Predictive Analysis of Ambient Environment for Urban Cultivation using IoT based Hydroponic System

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Abstract—***This paper tells about the best and optimum conditions in which one can grow crops using Hydroponic farming. For this work, we are growing coriander plant in a controlled environment with constant monitoring, the controlled environment being restricted water supply I,e Hydroponic farming. Various parameters like Soil pH, Moisture levels etc. are recorded on daily basis and made into a data set. This data set, then with the help of Supervised Machine Learning algorithms we are going to Co-Relate the data collected via IOT by the help of Regression Models ,find the trends within the taken parameters and give an idea as to which conditions give a better yield.***

Keywords— ***Controlled Environment, Hydroponic, Machine Learning Algorithms Supervised, Regression Models***

I. Introduction

In a rapidly developing country like India, which has the world's highest growing GDP Urbanization is being seen in every nuke and corner of the country. The difference between the population density of the cities and rural areas are very high. The population of the cities are growing exponentially every year, because of which the agricultural farms in and around the cities are being converted into residential sky scrapers. The need and demand for crops and food is growing up but the area to grow is going down. Due to this alarming scenario, hydroponic agriculture has risen in popularity and practice. It is a form of agriculture in which the plants are grown with restricted water supply.

No.	City	Corporation	Population (In Lakhs)	Area (sqkm)	Density (pph)	Core Area Density (pph)	Core Area (In sq.km)
1	Mumbai	MCGM	124.78	437	286	460	67.7*
2	Kolkata	KMC	44.96	205	219	219	205
3	Chennai	GCC	67.27	426	157	270	176**
4	Bengaluru	BBMP	84.25	712	118	214	216***
5	Delhi	MCD	164.19	1397	118	391	22.74****
6	Hyderabad	GHMC	67.31	650	104	232	172.6*****

Figure 1. Population Density of Indian Metropolitan Cities

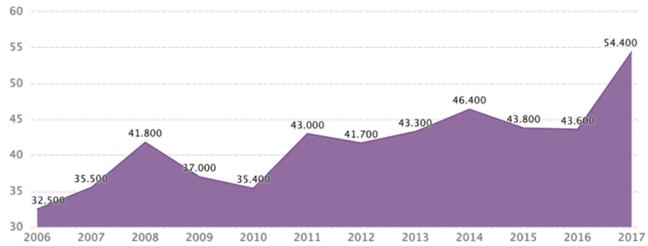

Figure 2. Per Capita Net Availability: Food grains: Pulses

Agriculture is India's principal employment and the backbone of the Indian economy. Agriculture, in addition to supplying food, gives job possibilities to rural people on a big scale in impoverished and emerging countries. It is the process of producing food, fibre and many other desired products by the cultivation and raising of domestic animals. Agriculture is a primary source of income for more than 58 percent of India's population.

As the population of the city grows significantly the need to feed the city heavily lays on the need of agricultural land. As most of the agriculture lands are dried up due to lack of water the need for starvation increases. Hence cities have to start cultivating crops and the need for automated farming in cities becomes crucial.

Climate changes will have a significant impact on agriculture by increasing water demand and limiting crop productivity in areas where irrigation is most needed. Some of the strategies established to create better crops that may not use water effectively include irrigation systems, rain fed agriculture, and groundwater irrigation. A smart system is intended to use water effectively.. In the system farmers need not make the water flow into fields manually, but the system automatically does that efficiently.

People's traditional practises of water conservation may result in massive water waste. As a result, the notion of robotized farming with a combination of IoT has emerged. Technological developments began to significantly boost manufacturing efficiency, resulting in a dependable system. The understanding of soil qualities causes the water supply to be driven in an intelligent manner. Agriculture practised wisely aids in the acquisition of understanding about soil and temperature conditions. Developing smart agriculture employing IoT-based devices not only boosts output but also reduces water waste.

II. BACKGROUND

Hydroponic farming is heavily dependent upon the water retention. The limited amount of water available will be retained with the help of a special soil mixture provided whose key role is to maintain the water level without losing the soil moisture.

A lot of work has already been done on the aspect of hydroponic farming. We have gone through various papers and found the following drawbacks and concepts.

Feature Selection has not yet been used in the creation of the machine learning model in this study. As a result, the outcome was less than satisfactory. The lettuce was standing straight one day and swaying to the side the next due to the blowing wind. Other errors were influenced by the amount of sunlight and temperature on that particular day. A lot of sunlight causes the plant to wither and unfold. When measured on a day with less sunlight and temperature, the width is smaller than when measured on a day with more sunlight and temperature.[4] Finally, these flaws caused the model to fail to produce a good learning result.

This work focuses on a model which maintains soil moisture level which is optimum for the crop growth.
This level of soil moisture will be maintained constantly for the next 24 hours with no impact and consideration of the weather condition. This work also talks about smart irrigation system which helps in apt water management and provides ideal crop suggestions based on historic soil data.
This work also provides the type and quantity of various minerals needed.[9] This work does not talk about the plant diseases, this can further be extended so as to detect diseases and automated dispersal of pesticides and insecticides.

This work emphasizes on the importance of IoT based technologies in agriculture. This paper works on the use of Low-Power Wide-Area Network(LPWAN) to reduce the power consumption and increasing the wireless range by eliminating the unnecessary dependency of third party and backhaul networks. It also describes the comparisons between Coverage Range, Quality of Service, Battery Life, Latency, Scalability, Payload Length and Development model between LPWAN technologies. The only major drawback of the paper is the maintenance the LPWAN requires to keep it running as the technology used won't have the ideal conditions to run in an agricultural setup even though the batter life and power consumption are ideal.[7]

Multi-Level IOT framework, which uses Application Layer, Internet Layer, Sensor and Actuator Framework along with Distribution middleware and follows MQTT protocol. In the output, the End User Experiences VPS interaction in one aspect and in the other aspect, it uses VPS and Local Server Interaction. This works falls back in implementing limiting factors such as nitrate, nitrate and ammonia via the electronic sensors. Automated data collection can be implemented into this work so that the system can function with better efficiency and maybe it could send alerts to the sender if there is any change or drastic changes in the parameters.[1]

The paper focuses on five main concepts, namely Hydroponics, Need for Automation Control, Climate Statistics, Data Analytics and Cloud, Proposed System.
The sensors record analog Data through Hydroponic system with the help of MCP 3008 ADC. This work acts as an eye mainly to farmers but this technology can sometimes act more of an ban than a boon for the farmers. This work is done solely done on the famer end so, it can be implemented in other factors as well[2].

III. SYSTEM ARCHITECTURE

A. *Hydroponic Farming*

In the present fast pace world, the form of hydroponic farming is taking over. The ongoing research paved new ways and paths for a better and substantial way of farming. Noticing the ways and researching the present trends, mainly followed in metropolitan cities and technologically advanced countries makes lives a lot easier in terms of hydroponic farming.

The work done by us addresses the key issues of automation and IoT integration into the way of sustainable farming in constraints such as limited water supply and space.

B. *Necesity for automation*

The work being done needs constant monitoring as various sensors are used in an confined and controlled environment. As pre-processing homo sapiens , we tend to make unavoidable errors in our work. To avoid such mistakes that in other ways cannot be avoided, automation is the way.

With the help of Arduino , ESp 8266 and aurd Spread Sheet the reading from the sensors are directly stored into the spreads sheet with almost no error. The readings are recorded once every 10 minutes which without automation requires a immense amount of man power which intern may lead to loss or errors in recorded results.

C. *Climate Maintained*

Farming mainly depends on ambient climatic conditions but the city environment is not suitable for the growth of crops in the traditional way.

