

# Geo Fencing of Agricultural Lands Based On Soil Quality Using Drones and Smart Devices

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**ABSTRACT:** *Smart agriculture was introduced in all developing countries of the world, but all farmers are not cultivated more crops and yield due to their land parameters problems such as quality of soil, water contaminants, and nutrition. Cultivating more amounts of plants is possible in some farmer's land where the neighboring land doesn't produce that much growth will lead to a major problem in agriculture. Researchers were doing more experiments on this but they are not concluding that this land will produce all kinds of crops and plants effectively. There are multiple methods used by the small-scale farmers, nevertheless, the improvement was not at the expected level especially in paddy, vegetable cultivation. To overcome this problem in developed countries drones are used to find the soil quality and nutrition level of the farmers and with the pictures taken from the drones. Based on the results given by the drones, the affected areas are identified and their nutrition level is also found in agricultural land. Smart devices like mobile phones, tabs are used with applications or software to reveal the amount of nutrition provided to that land and fertilizers used also. This research work proposed a method called Geo-Fencing which is used to identify the soil quality and nutrition of the land with the help of drone images. Analytics can be done with the help of application software and notifications will send to the farmers for using them in regular intervals. This research also improves the land quality by adding fertilizers to produce the expected crops and vegetables in each season.*

**Keywords:** *Cultivation, Geo-Fencing, paddy, soil quality, fertilizers, drone images*

## 1. INTRODUCTION

In the agriculture world, the farmers are doing the cultivation process done with the help of the soils and their quality levels. It will vary from season to season due to the hardness of the soil and changed their capability in a different part of the countries [1]. To overcome this problem researchers and farmers are working on the development of soil quality levels especially in minerals improvement. Fertilizers used for farming are very high to increase crop growth and yields. For that purpose nutrition, fertilizer and minerals are used in agricultural lands [2]. The farmers are doesn't worried about their levels maintained in the land and water quality. The values of the minerals drained by the land will decrease at different seasons. Monitoring and controlling of this process cannot be done by the farmers with a low-cost system. IoT framework is helped to these farmers for improving the soil quality of the land remotely using centralized server control [3]. Moreover, minerals identified lands are marked using the Geo-Fencing technique created with mobile phone applications and details will be stored in cloud storage for future analytics purposes.

Geo-Fencing is the technique to improve the soil quality of the farmer's land using droned images taken from the land frequently. Drone images have been created on the land place or taken as a dataset from the approved government websites. The mapped images are further connected with the Google map application for easy recovery for analytics purposes [4]. This system will improve the soil quality levels information and the values to the farmers through smart devices for decision making. The following figure 1 describes the geo fencing of various lands based on the farmer's area and soil quality.

