

**A MAJOR PROJECT**  
**On**  
**AGRICULTURE OPTIMIZATION DATA ANALYSIS**

Dissertation submitted in the partial fulfillment of the  
requirements for the award of the degree of

**BACHELOR OF TECHNOLOGY**

*By*

**DEPARTMENT OF INTERNSHIPS**

<b>Mr. Neyyala Tarun Kumar</b>	<b>CSINP40D</b>
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*Under the esteemed Guidance of*

**Er. Y V D CHANDRA SEKHAR**

*Founder & Chief Executive Officer*

**CS CODENZ**



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**GUDIVADA – 521 323, ANDHRA PRADESH, INDIA**  
**2022-2023**

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## **CS CODENZ**



### **CERTIFICATE**

This is to certify that dissertation entitled "**PROJECT ON AGRICULTURE OPTIMIZATION DATA ANALYSIS**" submitted by Neyyala Tarun Kumar (CSINP40D), Kutchrlapati Reshma (CSINP40E), Vadlana Pravalika (CSINP40E), Chelimela Mounika (CSINP40C), Shaik Borra Shoheb Akthar (CSINP40B) in the partial fulfillment of the requirements for the award of the degree of **BACHELOR OF TECHNOLOGY** from CS CODENZ is a record of Bonafede work carried out by them under my guidance and supervision during the year 2022-2023. The result embodied in this dissertation have not been submitted by any other university or institution for the award of degree

#### **Signature of the Supervisor**

**Er. Y V D CHANDRA SEKHAR**

**Founder & CEO, CS CODENZ**

## **DECLARATION**

I Neyyala Tarun Kumar (CSINP40D) declared that the dissertation report entitled “PROJECT ON AGRICULTURE OPTIMIZATION DATA ANALYSIS” is no more than 1,00,000 words in length including quotes and exclusive of tables, figures, bibliography, and references. This dissertation contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated this dissertation is our own work.

<b>Roll No</b>	<b>Name</b>	<b>Signature</b>
CSINP40D	Neyyala Tarun Kumar	

Date:

Place:

## COs, POs and PSOs Mapping

Subject Name : Major Project

Subject Code : PY42223

Subject Code	Course Outcomes	
PR4204	CO1	Formulate solutions to computing problems using latest technologies and tools
	CO2	Work effectively in teams to design and implement solutions to computational problems and socially relevant issues
	CO3	Recognize the social and ethical responsibilities of a professional working in the discipline
	CO4	Apply advanced algorithmic and mathematical concepts to the design and analysis of software
	CO5	Devise a communication strategy (language, content and medium) to deliver messages according to the situation and need of the audience.
	CO6	Deliver effective presentations, extemporaneous or impromptu oral presentations. Setting up technical reports using technical tools.

### CO-PO-PSOs Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	-	2	2	-	-	-	-	-	-	-	3	-	-
CO 2	2	3	-	2	2	-	-	-	-	-	-	-	3	-	-
CO 3	2	3	-	2	2	-	-	-	-	-	-	-	3	-	-
CO 4	3	3	-	2	2	-	-	-	-	-	-	2	3	-	-
CO 5	2	2	3	3	2	-	-	-	-	3	2	1	3	-	-
CO 6	3	3	2	2	3	-	-	-	2	2	2	2	3	-	-
<b>Avg</b>	<b>2.50</b>	<b>2.66</b>	<b>2.50</b>	<b>2.17</b>	<b>2.17</b>	-	-	-	<b>2.00</b>	<b>2.50</b>	<b>2.00</b>	<b>1.6.7</b>	<b>3.00</b>	-	-

*Note: 1 – Good, 2 – Average, 3 - Excellent*

Academic Year : 2022 - 2023

Signature of student with date

Signature of guide with date

## **ACKNOWLEDGEMENT**

This report dissertation could not have been written without the support of our guide **Er. Y V D Chandra Sekhar, Founder & CEO, CS CODENZ** who not only served as our superior but also encouraged and challenged us throughout our academic program our foremost thanks go to his. Without this dissertation would not have been possible. We appreciate him vast knowledge in many areas, and his insights, suggestions and guidance that helped to shape our research skills

It is needed with a great sense of pleasure and immense sense of gratitude that we acknowledge the help of these individuals. We owe many thanks to many people who helped and supported us during the writing of this report

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CSINP40D	Neyyala Tarun Kumar
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## **TABLE OF CONTENT**

Abstract .....	(i)
1.Introduction .....	1
1.1 Feasibility Study.....	1
1.2 Problem Statement.....	3

## **ABSTRACT**

Modern agriculture faces the challenge of feeding an ever-growing global population while minimizing environmental impact. Agriculture optimization aims to enhance crop yields, resource efficiency, and sustainability through the integration of advanced technologies. This abstract explores key strategies such as precision farming, data-driven decision-making, remote sensing, and AI-assisted practices. By harnessing real-time data, predictive analytics, and innovative cultivation methods, agriculture optimization seeks to strike a balance between productivity and ecological conservation, ensuring food security for future generations.

# Chapter-1

## INTRODUCTION

### 1.1 Feasibility Study:

#### AGRICULTURE OPTIMIZATION

##### Agriculture:

Agriculture means growing of crops, vegetables, crops & cultivating soil. The agriculture leads a main role in our daily lives. India is an agricultural country produce a large amount of product (crops, vegetables, fruits etc..).

Agriculture is a source of food & also provides an employment for large population. On 23<sup>rd</sup> December India celebrates national formers day. Some of the top agricultural states in India is Uttar Pradesh, West Bengal, Punjab.

##### Types of Agriculture:

We commonly use three types of Agriculture processes

1. Organic farming.
2. Commercial farming.
3. Subsistence farming.

##### Agriculture optimization:

##### Optimization:

Optimization means the process of getting results in an effective & Perfective way.

##### Why we should use optimization in agriculture?

To increase growing of crops & cultivating of soil in an effective way. It decreases stress & hard work to the workers (Formers). It is also used to decreases the inputs for agriculture and helps to increase the outcome of the agriculture. In the process of optimization, we will use pesticides, hybrid seeds. Water consumption can be optimized by improving irrigation system etc.

The technology in agriculture has developed a lot as compared to olden days and present. The technology increases day by day in olden days the lot of workers used to work for agriculture after optimization is introduced some machines due to this work time will reduces and introduce time complexity and reduces work pressure.

Now a days we will use some machineries to reduce the time for growing up of crops like Tractors, Cultivators, Land imprinter, planter, sprinkler system, bale wrapper etc.

## **Advantages of optimization in agriculture:**

- It reduces human labors in agriculture to work in fields.
- 
- The crops were growing up in an efficiently in an effective way.
- It improves the structure of soil.
- It reduces the cost & negative impact on environment.
- Minimization of water, reduces the time for agriculture process.
- It introduces a pesticide, fertilizers in organic manner, high quality seeds to protect from insects and diseases, Bacteria & virus.

## **Disadvantages:**

- Negative impact on environment.
- Water & soil pollution.
- High maintenance cost for the machinery.
- Loss of traditional skills of agriculture.

## **Conclusion:**

The food & agriculture sector is very important in everyday life. The Indian economy depends highly on the agriculture sector. The agriculture sector also supports an industrial sector and international trade. Its improvements include more efficient resource allocation, better crop management, optimized irrigation strategies, and enhanced decision-making processes. The use of data analysis tools and techniques can lead to increased yields, reduced waste, and ultimately contribute to more sustainable and productive agricultural practices. They can generate benefits for the producers and society. Also, the use of technology in agriculture has increased a lot compared to old days.

## **1.2 Problem Statement:**

These days there is more global population. We should need to maximize agricultural productivity. Sometimes farming methods are wasteful and do not always generate the highest yields. There is a lot of growing demand for farming. Farmers have many problems that is with the climate change, soil irrigation. Nowadays, people are changing tastes and expectations on food. There are irrigation problems lack of high-quality seeds lack of insurance, lack of income. Farmers in developing country have time. They have to transport this food by roads, vehicles and also, they carry these farms to local markets on foot or bicycle. It takes lot of time for travelling. By the technique of optimization, they use lot of fertilizers, loss of soil fertility these are major problems

## **Abstract:**

Modern agriculture faces the challenge of feeding an ever-growing global population while minimizing environmental impact. Agriculture optimization aims to enhance crop yields, resource efficiency, and sustainability through the integration of advanced technologies. This abstract explores key strategies such as precision farming, data-driven decision-making, remote sensing, and AI-assisted practices. By harnessing real-time data, predictive analytics, and innovative cultivation methods, agriculture optimization seeks to strike a balance between productivity and ecological conservation, ensuring food security for future generations.

## Chapter-2

### MOTIVATION AND OBJECTIVE

#### 2.1 Motivation:

They can generate benefits for the produce and society by increasing agriculture yield reducing costs and reducing the negotiate impacts on the environment in this. We can learn new things the ultimate goal of farming is not the growing of crops but the cultivation and perfection of human beings. Agriculture is the most helpful and most useful. People think by doing agriculture we cannot earn money if everyone thinks the same then there will be no food. We should respect the farmer. The farmer is also God because of the farmer we get food without food people can't live. Agriculture is the most important sector that influences the economy of India.

Agriculture contributes to 18% of India's gross Domestic Product. People of India are practicing Agriculture for years but the results are never satisfying due to various factors that affect the crop yield so, we will use optimization in agriculture. Like Machine learning techniques, Artificial intelligence, IoT etc...

#### 2.2 Objective:

The main objectives of the agriculture optimization are:

- To protect and decrease the pollution of environment and natural resources
- To reduce the working of people
- To minimize the usage of the Fertilizers, Chemicals.
- To maximize the crop yield quantity and quality.
- Earning more foreign exchanges.

## Chapter-3

### SOFTWARE AND HARDWARE REQUIREMENTS

#### ❖ Software Requirements:

<b>Operating System</b>	: Windows 7 or higher/ Linux/ Mac Os
<b>Programming Language</b>	: Python
<b>Modules Required</b>	: NumPy, Pandas, Mat plot lib.
<b>Datasets</b>	: Created by own
<b>IDE's</b>	: Google Collaboratory, Spyder, Anaconda

#### ❖ Hardware requirements:

<b>Processor</b>	: Corei3 or higher
<b>RAM</b>	: Minimum of 4GB
<b>Hard disc</b>	: Minimum of 500GB

## Chapter-4

### LITERATURE SURVEY

A large number of studies have been carried out on the agriculture sector and measurement of its productivity in India. All these studies can be categorized into two group agriculture sector and other crops specific sector. These studies have proved that Total Factor Productivity growth of agriculture has been vital contributing for acceleration of Indian national income growth.

The number of techniques & technologies are used in agriculture to develop the production and crop health and decreasing the time and work of the people.

**Eg:**

- Irrigation.
- Crop rotation.
- Inter cropping.
- Organic farming.
- Precision agriculture.

## Chapter-5

### KEYWORDS AND DEFINITIONS

#### **5.1 Classification:**

It is a predictive it focuses on the values in a data set.

#### **5.2 Regression:**

It's a process of fitting the data into graph in straight or curved shape.

#### **5.3 Clustering:**

Grouping the data into their own belongs.

#### **5.4 Data Visualization:**

The process of representing the data into a graphical representation. Here we need to use a module called "Matplotlib".

#### **5.5 Correlation:**

It's a relation between two column data members in a data set, we can use a method corr () for find the Correlation. It lies Between **-1 to +1**.

#### **5.6 Covariance:**

The relation between two data members which are in two different attributes. It is a measurement of correlation. Its lies between  $-\infty$  to  $+\infty$

#### **5.7 Data Mining:**

It's a process of gathering all information/data regards data set i.e Collection of data set for transforming raw data to another for performing better operations & easy to understand. It's also known as Data Wrangling.

#### **5.8 Data filtering:**

It's a process of getting only required data or information from the resources is known as data filtering. We don't have any methods for filtering the data.

## Chapter-6

### METHODOLOGY

#### **6.1 Data set generation:**

Data set Generation is a process of creating the data set. Data set is a collection of data. In the case of tabular form. We create our data set by using the predicted values of the past data of agriculture.

**Eg:** Data set of students.

```
import numpy as np
import pandas as pd
ds=
{
'S.no':pd.Series([1,2,3,4,5]),
'Name':pd.Series(['Tarun','Reshma','Mounika','Akthar','Pravallika']),
'Age':pd.Series([18,18,18,18,18]),
}
df=pd.DataFrame(ds)
print(df)
```

#### **Output:**

	S.no	Name	Age
0	1	Tarun	18
1	2	Reshma	18
2	3	Mounika	18
3	4	Akthar	18
4	5	Pravallika	18

#### **6.2 Operations:**

Deep Copy, Shallow copy, Viewing of data, info(), Row operations, column operations, slicing, Correlation, Covariance etc...

**Eg1:** Shallow copy:

**Input:**

```
sc=df.copy(deep=False)
print(sc)
```

**Output:**

	S.no	Name	Age
0	1	Tarun	18
1	2	Reshma	18
2	3	Mounika	18
3	4	Akthar	18
4	5	Pravallika	18

### **6.3 Data Mining:**

It's a process of gathering all information/data regards data set i.e Collection of data set for transforming raw data to another for performing better operations & easy to understand. It's also known as Data Wrangling.

### **6.4 Data Visualization:**

The process of representing the data into a graphical representation. Here we need to use a module called "Matplotlib".

## Chapter-7

### EXPLORATORY DATA ANALYSIS

- Data Set Generation.
- Operations on Data Set.
- Data Mining.
- Data Visualization.

#### 7.1 Data Set Generation:

Data set Generation is a process of creating the data set. Data set is a collection of data. In the case of tabular form. We create our data set by using the predicted values of the past data of agriculture.

For data set generation we use the function **DataFrame & Importing Pandas Library** from python.

Here it is the Agriculture Optimization Data Analysis 20\*20 Data Set (Data Set Having 20 Columns and 20 Rows)

```
import pandas as pd  
import numpy as np  
from matplotlib import pyplot as plt
```

---

```
ds={'S.No':pd.Series([1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20]),  
'State':pd.Series(['Uttar Pradesh','Punjab','Haryana','Maharastra','Kerala','Tamilnadu','Gujarat','Karnataka','Andhra Pradesh','Arunachal Pradesh','Assam','Bihar','Chattisgarh','Himachal Pradesh','Jammu& Kashmir','Jharkhand','Manipur','Meghalaya','Mizoram','Nagaland']),  
'Population':pd.Series([199812341,27743338,25545198,112372333,33406061,72147030,60439692,61095297,  
84580777,1458545,31205576,104099452,25351462,6864602,13635010,32988134,2855794,2966889,1097206,  
1978502]),  
'Growth of Crops':pd.Series(['Rice','Maize','Sugarcane','Bajra','Coconut','Banana','Jowar','Ragi','Rice','Maize','Maize','Rice','Maize','Vegetables','Apples','Ragi','Cotton','Maize','Maize','Millet']),  
'Soil Type':pd.Series(['Sandy loan','Claly soil','Alluvial Soil','Residual','Red soil','Red Loam','Black Soil','Red Soil','Red Lateritic','Inceptisols','Hill Soil','Piedmontswamp','Clary Soil','Brown Hill Soil','Alluvial Soil','Red Soil','Inceptisols','Loamy Soil','Sand-Loamy Soil','Ultisols Soil']),  
'ph Level':pd.Series([6.54,6.83,7.45,8.01,8.10,7.30,6.25,7.72,7.80,6.47,6.81,7.07,7.65,7.66,6.86,8.40,8.10,7.65,  
6.59,8.13]),  
'Temperature':pd.Series([20.87,21.77,23.00,26.49,20.13,23.05,22.70,20.27,24.51,23.22,26.52,23.97,26.80,  
24.01,  
25.66,24.28,21.58,23.79,21.86,23.57]),  
'Humidity':pd.Series([82.00,80.31,82.32,80.15,81.60,83.37,82.63,82.89,83.53,83.03,81.41,81.45,80.88,82.05,  
80.66,80.30,82.78,80.41,80.19,83.58])}
```

```

'Season':pd.Series(['Kharif','Zaid','Rabi','Kharif','Zaid','Zaid','Rabi','Kharif','Zaid','Rabi','Kharif','Zaid','Rabi','Zaid','Kharif','Zaid','Rabi','Rabi','Zaid']),
'Area':pd.Series([1312.7,1654.8,1119.5,1055.2,9895.6,1689.1,8665.8,4985,7989.4,1055.4,1629.8,1449.9,1222.,1349.1,1439,1636.5,1334,1629.5,9560.7,1308.8]), 
'Production':pd.Series([2061,2083,1525,5239,5267,5182,1278,1763,10882,11558,13.5,15.86,102.5,104.37,192,208,208.5,3324,26.14,6443]), 
'Crop Health(%)':pd.Series([87,87,76,68,86,67,78,78,89,88,90,68,79,86,82,58,76,65,88,79]), 
'Water Quality(%)':pd.Series([50,60,87,76,67,88,47,97,86,56,77,88,56,76,77,57,87,69,58,68]), 
'Type of Agriculture Used':pd.Series(['Organic Farming', 'Aquaponics', 'Vertical Farming', 'Hydroponics', 'Permaculture', 'Precision Agriculture', 'Agroforestry', 'Greenhouse Cultivation', 'Urban Farming', 'Intensive Farming', 'Sustainable Agriculture', 'Crop Rotation', 'No-Till Farming', 'Regenerative Agriculture', 'Biodynamic Farming', 'Dry Farming', 'Alley Cropping', 'Silvopasture', 'Cover Cropping', 'Raised Bed Gardening']), 
'Water pollution(%)':pd.Series(['3.5%', '1.8%', '2.7%', '4.2%', '0.9%', '5.1%', '2.3%', '3.8%', '1.5%', '4.8%', '0.7%', '2.1%', '3.2%', '1.2%', '4.4%', '0.5%', '5.3%', '2.9%', '4.6%', '1.1%']), 
'Soil pollution(%)':pd.Series(['3.25%', '8.71%', '12.46%', '5.89%', '19.72%', '1.34%', '7.56%', '14.92%', '9.83%', '4.67%', '11.28%', '6.73%', '2.57%', '15.61%', '18.09%', '10.17%', '13.75%', '0.92%', '16.39%', '20.45%']), 
'Goverment subsidies':pd.Series(["Rashtriya Krishi Vikas Yojana","National Food Security Mission","Sub-Mission on Agricultural Mechanization","NABARD loans in India","Yantra Laxmi Scheme","Rashtriya Krishi Vikas Yojana","National Food Security Mission","Sub-Mission on Agricultural Mechanization","NABARD loans in India""Yantra Laxmi Scheme","Rashtriya Krishi Vikas Yojana","National Food Security Mission","Sub-Mission on Agricultural Mechanization","NABARD loans in India","Yantra Laxmi Scheme","Rashtriya Krishi Vikas Yojana","National Food Security Mission"]), 
'Organic Fertilizers Used (%)': pd.Series(['5%', '10%', '15%', '20%', '25%', '30%', '35%', '40%', '28.2%', '37.6%', '15.7%', '44.8%', '9.3%', '19.6%', '32.1%', '26.8%', '51.2%', '8.7%', '45%', '50%']), 
'Power Consumption (%)': pd.Series(['12.5%', '35.9%', '14.6%', '42.3%', '10.9%', '20.3%', '30.7%', '45.9%', '7.8%', '17.1%', '41.5%', '22.9%', '47.4%', '11.6%', '36.3%', '16.2%', '38.7%', '13.1%', '25.6%', '22.3%']), 
'Type of Technology Used': pd.Series(['Precision Agriculture', 'IoT Agriculture', 'Smart Farming', 'Drones in Agriculture', 'Agricultural Robots', 'Machine Learning', 'Artificial Intelligence', 'Blockchain in Agriculture', 'Data Analytics', 'Dry Farming', 'Rainfed Agriculture', 'Conservation Agriculture', 'No-Till Farming', 'Strip Cropping', 'Cover Cropping', 'Terrace Farming', 'Rice Intensification System', 'Permaculture', 'Precision Livestock Farming', 'Smart Livestock Management']) 
}

df=pd.DataFrame(ds)
print(df)

```

## Output:

S.No		State	Population	Growth of Crops	Soil Type	\
0	1	Uttar Pradesh	199812341	Rice	Sandy loam	
1	2	Punjab	27743338	Maize	Claly soil	
2	3	Haryana	25545198	Sugarcane	Alluvial Soil	
3	4	Maharastra	112372333	Bajra	Residual	
4	5	Kerala	33406061	Coconut	Red soil	
5	6	Tamilnadu	72147030	Banana	Red Loam	
6	7	Gujarat	60439692	Jowar	Black Soil	
7	8	Karnataka	61095297	Ragi	Red Soil	
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic	
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols	
10	11	Assam	31205576	Maize	Hill Soil	
11	12	Bihar	104099452	Rice	Piedmontswamp	
12	13	Chattisgarh	25351462	Maize	Clary Soil	
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil	
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil	
15	16	Jharkhand	32988134	Ragi	Red Soil	
16	17	Manipur	2855794	Cotton	Inceptisols	
17	18	Meghalaya	2966889	Maize	Loamy Soil	
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil	
19	20	Nagaland	1978502	Millet	Ultisols Soil	

ph Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00
1	6.83	21.77	80.31	Zaid	1654.8	2083.00
2	7.45	23.00	82.32	Rabi	1119.5	1525.00
3	8.01	26.49	80.15	Kharif	1055.2	5239.00
4	8.10	20.13	81.60	Zaid	9895.6	5267.00
5	7.30	23.05	83.37	Zaid	1689.1	5182.00
6	6.25	22.70	82.63	Rabi	8665.8	1278.00
7	7.72	20.27	82.89	Kharif	4985.0	1763.00
8	7.80	24.51	83.53	Kharif	7989.4	10882.00
9	6.47	23.22	83.03	Zaid	1055.4	11558.00
10	6.81	26.52	81.41	Rabi	1629.8	13.50
11	7.07	23.97	81.45	Kharif	1449.9	15.86
12	7.65	26.80	80.88	Zaid	1222.2	102.50
13	7.66	24.01	82.05	Rabi	1349.1	104.37
14	6.86	25.66	80.66	Zaid	1439.0	192.00
15	8.40	24.28	80.30	Kharif	1636.5	208.00
16	8.10	21.58	82.78	Zaid	1334.0	208.50
17	7.65	23.79	80.41	Rabi	1629.5	3324.00
18	6.59	21.86	80.19	Rabi	9560.7	26.14
19	8.13	23.57	83.58	Zaid	1308.8	6443.00

Crop Health(%)	Water Quality(%)	Type of Agriculture Used \
0	87	Organic Farming
1	87	Aquaponics
2	76	Vertical Farming
3	68	Hydroponics
4	86	Permaculture
5	67	Precision Agriculture
6	78	Agroforestry
7	78	Greenhouse Cultivation
8	89	Urban Farming
9	88	Intensive Farming
10	90	Sustainable Agriculture
11	68	Crop Rotation
12	79	No-Till Farming
13	86	Regenerative Agriculture
14	82	Biodynamic Farming
15	58	Dry Farming
16	76	Alley Cropping
17	65	Silvopasture
18	88	Cover Cropping
19	79	Raised Bed Gardening

	Water pollution(%)	Soil pollution(%) \
0	3.5%	3.25%
1	1.8%	8.71%
2	2.7%	12.46%
3	4.2%	5.89%
4	0.9%	19.72%
5	5.1%	1.34%
6	2.3%	7.56%
7	3.8%	14.92%
8	1.5%	9.83%
9	4.8%	4.67%
10	0.7%	11.28%
11	2.1%	6.73%
12	3.2%	2.57%
13	1.2%	15.61%
14	4.4%	18.09%
15	0.5%	10.17%
16	5.3%	13.75%
17	2.9%	0.92%
18	4.6%	16.39%
19	1.1%	20.45%

	Goverment subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana		5%
1	National Food Security Mission		10%
2	Sub-Mission on Agricultural Mechanization		15%
3	NABARD loans in India		20%
4	Yantra Laxmi Scheme		25%
5	Rashtriya Krishi Vikas Yojana		30%
6	National Food Security Mission		35%
7	Sub-Mission on Agricultural Mechanization		40%
8	NABARD loans in India	Yantra Laxmi Scheme	28.2%
9	Rashtriya Krishi Vikas Yojana		37.6%
10	National Food Security Mission		15.7%
11	Sub-Mission on Agricultural Mechanization		44.8%
12	NABARD loans in India	Yantra Laxmi Scheme	9.3%
13	Rashtriya Krishi Vikas Yojana		19.6%
14	National Food Security Mission		32.1%
15	Sub-Mission on Agricultural Mechanization		26.8%
16	NABARD loans in India		51.2%
17	Yantra Laxmi Scheme		8.7%
18	Rashtriya Krishi Vikas Yojana		45%
19	National Food Security Mission		50%

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management

## 7.2 Operations on Data Set.

### ➤ Shallow Copy:

Shallow copy Creates a reference of original data set.

```
sc=df.copy(deep=False)
print("***** SHALLOW COPY OF DATA SET *****")
print(sc)
```

**Output:**

***** SHALLOW COPY OF DATA SET *****							
S.No		State	Population	Growth of Crops		Soil Type	\
0	1	Uttar Pradesh	199812341	Rice	Sandy loam		
1	2	Punjab	27743338	Maize	Claly soil		
2	3	Haryana	25545198	Sugarcane	Alluvial Soil		
3	4	Maharastra	112372333	Bajra	Residual		
4	5	Kerala	33406061	Coconut	Red soil		
5	6	Tamilnadu	72147030	Banana	Red Loam		
6	7	Gujarat	60439692	Jowar	Black Soil		
7	8	Karnataka	61095297	Ragi	Red Soil		
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic		
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols		
10	11	Assam	31205576	Maize	Hill Soil		
11	12	Bihar	104099452	Rice	Piedmontswamp		
12	13	Chattisgarh	25351462	Maize	Clary Soil		
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil		
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil		
15	16	Jharkhand	32988134	Ragi	Red Soil		
16	17	Manipur	2855794	Cotton	Inceptisols		
17	18	Meghalaya	2966889	Maize	Loamy Soil		
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil		
19	20	Nagaland	1978502	Millet	Ultisols Soil		

ph Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00
1	6.83	21.77	80.31	Zaid	1654.8	2083.00
2	7.45	23.00	82.32	Rabi	1119.5	1525.00
3	8.01	26.49	80.15	Kharif	1055.2	5239.00
4	8.10	20.13	81.60	Zaid	9895.6	5267.00
5	7.30	23.05	83.37	Zaid	1689.1	5182.00
6	6.25	22.70	82.63	Rabi	8665.8	1278.00
7	7.72	20.27	82.89	Kharif	4985.0	1763.00
8	7.80	24.51	83.53	Kharif	7989.4	10882.00
9	6.47	23.22	83.03	Zaid	1055.4	11558.00
10	6.81	26.52	81.41	Rabi	1629.8	13.50
11	7.07	23.97	81.45	Kharif	1449.9	15.86
12	7.65	26.80	80.88	Zaid	1222.2	102.50
13	7.66	24.01	82.05	Rabi	1349.1	104.37
14	6.86	25.66	80.66	Zaid	1439.0	192.00
15	8.40	24.28	80.30	Kharif	1636.5	208.00
16	8.10	21.58	82.78	Zaid	1334.0	208.50
17	7.65	23.79	80.41	Rabi	1629.5	3324.00
18	6.59	21.86	80.19	Rabi	9560.7	26.14
19	8.13	23.57	83.58	Zaid	1308.8	6443.00

	Crop Health(%)	Water Quality(%)	Type of Agriculture Used \
0	87	50	Organic Farming
1	87	60	Aquaponics
2	76	87	Vertical Farming
3	68	76	Hydroponics
4	86	67	Permaculture
5	67	88	Precision Agriculture
6	78	47	Agroforestry
7	78	97	Greenhouse Cultivation
8	89	86	Urban Farming
9	88	56	Intensive Farming
10	90	77	Sustainable Agriculture
11	68	88	Crop Rotation
12	79	56	No-Till Farming
13	86	76	Regenerative Agriculture
14	82	77	Biodynamic Farming
15	58	57	Dry Farming
16	76	87	Alley Cropping
17	65	69	Silvopasture
18	88	58	Cover Cropping
19	79	68	Raised Bed Gardening

	Water pollution(%)	Soil pollution(%) \
0	3.5%	3.25%
1	1.8%	8.71%
2	2.7%	12.46%
3	4.2%	5.89%
4	0.9%	19.72%
5	5.1%	1.34%
6	2.3%	7.56%
7	3.8%	14.92%
8	1.5%	9.83%
9	4.8%	4.67%
10	0.7%	11.28%
11	2.1%	6.73%
12	3.2%	2.57%
13	1.2%	15.61%
14	4.4%	18.09%
15	0.5%	10.17%
16	5.3%	13.75%
17	2.9%	0.92%
18	4.6%	16.39%
19	1.1%	20.45%

		Goverment subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana			5%
1	National Food Security Mission			10%
2	Sub-Mission on Agricultural Mechanization			15%
3	NABARD loans in India			20%
4	Yantra Laxmi Scheme			25%
5	Rashtriya Krishi Vikas Yojana			30%
6	National Food Security Mission			35%
7	Sub-Mission on Agricultural Mechanization			40%
8	NABARD loans in India	Yantra Laxmi Scheme		28.2%
9	Rashtriya Krishi Vikas Yojana			37.6%
10	National Food Security Mission			15.7%
11	Sub-Mission on Agricultural Mechanization			44.8%
12	NABARD loans in India	Yantra Laxmi Scheme		9.3%
13	Rashtriya Krishi Vikas Yojana			19.6%
14	National Food Security Mission			32.1%
15	Sub-Mission on Agricultural Mechanization			26.8%
16	NABARD loans in India			51.2%
17	Yantra Laxmi Scheme			8.7%
18	Rashtriya Krishi Vikas Yojana			45%
19	National Food Security Mission			50%

