

CPSC 304 Project Cover Page

Milestone #2

Date: October 22nd, 2025

Group Number: 31

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By typing our names and student numbers in the above table, we certify that the work in the attached assignment was performed solely by those whose names and student IDs are included above. (In the case of Project Milestone 0, the main purpose of this page is for you to let us know your e-mail address, and then let us assign you to a TA for your project supervisor.)

In addition, we indicate that we are fully aware of the rules and consequences of plagiarism, as set forth by the Department of Computer Science and the University of British Columbia

Repository Link: github.students.cs.ubc.ca/CPSC304-2025W-T1/team_31

SQL Script Reference:

https://github.students.cs.ubc.ca/CPSC304-2025W-T1/team_31/blob/main/project.sql

Project Description/Accomplishments:

Our project is based in the sustainable agriculture/farm management space. The system will help farms keep organized records about the crops they grow and the certifications their farm has (ie. organic, non-GMO, etc.). Data is seasonal and can change over time, thus a centralized platform will help farmers review yearly crop records. Users are able to input information about their farms, including the field it is grown on, the types of crops, records of field conditions, and other miscellaneous things used like pesticides and records of irrigation. They are also able to update and delete their farm information, select specific fields based on attributes like area, fieldID and farmID, project specific columns from the ContainsField relation, look at which crop belongs to which farm, find the average irrigation used per field and the healthy fields, return the fieldID with the highest moisture and return fieldID that uses all pesticides.

The final schema made changes that were recommended based on the Milestone 2 rubric:

- The weak identity PK is now (CropID, TotalYield) since we had the incorrect PK
- FarmID was removed from the GrowsCrop relation (no relation to GrowsCrop)
- Area was removed from the SoilsRecords relation (since area was not a PK)

The changes for the latter two were made due to unnecessary information being in the table

SQL Queries:

#1 INSERT

Location: appService.js Line 598

```
async function insertFarm(farmID, name, location, farmerID) {
  if (!validate.isPositiveInteger(farmID) ||
    !validate.isValidString(name, 20) ||
    !validate.isValidString(location, 20) ||
    !validate.isPositiveInteger(farmerID)) {
    return false;
  }
  return await withOracleDB(async (connection) => {
    const result = await connection.execute(
      `INSERT INTO OwnsFarm VALUES (:farmID, :name, :location, :farmerID)\`,
      [farmID, name, location, farmerID],
      { autoCommit: true }
    );
    return result.rowsAffected && result.rowsAffected > 0;
  }).catch(() => {
    return false;
  });
}
```

#2 UPDATE

Location: appService.js Line 913

```
// Allows transfer of farm to new farmer, or change name/location of farm
async function updateFarmInfo(farmID, farmName, location, farmerID) {
  const updates = [];
  const values = {};

  values.farmID = farmID;

  if (farmName?.trim()) {
    updates.push("Name = :farmName");
    values.farmName = farmName;
  }

  if (location?.trim()) {
    updates.push("Location = :location");
    values.location = location;
  }

  if (farmerID?.trim()) {
    updates.push("FarmerID = :farmerID");
    values.farmerID = farmerID;
  }

  // Empty fields
  if (updates.length === 0) {
    return { success: false, message: "Update fields are all blank. Please check and try again." };
  }

  const sql = `UPDATE OwnsFarm
    SET ${updates.join(", ")}
    WHERE FarmID = :farmID`;

  return await withOracleDB(async (connection) => {
    try {
      const result = await connection.execute(
        sql, values, { autoCommit: true }
      );

      if (result.rowsAffected === 0) {
        return { success: false, message: "No farm found with this FarmID. Please check and try again." };
      }

      return { success: true, message: "Update successful!" };
    } catch (err) {
      // foreign key violation (does not exist)
      if (err.errorNum === 2291) {
        return { success: false, message: "farmerID not recognized. Please provide a valid existing farmerID." };
      }

      // log error and return generic err message
      console.error("Database error:", err);
      return { success: false, message: "Update failed due to an unexpected error" };
    }
  }).catch((err) => {
    console.error("Database connection failed:", err);
    return { success: false, message: "Update failed due to an unexpected error" };
  });
}
```