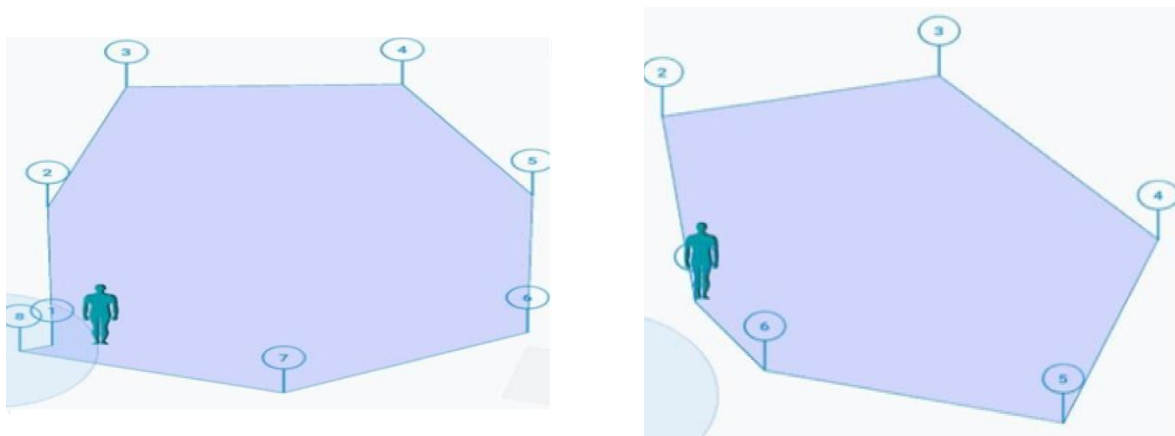


Figure 1: Geo-Fencing model of different size lands

## 2. RELATED WORKS

This geofencing system is a new innovative approach and it was done in various countries to improve the land soil details in real-time. Initial level soil quality was calculated from the biochemistry chemicals used in the chemical department [5]. The drawback is we have to wait for a long time to get results. Later IoT was introduced with its sensors it is easy to get

the soil details generated from the sensors in real-time. For analysis purposes it took a long time and storage was not maximum when data size is large [6]. Then cloud server concept was introduced to maintain the huge volume of data from the farmer's land. Finally, these geo-fencing concepts were introduced along with IoT techniques to identify the soil quality in a proper area and marked as a healthy soil quality area for cultivation [7]. The remaining area of land the fertilizers level will be increased based on the present levels. The results have taken from the land at different seasons then doing analytics using cloud databases for sending notifications to the neighbor land farmers and other farmers who going to improve their soil quality[8-12].

### **Proposed Architecture**

The proposed architecture contains an IoT sensor unit that includes a temperature sensor, pH sensor, soil NPK sensor, soil moisture sensor, and humidity sensor for monitoring land details. Land details are collected from the farmers and the images are taken by the drones especially utilized for agriculture. From these images, minerals and fertilizers present in soil can detect and measured from centralized control unit using microcontrollers continuously. All details will send to the mobile app and based on the results land will be geo-fenced using a mobile app to separate the farmer's land easily. If the soil quality level is not maintained properly inland then sensors will send notifications to the farmers for increasing the fertilizer level in their soil. The following figure 2 and 3 explain the proposed architecture and its work flow neatly.

