Agriculture Management System

Database Narrative:

The Agriculture Management System (AMS) database is designed to assist farmers and agricultural professionals in efficiently managing various aspects of crop production and farm operations. This database serves as a central repository of data related to crop production, field management, labour, pest control, irrigation, weather, crop diseases, storage, and market pricing. The database allows users to record, access, and analyse essential agricultural data to make informed decisions and optimize farming processes. It is primarily created to support modern agricultural practices, promoting sustainable and efficient farming methods. It caters to the needs of individual farmers, agricultural cooperatives, and agribusinesses.

Users:

Farmers: Farmers can utilize the database to monitor and optimize crop production, make informed decisions about planting and harvesting, and assess the economic viability of their agricultural activities.

Agronomists and Researchers: Agronomists and researchers rely on the database to analyse soil characteristics, weather trends, and disease incidence to develop more effective farming practices and conduct research.

Government Agencies: Government agencies use the AMS to gather data on crop production, pest control, and labour requirements to make informed policy decisions, agricultural research, and monitoring compliance with agricultural regulations.

Marketers and Traders: Those involved in marketing and trading agricultural products can access market price and supply data, helping them to make strategic decisions regarding purchases and sales.

Information Needs:

Crop Production: The database provides detailed records of crop production, including the type of crop, the area cultivated, the yield, and the average price per ton. This information is essential for farmers and government agencies to monitor and assess agricultural productivity and profitability.

Field Information: Users can manage fields by recording field names, locations, areas, type of crops and soil characteristics. Field information helps in planning crop rotations, irrigation, and labour allocation.

Crop Planting: Data on crop planting includes crop IDs, field IDs, planting dates, planting quantities, and planting methods. This information assists in scheduling planting operations and optimizing planting techniques.

Soil Characteristics: Soil data includes soil types, pH levels, nutrient content, moisture levels, and field associations. These details are crucial for assessing soil quality and recommending suitable crops and fertilization methods.

Pesticide Usage: The database tracks pesticide names, application dates, and quantities applied. This information is valuable for farmers and researchers in developing integrated pest management strategies assisting in managing pest control while minimizing environmental impact.

Irrigation Methods: The AMS records information of irrigation type, water sources, and field associations. It helps farmers to choose the most efficient and sustainable techniques for their specific crops.

Weather Data: Weather information includes dates, temperature, humidity, and precipitation data These details are crucial for predicting crop growth and disease outbreaks and are vital for planning planting and harvesting.

Crop Diseases: The database stores data on crop diseases, including disease names, symptoms, treatment methods, and severity. It is beneficial for farmers and researchers in implementing preventive measures and minimizing crop losses.

Crop Rotation History: The history of crop rotation, including the field ID, previous and current crops, and soil fertility status, is critical for ensuring soil health and maintaining sustainable farming practices.

Market Prices: Market pricing information includes crop IDs, market names, dates, and prices. This data is essential for marketers, traders, and farmers to make informed decisions about when and where to sell their crops.

Farm Labor: The database contains data on labor requirements, such as labor hours, types of labor (permanent or seasonal), and labor costs. This information assists farmers in managing their workforce efficiently.

Crop Storage: Crop storage data includes the type of crop, storage facility, duration, quantity stored, and storage conditions. This is vital for post-harvest management and quality control.

Crop Disease Association: This records the association between specific crops and diseases, including infection dates. It aids in understanding disease patterns and managing disease outbreaks.

Data Dictionary:

Table Name	Attributes	Contents	Data Type	Format	Range	Required	PK/FK	Reference
Crop_Production	Crop_ID	Crop Identifier	INT(2)	99	0-99	Y	PK	
	Crop_Name	Name of the Crop	VARCHAR(20)	Xxxxxxx		Y		
	Crop_Variety	Variety of Crop	VARCHAR(15)	Xxxxxxx		Y		
	Yield	Crop Yield	DECIMAL(4,2)	9999.99	0.01-9999.99	Y		
	Date_Planted	Date of Planting	DATE	Yyyy-mm-dd		Y		
	Date_Harvested	Date of Harvest	DATE	Yyyy-mm-dd		Y		
Field_Information	Field_ID	Field Identifier	INT(3)	999	0-999	Y	PK	
	Field_Name	Name of the Field	VARCHAR(25)	Xxxxxxx		Y		
	Location	Field Location	VARCHAR(20)	Xxxxxxx		Y		
	Area	Field Area	DECIMAL(4,2)	9999.99	0.01-9999.99	Y		
	Crop_ID	Crop Identifier	INT(2)	99	0--99	Y	FK	Crop_Production
	Soil_ID	Soil Identifier	INT(2)	99	0-99	Y	FK	Soil_Characteristics

Crop_Planting	Planting_ID	Planting Identifier	INT(2)	99	0-99	Y	PK	
	Crop_ID	Crop Identifier	INT(2)	99	0--99	Y	FK	Crop_Production
	Field_ID	Field Identifier	INT(3)	999	0-999	Y	FK	Field_Information
	Planting_Date	Date of Planting	DATE	Yyyy-mm-dd		Y		
	Quantity	Quantity Planted	INT(4)	9999	0-9999	Y		
	Planting_Method	Method of Planting	VARCHAR(20)	Xxxxxxx		Y		
Soil_Characteristics	Soil_ID	Soil Identifier	INT(2)	99	0-99	Y	PK	
	Soil_Type	Type of Soil	VARCHAR(20)	Xxxxxxx		Y		
	pH_Level	pH level of soil	DECIMAL(2,1)	99.9	0.01-99.9	Y		
	Nutrient_Content	Soil Nutrient Content	CHAR(10)	Xxxxxxx	“High”, “Low”, ” Medium”	Y		
	Moisture_Level	Soil Moisture Level	CHAR(9)	Xxxxxxx	“High”, “Low”, ” Medium”	Y		
	Field_ID	Field Identifier	INT(3)	999	0-999	Y	FK	Field_Information
Crop_Rotation_History	Rotation_ID	Rotation Identifier	INT(2)	99	0-99	Y	PK	

