```
#IMPORTING NECESSARY LIBRARIES
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression

df=pd.read_csv("smart_plant_monitoring_data.csv")
```

```
#IMPORTING NECESSARY LIBRARIES
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
```

```
df.head() #returns first 5 entries
```

```
             Timestamp  Soil_Moisture Soil_Status Pump_Status
Battery_Voltage
0  2025-06-23 00:00:00            774      Medium          OFF
3.98
1  2025-06-23 01:00:00            679      Medium          OFF
3.92
2  2025-06-23 02:00:00            797      Medium          OFF
3.91
3  2025-06-23 03:00:00            928      Medium          OFF
3.92
4  2025-06-23 04:00:00            664      Medium          OFF
3.99
```

```
df.tail() #returns first 5 entries
```

```
                Timestamp  Soil_Moisture Soil_Status Pump_Status
163  2025-06-29 19:00:00            576      Medium          OFF  \
164  2025-06-29 20:00:00            844      Medium          OFF
165  2025-06-29 21:00:00            761      Medium          OFF
166  2025-06-29 22:00:00            823      Medium          OFF
167  2025-06-29 23:00:00            984         Dry           ON

     Battery_Voltage
163             3.91
164             4.01
165             3.93
166             4.10
167             3.99
```

```
df.shape
```

```
(168, 5)
```

```
df.isnull().sum()
```

```
Timestamp          0
Soil_Moisture      0
Soil_Status        0
Pump_Status        0
Battery_Voltage    0
dtype: int64
```

```
df.dtypes
```

```
Timestamp           object
Soil_Moisture        int64
Soil_Status         object
Pump_Status         object
Battery_Voltage    float64
dtype: object
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 168 entries, 0 to 167
Data columns (total 5 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   Timestamp        168 non-null    object 
 1   Soil_Moisture    168 non-null    int64  
 2   Soil_Status      168 non-null    object 
 3   Pump_Status      168 non-null    object 
 4   Battery_Voltage  168 non-null    float64