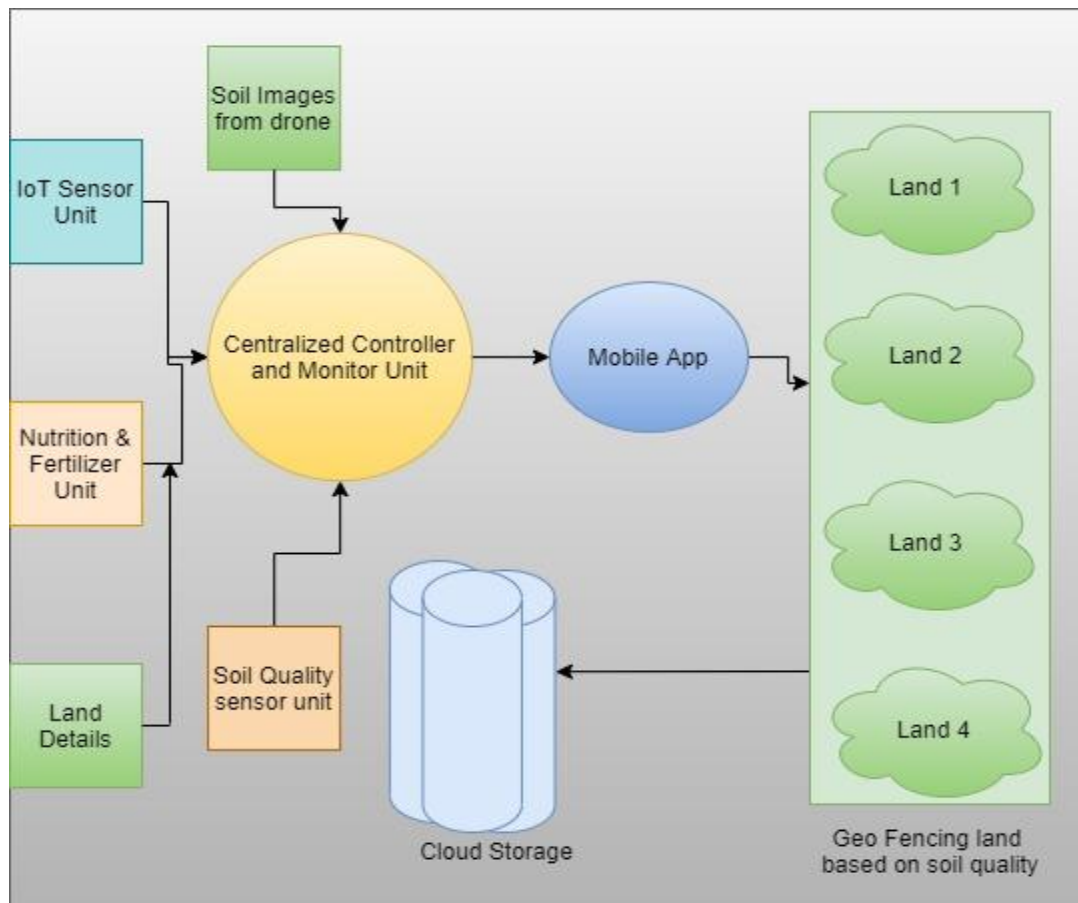


Figure 2: Proposed Architecture of Geo Fencing System

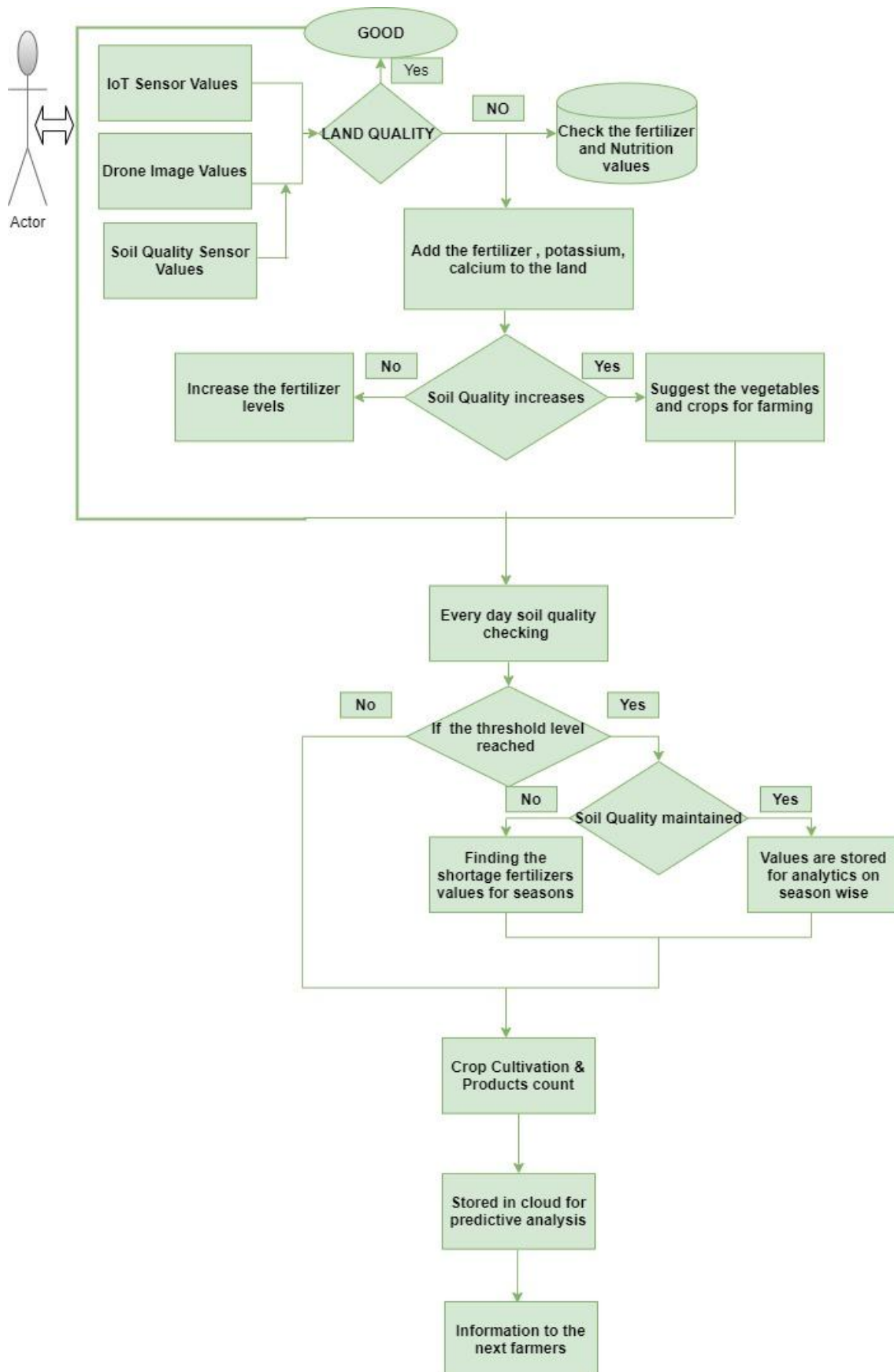


Figure 3: Work Flow of Geo fencing System

### 3. EXPERIMENTAL SETUP

The experimental setup has taken on small land probably half an acre and their images are captured using drones and different sensors of IoT framework initialized on the land separately. The cloud server setup is located remotely and a mobile app is developed for doing analytics and geo-fencing purposes. The following table 1 summarizes the sensors used in this system and their descriptions.

Table 1: IoT sensors used and their descriptions

S No	Equipments	Descriptions
1	Arduino	Act as a centralized controller
2	Temperature and humidity sensor	Levels of soil
4	Soil water sensor	Calculate pH level of soil water
5	Soil moisture sensor	Measure the levels of various soils
6	Soil NPK sensor	Calculate the nutrients in the soil
7	Nodemcu	Storing data to cloud/ mobile app
8	pH sensor	For water purity level
9	Mobil app	Making fencing using co ordinates
10	GSM module	Sending notifications to the farmers

### 4. RESULTS AND DISCUSSIONS

The results have been taken from the experiments on the different lands and the values are stored in a cloud than doing the analytics in a predictive-based manner. Since the results are taken from the various lands, so the level of soil quality is varied due to the minerals used. The minerals taken for consideration are potassium, calcium, pH level, and magnesium level used in the land. But it varied at different seasons or the crops cultivated in the previous stage. Four different soils are collected from the zones like the city center, city outer, agricultural land, and industrial near soil for consideration. These values are varied from their nature and we also include several minerals for improving the utilization of the soil. When the results are classified based on the land location and they will be sent to the mobile application for creating geo fencing to the particular land. Finally, it will be marked as a healthy land or poor land based on the minerals used inland and the results are stored in the cloud for the next seasons. Seasons like summer and winter have been considered for comparisons due to the moisture levels changing the land. The following table 2 summarizes the soil quality values changed at different seasons, types.

