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# Analysis of Internet of Things based Agriculture Fertilizer Nutrient Management Soil Health Irrigation System and its Applications

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***Abstract*—Crops require irrigation in order to grow, and irrigation promotes economic growth gradually. The time required for an effective water flow to the crop fields will be determined by the combinations of these parameters. An essential component of the production of agricultural products is irrigation. Moreover, the current sky circumstances are specified by earlier study, which yields results that are 95 percent accurate. The agronomic design, which determines the quantity of water required for each crop, is an additional task. An irrigation system based on fuzzy rules has been devised for the other research. However, the proposed model has an additional feature: a rain sensor. It makes use of to get around the problem of irregular irrigation activation. The other feature that activates the spray on the region when the farmer flips on the fertilizer button is fertilizer control.**

***Keywords*— *Artificial intelligence, Agriculture, Fertilizer, Internet of Things, Crops***

## I. INTRODUCTION

The fuzzy irrigation system's availability and unavailability in the event of rain or not are the two indications in this model that control and conserve water for the system. It is appropriate for nearly all applications that call for a dependable and sensitive rain sensor, such as wiper control, irrigation management, drop detection, and condensation sensing. FM, or fuzzy model the architecture of hardware and software that makes up the automated system serves as a system for managing an environment. Fuzzy logic's power lies in its ability to transform verbal descriptions and human common sense into computer-controlled structures [1]. Designing fuzzy logic systems requires an understanding of fundamental logical procedures. For instance, partial truths those that lie between being entirely true and entirely false—need the use of Boolean operators. Model for Fertilizer Control (FCM) The crop fields' irrigation system is run by this model. It is made up of two probes that measure resistance and allow current to flow through the soil to indicate the moisture content [2].

The predicted result of the suggested system was ascertained by simulation using the Matlab Fuzzy Logic Designer, also known as the Fuzzy Inference System (FIS). In order to determine how much water to give crops with, the three input factors were considered. The fuzzy rule evaluation (FRE) and fuzzy surface output (FSO) are the two FIS outputs used in this investigation. Conversely, used data from various trials to determine the accuracy of the system. The judgment made using the created fuzzy rules and the FRE result are identical. The input values for Test 3 are 0.687 meters (11.45%), 39.3°C (98.25%), and 10.5 cbar (17.5%) for soil moisture and temperature, respectively. The sum of these numbers yielded an irrigation duration of 44 minutes (24.44%), which is considered a brief irrigation period. soil temperature, moisture content, and water level are all directly related to the time duration output, as shown by the three FSO diagrams. It is evident that the time length grows along with the inputs. The time length likewise lowers as the inputs do [3]. With a fuzzy algorithm, an automated system can enhance the watering process. The decision-making process about the length of time to water crops is linked to three input parameters: soil temperature, soil moisture content, and water level. In addition, the system has a fertilizer control model and a rain detecting capability. The correctness and efficiency of the system were examined by testing and simulating the input data using the MATLAB Fuzzy Logic Designer.

## II. CROP, FERTILIZER RECOMMENDATION FOR FARMERS

Since 79% of Indians are either in or dependent upon agriculture, it is often recognized as one of the most important jobs and the foundation of the nation's economy. Two important factors that affect agriculture are soil quality and climate. Selecting a crop that is unsuited to the climate or soil depletes the crop's quality as well as quantity [4]. Dependency analyses of several variables and machine learning models pertaining to fertilizer recommendations. Farmers who use the same fertilizer will receive the lowest yield possible since the changing environmental conditions have caused significant changes in the qualities of the soil. There is a gap in the literature's identification of every potential component related to fertilizer suggestion, despite the fact that many algorithmic analyses have been conducted to predict the fertilizer taking various parameters into consideration [5]. Therefore, in order to provide a more accurate fertilizer prediction and increase crop yield, have used a variety of soil and environmental factors in our proposed work, such as humidity, rainfall, and weather conditions, as well as values for phosphorus, potassium, and nitrogen. It also performed a dependency analysis of these factors.