dtypes: float64(1), int64(1), object(3)
memory usage: 6.7+ KB
```

```
data=df.groupby('Soil_Status')
```

```
df.head()
```

```
             Timestamp  Soil_Moisture Soil_Status Pump_Status
Battery_Voltage
0  2025-06-23 00:00:00            774      Medium         OFF
3.98
1  2025-06-23 01:00:00            679      Medium         OFF
3.92
2  2025-06-23 02:00:00            797      Medium         OFF
3.91
3  2025-06-23 03:00:00            928      Medium         OFF
3.92
4  2025-06-23 04:00:00            664      Medium         OFF
3.99
```

```
df.head()
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```
             Timestamp  Soil_Moisture Soil_Status Pump_Status
Battery_Voltage
0  2025-06-23 00:00:00            774      Medium         OFF
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3.92
2  2025-06-23 02:00:00            797      Medium         OFF
3.91
3  2025-06-23 03:00:00            928      Medium         OFF
3.92
4  2025-06-23 04:00:00            664      Medium         OFF
3.99
```

```
df['Timestamp'] = pd.to_datetime(df['Timestamp'])

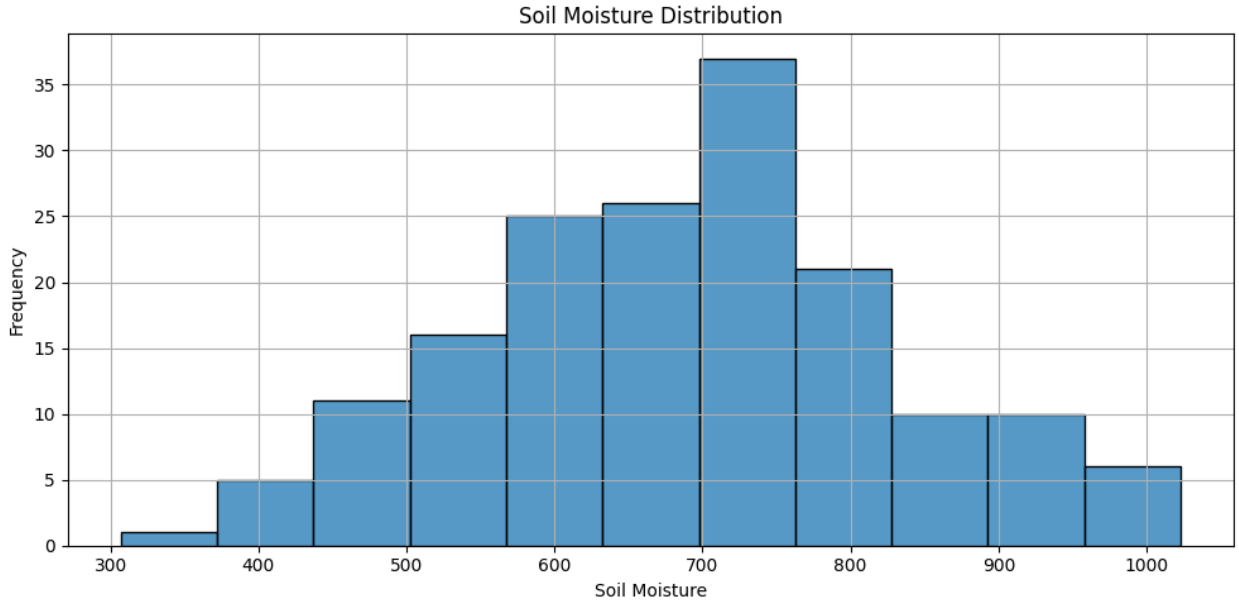
print("Dataset Summary:")
print(df.describe())
```

```
Dataset Summary:
                 Timestamp  Soil_Moisture  Battery_Voltage
count                  168     168.000000       168.000000
mean   2025-06-26 11:30:00     693.333333         4.007798
min    2025-06-23 00:00:00     307.000000         3.680000
25%    2025-06-24 17:45:00     597.750000         3.930000
50%    2025-06-26 11:30:00     698.500000         4.010000
75%    2025-06-28 05:15:00     778.750000         4.070000
max    2025-06-29 23:00:00    1023.000000         4.390000
std                    NaN     140.841809         0.098385
```

```
soil_counts = df['Soil_Status'].value_counts()
print("\nSoil Status Counts:")
print(soil_counts)
```

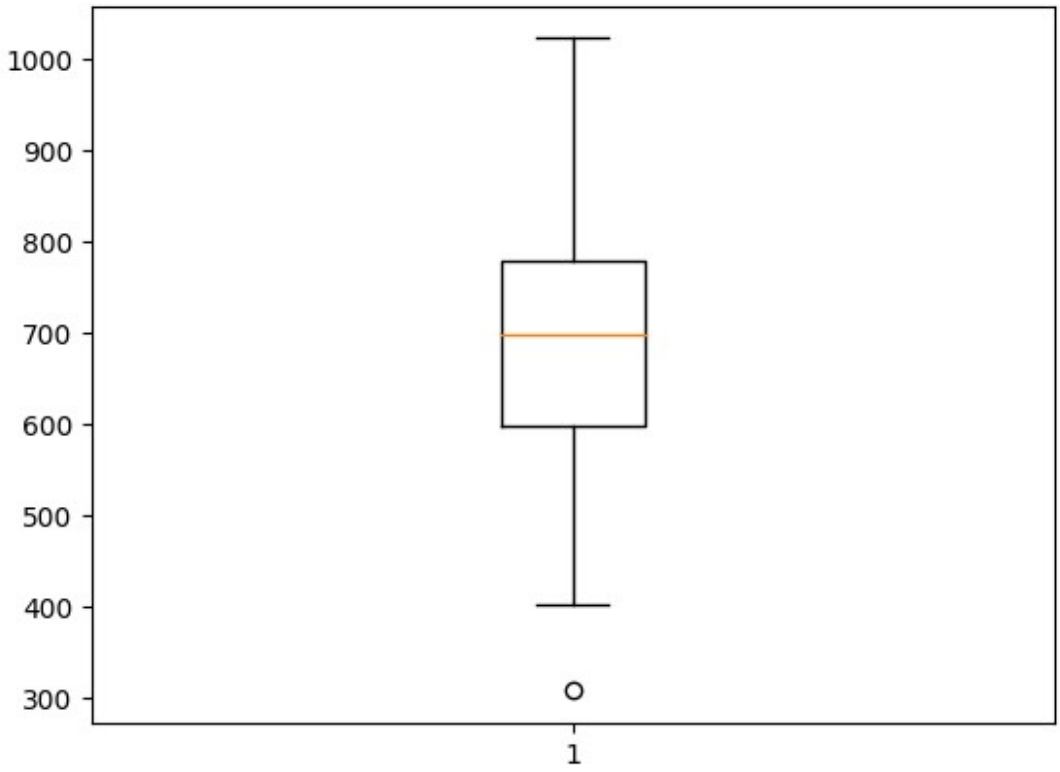
```
Soil Status Counts:
Soil_Status
Medium    161
Dry         6
Wet         1
Name: count, dtype: int64
```

```
plt.figure(figsize=(10, 5))