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management

## ➤ Deep copy:

In the deep copy the original data will be copy directly.

```
dc=df.copy(deep=True)
```

```
print("***** DEEP COPY OF DATA SET *****")
```

```
print(dc)
```

**Output:**

***** DEEP COPY OF DATA SET *****							
S.No		State	Population	Growth of Crops		Soil Type	\
0	1	Uttar Pradesh	199812341	Rice	Sandy loan		
1	2	Punjab	27743338	Maize	Claly soil		
2	3	Haryana	25545198	Sugarcane	Alluvial Soil		
3	4	Maharastra	112372333	Bajra	Residual		
4	5	Kerala	33406061	Coconut	Red soil		
5	6	Tamilnadu	72147030	Banana	Red Loam		
6	7	Gujarat	60439692	Jowar	Black Soil		
7	8	Karnataka	61095297	Ragi	Red Soil		
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic		
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols		
10	11	Assam	31205576	Maize	Hill Soil		
11	12	Bihar	104099452	Rice	Piedmontswamp		
12	13	Chattisgarh	25351462	Maize	Clary Soil		
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil		
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil		
15	16	Jharkhand	32988134	Ragi	Red Soil		
16	17	Manipur	2855794	Cotton	Inceptisols		
17	18	Meghalaya	2966889	Maize	Loamy Soil		
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil		
19	20	Nagaland	1978502	Millet	Ultisols Soil		

ph	Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00	
1	6.83	21.77	80.31	Zaid	1654.8	2083.00	
2	7.45	23.00	82.32	Rabi	1119.5	1525.00	
3	8.01	26.49	80.15	Kharif	1055.2	5239.00	
4	8.10	20.13	81.60	Zaid	9895.6	5267.00	
5	7.30	23.05	83.37	Zaid	1689.1	5182.00	
6	6.25	22.70	82.63	Rabi	8665.8	1278.00	
7	7.72	20.27	82.89	Kharif	4985.0	1763.00	
8	7.80	24.51	83.53	Kharif	7989.4	10882.00	
9	6.47	23.22	83.03	Zaid	1055.4	11558.00	
10	6.81	26.52	81.41	Rabi	1629.8	13.50	
11	7.07	23.97	81.45	Kharif	1449.9	15.86	
12	7.65	26.80	80.88	Zaid	1222.2	102.50	
13	7.66	24.01	82.05	Rabi	1349.1	104.37	
14	6.86	25.66	80.66	Zaid	1439.0	192.00	
15	8.40	24.28	80.30	Kharif	1636.5	208.00	
16	8.10	21.58	82.78	Zaid	1334.0	208.50	
17	7.65	23.79	80.41	Rabi	1629.5	3324.00	
18	6.59	21.86	80.19	Rabi	9560.7	26.14	
19	8.13	23.57	83.58	Zaid	1308.8	6443.00	

	Crop Health(%)	Water Quality(%)	Type of Agriculture Used \
0	87	50	Organic Farming
1	87	60	Aquaponics
2	76	87	Vertical Farming
3	68	76	Hydroponics
4	86	67	Permaculture
5	67	88	Precision Agriculture
6	78	47	Agroforestry
7	78	97	Greenhouse Cultivation
8	89	86	Urban Farming
9	88	56	Intensive Farming
10	90	77	Sustainable Agriculture
11	68	88	Crop Rotation
12	79	56	No-Till Farming
13	86	76	Regenerative Agriculture
14	82	77	Biodynamic Farming
15	58	57	Dry Farming
16	76	87	Alley Cropping
17	65	69	Silvopasture
18	88	58	Cover Cropping
19	79	68	Raised Bed Gardening

	Water pollution(%)	Soil pollution(%) \
0	3.5%	3.25%
1	1.8%	8.71%
2	2.7%	12.46%
3	4.2%	5.89%
4	0.9%	19.72%
5	5.1%	1.34%
6	2.3%	7.56%
7	3.8%	14.92%
8	1.5%	9.83%
9	4.8%	4.67%
10	0.7%	11.28%
11	2.1%	6.73%
12	3.2%	2.57%
13	1.2%	15.61%
14	4.4%	18.09%
15	0.5%	10.17%
16	5.3%	13.75%
17	2.9%	0.92%
18	4.6%	16.39%
19	1.1%	20.45%

	Government subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana		5%
1	National Food Security Mission		10%
2	Sub-Mission on Agricultural Mechanization		15%
3	NABARD loans in India		20%
4	Yantra Laxmi Scheme		25%
5	Rashtriya Krishi Vikas Yojana		30%
6	National Food Security Mission		35%
7	Sub-Mission on Agricultural Mechanization		40%
8	NABARD loans in India	Yantra Laxmi Scheme	28.2%
9	Rashtriya Krishi Vikas Yojana		37.6%
10	National Food Security Mission		15.7%
11	Sub-Mission on Agricultural Mechanization		44.8%
12	NABARD loans in India	Yantra Laxmi Scheme	9.3%
13	Rashtriya Krishi Vikas Yojana		19.6%
14	National Food Security Mission		32.1%
15	Sub-Mission on Agricultural Mechanization		26.8%
16	NABARD loans in India	Yantra Laxmi Scheme	51.2%
17	Rashtriya Krishi Vikas Yojana		8.7%
18	National Food Security Mission		45%
19			50%

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management

### ➤ Size:

This method shows the Size of the data set.

```
print("***** SIZE OF DATA SET *****")
```

```
print(dc.size)
```

**Output:**

```
***** SIZE OF DATA SET *****
400
```

### ➤ Shape:

This method shows the Shape of the data set.

```
print("***** SHAPE OF DATA SET *****")
```

```
print(sc.shape)
```

**Output:**

```
***** SHAPE OF DATA SET *****
(20, 20)
```

### ➤ Index:

This method shows the index of the data set.

```
print("***** INDEX OF DATA SET *****")
```

```
print(dc.index)
```

**Output:**

```
***** INDEX OF DATA SET *****
RangeIndex(start=0, stop=20, step=1)
```

### ➤ Dimension:

It will show the dimensions about the data set.

```
print("***** DIMENSION OF DATA SET *****")
```

```
print(sc.ndim)
```

**Output:**

```
***** DIMENSION OF DATA SET *****
2
```

## ➤ Info:

This method shows the all information related to the data set.

```
print("**** INFO OF DATA SET ****")
print(df.info())
```

### Output:

```
**** INFO OF DATA SET ****
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 20 entries, 0 to 19
Data columns (total 20 columns):
 #   Column           Non-Null Count  Dtype  
--- 
 0   S.No             20 non-null      int64  
 1   State            20 non-null      object  
 2   Population       20 non-null      int64  
 3   Growth of Crops  20 non-null      object  
 4   Soil Type        20 non-null      object  
 5   ph Level          20 non-null      float64 
 6   Temperature      20 non-null      float64 
 7   Humidity          20 non-null      float64 
 8   Season            20 non-null      object  
 9   Area              20 non-null      float64 
 10  Production        20 non-null      float64 
 11  Crop Health(%)  20 non-null      int64  
 12  Water Quality(%) 20 non-null      int64  
 13  Type of Agriculture Used 20 non-null  object  
 14  Water pollution(%) 20 non-null  object  
 15  Soil pollution(%) 20 non-null  object  
 16  Goverment subsidies 20 non-null  object  
 17  Organic Fertilizers Used (%) 20 non-null  object  
 18  Power Consumption (%) 20 non-null  object  
 19  Type of Technology Used 20 non-null  object  
dtypes: float64(5), int64(4), object(11)
memory usage: 3.2+ KB
None
```

## ➤ Memory\_Usage:

It will show the Memory usages of the different attributes in our data set.

```
print("***** MEMORY_USAGE OF DATA SET *****")
```

```
print(dc.memory_usage())
```

**Output:**

```
***** MEMORY_USAGE OF DATA SET *****  
Index          128  
S.No           160  
State          160  
Population     160  
Growth of Crops 160  
Soil Type      160  
ph Level       160  
Temperature    160  
Humidity       160  
Season          160  
Area            160  
Production     160  
Crop Health(%) 160  
Water Quality(%) 160  
Type of Agriculture Used 160  
Water pollution(%) 160  
Soil pollution(%) 160  
Government subsidies 160  
Organic Fertilizers Used (%) 160  
Power Consumption (%) 160  
Type of Technology Used 160  
dtype: int64
```

## ➤ Describe:

It provides a summary statistic for numerical columns in pandas DataFrame.  
(Mathematical Equation Results).

```
print("***** DESCRIBE ABOUT DATA SET *****")
```

```
print(df.describe)
```

**Output:**

***** DESCRIBE ABOUT DATA SET *****							
			S.No	State	Population	Growth of Crops	Soil Type \
0	1	Uttar Pradesh	199812341	Rice	Sandy loan		
1	2	Punjab	27743338	Maize	Claly soil		
2	3	Haryana	25545198	Sugarcane	Alluvial Soil		
3	4	Maharastra	112372333	Bajra	Residual		
4	5	Kerala	33406061	Coconut	Red soil		
5	6	Tamilnadu	72147030	Banana	Red Loam		
6	7	Gujarat	60439692	Jowar	Black Soil		
7	8	Karnataka	61095297	Ragi	Red Soil		
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic		
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols		
10	11	Assam	31205576	Maize	Hill Soil		
11	12	Bihar	104099452	Rice	Piedmontswamp		
12	13	Chattisgarh	25351462	Maize	Clary Soil		
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil		
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil		
15	16	Jarkhand	32988134	Ragi	Red Soil		
16	17	Manipur	2855794	Cotton	Inceptisols		
17	18	Megalaya	2966889	Maize	Loamy Soil		
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil		
19	20	Nagaland	1978502	Millet	ultisols Soil		

	ph	Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00		
1	6.83	21.77	80.31	Zaid	1654.8	2083.00		
2	7.45	23.00	82.32	Rabi	1119.5	1525.00		
3	8.01	26.49	80.15	Kharif	1055.2	5239.00		
4	8.10	20.13	81.60	Zaid	9895.6	5267.00		
5	7.30	23.05	83.37	Zaid	1689.1	5182.00		
6	6.25	22.70	82.63	Rabi	8665.8	1278.00		
7	7.72	20.27	82.89	Kharif	4985.0	1763.00		
8	7.80	24.51	83.53	Kharif	7989.4	10882.00		
9	6.47	23.22	83.03	Zaid	1055.4	11558.00		
10	6.81	26.52	81.41	Rabi	1629.8	13.50		
11	7.07	23.97	81.45	Kharif	1449.9	15.86		
12	7.65	26.80	80.88	Zaid	1222.2	102.50		
13	7.66	24.01	82.05	Rabi	1349.1	104.37		
14	6.86	25.66	80.66	Zaid	1439.0	192.00		
15	8.40	24.28	80.30	Kharif	1636.5	208.00		
16	8.10	21.58	82.78	Zaid	1334.0	208.50		
17	7.65	23.79	80.41	Rabi	1629.5	3324.00		
18	6.59	21.86	80.19	Rabi	9560.7	26.14		
19	8.13	23.57	83.58	Zaid	1308.8	6443.00		

Crop Health(%)	Water Quality(%)	Type of Agriculture Used \
0	87	Organic Farming
1	87	Aquaponics
2	76	Vertical Farming
3	68	Hydroponics
4	86	Permaculture
5	67	Precision Agriculture
6	78	Agroforestry
7	78	Greenhouse Cultivation
8	89	Urban Farming
9	88	Intensive Farming
10	90	Sustainable Agriculture
11	68	Crop Rotation
12	79	No-Till Farming
13	86	Regenerative Agriculture
14	82	Biodynamic Farming
15	58	Dry Farming
16	76	Alley Cropping
17	65	Silvopasture
18	88	Cover Cropping
19	79	Raised Bed Gardening

Water pollution(%)	Soil pollution(%) \
0	3.5%
1	1.8%
2	2.7%
3	4.2%
4	0.9%
5	5.1%
6	2.3%
7	3.8%
8	1.5%
9	4.8%
10	0.7%
11	2.1%
12	3.2%
13	1.2%
14	4.4%
15	0.5%
16	5.3%
17	2.9%
18	4.6%
19	1.1%

	Government subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana		5%
1	National Food Security Mission		10%
2	Sub-Mission on Agricultural Mechanization		15%
3	NABARD loans in India		20%
4	Yantra Laxmi Scheme		25%
5	Rashtriya Krishi Vikas Yojana		30%
6	National Food Security Mission		35%
7	Sub-Mission on Agricultural Mechanization		40%
8	NABARD loans in India	Yantra Laxmi Scheme	28.2%
9	Rashtriya Krishi Vikas Yojana		37.6%
10	National Food Security Mission		15.7%
11	Sub-Mission on Agricultural Mechanization		44.8%
12	NABARD loans in India	Yantra Laxmi Scheme	9.3%
13	Rashtriya Krishi Vikas Yojana		19.6%
14	National Food Security Mission		32.1%
15	Sub-Mission on Agricultural Mechanization		26.8%
16	NABARD loans in India	Yantra Laxmi Scheme	51.2%
17	Rashtriya Krishi Vikas Yojana		8.7%
18	National Food Security Mission		45%
19			50%

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management

➤ **Column Operations:**

➤ Column Selection:

```
print("***** Column selection ****")
print(df['Type of Technology Used'])
```

**Output:**

```
***** Column selection ****
0          Precision Agriculture
1                  IoT Agriculture
2                  Smart Farming
3        Drones in Agriculture
4      Agricultural Robots
5            Machine Learning
6      Artificial Intelligence
7  Blockchain in Agriculture
8          Data Analytics
9            Dry Farming
10         Rainfed Agriculture
11    Conservation Agriculture
12          No-Till Farming
13          Strip Cropping
14          Cover Cropping
15        Terrace Farming
16  Rice Intensification System
17          Permaculture
18  Precision Livestock Farming
19  Smart Livestock Management
Name: Type of Technology Used, dtype: object
```

➤ Column Addition:

```
print("***** Column Addition *****")
sc['Rank']=pd.Series([1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20])
print(df)
```

**Output:**

***** Column Addition *****							
S.No		State	Population	Growth of Crops		Soil Type	\
0	1	Uttar Pradesh	199812341	Rice	Sandy loan		
1	2	Punjab	27743338	Maize	Claly soil		
2	3	Haryana	25545198	Sugarcane	Alluvial Soil		
3	4	Maharastra	112372333	Bajra	Residual		
4	5	Kerala	33406061	Coconut	Red soil		
5	6	Tamilnadu	72147030	Banana	Red Loam		
6	7	Gujarat	60439692	Jowar	Black Soil		
7	8	Karnataka	61095297	Ragi	Red Soil		
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic		
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols		
10	11	Assam	31205576	Maize	Hill Soil		
11	12	Bihar	104099452	Rice	Piedmontswamp		
12	13	Chattisgarh	25351462	Maize	Clary Soil		
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil		
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil		
15	16	Jarkhand	32988134	Ragi	Red Soil		
16	17	Manipur	2855794	Cotton	Inceptisols		
17	18	Megalaya	2966889	Maize	Loamy Soil		
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil		
19	20	Nagaland	1978502	Millet	Ultisols Soil		

ph	Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00	
1	6.83	21.77	80.31	Zaid	1654.8	2083.00	
2	7.45	23.00	82.32	Rabi	1119.5	1525.00	
3	8.01	26.49	80.15	Kharif	1055.2	5239.00	
4	8.10	20.13	81.60	Zaid	9895.6	5267.00	
5	7.30	23.05	83.37	Zaid	1689.1	5182.00	
6	6.25	22.70	82.63	Rabi	8665.8	1278.00	
7	7.72	20.27	82.89	Kharif	4985.0	1763.00	
8	7.80	24.51	83.53	Kharif	7989.4	10882.00	
9	6.47	23.22	83.03	Zaid	1055.4	11558.00	
10	6.81	26.52	81.41	Rabi	1629.8	13.50	
11	7.07	23.97	81.45	Kharif	1449.9	15.86	
12	7.65	26.80	80.88	Zaid	1222.2	102.50	
13	7.66	24.01	82.05	Rabi	1349.1	104.37	
14	6.86	25.66	80.66	Zaid	1439.0	192.00	
15	8.40	24.28	80.30	Kharif	1636.5	208.00	
16	8.10	21.58	82.78	Zaid	1334.0	208.50	
17	7.65	23.79	80.41	Rabi	1629.5	3324.00	
18	6.59	21.86	80.19	Rabi	9560.7	26.14	
19	8.13	23.57	83.58	Zaid	1308.8	6443.00	

	Crop Health(%)	Water Quality(%)	Type of Agriculture Used \
0	87	50	Organic Farming
1	87	60	Aquaponics
2	76	87	Vertical Farming
3	68	76	Hydroponics
4	86	67	Permaculture
5	67	88	Precision Agriculture
6	78	47	Agroforestry
7	78	97	Greenhouse Cultivation
8	89	86	Urban Farming
9	88	56	Intensive Farming
10	90	77	Sustainable Agriculture
11	68	88	Crop Rotation
12	79	56	No-Till Farming
13	86	76	Regenerative Agriculture
14	82	77	Biodynamic Farming
15	58	57	Dry Farming
16	76	87	Alley Cropping
17	65	69	Silvopasture
18	88	58	Cover Cropping
19	79	68	Raised Bed Gardening

	Water pollution(%)	Soil pollution(%) \
0	3.5%	3.25%
1	1.8%	8.71%
2	2.7%	12.46%
3	4.2%	5.89%
4	0.9%	19.72%
5	5.1%	1.34%
6	2.3%	7.56%
7	3.8%	14.92%
8	1.5%	9.83%
9	4.8%	4.67%
10	0.7%	11.28%
11	2.1%	6.73%
12	3.2%	2.57%
13	1.2%	15.61%
14	4.4%	18.09%
15	0.5%	10.17%
16	5.3%	13.75%
17	2.9%	0.92%
18	4.6%	16.39%
19	1.1%	20.45%

	Government subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana	5%	
1	National Food Security Mission	10%	
2	Sub-Mission on Agricultural Mechanization	15%	
3	NABARD loans in India	20%	
4	Yantra Laxmi Scheme	25%	
5	Rashtriya Krishi Vikas Yojana	30%	
6	National Food Security Mission	35%	
7	Sub-Mission on Agricultural Mechanization	40%	
8	NABARD loans in India	28.2%	
9	Yantra Laxmi Scheme	37.6%	
10	Rashtriya Krishi Vikas Yojana	15.7%	
11	National Food Security Mission	44.8%	
12	Sub-Mission on Agricultural Mechanization	9.3%	
13	NABARD loans in India	19.6%	
14	Yantra Laxmi Scheme	32.1%	
15	Rashtriya Krishi Vikas Yojana	26.8%	
16	National Food Security Mission	51.2%	
17	Sub-Mission on Agricultural Mechanization	8.7%	
18	NABARD loans in India	45%	
19	Yantra Laxmi Scheme	50%	

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management

➤ Column Deletion:

```
print("***** Column Deletion *****")
del sc['Rank']
print(sc)
```

**Output:**

***** Column Deletion *****						
S.No		State	Population	Growth of Crops	Soil Type	\
0	1	Uttar Pradesh	199812341	Rice	Sandy loan	
1	2	Punjab	27743338	Maize	Claly soil	
2	3	Haryana	25545198	Sugarcane	Alluvial Soil	
3	4	Maharastra	112372333	Bajra	Residual	
4	5	Kerala	33406061	Coconut	Red soil	
5	6	Tamilnadu	72147030	Banana	Red Loam	
6	7	Gujarat	60439692	Jowar	Black Soil	
7	8	Karnataka	61095297	Ragi	Red Soil	
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic	
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols	
10	11	Assam	31205576	Maize	Hill Soil	
11	12	Bihar	104099452	Rice	Piedmontswamp	
12	13	Chattisgarh	25351462	Maize	Clary Soil	
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil	
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil	
15	16	Jarkhand	32988134	Ragi	Red Soil	
16	17	Manipur	2855794	Cotton	Inceptisols	
17	18	Megalaya	2966889	Maize	Loamy Soil	
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil	
19	20	Nagaland	1978502	Millet	Ultisols Soil	

ph Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00
1	6.83	21.77	80.31	Zaid	1654.8	2083.00
2	7.45	23.00	82.32	Rabi	1119.5	1525.00
3	8.01	26.49	80.15	Kharif	1055.2	5239.00
4	8.10	20.13	81.60	Zaid	9895.6	5267.00
5	7.30	23.05	83.37	Zaid	1689.1	5182.00
6	6.25	22.70	82.63	Rabi	8665.8	1278.00
7	7.72	20.27	82.89	Kharif	4985.0	1763.00
8	7.80	24.51	83.53	Kharif	7989.4	10882.00
9	6.47	23.22	83.03	Zaid	1055.4	11558.00
10	6.81	26.52	81.41	Rabi	1629.8	13.50
11	7.07	23.97	81.45	Kharif	1449.9	15.86
12	7.65	26.80	80.88	Zaid	1222.2	102.50
13	7.66	24.01	82.05	Rabi	1349.1	104.37
14	6.86	25.66	80.66	Zaid	1439.0	192.00
15	8.40	24.28	80.30	Kharif	1636.5	208.00
16	8.10	21.58	82.78	Zaid	1334.0	208.50
17	7.65	23.79	80.41	Rabi	1629.5	3324.00
18	6.59	21.86	80.19	Rabi	9560.7	26.14
19	8.13	23.57	83.58	Zaid	1308.8	6443.00

	Crop Health(%)	Water Quality(%)	Type of Agriculture Used	\
0	87	50	Organic Farming	
1	87	60	Aquaponics	
2	76	87	Vertical Farming	
3	68	76	Hydroponics	
4	86	67	Permaculture	
5	67	88	Precision Agriculture	
6	78	47	Agroforestry	
7	78	97	Greenhouse Cultivation	
8	89	86	Urban Farming	
9	88	56	Intensive Farming	
10	90	77	Sustainable Agriculture	
11	68	88	Crop Rotation	
12	79	56	No-Till Farming	
13	86	76	Regenerative Agriculture	
14	82	77	Biodynamic Farming	
15	58	57	Dry Farming	
16	76	87	Alley Cropping	
17	65	69	Silvopasture	
18	88	58	Cover Cropping	
19	79	68	Raised Bed Gardening	

	Water pollution(%)	Soil pollution(%)	\
0	3.5%	3.25%	
1	1.8%	8.71%	
2	2.7%	12.46%	
3	4.2%	5.89%	
4	0.9%	19.72%	
5	5.1%	1.34%	
6	2.3%	7.56%	
7	3.8%	14.92%	
8	1.5%	9.83%	
9	4.8%	4.67%	
10	0.7%	11.28%	
11	2.1%	6.73%	
12	3.2%	2.57%	
13	1.2%	15.61%	
14	4.4%	18.09%	
15	0.5%	10.17%	
16	5.3%	13.75%	
17	2.9%	0.92%	
18	4.6%	16.39%	
19	1.1%	20.45%	

	Goverment subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana	5%	
1	National Food Security Mission	10%	
2	Sub-Mission on Agricultural Mechanization	15%	
3	NABARD loans in India	20%	
4	Yantra Laxmi Scheme	25%	
5	Rashtriya Krishi Vikas Yojana	30%	
6	National Food Security Mission	35%	
7	Sub-Mission on Agricultural Mechanization	40%	
8	NABARD loans in India	28.2%	Yantra Laxmi Scheme
9	Rashtriya Krishi Vikas Yojana	37.6%	
10	National Food Security Mission	15.7%	
11	Sub-Mission on Agricultural Mechanization	44.8%	
12	NABARD loans in India	9.3%	Yantra Laxmi Scheme
13	Rashtriya Krishi Vikas Yojana	19.6%	
14	National Food Security Mission	32.1%	
15	Sub-Mission on Agricultural Mechanization	26.8%	
16	NABARD loans in India	51.2%	
17	Yantra Laxmi Scheme	8.7%	
18	Rashtriya Krishi Vikas Yojana	45%	
19	National Food Security Mission	50%	

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management

➤ Column Deletion Using Pop() function

```
print("***** Column Deletion using pop operation *****")
```

```
sc.pop('Type of Technology Used')
```

```
print(sc)
```

**Output:**

***** Column Deletion using pop operation *****						
S.No		State	Population	Growth of Crops	Soil Type	\
0	1	Uttar Pradesh	199812341	Rice	Sandy loan	
1	2	Punjab	27743338	Maize	Claly soil	
2	3	Haryana	25545198	Sugarcane	Alluvial Soil	
3	4	Maharastra	112372333	Bajra	Residual	
4	5	Kerala	33406061	Coconut	Red soil	
5	6	Tamilnadu	72147030	Banana	Red Loam	
6	7	Gujarat	60439692	Jowar	Black Soil	
7	8	Karnataka	61095297	Ragi	Red Soil	
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic	
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols	
10	11	Assam	31205576	Maize	Hill Soil	
11	12	Bihar	104099452	Rice	Piedmontswamp	
12	13	Chattisgarh	25351462	Maize	Clary Soil	
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil	
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil	
15	16	Jarkhand	32988134	Ragi	Red Soil	
16	17	Manipur	2855794	Cotton	Inceptisols	
17	18	Megalaya	2966889	Maize	Loamy Soil	
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil	
19	20	Nagaland	1978502	Millet	ultisols Soil	

ph Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00
1	6.83	21.77	80.31	Zaid	1654.8	2083.00
2	7.45	23.00	82.32	Rabi	1119.5	1525.00
3	8.01	26.49	80.15	Kharif	1055.2	5239.00
4	8.10	20.13	81.60	Zaid	9895.6	5267.00
5	7.30	23.05	83.37	Zaid	1689.1	5182.00
6	6.25	22.70	82.63	Rabi	8665.8	1278.00
7	7.72	20.27	82.89	Kharif	4985.0	1763.00
8	7.80	24.51	83.53	Kharif	7989.4	10882.00
9	6.47	23.22	83.03	Zaid	1055.4	11558.00
10	6.81	26.52	81.41	Rabi	1629.8	13.50
11	7.07	23.97	81.45	Kharif	1449.9	15.86
12	7.65	26.80	80.88	Zaid	1222.2	102.50
13	7.66	24.01	82.05	Rabi	1349.1	104.37
14	6.86	25.66	80.66	Zaid	1439.0	192.00
15	8.40	24.28	80.30	Kharif	1636.5	208.00
16	8.10	21.58	82.78	Zaid	1334.0	208.50
17	7.65	23.79	80.41	Rabi	1629.5	3324.00
18	6.59	21.86	80.19	Rabi	9560.7	26.14
19	8.13	23.57	83.58	Zaid	1308.8	6443.00

Crop Health(%)	Water Quality(%)	Type of Agriculture Used \
0	87	50      Organic Farming
1	87	60      Aquaponics
2	76	87      Vertical Farming
3	68	76      Hydroponics
4	86	67      Permaculture
5	67	88      Precision Agriculture
6	78	47      Agroforestry
7	78	97      Greenhouse Cultivation
8	89	86      Urban Farming
9	88	56      Intensive Farming
10	90	77      Sustainable Agriculture
11	68	88      Crop Rotation
12	79	56      No-Till Farming
13	86	76      Regenerative Agriculture
14	82	77      Biodynamic Farming
15	58	57      Dry Farming
16	76	87      Alley Cropping
17	65	69      Silvopasture
18	88	58      Cover Cropping
19	79	68      Raised Bed Gardening

Water pollution(%)	Soil pollution(%) \
0	3.5%
1	1.8%
2	2.7%
3	4.2%
4	0.9%
5	5.1%
6	2.3%
7	3.8%
8	1.5%
9	4.8%
10	0.7%
11	2.1%
12	3.2%
13	1.2%
14	4.4%
15	0.5%
16	5.3%
17	2.9%
18	4.6%
19	1.1%

	Water pollution(%)	Soil pollution(%)	\
0	3.5%	3.25%	
1	1.8%	8.71%	
2	2.7%	12.46%	
3	4.2%	5.89%	
4	0.9%	19.72%	
5	5.1%	1.34%	
6	2.3%	7.56%	
7	3.8%	14.92%	
8	1.5%	9.83%	
9	4.8%	4.67%	
10	0.7%	11.28%	
11	2.1%	6.73%	
12	3.2%	2.57%	
13	1.2%	15.61%	
14	4.4%	18.09%	
15	0.5%	10.17%	
16	5.3%	13.75%	
17	2.9%	0.92%	
18	4.6%	16.39%	
19	1.1%	20.45%	

	Power Consumption (%)
0	12.5%
1	35.9%
2	14.6%
3	42.3%
4	10.9%
5	20.3%
6	30.7%
7	45.9%
8	7.8%
9	17.1%
10	41.5%
11	22.9%
12	47.4%
13	11.6%
14	36.3%
15	16.2%
16	38.7%
17	13.1%
18	25.6%
19	22.3%

➤ Column Reindexing:

```
print("***** COLUMN INDEXING *****")
print(sc.reindex(['S.No','State','Population','Soil Type','ph Level','Growth of Crops','Season','Temperature',
'Humidity','Production','Crop Health(%),'Water Quality(%),'Organic Fertilizers Used (%)','Power
Consumption (%),'Soil pollution(%),'Water pollution(%),'Type of Agriculture Used','Goverment subsidies',
'Type of Technology Used'],axis='columns'))
print(sc)
```