The availability of nutrients for plants from a variety of soil layers is demonstrated, accounting for the fact that plants can remove nutrients as well as the characteristics of the root system's growth, distribution, and structure. Through this work, can gain a deeper knowledge of the function that different soil layers with their unique moisture conditions, nutrient levels, and root placement characteristics play in the production of corn crops and how those qualities affect the quality of feed [6].

A high K2O content in the fertilizer-treated variety was defined as 5 percent of the area and a very high 95%. The fluctuation of the NNH4 level in the soil was significantly impacted by the application of nitrogen fertilizers. The experimental versions of this indicator had fluctuation coefficients of 38 and 45% at the time of soil sampling [7]. Uneven conditions for crop growth and development are produced as a result of differences in the environment's response and the nutrient content in various fields, which results in a diversity of productivity. As a result, the growing circumstances unique to the soil's subsurface will have an impact on the development and nurturing of plants. Technical methods for fertilizing deep soil have been developed recently in this regard [8]. Examining how much of the nutrients are assimilated by plants from various soil layers when applying mineral fertilizers mechanically to varying depths is vital. In order to better understand how each soil layer affects plant productivity and product quality, a more comprehensive layer-by-layer assessment is necessary for soils with extremely diverse agrochemical properties in the vertical section.

## III. Trends in Agriculture

The Green Movement and sophisticated agriculture have raised total output to assure food security, yet there is a yield gap. However, new cultivars, irrigation, and other inputs, along with the usage of agrochemicals like pesticides and fertilizers, continue to harm agriculture in some places. Acidification, a decrease in soil fertility, and environmental degradation are possible outcomes of conventional agrochemical-based agriculture. Fig 1 Soil quality and crop productivity can only be maintained by using the right fertilizers and minimizing the amount of soil resources that are used. For this reason, following fertilizer recommendations in agriculture is essential to achieving desired levels of output and profitability while reducing nutrient losses to the environment. In this study, an autonomous fertilizer recommendation system for farmers will be built using the smart phone app [9]. The Kaggle website was the source of the dataset. The data entries are converted to numeric values using the encoding approach. The performance analysis indicates that the RF has a high accuracy of 96%.

## IV. Sensing based Smart Agriculture

Two sensor systems utilized in smart agriculture are shown in this research. The first sensor device can remotely check on the status of grains kept in silo bags in real time. The nitrogen (N), potassium (K), phosphorus (P), and pH sensors in the soil make up the second sensor system, which is used to optimize the precise administration of fertilizers in real time. The design and construction details of these sensor systems, as well as a few experimental findings from field testing, are presented.