Table 2: Soil Quality levels at different seasons

Details of the Soil	Soil Quality on Summer				Soil Quality on Winter			
	Potassium %	Calcium %	pH	Magnesium %	Potassium %	Calcium %	pH	Magnesium %
City center soil	5	75	7.9	12.3	4.7	71	7.2	11.9
Outer soil	4	72	7.2	11.6	3.7	70	6.7	11.0
Agriculture Land soil	6	80	8.2	14.5	5.8	78	7.2	14.1
Near Industries	3.5	70	6.7	10.3	3.1	69	6.0	6.2

The results are classified based on the minerals levels present in the soil and the type of soil qualities collected from the different places. When compared with all minerals the level of magnesium is high compared with potassium and calcium. The pH level of the water content used in the soil depends upon the water flow used on the land. The following figure 4 and 5 describes the minerals and fertilizers level used in different type of soil collected from various parts of the city and the summer season level analysis.

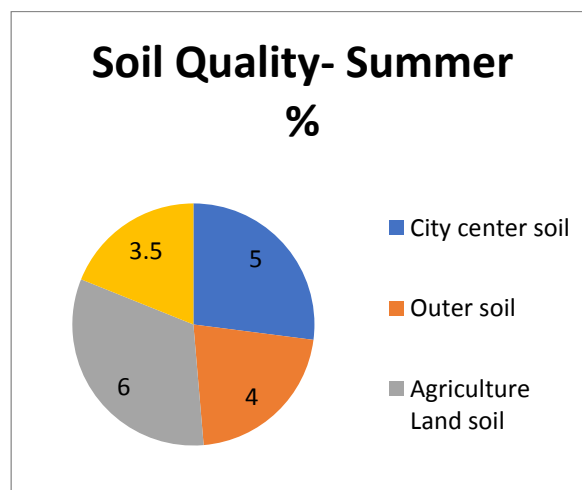


Figure 4: Soil Quality level of different soil types

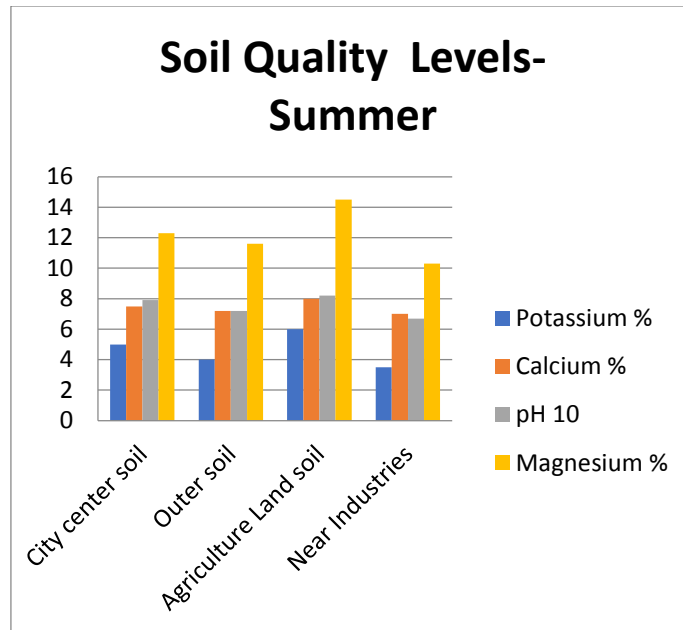


Figure 5: Soil quality at summer

The season-wise data have been considered for analytics purposes to rectify the mineral level variation and soil quality changes on different soils. Moreover, a lot of analytics have done using visualization tools using big data and will help to notify the farmers to predict their land quality for the farming process. The following figure 6 and 7 denotes the winter season soil quality levels from the different soils are visualized.

