID.
- There are no transitive dependencies. All non-key attributes depend directly on `Contact_ID.

7. Farm_Crops Table

Attributes
Farm_Crop_ID (PK), Farm_ID (FK), Crop_ID (FK)

- Primary Key: Farm_Crop_ID.
- No transitive dependencies exist as Farm_ID and Crop_ID are foreign keys, and there are no other non-key attributes to introduce a transitive dependency.

8. Weather_Data Table

Attributes
Weather_ID (PK), Farm_ID (FK), Temperature, Rainfall, Humidity, Wind_Speed, Observation_Date

- Primary Key: Weather_ID.
- There are no transitive dependencies since Temperature, Rainfall, Humidity, Wind_Speed, and Observation_Date all depend directly on Weather_ID.

9. Sustainability_Measures Table

Attributes
Measure_ID (PK), Farm_ID (FK), Sustainability_Type, Implementation_Date, Effectiveness

Primary Key: Measure_ID.

- There are no transitive dependencies. Sustainability_Type, Implementation_Date, and Effectiveness depend directly on Measure_ID.

10. Researchers Table

Attributes
Researcher_ID (PK), Researcher_Name, Institution

Primary Key: Researcher_ID.
- There are no transitive dependencies. Both Researcher_Name and Institution depend on the primary key.

11. Research_Data Table

Attributes
Research_ID (PK), Researcher_ID (FK), Farm_ID (FK), Carbon_Tracking_ID (FK), Research_Title, Findings, Date_Conducted

- Primary Key: Research_ID.
- There are no transitive dependencies as all attributes depend directly on Research_ID.

12. Policies Table

Attributes
Policy_ID (PK), Policy_Name, Description, Effective_Date, Expiry_Date

- Primary Key: Policy_ID.
- No transitive dependencies exist, as all attributes depend directly on Policy_ID.

13. Farm_Characteristics Table

Attributes
Farm_Char_ID (PK), Farm_ID (FK), Farm_Size, Soil_Type, Irrigation_Method

Primary Key: Farm_Char_ID.
- No transitive dependencies exist as all attributes (Farm_Size, Soil_Type, Irrigation_Method) depend directly on Farm_Char_ID.

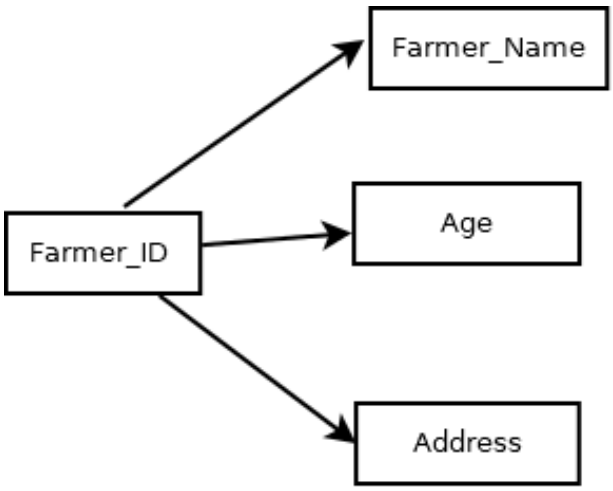
Final list of tables after normalization

Table No	Table Name	Attributes

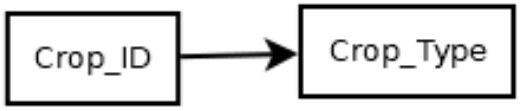
1	Farmers	Farmer_ID (PK), Farmer_Name, Age, Address
2	Crops	Crop_ID (PK), Crop_Type
3	Farm_Activities	Activity_ID (PK), Farm_ID (FK), Activity_Type
4	Resource_Usage	Resource_Usage_ID (PK), Activity_ID (FK), Resource_Type
5	Carbon_Tracking	Tracking_ID (PK), Farm_ID (FK), Total_Carbon_Emissions, Measurement_Period, Reduction_Strategies
6	Contact_Details	Contact_ID (PK), Farmer_ID (FK), Phone_Number, Email_Address, Address
7	Farm_Crops	Farm_Crop_ID (PK), Farm_ID (FK), Crop_ID (FK)
8	Weather_Data	Weather_ID (PK), Farm_ID (FK), Temperature, Rainfall, Humidity, Wind_Speed, Observation_Date
9	Sustainability_Measures	Measure_ID (PK), Farm_ID (FK), Sustainability_Type, Implementation_Date, Effectiveness
10	Researchers	Researcher_ID (PK), Researcher_Name, Institution
11	Research_Data	Research_ID (PK), Researcher_ID (FK), Farm_ID (FK), Carbon_Tracking_ID (FK), Research_Title, Findings, Date_Conducted