## V. Nutrient Management systems

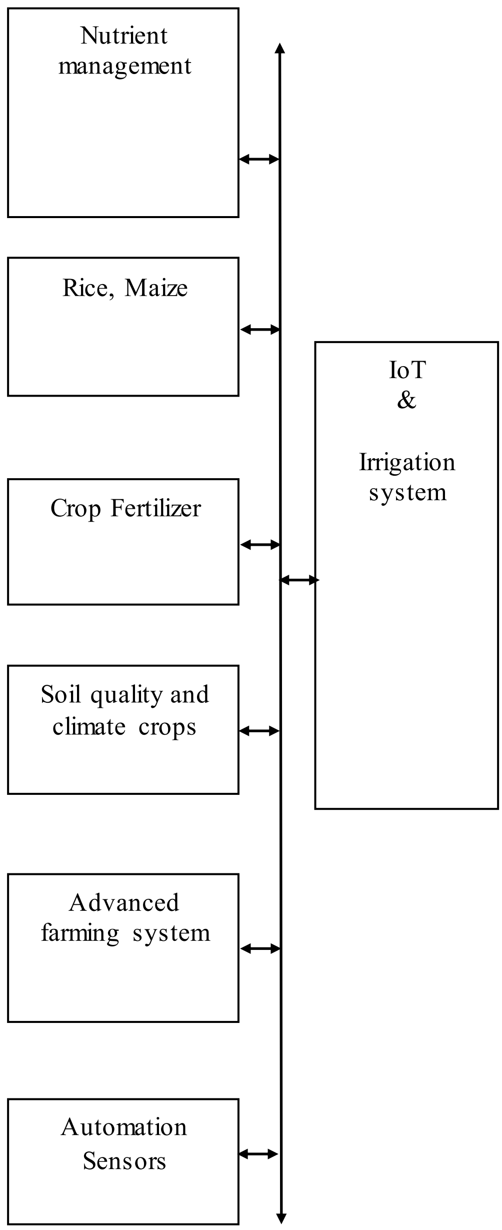


Fig. 1. Block diagram

Automation is referred to as the technological revolution and has a hugely beneficial influence on all areas & domains. The main goal of automation is to boost output.

The country's population is growing exponentially, which necessitates an exponential increase in food production. The question of what controls the rising food production emerges. One of the solutions is that sufficient nutrient concentrations in the soil are a controlling factor that impacts food production and must be routinely observed [10]. Agriculture automation is the only way to achieve exponential growth in food production. Several existing technologies, such as wireless communication, AI and ML, deep learning, big data analytics, and IoT, can be used to automate agriculture. Using the Soil Health Monitoring [SHM] system to maintain sufficient availability of crop- and site-specific nutrient contents in the soil becomes the main difficulty that needs to be solved using automation technology. The different SSNM [Site Specific Nutrient Management systems that are available are covered in this article, along with the potential integration of automation technologies that will help with SHM by suggesting crop- and site-specific fertilizer at the appropriate time.

## VI. Fertilizer for Advanced Farming

A significant portion of the global population more than 55 % makes their living from agriculture. Fig 2 By using the recommended bot, farmers can save time and resources while improving operational efficiency. Farmers are less physically burdened and can make more money overall from their farms as there is no longer a requirement for physical labor [11]. The autonomous plantation layout and fertilizer bot that have been designed and implemented present a viable way to progress the agricultural sector.

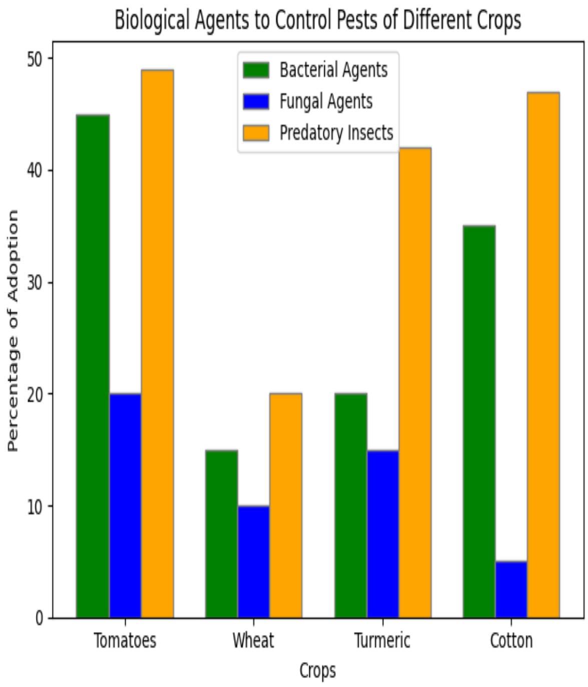


Fig. 2. Biological adoption system

Using soil series to predict fertilizer, choose crops, and classify soil. India is an agricultural country with an economy mostly based on agricultural and agro-industry products. Examine the several related variables, including the location and the pH level that were utilized to determine the alkalinity of the soil. In addition to using third-party apps such as APIs for weather and temperature, location is also utilized to determine factors like soil type, fertilizer value, rainfall amount, and composition. Nutrient percentages such as potassium (K), phosphorus (P), and nitrogen (N) are also taken into account. In order to build a model, all of these data attributes will be looked at, and the data will be trained utilizing a number of efficient machine learning techniques [12]. The system that provides suggestions for the necessary fertilizer ratio based on soil and atmospheric characteristics is given to the end user. In terms of predicting agricultural productivity, the system is exact and reliable.