For our work as we targeted the metropolitan cities we made sure that the temperature rage varied from 28 degree Celsius to 36 degree Celsius. In hydroponic farming, the crops are not exposed to sunlight throughout. Rather than exposing them to sunlight throughout, we made sure that an adequate sunlight was available which in the day reaches approximately 240 candela and in the night for the integrity of the results, we made sure no light from any source was available which resulted in 0 candela.

Speaking about the soil moisture, for better understating of the impact of moisture retention of the soil we grew the crops in early summer because of which there is humidity in the air than normal. The humidity varied from 40 percent to 80 percent which is the normal range in a coastal city.

TABLE 1

Range of Parameters Full Phase of crop growth

PARAMETER	MAX	MIN
PH	27.13	6.68
LUMINOUS INTENSITY	226	0
HUMIDITY	82.5	47.8

TEMPERATURE	38.6	25.7
SOIL MOISTURE	687	579
WATER LEVEL	731	153

TABLE 2

Range of Parameters Initial Phase of crop growth

PARAMETER	MAX	MIN
PH	27.13	6.68
LUMINOUS INTENSITY	226	0
HUMIDITY	82.5	47.8
TEMPERATURE	38.6	25.7
SOIL MOISTURE	687	579
WATER LEVEL	731	153

TABLE 3

Range of Parameters Growing Phase of crop growth

PARAMETER	MAX	MIN
PH	12.59	0
LUMINOUS INTENSITY	220	0
HUMIDITY	72.7	43.6
TEMPERATURE	36.3	27.7
SOIL MOISTURE	685	676
WATER LEVEL	661	272

TABLE 4

Range of Parameters Harvesting Phase of crop growth

PARAMETER	MAX	MIN
PH	27.13	6.68
LUMINOUS INTENSITY	226	0
HUMIDITY	82.5	47.8
TEMPERATURE	38.6	25.7
SOIL MOISTURE	687	579
WATER LEVEL	731	153

D. *Data Analysis*

All the information collected from the sensors is stored in the personal systems directly rather than cloud as clod is heavily dependent upon an uninterrupted internet connection which sometimes may not be possible.

The data collected is stored and processed with the help of python to create results which help in better understanding of the data.

E. *Proposed System*

An innovative form of hydroponic farming is used. A coco pit is used as an soil replacement as the water retention capacity is much higher in this compared to general soil. The coco pit is connected to water supply which is regulated. Six different sensors are connected to the system. The sensors being, pH sensor which monitors the pH of the water in the coco pit. The water in coco pit pH initially at the time of laying it down was 6.5. The second sensor used is Luminous Intensity Sensor. This sensor monitors the amount of luminescence around the setup. The third sensor is Humidity sensor, this sensor monitors the humidity in the surroundings of the setup. Next sensor used was temperature sensor, this sensor monitors the temperature of the surroundings. The fifth sensor used was soil moisture sensor, this sensor measured the amount of moisture in coco pit throughout the experiment. The final sensor used is water level sensor, this sensor measures the amount of water provided to the system daily. The seeds used were coriander seeds as they take less time to grow which afforded us a chance to cross verify the results by repeating the experiment.

IV. Experimental Process

According to the proposed system, the experiment is designed in such a way that it is a prototypical implementation. The design procedures are explained with a block Diagram.

A. *Block Diagram*

In the following proposed system, the analoge and digital sensors collect information from the hydrophonic setup. With the help of Arduino Mega 2560 data is send to spreadsheet in a very smooth and effective manner. The data is collected and saved in database using a wifi module. The block figure is represented for the proposed system.

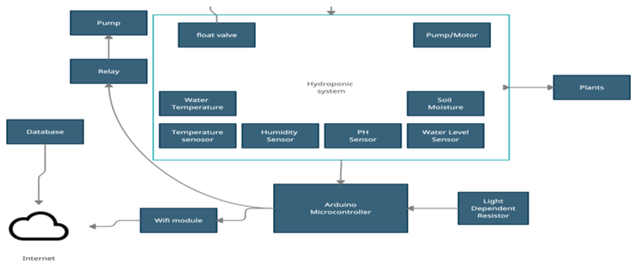

Figure 3. Block diagram of proposed Hydroponic system

Major Steps explained in proposed system is mentioned as flow chart.

B. *Circuit diagram and components*

The proposed circuit is created in such a way that the cost of components is economical and also the quality the components is not comparamised and also the performance of the components are very good.

The Major components invloved in proposed system are:

- Arduino Mega 2560
- Temperature sensor (DHT-22)
- Humidity Sensor (DHT-22)
- Water Level Sensor
- Soil Moisture Sensor
- PH Sensor
- Luminous Intensity Sensor
- WIFI module (ESP 8266)
- Breadboard
- Jumper wires
- Pump
- Water Tube
- 5V motor
- 5V power supply

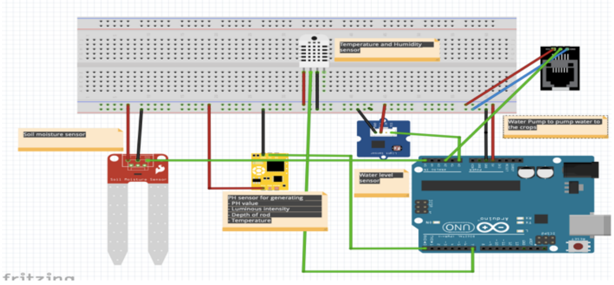

Figure 4. Circuit diagram of proposed Hydroponic System

The main component of the automated system is Arduino Uno Mega 2560 which is a very stable model which provides propper power supply and also helps in uploading large bundle of code.

Figure 5. Economic PH sensor with Luminous intensity sensor

PH Sensor - In both soil and hydroponics gardening, optimal pH levels are crucial for healthy plants and excellent harvests. Maintaining those ideal values necessitates frequent, reliable pH testing, especially in soilless growth systems. A plant's nutrient uptake is maximised at ideal pH values. The vigour and productivity of a plant are increased as a result of these nutrients. Luminous Intensity Sensor helps to capture the amount of sunlight hitting the product

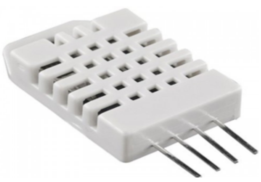

Figure 6. DHT-22 Humidity and Temperature Sensor

DHT22 Temperature/Humidity Sensor - The DHT22 is a Temperature and Humidity sensor with digital interface temperature. The sensor is made in such a way that it can get propper calibrated value of humidity and temperature.

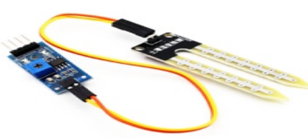

Figure 7. Image of soil moisture Sensor

Soil Moisture Sensor - This soil moisture sensor can be used to detect soil moisture or evaluate if there is water around the sensor. It also tells you if the plants in the mesh pot need to be watered.

Figure 8. Image of Water Level Sensor

Water-Level Sensor - A water-level sensor is a device that detects the level of water in a container. Maintaining the water level allows the roots to absorb the proper amount of water and prevents the plant from being spoilt.

V. Dataset Analysis

A. *Variation of PH with respect to time*

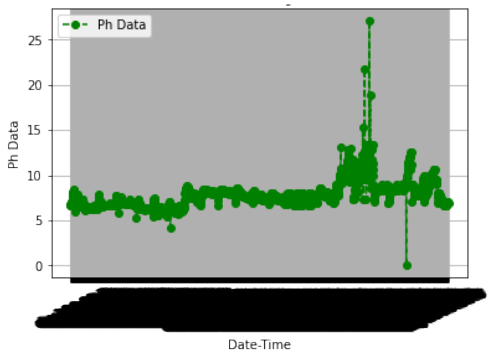

Figure 9. Time series Analysis of PH

Fig: 9 shows the pH values of the water through the experiment. The minimum value recorded is 5.5 on the ph scale and this was recorded during the Initial phase of the experiment. The maximum recorded is 13 and it was recorded during the growth phase due to the addition of mineral water to the water supply, it became more basic. After the growth phase we supplied general water again so, the pH dropped gradually making it more neutral.

