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E_Farming-Effective Yield Production Incorporating Cloud Computing with Vertical Farming in Agriculture

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***Abstract*— India is a country in which agriculture plays an important role in enhancing the country's GDP rate and enriching the country's pride. The agricultural yield produced from urban areas are nearly zero. In today's world, many high rise buildings are constructed in cities. It is impossible to do an agriculture in these areas. Hence it is a time to emphasize something innovative towards agriculture. Vertical farming is a new concept, which will help raise production without occupying much space. If a building stood on a five-hectare plot of land, it would result in production from (five*height of the building) hectare of land. Here we have focused on introducing latest technologies to agriculture that is ICT based agriculture. This proposed model is constructed with the integration of vertical farming and cloud computing under the controlled environment and thus the crop growth can be closely monitored and examined. The values from which are directly uploaded to the cloud. A report on the growth rate will also be sent to the mail id of the particular person. This helps us to enhance the crop production particularly in urban areas. In general the contribution of revenue from agriculture to the country is predominantly from villages only, hence if vertical farming is being implemented, the contribution to country with regarding will give a very great impact.**

***Keywords*— Vertical farming, Cloud computing, analytics.**

I. INTRODUCTION

Agriculture has always been a part of human life since pre-historic times. Since technology has always helped in lessening the work of every other sector, it is important to adapt the process of cultivating crops in vertically stacked layers and / or integrated to other structures. This follows CEA technology that is all the crop cultivation process is performed under controlled environment. The main idea behind Vertical farming is to encourage farming in cities. Practicing vertical farming in cities needs high-rise buildings. By the year 2050, nearly 80% of the population will shift towards urban centres [2]. The human population will Increase by about 3 billion people during the period. At present, throughout the world, over 80% of the land that is suitable for raising crops is in use (sources: FAO and NASA). Historically, some 15% of that has been laid waste by poor management practices.

Hydroponics is the process of using solution that contains nutrients and minerals that is important for the plant's growth. This procedure is found to be highly effective as the yield value is extremely high when compared to the conventional methods. At the same time the water usage is found to be three times lesser than the conventional methods.[12] Cloud Computing refers to both the applications delivered as services over the Internet and the hardware and software in the data centres that provide those services. The services themselves have long been referred to as Software as a Service (SaaS). The data centre hardware and software is what we will call a Cloud. When a Cloud is made available in a pay-as-you-go manner to the general public, we call it a Public Cloud; the service being sold is Utility Computing. We use the term Private Cloud to refer to internal data centres of a business or other organization, not made available to the general public. Thus, Cloud Computing is the sum of SaaS and Utility Computing, but does not include Private Clouds. People can be users or providers of SaaS, or users or providers of Utility Computing. We focus on SaaS Providers (Cloud Users) and Cloud Providers, which have received less attention than SaaS Users or providers of Utility Computing. Cloud provide SQL Database Such as PostgreSQL, NuoDB, Oracle

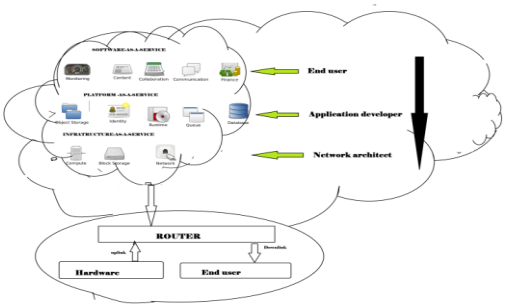

Figure1: Services in cloud computing

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Database, Microsoft SOL Server, Maria DB and My SQL instance. For it is very safe and secure to store data in cloud. And at the same time, multiple servers can access the data from anywhere using cloud. Furthermore mongo dB is more expensive so we take up cloud computing in vertical farming. The one other added advantage is that in Google Cloud Platform we needn't pay for the data that we store instead we only pay for the services that The process of collecting useful information from a large database is called as Data Mining. The advantages of using Big Data solutions when compared to other data mining [1] tools is that we can directly import data from Google cloud and above all it uses SQL to query the data thus making the analysis easier. The access to which can also be further restricted to certain people. The best advantage is that it can be accessed anywhere anytime. Clustering can be said as identification of similar classes of objects [6]. By using clustering techniques we can further identify dense and sparse regions in object space and can discover overall distribution pattern and correlations among data attributes.

