**First Review**

**Predictive analysis of ambient conditions for crop growth using Internet Of Things**

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**Abstract:**

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, hydropic agriculture has risen in popularity and practice. It is a form of agriculture in which the plants are grown with restricted water supply. In 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*: Supervised Machine Learning Algorithms, Regression Models, Controlled Environment, Hydroponic, Urbanization**

**Introduction:**

Agriculture is the primary occupation in India and is the backbone of Indian economic system. Agriculture provides employment opportunities to rural people on a large scale in underdeveloped and developing countries in addition to providing food. It is the process of producing food, fibre and many other desired products by the cultivation and raising of domestic animals. Agriculture is the primary source of livelihood for about more than 58% 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. Irrigation system, rain fed agriculture, groundwater irrigation are some of the methods introduced to produce healthier crops which may not use water efficiently. In order to use water efficiently a smart system is designed. In the system farmers need not make the water flow into fields manually, but the system automatically does that efficiently.

The traditional methods practiced by people may result in huge wastage of water. Hence, the concept of robotized farming with a mix of IoT has been developed. The technological advancements began to increase the efficiency of production remarkably thus, making it a reliable system. The knowledge of properties of soil determines the water supply to be driven in a smart way. The practice of agriculture in a smart way helps to acquire knowledge of soil and temperature conditions. Developing the smart agriculture using IoT based systems not only increases the production but also avoids wastage of water

**Objective:**

The main objective of our work is to find and show the correlation between various parameters take into account while growing a crop through hydroponic agriculture and predict the range of parameters which result in the best growth of the crops.

**Problem Statement:**

In this fast paced world the population in metropolitan Cities is growing exponentially. This is due to both ecological factors and also migration into the cities because of urbanization  for a better lifestyle which is directly proportional to the rise in population density. With increasing urbanization and depleting natural resources, it is getting very difficult to satisfy the  very basic needs of the population. With cities expanding, Once agricultural land is now being made into real estate for development which in turn is leading to scarcity of staple foods.

This is the main reason why there is a rise in demand for hydropic and other forms of sustainable agriculture.