B. *Variation of Sunlight with respect to time*

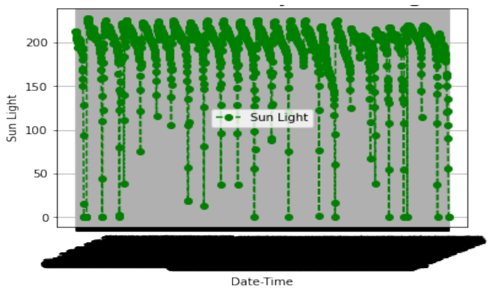

Figure 10. Time series Analysis of Luminous Intensity/ Sunlight for plant

Fig: 10 depicts the Luminous intensity on candle scale over the whole duration of the experiment. The least recorded is Zero as during the night, it is made sure that the experimental setup is not exposed to any form of light energy. The highest value recorded is around 250 candela during the day.

C. *Variation of Humidity with respect to time*

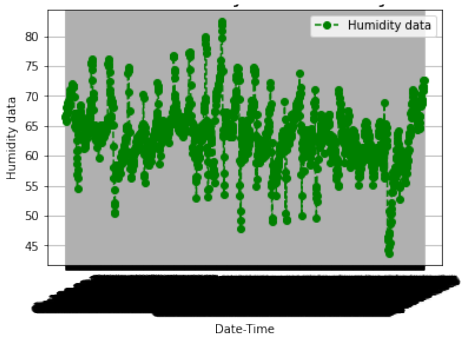

Figure 11. Time series Analysis of Humidity

Fig 11: shows the humidity in the surroundings of the setup. As the experiment setup was in a coastal city, the humidity is relatively high but is under the normal humidity levels for the city. The lowest recoded is 45% and the highest is around 80%. To make sure that the humidity level doesn’t go overboard, we conducted the experiment during early summer.

D. *Variation of Temperature with respect to time*

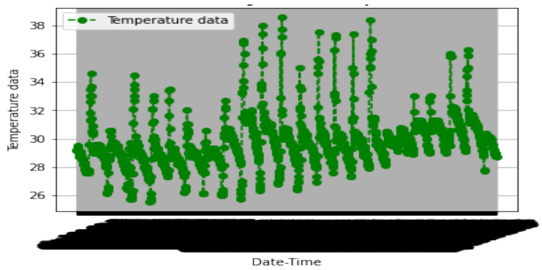

Figure 12. Time series Analysis of Temperature

Fig 12: represents the Temperature of the surroundings throughout the experiment. The temperature kept on raising during the experiment gradually. The lowest recoded temperature was 26degree Celsius and highest was 36degree Celsius. The lowest average temperature was during the initial phase and the highest average was during the harvesting phase.

E. *Variation of Soilmoisture with respect to time*

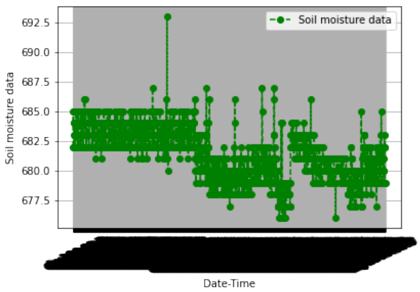

Figure 13. Time series Analysis of Soil Moisture

Fig: 13 shows the moisture in the coco pit during the experiment timeline. During the initial phase the moisture level was between 682-686. The moisture level was highest during the growth phase which ranges between 680-692. The moisture level during the harvest phase is lowest in terms of average, its range varies from 676-680.

F. *Variation of Water Level with respect to time*

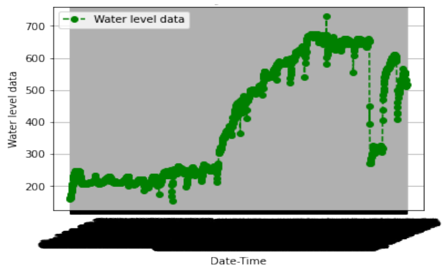

Figure 14. Time series Analysis of Water Level

Fig: 14 depicts the water level in the experiment. The water level gradually increases till the growth phase and decreases there on. The water level during the initial phase was between 160 and 240ml, during growth phase it is between 200ml and 650ml. During the harvest phase, the water level required is low , it ranges from 200-500ml.

VI. Result And Discussion

The main objective of the result is to corelate the various parameters of the experiments with the help of four evaluation parameters, namely

- Mean Absolute Error (MAE)
- Root Mean Square Error (MASE)
- Root Mean Square Log Error (RMSE)
- R Squared(R2)

The lower the value of MAE, the more the parameters are corelated. The R2 specifies the error in the calculations I,e the lesser the value of R2, the better the correlation is.

A. *Predictive Analysis of parameters using Linear Regression*

TABLE 5

Linear Regression Between Parameters for Initial Phase of Coriander Plant Growth

PARAMETER VS PARAMETER	PH	SUNLIGHT	HUMIDITY	TEMPERATURE	SOILMOISTURE	WATER LEVEL
PH	X	MAE=26.54 MASE=1702.59 RMSE=41.26 R2=-0.00288	MAE=3.13 MASE=17.055 RMSE=4.1298 R2=0.03718	MAE=0.9522 MASE=2.0584 RMSE=1.43474 R2=-0.003785	MAE=0.9161 MASE=1.1950 RMSE=1.0931 R2=-0.011836	MAE=11.9423. MASE=233.031 RMSE=15.265 R2=-0.0039
SUNLIGHT	MAE=0.3905 MASE=0.2885 RMSE=0.5371 R2= -0.00707	X	MAE=2.9133 MASE=16.551 RMSE=4.0683 R2=0.0650	MAE=0.7492 MASE=1.268 RMSE=1.126 R2=0.145	MAE=0.902 MASE=1.160 RMSE=1.077 R2=-0.0417	MAE=1.0388 MASE=1.521 RMSE=1.233 R2=0.078

HUMIDITY	MAE=0.3817 MASE=0.253 RMSE=0.503 R2=-0.0074	MAE=21.29 MASE=1630.14 RMSE=40.375 R2=0.157	X	MAE=0.831 MASE=1.205 RMSE=1.097 R2=0.517	MAE=0.875 MASE=1.06 RMSE=1.033 R2= -0.0056	MAE=9.843 MASE=174.68 RMSE=13.21 R2=0.0941
TEMPERATURE	MAE=0.409 MASE=0.316 RMSE=0.562 R2=0.0032	MAE=22.06 MASE=1529.58 RMSE=39.109 R2=0.216	MAE=2.64 MASE=10.3 RMSE=3.214 R2=0.505	X	MAE=0.9160 MASE=1.190 RMSE=1.090 R2=-0.012	MAE=9.714 MASE=168.86 RMSE=12.99 R2=0.087
SOILMOISTURE	MAE=0.389 MASE=0.278 RMSE=0.527 R2= = -0.0094	MAE=24.12 MASE=1462.23 RMSE=38.23 R2=0.0032	MAE=0.933 MASE=2.1119 RMSE=1.453 R2= -0.0231	MAE=2.890 MASE=15.77 RMSE=3.97 R2=-0.018	X	MAE=11.212 MASE=229.93 RMSE=15.16 R2= -0.0049
WATER LEVEL	MAE=0.339 MASE=0.232 RMSE=0.4819 R2=0.0221	MAE=22.450 MASE=1350.67 RMSE=36.75 R2=0.190	MAE=3.35 MASE=2.043 RMSE=1.4296 R2=0.0010	MAE=3.356 MASE=18.41 RMSE=4.29 R2=0.039	MAE=0.797 MASE=1.540 RMSE=1.240 R2=0.0032	X

From Table 5, it can be inferred that water level and pH are the most corelated parameters in the initial phase of the experiment as MAE=0.339. This means, with a given Water Level, we can predict the value of pH required for a good yield. The parameters that cannot be corelated are pH and Sunlight as the MAE=26.54, this means that the value of Luminous intensity cannot be predicted with the pH level.