	Field_ID	Field Identifier	INT(3)	999	0-999	Y	FK	Field_Information
	Previous_Crop	Previous Crop	VARCHAR(20)	Xxxxxxx		Y		
	Current_Crop	Current Crop	VARCHAR(20)	Xxxxxxx		Y		
	Rotation_Date	Date of Rotation	DATE	Yyyy-mm-dd		Y		
Farm_Labour	Labour_ID	Labour Identifier	INT(3)	999	0-999	Y	PK	
	Labour_Name	Name of Labour	VARCHAR(30)	Xxxxxxx		Y		
	Labour_Role	Role of Labour	VARCHAR(25)	Xxxxxxx		Y		
	Date_Hired	Date of Hiring	DATE	Yyyy-mm-dd		Y		
	Date_Terminated	Date of Termination	DATE	Yyyy-mm-dd		Y		
	Field_ID	Field Identifier	INT(3)	999	0-999	Y	FK	Field_Information
Pesticide_Usage	Pesticide_ID	Pesticide Identifier	INT(11)	99999999999	0-99999999999	Y	PK	
	Pesticide_Name	Name of the pesticide	VARCHAR(30)	Xxxxxxx		Y		
	Applied_Date	Applied Date	DATE	Yyyy-mm-dd		Y		

	Total_Quantity_Applied	Total Quantity Applied	DECIMAL(2,1)	99.9	0.01-99.9	Y		
	Crop_ID	Crop Identifier	INT(2)	99	0-99	Y	FK	Crop_Production
Irrigation_Methods	Irrigation_ID	Irrigation Identifier	INT(2)	99	0-99	Y	PK	
	Irrigation_Type	Type of Irrigation	VARCHAR(25)	Xxxxxxx		Y		
	Water_Source	Source of Water	VARCHAR(15)	Xxxxxxx		Y		
	Field_ID	Field Identifier	INT(3)	999	0-999	Y	FK	Field_Information
Weather_Data	Weather_ID	Weather Identifier	INT(3)	999	0-999	Y	PK	
	Date	Date of Weather Data	DATE	Yyyy-mm-dd		Y		
	Temperature	Temperature Data	DECIMAL(3,2)	999.99	0.01-999.99	Y		
	Humidity	Humidity Data	DECIMAL(2,2)	99.99	0.01-99.99	Y		
	Precipitation	Precipitation Data	DECIMAL(2,2)	99.99	0.01-99.99	Y		

	Field_ID	Field Identifier	INT(3)	999	0-999	Y	FK	Field_Information
Crop_Storage	Storage_ID	Storage Identifier	INT(2)	99	0-99	Y	PK	
	Storage_Location	Storage Location	VARCHAR(30)	Xxxxxxx		Y		
	Capacity	Storage Capacity	DECIMAL(3,1)	999.9	0.01-999.9	Y		
	Storage_Conditions	Storage Conditions	VARCHAR(30)	Xxxxxxx		Y		
	Crop_ID	Crop Identifier	INT(3)	999	0-999	Y	FK	Crop_Production
Market_Prices	Price_ID	Price Identifier	INT(2)	99	0-99	Y	PK	
	Crop_ID	Crop Identifier	INT(2)	99	0-99	Y	FK	Crop_Production
	Market_Name	Name of the Market	VARCHAR(30)	Xxxxxxx		Y		
	Date	Date of Price	DATE	Yyyy-mm-dd		Y		
	Price	Crop Price	DECIMAL(6,2)	999999.99	0.01-999999.99	Y		
Crop_Diseases	Disease_ID	Disease Identifier	INT(2)	99	0-99	Y	PK	
	Disease_Name	Name of the Disease	VARCHAR(40)	Xxxxxxx		Y		

	Symptoms	Symptoms of Disease	VARCHAR(50)	Xxxxxxx		Y		
	Treatment_Method	Treatment method	VARCHAR(40)	Xxxxxxx		Y		
	Severity	Severity of Disease	CHAR(10)	Xxxxxxx	“High”, “Low”, ” Moderate”, ” Severe”	Y		
Crop_Disease_Association	Crop_ID	Crop Identifier	INT(2)	99	0-99	Y	PK/FK	Crop_Production
	Disease_ID	Disease Identifier	INT(2)	99	0-99	Y	PK/FK	Crop_Diseases
	Infection_Date	Infection Date	DATE	Yyyy-mm-dd		Y		

Entity-Relationship Model:

ENTITY	RELATIONSHIP	CONNECTIVITY	**ENTITY**
Crop_Production	is planted in	(1:M)	Crop_Planting
Crop_Production	Tracks prices in	(1:M)	Market_Prices

Crop_Production	is stored in	(1:M)	Crop_Storage
Crop_Production	uses	(M:N)	Pesticide_Usage
Field_Information	records	(1:M)	Crop_Rotation_History
Field_Information	cultivates	(1:M)	Crop_Planting
Field_Information	manages	(1:1)	Crop_Production
Field_Information	employs	(1:M)	Farm_Labour
Field_Information	Has soil	(1:1)	Soil_Characteristics
Field_Information	monitors	(1:M)	Weather_Data
Field_Information	utilizes	(1:M)	Irrigation_Methods
Crop_Production	Is affected by	(M:N)	Crop_Diseases

Business Rules:

1. Crop_Production / Crop_Planting (1:M)

- Each crop production instance can have multiple planting records.
- Each planting record is associated with a single crop production.

2. Crop_Production /Market_Prices (1:M)

- A crop production instance can have multiple market price records.

- Each market price record is associated with a single crop production.

3. Crop_Production/Crop_Storage (1:M)

- A crop production instance can have multiple storage records
- Each crop storage record is associated with a single crop production.

4. Crop_Production / Pesticide_Usage (M:N)

- Each crop production instance can be associated with multiple pesticide usage records.
- Each pesticide usage record (Pesticide_Usage) can be associated with multiple crop productions.

5. Field_Information / Crop_Rotation_History (1:M)

- Each Field_Information instance can have multiple crop rotation history records.
- Each crop rotation history record is associated with a single Field_Information.

6. Field_Information / Crop_Planting (1:M)

- Each Field_Information instance can have multiple crop planting records
- Each crop planting record is associated with a single Field_Information.

7. Field_Information /Crop_Production (1:1)

- Each Field_Information can have one instance of crop production record.
- Each crop production record is associated with a single Field_Information.

8. Field_Information / Farm_Labour (1:M)

- Each Field_Information instance can have multiple farm labor records.
- Each farm labor record is associated with a single Field_Information.

9. Field_Information /Soil_Characteristics (1:1)

- Each Field_Information instance can have one instance of soil characteristics record.
- Each soil characteristics record can be associated with one Field_Information instance.

10. Field_Information /Weather_Data (1:M)

- Each Field_Information instance can have multiple weather data records.
- Each weather data record is associated with a single Field_Information instance.

11. Field_Information / Irrigation_Methods (1:M)

- Each Field_Information instance can have multiple irrigation method records .