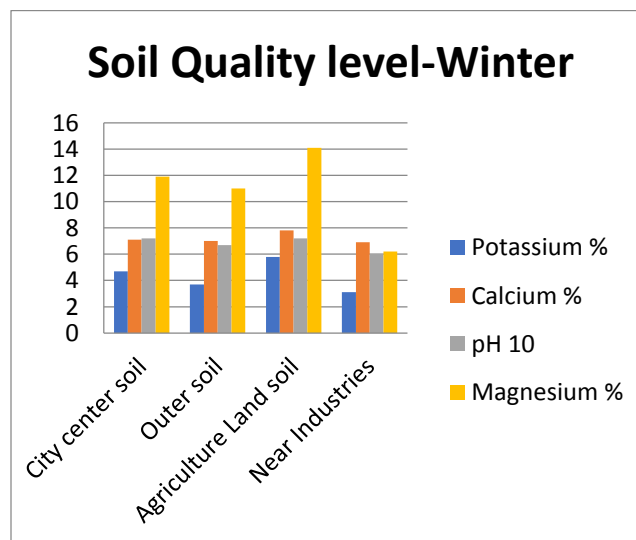


Figure 6: Soil quality in winter season



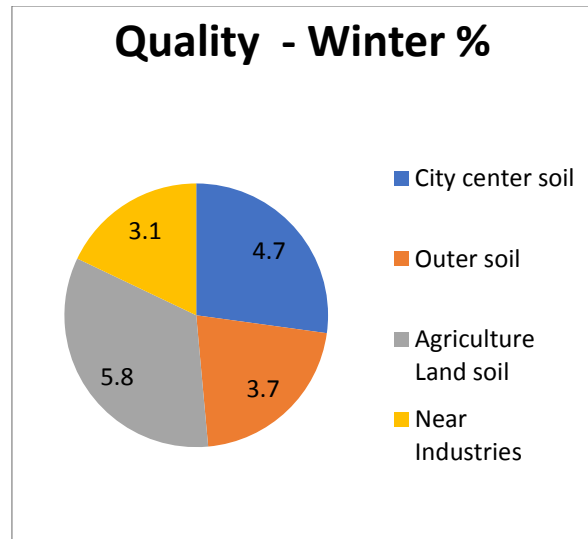


Figure 7: Different types of soil at winter

The entire experimental setup is monitored with IoT Framework for one season continuously and the minerals ranges are noted regularly. Any deviations on that immediately this system will provide fertilizers to that particular land. The following figure will denote the soil quality from the different land soils at day wise report.

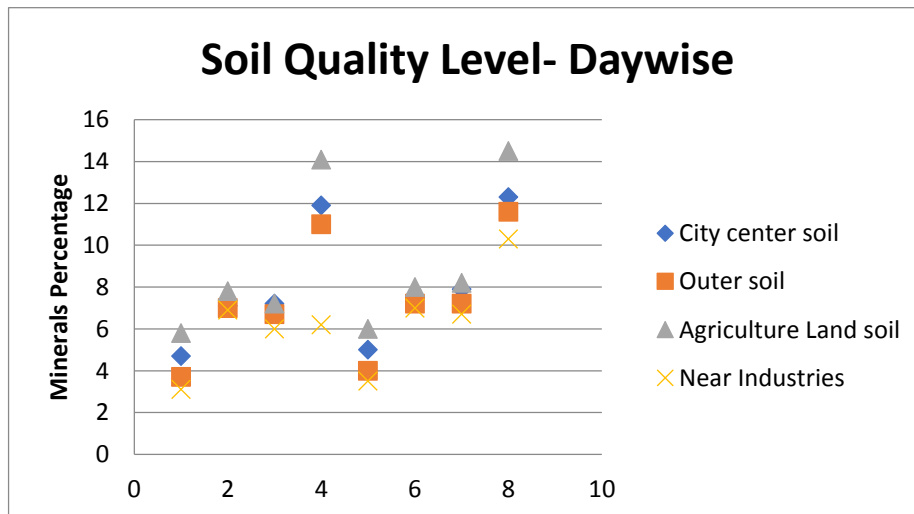


Figure 8: Day wise soil quality checking at land

The final output of the result get from the system is calculated the mineral levels on the different soil levels collected from the various lands are considered for analytics. There are multiple methods are used to predict the soil quality of the land but season-wise reports have not been implemented as of now. The minerals levels are changed in terms of percentage on each land and it differs in each type also. The following figure 9 describes the mineral levels on the soil in the different land and different seasons.