#3 DELETE

Location: appService.js Line 985

```
// Delete farms
async function deleteFarmsInfo(farmID) {
  return await withOracleDB(async (connection) => {
    try {
      const result = await connection.execute(
        'DELETE FROM OwnsFarm WHERE FarmID = :farmID', [farmID], { autoCommit: true });

      if (result.rowsAffected === 0) {
        return { success: false, message: "No farm found with this FarmID. Please check and try again." };
      }

      return { success: true, message: "Cascade Delete successful!" };
    } catch (err) {
      console.error("Database error:", err);
      return { success: false, message: "Delete failed due to an unexpected error" };
    }
  }).catch((err) => {
    console.error("Database error:", err);
    return { success: false, message: "Delete failed due to an unexpected error" };
  })
};
```

#4 SELECTION

Location: appService.js Line 1119

```
async function selectFields(filter) {
  const validAttributes = ["FieldID", "FarmID", "Area"];
  const validOperators = ["=", "<", ">", "<", ">=", "<="];
  const validConnectors = ["AND", "OR"];

  let whereParts = [];
  let binds = {};

  filter.conditions.forEach((cond, idx) => {
    const attr = cond.attribute;
    const op = cond.operator;
    const val = cond.value;
    const join = cond.connector;

    if (!validAttributes.includes(attr)) return;
    if (!validOperators.includes(op)) return;
    if (idx > 0 && !validConnectors.includes(join)) return;

    const bindKey = `v${idx}`;
    binds[bindKey] = val;

    const clause = `${attr} ${op} :${bindKey}`;

    if (idx === 0) {
      whereParts.push(clause);
    } else {
      whereParts.push(`${join} ${clause}`);
    }
  });

  // Select the whole table if no restrictions apply
  if (whereParts.length === 0) {
    const sql = `SELECT FieldID, FarmID, Area FROM ContainsField`;
    return await withOracleDB(async (connection) => {
      try {
        const result = await connection.execute(sql);
        return {
          success: true,
          message: "Selection successful!",
          data: result.rows
        };
      } catch (err) {
        console.error("Selection SQL error:", err);
        return { success: false, message: "Selection failed due to an unexpected error." };
      }
    });
  }

  const where = "WHERE " + whereParts.join(" ");
  const sql = `SELECT FieldID, FarmID, Area
    FROM ContainsField
    ${where}
    `;

  return await withOracleDB(async (connection) => {
    try {
      const result = await connection.execute(sql, binds);
      return {
        success: true,
        message: 'Selection successful!',
        data: result.rows
      };
    } catch (err) {
      console.error("Database error:", err);
      return { success: false, message: "Selection failed due to an unexpected error." };
    }
  }).catch((err) => {
    console.error("Database error:", err);
    return { success: false, message: "Selection failed due to an unexpected error." };
  });
}
```

#5 Projection

Location: appService.js Line 1060

```
async function getFields(filter) {
  const fieldFields = ["FieldID", "FarmID", "Area"];

  const selectCols = [];

  if (!filter) {
    return {
      success: false,
      message: "No columns selected. Please choose at least one valid field.",
      data: []
    };
  }

  if (filter.display) {
    const cols = filter.display.split(",");

    cols.forEach(col => {
      // ContainsField table
      if (col === "FarmID") selectCols.push("fd.FarmID AS FarmID");
      if (col === "FieldID") selectCols.push("fd.FieldID AS FieldID");
      if (col === "Area") selectCols.push("fd.Area AS Area");
    });
  }

  // Error handling, 0 features chosen send error
  if (selectCols.length === 0) {
    return {
      success: false,
      message: "None of the selected columns exist. Please choose valid fields.",
      data: []
    };
  }

  const select = `SELECT ${selectCols.join(", ")}`;
  const from = `FROM ContainsField fd`;

  const query = `${select} ${from}`;

  return await withOracleDB(async (connection) => {
    try {
      const result = await connection.execute(query);
      return {
        success: true,
        message: 'Projection successful!',
        data: result.rows
      }
    } catch (err) {
      console.error("Database error:", err);
      return { success: false, message: "Projection failed due to an unexpected error." };
    }
  }).catch((err) => {
    console.error("Database error:", err);
    return { success: false, message: "Projection failed due to an unexpected error." };
  });
}
```