**Output:**

***** COLUMN INDEXING *****							
S.No	State	Population	Soil Type	ph Level			\
0	1 Uttar Pradesh	199812341	Sandy loan	6.54			
1	2 Punjab	27743338	Claly soil	6.83			
2	3 Haryana	25545198	Alluvial Soil	7.45			
3	4 Maharashtra	112372333	Residual	8.01			
4	5 Kerala	33406061	Red soil	8.10			
5	6 Tamilnadu	72147030	Red Loam	7.30			
6	7 Gujarat	60439692	Black Soil	6.25			
7	8 Karnataka	61095297	Red Soil	7.72			
8	9 Andhra Pradesh	84580777	Red Lateritic	7.80			
9	10 Arunachal Pradesh	1458545	Inceptisols	6.47			
10	11 Assam	31205576	Hill Soil	6.81			
11	12 Bihar	104099452	Piedmontswamp	7.07			
12	13 Chattisgarh	25351462	Clary Soil	7.65			
13	14 Himachal Pradesh	6864602	Brown Hill Soil	7.66			
14	15 Jammu& Kashmir	13635010	Alluvial Soil	6.86			
15	16 Jharkhand	32988134	Red Soil	8.40			
16	17 Manipur	2855794	Inceptisols	8.10			
17	18 Meghalaya	2966889	Loamy Soil	7.65			
18	19 Mizoram	1097206	Sand-Loamy Soil	6.59			
19	20 Nagaland	1978502	Ultisols Soil	8.13			

***** COLUMN INDEXING *****							
Growth of Crops	Season	Temperature	Humidity	Production	Crop Health(%)		\
0 Rice	Kharif	20.87	82.00	2061.00	87		
1 Maize	Zaid	21.77	80.31	2083.00	87		
2 Sugarcane	Rabi	23.00	82.32	1525.00	76		
3 Bajra	Kharif	26.49	80.15	5239.00	68		
4 Coconut	Zaid	20.13	81.60	5267.00	86		
5 Banana	Zaid	23.05	83.37	5182.00	67		
6 Jowar	Rabi	22.70	82.63	1278.00	78		
7 Ragi	Kharif	20.27	82.89	1763.00	78		
8 Rice	Kharif	24.51	83.53	10882.00	89		
9 Maize	Zaid	23.22	83.03	11558.00	88		
10 Maize	Rabi	26.52	81.41	13.50	90		
11 Rice	Kharif	23.97	81.45	15.86	68		
12 Maize	Zaid	26.80	80.88	102.50	79		
13 Vegetables	Rabi	24.01	82.05	104.37	86		
14 Apples	Zaid	25.66	80.66	192.00	82		
15 Ragi	Kharif	24.28	80.30	208.00	58		
16 Cotton	Zaid	21.58	82.78	208.50	76		
17 Maize	Rabi	23.79	80.41	3324.00	65		
18 Maize	Rabi	21.86	80.19	26.14	88		
19 Millet	Zaid	23.57	83.58	6443.00	79		

	Water Quality(%)	Organic Fertilizers Used (%)	Power Consumption (%)	\
0	50	5%	12.5%	
1	60	10%	35.9%	
2	87	15%	14.6%	
3	76	20%	42.3%	
4	67	25%	10.9%	
5	88	30%	20.3%	
6	47	35%	30.7%	
7	97	40%	45.9%	
8	86	28.2%	7.8%	
9	56	37.6%	17.1%	
10	77	15.7%	41.5%	
11	88	44.8%	22.9%	
12	56	9.3%	47.4%	
13	76	19.6%	11.6%	
14	77	32.1%	36.3%	
15	57	26.8%	16.2%	
16	87	51.2%	38.7%	
17	69	8.7%	13.1%	
18	58	45%	25.6%	
19	68	50%	22.3%	

	Soil pollution(%)	Water pollution(%)	Type of Agriculture Used	\
0	3.25%	3.5%	Organic Farming	
1	8.71%	1.8%	Aquaponics	
2	12.46%	2.7%	Vertical Farming	
3	5.89%	4.2%	Hydroponics	
4	19.72%	0.9%	Permaculture	
5	1.34%	5.1%	Precision Agriculture	
6	7.56%	2.3%	Agroforestry	
7	14.92%	3.8%	Greenhouse Cultivation	
8	9.83%	1.5%	Urban Farming	
9	4.67%	4.8%	Intensive Farming	
10	11.28%	0.7%	Sustainable Agriculture	
11	6.73%	2.1%	Crop Rotation	
12	2.57%	3.2%	No-Till Farming	
13	15.61%	1.2%	Regenerative Agriculture	
14	18.09%	4.4%	Biodynamic Farming	
15	10.17%	0.5%	Dry Farming	
16	13.75%	5.3%	Alley Cropping	
17	0.92%	2.9%	Silvopasture	
18	16.39%	4.6%	Cover Cropping	
19	20.45%	1.1%	Raised Bed Gardening	

		Type of Technology Used
0	Goverment subsidies Rashtriya Krishi Vikas Yojana	Precision Agriculture
1	National Food Security Mission	IoT Agriculture
2	Sub-Mission on Agricultural Mechanization	Smart Farming
3	NABARD loans in India	Drones in Agriculture
4	Yantra Laxmi Scheme	Agricultural Robots
5	Rashtriya Krishi Vikas Yojana	Machine Learning
6	National Food Security Mission	Artificial Intelligence
7	Sub-Mission on Agricultural Mechanization	Blockchain in Agriculture
8	NABARD loans in India	Data Analytics
9	Yantra Laxmi Scheme	Dry Farming
10	Rashtriya Krishi Vikas Yojana	Rainfed Agriculture
11	National Food Security Mission	Conservation Agriculture
12	Sub-Mission on Agricultural Mechanization	No-Till Farming
13	NABARD loans in India	Strip Cropping
14	Yantra Laxmi Scheme	Cover Cropping
15	Rashtriya Krishi Vikas Yojana	Terrace Farming
16	National Food Security Mission	Rice Intensification System
17	Sub-Mission on Agricultural Mechanization	Permaculture
18	NABARD loans in India	Precision Livestock Farming
19	Yantra Laxmi Scheme	Smart Livestock Management
	Rashtriya Krishi Vikas Yojana	
	National Food Security Mission	

## ➤ Row Operations:

### ➤ Row Selection:

```
print("***** ROW SELECTION *****")
print(df.loc[8],df.loc[5])
```

### Output:

```
***** ROW SELECTION *****
S.No                               9
State                             Andhra Pradesh
Population                         84580777
Growth of Crops                   Rice
Soil Type                          Red Lateritic
ph Level                           7.8
Temperature                         24.51
Humidity                            83.53
Season                             Kharif
Area                                7989.4
Production                          10882.0
Crop Health(%)                    89
Water Quality(%)                  86
Type of Agriculture Used          Urban Farming
Water pollution(%)                1.5%
Soil pollution(%)                 9.83%
Goverment subsidies               NABARD loans in IndiaYantra Laxmi Scheme
Organic Fertilizers Used (%)      28.2%
Power Consumption (%)              7.8%
Type of Technology Used           Data Analytics
```

```
Name: 8, dtype: object S.No                               6
State                             Tamilnadu
Population                         72147030
Growth of Crops                   Banana
Soil Type                          Red Loam
ph Level                           7.3
Temperature                         23.05
Humidity                            83.37
Season                             Zaid
Area                                1689.1
Production                          5182.0
Crop Health(%)                    67
Water Quality(%)                  88
Type of Agriculture Used          Precision Agriculture
Water pollution(%)                5.1%
Soil pollution(%)                 1.34%
Goverment subsidies               Rashtriya Krishi Vikas Yojana
Organic Fertilizers Used (%)      30%
Power Consumption (%)              20.3%
Type of Technology Used           Machine Learning
Name: 5, dtype: object
```

➤ Row Addition:

```
print("***** ROW ADDITION *****")
dc.loc[88]=[21,'Andhra Pradesh',199875544,'Rice','Sandy loam',6.54,20.87,82.00,'Kharif',1312.5,
2062.85,60.55,'Organic Forming','3.6%','3.35%',"National Food Security Mission",'26.2%', 'Iot Agriculture']
print(dc)
```

**Output:**

***** ROW ADDITION *****							
S.No		State	Population	Growth of Crops	Soil Type		\
0	1	Uttar Pradesh	199812341	Rice	Sandy loam		
1	2	Punjab	27743338	Maize	Claly soil		
2	3	Haryana	25545198	Sugarcane	Alluvial Soil		
3	4	Maharastra	112372333	Bajra	Residual		
4	5	Kerala	33406061	Coconut	Red soil		
5	6	Tamilnadu	72147030	Banana	Red Loam		
6	7	Gujarat	60439692	Jowar	Black Soil		
7	8	Karnataka	61095297	Ragi	Red Soil		
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic		
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols		
10	11	Assam	31205576	Maize	Hill Soil		
11	12	Bihar	104099452	Rice	Piedmontswamp		
12	13	Chattisgarh	25351462	Maize	Clary soil		
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill soil		
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil		
15	16	Jharkhand	32988134	Ragi	Red Soil		
16	17	Manipur	2855794	Cotton	Inceptisols		
17	18	Meghalaya	2966889	Maize	Loamy Soil		
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil		
19	20	Nagaland	1978502	Millet	Ultisols Soil		
88	21	Andhra Pradesh	199875544	Rice	Sandy loam		

ph Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00
1	6.83	21.77	80.31	Zaid	1654.8	2083.00
2	7.45	23.00	82.32	Rabi	1119.5	1525.00
3	8.01	26.49	80.15	Kharif	1055.2	5239.00
4	8.10	20.13	81.60	Zaid	9895.6	5267.00
5	7.30	23.05	83.37	Zaid	1689.1	5182.00
6	6.25	22.70	82.63	Rabi	8665.8	1278.00
7	7.72	20.27	82.89	Kharif	4985.0	1763.00
8	7.80	24.51	83.53	Kharif	7989.4	10882.00
9	6.47	23.22	83.03	Zaid	1055.4	11558.00
10	6.81	26.52	81.41	Rabi	1629.8	13.50
11	7.07	23.97	81.45	Kharif	1449.9	15.86
12	7.65	26.80	80.88	Zaid	1222.2	102.50
13	7.66	24.01	82.05	Rabi	1349.1	104.37
14	6.86	25.66	80.66	Zaid	1439.0	192.00
15	8.40	24.28	80.30	Kharif	1636.5	208.00
16	8.10	21.58	82.78	Zaid	1334.0	208.50
17	7.65	23.79	80.41	Rabi	1629.5	3324.00
18	6.59	21.86	80.19	Rabi	9560.7	26.14
19	8.13	23.57	83.58	Zaid	1308.8	6443.00
88	6.54	20.87	82.00	Kharif	1312.5	2062.00

Crop Health(%)	Water Quality(%)	Type of Agriculture Used \
0	87	50      Organic Farming
1	87	60      Aquaponics
2	76	87      Vertical Farming
3	68	76      Hydroponics
4	86	67      Permaculture
5	67	88      Precision Agriculture
6	78	47      Agroforestry
7	78	97      Greenhouse Cultivation
8	89	86      Urban Farming
9	88	56      Intensive Farming
10	90	77      Sustainable Agriculture
11	68	88      Crop Rotation
12	79	56      No-Till Farming
13	86	76      Regenerative Agriculture
14	82	77      Biodynamic Farming
15	58	57      Dry Farming
16	76	87      Alley Cropping
17	65	69      Silvopasture
18	88	58      Cover Cropping
19	79	68      Raised Bed Gardening
88	85	60      Organic Farming

Water pollution(%)	Soil pollution(%) \
0	3.5%      3.25%
1	1.8%      8.71%
2	2.7%      12.46%
3	4.2%      5.89%
4	0.9%      19.72%
5	5.1%      1.34%
6	2.3%      7.56%
7	3.8%      14.92%
8	1.5%      9.83%
9	4.8%      4.67%
10	0.7%      11.28%
11	2.1%      6.73%
12	3.2%      2.57%
13	1.2%      15.61%
14	4.4%      18.09%
15	0.5%      10.17%
16	5.3%      13.75%
17	2.9%      0.92%
18	4.6%      16.39%
19	1.1%      20.45%
88	3.6%      3.35%

		Goverment subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana		5%	
1	National Food Security Mission		10%	
2	Sub-Mission on Agricultural Mechanization		15%	
3	NABARD loans in India		20%	
4	Yantra Laxmi Scheme		25%	
5	Rashtriya Krishi Vikas Yojana		30%	
6	National Food Security Mission		35%	
7	Sub-Mission on Agricultural Mechanization		40%	
8	NABARD loans in India		28.2%	
9	Yantra Laxmi Scheme		37.8%	
10	Rashtriya Krishi Vikas Yojana		15.7%	
11	National Food Security Mission		44.8%	
12	NABARD loans in India		9.3%	
13	Yantra Laxmi Scheme		19.6%	
14	Rashtriya Krishi Vikas Yojana		32.1%	
15	National Food Security Mission		26.8%	
16	Sub-Mission on Agricultural Mechanization		51.2%	
17	NABARD loans in India		8.7%	
18	Yantra Laxmi Scheme		43%	
19	Rashtriya Krishi Vikas Yojana		50%	
88	National Food Security Mission		55%	

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management
88	26.2%	Iot Agriculture

➤ Row Deletion:

```
print("***** ROW DELETION *****")
print(dc.drop(5))
```

**Output:**

***** ROW DELETION *****							
S.No		State	Population	Growth of Crops		Soil Type	\
0	1	Uttar Pradesh	199812341	Rice		Sandy loam	
1	2	Punjab	27743338	Maize		Claly soil	
2	3	Haryana	25545198	Sugarcane		Alluvial Soil	
3	4	Maharastra	112372333	Bajra		Residual	
4	5	Kerala	33406061	Coconut		Red soil	
5	6	Tamilnadu	72147030	Banana		Red Loam	
6	7	Gujarat	60439692	Jowar		Black Soil	
7	8	Karnataka	61095297	Ragi		Red Soil	
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic		
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols		
10	11	Assam	31205576	Maize	Hill Soil		
11	12	Bihar	104099452	Rice	Piedmontswamp		
12	13	Chattisgarh	25351462	Maize	Clary Soil		
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil		
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil		
15	16	Jharkhand	32988134	Ragi	Red Soil		
16	17	Manipur	2855794	Cotton	Inceptisols		
17	18	Meghalaya	2966889	Maize	Loamy Soil		
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil		
19	20	Nagaland	1978502	Millet	Ultisols Soil		

ph Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00
1	6.83	21.77	80.31	Zaid	1654.8	2083.00
2	7.45	23.00	82.32	Rabi	1119.5	1525.00
3	8.01	26.49	80.15	Kharif	1055.2	5239.00
4	8.10	20.13	81.60	Zaid	9895.6	5267.00
5	7.30	23.05	83.37	Zaid	1689.1	5182.00
6	6.25	22.70	82.63	Rabi	8665.8	1278.00
7	7.72	20.27	82.89	Kharif	4985.0	1763.00
8	7.80	24.51	83.53	Kharif	7989.4	10882.00
9	6.47	23.22	83.03	Zaid	1055.4	11558.00
10	6.81	26.52	81.41	Rabi	1629.8	13.50
11	7.07	23.97	81.45	Kharif	1449.9	15.86
12	7.65	26.80	80.88	Zaid	1222.2	102.50
13	7.66	24.01	82.05	Rabi	1349.1	104.37
14	6.86	25.66	80.66	Zaid	1439.0	192.00
15	8.40	24.28	80.30	Kharif	1636.5	208.00
16	8.10	21.58	82.78	Zaid	1334.0	208.50
17	7.65	23.79	80.41	Rabi	1629.5	3324.00
18	6.59	21.86	80.19	Rabi	9560.7	26.14
19	8.13	23.57	83.58	Zaid	1308.8	6443.00

Crop Health(%)	Water Quality(%)	Type of Agriculture Used \
0	87	50 Organic Farming
1	87	60 Aquaponics
2	76	87 Vertical Farming
3	68	76 Hydroponics
4	86	67 Permaculture
5	67	88 Precision Agriculture
6	78	47 Agroforestry
7	78	97 Greenhouse Cultivation
8	89	86 Urban Farming
9	88	56 Intensive Farming
10	90	77 Sustainable Agriculture
11	68	88 Crop Rotation
12	79	56 No-Till Farming
13	86	76 Regenerative Agriculture
14	82	77 Biodynamic Farming
15	58	57 Dry Farming
16	76	87 Alley Cropping
17	65	69 Silvopasture
18	88	58 Cover Cropping
19	79	68 Raised Bed Gardening

Water pollution(%)	Soil pollution(%) \
0	3.5% 3.25%
1	1.8% 8.71%
2	2.7% 12.46%
3	4.2% 5.89%
4	0.9% 19.72%
5	5.1% 1.34%
6	2.3% 7.56%
7	3.8% 14.92%
8	1.5% 9.83%
9	4.8% 4.67%
10	0.7% 11.28%
11	2.1% 6.73%
12	3.2% 2.57%
13	1.2% 15.61%
14	4.4% 18.09%
15	0.5% 10.17%
16	5.3% 13.75%
17	2.9% 0.92%
18	4.6% 16.39%
19	1.1% 20.45%

	Goverment subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana	5%	
1	National Food Security Mission	10%	
2	Sub-Mission on Agricultural Mechanization	15%	
3	NABARD loans in India	20%	
4	Yantra Laxmi Scheme	25%	
5	Rashtriya Krishi Vikas Yojana	30%	
6	National Food Security Mission	35%	
7	Sub-Mission on Agricultural Mechanization	40%	
8	NABARD loans in India	28.2%	
9	Yantra Laxmi Scheme	37.6%	
10	Rashtriya Krishi Vikas Yojana	15.7%	
11	National Food Security Mission	44.8%	
12	Sub-Mission on Agricultural Mechanization	9.3%	
13	NABARD loans in India	19.6%	
14	Yantra Laxmi Scheme	32.1%	
15	Rashtriya Krishi Vikas Yojana	26.8%	
16	National Food Security Mission	51.2%	
17	Sub-Mission on Agricultural Mechanization	8.7%	
18	NABARD loans in India	45%	
19	Yantra Laxmi Scheme	50%	

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management

➤ Row Reindexing:

```
print("*** ROW INDEXING ***")
c=sc.reindex([20,19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1])
print(c)
```

**Output:**

*** ROW INDEXING ***							
S.No	State	Population	Growth of Crops	Soil Type	\		
20	NaN	NaN	NaN	NaN	Ultisols	Soil	
19	20.0	Nagaland	1978502.0	Millet	Sand-Loamy	Soil	
18	19.0	Mizoram	1097206.0	Maize	Loamy	Soil	
17	18.0	Meghalaya	2966889.0	Maize	Inceptisols		
16	17.0	Manipur	2855794.0	Cotton	Red Soil		
15	16.0	Jharkhand	32988134.0	Ragi	Alluvial	Soil	
14	15.0	Jammu & Kashmir	13635010.0	Apples	Piedmontswamp		
13	14.0	Himachal Pradesh	6864602.0	Vegetables	Brown Hill	Soil	
12	13.0	Chattisgarh	25351462.0	Maize	Clary	Soil	
11	12.0	Bihar	104099452.0	Rice	Black	Soil	
10	11.0	Assam	31205576.0	Maize	Red Loam		
9	10.0	Arunachal Pradesh	1458545.0	Maize	Inceptisols		
8	9.0	Andhra Pradesh	84580777.0	Rice	Red Lateritic		
7	8.0	Karnataka	61095297.0	Ragi	Residual		
6	7.0	Gujarat	60439692.0	Jowar	Red Soil		
5	6.0	Tamilnadu	72147030.0	Banana	Black Soil		
4	5.0	Kerala	33406061.0	Coconut	Red soil		
3	4.0	Maharastra	112372333.0	Bajra	Red Loam		
2	3.0	Haryana	25545198.0	Sugarcane	Piedmontswamp	Soil	
1	2.0	Punjab	27743338.0	Maize	Claly	soil	

*** Row Reindexing ***							
ph	Level	Temperature	Humidity	Season	Area	Production	\
20	NaN	NaN	NaN	NaN	NaN	NaN	
19	8.13	23.57	83.58	Zaid	1308.8	6443.00	
18	6.59	21.86	80.19	Rabi	9560.7	26.14	
17	7.65	23.79	80.41	Rabi	1629.5	3324.00	
16	8.10	21.58	82.78	Zaid	1334.0	208.50	
15	8.40	24.28	80.30	Kharif	1636.5	208.00	
14	6.86	25.66	80.66	Zaid	1439.0	192.00	
13	7.66	24.01	82.05	Rabi	1349.1	104.37	
12	7.65	26.80	80.88	Zaid	1222.2	102.50	
11	7.07	23.97	81.45	Kharif	1449.9	15.86	
10	6.81	26.52	81.41	Rabi	1629.8	13.50	
9	6.47	23.22	83.03	Zaid	1055.4	11558.00	
8	7.80	24.51	83.53	Kharif	7989.4	10882.00	
7	7.72	20.27	82.89	Kharif	4985.0	1763.00	
6	6.25	22.70	82.63	Rabi	8665.8	1278.00	
5	7.30	23.05	83.37	Zaid	1689.1	5182.00	
4	8.10	20.13	81.60	Zaid	9895.6	5267.00	
3	8.01	26.49	80.15	Kharif	1055.2	5239.00	
2	7.45	23.00	82.32	Rabi	1119.5	1525.00	
1	6.83	21.77	80.31	Zaid	1654.8	2083.00	

Crop Health(%)	Water Quality(%)	Type of Agriculture Used \
20	NaN	NaN
19	79.0	Raised Bed Gardening
18	88.0	Cover Cropping
17	65.0	Silvopasture
16	76.0	Alley Cropping
15	58.0	Dry Farming
14	82.0	Biodynamic Farming
13	86.0	Regenerative Agriculture
12	79.0	No-Till Farming
11	68.0	Crop Rotation
10	90.0	Sustainable Agriculture
9	88.0	Intensive Farming
8	89.0	Urban Farming
7	78.0	Greenhouse Cultivation
6	78.0	Agroforestry
5	67.0	Precision Agriculture
4	86.0	Permaculture
3	68.0	Hydroponics
2	76.0	Vertical Farming
1	87.0	Aquaponics

Water pollution(%)	Soil pollution(%) \
20	NaN
19	1.1%
18	4.6%
17	2.9%
16	5.3%
15	0.5%
14	4.4%
13	1.2%
12	3.2%
11	2.1%
10	0.7%
9	4.8%
8	1.5%
7	3.8%
6	2.3%
5	5.1%
4	0.9%
3	4.2%
2	2.7%
1	1.8%

	Goverment subsidies	Organic Fertilizers Used (%)	\
20	National Food Security Mission	NaN	NaN
19	Rashtriya Krishi Vikas Yojana	50%	
18	Yantra Laxmi Scheme	45%	
17	NABARD loans in India	8.7%	
16	Sub-Mission on Agricultural Mechanization	51.2%	
15	National Food Security Mission	26.8%	
14	Rashtriya Krishi Vikas Yojana	32.1%	
13	NABARD loans in India	19.6%	
12	Yantra Laxmi Scheme	9.3%	
11	Sub-Mission on Agricultural Mechanization	44.8%	
10	National Food Security Mission	15.7%	
9	Rashtriya Krishi Vikas Yojana	37.6%	
8	NABARD loans in India	28.2%	
7	Yantra Laxmi Scheme	40%	
6	Sub-Mission on Agricultural Mechanization	35%	
5	National Food Security Mission	30%	
4	Rashtriya Krishi Vikas Yojana	25%	
3	Yantra Laxmi Scheme	20%	
2	NABARD loans in India	15%	
1	Sub-Mission on Agricultural Mechanization	10%	

### Power Consumption (%)

20	NaN
19	22.3%
18	25.6%
17	13.1%
16	38.7%
15	16.2%
14	36.3%
13	11.6%
12	47.4%
11	22.9%
10	41.5%
9	17.1%
8	7.8%
7	45.9%
6	30.7%
5	20.3%
4	10.9%
3	42.3%
2	14.6%
1	35.9%

## ➤ Head() Function:

The head function in Python displays the first five rows of the Dataframe by default. It takes ion a single Parameter.

We can use this parameter to display the number of rows of our Choice.

```
print("***** HEAD IN DEFAULT FUNCTION *****")
```

```
print(df.head())
```

**Output:**

```
***** HEAD IN DEFAULT FUNCTION *****\n\nS.No          State  Population Growth of Crops      Soil Type ph Level  \\\n0    1  Uttar Pradesh  199812341            Rice    Sandy loam   6.54\n1    2        Punjab  27743338           Maize    Clayey soil   6.83\n2    3       Haryana  25545198        Sugarcane Alluvial Soil   7.45\n3    4  Maharashtra  112372333          Bajra    Residual   8.01\n4    5       Kerala  33406061         Coconut   Red soil    8.10\n\nTemperature  Humidity  Season  Area  Production  Crop Health(%)  \\\n0      20.87    82.00  Kharif  1312.7    2061.0        87\n1      21.77    80.31  Zaid    1654.8    2083.0        87\n2      23.00    82.32  Rabi    1119.5    1525.0        76\n3      26.49    80.15  Kharif  1055.2    5239.0        68\n4      20.13    81.60  Zaid    9895.6    5267.0        86\n\nWater Quality(%)  Type of Agriculture Used Water pollution(%)  \\\n0            50          Organic Farming            3.5%\n1            60          Aquaponics              1.8%\n2            87        Vertical Farming            2.7%\n3            76          Hydroponics             4.2%\n4            67        Permaculture              0.9%\n\nSoil pollution(%)  Government subsidies  \\\n0            3.25%  Rashtriya Krishi Vikas Yojana\n1            8.71%  National Food Security Mission\n2           12.46% Sub-Mission on Agricultural Mechanization\n3            5.89%  NABARD loans in India\n4           19.72%  Yantra Laxmi Scheme\n\nOrganic Fertilizers Used (%)  Power Consumption (%)  Type of Technology Used\n0                  5%          12.5%  Precision Agriculture\n1                 10%          35.9%     IoT Agriculture\n2                 15%          14.6%     Smart Farming\n3                 20%          42.3% Drones in Agriculture\n4                 25%          10.9% Agricultural Robots
```

```

print("***** HEAD (SPECIFIC VALUE) *****")
print(df.head(15))

```

**Output:**

***** HEAD (SPECIFIC VALUE) *****							
S.No		State	Population	Growth of Crops		Soil Type	\
0	1	Uttar Pradesh	199812341	Rice		Sandy loam	
1	2	Punjab	27743338	Maize		Claly soil	
2	3	Haryana	25545198	Sugarcane		Alluvial Soil	
3	4	Maharastra	112372333	Bajra		Residual	
4	5	Kerala	33406061	Coconut		Red soil	
5	6	Tamilnadu	72147030	Banana		Red Loam	
6	7	Gujarat	60439692	Jowar		Black Soil	
7	8	Karnataka	61095297	Ragi		Red Soil	
8	9	Andhra Pradesh	84580777	Rice		Red Lateritic	
9	10	Arunachal Pradesh	1458545	Maize		Inceptisols	
10	11	Assam	31205576	Maize		Hill Soil	
11	12	Bihar	104099452	Rice		Piedmontswamp	
12	13	Chattisgarh	25351462	Maize		Clary Soil	
13	14	Himachal Pradesh	6864602	Vegetables		Brown Hill Soil	
14	15	Jammu& Kashmir	13635010	Apples		Alluvial Soil	
ph Level	Temperature	Humidity	Season	Area	Production	\	
0	6.54	20.87	82.00	Kharif	1312.7	2061.00	
1	6.83	21.77	80.31	Zaid	1654.8	2083.00	
2	7.45	23.00	82.32	Rabi	1119.5	1525.00	
3	8.01	26.49	80.15	Kharif	1055.2	5239.00	
4	8.10	20.13	81.60	Zaid	9895.6	5267.00	
5	7.30	23.05	83.37	Zaid	1689.1	5182.00	
6	6.25	22.70	82.63	Rabi	8665.8	1278.00	
7	7.72	20.27	82.89	Kharif	4985.0	1763.00	
8	7.80	24.51	83.53	Kharif	7989.4	10882.00	
9	6.47	23.22	83.03	Zaid	1055.4	11558.00	
10	6.81	26.52	81.41	Rabi	1629.8	13.50	
11	7.07	23.97	81.45	Kharif	1449.9	15.86	
12	7.65	26.80	80.88	Zaid	1222.2	102.50	
13	7.66	24.01	82.05	Rabi	1349.1	104.37	
14	6.86	25.66	80.66	Zaid	1439.0	192.00	

	Crop Health(%)	Water Quality(%)	Type of Agriculture Used \
0	87	50	Organic Farming
1	87	60	Aquaponics
2	76	87	Vertical Farming
3	68	76	Hydroponics
4	86	67	Permaculture
5	67	88	Precision Agriculture
6	78	47	Agroforestry
7	78	97	Greenhouse Cultivation
8	89	86	Urban Farming
9	88	56	Intensive Farming
10	90	77	Sustainable Agriculture
11	68	88	Crop Rotation
12	79	56	No-Till Farming
13	86	76	Regenerative Agriculture
14	82	77	Biodynamic Farming
	Water pollution(%)	Soil pollution(%)	\
0	3.5%	3.25%	
1	1.8%	8.71%	
2	2.7%	12.46%	
3	4.2%	5.89%	
4	0.9%	19.72%	
5	5.1%	1.34%	
6	2.3%	7.56%	
7	3.8%	14.92%	
8	1.5%	9.83%	
9	4.8%	4.67%	
10	0.7%	11.28%	
11	2.1%	6.73%	
12	3.2%	2.57%	
13	1.2%	15.61%	
14	4.4%	18.09%	

	Government subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana	5%	
1	National Food Security Mission	10%	
2	Sub-Mission on Agricultural Mechanization	15%	
3	NABARD loans in India	20%	
4	Yantra Laxmi Scheme	25%	
5	Rashtriya Krishi Vikas Yojana	30%	
6	National Food Security Mission	35%	
7	Sub-Mission on Agricultural Mechanization	40%	
8	NABARD loans in India	28.2%	Yantra Laxmi Scheme
9	Rashtriya Krishi Vikas Yojana	37.6%	
10	National Food Security Mission	15.7%	
11	Sub-Mission on Agricultural Mechanization	44.8%	
12	NABARD loans in India	9.3%	Yantra Laxmi Scheme
13	Rashtriya Krishi Vikas Yojana	19.6%	
14	National Food Security Mission	32.1%	
	Power Consumption (%)	Type of Technology Used	
0	12.5%	Precision Agriculture	
1	35.9%	IoT Agriculture	
2	14.6%	Smart Farming	
3	42.3%	Drones in Agriculture	
4	10.9%	Agricultural Robots	
5	20.3%	Machine Learning	
6	30.7%	Artificial Intelligence	
7	45.9%	Blockchain in Agriculture	
8	7.8%	Data Analytics	
9	17.1%	Dry Farming	
10	41.5%	Rainfed Agriculture	
11	22.9%	Conservation Agriculture	
12	47.4%	No-Till Farming	
13	11.6%	Strip Cropping	
14	36.3%	Cover Cropping	

## ➤ Tail() Function:

The tail function in Python displays the last five rows of the Dataframe by default.  
It takes ion a single Parameter.