## VII. Farming Robot Spray Water, Plant Seeds, And Fertilizer

These developments are based on the tremendous advancements in robotics, which have solved many of the major problems facing the agricultural field, including random sowing, which costs more money in seeds, water consumption, and fertilization quantity [13]. Fig 3 In order to prevent water waste, this article develops a robot that can assess the distance between seeds and use a soil pH sensor to decide when plants need fertilizer.

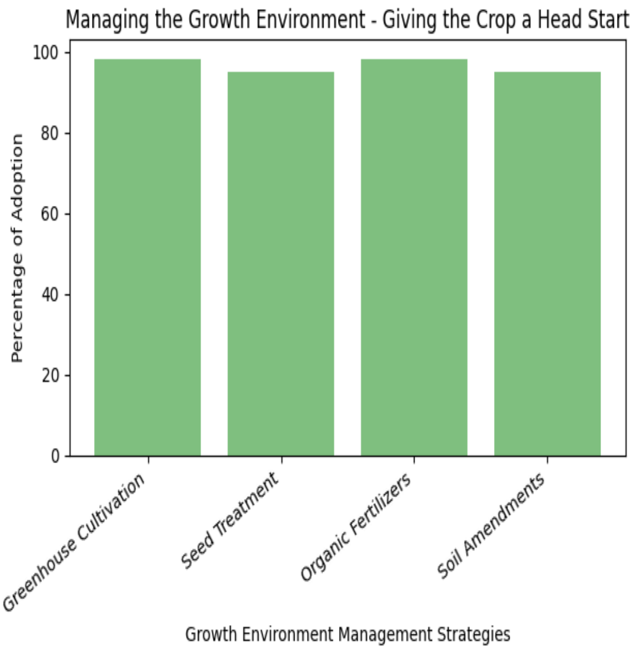


Fig. 3. Managing the growth environment giving the crop

A planting medium called fertilizer is used to provide the nutrients plants require to grow healthily and yield high-quality output. Fertilizer was the study subject. Plants require it to produce high-quality results. Furthermore, plants are not the only things that benefit from organic fertilizers. Nevertheless, because fertilizer for plants has so many advantages, they can also lessen environmental contamination and enhance the quality of the land going forward. Fig 4 giving plants the incorrect fertilizer is a painful experience for growers of purple sweet potatoes as it degrades plant quality and boosts output

## VIII. Soil Fertilizer Recommendation System

A crop's development and yield are directly influenced by the season and the nutrients in the soil. While applying too much soil fertilizer can also have a detrimental impact on crop development, a deficiency in nutrients in the soil can lead to plant disease [14]. As the season transitions from the rainy to the dry, the nutrients in the soil also change. The outcome demonstrates the successful development and simulation of the fuzzy logic system to provide appropriate fertilizer recommendations

## IX. Applications Machine Learning for Fertilizer Forecasting

More data is handled by machine learning, a relatively new technology, than by any other in the world right now. In India, agriculture is the main source of revenue. The main objectives are to boost profitability and provide adequate food for everyone in India, however in order to advance the sector and meet the targets, agriculture is coupled with cutting-edge technology. Predictions on the fertilizers that will raise agricultural productivity and improve profitability are made in this study. One of the most important tasks in agriculture is fertilizer prediction, which is figuring out the right kind and amount of fertilizer to apply for a particular crop.

Despite being essential for increasing agricultural yields and lessening the impact of farming on the environment, this effort faces several challenges. Machine learning techniques like Random Forest have been used to get around issue. This approach is taken into consideration because it shows better accuracy when compared to other approaches such as K-Nearest Neighbors, linear regression, etc. This study makes use of Kaggle datasets and takes into account the previous circumstances, farmers' experiences, and their responses. The soil, plant, and ambient factors are taken into account when predicting the fertilizers using the datasets. As a result, this study forecasts the fertilizers that are appropriate for the aforementioned circumstances.