TABLE 6
Linear Regression Between Parameters for Growing Phase of Coriander Plant Growth

PARAMETER VS PARAMETER	PH	SUNLIGHT	HUMIDITY	TEMPERATURE	SOILMOISTURE	WATER LEVEL
PH	X	MAE=21.157 MASE=1228.42 RMSE=35.04 R2=-0.0048	MAE=3.400 MASE=21.329 RMSE=4.618 R2= -0.0108	MAE=1.155 MASE=3.1804 RMSE=1.783 R2=-0.0061	MAE=1.6315 MASE=3.9975 RMSE=1.999 R2=0.0096	MAE= 136.46. MASE= 23789.17 RMSE= 154.2 R2=0.1199
SUNLIGHT	MAE=0.944 MASE= 2.5054 RMSE= 1.582 R2= 0.0000523	X	MAE= 3.309 MASE= 20.457 RMSE= 4.522 R2=0.194	MAE= 1.010 MASE= 2.544 RMSE= 1.595 R2= 0.1704	MAE=1.556 MASE=3.836 RMSE= 1.958 R2=0.0247	MAE=1.562 MASE= 3.678 RMSE= 1.917 R2=0.033
HUMIDITY	MAE=0.9677 MASE=2.328 RMSE= 1.525 R2=0.00814	MAE=19.44 MASE= 1072.59 RMSE= 32.750 R2= 0.1304	X	MAE= 0.943 MASE= 1.686 RMSE= 1.298 R2= 0.5603	MAE=1.6009 MASE=3.845 RMSE=1.96 R2= 0.00245	MAE=134.715 MASE=24155.87 RMSE=155.42 R2=0.1037
TEMPERATURE	MAE=0.8932 MASE=1.6079 RMSE=1.268 R2=-0.0076	MAE=18.107 MASE=888.58 RMSE=29.80 R2=0.165	MAE=2.487 MASE=10.05 RMSE=3.171 R2=0.563	X	MAE=1.780 MASE=4.511 RMSE=2.123 R2=-0.0042	MAE=142.16 MASE=25289.25 RMSE=159.02 R2=0.0057
SOILMOISTURE	MAE= 0.959 MASE= 2.385 RMSE= 1.544 R2= = 0.01081	MAE=19.289 MASE= 834.443 RMSE= 28.88 R2=0.0037	MAE= 1.0317 MASE=2.1168 RMSE=1.454 R2= -0.0373	MAE=3.3324 MASE=21.27 RMSE= 4.612 R2=-0.00273	X	MAE=130.00 MASE=23137.316 RMSE= 152.109 R2= 0.0110
WATER LEVEL	MAE= 0.886 MASE=2.728 RMSE=1.65 R2=0.1177	MAE= 20.0011 MASE= 1183.82 RMSE= 34.406 R2= 0.0038	MAE= 1.563 MASE=3.701 RMSE= 1.923 R2=0.0199	MAE=3.494 MASE=20.4542 RMSE=4.5226 R2=0.073	MAE=1.173 MASE=2.624 RMSE= 1.62 R2= 0.0017	X

From Table 6, it can be inferred that temperature and pH are the most corelated parameters in the growth phase of the experiment as MAE=0.8932. This means, with a given temperature, we can predict the value of pH required for a good yield. The parameters that cannot be corelated are temperature and water level as the MAE=142.16, this means that the value of Water level cannot be predicted with a given temperature.

TABLE 7
Linear Regression Between Parameters for Harvesting Phase of Coriander Plant Growth

PARAMETER VS PARAMETER	PH	SUNLIGHT	HUMIDITY	TEMPERATURE	SOILMOISTURE	WATER LEVEL
PH	X	MAE=22.685 MASE= 1027.818 RMSE= 32.059 R2=-0.020	MAE= 4.589 MASE =33.367 RMSE =5.77 R2= -0.154	MAE=0.906 MASE= 1.836 RMSE=1.35 R2=0.0653	MAE=1.1328 MASE=1.821 RMSE=1.349 R2=0.032	MAE= 100.54. MASE=15723.309 RMSE= 125.392 R2=-0.05177
SUNLIGHT	MAE= 0.9731 MASE = 1.421 RMSE = 1.192 R2= -0.0967	X	MAE= 3.446 MASE = 20.575 RMSE = 4.535 R2= 0.1587	MAE= 0.7630 MASE= 1.6451 RMSE= 1.282 R2= 0.2184	MAE=0.945 MASE=1.470 RMSE= 1.212 R2=-0.0047	MAE=1.0651 MASE= 1.972 RMSE= 1.404 R2=0.00676
HUMIDITY	MAE= 0.8707 MASE =1.2903 RMSE = 1.1359 R2=0.153	MAE=19.1465 MASE= 1114.27 RMSE= 33.38 R2= 0.205	X	MAE=0.725 MASE= 1.277 RMSE= 1.130 R2= 0.290	MAE=1.008 MASE=1.796 RMSE=1.340 R2= 0.01474	MAE=108.25 MASE=14820.36 RMSE=121.738 R2=0.207
TEMPERATURE	MAE= 0.9607 MASE =1.441 RMSE =1.2004 R2=0.075	MAE=20.242 MASE= 1750.404 RMSE= 41.837 R2=0.2634	MAE= 3.8819 MASE =25.495 RMSE =5.049 R2=0.3559	X	MAE=1.130 MASE=2.060 RMSE=1.435 R2=0.00103	MAE=111.24 MASE=16898.54RMSE=129.99 R2=0.026065
SOILMOISTURE	MAE= 0.9433 MASE = 2.2974 RMSE = 1.515 R2= = - 0.0189	MAE=23.149 MASE= 1434.32 RMSE= 37.87 R2=-0.00766	MAE= 1.0291 MASE =1.813 RMSE = 1.346 R2= - 0.1067	MAE=4.599 MASE= 33.304 RMSE= 5.770 R2=-0.0732	X	MAE=105.00 MASE=16357.032 RMSE=127.894 R2= -0.004
WATER LEVEL	MAE= 0.9163 MASE =1.311 RMSE =1.145 R2=0.0459	MAE= 28.312 MASE= 2365.95 RMSE= 48.641 R2= 0.000481	MAE= 1.055 MASE =1.63225 RMSE =1.2775 RE=0.0771	MAE=4.03624 MASE= 25.24 RMSE=5.024 R2=0.16178	MAE=0.9096 MASE=1.342 RMSE= 1.158 R2= 0.0436	X

From Table 7, it can be inferred that humidity and temperature are the most corelated parameters in the harvesting phase of the experiment as MAE=0.723. This means, with a given humidity level, we can predict the temperature required for a good yield. The parameters that cannot be corelated are temperature and water level as the MAE=111.24, this means that the value of Water level cannot be predicted with a given temperature.