#6 Join

Location: appService.js Line 1010

```
// Joins farms with the crops they grow
async function joinFarmCrop(farmID) {
  // Includes contact info and name even if farm has no crops or fields
  const sql = `SELECT
    f.FarmID,
    cin.Name AS FarmerName,
    cin.ContactInfo,
    ct.Name AS CropName
  FROM OwnsFarm f
  JOIN Farmer fr ON f.FarmerID = fr.FarmerID
  JOIN ContactInfoName cin ON fr.ContactInfo = cin.ContactInfo
  LEFT JOIN ContainsField fld ON f.farmID = fld.FarmID
  LEFT JOIN GrowsCrop gc ON fld.FieldID = gc.FieldID
  LEFT JOIN CropType ct ON gc.Name = ct.Name
  WHERE f.FarmID = :farmID
  ORDER BY ct.Name
  `;

  return await withOracleDB(async (connection) => {
    try {
      const result = await connection.execute(
        sql,
        { farmID }
      );

      if (result.rows.length == 0) {
        return {
          success: false,
          message: "No farm found for this FarmID. Please check and try again.",
          data: null
        };
      }

      return {
        success: true,
        message: "Search successful!",
        data: result.rows
      };
    } catch (err) {
      console.error("Database error:", err);
      return { success: false, message: "Query failed due to an unexpected error." };
    }
  }).catch((err) => {
    console.error("Database connection failed", err);
    return { success: false, message: "Query failed due to an unexpected error." };
  });
}
```


#7 GROUP BY

Location: appService.js Line 1192

Purpose: This query finds the average irrigated volume for each field. The grouping list is identified by farm name and fieldID, and the average volume is calculated.

```
// find the average volume for each field
async function fetchAverageVolume() {
    const sql = `SELECT i.FieldID, o.Name, AVG(i.Volume) as AvgVolume
    FROM IrrigationRecords i
    JOIN ContainsField f ON f.FieldID = i.FieldID
    JOIN OwnsFarm o ON o.FarmID = f.FarmID
    GROUP BY o.Name, i.FieldID
    ORDER BY i.FieldID ASC
    `;

    return await withOracleDB(async (connection) => {
        try {
            const result = await connection.execute(sql);

            return {
                success: true,
                message: "Search successful!",
                data: result.rows
            };
        } catch (err) {
            console.error("Database error:", err);
            return { success: false, message: "Query failed due to an unexpected error." };
        }
    }).catch((err) => {
        console.error("Database connection failed", err);
        return { success: false, message: "Query failed due to an unexpected error." };
    });
}
```

#8 HAVING

Location: appService.js Line 1221

Purpose: Returns all fields such that the average pH for each recording of the field is healthy (between 5.5 and 7.5). The having ensures that tuples are kept only if the field's (fieldID) average pH is healthy.

```
async function fetchHealthyFields() {
  const sql = `SELECT s.FieldID, o.Name, AVG(s.pH) as AvgpH
    FROM SoilRecords s
    JOIN ContainsField f ON f.FieldID = s.FieldID
    JOIN OwnsFarm o ON o.FarmID = f.FarmID
    GROUP BY o.Name, s.FieldID
    HAVING AVG(s.pH) BETWEEN 5.5 AND 7.5
    ORDER BY s.FieldID ASC
  `;

  return await withOracleDB(async (connection) => {
    try {
      const result = await connection.execute(sql);

      return {
        success: true,
        message: "Search successful!",
        data: result.rows
      };
    } catch (err) {
      console.error("Database error:", err);
      return { success: false, message: "Query failed due to an unexpected error." };
    }
  }).catch((err) => {
    console.error("Database connection failed", err);
    return { success: false, message: "Query failed due to an unexpected error." };
  });
}
```

#9 Nested Aggregation

Location: appService.js Line 1252

Purpose: This query returns the fieldID with the highest moisture.

```
async function fetchHighestMoistureField() {
  const sql = `SELECT sr.FieldID
    FROM SoilRecords sr
   JOIN MoistureByChemistry mc
  ON sr.SampleDate = mc.SampleDate AND sr.pH = mc.pH
  GROUP BY sr.FieldID
  HAVING AVG(mc.moisture) >= ALL (
    SELECT AVG(mc2.moisture)
    FROM SoilRecords sr2
   JOIN MoistureByChemistry mc2
  ON sr2.SampleDate = mc2.SampleDate AND sr2.pH = mc2.pH
  GROUP BY sr2.FieldID
  )
  `;

  return await withOracleDB(async (connection) => {
    try {
      const result = await connection.execute(sql);

      return {
        success: true,
        message: "Search successful!",
        data: result.rows
      };
    } catch (err) {
      console.error("Database error:", err);
      return { success: false, message: "Query failed due to an unexpected error." };
    }
  }).catch((err) => {
    console.error("Database connection failed", err);
    return { success: false, message: "Query failed due to an unexpected error." };
  });
}
```