## X. Family Fertilizer Recommendations and Fruit Disease Prediction

Citrus fruit plants are harmed by a number of diseases, such as orange black spot, melanose, lemon canker, etc. A communicable disease known as citrus canker affects citrus trees, resulting in scabs on the leaves or fruits and yellow halo lesions. Severe illnesses have the capacity to harm fruit as well as kill a person. The cancer-causing bacteria can travel swiftly and easily through clothing and other infected objects to plants, wildlife, and people [15]. The suggested technique recognizes and classifies citrus illnesses from citrus photos using efficient CNN models. Computational approaches considerably enable the automatic detection and early diagnosis of diseases in citrus fruits, hence improving their development and quality.

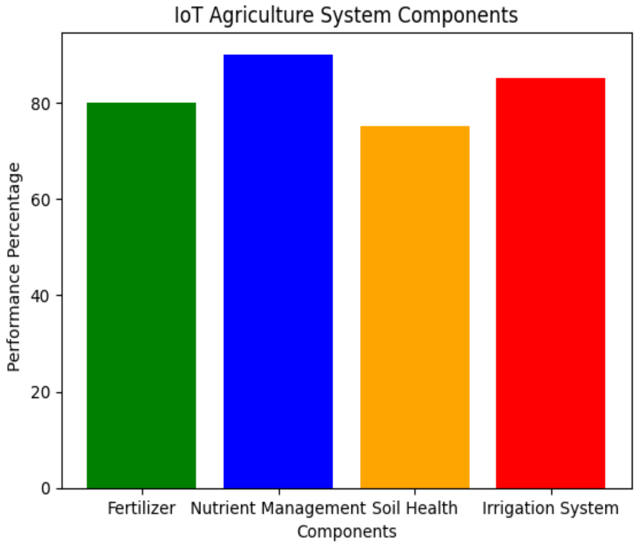


Fig. 4. Agriculture system components

Picture processing techniques used to develop a citrus plant disease diagnosis system include pre-processing, picture segmentation, features extraction, and classification. Most of the time, sensors and cameras were used by users to capture pictures of citrus fruit and foliage from the field [16]. Pre-processing techniques enhance the photos by eliminating noise from the ones that are taken. CNN separates features from raw inputs analytically. The traits with the highest likelihood value are chosen for categorization. Feature extraction techniques are used to extract the features of the affected regions. Citrus fruit illnesses are then identified using the categorization procedures.

## XI. Output Recommendation of Macronutrients using an Integrated Nutrient Management System

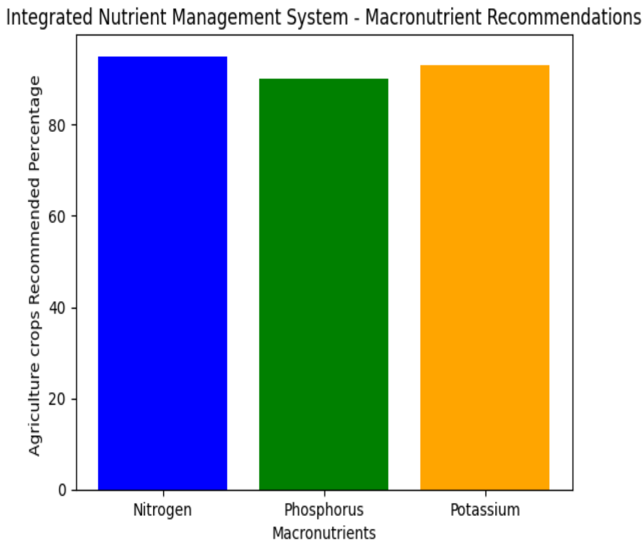


Fig. 5. Integrated nutrient management system macronutrient recommendations for crops '

The most challenging area nowadays is agriculture, which is essential to the production of food. Every crop has different requirements than others.

Fig. 6. Iutput of multiple crops irrigation system

Water and fertilizers, for example, should be applied in accordance with crop requirements and soil type. Using deep learning and machine Learning, online crop doctor those who are new to farming could also benefit from it. For crop suggestion, Open Weather Map API can also be used to obtain real-time weather data or forecasts.