sns.histplot(df['Soil_Moisture'])
plt.title("Soil Moisture Distribution")
plt.xlabel("Soil Moisture")
plt.ylabel("Frequency")
plt.grid(True)
plt.tight_layout()
plt.show()
```



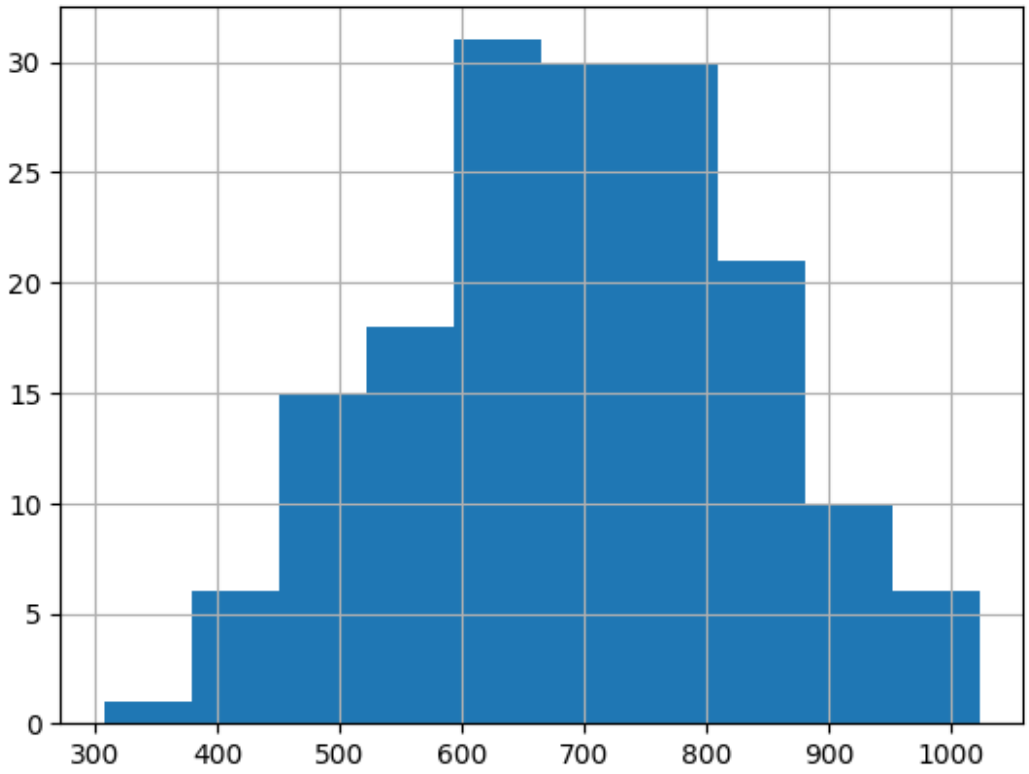

```
plt.boxplot(df['Soil_Moisture'])
```

```
{'whiskers': [<matplotlib.lines.Line2D at 0x2d5de68ab20>,
  <matplotlib.lines.Line2D at 0x2d5de68aeb0>],
 'caps': [<matplotlib.lines.Line2D at 0x2d5de69b280>,
  <matplotlib.lines.Line2D at 0x2d5de69b610>],
 'boxes': [<matplotlib.lines.Line2D at 0x2d5de68a760>],
 'medians': [<matplotlib.lines.Line2D at 0x2d5de69b9a0>],
 'fliers': [<matplotlib.lines.Line2D at 0x2d5de69bd30>],
 'means': []}
```



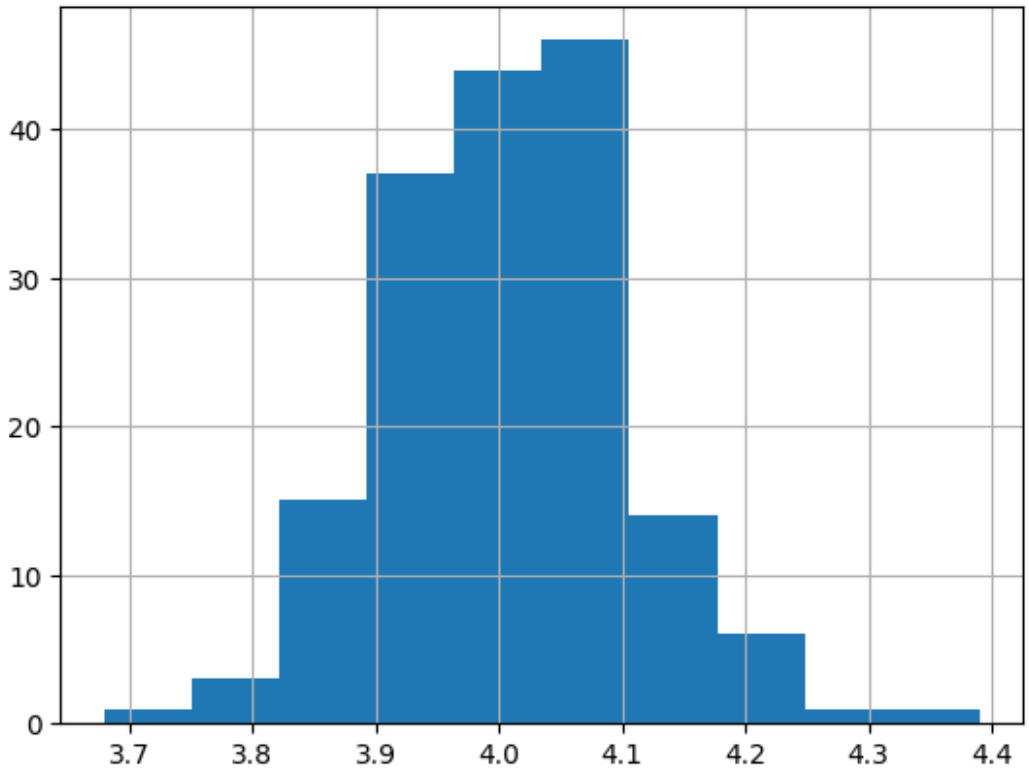

```
df['Soil_Moisture'].hist()
```

```
<AxesSubplot:>
```

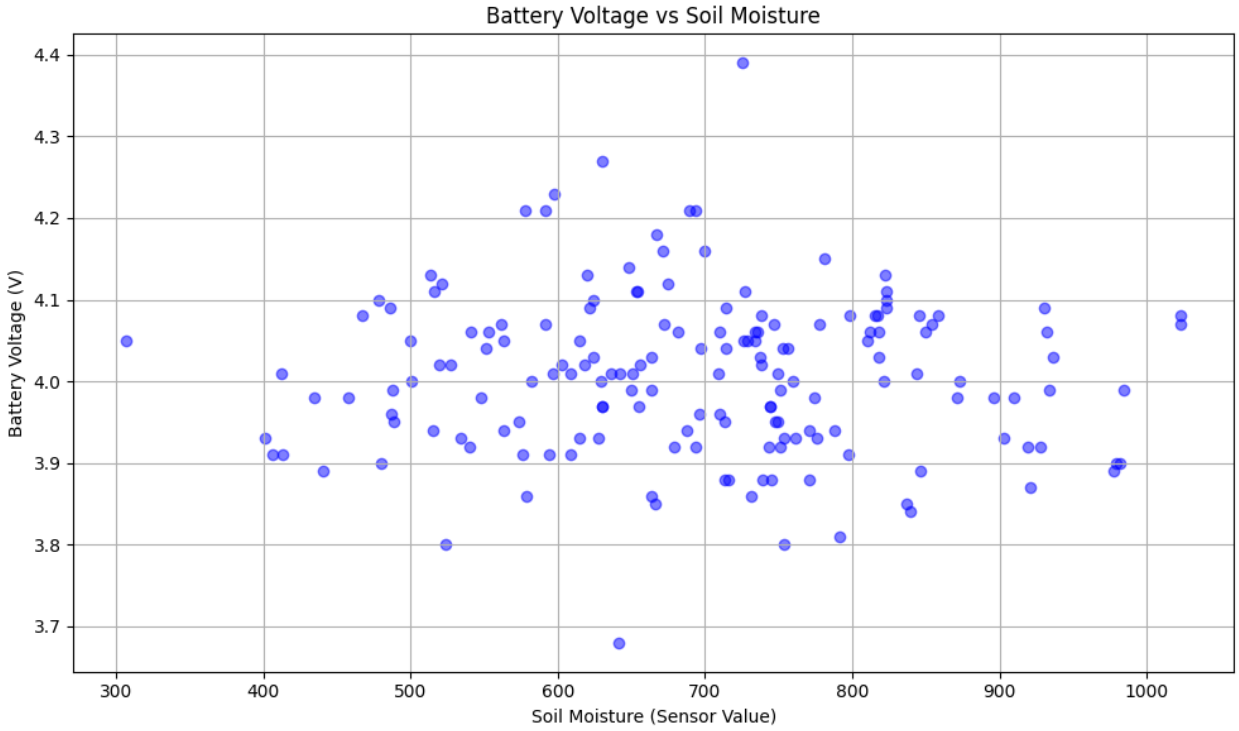



```
df['Battery_Voltage'].hist()
```

```
<AxesSubplot:>
```

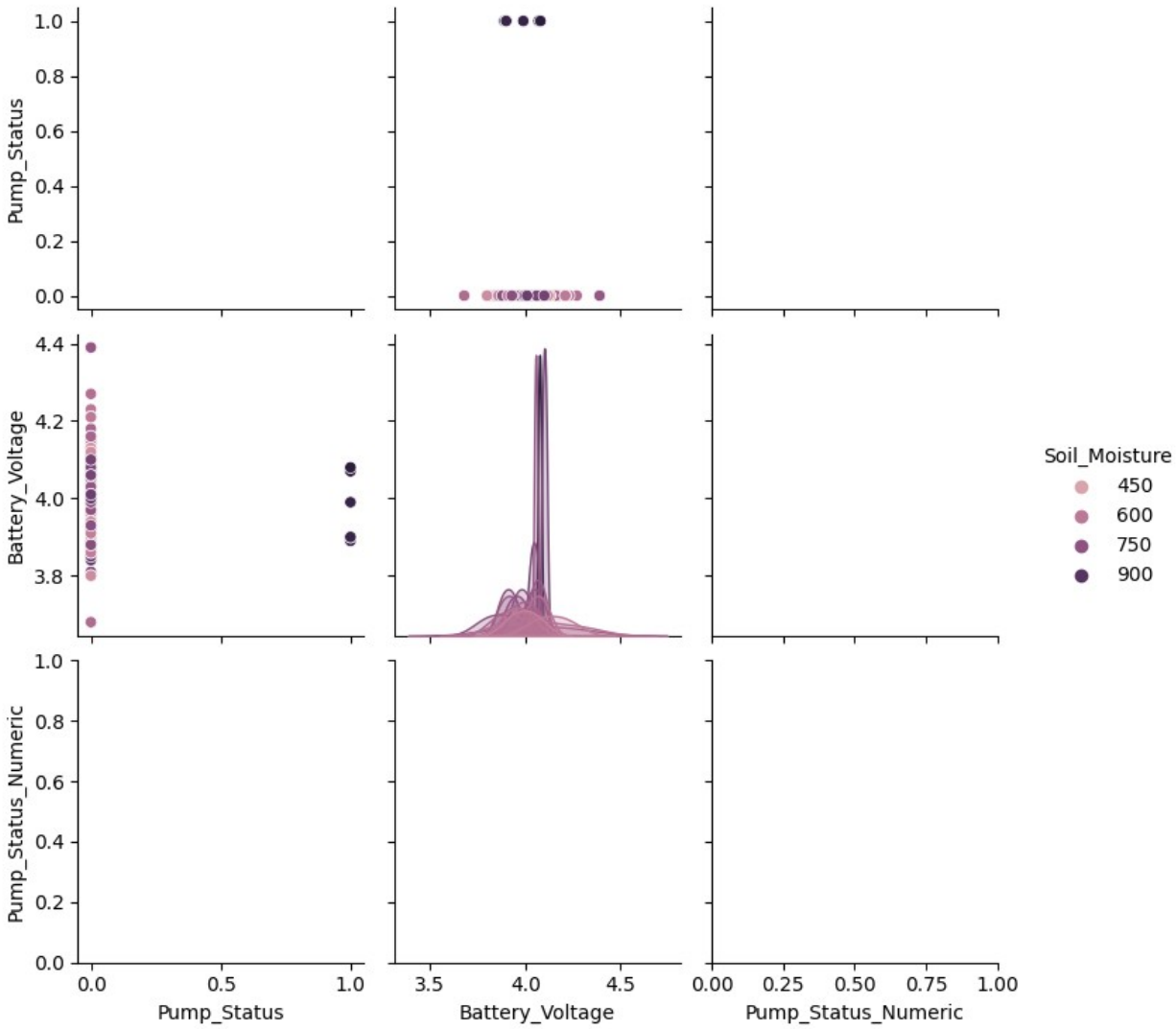



```
plt.figure(figsize=(10, 6))
plt.scatter(df['Soil_Moisture'], df['Battery_Voltage'], alpha=0.5,