We can use this parameter to display the number of rows of our Choice.

```
print("***** TAILS IN DEFAULT FUNCTION *****")
```

```
print(df.tail())
```

### Output:

```
***** TAILS IN DEFAULT FUNCTION *****
```

S.No	State	Population	Growth of Crops	Soil Type	ph Level	\
15	Jarkhand	32988134	Ragi	Red Soil	8.40	
16	Manipur	2855794	Cotton	Inceptisols	8.10	
17	Megalaya	2966889	Maize	Loamy Soil	7.65	
18	Mizoram	1097206	Maize	Sand-Loamy Soil	6.59	
19	Nagaland	1978502	Millet	Ultisols Soil	8.13	

	Temperature	Humidity	Season	Area	Production	Crop Health(%)	\
15	24.28	80.30	Kharif	1636.5	208.00	58	
16	21.58	82.78	Zaid	1334.0	208.50	76	
17	23.79	80.41	Rabi	1629.5	3324.00	65	
18	21.86	80.19	Rabi	9560.7	26.14	88	
19	23.57	83.58	Zaid	1308.8	6443.00	79	

	Water Quality(%)	Type of Agriculture	Used Water pollution(%)	\
15	57	Dry Farming	0.5%	
16	87	Alley Cropping	5.3%	
17	69	Silvopasture	2.9%	
18	58	Cover Cropping	4.6%	
19	68	Raised Bed Gardening	1.1%	

	Soil pollution(%)	Goverment subsidies \
15	10.17%	Sub-Mission on Agricultural Mechanization
16	13.75%	NABARD loans in India
17	0.92%	Yantra Laxmi Scheme
18	16.39%	Rashtriya Krishi Vikas Yojana
19	20.45%	National Food Security Mission

	Organic Fertilizers Used (%)	Power Consumption (%) \
15	26.8%	16.2%
16	51.2%	38.7%
17	8.7%	13.1%
18	45%	25.6%
19	50%	22.3%

	Type of Technology Used
15	Terrace Farming
16	Rice Intensification System
17	Permaculture
18	Precision Livestock Farming
19	Smart Livestock Management

```
print("***** TAILS (SPECIFIC VALUE) *****")
```

```
print(df.tail(17))
```

**Output:**

***** TAILS (SPECIFIC VALUE) *****							
S.No		State	Population	Growth of Crops		Soil Type	\
3	4	Maharashtra	112372333	Bajra		Residual	
4	5	Kerala	33406061	Coconut		Red soil	
5	6	Tamilnadu	72147030	Banana		Red Loam	
6	7	Gujarat	60439692	Jowar		Black Soil	
7	8	Karnataka	61095297	Ragi		Red Soil	
8	9	Andhra Pradesh	84580777	Rice		Red Lateritic	
9	10	Arunachal Pradesh	1458545	Maize		Inceptisols	
10	11	Assam	31205576	Maize		Hill Soil	
11	12	Bihar	104099452	Rice		Piedmontswamp	
12	13	Chattisgarh	25351462	Maize		Clary Soil	
13	14	Himachal Pradesh	6864602	Vegetables		Brown Hill Soil	
14	15	Jammu& Kashmir	13635010	Apples		Alluvial Soil	
15	16	Jarkhand	32988134	Ragi		Red Soil	
16	17	Manipur	2855794	Cotton		Inceptisols	
17	18	Megalaya	2966889	Maize		Loamy Soil	
18	19	Mizoram	1097206	Maize		Sand-Loamy Soil	
19	20	Nagaland	1978502	Millet		Ultisols Soil	

ph Level	Temperature	Humidity	Season	Area	Production	\
3	8.01	26.49	80.15	Kharif	1055.2	5239.00
4	8.10	20.13	81.60	Zaid	9895.6	5267.00
5	7.30	23.05	83.37	Zaid	1689.1	5182.00
6	6.25	22.70	82.63	Rabi	8665.8	1278.00
7	7.72	20.27	82.89	Kharif	4985.0	1763.00
8	7.80	24.51	83.53	Kharif	7989.4	10882.00
9	6.47	23.22	83.03	Zaid	1055.4	11558.00
10	6.81	26.52	81.41	Rabi	1629.8	13.50
11	7.07	23.97	81.45	Kharif	1449.9	15.86
12	7.65	26.80	80.88	Zaid	1222.2	102.50
13	7.66	24.01	82.05	Rabi	1349.1	104.37
14	6.86	25.66	80.66	Zaid	1439.0	192.00
15	8.40	24.28	80.30	Kharif	1636.5	208.00
16	8.10	21.58	82.78	Zaid	1334.0	208.50
17	7.65	23.79	80.41	Rabi	1629.5	3324.00
18	6.59	21.86	80.19	Rabi	9560.7	26.14
19	8.13	23.57	83.58	Zaid	1308.8	6443.00

	Crop Health(%)	Water Quality(%)	Type of Agriculture Used \
3	68	76	Hydroponics
4	86	67	Permaculture
5	67	88	Precision Agriculture
6	78	47	Agroforestry
7	78	97	Greenhouse Cultivation
8	89	86	Urban Farming
9	88	56	Intensive Farming
10	90	77	Sustainable Agriculture
11	68	88	Crop Rotation
12	79	56	No-Till Farming
13	86	76	Regenerative Agriculture
14	82	77	Biodynamic Farming
15	58	57	Dry Farming
16	76	87	Alley Cropping
17	65	69	Silvopasture
18	88	58	Cover Cropping
19	79	68	Raised Bed Gardening

	Water pollution(%)	Soil pollution(%) \
3	4.2%	5.89%
4	0.9%	19.72%
5	5.1%	1.34%
6	2.3%	7.56%
7	3.8%	14.92%
8	1.5%	9.83%
9	4.8%	4.67%
10	0.7%	11.28%
11	2.1%	6.73%
12	3.2%	2.57%
13	1.2%	15.61%
14	4.4%	18.09%
15	0.5%	10.17%
16	5.3%	13.75%
17	2.9%	0.92%
18	4.6%	16.39%
19	1.1%	20.45%

	Goverment subsidies	Organic Fertilizers Used (%)	\
3	NABARD loans in India	20%	
4	Yantra Laxmi Scheme	25%	
5	Rashtriya Krishi Vikas Yojana	30%	
6	National Food Security Mission	35%	
7	Sub-Mission on Agricultural Mechanization	40%	
8	NABARD loans in India	28.2%	Yantra Laxmi Scheme
9	Rashtriya Krishi Vikas Yojana	37.6%	
10	National Food Security Mission	15.7%	
11	Sub-Mission on Agricultural Mechanization	44.8%	
12	NABARD loans in India	9.3%	Yantra Laxmi Scheme
13	Rashtriya Krishi Vikas Yojana	19.6%	
14	National Food Security Mission	32.1%	
15	Sub-Mission on Agricultural Mechanization	26.8%	
16	NABARD loans in India	51.2%	
17	Yantra Laxmi Scheme	8.7%	
18	Rashtriya Krishi Vikas Yojana	45%	
19	National Food Security Mission	50%	

	Power Consumption (%)	Type of Technology Used
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management

## ➤ Min() & Max() Functions:

The Min() function shows the minimum values in the DataFrame for the Specific Column.

The Max() function shows the maximum values in the DataFrame for the Specific Column.

```
print("** MIN & MAX VALUES **")  
min=dc['Population'].min()  
max=df['Population'].max()  
print("VALUE OF MIN :: ",min)  
print("VALUE OF MAX :: ",max)
```

**Output:**

```
** MIN & MAX VALUES **  
VALUE OF MIN :: 1097206  
VALUE OF MAX :: 199812341
```

## ➤ Rank() Function:

The rank function is used to calculate the Numerical ranks of the data and returns the Individual index of the Series.

By using this method, we can rank all the Data members in a column in an ascending order if those are in numeric, come to alphabets it follows alphabetic order.

```
print("****Rank value for the data set****")  
print(df.rank())
```

**Output:**

```
****Rank value for the data set****  
   S.No  State  Population  Growth of Crops  Soil Type  ph Level  \\\n0    1.0    20.0        20.0      17.0    19.0    3.0  
1    2.0    18.0        10.0      9.5     5.0    6.0  
2    3.0     7.0         9.0      19.0    1.5    10.0  
3    4.0    13.0        19.0      2.0     17.0    16.0  
4    5.0    12.0        13.0      4.0     16.0    17.5  
5    6.0    19.0        16.0      3.0     13.0    9.0  
6    7.0     6.0        14.0      6.0     3.0    1.0  
7    8.0    11.0        15.0      14.5    14.5    14.0  
8    9.0     1.0        17.0      17.0    12.0    15.0  
9   10.0     2.0         2.0      9.5     8.5    2.0  
10   11.0     3.0        11.0      9.5     7.0    5.0  
11   12.0     4.0        18.0      17.0    11.0    8.0  
12   13.0     5.0         8.0      9.5     6.0    11.5  
13   14.0     8.0         6.0      20.0    4.0    13.0  
14   15.0     9.0         7.0      1.0     1.5    7.0  
15   16.0    10.0        12.0      14.5    14.5    20.0  
16   17.0    14.0         4.0      5.0     8.5    17.5  
17   18.0    15.0         5.0      9.5     10.0   11.5  
18   19.0    16.0         1.0      9.5     18.0    4.0  
19   20.0    17.0         3.0      13.0    20.0   19.0
```

	Water Quality(%)	Type of Agriculture Used	Water pollution(%)	\
0	2.0		12.0	13.0
1	7.0		3.0	7.0
2	16.5		20.0	10.0
3	11.5		9.0	15.0
4	8.0		13.0	3.0
5	18.5		14.0	19.0
6	1.0		1.0	9.0
7	20.0		8.0	14.0
8	15.0		19.0	6.0
9	3.5		10.0	18.0
10	13.5		18.0	2.0
11	18.5		6.0	8.0
12	3.5		11.0	12.0
13	11.5		16.0	5.0
14	13.5		4.0	16.0
15	5.0		7.0	1.0
16	16.5		2.0	20.0
17	10.0		17.0	11.0
18	6.0		5.0	17.0
19	9.0		15.0	4.0

	Temperature	Humidity	Season	Area	Production	Crop Health(%)	\
0	3.0	11.0	3.5	6.0	12.0	15.5	
1	5.0	4.0	16.5	14.0	13.0	15.5	
2	8.0	13.0	9.5	3.0	10.0	6.5	
3	18.0	1.0	3.5	1.0	16.0	4.5	
4	1.0	10.0	16.5	20.0	17.0	13.5	
5	9.0	18.0	16.5	15.0	15.0	3.0	
6	7.0	14.0	9.5	18.0	9.0	8.5	
7	2.0	16.0	3.5	16.0	11.0	8.5	
8	16.0	19.0	3.5	17.0	19.0	19.0	
9	10.0	17.0	16.5	2.0	20.0	17.5	
10	19.0	8.0	9.5	12.0	1.0	20.0	
11	13.0	9.0	3.5	10.0	2.0	4.5	
12	20.0	7.0	16.5	4.0	4.0	10.5	
13	14.0	12.0	9.5	8.0	5.0	13.5	
14	17.0	6.0	16.5	9.0	6.0	12.0	
15	15.0	3.0	3.5	13.0	7.0	1.0	
16	4.0	15.0	16.5	7.0	8.0	6.5	
17	12.0	5.0	9.5	11.0	14.0	2.0	
18	6.0	2.0	9.5	19.0	3.0	17.5	
19	11.0	20.0	16.5	5.0	18.0	10.5	

	Power Consumption (%)	Type of Technology Used
0	3.0	13.0
1	13.0	9.0
2	5.0	17.0
3	17.0	7.0
4	1.0	1.0
5	8.0	10.0
6	12.0	2.0
7	18.0	3.0
8	20.0	6.0
9	7.0	8.0
10	16.0	15.0
11	10.0	4.0
12	19.0	11.0
13	2.0	19.0
14	14.0	5.0
15	6.0	20.0
16	15.0	16.0
17	4.0	12.0
18	11.0	14.0
19	9.0	18.0

	Soil pollution(%)	Goverment subsidies	Organic Fertilizers Used (%)	\
0	14.0	12.0	16.0	
1	19.0	7.0	1.0	
2	5.0	16.5	2.0	
3	16.0	1.5	5.0	
4	11.0	19.5	6.0	
5	2.0	12.0	9.0	
6	18.0	7.0	11.0	
7	7.0	16.5	13.0	
8	20.0	3.5	8.0	
9	15.0	12.0	12.0	
10	4.0	7.0	3.0	
11	17.0	16.5	14.0	
12	12.0	3.5	20.0	
13	8.0	12.0	4.0	
14	10.0	7.0	10.0	
15	3.0	16.5	7.0	
16	6.0	1.5	18.0	
17	1.0	19.5	19.0	
18	9.0	12.0	15.0	
19	13.0	7.0	17.0	

```
print("***** RANK FOR THE SPECIFIC ATTRIBUTE *****")
print(df['Population'].rank())
```

**Output:**

```
***** RANK FOR THE SPECIFIC ATTRIBUTE *****
0    20.0
1    10.0
2     9.0
3    19.0
4    13.0
5    16.0
6    14.0
7    15.0
8    17.0
9     2.0
10   11.0
11   18.0
12    8.0
13    6.0
14    7.0
15   12.0
16    4.0
17    5.0
18    1.0
19    3.0
Name: Population, dtype: float64
```

## ➤ Correlation (Corr()) Function:

It is a relationship between two column data members in a dataset.

We can use a method called corr(). It is a scaled form of the Covariance.

The Correlation values are lies between -1 & +1

There are 3 types of correlation they are:

- Positive Correlation.
- Negative Correlation.
- No- Correlation.

**Formula:**

$$\gamma = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma y)^2]}}$$

where

$n$  = Quantity of information

$\Sigma x$  = Total of the first variable value

$\Sigma y$  = Total of the second variable value

$\Sigma xy$  = Sum of the Product of first & second values.

$\Sigma x^2$  = Sum of Squares of the first value

$\Sigma y^2$  = Sum of the squares of the second value

---

### # CORRELATION:

```
print("** APPLY CORRELATION FUNCTION () **")
a=df['ph Level'].corr(df['Area'])
print(a)
b=df['Temperature'].corr(df['Humidity'])
print(b)
c=df['Area'].corr(df['Production'])
print(c)
d=df['Crop Health(%']].corr(df['Water Quality(%)'])
print(d)
```

**Output:**

```
** APPLY CORRELATION FUNCTION () **
-0.10890600524719746
-0.2953101866969197
0.1431047656971367
-0.18695346212662067
```

### Mathematical Representation:

\* Correlation b/w PH Value & Area

$$\gamma = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma y)^2]}}$$

$$= \frac{20(458117.306) - (147.39)(61982.0)}{\sqrt{[20(1094.1811) - (147.39)^2][20(3845998.7508) - (61982.0)^2]}}$$

$$= \frac{9062846.12 - 9135526.98}{\sqrt{[159.8099][3850229177.6]}}$$

$$= -0.10890$$

\* Correlation b/w Temperature & humidity

$$\gamma = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma y)^2]}}$$

$$= \frac{20(38262.321)(468.05)(1635.54)}{\sqrt{[20(11028.411) - 468.05)^2][20(33778.7287) - (1635.54)^2]}$$

$$= \frac{-268.077}{\sqrt{(1497.4175)(583.4824)}}$$

$$= -0.28679$$

correlation b/w crop Health & water quality

$$\rho = \frac{20(110769) - (1575)(1427)}{\sqrt{[20(125691) - (1575)^2] [20(165909) - (1427)^2]}} \\ = \frac{-32145}{\sqrt{(33195)(81851)}} \\ = -0.1869$$

correlation b/w area & production

$$\rho = \frac{20(318353177.079) - (61982)}{(57475.87)} \\ \sqrt{[20(386697811.05) - (3841768324)]} \\ [20(402407625.6861) - (3303475632.2569)] \\ = \frac{2804594167}{\sqrt{(3892187898)(4744676881)}} \\ = 0.143104$$

## ➤ Covariance (Cov()) Function:

The relation between two data members which are in two different attributes. It is a measurement of correlation.

The result may vary every second. The Covariance lies between the  $-\infty$  to  $+\infty$ .

**Formula:**

$$\text{Cov}(x,y) = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{N-1}$$

where

$x_i$  = data values of  $x$

$y_i$  = data values of  $y$

$\bar{x}$  = Mean of  $x$

$\bar{y}$  = Mean of  $y$

$N$  = Number of data values.

---

```
print("***** APPLY THE COVARIANCE FUNCTION *****")
```

```
a=df['ph Level'].cov(df['Area'])
```

```
print(a)
```

```
b=df['Temperature'].cov(df['Humidity'])
```

```
print(b)
```

```
c=df['Area'].cov(df['Production'])
```

```
print(c)
```

```
d=df['Crop Health(%']].cov(df['Water Quality(%')]])
```

```
print(d)
```

**Output:**

```
***** APPLY THE COVARIANCE FUNCTION *****
```

```
-223.79700000000037
```

```
-0.7054657894736839
```

```
1602353.0716842099
```

```
-25.644736842105242
```

### Mathematical Representation:

→ covariance b/w pH value and Area.

$$\text{cov}(x,y) = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{N-1}$$

$$= \frac{-4252.0947}{20-1} = \frac{-4252.0947}{19}$$

$$= -223.794458$$

→ covariance b/w Temperature and Humidity.

$$\text{cov}(x,y) = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{N-1}$$

$$= \frac{-14.47415}{20-1} = \frac{-14.47415}{19}$$

$$= -0.761797$$

→ covariance b/w Area. and production.

$$\text{cov}(x,y) = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{N-1}$$

$$= \frac{30444708.3}{20-1} = \frac{30444708.3}{19}$$

$$= 1602853.07$$

→ covariance b/w crop health and water quality

$$\text{cov}(x,y) = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{N-1}$$

$$= \frac{-487.25}{20-1} = \frac{-487.25}{19}$$

$$= -25.64447368$$

## ➤ Slicing:

The Slice() function returns a slice object. A slice object is used to specify how to slice a sequence. You can specify where to start the slicing, and where to end.

**Syntax:** slice(start, end, step).

```
print("APPLYING SLICING OPERATION TO THE DATA SET")
```

```
df1 = df.iloc[:,0:5:1]
```

```
print(df1)
```

**Output:**

APPLYING SLICING OPERATION TO THE DATA SET						
S.No		State	Population	Growth of Crops	Soil Type	
0	1	Uttar Pradesh	199812341	Rice	Sandy loam	
1	2	Punjab	27743338	Maize	Claly soil	
2	3	Haryana	25545198	Sugarcane	Alluvial Soil	
3	4	Maharastra	112372333	Bajra	Residual	
4	5	Kerala	33406061	Coconut	Red soil	
5	6	Tamilnadu	72147030	Banana	Red Loam	
6	7	Gujarat	60439692	Jowar	Black Soil	
7	8	Karnataka	61095297	Ragi	Red Soil	
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic	
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols	
10	11	Assam	31205576	Maize	Hill Soil	
11	12	Bihar	104099452	Rice	Piedmontswamp	
12	13	Chattisgarh	25351462	Maize	Clary Soil	
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil	
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil	
15	16	Jarkhand	32988134	Ragi	Red Soil	
16	17	Manipur	2855794	Cotton	Inceptisols	
17	18	Megalaya	2966889	Maize	Loamy Soil	
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil	
19	20	Nagaland	1978502	Millet	Ultisols Soil	

### 7.3 DATA MINING:

It is a process of gathering all information regards data set i,e collection of dataset for transferring raw data to another for performing better operations & easy to understand. Data Mining is also known as Data Wrangling.

(or)

Is the process of extracting insights from a big amount of data.

➤ Operations in Data Mining:

- I. Data Filtering.
- II. Merging data.
- III. Reshaping data.
- IV. Aggregation.
- V. Grouping.

➤ Data Filtering; Data filtering is a process of getting only required information from data set is known as the Data filtering, for the process of filtering we use no methods.

➤ Data Merging: It is a process of combining of two data sets into a one data set.

**Syntax:** merge (Df1,Df2,on="Field")

➤ Reshaping of Data: Reshaping of data is a process use to transform the structure of the DataFrame to better suit the analysis or visualization needs.

➤ Data Aggregation: Data aggregation its focus on joins two data frames.

**Method:** pd.concat()

**Syntax:** pd.concat([DataFrame1,DataFrame2])

➤ Data Grouping: It is a process of make a group based on some condition from data in dataset.

**Method:** pd.groupby()

**Syntax;** pd.groupby('field\_name')

```

#dataset-1
a={'S.No':pd.Series([1,2,3,4,5,6,7,8,9,10]),
'State':pd.Series(['Uttar Pradesh','Punjab','Haryana','Maharastra','Kerala','Tamilnadu','Guja'Gujarat','Karnataka','Andhra Pradesh','Arunachal Pradesh']),
'Population':pd.Series([199812341,27743338,25545198,112372333,33406061,72147030,60439692,61095297,84580777,1458545]),
'Growth of Crops':pd.Series(['Rice','Maize','Sugarcane','Bajra','Coconut','Banana','Jowar','Ragi','Rice','Maize']),
'Soil Type':pd.Series(['Sandy loan','Claly soil','Alluvial Soil','Residual','Red soil','Red Loam','Black Soil','Red Soil','Red Lateritic','Inceptisols']),
'ph Level':pd.Series([6.54,6.83,7.45,8.01,8.10,7.30,6.25,7.72,7.80,6.47]),
'Temperature':pd.Series([20.87,21.77,23.00,26.49,20.13,23.05,22.70,20.27,24.51,23.22]),
'Humidity':pd.Series([82.00,80.31,82.32,80.15,81.60,83.37,82.63,82.89,83.53,83.03]),
'Season':pd.Series(['Kharif','Zaid','Rabi','Kharif','Zaid','Zaid','Rabi','Kharif','Kharif','Zaid']),
'Area':pd.Series([1312.7,1654.8,1119.5,1055.2,9895.6,1689.1,8665.8,4985,7989.4,1055.4]),
'Production':pd.Series([2061,2083,1525,5239,5267,5182,1278,1763,10882,11558]),
'Type of Agriculture Used':pd.Series(['Organic Farming', 'Aquaponics', 'Vertical Farming', 'Hydropponics', 'Permaculture', 'Precision Agriculture', 'Agroforestry', 'Greenhouse Cultivation', 'Urban Farming', 'Intensive Farming']),
}

x=pd.DataFrame(a)
print(x)

```

### Output:

S.No	State	Population	Growth of Crops	Soil Type	\	
0	1 Uttar Pradesh	199812341	Rice	Sandy loan		
1	2 Punjab	27743338	Maize	Claly soil		
2	3 Haryana	25545198	Sugarcane	Alluvial Soil		
3	4 Maharastra	112372333	Bajra	Residual		
4	5 Kerala	33406061	Coconut	Red soil		
5	6 Tamilnadu	72147030	Banana	Red Loam		
6	7 Gujarat	60439692	Jowar	Black Soil		
7	8 Karnataka	61095297	Ragi	Red Soil		
8	9 Andhra Pradesh	84580777	Rice	Red Lateritic		
9	10 Arunachal Pradesh	1458545	Maize	Inceptisols		
ph Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061
1	6.83	21.77	80.31	Zaid	1654.8	2083
2	7.45	23.00	82.32	Rabi	1119.5	1525
3	8.01	26.49	80.15	Kharif	1055.2	5239
4	8.10	20.13	81.60	Zaid	9895.6	5267
5	7.30	23.05	83.37	Zaid	1689.1	5182
6	6.25	22.70	82.63	Rabi	8665.8	1278
7	7.72	20.27	82.89	Kharif	4985.0	1763
8	7.80	24.51	83.53	Kharif	7989.4	10882
9	6.47	23.22	83.03	Zaid	1055.4	11558

Type of Agriculture Used	
0	Organic Farming
1	Aquaponics
2	Vertical Farming
3	Hydroponics
4	Permaculture
5	Precision Agriculture
6	Agroforestry
7	Greenhouse Cultivation
8	Urban Farming
9	Intensive Farming

```

#dataset-2
c={'S.No':pd.Series([1,2,3,4,5,6,7,8,9,10]),
 'Crop Health(%)':pd.Series([87,87,76,68,86,67,78,78,89,88]),
 'Water Quality(%)':pd.Series([50,60,87,76,67,88,47,97,86,56]),
 'Type of Agriculture Used':pd.Series(['Organic Farming', 'Aquaponics', 'Vertical Farming', 'Hydroponics', 'Precision Agriculture', 'Agroforestry', 'Greenhouse Cultivation', 'Urban Farming', 'Intensive Farming']),
 'Water pollution(%)':pd.Series(['3.5%', '1.8%', '2.7%', '4.2%', '0.9%', '5.1%', '2.3%', '3.8%', '1.5%', '4.8%']),
 'Soil pollution(%)':pd.Series(['3.25%', '8.71%', '12.46%', '5.89%', '19.72%', '1.34%', '7.56%', '14.92%', '9.83%', '4.67%']),
 'Goverment subsidies':pd.Series(["Rashtriya Krishi Vikas Yojana", "National Food Security Mission", "Sub-Mission on Agricultural Mechanization", "NABARD loans in India", "Yantra Laxmi Scheme", "Rashtriya Krishi Vikas Yojana", "National Food Security Mission", "Sub-Mission on Agricultural Mechanization", "NABARD loans in India", "Yantra Laxmi Scheme"]),
 'Organic Fertilizers Used (%)': pd.Series(['5%', '10%', '15%', '20%', '25%', '30%', '35%', '40%', '28.2%', '37.6%']),
 'Power Consumption (%)': pd.Series(['12.5%', '35.9%', '14.6%', '42.3%', '10.9%', '20.3%', '30.7%', '45.9%', '7.8%', '17.1%']),
 'Type of Technology Used': pd.Series(['Precision Agriculture', 'IoT Agriculture', 'Smart Farming', 'Drones in Agriculture', 'Agricultural Robots', 'Machine Learning', 'Artificial Intelligence', 'Blockchain in Agriculture', 'Data Analytics', 'Dry Farming'])}
}

y=pd.DataFrame(c)
print(y)

```

#### Output:

S.No	Crop Health(%)	Water Quality(%)	Type of Agriculture Used	\
0	1	87	50	Organic Farming
1	2	87	60	Aquaponics
2	3	76	87	Vertical Farming
3	4	68	76	Hydroponics
4	5	86	67	Permaculture
5	6	67	88	Precision Agriculture
6	7	78	47	Agroforestry
7	8	78	97	Greenhouse Cultivation
8	9	89	86	Urban Farming
9	10	88	56	Intensive Farming
Water pollution(%)		Soil pollution(%)	\	
0		3.5%	3.25%	
1		1.8%	8.71%	
2		2.7%	12.46%	
3		4.2%	5.89%	
4		0.9%	19.72%	
5		5.1%	1.34%	
6		2.3%	7.56%	
7		3.8%	14.92%	
8		1.5%	9.83%	
9		4.8%	4.67%	

	Goverment subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana		5%
1	National Food Security Mission		10%
2	Sub-Mission on Agricultural Mechanization		15%
3	NABARD loans in India		20%
4	Yantra Laxmi Scheme		25%
5	Rashtriya Krishi Vikas Yojana		30%
6	National Food Security Mission		35%
7	Sub-Mission on Agricultural Mechanization		40%
8	NABARD loans in India		28.2%
9	Yantra Laxmi Scheme		37.6%

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming

➤ Data Merging:

```
print("**** Merging of dataset1 and dataset2 ****")
print(pd.merge(x,y,on='Type of Agriculture Used'))
```

**Output:**

**** Merging of dataset1 and dataset2 ****						
S.No_x	State	Population	Growth of Crops	Soil Type	\	
0	1      Uttar Pradesh	199812341	Rice	Sandy loam		
1	2      Punjab	27743338	Maize	Claly soil		
2	3      Haryana	25545198	Sugarcane	Alluvial Soil		
3	4      Maharastra	112372333	Bajra	Residual		
4	5      Kerala	33406061	Coconut	Red soil		
5	6      Tamilnadu	72147030	Banana	Red Loam		
6	7      Gujarat	60439692	Jowar	Black Soil		
7	8      Karnataka	61095297	Ragi	Red Soil		
8	9      Andhra Pradesh	84580777	Rice	Red Lateritic		
9	10     Arunachal Pradesh	1458545	Maize	Inceptisols		
ph Level	Temperature	Humidity	Season	Area	...	\
0	6.54	20.87	82.00	Kharif	1312.7	...
1	6.83	21.77	80.31	Zaid	1654.8	...
2	7.45	23.00	82.32	Rabi	1119.5	...
3	8.01	26.49	80.15	Kharif	1055.2	...
4	8.10	20.13	81.60	Zaid	9895.6	...
5	7.30	23.05	83.37	Zaid	1689.1	...
6	6.25	22.70	82.63	Rabi	8665.8	...
7	7.72	20.27	82.89	Kharif	4985.0	...
8	7.80	24.51	83.53	Kharif	7989.4	...
9	6.47	23.22	83.03	Zaid	1055.4	...
Type of Agriculture Used	S.No_y	Crop	Health(%)	Water Quality(%)	\	
0	Organic Farming	1	87	50		
1	Aquaponics	2	87	60		
2	Vertical Farming	3	76	87		
3	Hydroponics	4	68	76		
4	Permaculture	5	86	67		
5	Precision Agriculture	6	67	88		
6	Agroforestry	7	78	47		
7	Greenhouse Cultivation	8	78	97		
8	Urban Farming	9	89	86		
9	Intensive Farming	10	88	56		
Water pollution(%)	Soil pollution(%)	\				
0	3.5%	3.25%				
1	1.8%	8.71%				
2	2.7%	12.46%				
3	4.2%	5.89%				
4	0.9%	19.72%				
5	5.1%	1.34%				
6	2.3%	7.56%				
7	3.8%	14.92%				
8	1.5%	9.83%				
9	4.8%	4.67%				