#10 Division

Location: appService.js Line 1286

Purpose: This query returns all fieldID's that contain all pesticides. Fields are included if no pesticides are missing.

```
async function fetchFieldsAllPesticides() {
  const sql = `SELECT cf.FieldID
    FROM ContainsField cf
    WHERE NOT EXISTS (
      (SELECT p.pestID
        FROM Pesticide p)

      MINUS

      (SELECT t.PestID
        FROM GrowsCrop gc
        JOIN Treats t ON gc.CropID = t.CropID
        WHERE gc.FieldID = cf.FieldID
      )
    )
  `;

  return await withOracleDB(async (connection) => {
    try {
      const result = await connection.execute(sql);

      return {
        success: true,
        message: "Search successful!",
        data: result.rows
      };
    } catch (err) {
      console.error("Database error:", err);
      return { success: false, message: "Query failed due to an unexpected error." };
    }
  }).catch((err) => {
    console.error("Database connection failed", err);
    return { success: false, message: "Query failed due to an unexpected error." };
  });
}
```

Schemas after Initialization of SQL Script:

<pre>CREATE TABLE ContactInfoName (ContactInfo VARCHAR(80) PRIMARY KEY, Name VARCHAR(20) NOT NULL);</pre>	<table><tr><th>ContactInfo</th><th>Name</th></tr><tr><td>john.doe@example.com</td><td>John Doe</td></tr><tr><td>jack.smith@example.com</td><td>Jack Smith</td></tr><tr><td>brian.smith@example.com</td><td>Brian Smith</td></tr><tr><td>cora.doe@example.com</td><td>Cora Doe</td></tr><tr><td>eve.miller@example.com</td><td>Eve Miller</td></tr></table>	ContactInfo	Name	john.doe@example.com	John Doe	jack.smith@example.com	Jack Smith	brian.smith@example.com	Brian Smith	cora.doe@example.com	Cora Doe	eve.miller@example.com	Eve Miller												
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eve.miller@example.com	Eve Miller																								
<pre>CREATE TABLE Farmer (FarmerID INT PRIMARY KEY, ContactInfo VARCHAR(80) NOT NULL, CONSTRAINT fk_farmer_contact FOREIGN KEY (ContactInfo) REFERENCES ContactInfoName(ContactInfo), CONSTRAINT uq_farmer_contact UNIQUE (ContactInfo));</pre>	<table><tr><th>FarmerID</th><th>ContactInfo</th></tr><tr><td>1</td><td>john.doe@example.com</td></tr><tr><td>2</td><td>jack.smith@example.com</td></tr><tr><td>3</td><td>brian.smith@example.com</td></tr><tr><td>4</td><td>cora.doe@example.com</td></tr><tr><td>5</td><td>eve.miller@example.com</td></tr></table>	FarmerID	ContactInfo	1	john.doe@example.com	2	jack.smith@example.com	3	brian.smith@example.com	4	cora.doe@example.com	5	eve.miller@example.com												
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<pre>CREATE TABLE OwnsFarm (FarmID INT PRIMARY KEY, Name VARCHAR(20) NOT NULL, Location VARCHAR(20) NOT NULL, FarmerID INT NOT NULL, CONSTRAINT fk_farm_farmer FOREIGN KEY (FarmerID) REFERENCES Farmer(FarmerID));</pre>	<table><tr><th>FarmID</th><th>Name</th><th>Location</th><th>FarmerID</th></tr><tr><td>101</td><td>Sunny Fields</td><td>British Columbia</td><td>1</td></tr><tr><td>102</td><td>Green Valley</td><td>Alberta</td><td>2</td></tr><tr><td>103</td><td>River Farm</td><td>Ontario</td><td>3</td></tr><tr><td>104</td><td>Highland Acres</td><td>British Columbia</td><td>4</td></tr><tr><td>105</td><td>Golden Harvest</td><td>Manitoba</td><td>5</td></tr></table>	FarmID	Name	Location	FarmerID	101	Sunny Fields	British Columbia	1	102	Green Valley	Alberta	2	103	River Farm	Ontario	3	104	Highland Acres	British Columbia	4	105	Golden Harvest	Manitoba	5
FarmID	Name	Location	FarmerID																						
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103	River Farm	Ontario	3																						
104	Highland Acres	British Columbia	4																						
105	Golden Harvest	Manitoba	5																						
<pre>CREATE TABLE ContainsField (FieldID INT PRIMARY KEY, FarmID INT NOT NULL, Area INT, CONSTRAINT fk_field_farm FOREIGN KEY (FarmID) REFERENCES OwnsFarm(FarmID));</pre>	<table><tr><th>FieldID</th><th>FarmID</th><th>Area</th></tr><tr><td>1001</td><td>101</td><td>25</td></tr><tr><td>1002</td><td>102</td><td>40</td></tr><tr><td>1003</td><td>103</td><td>30</td></tr><tr><td>1004</td><td>104</td><td>35</td></tr><tr><td>1005</td><td>105</td><td>25</td></tr><tr><td>1006</td><td>103</td><td>65</td></tr></table>	FieldID	FarmID	Area	1001	101	25	1002	102	40	1003	103	30	1004	104	35	1005	105	25	1006	103	65			
FieldID	FarmID	Area																							
1001	101	25																							
1002	102	40																							
1003	103	30																							
1004	104	35																							
1005	105	25																							
1006	103	65																							