- Each irrigation method record is associated with a single field (Field_Information).

12. Crop_Production - Crop_Diseases (M:N)

- Each crop production instance can be associated with multiple crop disease records.
- Each crop disease record can be associated with multiple crop production records.

Intended Use:

First and foremost, this database serves as a comprehensive record-keeping system for crop production. Farmers can utilize it to track essential information such as crop varieties, planting and harvesting dates, yield, and soil characteristics. This data can be invaluable for optimizing farming practices, enhancing crop yields, and improving resource management. Farmers can make informed decisions about planting times, soil conditions, and crop rotation strategies, ultimately leading to more efficient and sustainable agricultural operations.

Researchers and agronomists can also leverage this database to analyze and gain insights into crop production patterns. They can use historical data on crop rotations, weather conditions, and pesticide usage to study the impact of various factors on crop health

and productivity. By identifying trends and correlations, they can develop strategies for disease prevention, pest management, and soil improvement. Additionally, the data can aid in the development of new agricultural technologies and sustainable farming practices.

Government agencies and policymakers can benefit from this database by using it to monitor and regulate agricultural practices. It can help track pesticide usage, water resource management, and compliance with environmental regulations. This information can inform policy decisions, support sustainable farming initiatives, and ensure the safety of agricultural products for consumers.

Furthermore, the database can be a valuable resource for crop insurance companies, enabling them to assess risk and determine appropriate coverage based on historical crop production and weather data. It also provides valuable market insights by tracking market prices and crop storage conditions, helping farmers make pricing and storage decisions.

In summary, this database is a versatile tool with a wide range of potential uses in the agricultural sector. It empowers farmers to optimize their practices, researchers to deepen their understanding of crop dynamics, and policymakers to make informed decisions. Its broad applicability makes it a valuable asset in promoting sustainable and efficient agriculture.

Agriculture Management System Entity Relationship Diagram

Relational Schema

Crop_Production (**Crop_ID**, Crop_Name, Crop_Variety, Yield, Date_Planted, Date_Harvested)

Field_Information (**Field_ID**, Field_Name, Location, Area, Crop_ID, Soil_ID)

Crop_Planting (**Planting_ID**, Crop_ID, Field_ID, Planting_Date, Quantity, Planting_Method)

Soil_Characteristics (**Soil_ID**, Soil_Type, pH_Level, Nutrient_Content, Moisture_Level, Field_ID)

Crop_Rotation_History (**Rotation_ID**, Field_ID, Previous_Crop, Current_Crop, Rotation_Date)

Farm_Labour (**Labour_ID**, Labour_Name, Labour_Role, Date_Hired, Date_Terminated, Field_ID)

Pesticide_Usage (**Pesticide_ID**, Pesticide_Name, Applied_Date, Total_Quantity_Applied, Crop_ID)

Irrigation_Methods (**Irrigation_ID**, Irrigation_Type, Water_Source, Field_ID)

Weather_Data (**Weather_ID**, Date, Temperature, Humidity, Precipitation, Field_ID)

Crop_Storage (**Storage_ID**, Storage_Location, Capacity, Storage_Conditions, Crop_ID)

Market_Prices (**Price_ID**, Crop_ID, Market_Name, Date, Price)

Crop_Diseases (**Disease_ID**, Disease_Name, Symptoms, Treatment_Method, Severity)

Crop_Disease_Association (**Crop_ID**, **Disease_ID**, Infection_Date)

Pre Normalization

The table below is to store information related to crop cultivation, diseases affecting crops, and the soil conditions of the fields. It allows for the tracking of crop details, disease information, and field characteristics, which can be helpful for managing agricultural activities, monitoring crop health, and optimizing yield. Dependent upon Field_ID, Disease_ID as composite primary keys, there are plenty of missing values and repeating groups in the table. Hence to remove redundancy and represent the data in efficient form we should perform Normalization Process.

Field_ID	Disease_ID	Crop_ID	Crop_Name	Crop_Variety	Yield	Date_Planted	Date_Harvested	Disease_Name	Symptoms	Treatment_Method	Severity	Field_Name	Location	Area	Soil_ID	Soil_Type	pH_Level	Nutrient_Content	Moisture_Level
1	1	1	Rice	Basmati	120	2023-05-05	2023-08-15	Blast	White lesions on leaves	pyroquilon	Low	Indiana farms	640 Eskenazi Ave, IN	25	1	Clay	6.0	Low	Normal
	2							Sheath Blight	Spots on leaf sheath	azoxystrobin	Medium	Indiana farms							
2	3	2	Corn	Dent Corn	80	2023-04-10	2023-09-05	Corn Smut	galls	Carbaryl	High	New age Farms	415 E 10th St,IN	15	2	Sandy	7.0	Medium	Dry
3		3		Sweet corn	65	2023-02-10	2023-07-05				High	Happy Farms	3415 E 10th St,IN	18	3	Loamy	6.8	High	Dry
4	4	4	Barley	Golden	40	2023-04-05	2023-07-15	Barley Scald	White spots on leaves	Prosaro	Low	Kael Urban Farms	5400 Guion Rd,IN	20	4	Sandy	7.5	Low	Normal
	5							Leaf Rust	bright yellow-orange spores	propiconazole	Medium								
5	6	5	Tomato	Cherry	30	2023-03-05	2023-07-05	Fusarium Wilt	Wilting of leaves	Organocide	High	Growing Places	727 N Oriental St,IN	12	5	loamy	6.8	Medium	Wet
6		6		Roma	28	2023-03-08	2023-07-08				High	Roka Farms	6845 Massachusetts Ave,IN	10	6	Clay	6.6	High	Normal

First Normal Form (1NF)

First Normal Form involves the process of eliminating repeating groups, missing values, identifying primary keys and, identifying all dependencies. From the below table, the composite primary keys of Field_ID and Disease_ID are recognized to create unique instances, and every associated value is filled out, leaving behind nulls and repeating groups. However, a few partial and transitive dependencies are identified in the table.Field_ID determines the value of attributes Crop_ID, Crop_Name, Crop_Variety, Yield, Date_Planted, Date_Harvested, Field_Name, Location, Area, Soil_ID, Soil_Type, pH_Level, Nutrient_Content, Moisture_Level, while the Disease_ID key determines Disease_Name, Symptoms, Treatment_Method, Severity. These two are partial dependencies.However, Crop_ID determines Crop_Name, Crop_Variety, Yield, Date_Planted, Date_Harvested and Soil_ID determines Soil_Type, pH_Level, Nutrient_Content, Moisture_Level, and Field_ID ,showing transitive dependency within partial dependency.