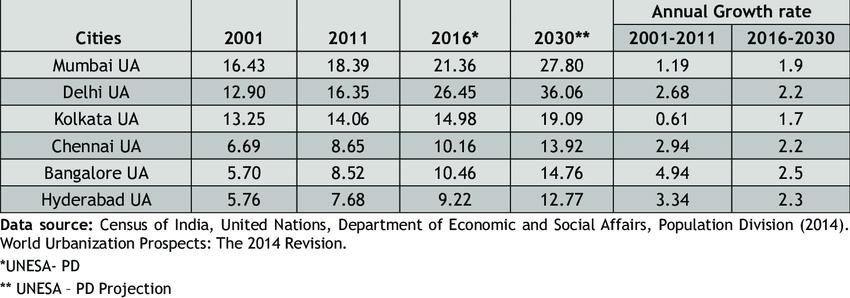


Figure : Exponential growth in metropolitan cities in India

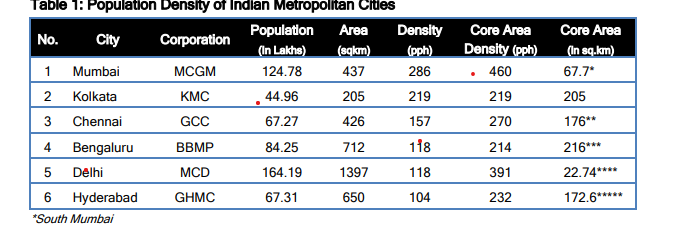


Figure :The population density in Indian metropolitan cities

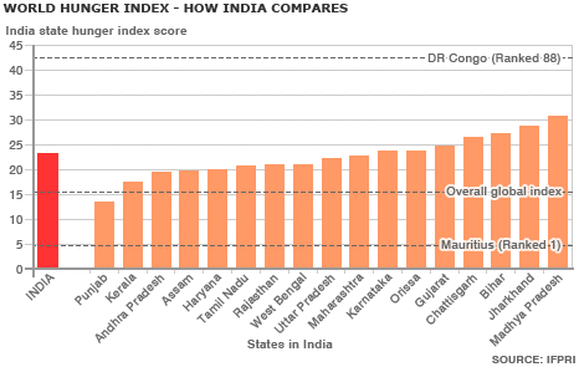


Figure :World Hunger Index in India

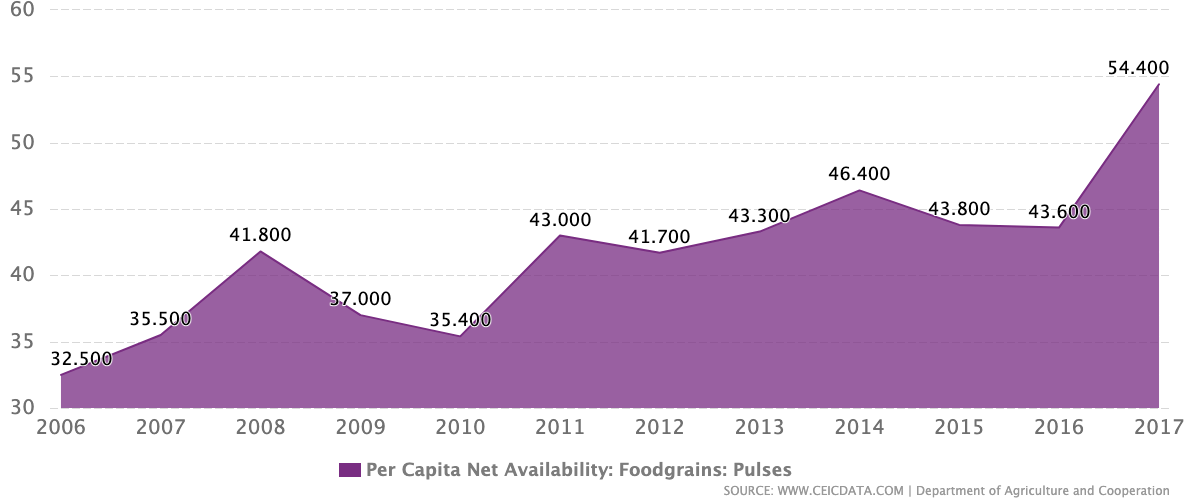


Figure :Per capita Net Availability in India

**Literature Survey**:

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| --- | --- | --- | --- | --- |
| S.No | Title | Authors | Methodologies Used | Drawbacks and Future Works |
| 1 | Data Acquisition and Actuation for Aquaponics using  IoT | Akhil Nicani, Sayantan Saha, Tushar Upadhyay, A. Ramya,  Maulin Tolia | 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. |
| 2 | An eye on hydroponics: The IoT initiative | Joshitha C,  P Kanakaraja,  Sarath Kumar,  Polavarapu Akanksha,  Guduru Satish | 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 |
| 3 | A Controlled Environment Agriculture with  Hydroponics: Variants, Parameters, Methodologies  and Challenges for Smart Farming | Srivani P,  Yammuna Devi C,  Manjula S H | The most innovative and peculiar aspect of this work is the growth of crops in an Controlled Environment Agricultural System(CEA) rather than the natural growth environment for the best growth.  Uses a four step architecture in which Sensor system, Data Processing System, Communication Device and Cloud Storage systems are used. | The major drawback of this work is the usage of CEA which stands for Controlled Environment Agriculture System.  Due to this, even though the work uses multiple regression models to predict the best conditions, it will not always give the best results as the criteria set are standard and always idealistic.  As it is set for Controlled environment, the power usage will be very high and can’t be implemented on a large scale. |
| 4 | Predictive models for Lettuce quality from Internet of  Things-based hydroponic farm. | Sethavidh Gertphol, Pariyanuj Chulaka,  Tanabut Changmai | This paper works on the growth of Lettuce in a controlled environment with the help of IoT, In a market where lettuce is not a commodity but a luxury. RMSE is one of the model used for model selection.  SVR, MLR and ANN are used for each weeks prediction.  They used SCIKIT in four steps, namely  Preparing Data and Normalising, Processing etc.. | 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. Finally, these flaws caused the model to fail to produce a good learning result. |
| 5 | A Study on IoT based Low-Cost Smart Kit  for Coconut Farm Management | S. Jaisankar, P.Nalini,  K. Krishna Rubigha | This work is concentrated on an innovative way to solve problem which is specific to Coconut farm owners.  A coco smart-kit is installed in every farm and it is linked to farmers smartphones.  It is a theoretical solution which helps in solving the following situations,  Safeguarding the coconut trees from wild animals,  Distribution of available water covering the fields,  Preventing the pests from coconut trees. | The main drawback of this work is the lack of experimentation, it is all in a theoretical stance so, scalability might be of major concern.  For this to work, every farmer must own a smartphone which is practically not possible as the farmers are not inclined towards technology.  For a total of 10 sensors, which include Fence alarm, Moisture sensor, Pest Sensor, Valve Control and GSM module, it costs Rs. 113.5 but in large scale, 10 sensors are not nearly enough to cover the whole field. With the help of generalising the coconut farm size in India, we would require around 1250 sensors which would cost around Rs 14000 for an Acer of Coconut farms which is not very cost effective. |
| 6 | A Survey on the Role of IoT in Agriculture for  the Implementation of Smart Farming | MUHAMMAD SHOAIB FAROOQ, SHAMYLA RIAZ, ADNAN ABID,  KAMRAN ABID, MUHAMMAD AZHAR NAEEM | As it is a Survey paper, it takes a closer look at various paper and gives us an idea on various uses of IoT in agriculture across the globe.  It talks about various agricultural Challenges such as the Hardware Challenges, Networking Challenges and the Networking Challenges.  Also discussed about various agricultural Security treats with IoT such as Confidentiality, Integrity, Authentication, Data freshness, Non repudiation, Authorisations, self-healing etc. along with Stack Challenges, Threat Models, Attack Taxonomy  And so on | As the work is a literature Survey, there are no drawbacks per say |
