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# A Smart Structure For Environmental Sustainability In Rose Fields

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**Abstract**

Indian floriculture industry has enhanced by multiple folds in the past decade and has grown to become one of the top ten leading producers of varieties of flower production. This tremendous growth of floriculture industry has proportionally attributed to the depletion of environmental system. The current work narrows down to handle the environmental hazards of rose farming in the floriculture industry through technology-driven fertilization process. The composition and quantity of nutrients, and the period of its application is very crucial for the plant's growth. The smart fertigation process helps in providing a balanced nutrient dose to the plants. The internet of things (IoT) is defined as a network of physical objects called as "things" that have embedded with sensors and software that allow these objects to communicate with each other. These objects are accessed, monitored and controlled remotely. While the reduction of one of the nutrients might result in poor development of the plant, overfeeding of nutrients leads of stagnation of salts and soil wilting. The paper proposes a smart IoT-based fertilizer application infrastructure for an optimal growth of plants with under a controlled usage of fertilizers. The dependency of fertilizers and insecticides during each stage of the plant development is monitored and a smart fertigation infrastructure is built to automate the process of feeding the plants with appropriate chemicals at appropriate intervals.

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## Introduction

Agriculture has been the backbone of our country. India is a country bestowed with various climatic zones to suit various agricultural practices. Indian floriculture industry has grown by multiple folds in the past decade and has become one of the top ten leading producers of varieties of flowers including rose, tuberose, anthurium, marigold etc in the world. The urbanization and the improved social outlook in the country have also added to the demand for flower production. On the other hand, the tremendous growth of floriculture industry has proportionally contributed to the depletion of environmental system. Therefore, technological

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invasions had to be encouraged and implemented to improve the quality of farming and farming community. While the technological innovations and enhancements has crept in to the agricultural sector, there is an immediate requirement for bridging the growing gap between farmers and the technological interventions. The internet era has been conceptualized to integrate high automation and digitization of real-time data. For example, the technological revolution in the form of industry 4.0 can be a major driver of innovation in agricultural sector. Real-time integrating in agriculture can optimize the consumption of natural resources. The agricultural sector is facing the threat of shortage of natural resources. The agricultural practices had led to the environmental devastation. The technologies are expected to improve on adaptability, resource efficiency and integration of supply and demand processes. The paper contributes to mitigate the effects on chemicals on the environmental structure. The floriculture depends on application of fertilizers and chemicals to thwart the infection in plants and to promote the rapid growth of the plants. The paper proposes a design where the plants are diagnosed for any abnormalities in the plant structure or the environment. On diagnosis, the farmer owners are alerted on the abnormalities. Furthermore, the system also checks for the nutrient deficiency in the soil and plant and treats them with the required nutrient immediately.

**Background Study**

The last decade has witnessed novel agricultural practices such as vertical farming, hydroponics, modern greenhouses, to name a few. These practices have induced huge technological investment on automation and robotics, artificial intelligence and blockchain etc. Rose is hailed to be the queen of flowers not only owing to its beauty and fragrance but also due to its medicinal benefits. The ideal temperature and the soil conditions of the country have added to the potential growth of the industry attracting a considerable figure of small and marginal farmers. It has also gained insight among the self-employed as a profitable source of income. With emphasis getting shifted from the traditional flowers to cut flowers the rose farming has been identified as a profitable agricultural produce with a massive commercial outreach. The demand for cut flowers has visualized a tremendous increase after the commercial floricultural industry boomed to become one of the largest export-oriented business in the country. On the other hand, this aggressive growth of the rose cultivation has been witnessing an alarming source of concern over its negative impact on the environmental factors.

**Literature Review**

The study of the aggressive growth of the rose cultivation has led to various alarming sources of concern over its negative impact on the environmental factors. The pesticides that are applied as powders and/or sprayed to the plants become airborne dusts and mists that tend to be inhaled by the farmers or animals in the farm. Most of these formulations contain volatile solvents that can evaporate and form hazardous vapor. In order to avoid the harmful effects of these pesticides the farmers rely on appropriate Personal Protective Equipments (PPE) such as water proof hat, gloves, goggle, respirator, rubber boots, high-visibility clothing when handling these pesticides. Tadeli Yeshiwas,[1] discusses in detail on the environmental issues pertaining to floriculture. The author also establishes the effects of the chemicals on the health of farming community.

Mythili *et al*[2] proposed a messaging service with Arduino UNO for farmers where a farmer is updated with the climatic conditions at frequent intervals. The work also communicates the soil condition such as moisture content to the farmers.

Kalp Patel *et al*[3] proposes an environmentally sustainable system in aquaponics farming. The design utilises the benefit of real-time data with multiple various sensors that communicate over the internet to provide the live status of the farm to the farm holders. The design adopts with NodeMCU as the communicator and aggregator of sensor data which is delivered to a web server.