12	Policies	Policy_ID (PK), Policy_Name, Description, Effective_Date, Expiry_Date
13	Farm_Characteristics	Farm_Char_ID (PK), Farm_ID (FK), Farm_Size, Soil_Type, Irrigation_Method

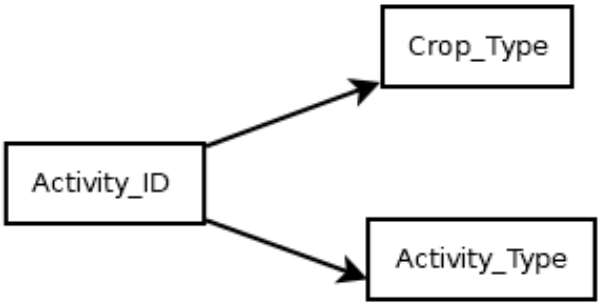
1. Farmers Table



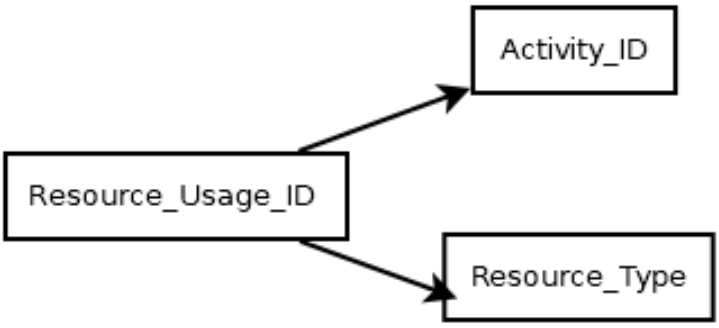
2. Crops Table



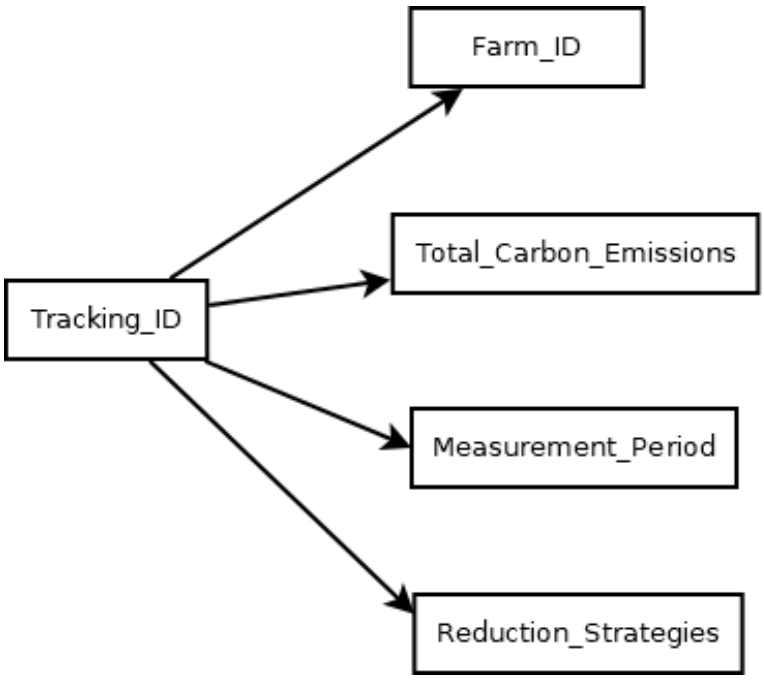
3. Farm_Activities



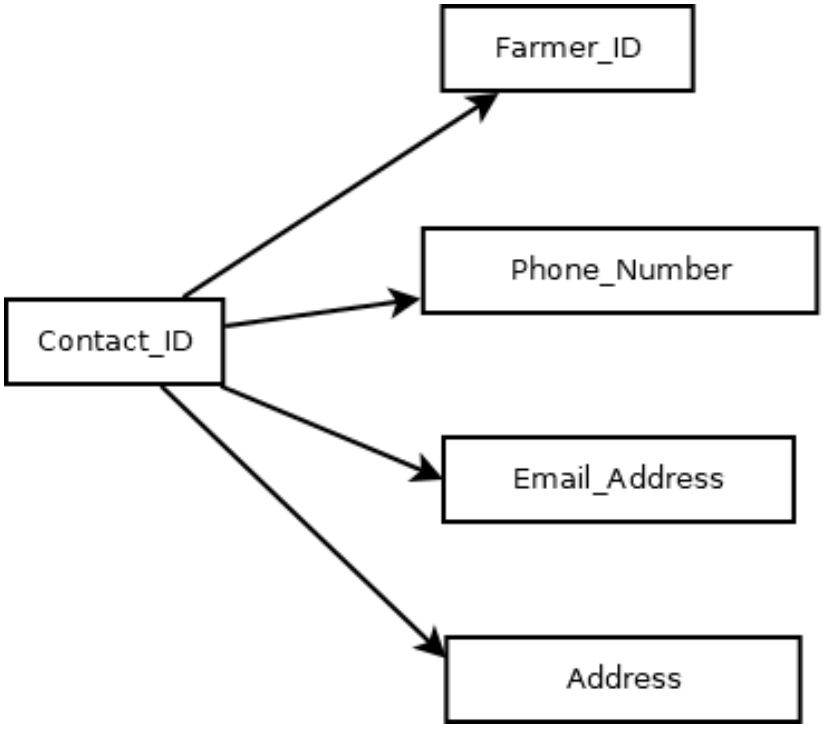
4.Resource_Usage