	Government subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana		5%
1	National Food Security Mission		10%
2	Sub-Mission on Agricultural Mechanization		15%
3	NABARD loans in India		20%
4	Yantra Laxmi Scheme		25%
5	Rashtriya Krishi Vikas Yojana		30%
6	National Food Security Mission		35%
7	Sub-Mission on Agricultural Mechanization		40%
8	NABARD loans in India		28.2%
9	Yantra Laxmi Scheme		37.6%
Power Consumption (%)		Type of Technology Used	
0	12.5%	Precision Agriculture	
1	35.9%	IoT Agriculture	
2	14.6%	Smart Farming	
3	42.3%	Drones in Agriculture	
4	10.9%	Agricultural Robots	
5	20.3%	Machine Learning	
6	30.7%	Artificial Intelligence	
7	45.9%	Blockchain in Agriculture	
8	7.8%	Data Analytics	
9	17.1%	Dry Farming	

[10 rows x 21 columns]

➤ Data Aggregation:

```
print(" **** Data aggregation/ joining two data frames ****")
print(pd.concat([x,y]))
```

**Output:**

**** Data aggregation/ joining two data frames ****						
S.No		State	Population	Growth of Crops	Soil Type	\
0	1	Uttar Pradesh	199812341.0	Rice	Sandy loam	
1	2	Punjab	27743338.0	Maize	Claly soil	
2	3	Haryana	25545198.0	Sugarcane	Alluvial Soil	
3	4	Maharastra	112372333.0	Bajra	Residual	
4	5	Kerala	33406061.0	Coconut	Red soil	
5	6	Tamilnadu	72147030.0	Banana	Red Loam	
6	7	Gujarat	60439692.0	Jowar	Black Soil	
7	8	Karnataka	61095297.0	Ragi	Red Soil	
8	9	Andhra Pradesh	84580777.0	Rice	Red Lateritic	
9	10	Arunachal Pradesh	1458545.0	Maize	Inceptisols	
0	1	Nan	NaN	NaN	NaN	
1	2	Nan	NaN	NaN	NaN	
2	3	Nan	NaN	NaN	NaN	
3	4	Nan	NaN	NaN	NaN	
4	5	Nan	NaN	NaN	NaN	
5	6	Nan	NaN	NaN	NaN	
6	7	Nan	NaN	NaN	NaN	
7	8	Nan	NaN	NaN	NaN	
8	9	Nan	NaN	NaN	NaN	
9	10	Nan	NaN	NaN	NaN	

ph	Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.0	
1	6.83	21.77	80.31	Zaid	1654.8	2083.0	
2	7.45	23.00	82.32	Rabi	1119.5	1525.0	
3	8.01	26.49	80.15	Kharif	1055.2	5239.0	
4	8.10	20.13	81.60	Zaid	9895.6	5267.0	
5	7.30	23.05	83.37	Zaid	1689.1	5182.0	
6	6.25	22.70	82.63	Rabi	8665.8	1278.0	
7	7.72	20.27	82.89	Kharif	4985.0	1763.0	
8	7.80	24.51	83.53	Kharif	7989.4	10882.0	
9	6.47	23.22	83.03	Zaid	1055.4	11558.0	
0	NaN	NaN	NaN	NaN	NaN	NaN	
1	NaN	NaN	NaN	NaN	NaN	NaN	
2	NaN	NaN	NaN	NaN	NaN	NaN	
3	NaN	NaN	NaN	NaN	NaN	NaN	
4	NaN	NaN	NaN	NaN	NaN	NaN	
5	NaN	NaN	NaN	NaN	NaN	NaN	
6	NaN	NaN	NaN	NaN	NaN	NaN	
7	NaN	NaN	NaN	NaN	NaN	NaN	
8	NaN	NaN	NaN	NaN	NaN	NaN	
9	NaN	NaN	NaN	NaN	NaN	NaN	

Type of Agriculture Used	Crop Health(%)	Water Quality(%)	\
Organic Farming	NaN	NaN	
Aquaponics	NaN	NaN	
Vertical Farming	NaN	NaN	
Hydroponics	NaN	NaN	
Permaculture	NaN	NaN	
Precision Agriculture	NaN	NaN	
Agroforestry	NaN	NaN	
Greenhouse Cultivation	NaN	NaN	
Urban Farming	NaN	NaN	
Intensive Farming	NaN	NaN	
Organic Farming	87.0	50.0	
Aquaponics	87.0	60.0	
Vertical Farming	76.0	87.0	
Hydroponics	68.0	76.0	
Permaculture	86.0	67.0	
Precision Agriculture	67.0	88.0	
Agroforestry	78.0	47.0	
Greenhouse Cultivation	78.0	97.0	
Urban Farming	89.0	86.0	
Intensive Farming	88.0	56.0	

Water pollution(%)	Soil pollution(%)	\
NaN	NaN	
3.5%	3.25%	
1.8%	8.71%	
2.7%	12.46%	
4.2%	5.89%	
0.9%	19.72%	
5.1%	1.34%	
2.3%	7.56%	
3.8%	14.92%	
1.5%	9.83%	
4.8%	4.67%	

	Government subsidies	Organic Fertilizers Used (%)	\
0	NaN	NaN	
1	NaN	NaN	
2	NaN	NaN	
3	NaN	NaN	
4	NaN	NaN	
5	NaN	NaN	
6	NaN	NaN	
7	NaN	NaN	
8	NaN	NaN	
9	NaN	NaN	
0	Rashtriya Krishi Vikas Yojana	5%	
1	National Food Security Mission	10%	
2	Sub-Mission on Agricultural Mechanization	15%	
3	NABARD loans in India	20%	
4	Yantra Laxmi Scheme	25%	
5	Rashtriya Krishi Vikas Yojana	30%	
6	National Food Security Mission	35%	
7	Sub-Mission on Agricultural Mechanization	40%	
8	NABARD loans in India	28.2%	
9	Yantra Laxmi Scheme	37.6%	

	Power Consumption (%)	Type of Technology Used
0	NaN	NaN
1	NaN	NaN
2	NaN	NaN
3	NaN	NaN
4	NaN	NaN
5	NaN	NaN
6	NaN	NaN
7	NaN	NaN
8	NaN	NaN
9	NaN	NaN
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming

➤ Data Grouping:

```
print("**** Data grouping by using condition****")
x=df.groupby('Soil Type')
print(x.get_group('Sandy loan'))
```

**Output:**

```
**** Data grouping by using condition****
   S.No      State  Population Growth of Crops  Soil Type  ph Level \
0      1  Uttar Pradesh    199812341           Rice  Sandy loan     6.54

   Temperature  Humidity  Season     Area  Production  Crop Health(%) \
0      20.87      82.0  Kharif  1312.7      2061.0            87

   Water Quality(%)  Type of Agriculture Used Water pollution(%) \
0          50            Organic Farming                  3.5%          

   Soil pollution(%)  Goverment subsidies \
0        3.25%  Rashtriya Krishi Vikas Yojana

   Organic Fertilizers Used (%)  Power Consumption (%)  Type of Technology Used
0                  5%                12.5%            Precision Agriculture
```

- notnull() method:

notnull is a general methodology in python that detects if values are not missing for either a single value .The function returns Boolean values only(True or False).

Value is null== False

Value is not null == True.

```
print("***** Using notnull() method *****")
print(df.notnull())
```

#### Output:

***** Using notnull() method *****									
	S.No	State	Population	Growth of Crops	Soil Type	ph Level	\		
0	True	True	True	True	True	True	\		
1	True	True	True	True	True	True	\		
2	True	True	True	True	True	True	\		
3	True	True	True	True	True	True	\		
4	True	True	True	True	True	True	\		
5	True	True	True	True	True	True	\		
6	True	True	True	True	True	True	\		
7	True	True	True	True	True	True	\		
8	True	True	True	True	True	True	\		
9	True	True	True	True	True	True	\		
10	True	True	True	True	True	True	\		
11	True	True	True	True	True	True	\		
12	True	True	True	True	True	True	\		
13	True	True	True	True	True	True	\		
14	True	True	True	True	True	True	\		
15	True	True	True	True	True	True	\		
16	True	True	True	True	True	True	\		
17	True	True	True	True	True	True	\		
18	True	True	True	True	True	True	\		
19	True	True	True	True	True	True	\		

Temperature Humidity Season Area Production Crop Health(%) \								
	Temperature	Humidity	Season	Area	Production	Crop	Health(%)	\
0	True	True	True	True	True	True	True	\
1	True	True	True	True	True	True	True	\
2	True	True	True	True	True	True	True	\
3	True	True	True	True	True	True	True	\
4	True	True	True	True	True	True	True	\
5	True	True	True	True	True	True	True	\
6	True	True	True	True	True	True	True	\
7	True	True	True	True	True	True	True	\
8	True	True	True	True	True	True	True	\
9	True	True	True	True	True	True	True	\
10	True	True	True	True	True	True	True	\
11	True	True	True	True	True	True	True	\
12	True	True	True	True	True	True	True	\
13	True	True	True	True	True	True	True	\
14	True	True	True	True	True	True	True	\
15	True	True	True	True	True	True	True	\
16	True	True	True	True	True	True	True	\
17	True	True	True	True	True	True	True	\
18	True	True	True	True	True	True	True	\
19	True	True	True	True	True	True	True	\

	Water Quality(%)	Type of Agriculture Used	Water pollution(%)	\
0	True	True	True	True
1	True	True	True	True
2	True	True	True	True
3	True	True	True	True
4	True	True	True	True
5	True	True	True	True
6	True	True	True	True
7	True	True	True	True
8	True	True	True	True
9	True	True	True	True
10	True	True	True	True
11	True	True	True	True
12	True	True	True	True
13	True	True	True	True
14	True	True	True	True
15	True	True	True	True
16	True	True	True	True
17	True	True	True	True
18	True	True	True	True
19	True	True	True	True

	Soil pollution(%)	Goverment subsidies	Organic Fertilizers Used (%)	\
0	True	True	True	True
1	True	True	True	True
2	True	True	True	True
3	True	True	True	True
4	True	True	True	True
5	True	True	True	True
6	True	True	True	True
7	True	True	True	True
8	True	True	True	True
9	True	True	True	True
10	True	True	True	True
11	True	True	True	True
12	True	True	True	True
13	True	True	True	True
14	True	True	True	True
15	True	True	True	True
16	True	True	True	True
17	True	True	True	True
18	True	True	True	True
19	True	True	True	True

	Power Consumption (%)	Type of Technology Used
0	True	True
1	True	True
2	True	True
3	True	True
4	True	True
5	True	True
6	True	True
7	True	True
8	True	True
9	True	True
10	True	True
11	True	True
12	True	True
13	True	True
14	True	True
15	True	True
16	True	True
17	True	True
18	True	True
19	True	True

➤ isnull() method:

The isnull() method returns a DataFrame object where all the values are replaced with a Boolean values. True for NULL otherwise false.

```
print("**** Empty cells/NaN values ****")
print("**** Using isnull() method ****")
print(df.isnull())
```

**Output:**

**** Empty cells/NaN values ****							
**** Using isnull() method ****							
S.No	State	Population	Growth of Crops	Soil Type	ph Level	\	
0	False	False	False	False	False	False	
1	False	False	False	False	False	False	
2	False	False	False	False	False	False	
3	False	False	False	False	False	False	
4	False	False	False	False	False	False	
5	False	False	False	False	False	False	
6	False	False	False	False	False	False	
7	False	False	False	False	False	False	
8	False	False	False	False	False	False	
9	False	False	False	False	False	False	
10	False	False	False	False	False	False	
11	False	False	False	False	False	False	
12	False	False	False	False	False	False	
13	False	False	False	False	False	False	
14	False	False	False	False	False	False	
15	False	False	False	False	False	False	
16	False	False	False	False	False	False	
17	False	False	False	False	False	False	
18	False	False	False	False	False	False	
19	False	False	False	False	False	False	

	Temperature	Humidity	Season	Area	Production	Crop	Health(%)	\
0	False	False	False	False	False	False	False	
1	False	False	False	False	False	False	False	
2	False	False	False	False	False	False	False	
3	False	False	False	False	False	False	False	
4	False	False	False	False	False	False	False	
5	False	False	False	False	False	False	False	
6	False	False	False	False	False	False	False	
7	False	False	False	False	False	False	False	
8	False	False	False	False	False	False	False	
9	False	False	False	False	False	False	False	
10	False	False	False	False	False	False	False	
11	False	False	False	False	False	False	False	
12	False	False	False	False	False	False	False	
13	False	False	False	False	False	False	False	
14	False	False	False	False	False	False	False	
15	False	False	False	False	False	False	False	
16	False	False	False	False	False	False	False	
17	False	False	False	False	False	False	False	
18	False	False	False	False	False	False	False	
19	False	False	False	False	False	False	False	

	Water Quality(%)	Type of Agriculture Used	Water pollution(%)	\
0	False	False	False	
1	False	False	False	
2	False	False	False	
3	False	False	False	
4	False	False	False	
5	False	False	False	
6	False	False	False	
7	False	False	False	
8	False	False	False	
9	False	False	False	
10	False	False	False	
11	False	False	False	
12	False	False	False	
13	False	False	False	
14	False	False	False	
15	False	False	False	
16	False	False	False	
17	False	False	False	
18	False	False	False	
19	False	False	False	

	Soil pollution(%)	Goverment subsidies	Organic Fertilizers Used (%)	\
0	False	False	False	
1	False	False	False	
2	False	False	False	
3	False	False	False	
4	False	False	False	
5	False	False	False	
6	False	False	False	
7	False	False	False	
8	False	False	False	
9	False	False	False	
10	False	False	False	
11	False	False	False	
12	False	False	False	
13	False	False	False	
14	False	False	False	
15	False	False	False	
16	False	False	False	
17	False	False	False	
18	False	False	False	
19	False	False	False	

	Power Consumption (%)	Type of Technology Used
0	False	False
1	False	False
2	False	False
3	False	False
4	False	False
5	False	False
6	False	False
7	False	False
8	False	False
9	False	False
10	False	False
11	False	False
12	False	False
13	False	False
14	False	False
15	False	False
16	False	False
17	False	False
18	False	False
19	False	False

- Wrong format:

It means the data with column is belong to some Datatype ,if not we treat as a wrong format.

---

```
print("**** wrong format ****")
print(df['Population'].sum())
```

#### Output:

```
**** wrong format ****
901643239
```

- Dropna() Method:

The dropna() method removes the rows that contain NULL values.

---

```
print(" **** USING dropna() method **** ")
print(df.dropna())
```

#### Output:

**** USING dropna() method ****						
S.No		State	Population	Growth of Crops	Soil Type	\
0	1	Uttar Pradesh	199812341	Rice	Sandy loam	
1	2	Punjab	27743338	Maize	Claly soil	
2	3	Haryana	25545198	Sugarcane	Alluvial Soil	
3	4	Maharastra	112372333	Bajra	Residual	
4	5	Kerala	33406061	Coconut	Red soil	
5	6	Tamilnadu	72147030	Banana	Red Loam	
6	7	Gujarat	60439692	Jowar	Black Soil	
7	8	Karnataka	61095297	Ragi	Red Soil	
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic	
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols	
10	11	Assam	31205576	Maize	Hill Soil	
11	12	Bihar	104099452	Rice	Piedmontswamp	
12	13	Chattisgarh	25351462	Maize	Clary Soil	
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil	
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil	
15	16	Jharkhand	32988134	Ragi	Red Soil	
16	17	Manipur	2855794	Cotton	Inceptisols	
17	18	Meghalaya	2966889	Maize	Loamy Soil	
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil	
19	20	Nagaland	1978502	Millet	Ultisols Soil	

	ph Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00	
1	6.83	21.77	80.31	Zaid	1654.8	2083.00	
2	7.45	23.00	82.32	Rabi	1119.5	1525.00	
3	8.01	26.49	80.15	Kharif	1055.2	5239.00	
4	8.10	20.13	81.60	Zaid	9895.6	5267.00	
5	7.30	23.05	83.37	Zaid	1689.1	5182.00	
6	6.25	22.70	82.63	Rabi	8665.8	1278.00	
7	7.72	20.27	82.89	Kharif	4985.0	1763.00	
8	7.80	24.51	83.53	Kharif	7989.4	10882.00	
9	6.47	23.22	83.03	Zaid	1055.4	11558.00	
10	6.81	26.52	81.41	Rabi	1629.8	13.50	
11	7.07	23.97	81.45	Kharif	1449.9	15.86	
12	7.65	26.80	80.88	Zaid	1222.2	102.50	
13	7.66	24.01	82.05	Rabi	1349.1	104.37	
14	6.86	25.66	80.66	Zaid	1439.0	192.00	
15	8.40	24.28	80.30	Kharif	1636.5	208.00	
16	8.10	21.58	82.78	Zaid	1334.0	208.50	
17	7.65	23.79	80.41	Rabi	1629.5	3324.00	
18	6.59	21.86	80.19	Rabi	9560.7	26.14	
19	8.13	23.57	83.58	Zaid	1308.8	6443.00	

	Crop Health(%)	Water Quality(%)	Type of Agriculture Used	\
0	87	50	Organic Farming	
1	87	60	Aquaponics	
2	76	87	Vertical Farming	
3	68	76	Hydroponics	
4	86	67	Permaculture	
5	67	88	Precision Agriculture	
6	78	47	Agroforestry	
7	78	97	Greenhouse Cultivation	
8	89	86	Urban Farming	
9	88	56	Intensive Farming	
10	90	77	Sustainable Agriculture	
11	68	88	Crop Rotation	
12	79	56	No-Till Farming	
13	86	76	Regenerative Agriculture	
14	82	77	Biodynamic Farming	
15	58	57	Dry Farming	
16	76	87	Alley Cropping	
17	65	69	Silvopasture	
18	88	58	Cover Cropping	
19	79	68	Raised Bed Gardening	

	Water pollution(%)	Soil pollution(%)	\
0	3.5%	3.25%	
1	1.8%	8.71%	
2	2.7%	12.46%	
3	4.2%	5.89%	
4	0.9%	19.72%	
5	5.1%	1.34%	
6	2.3%	7.56%	
7	3.8%	14.92%	
8	1.5%	9.83%	
9	4.8%	4.67%	
10	0.7%	11.28%	
11	2.1%	6.73%	
12	3.2%	2.57%	
13	1.2%	15.61%	
14	4.4%	18.09%	
15	0.5%	10.17%	
16	5.3%	13.75%	
17	2.9%	0.92%	
18	4.6%	16.39%	
19	1.1%	20.45%	

	Goverment subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana	5%	
1	National Food Security Mission	10%	
2	Sub-Mission on Agricultural Mechanization	15%	
3	NABARD loans in India	20%	
4	Yantra Laxmi Scheme	25%	
5	Rashtriya Krishi Vikas Yojana	30%	
6	National Food Security Mission	35%	
7	Sub-Mission on Agricultural Mechanization	40%	
8	NABARD loans in IndiaYantra Laxmi Scheme	28.2%	
9	Rashtriya Krishi Vikas Yojana	37.6%	
10	National Food Security Mission	15.7%	
11	Sub-Mission on Agricultural Mechanization	44.8%	
12	NABARD loans in IndiaYantra Laxmi Scheme	9.3%	
13	Rashtriya Krishi Vikas Yojana	19.6%	
14	National Food Security Mission	32.1%	
15	Sub-Mission on Agricultural Mechanization	26.8%	
16	NABARD loans in India	51.2%	
17	Yantra Laxmi Scheme	8.7%	
18	Rashtriya Krishi Vikas Yojana	45%	
19	National Food Security Mission	50%	

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management

➤ fillna() method:

The fillna() method replace the Null values with a specific value.

```
print("**** Using fillna() method ****")
print(df.fillna(method="pad"))
```

**Output:**

**** Using fillna() method ****						
S.No		State	Population	Growth of Crops	Soil Type	\
0	1	Uttar Pradesh	199812341	Rice	Sandy loam	
1	2	Punjab	27743338	Maize	Claly soil	
2	3	Haryana	25545198	Sugarcane	Alluvial Soil	
3	4	Maharastra	112372333	Bajra	Residual	
4	5	Kerala	33406061	Coconut	Red soil	
5	6	Tamilnadu	72147030	Banana	Red Loam	
6	7	Gujarat	60439692	Jowar	Black Soil	
7	8	Karnataka	61095297	Ragi	Red Soil	
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic	
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols	
10	11	Assam	31205576	Maize	Hill Soil	
11	12	Bihar	104099452	Rice	Piedmontswamp	
12	13	Chattisgarh	25351462	Maize	Clary Soil	
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil	
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil	
15	16	Jharkhand	32988134	Ragi	Red Soil	
16	17	Manipur	2855794	Cotton	Inceptisols	
17	18	Meghalaya	2966889	Maize	Loamy Soil	
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil	
19	20	Nagaland	1978502	Millet	Ultisols Soil	

	ph Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00	
1	6.83	21.77	80.31	Zaid	1654.8	2083.00	
2	7.45	23.00	82.32	Rabi	1119.5	1525.00	
3	8.01	26.49	80.15	Kharif	1055.2	5239.00	
4	8.10	20.13	81.60	Zaid	9895.6	5267.00	
5	7.30	23.05	83.37	Zaid	1689.1	5182.00	
6	6.25	22.70	82.63	Rabi	8665.8	1278.00	
7	7.72	20.27	82.89	Kharif	4985.0	1763.00	
8	7.80	24.51	83.53	Kharif	7989.4	10882.00	
9	6.47	23.22	83.03	Zaid	1055.4	11558.00	
10	6.81	26.52	81.41	Rabi	1629.8	13.50	
11	7.07	23.97	81.45	Kharif	1449.9	15.86	
12	7.65	26.80	80.88	Zaid	1222.2	102.50	
13	7.66	24.01	82.05	Rabi	1349.1	104.37	
14	6.86	25.66	80.66	Zaid	1439.0	192.00	
15	8.40	24.28	80.30	Kharif	1636.5	208.00	
16	8.10	21.58	82.78	Zaid	1334.0	208.50	
17	7.65	23.79	80.41	Rabi	1629.5	3324.00	
18	6.59	21.86	80.19	Rabi	9560.7	26.14	
19	8.13	23.57	83.58	Zaid	1308.8	6443.00	

	Crop Health(%)	Water Quality(%)	Type of Agriculture Used	\
0	87	50	Organic Farming	
1	87	60	Aquaponics	
2	76	87	Vertical Farming	
3	68	76	Hydroponics	
4	86	67	Permaculture	
5	67	88	Precision Agriculture	
6	78	47	Agroforestry	
7	78	97	Greenhouse Cultivation	
8	89	86	Urban Farming	
9	88	56	Intensive Farming	
10	90	77	Sustainable Agriculture	
11	68	88	Crop Rotation	
12	79	56	No-Till Farming	
13	86	76	Regenerative Agriculture	
14	82	77	Biodynamic Farming	
15	58	57	Dry Farming	
16	76	87	Alley Cropping	
17	65	69	Silvopasture	
18	88	58	Cover Cropping	
19	79	68	Raised Bed Gardening	

	Water pollution(%)	Soil pollution(%)	\
0	3.5%	3.25%	
1	1.8%	8.71%	
2	2.7%	12.46%	
3	4.2%	5.89%	
4	0.9%	19.72%	
5	5.1%	1.34%	
6	2.3%	7.56%	
7	3.8%	14.92%	
8	1.5%	9.83%	
9	4.8%	4.67%	
10	0.7%	11.28%	
11	2.1%	6.73%	
12	3.2%	2.57%	
13	1.2%	15.61%	
14	4.4%	18.09%	
15	0.5%	10.17%	
16	5.3%	13.75%	
17	2.9%	0.92%	
18	4.6%	16.39%	
19	1.1%	20.45%	

	Government subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana	5%	
1	National Food Security Mission	10%	
2	Sub-Mission on Agricultural Mechanization	15%	
3	NABARD loans in India	20%	
4	Yantra Laxmi Scheme	25%	
5	Rashtriya Krishi Vikas Yojana	30%	
6	National Food Security Mission	35%	
7	Sub-Mission on Agricultural Mechanization	40%	
8	NABARD loans in IndiaYantra Laxmi Scheme	28.2%	
9	Rashtriya Krishi Vikas Yojana	37.6%	
10	National Food Security Mission	15.7%	
11	Sub-Mission on Agricultural Mechanization	44.8%	
12	NABARD loans in IndiaYantra Laxmi Scheme	9.3%	
13	Rashtriya Krishi Vikas Yojana	19.6%	
14	National Food Security Mission	32.1%	
15	Sub-Mission on Agricultural Mechanization	26.8%	
16	NABARD loans in India	51.2%	
17	Yantra Laxmi Scheme	8.7%	
18	Rashtriya Krishi Vikas Yojana	45%	
19	National Food Security Mission	50%	

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management

```
print("**** using fillna(method='bfill' ****")
print(df.fillna(method='bfill'))
```

#### Output:

**** using fillna(method='bfill' ****						
S.No		State	Population	Growth of Crops	Soil Type	\
0	1	Uttar Pradesh	199812341	Rice	Sandy loam	
1	2	Punjab	27743338	Maize	Claly soil	
2	3	Haryana	25545198	Sugarcane	Alluvial Soil	
3	4	Maharastra	112372333	Bajra	Residual	
4	5	Kerala	33406061	Coconut	Red soil	
5	6	Tamilnadu	72147030	Banana	Red Loam	
6	7	Gujarat	60439692	Jowar	Black Soil	
7	8	Karnataka	61095297	Ragi	Red Soil	
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic	
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols	
10	11	Assam	31205576	Maize	Hill Soil	
11	12	Bihar	104099452	Rice	Piedmontswamp	
12	13	Chattisgarh	25351462	Maize	Clary Soil	
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil	
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil	
15	16	Jharkhand	32988134	Ragi	Red Soil	
16	17	Manipur	2855794	Cotton	Inceptisols	
17	18	Meghalaya	2966889	Maize	Loamy Soil	
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil	
19	20	Nagaland	1978502	Millet	Ultisols Soil	

	ph Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00	
1	6.83	21.77	80.31	Zaid	1654.8	2083.00	
2	7.45	23.00	82.32	Rabi	1119.5	1525.00	
3	8.01	26.49	80.15	Kharif	1055.2	5239.00	
4	8.10	20.13	81.60	Zaid	9895.6	5267.00	
5	7.30	23.05	83.37	Zaid	1689.1	5182.00	
6	6.25	22.70	82.63	Rabi	8665.8	1278.00	
7	7.72	20.27	82.89	Kharif	4985.0	1763.00	
8	7.80	24.51	83.53	Kharif	7989.4	10882.00	
9	6.47	23.22	83.03	Zaid	1055.4	11558.00	
10	6.81	26.52	81.41	Rabi	1629.8	13.50	
11	7.07	23.97	81.45	Kharif	1449.9	15.86	
12	7.65	26.80	80.88	Zaid	1222.2	102.50	
13	7.66	24.01	82.05	Rabi	1349.1	104.37	
14	6.86	25.66	80.66	Zaid	1439.0	192.00	
15	8.40	24.28	80.30	Kharif	1636.5	208.00	
16	8.10	21.58	82.78	Zaid	1334.0	208.50	
17	7.65	23.79	80.41	Rabi	1629.5	3324.00	
18	6.59	21.86	80.19	Rabi	9560.7	26.14	
19	8.13	23.57	83.58	Zaid	1308.8	6443.00	

	Crop Health(%)	Water Quality(%)	Type of Agriculture Used	\
0	87	50	Organic Farming	
1	87	60	Aquaponics	
2	76	87	Vertical Farming	
3	68	76	Hydroponics	
4	86	67	Permaculture	
5	67	88	Precision Agriculture	
6	78	47	Agroforestry	
7	78	97	Greenhouse Cultivation	
8	89	86	Urban Farming	
9	88	56	Intensive Farming	
10	90	77	Sustainable Agriculture	
11	68	88	Crop Rotation	
12	79	56	No-Till Farming	
13	86	76	Regenerative Agriculture	
14	82	77	Biodynamic Farming	
15	58	57	Dry Farming	
16	76	87	Alley Cropping	
17	65	69	Silvopasture	
18	88	58	Cover Cropping	
19	79	68	Raised Bed Gardening	

	Water pollution(%)	Soil pollution(%)	\
0	3.5%	3.25%	
1	1.8%	8.71%	
2	2.7%	12.46%	
3	4.2%	5.89%	
4	0.9%	19.72%	
5	5.1%	1.34%	
6	2.3%	7.56%	
7	3.8%	14.92%	
8	1.5%	9.83%	
9	4.8%	4.67%	
10	0.7%	11.28%	
11	2.1%	6.73%	
12	3.2%	2.57%	
13	1.2%	15.61%	
14	4.4%	18.09%	
15	0.5%	10.17%	
16	5.3%	13.75%	
17	2.9%	0.92%	
18	4.6%	16.39%	
19	1.1%	20.45%	