TABLE 8

Linear Regression Between Parameters for Full Phase of Coriander Plant Growth

PARAMETER VS PARAMETER	PH	SUNLIGHT	HUMIDITY	TEMPERATURE	SOILMOISTURE	WATER LEVEL
PH	X	MAE=23.313 MASE=1591.03 RMSE=39.88 R2=0.00118	MAE=3.9601 MASE=27.939 RMSE=5.285 R2= 0.00598	MAE=1.210 MASE=3.0650 RMSE=1.750 R2=0.0599	MAE=1.8210 MASE=4.899 RMSE=2.213 R2=0.0378	MAE= 137.684 MASE= 22732.459 RMSE= 150.772 R2=0.2893
SUNLIGHT	MAE=1.0360 MASE= 2.128 RMSE= 1.459 R2= -0.000246	X	MAE= 3.419 MASE= 21.26 RMSE= 4.61 R2= 0.157	MAE= 1.147 MASE= 2.604 RMSE= 1.613 R2= 0.185	MAE=1.921 MASE=5.188 RMSE= 2.277 R2=-0.0118	MAE=1.8404 MASE= 4.6457 RMSE=2.155 R2=-0.0026
HUMIDITY	MAE=0.9411 MASE= 1.633 RMSE= 1.278 R2=0.0245	MAE=20.003 MASE= 1241.13 RMSE= 35.22 R2= 0.1857	X	MAE= 0.929 MASE= 1.478 RMSE= 1.216 R2= 0.375	MAE=1.811 MASE=4.672 RMSE=2.161 R2= 0.023	MAE=165.664 MASE=31591.99 RMSE=31591.99 R2=0.02649
TEMPERATURE	MAE=0.9259 MASE= 2.554 RMSE= 1.598 R2=0.0676	MAE=20.468 MASE=1358.52 RMSE=36.85 R2=0.176	MAE=3.1046 MASE=16.046 RMSE=4.005 R2=0.4775	X	MAE=1.658 MASE=4.024 RMSE=2.006 R2=0.0590	MAE=166.6700 MASE=31745.512 RMSE=178.172 R2=0.0422
SOILMOISTURE	MAE= 0.936 MASE= 1.618 RMSE= 1.27 R2= =0.113	MAE=22.930 MASE= 1473.35 RMSE= 38.23 R2=- 0.0140	MAE=1.185 MASE=3.058 RMSE= 1.748 R2= 0.0505	MAE=3.6435 MASE=24.41 RMSE= 4.94 R2=0.0159	X	MAE=125.65 MASE=22858.07 RMSE= 151.18 R2= 0.288
WATER LEVEL	MAE= 0.850 MASE= 1.518 RMSE=1.23 R2=0.2719	MAE= 23.489 MASE= 1536.91 RMSE= 39.20 R2= 0.0056	MAE= 3.864 MASE= 28.33 RMSE= 5.322 R2= 0.0316	MAE=1.185 MASE=2.916 RMSE=1.707 R2=0.0823	MAE=1.451 MASE=3.329 RMSE= 1.824 R2= 0.3089	X

From Table 8, it can be inferred that water level and pH are the most corelated parameters in the full phase analysis of the experiment as MAE=0.850. This means, with a given water level, we can predict the pH required for a good yield. The parameters that cannot be corelated are temperature and water level as the MAE=166.67, this means that the value of Water level cannot be predicted with a given temperature.

B. *Predictive Analysis of parameters using Support Vector Regression*

TABLE 9

Support Vector Regression Between Parameters for Initial Phase of Coriander Plant Growth

PARAMETER VS PARAMETER	PH	SUNLIGHT	HUMIDITY	TEMPERATURE	SOILMOISTURE	WATER LEVEL
PH	X	MAE=22.102 MASE= 2351.64 RMSE= 48.493 R2=- 0.0852	MAE=2.9432 MASE= 15.363 RMSE= 3.919 R2= 0.2227	MAE=0.82803 MASE=1.598 RMSE=1.2642 R2=0.0446	MAE=0.8812 MASE=1.423 RMSE=1.193 R2=- 0.174	MAE= 10.6116 MASE= 218.732 RMSE= 14.789 R2=- 0.0377
SUNLIGHT	MAE=0.3460 MASE= 0.227 RMSE= 0.4766 R2= - 0.0458	X	MAE= 2.836 MASE= 13.770 RMSE= 3.710 R2= 0.264	MAE= 0.518 MASE= 0.871 RMSE= 0.933 R2= 0.450	MAE=0.8686 MASE=1.362 RMSE= 1.167 R2=- 0.120	MAE=0.989 MASE= 1.627 RMSE= 1.275 R2=- 0.225
HUMIDITY	MAE=0.310 MASE= 0.174 RMSE= 0.417 R2=0.275	MAE=17.27 MASE= 1259.407 RMSE= 35.48 R2= 0.0078	X	MAE= 0.683 MASE= 0.825 RMSE=0.908 R2= 0.3423	MAE=0.833 MASE=1.378 RMSE=1.174 R2= -0.057	MAE=9.329 MASE=169.081 RMSE=13.0031 R2=0.0302
TEMPERATURE	MAE=0.396 MASE= 0.317 RMSE= 0.563 R2=0.00755	MAE=13.68 MASE= 1172.59 RMSE= 34.24 R2=0.2142	MAE=2.742 MASE= 11.737 RMSE= 3.425 R2=0.466	X	MAE=0.842 MASE=1.325 RMSE=1.151 R2=- 0.1810	MAE=7.9547 MASE=137.199 RMSE=11.713 R2=0.25006
SOILMOISTURE	MAE= 0.348 MASE= 0.199 RMSE= 0.4461 R2= = - 0.0110	MAE=20.962 MASE= 2052.051 RMSE= 45.299 R2=- 0.0695	MAE=3.7415 MASE= 23.297 RMSE= 4.8267 R2= - 0.0293	MAE=0.896 MASE=1.852 RMSE= 1.3611 R2=- 0.1329	X	MAE=8.9695 MASE=161.8012 RMSE= 12.7201 R2= - 0.00836
WATER LEVEL	MAE= 0.359 MASE= 0.2667 RMSE= 0.5165 R2=- 0.0788	MAE= 23.2524 MASE= 2417.059 RMSE= 49.1636 R2=0.0059	MAE= 2.9750 MASE= 16.440 RMSE= 4.05465 R2=0.02438	MAE=1.00006 MASE=2.70294 RMSE=1.6440 R2=0.1164	MAE=0.7492 MASE=1.0809 RMSE= 1.0396 R2= - 0.1662	X

From Table 9, it can be inferred that humidity and pH are the most corelated parameters in the initial phase of the experiment as MAE=0.310. This means, with a given humidity level, we can predict the pH required for a good yield. The parameters that cannot be corelated are water level and sunlight as the MAE=23.025, this means that the value of Water level cannot be predicted with a given luminous intensity.