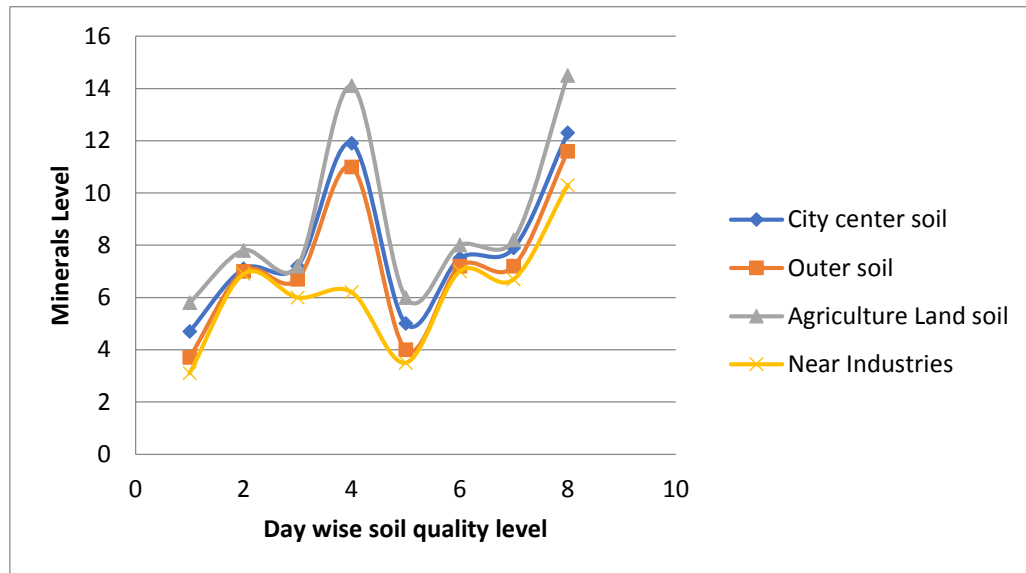


Figure 9: Day wise report of minerals at land

## 5. CONCLUSION

The Geo-fencing of agricultural lands based on soil quality using drones and smart devices research work has developed and results are taken from the different types of land in a city at changing seasons. The overall result intimates the geo-fencing techniques is used to identify healthy land farmers in terms of minerals added to the soil and how the farming process can be improved on various seasons. Multiple results have been taken and analyzed using modern tools for developing farmers' land quality at each cultivation process. Every time the cultivation process got over the percentage of the mineral in the soil is decreased elastically due to the crops used in previous cultivation. Those deviations are identified with the help of the IoT framework and future development will base on minerals present in the soil at various seasons like summer, winter, etc. Drones are used to take images of the land before starting the farming process to identify the mineral levels. A Cloud storage system will be used for data collection and analytics from the different land soils. Geo-fencing is the concept of classifying or categorizes healthy land or poor land based on the soil quality which is working in the different places of the city.

## 6. FUTURE ENHANCEMENT

The geo-fencing concept is working on the different types of lands to maintaining the minerals present in the soil constantly. This system is working on a small area of land and drones are used to taken the images in an early stage to identify the mineral levels. In the future, the big land place will be taken for farming process and geo-fencing techniques to improve the industry level standards [13-15]. All farmers are not in a situation to get drones and take an image for minerals present. To overcome this either datasets used or previous level results are taken as a message used in smart devices. At the future level, it will process in real-time with the

help of experts in IoT and wireless network [15-18] with drones in a rental base or from a government subsidy business model. Notifications are sent to the farmers at regular interval model has developed so far, but in the future centralized website will be developed and server also configured to maintain a huge amount of data as a big data through wireless network [16-18]. The cost-effective management of this geo fencing is very less when compared with classical approaches and time is also reduced to do the classification.

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