	Government subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana	5%	
1	National Food Security Mission	10%	
2	Sub-Mission on Agricultural Mechanization	15%	
3	NABARD loans in India	20%	
4	Yantra Laxmi Scheme	25%	
5	Rashtriya Krishi Vikas Yojana	30%	
6	National Food Security Mission	35%	
7	Sub-Mission on Agricultural Mechanization	40%	
8	NABARD loans in IndiaYantra Laxmi Scheme	28.2%	
9	Rashtriya Krishi Vikas Yojana	37.6%	
10	National Food Security Mission	15.7%	
11	Sub-Mission on Agricultural Mechanization	44.8%	
12	NABARD loans in IndiaYantra Laxmi Scheme	9.3%	
13	Rashtriya Krishi Vikas Yojana	19.6%	
14	National Food Security Mission	32.1%	
15	Sub-Mission on Agricultural Mechanization	26.8%	
16	NABARD loans in India	51.2%	
17	Yantra Laxmi Scheme	8.7%	
18	Rashtriya Krishi Vikas Yojana	45%	
19	National Food Security Mission	50%	

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management

---

```
print(df.fillna(10))
```

**Output:**

S.No	State	Population	Growth of Crops	Soil Type	\
0	Uttar Pradesh	199812341	Rice	Sandy loam	
1	Punjab	27743338	Maize	Claly soil	
2	Haryana	25545198	Sugarcane	Alluvial Soil	
3	Maharastra	112372333	Bajra	Residual	
4	Kerala	33406061	Coconut	Red soil	
5	Tamilnadu	72147030	Banana	Red Loam	
6	Gujarat	60439692	Jowar	Black Soil	
7	Karnataka	61095297	Ragi	Red Soil	
8	Andhra Pradesh	84580777	Rice	Red Lateritic	
9	Arunachal Pradesh	1458545	Maize	Inceptisols	
10	Assam	31205576	Maize	Hill Soil	
11	Bihar	104099452	Rice	Piedmontswamp	
12	Chattisgarh	25351462	Maize	Clary Soil	
13	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil	
14	Jammu& Kashmir	13635010	Apples	Alluvial Soil	
15	Jharkhand	32988134	Ragi	Red Soil	
16	Manipur	2855794	Cotton	Inceptisols	
17	Meghalaya	2966889	Maize	Loamy Soil	
18	Mizoram	1097206	Maize	Sand-Loamy Soil	
19	Nagaland	1978502	Millet	Ultisols Soil	

	ph Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00	
1	6.83	21.77	80.31	Zaid	1654.8	2083.00	
2	7.45	23.00	82.32	Rabi	1119.5	1525.00	
3	8.01	26.49	80.15	Kharif	1055.2	5239.00	
4	8.10	20.13	81.60	Zaid	9895.6	5267.00	
5	7.30	23.05	83.37	Zaid	1689.1	5182.00	
6	6.25	22.70	82.63	Rabi	8665.8	1278.00	
7	7.72	20.27	82.89	Kharif	4985.0	1763.00	
8	7.80	24.51	83.53	Kharif	7989.4	10882.00	
9	6.47	23.22	83.03	Zaid	1055.4	11558.00	
10	6.81	26.52	81.41	Rabi	1629.8	13.50	
11	7.07	23.97	81.45	Kharif	1449.9	15.86	
12	7.65	26.80	80.88	Zaid	1222.2	102.50	
13	7.66	24.01	82.05	Rabi	1349.1	104.37	
14	6.86	25.66	80.66	Zaid	1439.0	192.00	
15	8.40	24.28	80.30	Kharif	1636.5	208.00	
16	8.10	21.58	82.78	Zaid	1334.0	208.50	
17	7.65	23.79	80.41	Rabi	1629.5	3324.00	
18	6.59	21.86	80.19	Rabi	9560.7	26.14	
19	8.13	23.57	83.58	Zaid	1308.8	6443.00	

	Crop Health(%)	Water Quality(%)	Type of Agriculture Used	\
0	87	50	Organic Farming	
1	87	60	Aquaponics	
2	76	87	Vertical Farming	
3	68	76	Hydroponics	
4	86	67	Permaculture	
5	67	88	Precision Agriculture	
6	78	47	Agroforestry	
7	78	97	Greenhouse Cultivation	
8	89	86	Urban Farming	
9	88	56	Intensive Farming	
10	90	77	Sustainable Agriculture	
11	68	88	Crop Rotation	
12	79	56	No-Till Farming	
13	86	76	Regenerative Agriculture	
14	82	77	Biodynamic Farming	
15	58	57	Dry Farming	
16	76	87	Alley Cropping	
17	65	69	Silvopasture	
18	88	58	Cover Cropping	
19	79	68	Raised Bed Gardening	

	Water pollution(%)	Soil pollution(%)	\
0	3.5%	3.25%	
1	1.8%	8.71%	
2	2.7%	12.46%	
3	4.2%	5.89%	
4	0.9%	19.72%	
5	5.1%	1.34%	
6	2.3%	7.56%	
7	3.8%	14.92%	
8	1.5%	9.83%	
9	4.8%	4.67%	
10	0.7%	11.28%	
11	2.1%	6.73%	
12	3.2%	2.57%	
13	1.2%	15.61%	
14	4.4%	18.09%	
15	0.5%	10.17%	
16	5.3%	13.75%	
17	2.9%	0.92%	
18	4.6%	16.39%	
19	1.1%	20.45%	

	Goverment subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana	5%	
1	National Food Security Mission	10%	
2	Sub-Mission on Agricultural Mechanization	15%	
3	NABARD loans in India	20%	
4	Yantra Laxmi Scheme	25%	
5	Rashtriya Krishi Vikas Yojana	30%	
6	National Food Security Mission	35%	
7	Sub-Mission on Agricultural Mechanization	40%	
8	NABARD loans in India	28.2%	
9	Yantra Laxmi Scheme	37.6%	
10	Rashtriya Krishi Vikas Yojana	37.6%	
11	National Food Security Mission	15.7%	
12	Sub-Mission on Agricultural Mechanization	44.8%	
13	NABARD loans in India	9.3%	
14	Yantra Laxmi Scheme	19.6%	
15	Rashtriya Krishi Vikas Yojana	32.1%	
16	National Food Security Mission	26.8%	
17	Sub-Mission on Agricultural Mechanization	51.2%	
18	NABARD loans in India	8.7%	
19	Yantra Laxmi Scheme	45%	
	Rashtriya Krishi Vikas Yojana	50%	
	National Food Security Mission		

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management

➤ Removing Duplicates:

It is a process of removing duplicate values from the dataset.

Methods: .duplicated()  
.drop\_duplicated()

#Identify duplicated values

```
print("**** Duplicates ****")
print(df.duplicated)
```

**Output:**

**** Duplicates ****			S.No	State	Population	Growth of Crops	Soil Type \
0	1	Uttar Pradesh	199812341	Rice	Sandy loam		
1	2	Punjab	27743338	Maize	Claly soil		
2	3	Haryana	25545198	Sugarcane	Alluvial Soil		
3	4	Maharastra	112372333	Bajra	Residual		
4	5	Kerala	33406061	Coconut	Red soil		
5	6	Tamilnadu	72147030	Banana	Red Loam		
6	7	Gujarat	60439692	Jowar	Black Soil		
7	8	Karnataka	61095297	Ragi	Red Soil		
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic		
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols		
10	11	Assam	31205576	Maize	Hill Soil		
11	12	Bihar	104099452	Rice	Piedmontswamp		
12	13	Chattisgarh	25351462	Maize	Clary Soil		
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil		
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil		
15	16	Jharkhand	32988134	Ragi	Red Soil		
16	17	Manipur	2855794	Cotton	Inceptisols		
17	18	Meghalaya	2966889	Maize	Loamy Soil		
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil		
19	20	Nagaland	1978502	Millet	Ultisols Soil		

ph	Level	Temperature	Humidity	Season	Area	Production \
0	6.54	20.87	82.00	Kharif	1312.7	2061.00
1	6.83	21.77	80.31	Zaid	1654.8	2083.00
2	7.45	23.00	82.32	Rabi	1119.5	1525.00
3	8.01	26.49	80.15	Kharif	1055.2	5239.00
4	8.10	20.13	81.60	Zaid	9895.6	5267.00
5	7.30	23.05	83.37	Zaid	1689.1	5182.00
6	6.25	22.70	82.63	Rabi	8665.8	1278.00
7	7.72	20.27	82.89	Kharif	4985.0	1763.00
8	7.80	24.51	83.53	Kharif	7989.4	10882.00
9	6.47	23.22	83.03	Zaid	1055.4	11558.00
10	6.81	26.52	81.41	Rabi	1629.8	13.50
11	7.07	23.97	81.45	Kharif	1449.9	15.86
12	7.65	26.80	80.88	Zaid	1222.2	102.50
13	7.66	24.01	82.05	Rabi	1349.1	104.37
14	6.86	25.66	80.66	Zaid	1439.0	192.00
15	8.40	24.28	80.30	Kharif	1636.5	208.00
16	8.10	21.58	82.78	Zaid	1334.0	208.50
17	7.65	23.79	80.41	Rabi	1629.5	3324.00
18	6.59	21.86	80.19	Rabi	9560.7	26.14
19	8.13	23.57	83.58	Zaid	1308.8	6443.00

	Crop Health(%)	Water Quality(%)	Type of Agriculture Used \
0	87	50	Organic Farming
1	87	60	Aquaponics
2	76	87	Vertical Farming
3	68	76	Hydroponics
4	86	67	Permaculture
5	67	88	Precision Agriculture
6	78	47	Agroforestry
7	78	97	Greenhouse Cultivation
8	89	86	Urban Farming
9	88	56	Intensive Farming
10	90	77	Sustainable Agriculture
11	68	88	Crop Rotation
12	79	56	No-Till Farming
13	86	76	Regenerative Agriculture
14	82	77	Biodynamic Farming
15	58	57	Dry Farming
16	76	87	Alley Cropping
17	65	69	Silvopasture
18	88	58	Cover Cropping
19	79	68	Raised Bed Gardening

	Water pollution(%)	Soil pollution(%) \
0	3.5%	3.25%
1	1.8%	8.71%
2	2.7%	12.46%
3	4.2%	5.89%
4	0.9%	19.72%
5	5.1%	1.34%
6	2.3%	7.56%
7	3.8%	14.92%
8	1.5%	9.83%
9	4.8%	4.67%
10	0.7%	11.28%
11	2.1%	6.73%
12	3.2%	2.57%
13	1.2%	15.61%
14	4.4%	18.09%
15	0.5%	10.17%
16	5.3%	13.75%
17	2.9%	0.92%
18	4.6%	16.39%
19	1.1%	20.45%

	Government subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana	5%	
1	National Food Security Mission	10%	
2	Sub-Mission on Agricultural Mechanization	15%	
3	NABARD loans in India	20%	
4	Yantra Laxmi Scheme	25%	
5	Rashtriya Krishi Vikas Yojana	30%	
6	National Food Security Mission	35%	
7	Sub-Mission on Agricultural Mechanization	40%	
8	NABARD loans in India	28.2%	
9	Yantra Laxmi Scheme		
10	Rashtriya Krishi Vikas Yojana	37.6%	
11	National Food Security Mission	15.7%	
12	Sub-Mission on Agricultural Mechanization	44.8%	
13	NABARD loans in India	9.3%	
14	Yantra Laxmi Scheme		
15	Rashtriya Krishi Vikas Yojana	19.6%	
16	National Food Security Mission	32.1%	
17	Sub-Mission on Agricultural Mechanization	26.8%	
18	NABARD loans in India	51.2%	
19	Yantra Laxmi Scheme		
	Rashtriya Krishi Vikas Yojana	8.7%	
	National Food Security Mission	45%	
		50%	

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
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5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management >

```
print(" **** Droping the duplicate values **** ")
```

```
df=df.drop_duplicates()
```

```
print(df)
```

**Output:**

**** Droping the duplicate values ****				S.No	State	Population	Growth of Crops	Soil Type \
0	1	Uttar Pradesh	199812341	Rice	Sandy loan			
1	2	Punjab	27743338	Maize	Claly soil			
2	3	Haryana	25545198	Sugarcane	Alluvial Soil			
3	4	Maharastra	112372333	Bajra	Residual			
4	5	Kerala	33406061	Coconut	Red soil			
5	6	Tamilnadu	72147030	Banana	Red Loam			
6	7	Gujarat	60439692	Jowar	Black Soil			
7	8	Karnataka	61095297	Ragi	Red Soil			
8	9	Andhra Pradesh	84580777	Rice	Red Lateritic			
9	10	Arunachal Pradesh	1458545	Maize	Inceptisols			
10	11	Assam	31205576	Maize	Hill Soil			
11	12	Bihar	104099452	Rice	Piedmontswamp			
12	13	Chattisgarh	25351462	Maize	Clary Soil			
13	14	Himachal Pradesh	6864602	Vegetables	Brown Hill Soil			
14	15	Jammu& Kashmir	13635010	Apples	Alluvial Soil			
15	16	Jharkhand	32988134	Ragi	Red Soil			
16	17	Manipur	2855794	Cotton	Inceptisols			
17	18	Meghalaya	2966889	Maize	Loamy Soil			
18	19	Mizoram	1097206	Maize	Sand-Loamy Soil			
19	20	Nagaland	1978502	Millet	Ultisols Soil			

ph	Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00	
1	6.83	21.77	80.31	Zaid	1654.8	2083.00	
2	7.45	23.00	82.32	Rabi	1119.5	1525.00	
3	8.01	26.49	80.15	Kharif	1055.2	5239.00	
4	8.10	20.13	81.60	Zaid	9895.6	5267.00	
5	7.30	23.05	83.37	Zaid	1689.1	5182.00	
6	6.25	22.70	82.63	Rabi	8665.8	1278.00	
7	7.72	20.27	82.89	Kharif	4985.0	1763.00	
8	7.80	24.51	83.53	Kharif	7989.4	10882.00	
9	6.47	23.22	83.03	Zaid	1055.4	11558.00	
10	6.81	26.52	81.41	Rabi	1629.8	13.50	
11	7.07	23.97	81.45	Kharif	1449.9	15.86	
12	7.65	26.80	80.88	Zaid	1222.2	102.50	
13	7.66	24.01	82.05	Rabi	1349.1	104.37	
14	6.86	25.66	80.66	Zaid	1439.0	192.00	
15	8.40	24.28	80.30	Kharif	1636.5	208.00	
16	8.10	21.58	82.78	Zaid	1334.0	208.50	
17	7.65	23.79	80.41	Rabi	1629.5	3324.00	
18	6.59	21.86	80.19	Rabi	9560.7	26.14	
19	8.13	23.57	83.58	Zaid	1308.8	6443.00	

	Crop Health(%)	Water Quality(%)	Type of Agriculture Used \
0	87	50	Organic Farming
1	87	60	Aquaponics
2	76	87	Vertical Farming
3	68	76	Hydroponics
4	86	67	Permaculture
5	67	88	Precision Agriculture
6	78	47	Agroforestry
7	78	97	Greenhouse Cultivation
8	89	86	Urban Farming
9	88	56	Intensive Farming
10	90	77	Sustainable Agriculture
11	68	88	Crop Rotation
12	79	56	No-Till Farming
13	86	76	Regenerative Agriculture
14	82	77	Biodynamic Farming
15	58	57	Dry Farming
16	76	87	Alley Cropping
17	65	69	Silvopasture
18	88	58	Cover Cropping
19	79	68	Raised Bed Gardening

	Water pollution(%)	Soil pollution(%) \
0	3.5%	3.25%
1	1.8%	8.71%
2	2.7%	12.46%
3	4.2%	5.89%
4	0.9%	19.72%
5	5.1%	1.34%
6	2.3%	7.56%
7	3.8%	14.92%
8	1.5%	9.83%
9	4.8%	4.67%
10	0.7%	11.28%
11	2.1%	6.73%
12	3.2%	2.57%
13	1.2%	15.61%
14	4.4%	18.09%
15	0.5%	10.17%
16	5.3%	13.75%
17	2.9%	0.92%
18	4.6%	16.39%
19	1.1%	20.45%

		Government subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana		5%	
1	National Food Security Mission		10%	
2	Sub-Mission on Agricultural Mechanization		15%	
3	NABARD loans in India		20%	
4	Yantra Laxmi Scheme		25%	
5	Rashtriya Krishi Vikas Yojana		30%	
6	National Food Security Mission		35%	
7	Sub-Mission on Agricultural Mechanization		40%	
8	NABARD loans in India	Yantra Laxmi Scheme	28.2%	
9	Rashtriya Krishi Vikas Yojana		37.6%	
10	National Food Security Mission		15.7%	
11	Sub-Mission on Agricultural Mechanization		44.8%	
12	NABARD loans in India	Yantra Laxmi Scheme	9.3%	
13	Rashtriya Krishi Vikas Yojana		19.6%	
14	National Food Security Mission		32.1%	
15	Sub-Mission on Agricultural Mechanization		26.8%	
16	NABARD loans in India		51.2%	
17	Yantra Laxmi Scheme		8.7%	
18	Rashtriya Krishi Vikas Yojana		45%	
19	National Food Security Mission		50%	

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management >

```
print("***** using drop_duplicated(inplace=True) *****")
print(df.drop_duplicates(inplace=True))
```

**Output:**

```
***** using drop_duplicated(inplace=True) *****
None
```

### ➤ Classification:

It is a predictive its focuses on the values in a dataset, by setting the range.

```
df['Population']=df['Temperature']+df['Humidity']
print(df.head(20))
```

**Output:**

S.No	State	Population	Growth of Crops	Soil Type	\
0	Uttar Pradesh	102.87	Rice	Sandy loam	
1	Punjab	102.08	Maize	Claly soil	
2	Haryana	105.32	Sugarcane	Alluvial Soil	
3	Maharastra	106.64	Bajra	Residual	
4	Kerala	101.73	Coconut	Red soil	
5	Tamilnadu	106.42	Banana	Red Loam	
6	Gujarat	105.33	Jowar	Black Soil	
7	Karnataka	103.16	Ragi	Red Soil	
8	Andhra Pradesh	108.04	Rice	Red Lateritic	
9	Arunachal Pradesh	106.25	Maize	Inceptisols	
10	Assam	107.93	Maize	Hill Soil	
11	Bihar	105.42	Rice	Piedmontswamp	
12	Chattisgarh	107.68	Maize	Clary Soil	
13	Himachal Pradesh	106.06	Vegetables	Brown Hill Soil	
14	Jammu& Kashmir	106.32	Apples	Alluvial Soil	
15	Jharkhand	104.58	Ragi	Red Soil	
16	Manipur	104.36	Cotton	Inceptisols	
17	Meghalaya	104.20	Maize	Loamy Soil	
18	Mizoram	102.05	Maize	Sand-Loamy Soil	
19	Nagaland	107.15	Millet	Ultisols Soil	

	ph Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00	
1	6.83	21.77	80.31	Zaid	1654.8	2083.00	
2	7.45	23.00	82.32	Rabi	1119.5	1525.00	
3	8.01	26.49	80.15	Kharif	1055.2	5239.00	
4	8.10	20.13	81.60	Zaid	9895.6	5267.00	
5	7.30	23.05	83.37	Zaid	1689.1	5182.00	
6	6.25	22.70	82.63	Rabi	8665.8	1278.00	
7	7.72	20.27	82.89	Kharif	4985.0	1763.00	
8	7.80	24.51	83.53	Kharif	7989.4	10882.00	
9	6.47	23.22	83.03	Zaid	1055.4	11558.00	
10	6.81	26.52	81.41	Rabi	1629.8	13.50	
11	7.07	23.97	81.45	Kharif	1449.9	15.86	
12	7.65	26.80	80.88	Zaid	1222.2	102.50	
13	7.66	24.01	82.05	Rabi	1349.1	104.37	
14	6.86	25.66	80.66	Zaid	1439.0	192.00	
15	8.40	24.28	80.30	Kharif	1636.5	208.00	
16	8.10	21.58	82.78	Zaid	1334.0	208.50	
17	7.65	23.79	80.41	Rabi	1629.5	3324.00	
18	6.59	21.86	80.19	Rabi	9560.7	26.14	
19	8.13	23.57	83.58	Zaid	1308.8	6443.00	

	Crop Health(%)	Water Quality(%)	Type of Agriculture Used	\
0	87	50	Organic Farming	
1	87	60	Aquaponics	
2	76	87	Vertical Farming	
3	68	76	Hydroponics	
4	86	67	Permaculture	
5	67	88	Precision Agriculture	
6	78	47	Agroforestry	
7	78	97	Greenhouse Cultivation	
8	89	86	Urban Farming	
9	88	56	Intensive Farming	
10	90	77	Sustainable Agriculture	
11	68	88	Crop Rotation	
12	79	56	No-Till Farming	
13	86	76	Regenerative Agriculture	
14	82	77	Biodynamic Farming	
15	58	57	Dry Farming	
16	76	87	Alley Cropping	
17	65	69	Silvopasture	
18	88	58	Cover Cropping	
19	79	68	Raised Bed Gardening	

	Water pollution(%)	soil pollution(%)	\
0	3.5%	3.25%	
1	1.8%	8.71%	
2	2.7%	12.46%	
3	4.2%	5.89%	
4	0.9%	19.72%	
5	5.1%	1.34%	
6	2.3%	7.56%	
7	3.8%	14.92%	
8	1.5%	9.83%	
9	4.8%	4.67%	
10	0.7%	11.28%	
11	2.1%	6.73%	
12	3.2%	2.57%	
13	1.2%	15.61%	
14	4.4%	18.09%	
15	0.5%	10.17%	
16	5.3%	13.75%	
17	2.9%	0.92%	
18	4.6%	16.39%	
19	1.1%	20.45%	

	Goverment subsidies	Organic Fertilizers Used (%)	\
0	Rashtriya Krishi Vikas Yojana	5%	
1	National Food Security Mission	10%	
2	Sub-Mission on Agricultural Mechanization	15%	
3	NABARD loans in India	20%	
4	Yantra Laxmi Scheme	25%	
5	Rashtriya Krishi Vikas Yojana	30%	
6	National Food Security Mission	35%	
7	Sub-Mission on Agricultural Mechanization	40%	
8	NABARD loans in IndiaYantra Laxmi Scheme	28.2%	
9	Rashtriya Krishi Vikas Yojana	37.6%	
10	National Food Security Mission	15.7%	
11	Sub-Mission on Agricultural Mechanization	44.8%	
12	NABARD loans in IndiaYantra Laxmi Scheme	9.3%	
13	Rashtriya Krishi Vikas Yojana	19.6%	
14	National Food Security Mission	32.1%	
15	Sub-Mission on Agricultural Mechanization	26.8%	
16	NABARD loans in India	51.2%	
17	Yantra Laxmi Scheme	8.7%	
18	Rashtriya Krishi Vikas Yojana	45%	
19	National Food Security Mission	50%	

	Power Consumption (%)	Type of Technology Used
0	12.5%	Precision Agriculture
1	35.9%	IoT Agriculture
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
6	30.7%	Artificial Intelligence
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
9	17.1%	Dry Farming
10	41.5%	Rainfed Agriculture
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
14	36.3%	Cover Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
18	25.6%	Precision Livestock Farming
19	22.3%	Smart Livestock Management

```
print("**** data mungning/wrangling ****")
print("**** data filtering By using the comdition ****")
x=df['ph Level']>=7
```

print(x)

**Output:**

```
] **** data mungning/wrangling ****
**** data filtering By using the comdition ****
0    False
1    False
2     True
3     True
4     True
5     True
6    False
7     True
8     True
9    False
10   False
11   True
12   True
13   True
14   False
15   True
16   True
17   True
18   False
19   True
Name: ph Level, dtype: bool
```

```
z=df[df['ph Level']<=7].copy()
```

```
print(z)
```

**Output:**

S.No	State	Population	Growth of Crops	Soil Type	\
0	Uttar Pradesh	102.87	Rice	Sandy loam	
1	Punjab	102.08	Maize	Claly soil	
6	Gujarat	105.33	Jowar	Black Soil	
9	Arunachal Pradesh	106.25	Maize	Inceptisols	
10	Assam	107.93	Maize	Hill Soil	
14	Jammu& Kashmir	106.32	Apples	Alluvial Soil	
18	Mizoram	102.05	Maize	Sand-Loamy Soil	

ph Level	Temperature	Humidity	Season	Area	Production	\
0	6.54	20.87	82.00	Kharif	1312.7	2061.00
1	6.83	21.77	80.31	Zaid	1654.8	2083.00
6	6.25	22.70	82.63	Rabi	8665.8	1278.00
9	6.47	23.22	83.03	Zaid	1055.4	11558.00
10	6.81	26.52	81.41	Rabi	1629.8	13.50
14	6.86	25.66	80.66	Zaid	1439.0	192.00
18	6.59	21.86	80.19	Rabi	9560.7	26.14

Crop Health(%)	Water Quality(%)	Type of Agriculture Used	\
0	87	50	Organic Farming
1	87	60	Aquaponics
6	78	47	Agroforestry
9	88	56	Intensive Farming
10	90	77	Sustainable Agriculture
14	82	77	Biodynamic Farming
18	88	58	Cover Cropping

Water pollution(%)	Soil pollution(%)	Goverment subsidies	\
0	3.5%	3.25%	Rashtriya Krishi Vikas Yojana
1	1.8%	8.71%	National Food Security Mission
6	2.3%	7.56%	National Food Security Mission
9	4.8%	4.67%	Rashtriya Krishi Vikas Yojana
10	0.7%	11.28%	National Food Security Mission
14	4.4%	18.09%	National Food Security Mission
18	4.6%	16.39%	Rashtriya Krishi Vikas Yojana

Organic Fertilizers Used (%)	Power Consumption (%)	\
0	5%	12.5%
1	10%	35.9%
6	35%	30.7%
9	37.6%	17.1%
10	15.7%	41.5%
14	32.1%	36.3%
18	45%	25.6%

Type of Technology Used
0 Precision Agriculture
1 IoT Agriculture
6 Artificial Intelligence
9 Dry Farming
10 Rainfed Agriculture
14 Cover Cropping
18 Precision Livestock Farming

S.No	State	Population	Growth of Crops	Soil Type	\
2	3 Haryana	105.32	Sugarcane	Alluvial Soil	
3	4 Maharashtra	106.64	Bajra	Residual	
4	5 Kerala	101.73	Coconut	Red soil	
5	6 Tamilnadu	106.42	Banana	Red Loam	
7	8 Karnataka	103.16	Ragi	Red Soil	
8	9 Andhra Pradesh	108.04	Rice	Red Lateritic	
11	12 Bihar	105.42	Rice	Piedmontswamp	
12	13 Chattisgarh	107.68	Maize	Clary Soil	
13	14 Himachal Pradesh	106.06	Vegetables	Brown Hill Soil	
15	16 Jharkhand	104.58	Ragi	Red Soil	
16	17 Manipur	104.36	Cotton	Inceptisols	
17	18 Meghalaya	104.20	Maize	Loamy Soil	
19	20 Nagaland	107.15	Millet	Ultisols	Soil

ph Level	Temperature	Humidity	Season	Area	Production	\
2	7.45	23.00	82.32	Rabi	1119.5	1525.00
3	8.01	26.49	80.15	Kharif	1055.2	5239.00
4	8.10	20.13	81.60	Zaid	9895.6	5267.00
5	7.30	23.05	83.37	Zaid	1689.1	5182.00
7	7.72	20.27	82.89	Kharif	4985.0	1763.00
8	7.80	24.51	83.53	Kharif	7989.4	10882.00
11	7.07	23.97	81.45	Kharif	1449.9	15.86
12	7.65	26.80	80.88	Zaid	1222.2	102.50
13	7.66	24.01	82.05	Rabi	1349.1	104.37
15	8.40	24.28	80.30	Kharif	1636.5	208.00
16	8.10	21.58	82.78	Zaid	1334.0	208.50
17	7.65	23.79	80.41	Rabi	1629.5	3324.00
19	8.13	23.57	83.58	Zaid	1308.8	6443.00

Crop Health(%)	Water Quality(%)	Type of Agriculture Used	\
2	76	87	Vertical Farming
3	68	76	Hydroponics
4	86	67	Permaculture
5	67	88	Precision Agriculture
7	78	97	Greenhouse Cultivation
8	89	86	Urban Farming
11	68	88	Crop Rotation
12	79	56	No-Till Farming
13	86	76	Regenerative Agriculture
15	58	57	Dry Farming
16	76	87	Alley Cropping
17	65	69	Silvopasture
19	79	68	Raised Bed Gardening

Water pollution(%)	Soil pollution(%)	\
2	2.7%	12.46%
3	4.2%	5.89%
4	0.9%	19.72%
5	5.1%	1.34%
7	3.8%	14.92%
8	1.5%	9.83%
11	2.1%	6.73%
12	3.2%	2.57%
13	1.2%	15.61%
15	0.5%	10.17%
16	5.3%	13.75%
17	2.9%	0.92%
19	1.1%	20.45%

	Goverment subsidies	Organic Fertilizers Used (%)	\
2	Sub-Mission on Agricultural Mechanization	15%	
3	NABARD loans in India	20%	
4	Yantra Laxmi Scheme	25%	
5	Rashtriya Krishi Vikas Yojana	30%	
7	Sub-Mission on Agricultural Mechanization	40%	
8	NABARD loans in India	28.2%	
11	Sub-Mission on Agricultural Mechanization	44.8%	
12	NABARD loans in India	9.3%	
13	Yantra Laxmi Scheme	19.6%	
15	Sub-Mission on Agricultural Mechanization	26.8%	
16	NABARD loans in India	51.2%	
17	Yantra Laxmi Scheme	8.7%	
19	National Food Security Mission	50%	

	Power Consumption (%)	Type of Technology Used
2	14.6%	Smart Farming
3	42.3%	Drones in Agriculture
4	10.9%	Agricultural Robots
5	20.3%	Machine Learning
7	45.9%	Blockchain in Agriculture
8	7.8%	Data Analytics
11	22.9%	Conservation Agriculture
12	47.4%	No-Till Farming
13	11.6%	Strip Cropping
15	16.2%	Terrace Farming
16	38.7%	Rice Intensification System
17	13.1%	Permaculture
19	22.3%	Smart Livestock Management

## 7.4 Data Visualization:

The process of representing the data into a Graphical Representation. Here we used the module called Matplotlib.