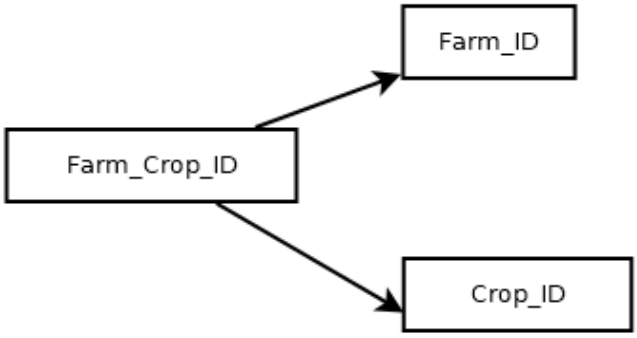
5.Carbon_Tracking



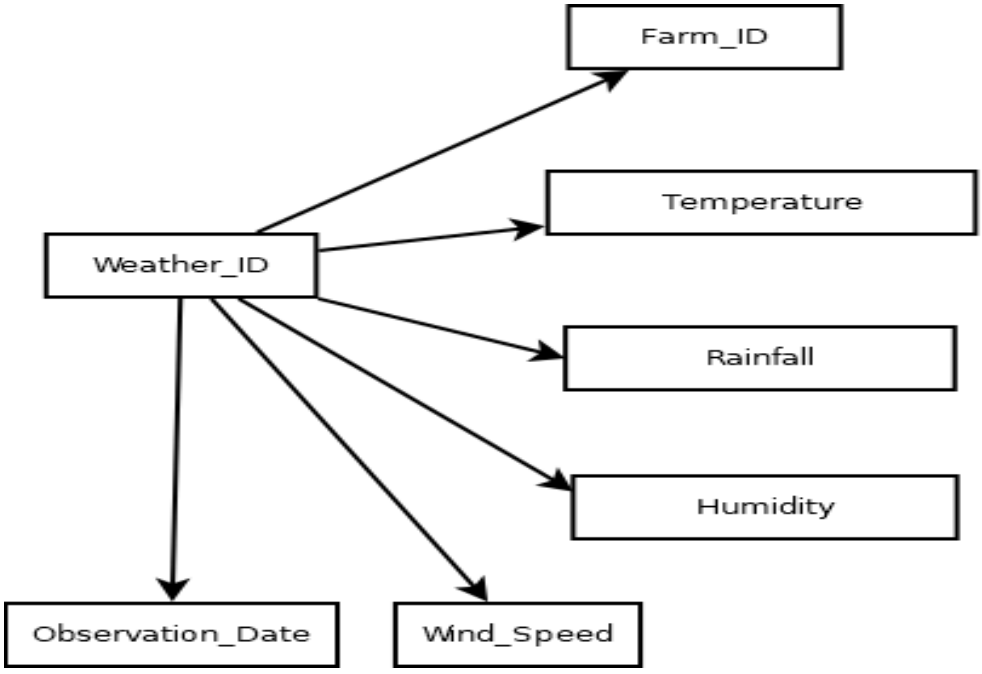
6.Contact_Details



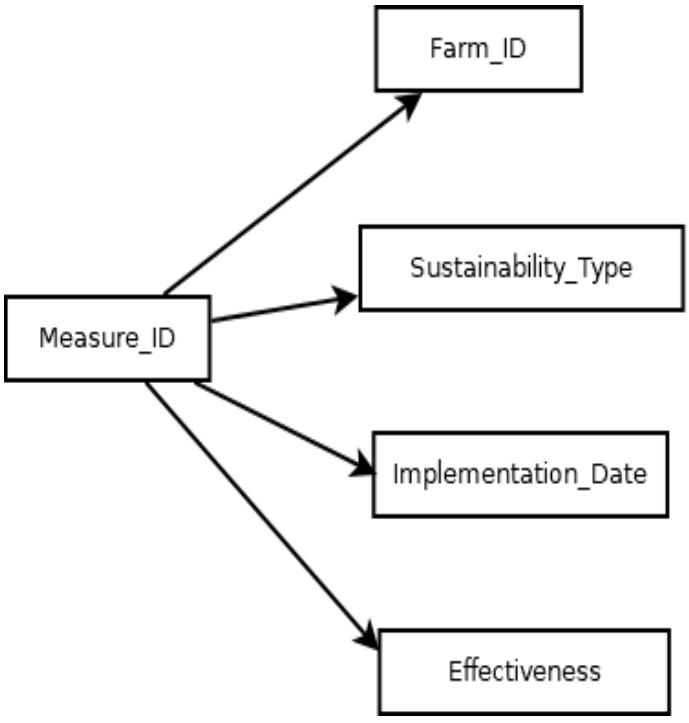
7.Farm_Crops



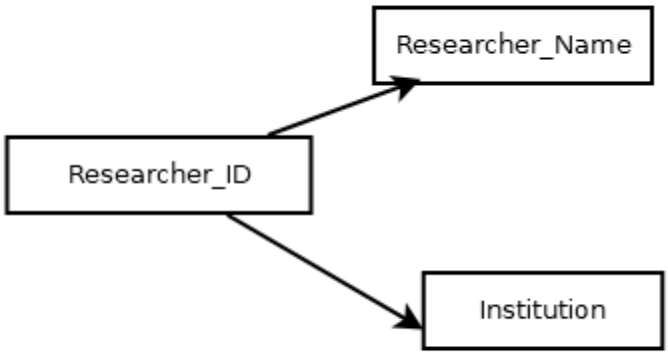