II. Methodology

Implementation Of Vertical Farming: The new farming technique envisages production of crops hydroponically (nutrient-enriched water) or aeroponically (nutrient-enriched air), or aquaponically (waste from farmed fishes used as nutrients in hydroponics) without using soil. In order to practice this vertical farming the basic requirement is a high-rise building [8]. Instead of having a high-rise building for crop production a commercial space is always preferred.

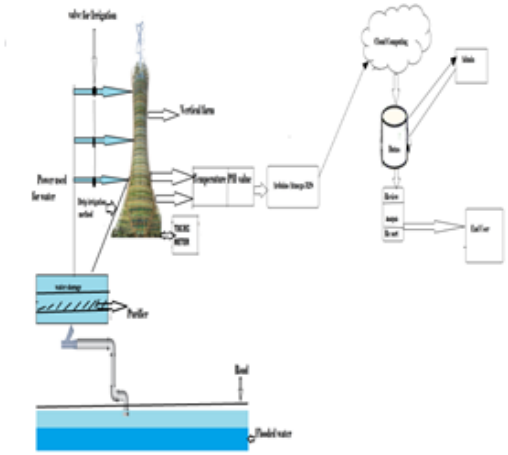
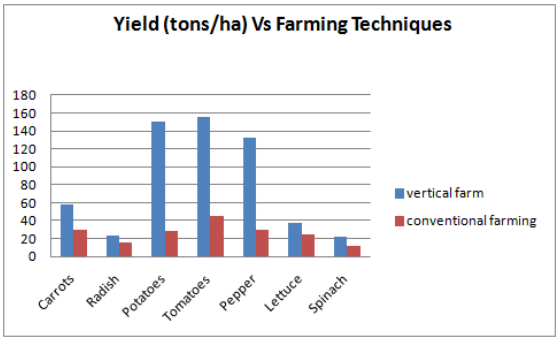


Figure 2 The full process flow diagram

The basic idea is to use these commercial high rise buildings are to multi-purpose with vertical farming so that both the needs are tended. The process of hydroponics is practiced here wherein the plants are submerged in the nutrient solution, which is frequently monitored and circulated to ensure that the correct chemical composition is maintained. [13]In this proposed system of vertical farming holes of 5cm diameter are pierced in the PVC pipes at equal distances. The dimension of the PVC pipes is that it is of 6 inch diameter and the length of the pipe is comparable to the length of the building.[9]As the PVC pipe is going to be wound around the building its inclination should also be considered. Each row is cultivated with different type of crops and mineral nutrient solution is filled all over the pipes. Generally hydroponics doesn't require excessive water consumption that is it uses only 10% of the water that is used in conventional techniques. [12]A water management system is used wherein the water is stored in a concrete storage tank. The rain water harvesting technique is followed that is the rainwater that gets collected all around the building is directly sent to the tank [11] .Apart from these techniques the water that gets stagnated in the nearby road is sucked in with the help of a pipe and this black water is sent

To a treatment plant to cleanse it and sent to the water storage enclosure. This stored water is fed to the crops present in each row with the help of tubes connected to a valve. Solar cells are used to provide power to suck the water from the tank and send it to pipes connecting each row. The amount of water that is to be sent to each crop is calculated and sent via the pipe that connects to the crops by turning the valve accordingly [4].

The TDP/EC meter is connected to an alarm that rings whenever the nutrient value is low. Thereby alerting the user to replace the solution immediately.



The graph above is a comparative study between the conventional farming techniques over vertical farming. This study clearly gives us knowledge on the yield value for various crops from both the farming techniques [14].