Field_ID	Disease_ID	Crop_ID	Crop_Name	Crop_Variety	Yield	Date_Planted	Date_Harvested	Disease_Name	Symptoms	Treatment_Method	Severity	Field_Name	Location	Area	Soil_ID	Soil_Type	pH_Level	Nutrient_Content	Moisture_Level
1	1	1	Rice	Basmati	120	2023-05-05	2023-08-15	Blast	White lesions on leaves	pyroquilon	Low	Indiana farms	640 Eskenazi Ave, IN	25	1	Clay	6.0	Low	Normal
1	2	1	Rice	Basmati	120	2023-05-05	2023-08-15	Sheath Blight	Spots on leaf sheath	azoxystrobin	Medium	Indiana farms	640 Eskenazi Ave, IN	25	1	Clay	6.0	Low	Normal
2	3	2	Corn	Dent Corn	80	2023-04-10	2023-09-05	Corn Smut	galls	Carbaryl	High	New age Farms	415 E 10th St,IN	15	2	Sandy	7.0	Medium	Dry
3	3	3	Corn	Sweet corn	65	2023-02-10	2023-07-05	Corn Smut	galls	Carbaryl	High	Happy Farms	3415 E 10th St,IN	18	3	Loamy	6.8	High	Dry
4	4	4	Barley	Golden	40	2023-04-05	2023-07-15	Barley Scald	White spots on leaves	Prosaro	Low	Kael Urban Farms	5400 Guion Rd,IN	20	4	Sandy	7.5	Low	Normal
4	5	4	Barley	Golden	40	2023-04-05	2023-07-15	Leaf Rust	bright yellow-orange spores	propiconazole	Medium	Kael Urban Farms	5400 Guion Rd,IN	20	4	Sandy	7.5	Low	Normal
5	6	5	Tomato	Cherry	30	2023-03-05	2023-07-05	Fusarium Wilt	Wilting of leaves	Organocide	High	Growing Places	727 N Oriental St,IN	12	5	loamy	6.8	Medium	Wet
6	6	6	Tomato	Roma	28	2023-03-08	2023-07-08	Fusarium Wilt	Wilting of leaves	Organocide	High	Roka Farms	6845 Massachusetts Ave,IN	10	6	Clay	6.6	High	Normal

1NF Dependency Diagram:

1NF (**<u>Field_ID, Disease_ID,</u>** Crop_ID, Crop_Name, Crop_Variety, Yield, Date_Planted, Date_Harvested, Disease_Name, Symptoms, Treatment_Method, Severity, Field_Name, Location, Area, Soil_ID, Soil_Type, pH_Level, Nutrient_Content, Moisture_Level)

Partial Dependencies:

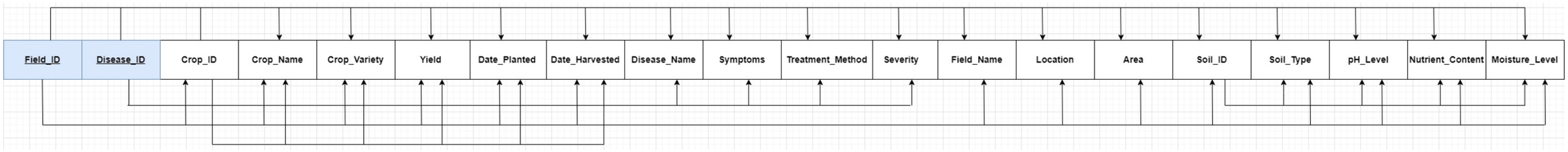
(Disease_ID ⟶ Disease_Name, Symptoms, Treatment_Method, Severity)

(Field_ID ⟶ Crop_ID, Crop_Name, Crop_Variety, Yield, Date_Planted, Date_Harvested, Field_Name, Location, Area, Soil_ID, Soil_Type, pH_Level, Nutrient_Content, Moisture_Level)

Transitive Dependencies:

(Soil_ID ⟶ Soil_Type, pH_Level, Nutrient_Content, Moisture_Level, Field_ID)

(Crop_ID ⟶ Crop_Name, Crop_Variety, Yield, Date_Planted, Date_Harvested)



Second Normal Form (2NF)

Second Normal Form involves the process of eliminating partial dependencies by separating into two new tables and determining the corresponding dependent attributes. The new tables will be Field_Information and Crop_Diseases.

Table : Crop_Diseases

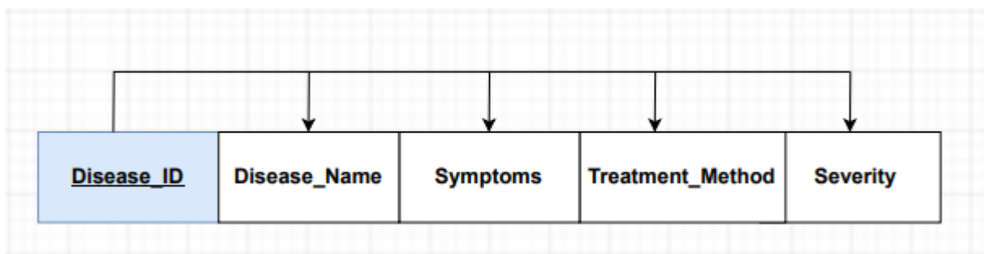
Disease_ID	Disease_Name	Symptoms	Treatment_Method	Severity
1	Blast	White lesions on leaves	pyroquilon	Low
2	Sheath Blight	Spots on leaf sheath	azoxystrobin	Medium
3	Corn Smut	galls	Carbaryl	High
4	Barley Scald	White spots on leaves	Prosaro	Low
5	Leaf Rust	bright yellow-orange spores	propiconazole	Medium
6	Fusarium Wilt	Wilting of leaves	Organocide	High