TABLE 10

Support Vector Regression Between Parameters for Growing Phase of Coriander Plant Growth

PARAMETER VS PARAMETER	PH	SUNLIGHT	HUMIDITY	TEMPERATURE	SOILMOISTURE	WATER LEVEL
PH	X	MAE=17.013 MASE= 1014.28 RMSE= 31.84 R2=- 0.0743	MAE=3.8003 MASE= 25.36 RMSE= 5.0361 R2= 0.0470	MAE=0.995 MASE=2.330 RMSE=1.526 R2=0.1112	MAE=1.638 MASE=4.429 RMSE=2.104 R2=0.0109	MAE= 120.94. MASE= 24176.55 RMSE= 155.48 R2=0.026
SUNLIGHT	MAE=1.005 MASE = 4.719 RMSE = 2.172 R2= - 0.0719	X	MAE= 3.602 MASE= 23.974 RMSE= 4.896 R2= 0.1506	MAE= 0.802 MASE=1.444 RMSE=1.2019 R2=0.430	MAE=1.6199 MASE=4.0536 RMSE=2.013 R2=0.0220	MAE=139.698 MASE=29287.10 RMSE=171.134 R2=- 0.1414
HUMIDITY	MAE=0.822 MASE	MAE=17.210 MASE=	X	MAE=0.745 MASE=0	MAE=1.749 MASE=4	MAE=134.739

	=1.879 RMSE = 1.370 R2=-0.0892	1090.04 RMSE= 33.015 R2= 0.0421		.958 RMSE=0.979 R2= 0.7400	.602 RMSE=2.1453 R2=0.0295	MASE= 24557.95 RMSE=156.709 R2=-0.0675
TEMPERATURE	MAE=0.839 MASE=1.934 RMSE=1.391 R2=-0.0447	MAE=18.473 MASE=1451.83 RMSE=38.102 R2=0.1318	MAE=2.618 MASE=11.78 RMSE=3.43 R2=0.572	X	MAE=1.564 MASE=3.69 RMSE=1.922 R2=0.0255	MAE=139.68 MASE=26889.48 RMSE=163.980 R2=-0.00359
SOILMOISTURE	MAE=0.886 MASE=2.831 RMSE=1.682 R2= -0.037	MAE=18.183 MASE=1149.82 RMSE=33.909 R2=-0.0549	MAE=4.1329 MASE=30.32 RMSE=5.5065 R2=0.0070	MAE=1.1566 MASE=3.419 RMSE=1.84 R2=-0.0083	X	MAE=136.775 MASE=24782.89 RMSE=157.42 R2=0.0698
WATER LEVEL	MAE=0.5868 MASE=1.542 RMSE=1.241 R2=0.3133	MAE=17.654 MASE=1008.07 RMSE=31.750 R2=-0.04008	MAE=3.581 MASE=24.307 RMSE=4.930 R2=0.1196	MAE=1.176 MASE=3.361 RMSE=1.83 R2=0.0380	MAE=1.2847 MASE=2.611 RMSE=1.616 R2=0.368	X

From Table 10, it can be inferred that water level and pH are the most corelated parameters in the growth phase of the experiment as MAE=0.586. This means, with a given water level, we can predict the pH required for a good yield. The parameters that cannot be corelated are temperature and water level as the MAE=139.68, this means that the value of Water level cannot be predicted with a given temperature.

TABLE 11
Support Vector Regression Between Parameters for Harvesting Phase of Coriander Plant Growth

PARAMETER VS PARAMETER	PH	SUNLIGHT	HUMIDITY	TEMPERATURE	SOILMOISTURE	WATER LEVEL
PH	X	MAE=14.519 MASE=1121.40 RMSE=33.487 R2=-0.055	MAE=3.750 MASE=23.179 RMSE=4.814 R2=0.2572	MAE=0.8486 MASE=1.7209 RMSE=1.311 R2=0.0536	MAE=1.2121 MASE=2.518 RMSE=1.586 R2=0.0438	MAE=109.77 MASE=21901.17 RMSE=147.99 R2=-0.1792
SUNLIGHT	MAE=0.975 MASE=1.782 RMSE=1.334 R2=0.0502	X	MAE=3.642 MASE=23.84 RMSE=4.883 R2=0.2922	MAE=0.5587 MASE=0.9602 RMSE=0.979 R2=0.537	MAE=1.033 MASE=1.731 RMSE=1.315 R2=-0.109	MAE=110.02 MASE=21459.37 RMSE=146.49 R2=0.334
HUMIDITY	MAE=0.733 MASE=1.0997 RMSE=1.0487 R2=0.1170	MAE=15.693 MASE=1416.608 RMSE=37.637 R2=0.1004	X	MAE=0.6907 MASE=1.549 RMSE=1.244 R2=0.144	MAE=1.197 MASE=2.227 RMSE=1.492 R2=-0.087	MAE=112.208 MASE=21545.41 RMSE=146.783 R2=-0.1230
TEMPERATURE	MAE=0.848 MASE=1.307 RMSE=1.143 R2=-0.0404	MAE=7.830 MASE=209.74 RMSE=14.482 R2=0.491	MAE=2.654 MASE=13.02 RMSE=3.609 R2=0.3560	X	MAE=0.9160 MASE=1.190 RMSE=1.090 R2=-0.012	MAE=103.405 MASE=18617.395 RMSE=136.445 R2=-0.0513
SOILMOISTURE	MAE=0.908 MASE=1.576 RMSE=1.255 R2=0.0711	MAE=14.502 MASE=1074.906 RMSE=32.785 R2=-0.0437	MAE=4.892 MASE=38.307 RMSE=6.189 R2=0.0917	MAE=1.027 MASE=2.190 RMSE=1.480 R2=-0.0648	X	MAE=117.428 MASE=22258.28 RMSE=149.192 R2=0.1749
WATER LEVEL	MAE=0.868 MASE=2.479 RMSE=1.574 R2=0.069	MAE=13.670 MASE=525.301 RMSE=22.919 R2= -0.1050	MAE=3.9546 MASE=25.571 RMSE=5.056 R2=0.3047	MAE=0.785 MASE=1.084 RMSE=1.041 R2=-0.011	MAE=0.9191 MASE=1.329 RMSE=1.152 R2=0.298	X

From Table 11, it can be inferred that sunlight and temperature are the most corelated parameters in the harvesting phase of the experiment as MAE=0.558. This means, with a given luminous intensity, we can predict the temperature required for a good yield. The parameters that cannot be corelated are soil moisture and water level as the MAE=117.428, this means that the value of Water level cannot be predicted with a soil moisture.

TABLE 12
Support Vector Regression Between Parameters for Full Phase of Coriander Plant Growth

PARAMETER VS PARAMETER	PH	SUNLIGHT	HUMIDITY	TEMPERATURE	SOILMOISTURE	WATER LEVEL
PH	X	MAE=18.38 MASE=1347.984 RMSE=36.71 R2=-0.0432	MAE=3.538 MASE=22.984 RMSE=4.7942 R2=0.0380	MAE=1.002 MASE=2.368 RMSE=1.539 R2=0.189	MAE=1.506 MASE=3.971 RMSE=1.992 R2=0.1733	MAE=127.77. MASE=22839.3 RMSE=151.12 R2=0.288
SUNLIGHT	MAE=0.9430 MASE=2.927 RMSE=1.711 R2= -0.00975	X	MAE=3.621 MASE=23.651 RMSE=4.8632 R2=0.21463	MAE=1.111 MASE=2.539 RMSE=1.593 R2=0.3130	MAE=1.9406 MASE=5.305 RMSE=2.3033 R2=-0.0322	MAE=162.013 MASE=31499.0 RMSE=177.479 R2=0.0218
HUMIDITY	MAE=0.9039 MASE=1.6860 RMSE=1.298 R2=-0.0062	MAE=18.2066 MASE=1258.105 RMSE=35.469 R2=0.0738	X	MAE=0.974 MASE=1.814 RMSE=1.3470 R2=0.486	MAE=1.715 MASE=4.422 RMSE=2.102 R2=0.0019	MAE=161.61 MASE=30181.06 RMSE=173.72 R2=0.057
TEMPERATURE	MAE=0.898 MASE=2.785 RMSE=1.668 R2=0.0656	MAE=18.518 MASE=1583.68 RMSE=39.109 R2=0.115	MAE=2.86 MASE=13.61 RMSE=3.689 R2=0.4670	X	MAE=1.609 MASE=4.139 RMSE=2.034 R2=0.0995	MAE=136.567 MASE=26169.03 RMSE=161.76 R2=0.148
SOILMOISTURE	MAE=0.8068 MASE=1.744 RMSE=1.320 R2=0.0942	MAE=20.280 MASE=1555.81 RMSE=39.443 R2=-0.055	MAE=3.8521 MASE=27.5794 RMSE=5.251 R2=0.0213	MAE=1.179 MASE=3.128 RMSE=1.768 R2=0.0436	X	MAE=110.411 MASE=21951.64 RMSE=148.160 R2=0.312
WATER LEVEL	MAE=0.682 MASE=1.331 RMSE=1.153 R2=0.388	MAE=19.253 MASE=1462.55 RMSE=38.243 R2= -0.0474	MAE=3.608 MASE=25.069 RMSE=5.0069 R2=-0.00369	MAE=1.0911 MASE=2.591 RMSE=1.609 R2=0.1359	MAE=1.237 MASE=2.696 RMSE=1.642 R2=0.4985	X