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It is understood that vertical farming gives an exuberantly high value of yield (in tons/ha) when compared with the prototypical types. By reusing the production space of the crops in vertical stack layer the yield rate gets tremendous increment. Considering the case of potatoes and tomatoes the yield value has shot the skies. About 84% and 78% increase has been found respectively. Thus considering the yield value as one of the parameters of efficiency vertical farming proves to be the best.

III. Cloud Computing And Analysis

The data such as temperature, and pH will be uploaded to the cloud with the help of these respective sensors. These sensors are connected to an Arduino Atmega328 which uploads the data to the cloud every day at a particular set time. The yield amount of each crop along with the ideal yield value of that crop is stored in the cloud database [3]. This is then followed by the analysis procedure.

The analysis is performed as follows:

1. The variation in the yield for the following time period can be calculated that is 3months, 6months and 1 year.
   1a. From this the maximum crop yield and the minimum crop yield can be calculated. Maximising strategies for the crops with minimum yield can also be studied.
2. The comparison between the ideal yield rates of a crop to the existing yield rate can be obtained.
3. If there is any drastic or irregular variation in the crop yield it can be studied.

Growth Rate Formula:

Final yield value-Initial yield value/Initial yield value.

The growth rate analysis is similar to that of Yield analysis [10].

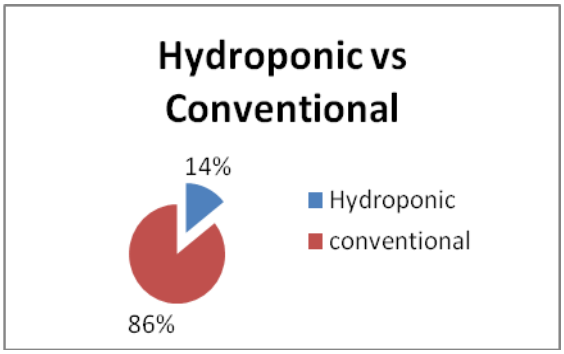
Once these analyses are made a report is created and sent to the farmer to his email id just before the harvest.

If the nutrient present in the solution is low it will alert the particular person to alter the solution accordingly.

IV. Precationary Measure

The maintenance procedure is very simple. Whenever there is a low nutrient content in the hydroponic solution then the TDS/EC meter will indicate it with the help of an alarm. In case the TDS/EC meter is malfunctions we have an estimated lifetime of the solution, if in case the alarm doesn't ring user will get to know the system failure. The malfunctioning of Arduino and other sensors can be easily found. Whenever the Arduino or other sensor fail to update the values to the cloud at the particular time in everyday. The malfunctioning of the hardware's can be identified.

There is a suction tube attached to the PVC pipe in order to obtain the solution after its usage. The energy required for both irrigation and suction is obtained from the solar cells if there is a system failure in the solar power an automatic battery system will start functioning.



Water consumption between the hydroponic and conventional production of lettuce in Arizona was comparable on an area basis[12].

V. Algorithm Of Vertical Farming

Step 1: PVC pipes with specified dimension are built in such a way that they are wound around the high-rise building.

Step 2: These PVC pipes are filled with a nutrient solution.

Step 3: The respective crops that grow efficiently in these solutions are sown.

Step 4: The pH sensor and temperature sensors are fixed in these PVC pipes along with tdc and ec meter.

Step 5: A water management system is exercised in such a way that, the rainwater which flows in and around the building will get collected in the storage tank.

VI. Conclusion

As engineers it is our sole responsibility to enhance the society's growth. Agriculture has a pressing need for it to be practiced in cities. Our efforts towards incorporating these ideas have resulted towards this model to practice agriculture in cities and help them feed themselves.

In large cities a high rise buildings are always preferred either for commercial or realty utilities. A vertical farm can be installed around these buildings so that all the needs are being tended to. All the resources such as water and power are optimally used sans soil. The yield from this type of crop production is found to be much higher than the conventional methods.

The one other major usage of this system is that all the data with respect to the crops that are collected are thoroughly analysed to provide useful results to the farmer. In order to help him improve his strategies. Thus cloud computing and analytics together help in providing better Strategies in the field of crop production.

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