Table : Field_Information

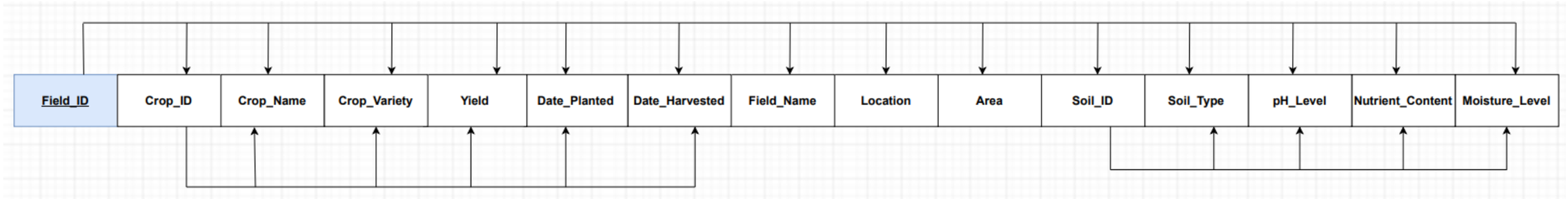
Field_ID	Crop_ID	Crop_Name	Crop_Variety	Yield	Date_Planted	Date_Harvested	Field_Name	Location	Area	Soil_ID	Soil_Type	pH_Level	Nutrient_Content	Moisture_Level
1	1	Rice	Basmati	120	2023-05-05	2023-08-15	Indiana farms	640 Eskenazi Ave, IN	25	1	Clay	6.0	Low	Normal
1	1	Rice	Basmati	120	2023-05-05	2023-08-15	Indiana farms	640 Eskenazi Ave, IN	25	1	Clay	6.0	Low	Normal
2	2	Corn	Dent Corn	80	2023-04-10	2023-09-05	New age Farms	415 E 10th St,IN	15	2	Sandy	7.0	Medium	Dry
3	3	Corn	Sweet corn	65	2023-02-10	2023-07-05	Happy Farms	3415 E 10th St,IN	18	3	Loamy	6.8	High	Dry
4	4	Barley	Golden	40	2023-04-05	2023-07-15	Kael Urban Farms	5400 Guion Rd,IN	20	4	Sandy	7.5	Low	Normal
4	4	Barley	Golden	40	2023-04-05	2023-07-15	Kael Urban Farms	5400 Guion Rd,IN	20	4	Sandy	7.5	Low	Normal
5	5	Tomato	Cherry	30	2023-03-05	2023-07-05	Growing Places	727 N Oriental St,IN	12	5	loamy	6.8	Medium	Wet
6	6	Tomato	Roma	28	2023-03-08	2023-07-08	Roka Farms	6845 Massachusetts Ave,IN	10	6	Clay	6.6	High	Normal

From the above, Field_Information and Crop_Diseases tables were created and corresponding attributes were assigned. Field_ID, and Disease_ID serves as primary key for corresponding entities.The attributes that are dependent on Disease_ID are added to Crop_Diseases table and attributes that are dependent on Field_ID are added to Field_Information table there by eliminating partial dependencies.However there are few transitive dependencies present in the table.Soil_ID determines Soil_Type, pH_Level, Nutrient_Content, Moisture_Level, Field_ID and Crop_ID determines Crop_Name, Crop_Variety, Yield, Date_Planted, Date_Harvested attributes. In order to remove the above transitive dependencies, the table has to be converted into Third Normal Form.

2NF Dependency Diagram:



Crop_Diseases (**Disease_ID**, Disease_Name, Symptoms, Treatment_Method, Severity)



Field_Information (**Field_ID**,Crop_ID, Crop_Name, Crop_Variety, Yield, Date_Planted, Date_Harvested, Field_Name, Location, Area, Soil_ID, Soil_Type, pH_Level, Nutrient_Content, Moisture_Level)

Transitive Dependencies:

(Soil_ID ⟶ Soil_Type, pH_Level, Nutrient_Content, Moisture_Level, Field_ID)

(Crop_ID ⟶ Crop_Name, Crop_Variety, Yield, Date_Planted, Date_Harvested)

Third Normal Form (3NF)

The purpose of Third Normal Form is to create a new table to eliminate transitive dependency and reassign corresponding attributes.

Table: Crop_Diseases

Disease_ID	Disease_Name	Symptoms	Treatment_Method	Severity
1	Blast	White lesions on leaves	pyroquilon	Low
2	Sheath Blight	Spots on leaf sheath	azoxystrobin	Medium
3	Corn Smut	galls	Carbaryl	High
4	Barley Scald	White spots on leaves	Prosaro	Low
5	Leaf Rust	bright yellow-orange spores	propiconazole	Medium
6	Fusarium Wilt	Wilting of leaves	Organocide	High

Table: Crop_Production

Crop_ID	Crop_Name	Crop_Variety	Yield	Date_Planted	Date_Harvested
1	Rice	Basmati	120	2023-05-05	2023-08-15
2	Corn	Dent Corn	80	2023-04-10	2023-09-05
3	Corn	Sweet corn	65	2023-02-10	2023-07-05
4	Barley	Golden	40	2023-04-05	2023-07-15
5	Tomato	Cherry	30	2023-03-05	2023-07-05
6	Tomato	Roma	28	2023-03-08	2023-07-08

Table: Soil_Characteristics

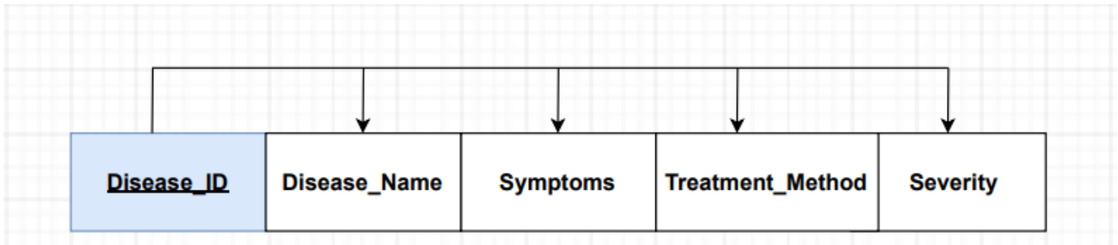
Soil_ID	Soil_Type	pH_Level	Nutrient_Content	Moisture_Level
1	Clay	6.0	Low	Normal
2	Sandy	7.0	Medium	Dry
3	Loamy	6.8	High	Dry
4	Sandy	7.5	Low	Normal
5	loamy	6.8	Medium	Wet
6	Clay	6.6	High	Normal