CREATE TABLE SeasonByPlantDate (PlantingDate DATE PRIMARY KEY, Season VARCHAR(20) NOT NULL);	<table><tr><th>PlantingDate</th><th>Season</th></tr><tr><td>2025-03-10</td><td>Spring</td></tr><tr><td>2025-04-15</td><td>Spring</td></tr><tr><td>2025-05-20</td><td>Summer</td></tr><tr><td>2025-07-01</td><td>Summer</td></tr><tr><td>2025-09-10</td><td>Fall</td></tr><tr><td>2025-10-10</td><td>Fall</td></tr></table>	PlantingDate	Season	2025-03-10	Spring	2025-04-15	Spring	2025-05-20	Summer	2025-07-01	Summer	2025-09-10	Fall	2025-10-10	Fall																
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2025-05-20	Summer																														
2025-07-01	Summer																														
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CREATE TABLE CropType (Name VARCHAR(60) PRIMARY KEY, PlantingDate DATE NOT NULL, HarvestDate DATE NOT NULL, CONSTRAINT fk_croptype_plantdate FOREIGN KEY (PlantingDate) REFERENCES SeasonByPlantDate(PlantingDate));	<table><tr><th>Name</th><th>PlantingDate</th><th>HarvestDate</th></tr><tr><td>Wheat</td><td>2025-03-10</td><td>2025-07-20</td></tr><tr><td>Corn</td><td>2025-04-15</td><td>2025-09-05</td></tr><tr><td>Tomato</td><td>2025-05-20</td><td>2025-08-25</td></tr><tr><td>Lettuce</td><td>2025-07-01</td><td>2025-08-01</td></tr><tr><td>Apple</td><td>2025-09-10</td><td>2026-03-01</td></tr><tr><td>Banana</td><td>2025-10-10</td><td>2026-06-01</td></tr></table>	Name	PlantingDate	HarvestDate	Wheat	2025-03-10	2025-07-20	Corn	2025-04-15	2025-09-05	Tomato	2025-05-20	2025-08-25	Lettuce	2025-07-01	2025-08-01	Apple	2025-09-10	2026-03-01	Banana	2025-10-10	2026-06-01									
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CREATE TABLE GrowsCrop (CropID INT PRIMARY KEY, FieldID INT NOT NULL, Name VARCHAR(60) NOT NULL, CONSTRAINT fk_crop_field FOREIGN KEY (FieldID) REFERENCES ContainsField(FieldID), CONSTRAINT fk_crop_name FOREIGN KEY (Name) REFERENCES CropType(Name));	<table><tr><th>CropID</th><th>FieldID</th><th>Name</th></tr><tr><td>201</td><td>1001</td><td>Wheat</td></tr><tr><td>206</td><td>1001</td><td>Corn</td></tr><tr><td>207</td><td>1001</td><td>Tomato</td></tr><tr><td>208</td><td>1001</td><td>Banana</td></tr><tr><td>202</td><td>1002</td><td>Corn</td></tr><tr><td>203</td><td>1003</td><td>Tomato</td></tr><tr><td>204</td><td>1004</td><td>Lettuce</td></tr><tr><td>205</td><td>1005</td><td>Apple</td></tr><tr><td>209</td><td>1005</td><td>Banana</td></tr></table>	CropID	FieldID	Name	201	1001	Wheat	206	1001	Corn	207	1001	Tomato	208	1001	Banana	202	1002	Corn	203	1003	Tomato	204	1004	Lettuce	205	1005	Apple	209	1005	Banana
CropID	FieldID	Name																													
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202	1002	Corn																													
203	1003	Tomato																													
204	1004	Lettuce																													
205	1005	Apple																													
209	1005	Banana																													
CREATE TABLE Grain (CropID INT PRIMARY KEY, GlutenContent DECIMAL(10,2), CONSTRAINT fk_grain_crop FOREIGN KEY (CropID) REFERENCES GrowsCrop(CropID) ON DELETE CASCADE);	<table><tr><th>CropID</th><th>GlutenContent</th></tr><tr><td>201</td><td>12.5</td></tr><tr><td>202</td><td>0</td></tr><tr><td>206</td><td>0</td></tr></table>	CropID	GlutenContent	201	12.5	202	0	206	0																						
CropID	GlutenContent																														
201	12.5																														
202	0																														
206	0																														