Rajeev Raut, *et al*[4] works on automating the irrigation process using sensors to sense the change in the temperature and humidity. Moreover, the N, P, and K amounts in the soil sample are determined as high, medium or low without manual intervention. These functionalities are notified to the user by e-mail sent by the system PC using Internet of Things.

Omar Mohammed Elhassan *et al*[5] in his product design uses moisture sensor to achieve and control Water Use Efficiency (WUE). The design assures

retainability of adequate soil moisture by enabling irrigation when the moisture drops below 30% is opened and disabled when the moisture reaches 70% (pre-set data according to plant needs). The design further control the fertilization of plants by monitoring the alkalinity and acidity of the soil.

Sachin B. Jadav *et al*[9] has proposed a CNN-based identification method to identify the diseases in a soybean plantation. The model identifies three soybean diseases after comparing with the healthy leaves. With a rich dataset of 1200 plants to process and distinguish between the healthy and infected leaf using feature extraction and classification models.

**Research Methodology**

The futuristic technologies ranging from drones to robotics has modified the outlook of conventional agriculture. The modern practices addressed issues of increasing global population at the cost of environmental depletion. The environmental impact of rose plantation has been the extensive use of natural resources. The inappropriate usage of chemicals had been considerably polluting the basic natural resources such as air, water and soil. Since the fertilizers and pesticides applied are easy to be washed off they enter the soil and water bodies. There are more probable ways that these chemicals leech in to the soil contaminating the underground water. The rich usage of nutrients leads to eutrophication where these excess nutrients washed off from the rose fields lead to an enormous growth of unwanted plants. Furthermore, the polluted environment is lethal to human beings and animals. Air pollution is another main concern due to the intensive use of pesticides. Only 0.1% of pesticides attain the intended goal whereas 99% of them turn out to be air pollutant poisoning the atmospheric air and leading to global warming. The intensive use of natural resources, hazardous management of fertilizers, and irresponsible disposal system of waste products few of the many reasons for the environmental impact.

The study on the production costs incurred by the rose farmers highlighted the significance of chemicals in rose production. The farmers expressed that the major share of the production cost is incurred on the fertilizers and plant chemicals. The production cost of rose cultivation was calibrated and shown in Table-1. But there was no visible technological contribution to control the pest and improve the production of roses. The table manifests the cost significance of the chemicals on the growth of plants.

**Table 1: Cost significance of chemicals**

| S.No | Categories | Cost Percentage Incurred |
|---|---|---|
| 1. | Cost of fertilizers | 17% |
| 2. | Cost towards Pest Control or plant diseases | 15% |
| 3. | Cost towards plant protection chemicals | 08% |
| 5. | Cost towards disease control | 30% |
| 6. | Other expenses | 60% |

Depletion of ground water levels has been another challenging factor to the farming industry. The drip irrigation system has been broadly implemented for effective usage of water sources. The chemicals for the plants are also infused through the drip pipes at regular intervals. Therefore, the technology for a controlled chemical infusion required to be incorporated in the drip irrigation mechanism. The fertigation is a method of injecting fertilizers required for a plant growth directly into the drip irrigation system. The fertigation process helps in equal distribution of water and the fertilizers. The composition and quantity of nutrients, and the period of its application is very crucial for the plant's growth. The smart fertigation process helps in providing a balanced nutrient dose to the plants. A technology for fertilizer application infrastructure based on Internet of Things (IoT) can be implemented for an optimal growth of plants under a controlled usage of fertilizers. With the prevailing conditions of soil, its properties such as pH and soil chemistry ion are determined. The procedure of soil testing is initiated

by collecting field samples. Based on these findings, recommendations for fertilizer are collected through recommendations by the authorized personnel.

The current work narrows down to handle the environmental hazards of rose farming in the floriculture industry through technology-driven fertilization process. According to Floristry and Floriculture Industry Statistics & Trends (2020), "The worldwide market for Flower and Ornamental Plants (those that are grown for the primary purpose of being solid as cut flowers, houseplants and in landscape design) is expected to grow roughly 6.3% over the next five years, reaching $57.4 Billion USD in 2024, up from $42.4 Billion USD in 2019". The Rose has been identified as a timeless symbol of love and romance throughout the year in addition to serving as a filler or compliment in mixed-stem arrangements for numerous gifting occasions.

Detecting and treating diseases in plants is very crucial in floriculture. Any infection in the plant affects the flowers immediately. Since the flowers form the significant part of the plant the effect of the disease invasion affects the growers. Henceforth, the farmers usually apply fertilisers to the entire area even if the infected region is smaller polluting the entire region. The proposed design helps to detect the disease in each plant and treat each plant immediately before the infection spreads out to the other plants. Since the rose plantation spreads to larger areas the chemicals are required in large quantities which adds to the cost overhead.