Table: Field_Information

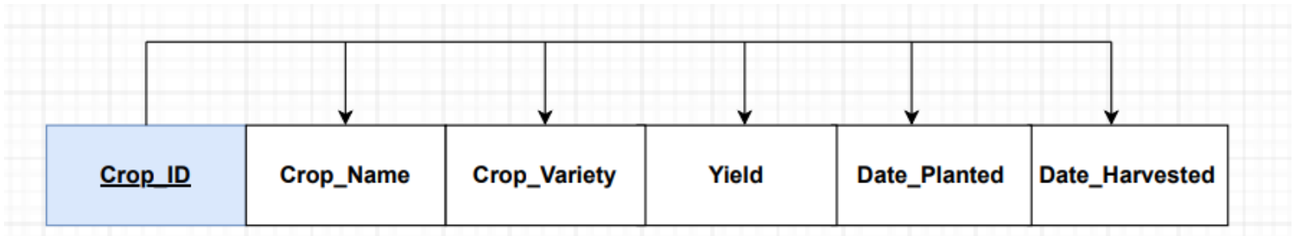
Field_ID	Field_Name	Location	Area	Soil_ID	Crop_ID
1	Indiana farms	640 Eskenazi Ave, IN	25	1	1
2	New age Farms	415 E 10th St,IN	15	2	2
3	Happy Farms	3415 E 10th St,IN	18	3	3
4	Kael Urban Farms	5400 Guion Rd,IN	20	4	4
5	Growing Places	727 N Oriental St,IN	12	5	5
6	Roka Farms	6845 Massachusetts Ave,IN	10	6	6

From the above, Crop_Production and Soil_Characteristics tables were created. Crop_ID,Soil_ID ,Disease_ID,Field_ID serves as primary keys for respective tables and corresponding attributes were assigned there by eliminating transitive dependencies. Therefore, all the above tables are represented in Third Normal Form removing redundancy and efficient representation of data.

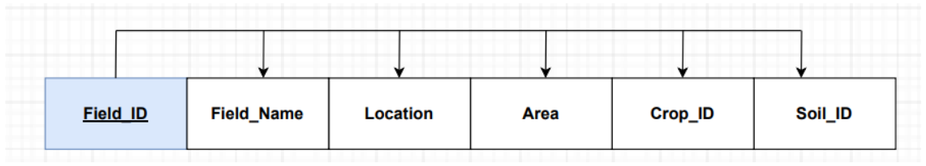
3NF Dependency Diagram:



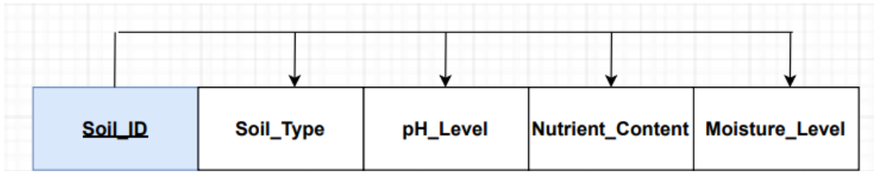
Crop_Diseases (**Disease_ID**, Disease_Name, Symptoms, Treatment_Method, Severity)



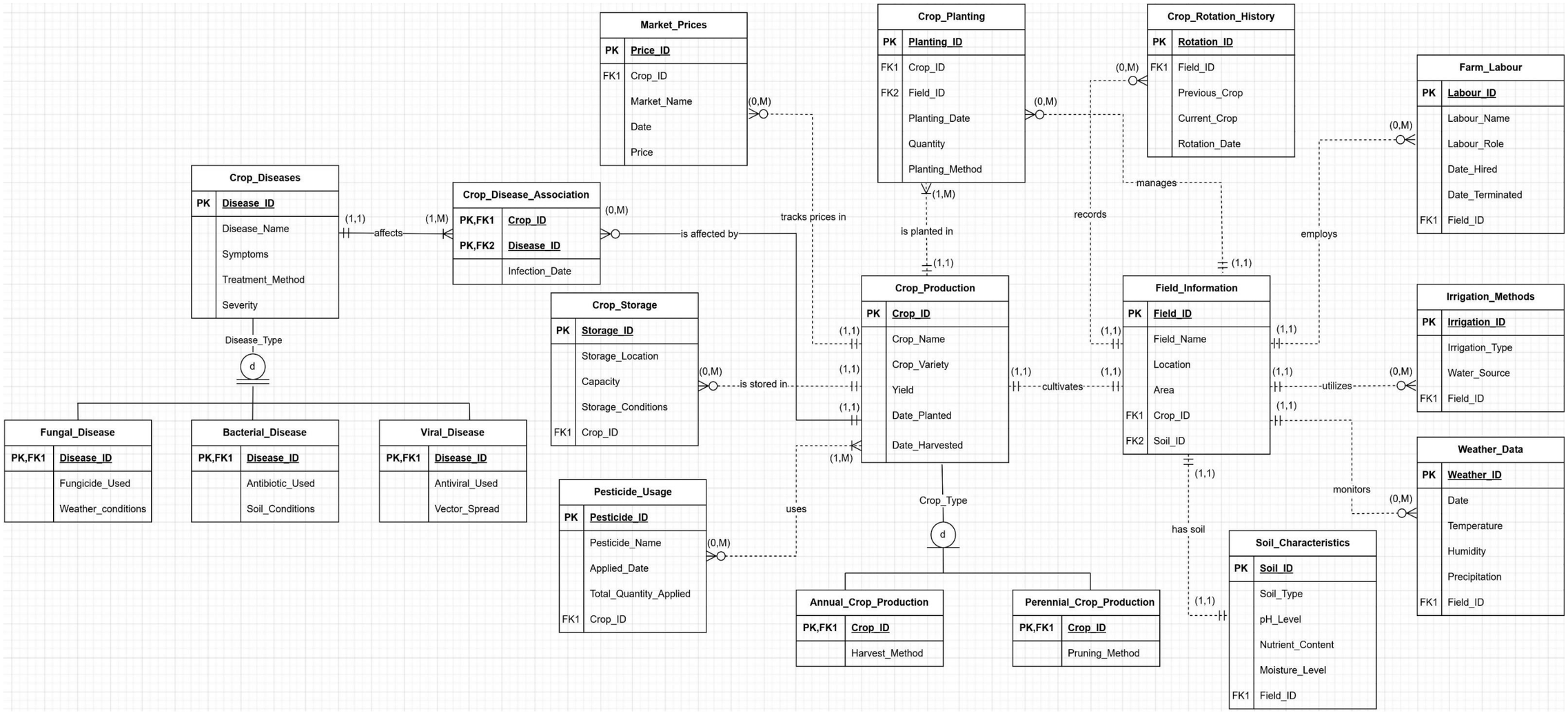
Crop_Production (**Crop_ID**, Crop_Name, Crop_Variety, Yield, Date_Planted, Date_Harvested)



Field_Information (**Field_ID**, Field_Name, Location, Area, Crop_ID, Soil_ID)



Soil_Characteristics (**Soil_ID**, Soil_Type, pH_Level, Nutrient_Content, Moisture_Level,Field_ID)