From Table 12, it can be inferred that water level and pH are the most corelated parameters in the full phase analysis of the experiment as MAE=0.682. This means, with a given water level, we can predict the pH required for a good yield. The parameters that cannot be corelated are sunlight and water level as the MAE=162.013, this means that the value of Water level cannot be predicted with a given luminous intensity.

C. *Predictive Analysis of parameters using Decision Tree Regression*

TABLE 13

Decision Tree Regression Between Parameters for Initial Phase of Coriander Plant Growth

PARAMETER VS PARAMETER	PH	SUNLIGHT	HUMIDITY	TEMPERATURE	SOILMOISTURE	WATER LEVEL
PH	X	MAE=25.117 MASE=1570.68 RMSE=39.631 R2=-0.0493	MAE=3.4989 MASE=21.020 RMSE=4.584 R2=0.262	MAE=1.085 MASE=2.704 RMSE=1.644 R2=-0.415	MAE=0.952 MASE=1.3727 RMSE=1.171 R2=-0.1289	MAE=11.330 MASE=266.11 RMSE=16.312 R2=-0.303
SUNLIGHT	MAE=0.4213 MASE=0.329 RMSE=0.573 R2= -0.227	X	MAE=3.117 MASE=16.69 RMSE=4.085 R2=0.216	MAE=0.637 MASE=1.028 RMSE=1.014 R2=0.5450	MAE=1.126 MASE=2.266 RMSE=1.505 R2=-0.0655	MAE=0.996 MASE=1.558 RMSE=1.248 R2=-0.3035
HUMIDITY	MAE=0.408 MASE=0.292 RMSE=0.541 R2=-0.365	MAE=36.44 MASE=4653.88 RMSE=68.219 R2=-0.3042	X	MAE=0.9103 MASE=1.477 RMSE=1.215 R2=0.174	MAE=1.0399 MASE=2.304 RMSE=1.517 R2=-0.2165	MAE=11.833 MASE=332.31 RMSE=18.22 R2=-1.0522
TEMPERATURE	MAE=0.389 MASE=0.280 RMSE=0.529 R2=-0.0033	MAE=23.802 MASE=2150.406 RMSE=46.37 R2=0.322	MAE=2.903 MASE=11.880 RMSE=3.446 R2=0.410	X	MAE=1.1320 MASE=1.858 RMSE=1.363 R2=-0.433	MAE=8.271 MASE=122.69 RMSE=11.07 R2=0.303
SOILMOISTURE	MAE=0.406 MASE=0.294 RMSE=0.542 R2= = -0.0160	MAE=28.44 MASE=2407.91 RMSE=49.070 R2=-0.0055	MAE=3.018 MASE=16.75 RMSE=4.093 R2= -0.020	MAE=0.7735 MASE=1.104 RMSE=1.050 R2=-0.0059	X	MAE=11.341 MASE=217.46 RMSE=14.74 R2= -0.205
WATER LEVEL	MAE=0.334 MASE=0.218 RMSE=0.4672 R2=-0.129	MAE=21.03 MASE=1526.93 RMSE=39.075 R2=0.2402	MAE=3.323 MASE=18.834 RMSE=4.339 R2=0.05843	MAE=0.919 MASE=2.70294 RMSE=1.5006 R2=0.0072	MAE=1.0835 MASE=1.879 RMSE=1.3707 R2=-0.5531	X

From Table 13, it can be inferred that water level and pH are the most corelated parameters in the initial phase of the experiment as MAE=0.334. This means, with a given water level, we can predict the pH required for a good yield. The parameters that cannot be corelated are water level and humidity as the MAE=11.833, this means that the value of Water level cannot be predicted with a given humidity.

TABLE 14

Decision Tree Regression Between Parameters for Growing Phase of Coriander Plant Growth

PARAMETER VS PARAMETER	PH	SUNLIGHT	HUMIDITY	TEMPERATURE	SOILMOISTURE	WATER LEVEL
PH	X	MAE=23.487 MASE=1556.330 RMSE=39.450 R2=-0.133	MAE=4.4440 MASE=33.518 RMSE=5.789 R2= -0.066	MAE=1.067 MASE=2.294 RMSE=1.514 R2=0.0555	MAE=1.662 MASE=4.845 RMSE=2.201 R2=0.0173	MAE=86.23 MASE=14214.92 RMSE=119.22 R2=0.422
SUNLIGHT	MAE=1.210 MASE=5.287 RMSE=2.299 R2= -0.220	X	MAE=3.764 MASE=24.775 RMSE=4.977 R2=0.1022	MAE=0.902 MASE=2.036 RMSE=2.036 R2=0.3970	MAE=1.852 MASE=5.100 RMSE=2.258 R2=-0.126	MAE=140.63 MASE=28070.58 RMSE=167.54 R2=-0.131
HUMIDITY	MAE=1.085 MASE=2.475 RMSE = 1.57 R2=-0.264	MAE=19.74 MASE=1059.71 RMSE=32.55 R2= -0.2786	X	MAE=0.9107 MASE=1.569 RMSE=1.252 R2=0.438	MAE=1.816 MASE=5.153 RMSE=2.270 R2= -0.4041	MAE=142.944 MASE=32162.22 RMSE=179.338 R2=-0.161
TEMPERATURE	MAE=0.947 MASE=1.723 RMSE=1.312 R2=-0.142	MAE=15.279 MASE=791.16 RMSE=28.127 R2=0.2953	MAE=2.512 MASE=11.047 RMSE=3.323 R2=0.475	X	MAE=1.775 MASE=4.988 RMSE=2.233 R2=-0.105	MAE=134.80 MASE=25756.83 RMSE=160.48 R2=-0.010
SOILMOISTURE	MAE=1.0263 MASE=4.360 RMSE=2.088 R2= =-0.0082	MAE=21.63 MASE=1319.71 RMSE=36.32 R2=-0.0284	MAE=3.285 MASE=19.059 RMSE=4.365 R2= -0.0023	MAE=1.063 MASE=2.231 RMSE=1.493 R2=0.0132	X	MAE=121.68 MASE=22438.58 RMSE=149.79 R2=0.1508
WATER LEVEL	MAE=0.698 MASE=1.371 RMSE=1.171 R2=0.0499	MAE=22.549 MASE=1676.62 RMSE=40.94 R2=-0.261	MAE=3.063 MASE=20.044 RMSE=4.477 R2=0.2023	MAE=1.067 MASE=3.0071 RMSE=1.734 R2=0.09765	MAE=1.528 MASE=3.8184 RMSE=1.9540 R2=0.0723	X

From Table 14, it can be inferred that water level and pH are the most corelated parameters in the growth phase of the experiment as MAE=0.698. This means, with a given water level, we can predict the pH required for a good yield. The parameters that cannot be corelated are water level and humidity as the MAE=142.944, this means that the value of Water level cannot be predicted with a given humidity.