**Design Proposal**

The technology-based fertilizer application infrastructure has been designed for an optimal growth of plants under a controlled usage of fertilizers. The work studies the development stages of the plants and their flowering patterns and the associated environmental factors. The dependency of fertilizers and insecticides during each stage of the plant development is monitored and a smart fertigation infrastructure is built to automate the process of feeding the plants with appropriate chemicals at appropriate intervals.

The design emphasizes on environmental sustainability by a smarter way of fertilization and pest management techniques in rose cultivation. The technology has been developed to observe the direct and indirect impact of the aggressive growth of rose farming on the environmental factors.

It assures fertigation through reduced intervals of fertilization and a reduced consumption of water with an automated fertigation system based on the internet of things (IoT). A smarter fertigation helps in providing a balanced nutrient dose to the plants. The sustainability of the system proposed assures optimal utilization of resources such as water, soil and nutrients. The soil constitutes the Nitrogen, Phosphorous and Potassium as its main nutrients. These components determine the fertility of a soil. The extensive use of rose plants exhausts these nutrients and had to be supplied as fertilizers. A balanced nutrition is crucial for the growth of a plant and quality of flower yield. While the reduction of one of the nutrients might result in poor development of the plant, overfeeding of nutrients leads of stagnation of salts and soil wilting. The crop response to fertilizers varies with its type and mode of application.

**Technology for Building a Smart Fertigation System**

The internet of things (IoT) is defined as a network of physical objects called as "things" that have embedded with sensors and software that allow these objects to communicate with each other. Moreover, the IoT allows these objects to be remotely accessed allowing remote monitoring and controlling. Muhammad Shoaib Farooq *et al*[6] discusses on the various applications of IoT in agriculture such as are Precision Farming, Livestock, and Greenhouses etc. The author indicates on the implications of latest technology such as IoT-based sensors with cloud-based data in managing and decision-making strategies.

The paper proposes a SMART IOT-based fertilizer application infrastructure for an optimal growth of plants with under a controlled usage of fertilizers. The model assures fertigation through reduced intervals of fertilization and a reduced consumption of water. A smarter fertigation helps in providing a balanced nutrient dose to the plants. The sustainability of the system proposed assures optimal utilization of resources such as water, soil and nutrients.

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The architecture of the sensor technology in to the farming is shown in figure 1. The initial process is to test the moisture, temperature and PH of the soil by the SMART Basic sensor unit and will deliver a command to the IOT gateway master unit in response will trigger a SMART actuator unit to supply the enough water by the dispenser pump to the landside.

The SMART analyser unit as two parts, the first part one will sample the soil which capture a image by an HD camera and manipulates the present soil status will compare with the data sets which thought to the system by machine learning. and will produce a consolidated result to the IOT gateway master unit and save it as data point 1.

The second part will sample the plant growth status by capture a image by an HD camera of the plant and manipulates the present plant status will compare with the data sets which thought to the system by machine learning, and will produce a consolidated result to the IOT gateway master unit and save it as data point-2.

Based on the two data points the IOT gateway master unit find the best solution and composite fertilizer required for the plant and soil, in turn will trigger a SMART actuator unit to supply the required fertilizer by the dispenser pump to the landside.

The IOT Gateway master will update the entire system and event status to the user by the way of SMS and by electronic mail.The system also provides a stackable feature for maintaining multi-location farms in a centralized web page which can be utilised at later stages of the development of an IOT SMART Farming project.