Query 1: A query that pulls data from one table

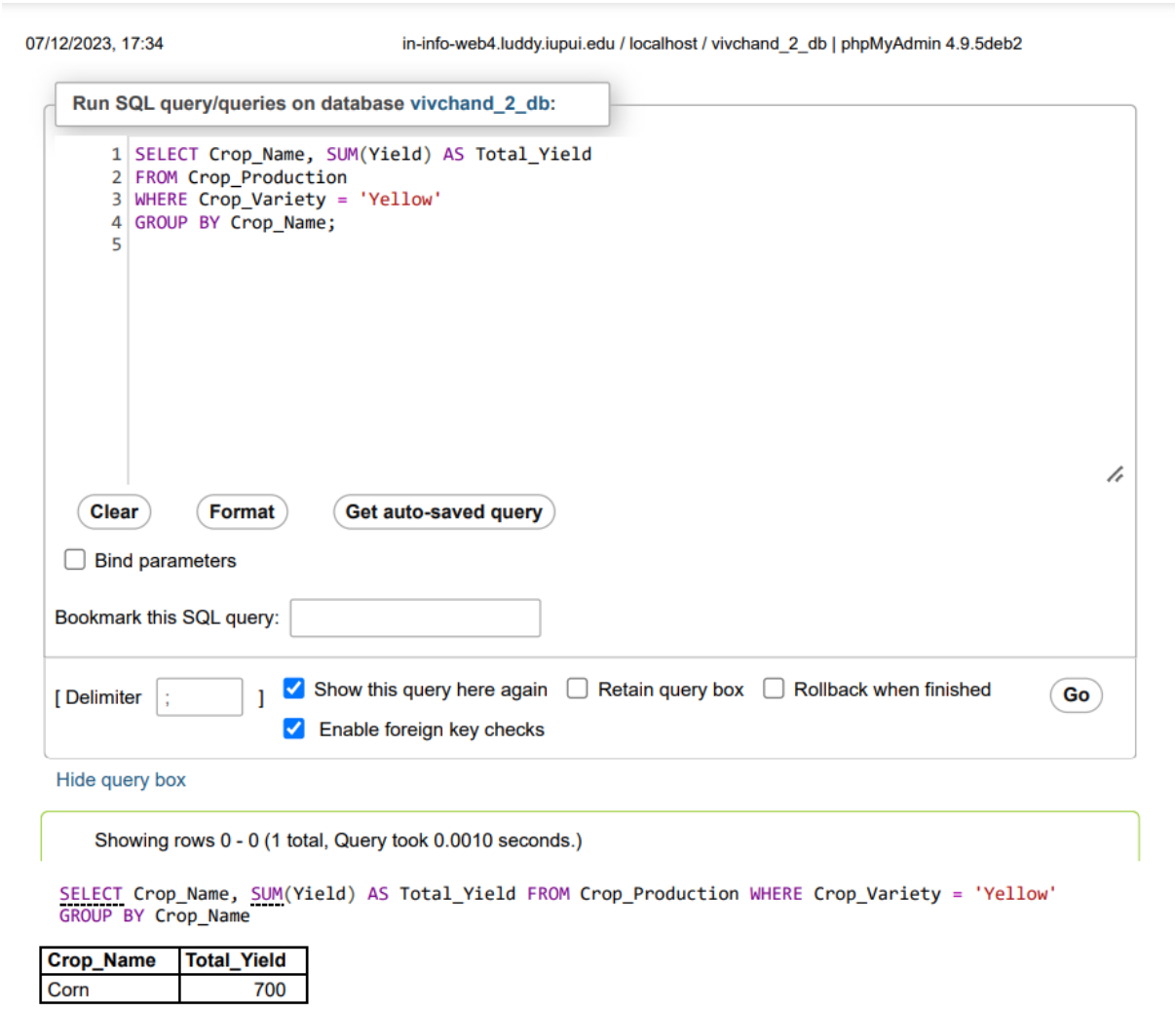
Question: What is the total yield of the crop variety named 'Corn'?

SELECT Crop_Name, SUM(Yield) AS Total_Yield

FROM Crop_Production

WHERE Crop_Variety = 'Yellow'

GROUP BY Crop_Name;



Crop_Name	Total_Yield
Corn	700

Query 2: A query that pulls data from two tables

Question: What are the crops and their respective planting dates for the field named 'Field_A'?

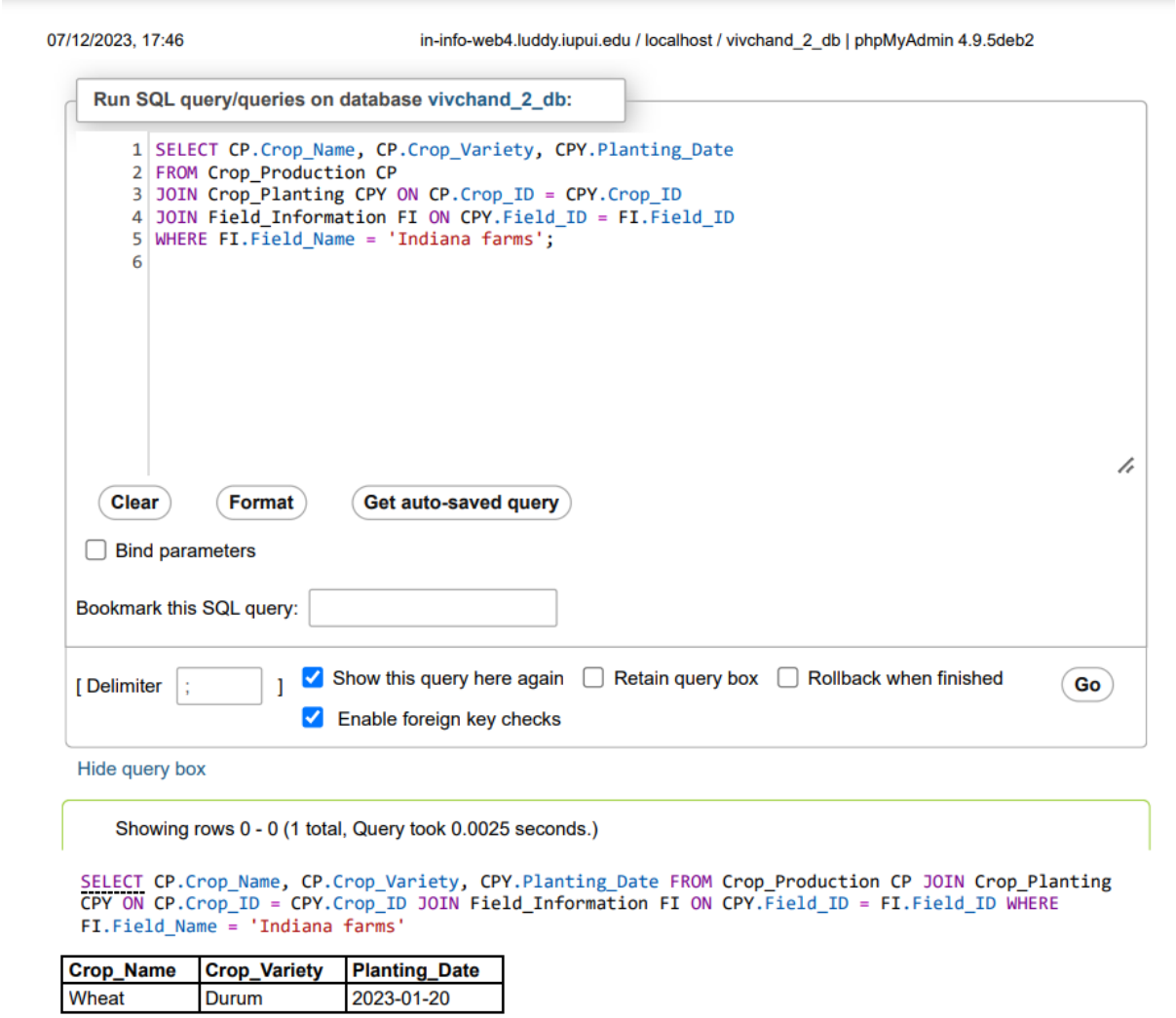
SELECT CP.Crop_Name, CP.Crop_Variety, CPY.Planting_Date