TABLE 15

Decision Tree Regression Between Parameters for Harvesting Phase of Coriander Plant Growth

PARAMETER VS PARAMETER	PH	SUNLIGHT	HUMIDITY	TEMPERATURE	SOILMOISTURE	WATER LEVEL
PH	X	MAE=22.732 MASE=2045.76 RMSE=45.230 R2=-0.0708	MAE=4.569 MASE=45.141 RMSE=6.718 R2= -0.4399	MAE=0.882 MASE=2.502 RMSE=1.581 R2=-0.225	MAE=1.471 MASE=4.134 RMSE=2.0333 R2=-0.8793	MAE=83.55 MASE=18340.29 RMSE=135.42 R2=-0.069
SUNLIGHT	MAE=1.146 MASE=2.743 RMSE=1.656 R2= -0.0261	X	MAE=3.395 MASE=21.554 RMSE=4.642 R2=0.414	MAE=0.6377 MASE=1.307 RMSE=1.143 R2=0.498	MAE=1.5740 MASE=3.8384 RMSE=1.959 R2=-0.453	MAE=129.51 MASE=25884.24 RMSE=160.885 R2=0.4367
HUMIDITY	MAE=1.062 MASE=2.186 RMSE=1.478 R2=-0.724	MAE=15.92 MASE=505.16 RMSE=22.47 R2=0.59	X	MAE=0.841 MASE=2.206 RMSE=1.485 R2= -0.262	MAE=1.522 MASE=3.722 RMSE=1.929 R2= -0.926	MAE=87.022 MASE=15484.1 RMSE=124.43 R2=0.135
TEMPERATURE	MAE=0.723 MASE=0.985 RMSE=0.992 R2=0.4802	MAE=7.183 MASE=198.86 RMSE=14.102 R2=0.787	MAE=3.359 MASE=23.251 RMSE=4.822 R2=0.342	X	MAE=1.123 MASE=1.954 RMSE=1.397 R2=-0.4325	MAE=93.27 MASE=15132.8 RMSE=123.01 R2=-0.0493
SOILMOISTURE	MAE=1.046 MASE=1.781 RMSE = 1.33 R2= = -0.018	MAE=28.62 MASE=2623.48 RMSE=51.220 R2=-0.0750	MAE=4.297 MASE=29.772 RMSE=5.456 R2= -0.190	MAE=1.060 MASE=1.905 RMSE=1.380 R2=-0.3879	X	MAE=117.64 MASE=22102.11 RMSE=148.66 R2= -0.1676
WATER LEVEL	MAE=0.7400 MASE=1.444 RMSE=1.201 R2=0.158	MAE=22.803 MASE=1843.464 RMSE=42.935 R2=-0.616	MAE=4.103 MASE=32.056 RMSE=5.661 R2=0.0454	MAE=1.0740 MASE=2.8656 RMSE=1.6928 R2=-0.9196	MAE=1.197 MASE=2.6819 RMSE=1.6376 R2=-0.33059	X

From Table 15, it can be inferred that sunlight and temperature are the most corelated parameters in the harvesting phase of the experiment as MAE=0.6377. This means, with a given temperature, we can predict the luminous intensity required for a good yield. The parameters that cannot be corelated are water level and sunlight as the MAE=129.51, this means that the value of Water level cannot be predicted with a given sunlight.

TABLE 16

Decision Tree Regression Between Parameters for Full Phase of Coriander Plant Growth

PARAMETER VS PARAMETER	PH	SUNLIGHT	HUMIDITY	TEMPERATURE	SOILMOISTURE	WATER LEVEL
PH	X	MAE=23.667 MASE=1574.28 RMSE=39.67 R2=-0.0871	MAE=3.77 MASE=26.197 RMSE=5.118 R2=0.0070	MAE=1.162 MASE=3.1117 RMSE=1.764 R2=0.0277	MAE=1.375 MASE=3.4744 RMSE=1.863 R2=0.2968	MAE=70.152 MASE=13362.83 RMSE=115.597 R2=0.589
SUNLIGHT	MAE=1.0190 MASE=2.469 RMSE=1.571 R2= -0.1476	X	MAE=3.674 MASE=22.97 RMSE=4.7930 R2=0.171	MAE=1.0661 MASE=2.232 RMSE=1.494 R2=0.2434	MAE=1.857 MASE=5.101 RMSE=2.258 R2=-0.155	MAE=163.11 MASE=34396.27 RMSE=185.46 R2=-0.0659
HUMIDITY	MAE=1.032 MASE=1.956 RMSE=1.398 R2=-0.219	MAE=22.217 MASE=1540.602 RMSE=39.250 R2=0.1037	X	MAE=0.961 MASE=1.620 RMSE=1.272 R2=0.3378	MAE=1.906 MASE=5.624 RMSE=2.371 R2= -0.1596	MAE=162.59 MASE=36533.3 RMSE=191.13 R2=-0.152
TEMPERATURE	MAE=0.911 MASE=1.703 RMSE=1.305 R2=0.11710	MAE=17.664 MASE=1005.81 RMSE=31.714 R2=0.0440	MAE=3.0675 MASE=16.238 RMSE=4.0296 R2=0.3001	X	MAE=1.650 MASE=4.224 RMSE=2.055 R2=0.0587	MAE=147.269 MASE=29019.5 RMSE=170.351 R2=0.1299
SOILMOISTURE	MAE=0.9751 MASE=2.7447 RMSE=1.656 R2=0.0873	MAE=20.854 MASE=1216.04 RMSE=34.87 R2=0.00587	MAE=3.995 MASE=28.318 RMSE=5.321 R2= -0.0553	MAE=1.0834 MASE=2.619 RMSE=1.618 R2=0.109	X	MAE=112.74 MASE=20885.92 RMSE=144.519 R2=0.3583
WATER LEVEL	MAE=0.706 MASE=1.328 RMSE=1.152 R2=0.210	MAE=23.019 MASE=1913.38 RMSE=43.74 R2=0.0553	MAE=3.665 MASE=25.972 RMSE=5.096 R2=0.0735	MAE=1.1366 MASE=3.302 RMSE=1.8172 R2=-0.2404	MAE=1.253 MASE=2.836 RMSE=1.684 R2=0.4258	X

From Table 16, it can be inferred that water level and pH are the most corelated parameters in the full phase analysis of the experiment as MAE=0.706. This means, with a given water level, we can predict the pH required for a good yield. The parameters that cannot be corelated are water level and sunlight as the MAE=163.11, this means that the value of Water level cannot be predicted with a given luminous intensity.

VII. CONCLUSION AND FUTURE WORKS

In conclusion, our whole work can be split into two main part. The first one being the growth of plants and creation of data set, in this we have grown the crops and taken the data with the help of sensors. In this aspect, there is minimal automation. The dataset is then created by taking the data and cleaning it to make sure that the anomalies are removed. With the help of this data set, we then move onto the second phase of the work. The second phase of this work is processing of the data set created and corelating the data to establish the best scenario for plant growth and good yield. With the help of Linear Regression, Support vector regression and Decision Tree Regression, we have established the parameters which are best corelated.

For the work that can be done to further the progress done by us is to fully automate the system. With the correlation achieved by us, the parameters can be used to know the ambient conditions required when a certain parameter is fixed and cannot be altered in any way possible especially in the city environment in countries like India.

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