To importing matplotlib: **Import matplotlib pyplot as plt**

Mat – Mathematical

Plot – Pointing the data values

Lib – Library

“John D Hunter” is known as the father of the data visualization.

**Methods:** plot()

show()

X label()

Y label()

grid()

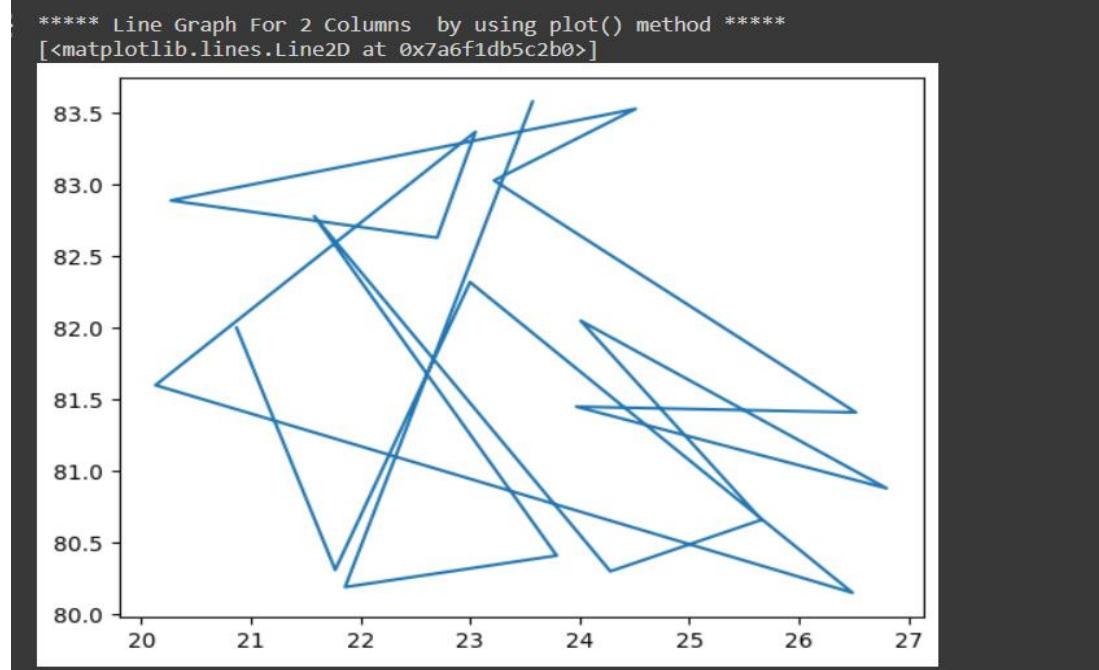
title()

**Types of Graphs:**

- I. Line Graph.
- II. Bar Graph.
- III. Area Graph.
- IV. Histogram Graph.
- V. Box Graph.
- VI. KDE Graph.

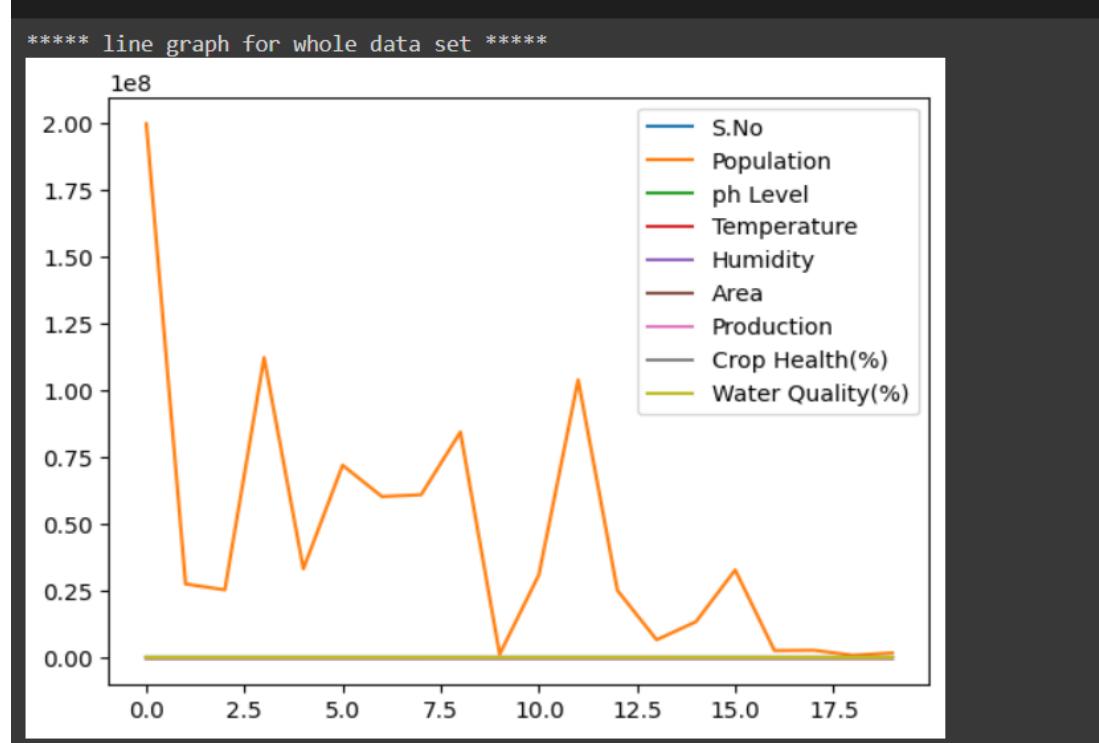
```
print("***** Line Graph For 2 Columns by using plot() method *****")
plt.plot(df['Temperature'],df['Humidity'])
```

**Output:**



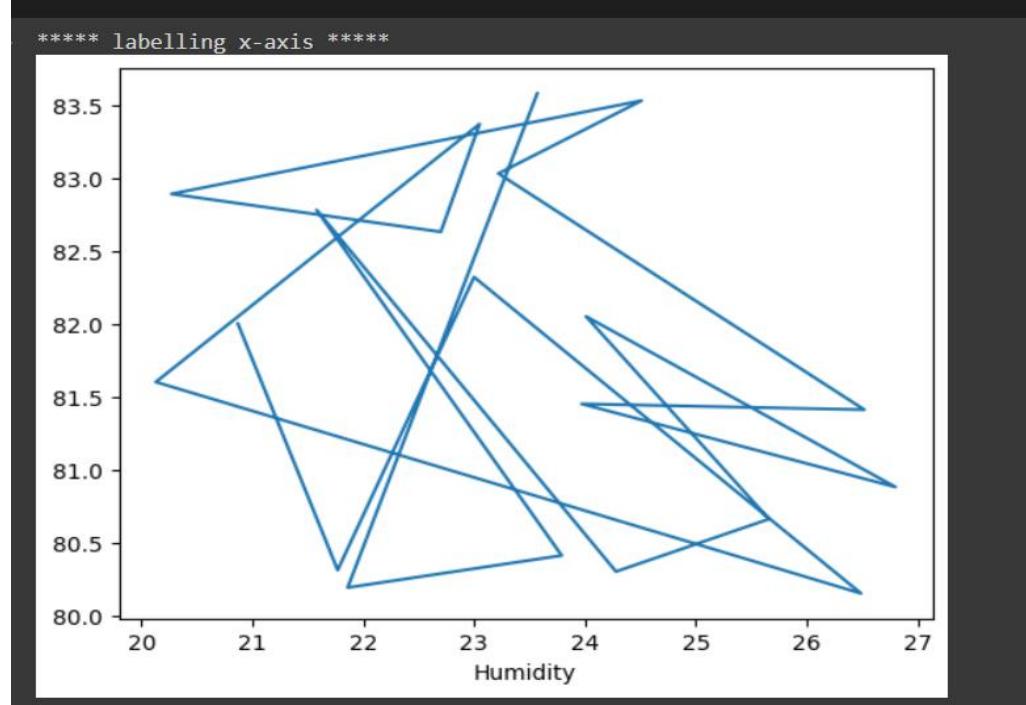
```
print("***** line graph for whole data set *****")
x=df.plot.line()
plt.show()# show () method
```

**Output:**



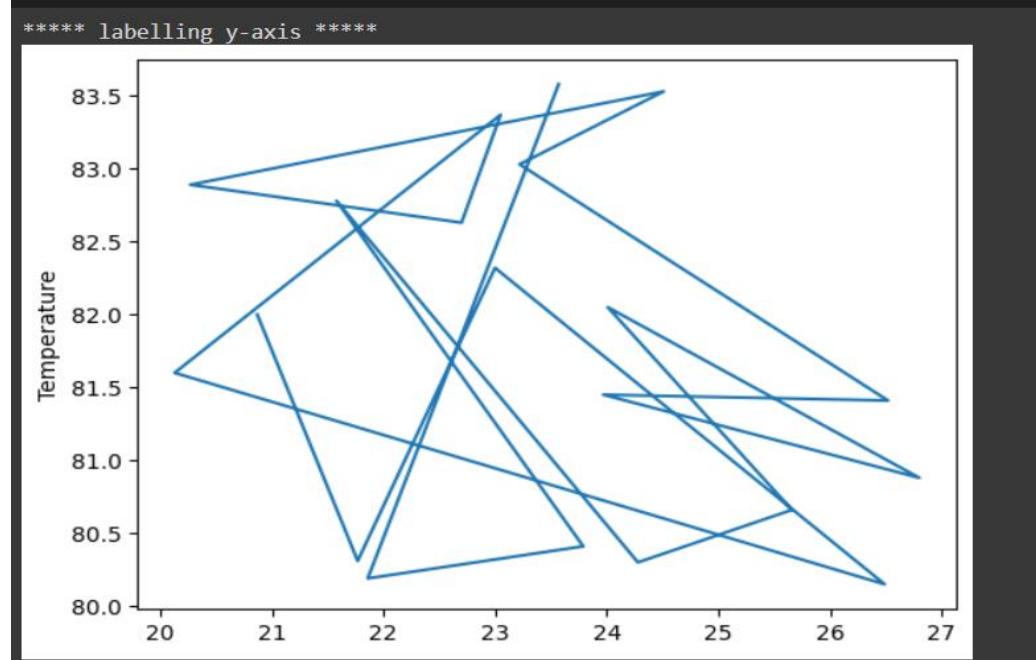
```
print("***** labelling x-axis *****")
plt.plot(df['Temperature'],df['Humidity'])
plt.xlabel('Humidity')
plt.show()
```

Output:



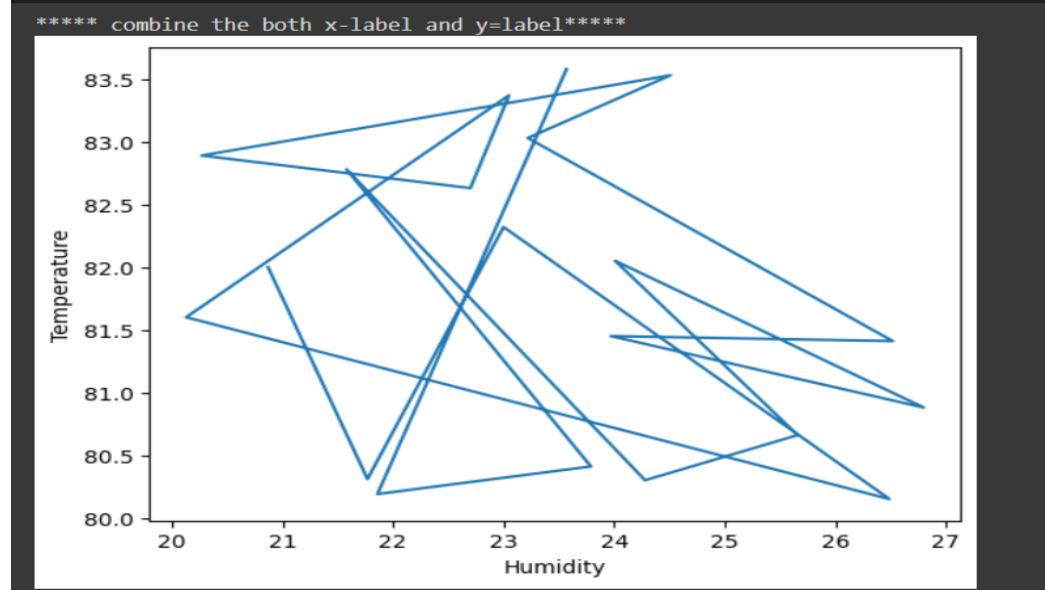
```
print("***** labelling y-axis *****")
plt.plot(df['Temperature'],df['Humidity'])
plt.ylabel('Temperature')
plt.show()
```

Output:



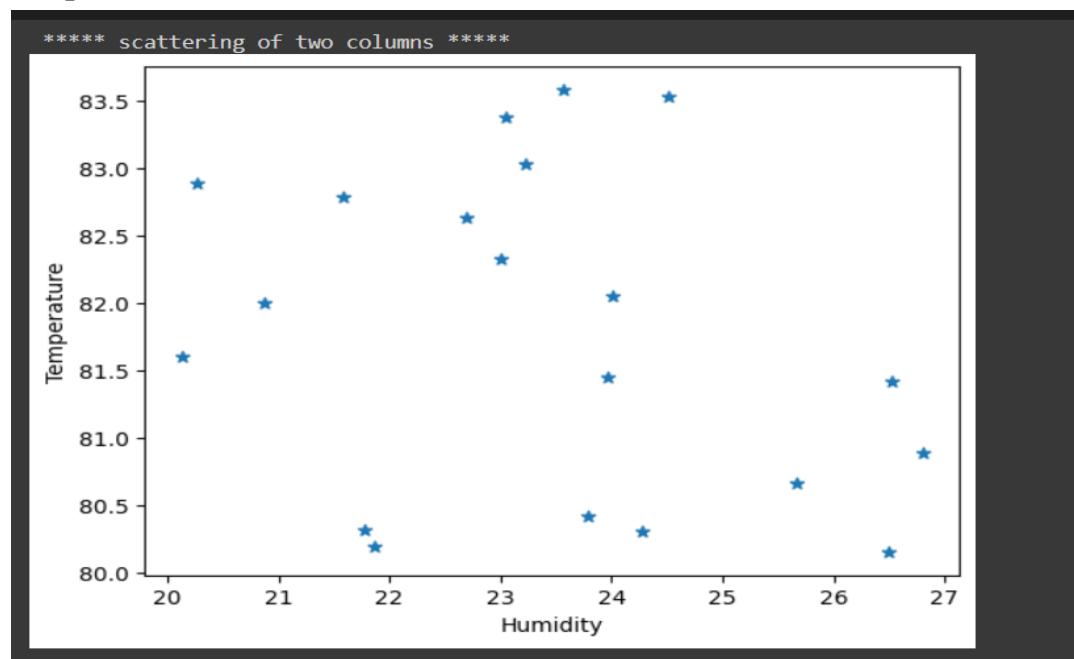
```
print("***** combine the both x-label and y=label*****")
plt.plot(df['Temperature'],df['Humidity'])
plt.xlabel('Humidity')
plt.ylabel('Temperature')
plt.show()
```

**Output:**



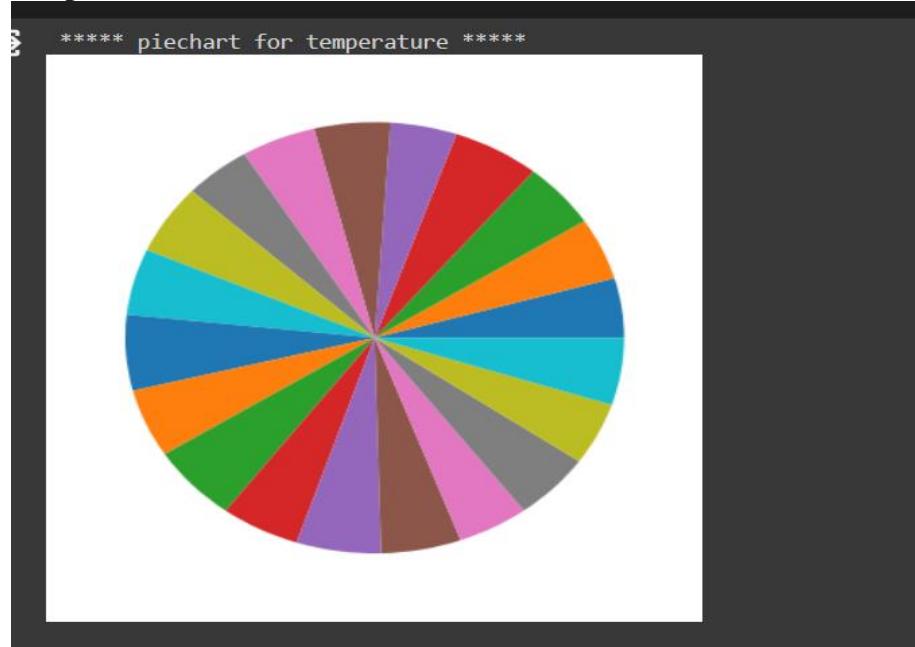
```
print( " ***** scattering of two columns *****")
plt.scatter(df['Temperature'],df['Humidity'],marker='*',linestyle='-' )
plt.xlabel('Humidity')
plt.ylabel('Temperature')
plt.show()
```

**Output:**



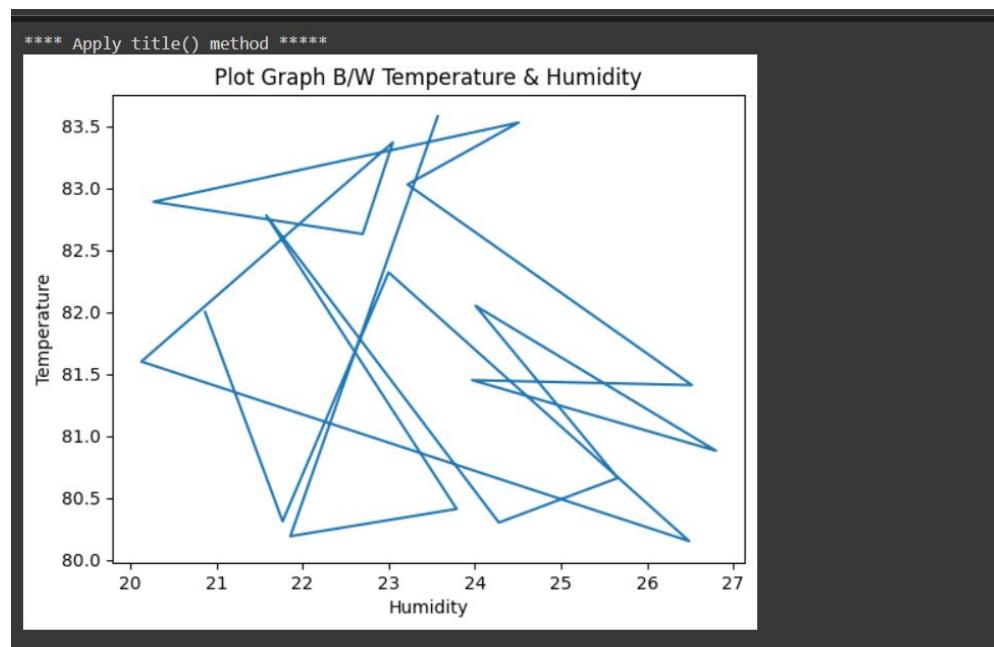
```
print( " ***** piechart for temperature ***** ")
plt.pie(df['Temperature'])
plt.show()
```

**Output:**



```
print("**** Apply title() method ****")
plt.plot(df['Temperature'],df['Humidity'])
plt.xlabel('Humidity')
plt.ylabel('Temperature')
plt.title("Plot Graph B/W Temperature & Humidity")
plt.show()
```

**Output:**

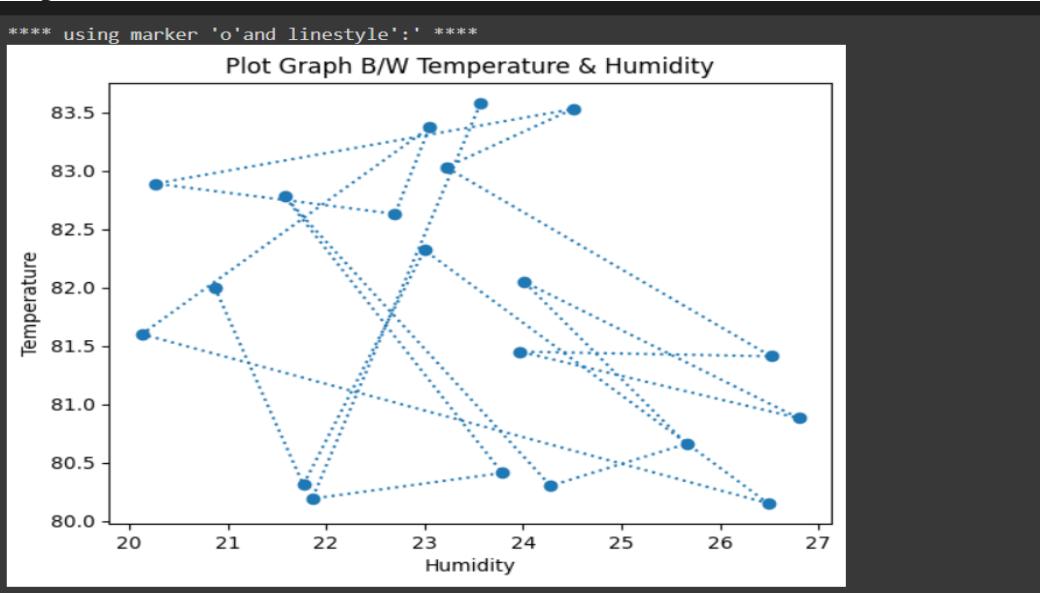


```

print("**** using marker 'o'and linestyle':-' ****")
plt.plot(df['Temperature'],df['Humidity'],marker='o',linestyle=':')
plt.xlabel('Humidity')
plt.ylabel('Temperature')
plt.title("Plot Graph B/W Temperature & Humidity")
plt.show()

```

**Output:**

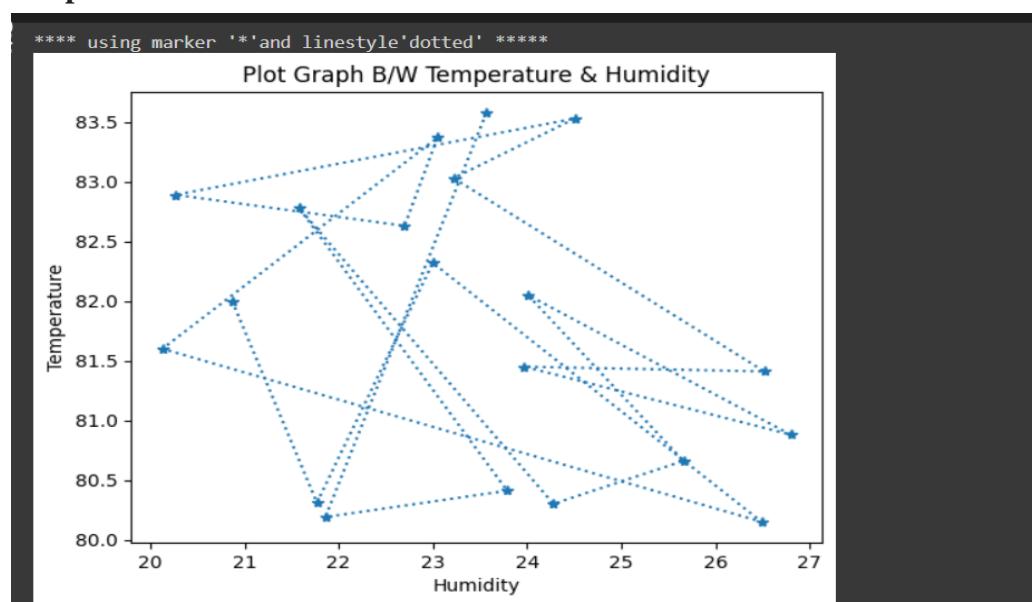


```

print("**** using marker '*'and linestyle'dotted' *****")
plt.plot(df['Temperature'],df['Humidity'],marker='*',linestyle='dotted')
plt.xlabel('Humidity')
plt.ylabel('Temperature')
plt.title("Plot Graph B/W Temperature & Humidity")
plt.show()

```

**Output:**

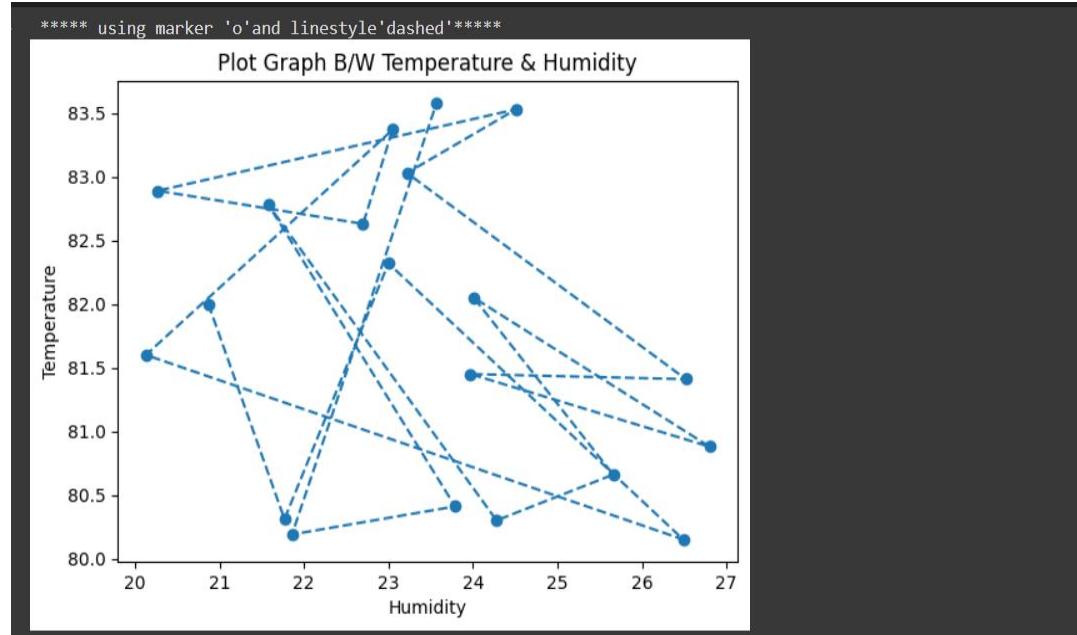


```

print(" ***** using marker 'o'and linestyle'dashed'***** ")
plt.plot(df['Temperature'],df['Humidity'],marker='o',linestyle='dashed')
plt.xlabel('Humidity')
plt.ylabel('Temperature')
plt.title("Plot Graph B/W Temperature & Humidity")
plt.show()

```

**Output:**

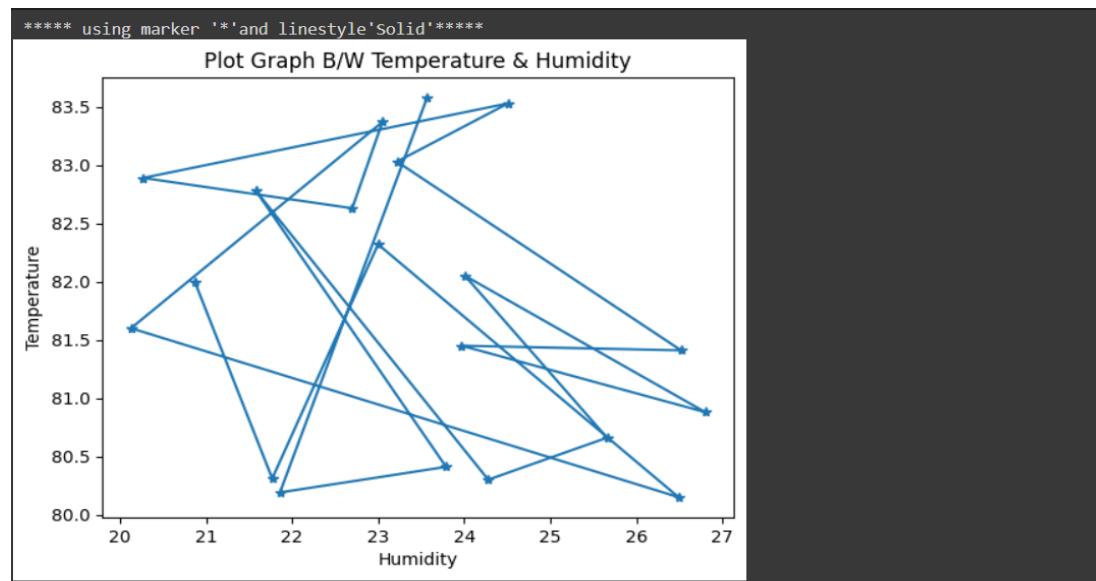


```

print(" ***** using marker '*'and linestyle'Solid'***** ")
plt.plot(df['Temperature'],df['Humidity'],marker='*',linestyle='solid')
plt.xlabel('Humidity')
plt.ylabel('Temperature')
plt.title("Plot Graph B/W Temperature & Humidity")
plt.show()