CREATE TABLE Vegetable (CropID INT PRIMARY KEY, IsLeafy NUMBER(1) NOT NULL, CONSTRAINT ck_veg_bool CHECK (IsLeafy IN (0,1)), CONSTRAINT fk_veg_crop FOREIGN KEY (CropID) REFERENCES GrowsCrop(CropID) ON DELETE CASCADE);	<table><tr><th>CropID</th><th>IsLeafy</th></tr><tr><td>203</td><td>0</td></tr><tr><td>204</td><td>1</td></tr><tr><td>207</td><td>0</td></tr></table>	CropID	IsLeafy	203	0	204	1	207	0										
CropID	IsLeafy																		
203	0																		
204	1																		
207	0																		
CREATE TABLE Fruit (CropID INT PRIMARY KEY, SugarContent DECIMAL(10,2), CONSTRAINT fk_fruit_crop FOREIGN KEY (CropID) REFERENCES GrowsCrop(CropID) ON DELETE CASCADE);	<table><tr><th>CropID</th><th>SugarContent</th></tr><tr><td>205</td><td>14.2</td></tr><tr><td>208</td><td>12.3</td></tr><tr><td>209</td><td>16.8</td></tr></table>	CropID	SugarContent	205	14.2	208	12.3	209	16.8										
CropID	SugarContent																		
205	14.2																		
208	12.3																		
209	16.8																		
CREATE TABLE CropYieldProduces (CropID INT, Total_Yield DECIMAL(10,2) NOT NULL, Health_Rating INT NOT NULL, PRIMARY KEY (CropID, Total_Yield), CONSTRAINT fk_yield_crop FOREIGN KEY (CropID) REFERENCES GrowsCrop(CropID) ON DELETE CASCADE);	<table><tr><th>CropID</th><th>Total_Yield</th><th>Health_Rating</th></tr><tr><td>201</td><td>5000</td><td>9</td></tr><tr><td>202</td><td>6500.5</td><td>8</td></tr><tr><td>203</td><td>2200.75</td><td>7</td></tr><tr><td>204</td><td>1800</td><td>9</td></tr><tr><td>205</td><td>8000.25</td><td>10</td></tr></table>	CropID	Total_Yield	Health_Rating	201	5000	9	202	6500.5	8	203	2200.75	7	204	1800	9	205	8000.25	10
CropID	Total_Yield	Health_Rating																	
201	5000	9																	
202	6500.5	8																	
203	2200.75	7																	
204	1800	9																	
205	8000.25	10																	
CREATE TABLE Pesticide (PestID INT PRIMARY KEY, Name VARCHAR(60));	<table><tr><th>PestID</th><th>Name</th></tr><tr><td>1</td><td>Mr Clean</td></tr><tr><td>2</td><td>Pest Killer</td></tr><tr><td>3</td><td>P-Cleaner Deluxe</td></tr><tr><td>4</td><td>Bye Bye Pests</td></tr><tr><td>5</td><td>Get Outta Here Pests</td></tr><tr><td>6</td><td>Pest Eliminator 3000</td></tr></table>	PestID	Name	1	Mr Clean	2	Pest Killer	3	P-Cleaner Deluxe	4	Bye Bye Pests	5	Get Outta Here Pests	6	Pest Eliminator 3000				
PestID	Name																		
1	Mr Clean																		
2	Pest Killer																		
3	P-Cleaner Deluxe																		
4	Bye Bye Pests																		
5	Get Outta Here Pests																		
6	Pest Eliminator 3000																		

```
CREATE TABLE Treats (
  CropID INT,
  PestID INT,
  PRIMARY KEY (CropID, PestID),
  CONSTRAINT fk_treats_crop
    FOREIGN KEY (CropID) REFERENCES
    GrowsCrop(CropID)
    ON DELETE CASCADE,
  CONSTRAINT fk_treats_pest
    FOREIGN KEY (PestID) REFERENCES
    Pesticide(PestID)
    ON DELETE CASCADE
);
```