Fig 6 Fertilizer recommendations are based on a straightforward method of comparing user-inputted values for potassium, phosphorus, and nitrogen with current data. The fig 7 and 8 preconfigured dictionary contains recommendations to show according to comparison findings. This system's third feature is its ability to forecast the sickness that tomato plants have contracted. Ten distinct classes of the model have been trained using thousands of leaf photos.

Fig. 7. Output of turmeric irrigation system

It is therefore restricted to tomato crops alone. To address vanishing gradient issues, convolution neural network and ResNet architectural concepts have been put into practice. To create and define neural networks and obtain a highly accurate trained model, use the PyTorch framework.

Fig. 8. Output of Cotton Crop prodcution

It is common practice to build soil tests to "optimal" levels and then maintain "optimal" soil test results in order to guarantee high crop output. In maintenance-based fertilization schemes, the amount of nutrients withdrawn by the crop is usually calculated, and then the rate of fertilizer application is adjusted to replenish the nutrients removed by the crop while maintaining soil test values close to the "optimal" soil test for each nutrient.

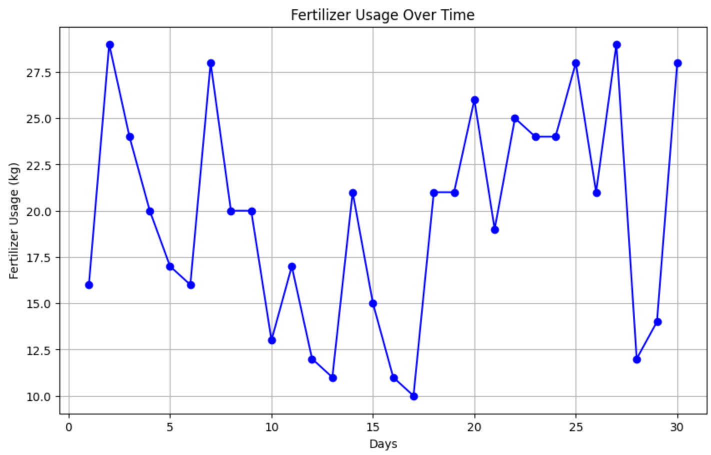


Fig. 9. Output Plant fertilizer recommendation

Determining the "optimal" soil test level and the quantity of fertilizer needed to keep soil test values there is the key obstacle of a build-and-maintain method. Decisions on the "optimal" soil test may differ from field to field depending on a producer's tolerance for risk and kind of land. Application of the precise quantity of potassium (K) and phosphorus (P) removed in a given year tends to increase, not maintain, soil test P and K levels, according to research.

The disease-specific fertilizer recommendation system prediction is a straightforward ML and DL based website that suggests the best-suited crop to grow, what fertilizers to use, and which diseases your crops will contract. A crop grows more quickly; the more fertilizer it gets. When a crop receives insufficient fertilizer, its response to growth is poor; conversely, when fertilizer rates are high, plant growth slows down and there's a risk of plant root damage or even death.

## XII. CONCLUSION

Analyzing preprocessing data and machine learning techniques to predict global fertilizer consumption worldwide governments, research organizations, and the agribusiness sector all have an interest in fertilizer consumption. An essential component in the food and organics production chain is the estimation of fertilizer usage. As a result, the growth in output might be scheduled appropriately so as to not negatively impact the environment. The analysis of fertilizer usage over time presents a significant problem due to the scarcity of available data and the difficulty in obtaining machine learning models that work well. While some programs employ statistical and machine learning techniques to anticipate fertilizer usage, a comprehensive analysis of data analytics approaches is required to improve predictions under various step-ahead horizons. The looked at various strategies for optimizing the building of the temporal data model, combining machine learning techniques with data preprocessing in pairs. Assessed these methods using actual NPK fertilizer data from the top 10 nations that make such demands. The obtained results indicated that obtaining trustworthy forecasts to plan for future demands might be possible by utilizing the suggested analytical tools.

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