color='blue')
plt.title('Battery Voltage vs Soil Moisture')
plt.xlabel('Soil Moisture (Sensor Value)')
plt.ylabel('Battery Voltage (V)')
plt.grid(True)
plt.tight_layout()
plt.show()
```



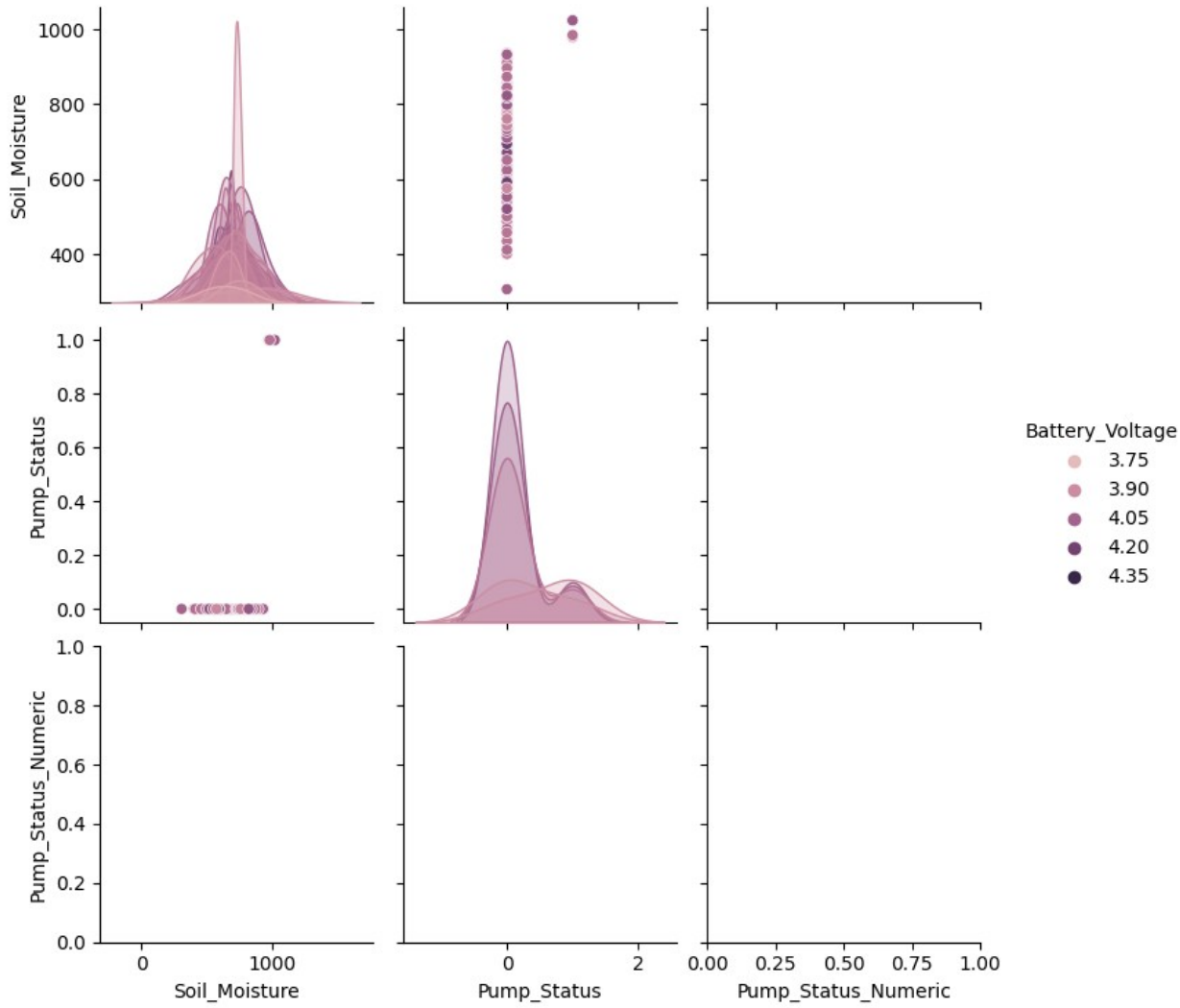

```
sns.pairplot(df, hue='Soil_Moisture')
```

```
<seaborn.axisgrid.PairGrid at 0x2d5dc838d60>
```

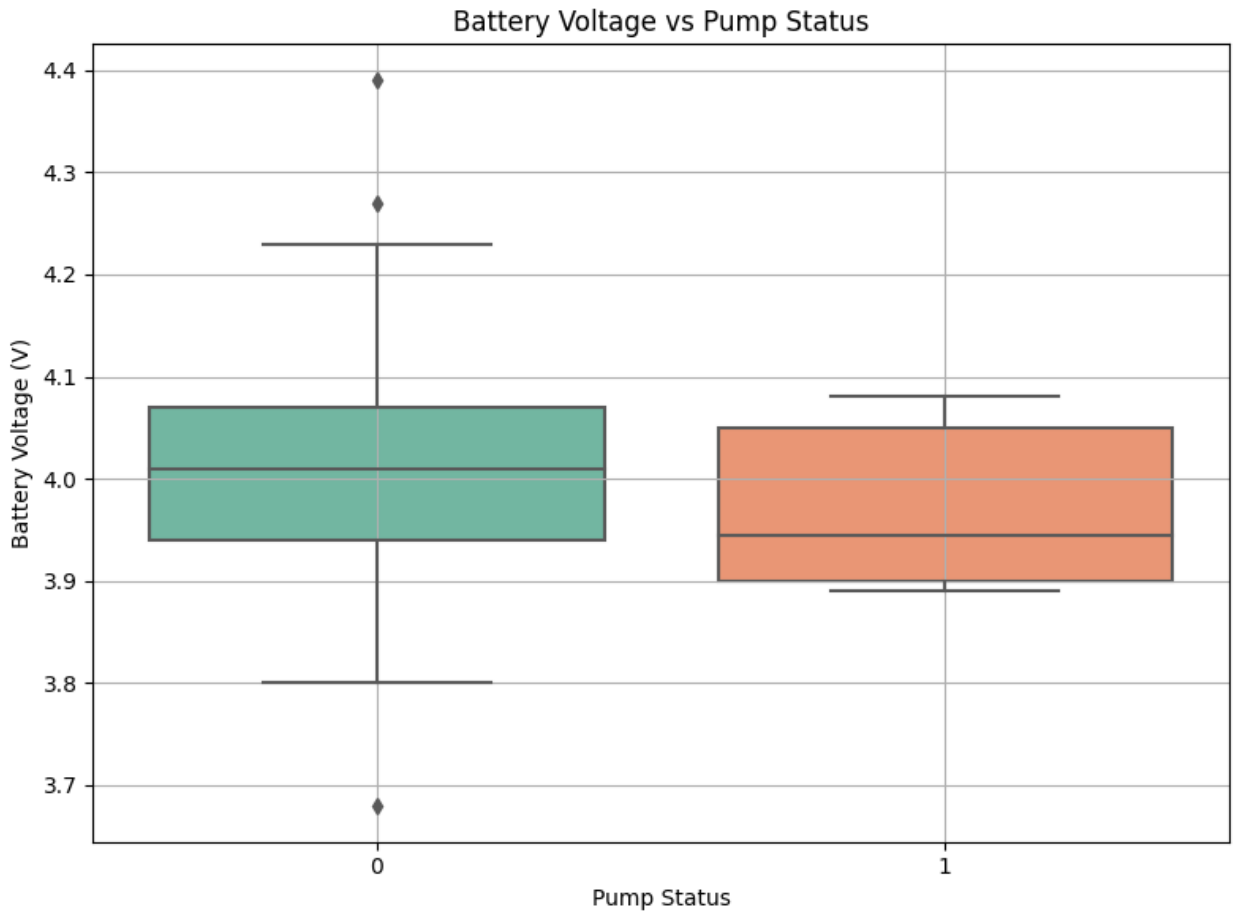



```
sns.pairplot(df, hue='Battery_Voltage')
```

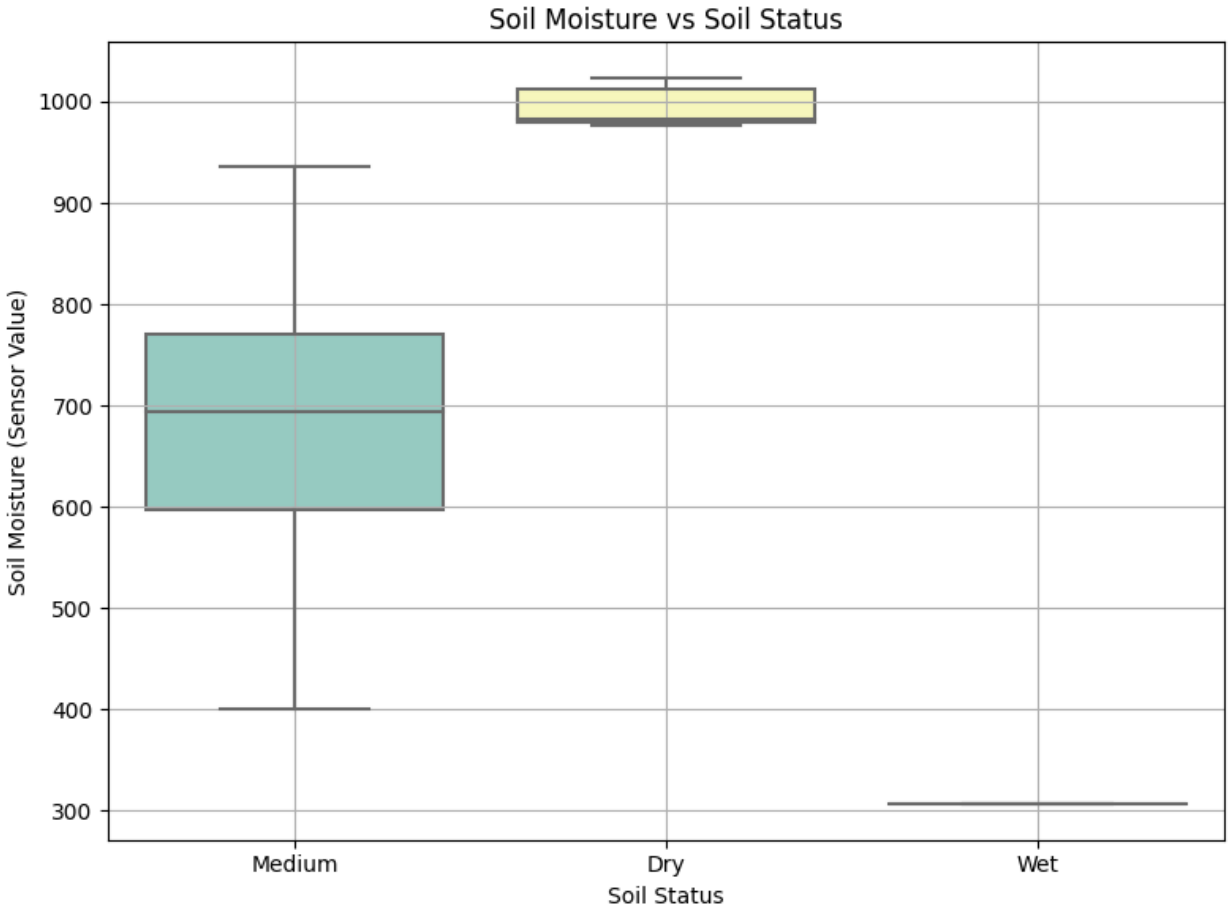
```
<seaborn.axisgrid.PairGrid at 0x2d5dc85a3d0>
```




```
plt.figure(figsize=(8, 6))
sns.boxplot(x='Pump_Status', y='Battery_Voltage', data=df,
palette='Set2')
plt.title('Battery Voltage vs Pump Status')
plt.xlabel('Pump Status')
plt.ylabel('Battery Voltage (V)')
plt.grid(True)
plt.tight_layout()
plt.show()
```

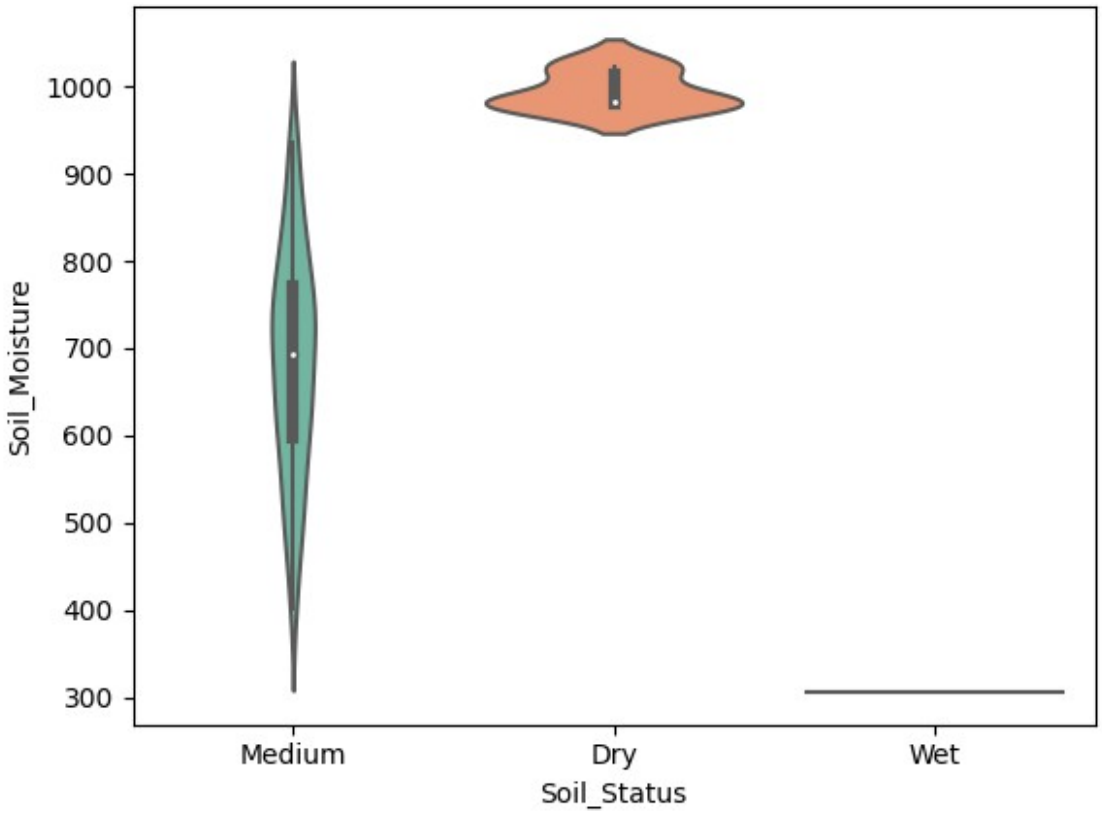



```
plt.figure(figsize=(8, 6))
sns.boxplot(x='Soil_Status', y='Soil_Moisture', data=df,
palette='Set3')
plt.title('Soil Moisture vs Soil Status')
plt.xlabel('Soil Status')