8.Weather_Data



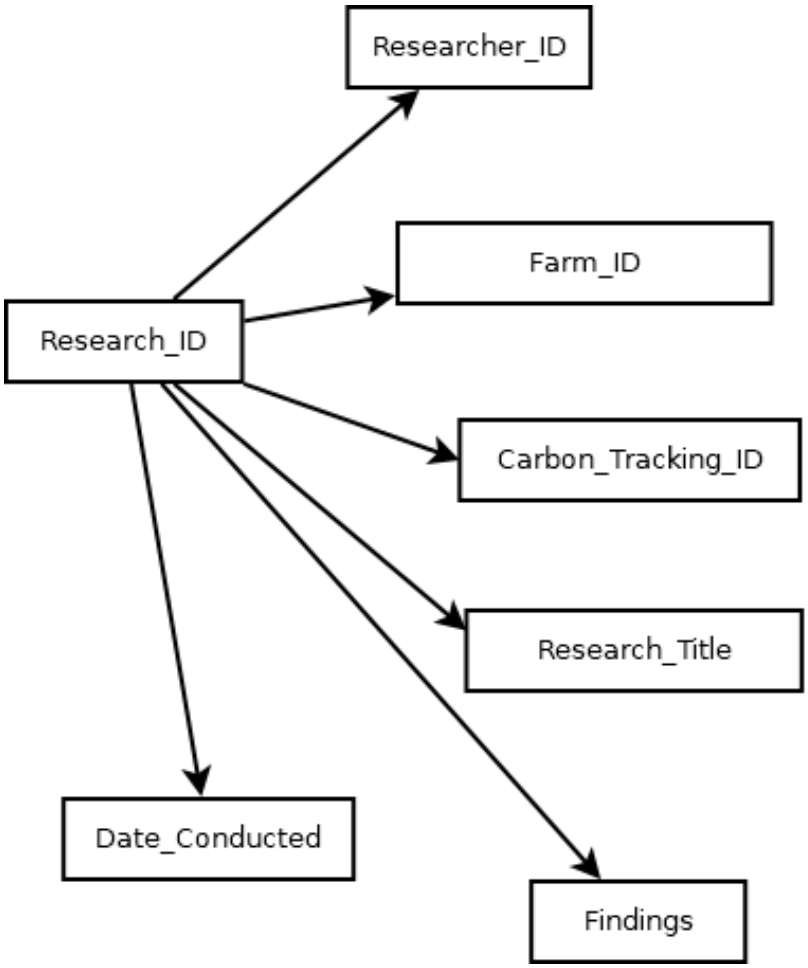
9.Sustainability_Measures



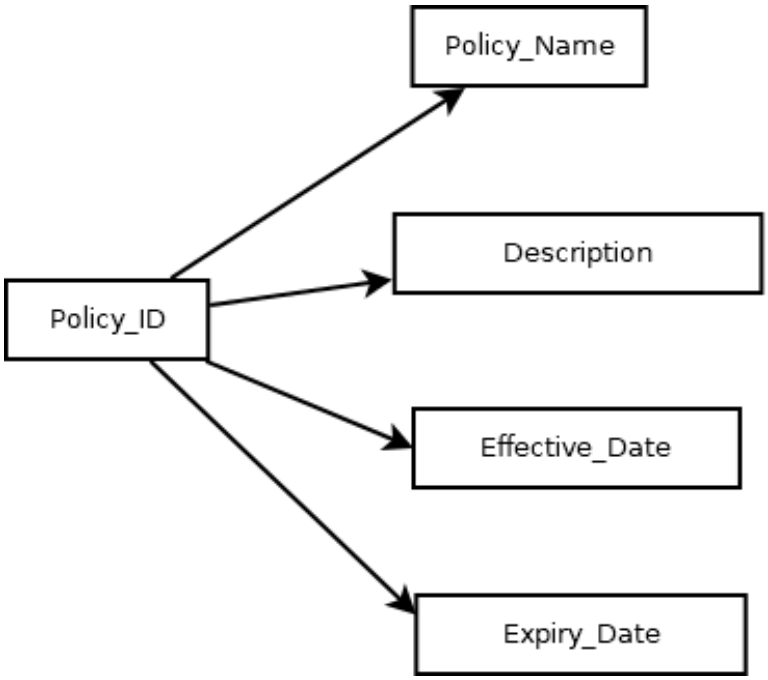
10.Researchers



11.Research_Data



12.Policies



13. Farm_Characteristics