| 7 | IoT Based Smart Farming: Are the LPWAN  Technologies Suitable for Remote Communication? | Nahina Islam,  Biplob Ray,  Faezeh Pasandideh | This work emphasises 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. |
| 8 | IoT for Smart Farm: A Case Study of the Fertilizer  Mixer Prototype | Sumarn Chaikhamwang,  Chalida Janthajirakowit,  Srinuan Fongmanee | The main research output of the work is to develop an application with the help of IoT to Control the fertilizer mixer. The work is split into two parts, being the hardware part which uses ESP32S platform for controlling devices and controlling applications and the software aspect helps the user to chose the right mixture of N-P-K by setting the required ratios of N,P and K. | The main drawbacks of this work are, when selecting the NPK values for the mixture, there is no option to shut off the process midway so, a shutoff valve can be implemented.  The prototype made uses high grade plastic as it doesn’t react with the chemicals but Non-reactive metals can be used for durability.  Lastly, the sensors used, are giving an output with less precession than the optimal so, high precession sensors can be used. |
| 9 | Low-cost IoT+ML design for smart farming with multiple  applications | Fahad K Sayed,  Agniswar Paul,  Ajay Kumar,  Jaideep Cherukuri | 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. | 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.  While maintaining the soil moisture levels, the weather condition is not taken into account because of which plant growth is affected in a adverse way. |

**Conclusion:**

In the current stage of our project we have implemented a hydroponic system to cultivate coriander crop where we are collecting data parameters such as ph value, temperature, humidity, soil moisture, and water level in the system. We are planning to collect data till the plant reaches its full growth and we will be analysing the trends in data using regression model and data analysis. After analysing the data we will be able to implement a prototype that can help people grow crops in cities through automation and improve more cultivation in urban areas. Hydroponic systems are going to become the future of agriculture in urban areas and help farmers to reduce the burden to provide food to urban regions.

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SUPPORT VECTOR REGRESSION(<https://half-nymphea-870.notion.site/Support-Vector-Regression-1319c8ef470b48f0990dc9ecbd64ae6e>)

Initial Phase

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **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 |

Growing Phase

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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=1.879 RMSE= 1.370 R2=-0.0892 | MAE=17.210 MASE=1090.04 RMSE=33.015 R2= 0.0421 | X | MAE=0.745 MASE=0.958 RMSE=0.979 R2= 0.7400 | MAE=1.749 MASE=4.602 RMSE=2.1453 R2=0.0295 | MAE=134.739  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 |

Harvesting Phase

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| --- | --- | --- | --- | --- | --- | --- |
| 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 |

Full Data

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| --- | --- | --- | --- | --- | --- | --- |
| 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 |

Decision Tree Regression(<https://half-nymphea-870.notion.site/Random-Forest-Regression-62ec7ded524e4e0cbb1cd8f2e2fd3bac>)

Initial Phase

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| 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 |

Growing Phase

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| 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 |

Harvesting Phase

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| 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=1.00740 MASE=2.8656 RMSE=1.6928 R2=-0.9196 | MAE=1.197 MASE=2.6819 RMSE=1.6376 R2= -0.33059 | X |

Full Data analysis

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| 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 |