plt.ylabel('Soil Moisture (Sensor Value)')
plt.grid(True)
plt.tight_layout()
plt.show()
```

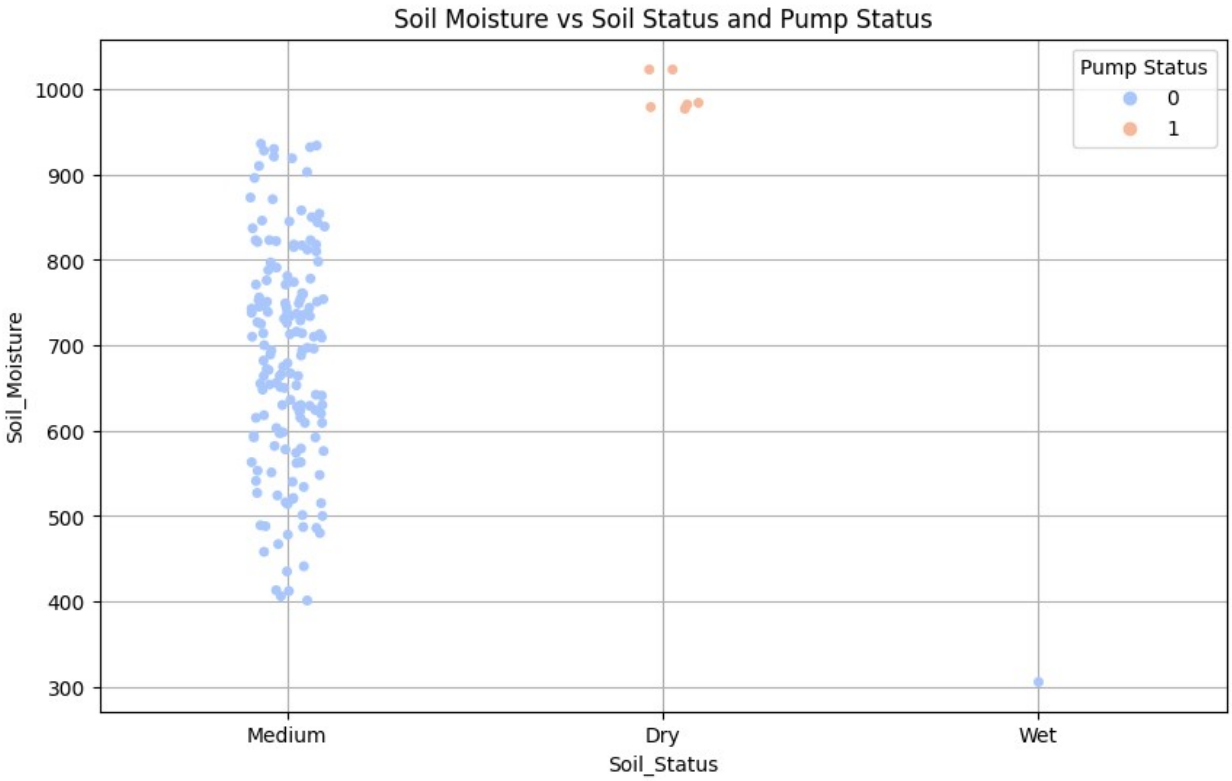



```
sns.violinplot(x='Soil_Status', y='Soil_Moisture', data=df,
palette='Set2')
```

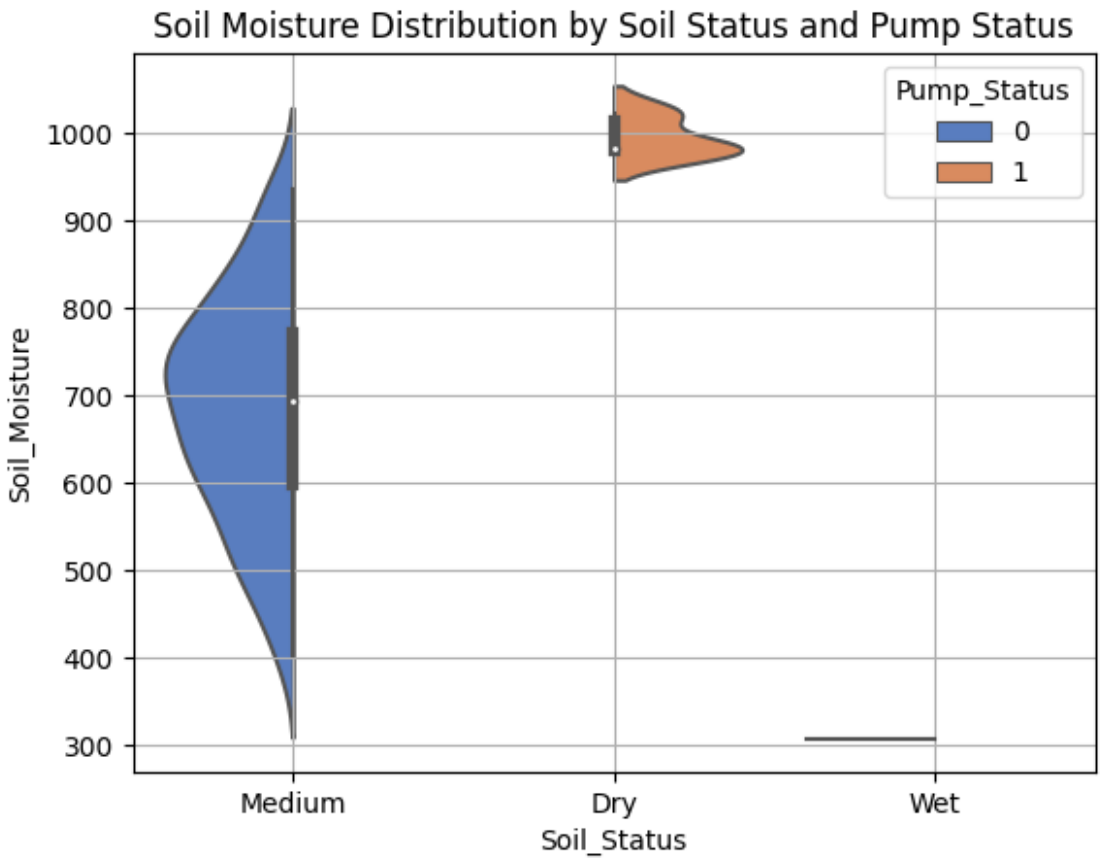
```
<AxesSubplot:xlabel='Soil_Status', ylabel='Soil_Moisture'>
```




```
plt.figure(figsize=(10, 6))
sns.stripplot(x='Soil_Status', y='Soil_Moisture', hue='Pump_Status',
data=df, jitter=True, palette='coolwarm')
plt.title('Soil Moisture vs Soil Status and Pump Status')
plt.legend(title='Pump Status')
plt.grid(True)
plt.show()
```




```
sns.violinplot(x='Soil_Status', y='Soil_Moisture', hue='Pump_Status',
data=df, split=True, palette='muted')
plt.title('Soil Moisture Distribution by Soil Status and Pump Status')
plt.grid(True)
plt.show()
```




```
import pandas as pd
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
from sklearn.preprocessing import LabelEncoder

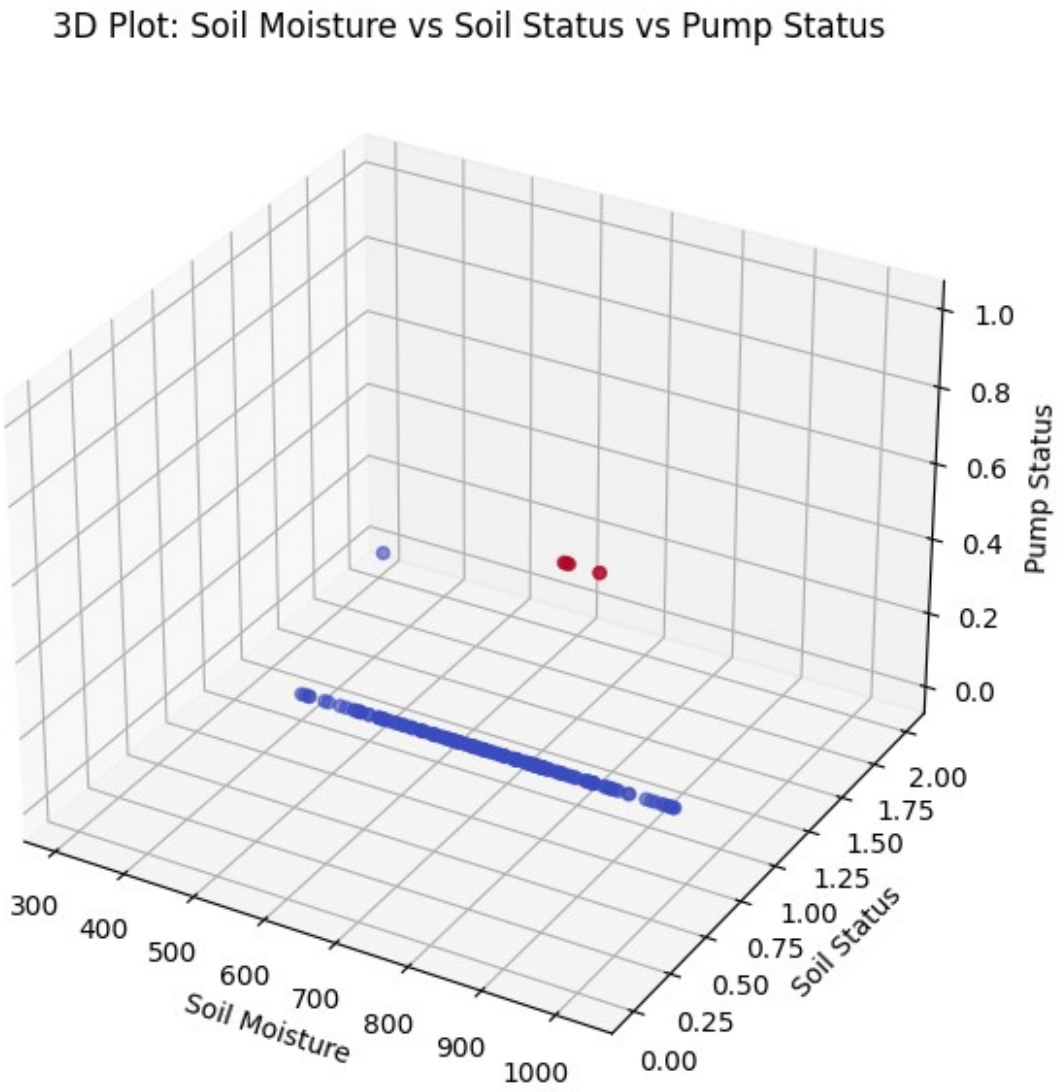
le_soil = LabelEncoder()