FROM Crop_Production CP

JOIN Crop_Planting CPY ON CP.Crop_ID = CPY.Crop_ID

JOIN Field_Information FI ON CPY.Field_ID = FI.Field_ID

WHERE FI.Field_Name = 'Indiana farms';



Crop_Name	Crop_Variety	Planting_Date
Wheat	Durum	2023-01-20

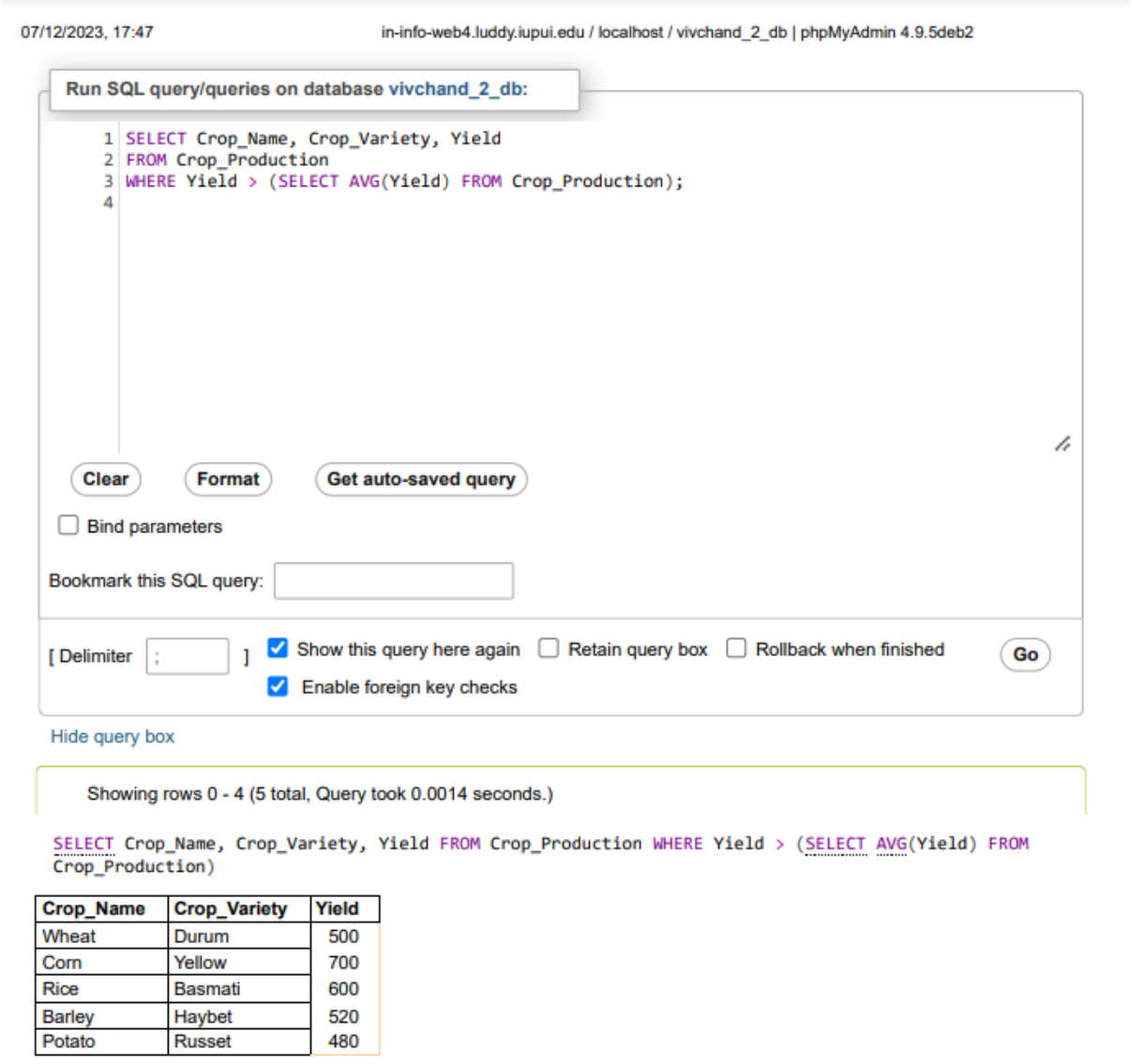
Query 3: A query that also includes a subquery

Question: Which crops have yields greater than the average yield of all crops?

SELECT Crop_Name, Crop_Variety, Yield

FROM Crop_Production

WHERE Yield > (SELECT AVG(Yield) FROM Crop_Production);



Crop_Name	Crop_Variety	Yield
Wheat	Durum	500
Corn	Yellow	700
Rice	Basmati	600
Barley	Haybet	520
Potato	Russet	480