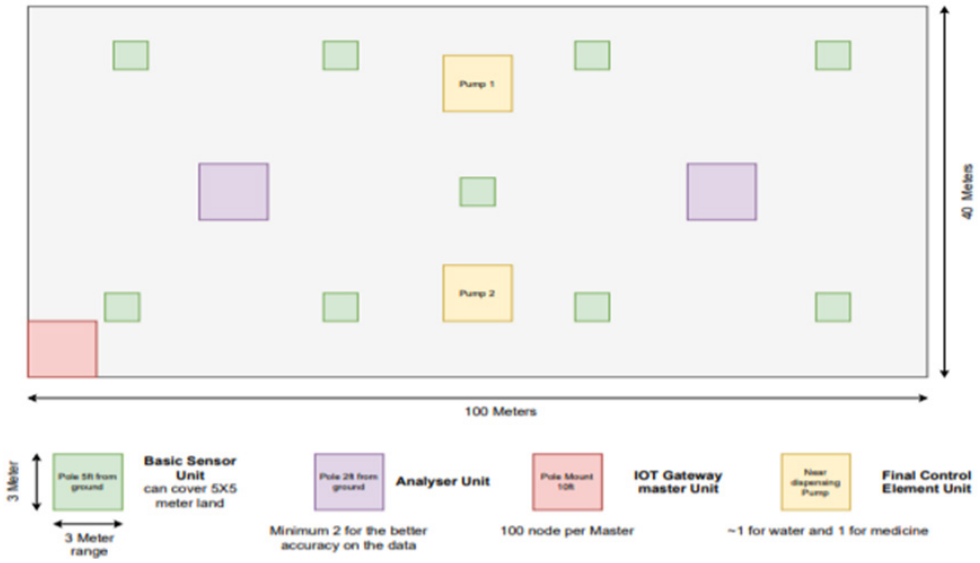


**Figure 1**

Roses being huge feeders, they require optimal amount of nitrogen, phosphorous and potassium (NPK) as plant nutrients. The Nitrogen aids in chlorophyll formation for vegetative growth and Phosphorous helps in seedling growth and stimulate growth of flowers. Potassium increase strength in stem, drought and disease resistance, it has direct role in quality constituent.[7] The model uses NPK sensors to read the respective quantity available in the soil. The audrino device transmits the observed

readings to the raspberry pi device which in turn compares with the pre-recorded dataset and notifies the grower if the quantity is abnormal using the GSM module. Identification of plant diseases is done through the installed pi cameras. The camera is used to captures and saves the images of the leaves. The model implements the Convolutional Neural Network (CNN) algorithm.The term convolutional network (CNN) is an architecture for applying neural networks in two-dimensional images based on spatially localized neural input.[8] The CNN model is built with datasets of different leaves of rose plants. The captured image is transmitted to the CNN model to compare with the stored dataset. The image processing technique allow us to map the image with the prestored dataset and analyse the health of the leaf. The model helps to identify the abnormalities and nutrient deficiency and notify to the grower. The entire model is built to function without or lesser human interaction. The model monitors the entire farming region and automatically enables the spindle taps connecting the fertilisers to the drip system. The grower is also notified on the prevailing growing conditions.

**Results and Discussion**

The technological intervention into the floriculture farming system assures better scope of increase in the productivity. An application of 400:200:200 ppm of NPK/plant/week is advised for rose plants. Regular and appropriate application of the NPK fertiliser using the proposed model increased both the number of flowers produced and the weight of each flower. The study was conducted in an area of 0.25 acre. The results observed has been represented in the table-2.

**Table 2: Observations**

| | **manual process** | **proposed system** |
|---|---|---|
| No. of flowers produced under the proposed system | 80 flowers/$m^2$ | 100 flowers/$m^2$ |
| Weight of flowers in manual process | 380 gms/$m^2$ | 400 gms/$m^2$ |
| Water Consumption | Not optimised | Optimised with the moisture sensors |
| Cost of fertilizers (application of n,p,k) | 17%* of total production cost | Reduced to 14% |

* - oral discussion with the farming community

The implementation also showed a decrease in the wastage of chemicals due to manual mishandling and spillages. The increase in production and profit can improve the living conditions of the farming community. The discussion with the farmersshowed their enthusiasm to learn and adapt to modern technologies. With more demand for the commercial crops the farming community is looking forward for new horizons of productivity in agriculture. With the advent of enthusiastic younger generation into farming, the technology-based farming would pave for more quality controlled and environmental friendly agricultural system. There are few technological interventions such as IoT sensing, remote sensing techniques which assist the farmers with digitizing the conventional farming practices. These digitization processes save the human efforts and also the natural resources. Planning farming operations has also revolutionized with new technological advents. For example, the logistical data of the health of the crops, weather patterns, revenue versus expense etc can be utilized to strategize more comprehensive plans to manage agro-business in the future. These approached can be used to plan the layout of a new facility for optimal performance.Integration of technology with the traditional farming ethics is certain to create ripples and out-reaching consequences throughout the world.

**Conclusion**

IoT assures creating a world where all the objects around are connected to enable communication among themselves with minimal human intervention.[11]

With the introduction of newer seed varieties, new methods of agriculture, and the use of efficient fertilizers, crop production has increased. But without

using the smarter methods, the agricultural domain still remains in the backlogs. The conventional method involves a lot of human instincts which at times fail. And thus there is a need for a smarter way of crop production using Internet of Things (IoT) and Machine Learning techniques.[12] The rapid growth of sensor network can be a revolutionizing the farming industry. The technology discussed observes the direct and indirect impact of the aggressive growth of rose farming on the environmental factors. The benefits of automating traditional farming processes addresses the issues of consumer preferences, labour shortages, and the environmental footprint of farming. The dependency of fertilizers and insecticides during each stage of the plant development is monitored. Moreover, the IoT allows these objects to be remotely accessed allowing remote monitoring and controlling.

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**Conflict of Interest**

The authors do not have any conflict of interest.

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