CropID	PestID
201	1
201	2
201	3
201	4
201	5
201	6
202	1
202	3
203	2
205	1
205	2
205	3
205	4
205	5
205	6

```
CREATE TABLE IrrigationRecords (
  IrrigID INT PRIMARY KEY,
  FieldID INT NOT NULL,
  EventDate DATE,
  Volume DECIMAL(10,2),
  CONSTRAINT fk_irrig_field
    FOREIGN KEY (FieldID) REFERENCES
    ContainsField(FieldID)
);
```

IrrigID	FieldID	EventDate	Volume
1	1001	2023-03-01	1500
2	1001	2023-04-15	2000
3	1002	2023-05-10	1800
4	1002	2023-06-20	2200
5	1003	2023-07-05	1600
6	1003	2023-08-18	2100

CREATE TABLE MoistureByChemistry (SampleDate DATE, pH DECIMAL(4,2), Moisture DECIMAL(6,2) NOT NULL, PRIMARY KEY (SampleDate, pH));	<table><tr><th>SampleDate</th><th>pH</th><th>Moisture</th></tr><tr><td>2023-03-15</td><td>6.5</td><td>22.5</td></tr><tr><td>2023-04-20</td><td>7</td><td>18</td></tr><tr><td>2023-05-10</td><td>5.8</td><td>25</td></tr><tr><td>2023-06-25</td><td>6.2</td><td>20</td></tr><tr><td>2023-07-30</td><td>7.5</td><td>15</td></tr><tr><td>2023-08-15</td><td>6.9</td><td>19.5</td></tr><tr><td>2023-09-01</td><td>4</td><td>28</td></tr><tr><td>2023-09-15</td><td>4.5</td><td>24</td></tr><tr><td>2023-10-05</td><td>5.2</td><td>30</td></tr><tr><td>2023-10-20</td><td>6.8</td><td>27.5</td></tr><tr><td>2024-09-15</td><td>5.5</td><td>24</td></tr><tr><td>2024-10-05</td><td>5.7</td><td>30</td></tr><tr><td>2024-10-20</td><td>4.2</td><td>27.5</td></tr></table>	SampleDate	pH	Moisture	2023-03-15	6.5	22.5	2023-04-20	7	18	2023-05-10	5.8	25	2023-06-25	6.2	20	2023-07-30	7.5	15	2023-08-15	6.9	19.5	2023-09-01	4	28	2023-09-15	4.5	24	2023-10-05	5.2	30	2023-10-20	6.8	27.5	2024-09-15	5.5	24	2024-10-05	5.7	30	2024-10-20	4.2	27.5																																		
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2024-10-05	5.7	30																																																																											
2024-10-20	4.2	27.5																																																																											
CREATE TABLE SoilRecords (SoilCondID INT PRIMARY KEY, FieldID INT NOT NULL, SampleDate DATE NOT NULL, pH DECIMAL(4,2) NOT NULL, CONSTRAINT fk_soil_field FOREIGN KEY (FieldID) REFERENCES ContainsField(FieldID), CONSTRAINT fk_soil_rule FOREIGN KEY (SampleDate, pH) REFERENCES MoistureByChemistry(SampleDate, pH));	<table><tr><th>SoilCondID</th><th>FieldID</th><th>SampleDate</th><th>pH</th></tr><tr><td>1</td><td>1001</td><td>2023-03-15</td><td>6.5</td></tr><tr><td>2</td><td>1001</td><td>2023-04-20</td><td>7</td></tr><tr><td>3</td><td>1001</td><td>2023-10-05</td><td>5.2</td></tr><tr><td>4</td><td>1002</td><td>2023-05-10</td><td>5.8</td></tr><tr><td>5</td><td>1002</td><td>2023-06-25</td><td>6.2</td></tr><tr><td>6</td><td>1002</td><td>2023-10-20</td><td>6.8</td></tr><tr><td>7</td><td>1003</td><td>2023-07-30</td><td>7.5</td></tr><tr><td>8</td><td>1003</td><td>2023-08-15</td><td>6.9</td></tr><tr><td>9</td><td>1003</td><td>2023-09-01</td><td>4</td></tr><tr><td>10</td><td>1004</td><td>2023-09-15</td><td>4.5</td></tr><tr><td>11</td><td>1004</td><td>2023-10-05</td><td>5.2</td></tr><tr><td>12</td><td>1004</td><td>2023-10-20</td><td>6.8</td></tr><tr><td>13</td><td>1005</td><td>2023-09-01</td><td>4</td></tr><tr><td>14</td><td>1005</td><td>2023-09-15</td><td>4.5</td></tr><tr><td>15</td><td>1005</td><td>2023-10-05</td><td>5.2</td></tr><tr><td>16</td><td>1006</td><td>2024-09-15</td><td>5.5</td></tr><tr><td>17</td><td>1006</td><td>2024-10-05</td><td>5.7</td></tr><tr><td>18</td><td>1006</td><td>2024-10-20</td><td>4.2</td></tr></table>	SoilCondID	FieldID	SampleDate	pH	1	1001	2023-03-15	6.5	2	1001	2023-04-20	7	3	1001	2023-10-05	5.2	4	1002	2023-05-10	5.8	5	1002	2023-06-25	6.2	6	1002	2023-10-20	6.8	7	1003	2023-07-30	7.5	8	1003	2023-08-15	6.9	9	1003	2023-09-01	4	10	1004	2023-09-15	4.5	11	1004	2023-10-05	5.2	12	1004	2023-10-20	6.8	13	1005	2023-09-01	4	14	1005	2023-09-15	4.5	15	1005	2023-10-05	5.2	16	1006	2024-09-15	5.5	17	1006	2024-10-05	5.7	18	1006	2024-10-20	4.2