le_pump = LabelEncoder()
df['Soil_Status_Code'] = le_soil.fit_transform(df['Soil_Status'])
df['Pump_Status_Code'] = le_pump.fit_transform(df['Pump_Status'])

fig = plt.figure(figsize=(10, 7))
ax = fig.add_subplot(111, projection='3d')

ax.scatter(df['Soil_Moisture'],
df['Soil_Status_Code'],
df['Pump_Status_Code'],
c=df['Pump_Status_Code'], cmap='coolwarm', alpha=0.6)

ax.set_xlabel('Soil Moisture')
ax.set_ylabel('Soil Status')
ax.set_zlabel('Pump Status')
ax.set_title('3D Plot: Soil Moisture vs Soil Status vs Pump Status')
```

```
Text(0.5, 0.92, '3D Plot: Soil Moisture vs Soil Status vs Pump Status')
```




```
ax.set_yticks([0, 1, 2])
ax.set_yticklabels(le_soil.inverse_transform([0, 1, 2]))
ax.set_zticks([0, 1])
ax.set_zticklabels(le_pump.inverse_transform([0, 1]))

plt.tight_layout()
plt.show()
```

```
<Figure size 640x480 with 0 Axes>
```

```
pd.crosstab(df['Soil_Status'], df['Pump_Status'])
```

```
Pump_Status    0  1
Soil_Status
Dry            0  6
Medium       161  0
Wet            1  0
```