```

**Output:**

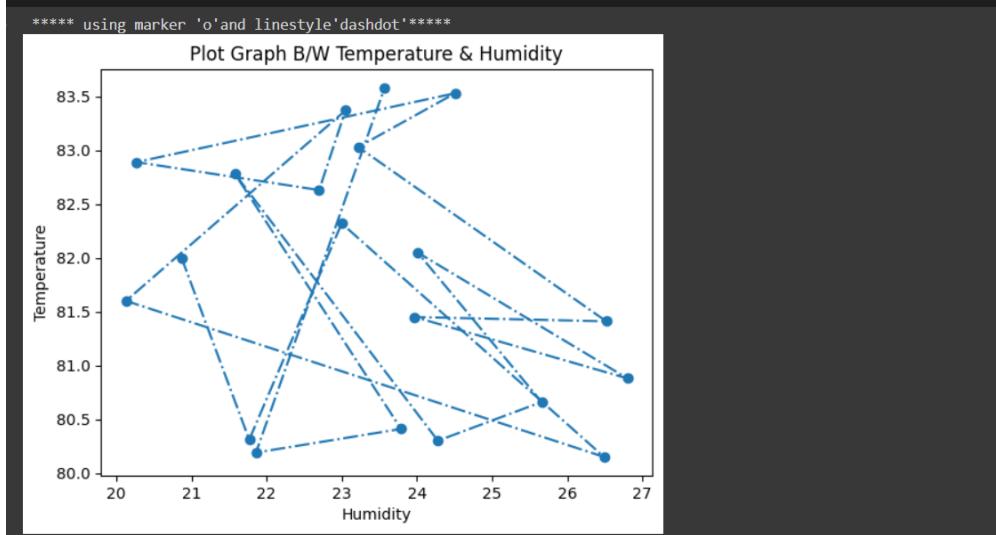


```

print("***** using marker 'o'and linestyle'dashdot'*****")
plt.plot(df['Temperature'],df['Humidity'],marker='o',linestyle='dashdot')
plt.xlabel('Humidity')
plt.ylabel('Temperature')
plt.title("Plot Graph B/W Temperature & Humidity")
plt.show()

```

**Output:**

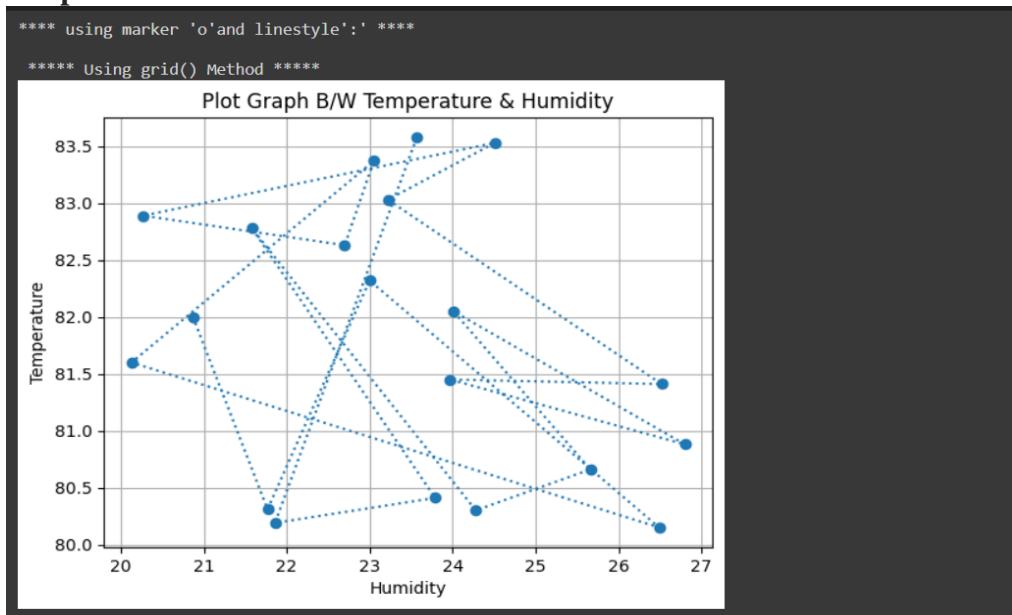


```

print("**** using marker 'o'and linestyle':' ****")
print( "          ")
print("***** Using grid() Method *****")
plt.plot(df['Temperature'],df['Humidity'],marker='o',linestyle=':')
plt.xlabel('Humidity')
plt.ylabel('Temperature')
plt.title("Plot Graph B/W Temperature & Humidity")
plt.grid()
plt.show()

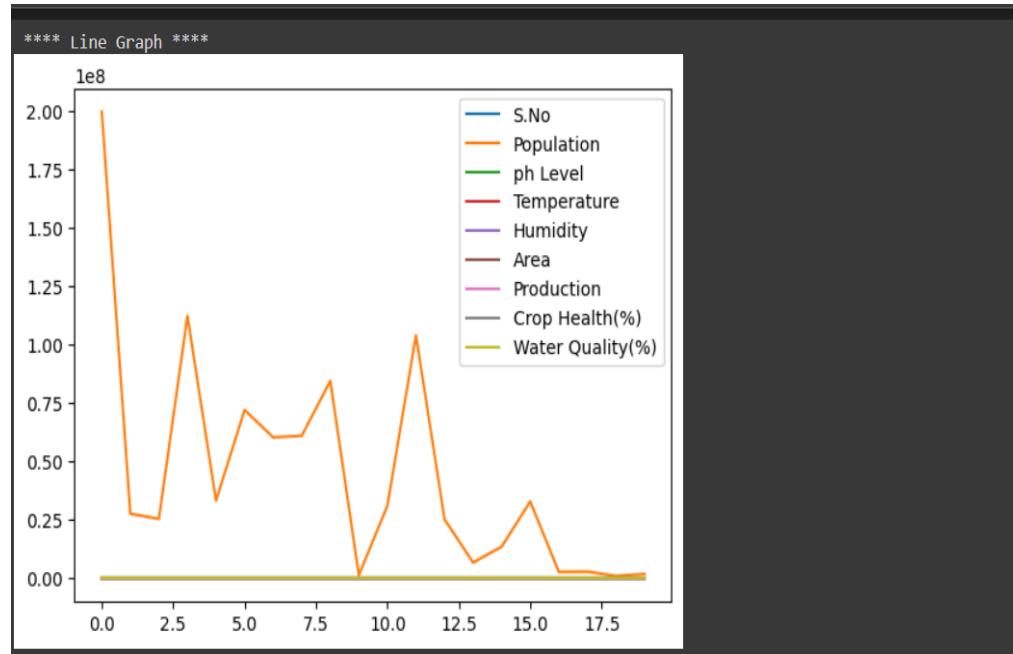
```

**Output:**



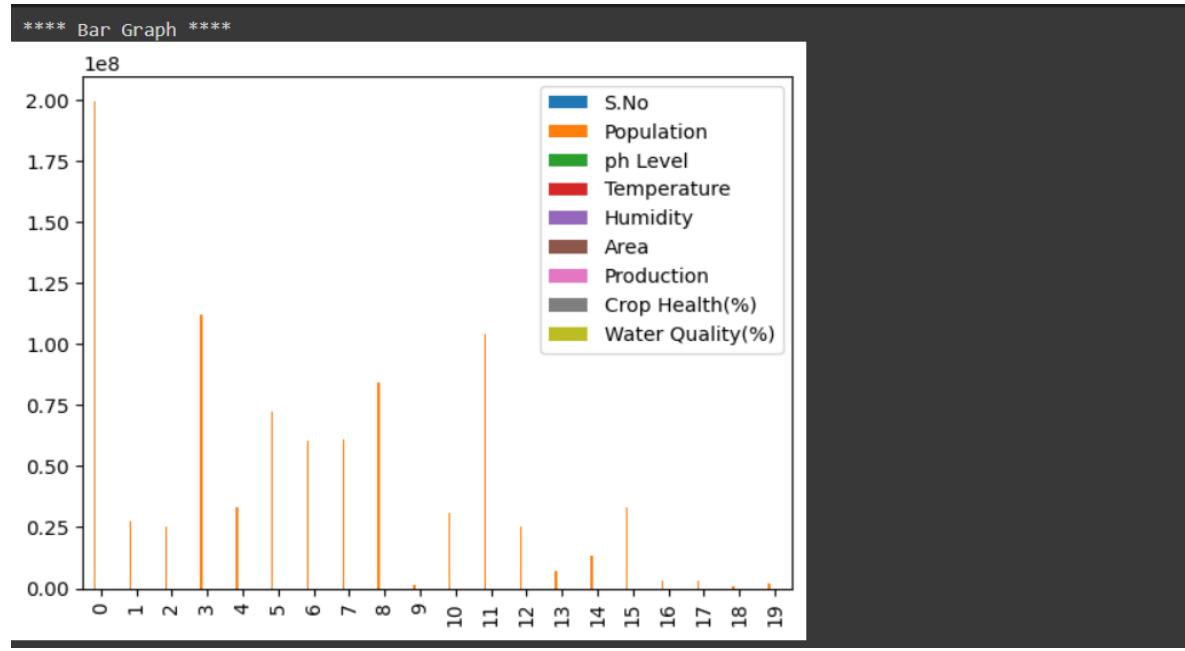
```
print(" **** Line Graph **** ")
x=df.plot.line()
```

**Output:**



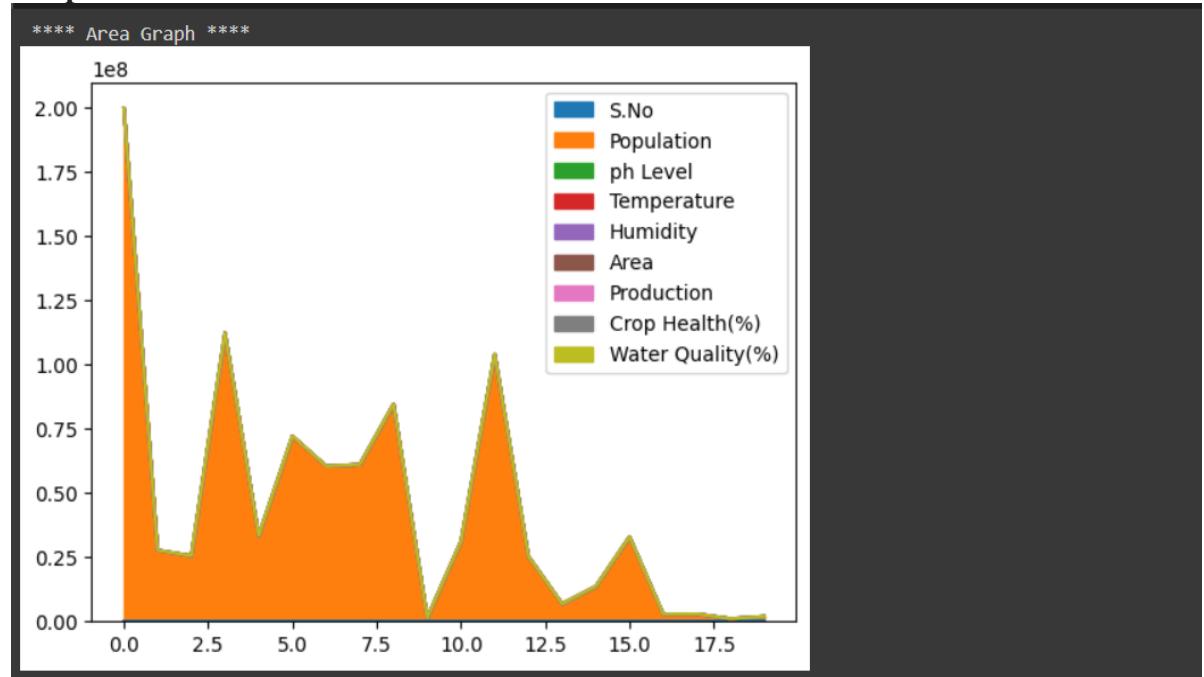
```
print(" **** Bar Graph **** ")
x=df.plot.bar()
```

**Output:**



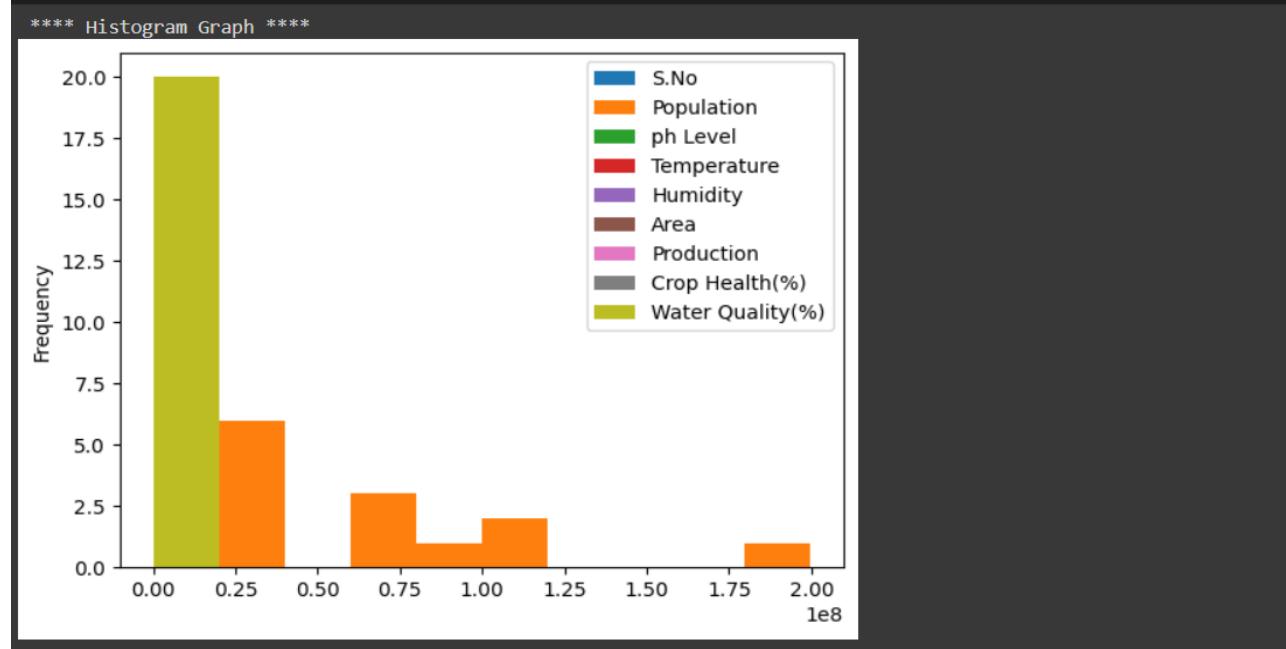
```
print(" **** Area Graph **** ")
x=df.plot.area()
```

**Output:**



```
print(" **** Histogram Graph **** ")
x=df.plot.hist()
```

**Output:**

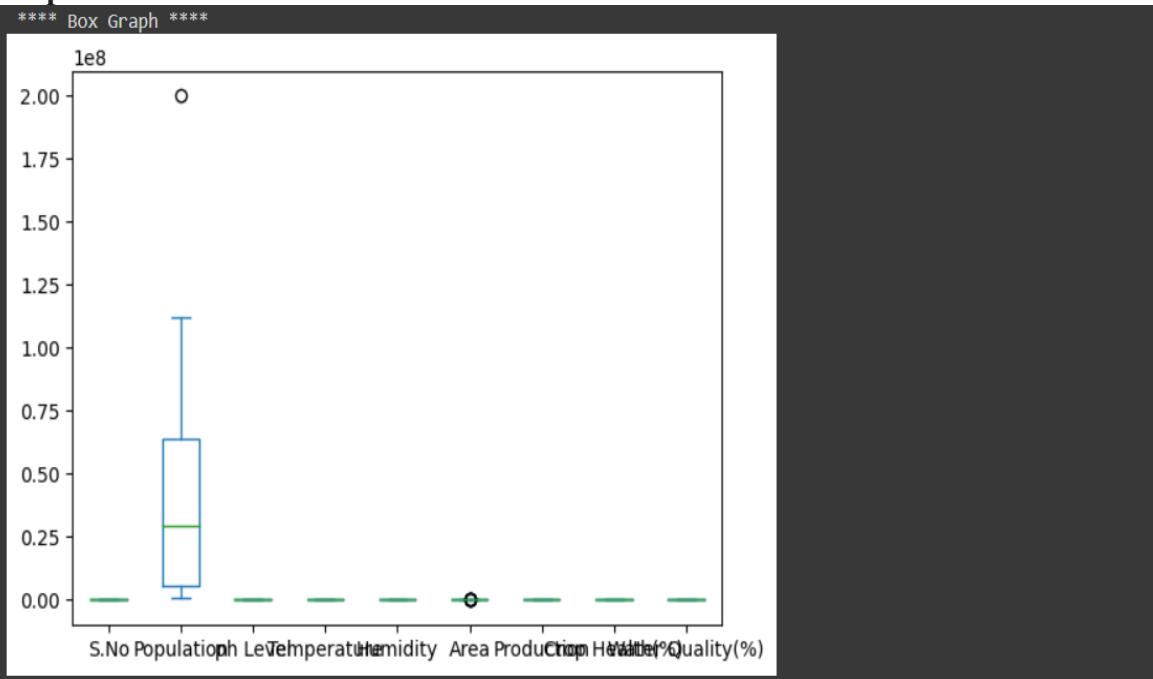


120



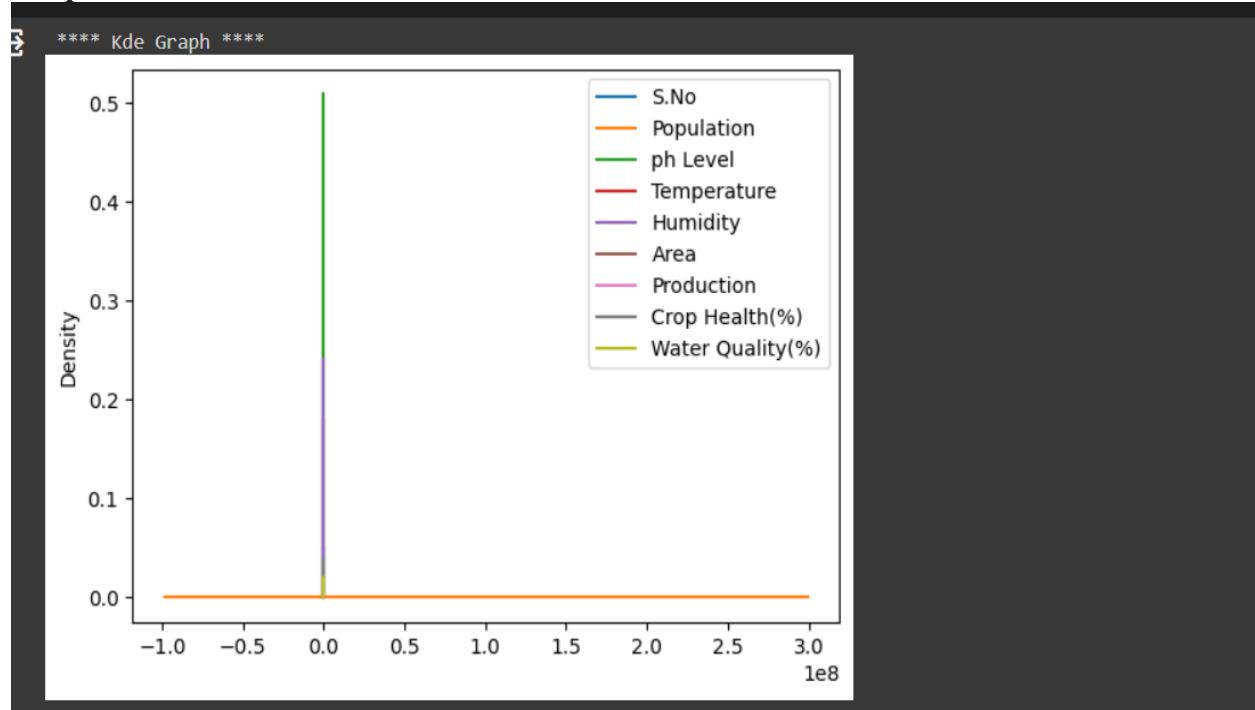
```
print(" **** Box Graph **** ")  
x=df.plot.box()
```

## Output:



```
print(" **** Kde Graph ****")  
x=df.plot.kde()
```

## Output:



## ➤ Data Distribution:

It is a process of that distribute the data based on Type of distribution.

To distribute we use

→numpy random module

### Types of Distribution:

- I. Normal Distribution.
- II. Uniform Distribution.
- III. Logistic Distribution.

---

```
print(" ** Normal Distribution ** ")
x=np.random.normal(1,2,10)
print(x)
```

### Output:

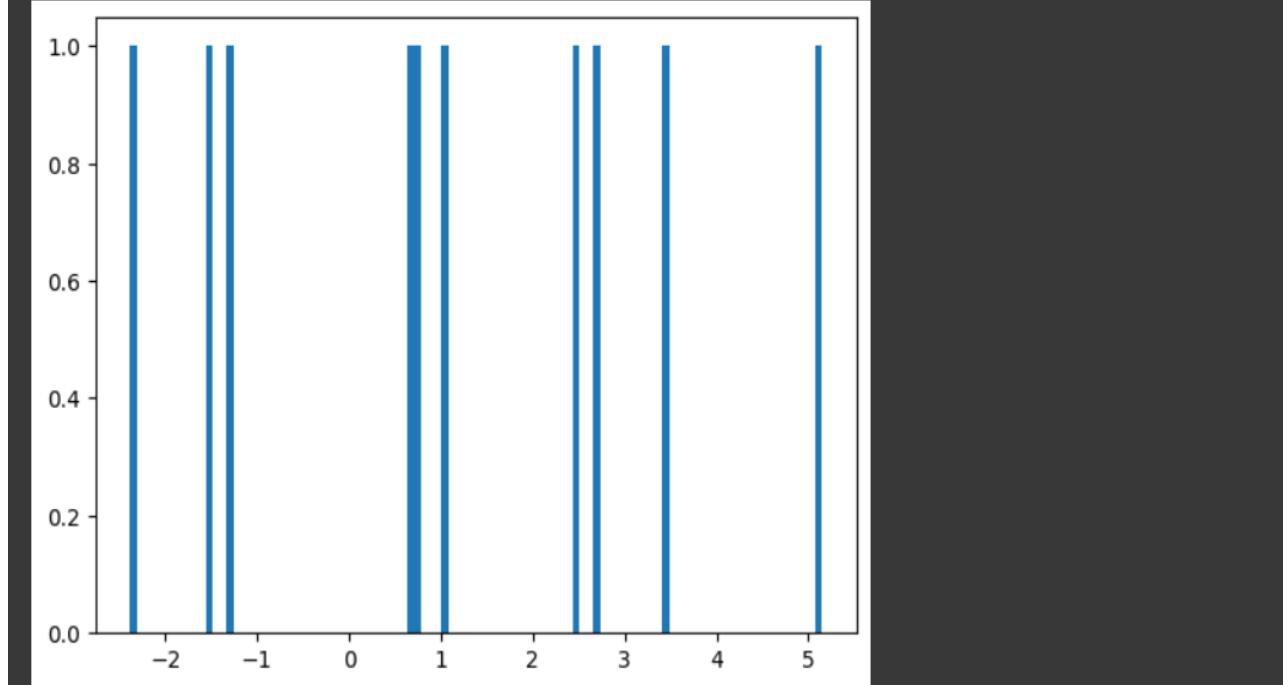
```
** Normal Distribution **
[-0.36226632 -1.77857895  4.81049881  0.9221851   2.66540183  2.40013871
 -1.2427852   0.92271832 -1.86423214  0.17989269]
```

---

```
x=np.random.normal(1,2,10)
print(x)
plt.hist(x,100)
plt.show()
```

### Output:

```
[ 1.04596704 -2.38543352  5.14648312 -1.25716027  0.72173022  2.4408369
 -1.50474377  3.47996281  0.63656815  2.67909783]
```



```
print( " ** Uniform Distribution ** ")
```

```
x=np.random.uniform(1,2,10)
```

```
print(x)
```

**Output:**

```
** Uniform Distribution **  
[1.38675677 1.11323635 1.89069593 1.69040736 1.50110289 1.44267342  
 1.80037177 1.70959007 1.06643832 1.71161078]
```

```
x=np.random.uniform(1,2,10)
```

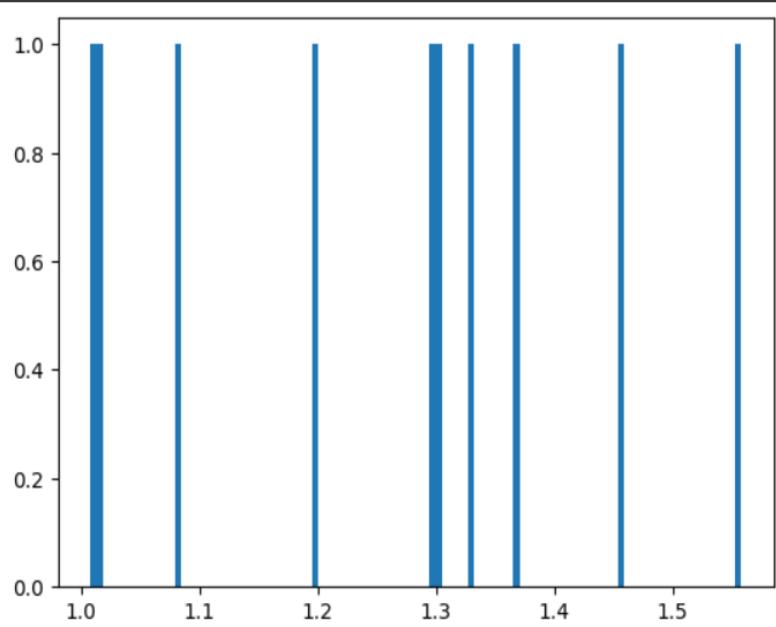
```
print(x)
```

```
plt.hist(x,100)
```

```
plt.show()
```

**Output:**

```
[1.33231963 1.00774664 1.55802546 1.45884143 1.37023806 1.30417456  
 1.08175115 1.01414181 1.19768022 1.29667909]
```



```
print(" ** Logistic Distribution ** ")
x=np.random.logistic(1,2,10)
print(x)
```

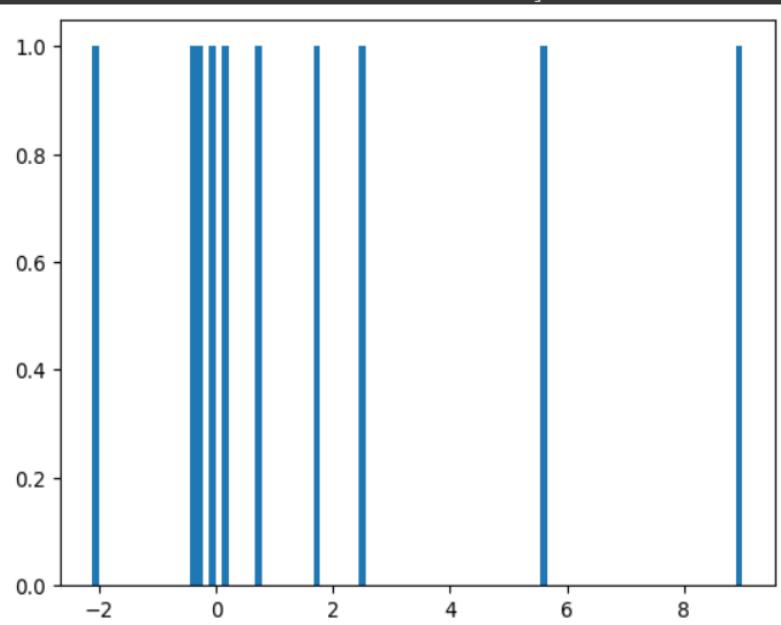
**Output:**

```
** Logistic Distribution **
[ 2.55667738  1.9210869 -0.38233059 -3.41581846  2.84281348 -1.24225539
 -2.31188496  3.97453684  1.78661295  3.27398136]
```

```
x=np.random.logistic(1,2,10)
print(x)
plt.hist(x,100)
plt.show()
```

**Output:**

```
[ 1.69756052 -0.2687622 -2.12069428  2.48840318  0.17875595 -0.0988484
 9.00079384 -0.42015913  0.75834543  5.59221781]
```



## Chapter-8

### **CONCLUSION:**

Agriculture optimization data analysis plays a pivotal role in help farmers to identify problems with their crops, use data from optimization and some optimizing techniques to detect problems like pests & diseases. This is helpful to farmers to protect their crops and take the immediate actions. It is used for track the yield data. To increase the production of the yield we use some technologies or some techniques like ML,Ai,Iot Agriculture and also govt of India providing some subsides for the farmers to produce the yields.

## REFERENCE LETTER

**Mr.Neyyala Tarun Kumar**

To whom it may concerned;

With great pleasure that I recommend Mr.Neyyala Tarun Kumar for the Master's in your university. I have known Mr.Neyyala Tarun Kumar for Three months while in Internship at CS CODENZ on Data Analysis using python for Machine Learning. In addition, he also performed a variety of clerical duties during his internship which was needed in completing his daily statistical reports.

Mr.Neyyala Tarun Kumar performed exceptional work that went beyond internship requirements is motivated, a self-starter and a quick learner. He always asked questions when clarification was needed. I was really pleased with his enthusiasm in taking on tasks that were new and challenging. His ability to communicate with team members was outstanding. Mr.Neyyala Tarun Kumar completed the internship project in a professional and timely manner.

I have been impressed with the way Mr.Neyyala Tarun Kumar carries his duties with passion and enthusiasm. During the period he served us, he was a great asset to us due to his quality productivity and timely completion of tasks assigned to him.

Mr.Neyyala Tarun Kumar has a high capability of following instructions given and articulation of ideas both verbally or in written form. He is a quick learner with self-motivation to carry his duties and perform tasks to perfection. I am confident he will be a significant pillar in your organization.

I, therefore, recommend Mr.Neyyala Tarun Kumar without reservation, and I know he will be of great input in your university. I am very confident he will initiate teamwork as he always did within our internship.

For more information about Mr.Neyyala Tarun Kumar , feel free to inquire anytime.

Sincerely,

Er. Y V D Chandra Sekhar,  
Founder & CEO ,  
CS CODENZ.