SoilCondID	FieldID	SampleDate	pH																																																																										
1	1001	2023-03-15	6.5																																																																										
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17	1006	2024-10-05	5.7																																																																										
18	1006	2024-10-20	4.2																																																																										
CREATE TABLE AwardExpiry (AwardedDate DATE PRIMARY KEY, ExpiryDate DATE NOT NULL);	<table><tr><th>AwardedDate</th><th>ExpiryDate</th></tr><tr><td>2021-10-16</td><td>2023-10-16</td></tr><tr><td>2022-01-15</td><td>2024-01-15</td></tr><tr><td>2023-02-15</td><td>2025-02-15</td></tr><tr><td>2024-05-11</td><td>2026-05-11</td></tr><tr><td>2024-12-30</td><td>2026-12-30</td></tr></table>	AwardedDate	ExpiryDate	2021-10-16	2023-10-16	2022-01-15	2024-01-15	2023-02-15	2025-02-15	2024-05-11	2026-05-11	2024-12-30	2026-12-30																																																																
AwardedDate	ExpiryDate																																																																												
2021-10-16	2023-10-16																																																																												
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2024-05-11	2026-05-11																																																																												
2024-12-30	2026-12-30																																																																												
CREATE TABLE Certification (CertID INT PRIMARY KEY, Name VARCHAR(80) NOT NULL, AwardedDate DATE NOT NULL, CONSTRAINT fk_cert_award FOREIGN KEY (AwardedDate) REFERENCES AwardExpiry(AwardedDate));	<table><tr><th>CertID</th><th>Name</th><th>AwardedDate</th></tr><tr><td>1</td><td>Organic</td><td>2022-01-15</td></tr><tr><td>2</td><td>Winner</td><td>2023-02-15</td></tr><tr><td>3</td><td>BestFarm</td><td>2024-12-30</td></tr><tr><td>4</td><td>PrettiestFarm</td><td>2024-05-11</td></tr><tr><td>5</td><td>BestEnvironment</td><td>2021-10-16</td></tr></table>	CertID	Name	AwardedDate	1	Organic	2022-01-15	2	Winner	2023-02-15	3	BestFarm	2024-12-30	4	PrettiestFarm	2024-05-11	5	BestEnvironment	2021-10-16																																																										
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5	BestEnvironment	2021-10-16																																																																											

<pre> CREATE TABLE Receives (FarmID INT, CertID INT, PRIMARY KEY (FarmID, CertID), CONSTRAINT fk_recv_farm FOREIGN KEY (FarmID) REFERENCES OwnsFarm(FarmID), CONSTRAINT fk_recv_cert FOREIGN KEY (CertID) REFERENCES Certification(CertID)); </pre>	<table> <tr> <th>FarmID</th><th>CertID</th></tr> <tr><td>101</td><td>1</td></tr> <tr><td>101</td><td>2</td></tr> <tr><td>102</td><td>1</td></tr> <tr><td>103</td><td>3</td></tr> <tr><td>104</td><td>2</td></tr> <tr><td>105</td><td>1</td></tr> </table>	FarmID	CertID	101	1	101	2	102	1	103	3	104	2	105	1
FarmID	CertID														
101	1														
101	2														
102	1														
103	3														
104	2														
105	1														