A Smart Fertilizer Calculation Computer Simulator For The Land Preparation Of Paddy Crop Field Based On WSN Leads To Precision Agriculture

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This proposed work is implemented on Java platform to simulate the land preparation for paddy crops interactively and listed out the name and quantity of fertilizers required to the proposed crop-field prior to start the agricultural process. Life in the land can only possible when adequate food is available to us. And today's technology goes a level to make the available land suitable for the crops and agriculture. Our work is focused on to develop a simulator tool which offers high customizable platform in terms of number of sensors, area of the field, position of Base Station (BS), type of fertilizers and chemicals, etc. Many agricultural based simulators are developed which deal with monitoring, harvesting, irrigation etc. But this proposed simulator is designed to helps farmers to draw an idea before starting farming in a practical crop field and provides the list of fertilizers needed for the crop field for suitable agriculture and to achieve high yield production which helps to fulfil the high population food consumption. Key features of this proposed simulator are delight visualization, real-time monitoring, instant controlling, and best suggestion of fertilizers with quantity. The proposed system has been developed on JDK 8 with Netbeans IDE. Java Swing is capable of talking with the real sensors over the network, hence this simulator can be upgraded to the real-time software application with interfacing real soil sensors.

CCS CONCEPTS • Paddy Crop • Land Preparation • Computer Simulator
Additional Keywords and Phrases: WSN, Sensors, Paddy crop, Precision Agriculture,

1 INTRODUCTION

Feeding the nation is one of the biggest challenges for an underdeveloped and economically unstable country. Developing countries like India, where the maximum population of the country depends on agriculture, have habituated to the traditional process of agriculture for a very long time, where farmers have minimal knowledge about the techno-biological facts behind the agricultural process. They are habituated to continue their farming by their traditional aptitude. So, the losses occur due to natural and supernatural perspectives that are not in the control of farmers in the entire process of agriculture. All abrupt deprivation that occurred in the framing span is considered an act of God and it is the principal cause of poverty. But nowadays technology achieved that position where it can be involved in these issues and tried to mitigate these chronicle problems using sensors and highly technological wireless communication systems to fight against poverty enhance their livelihood. WSN is one of the living and promising examples of it. WSN system can monitor as well as control all related facts behind the reasonable yield in the entire process of farming starting from land preparation to harvesting conscientiously from base station. Naturally, traditional farmers have to face countless numbers of problems and compromises with huge losses. So, working on technological development in the field of agriculture is always a prime scope of researchers throughout the globe.
Lots of research has already been carried out over many decades to give a new idea to upgrade the agriculture process. The process of agriculture where the steps are monitored meticulously is termed "Precision Agriculture (PA)" [1]. To implement PA in practice researchers have implemented various types of technology belonging to techno-biological and geological aspects. Wireless Sensor Networks (WSN) are one the example from them. WSN is the technological game of sensors and high-profile wireless communication which becomes the joint application in the domain of instrumentation and communication engineering. Nowadays WSN has been applied in various fields like medicine, defense, mines, agriculture, building structure, etc. [2] The fundamental concept of the WSN system is comprised of many sensor nodes (the number and types of sensor nodes depend on the application), and a wireless communication system governed by a smart routing procedure to monitor the application field economically and suggest the controlling action if needed. Sensor nodes are placed in the field to be monitored and controlled. The base Station (BS) is situated at a distance place from where the user can monitor and control the system interactively. BS is of two types: one, the monitoring and controlling system are installed inside the BS,

and second, the BS acts as a gateway and is equipped with mobile GSM or internet connectivity system by which BS sends the data packets to the distance place over GSM/CDMA channel or internet system to the user.
In agriculture, sensor nodes are placed in the farm field which is generally away from the home of the farmer. The sensor nodes are energized by a limited source of DC power like a battery. BS is located far from the crop field where sufficient electric power can be arranged for running high energy consumable systems like Gateway, GSM system, Monitoring system, etc.[3] Many researchers work on WSNs in the field of agriculture to monitor and control various parameters like weed control, snail detection, water level, temperature, pressure, insects, wind, etc.[4] Earlier works also concentrated on general soil parameters like salinity, humidity, need for proper irrigation to achieve high yield with minimum loss to the farmers.
This paper has been written on the work based on land preparation for the paddy crop field. Land preparation is the initial step toward the precision agriculture because seeding in the inappropriate field is the very basic cause of low productivity. This work has been carried out on the groundwork of an exhaustive literature review of the paddy crop field. The main target of this proposed work is to develop a simulator to simulate the agricultural process before start agriculture in practical field, which helps to mitigate the losses and triggered to achieve high yield farming. This proposed simulator has been programmed in advance Java to sense the situations and take action accordingly in fully automated manner. Again, this simulator tool also have some routing strategy for communication like grid based energy saving routing protocols [5] and one direct communication protocol for wireless interface among the sensors and sensors to BS.
The rest of the papers have been organized as: the second part elaborates on the related work which are carried out earlier by various researchers which plays the role of motivation for this work, the third section of this paper described thoroughly the theoretical background of this work. Later on, the next section of the paper explains the framework and system model of the proposed simulator with step-by-step mechanism to operate the simulator. The fifth part of the paper presents the algorithm and simulation results to validate the work and the last section ends with a conclusion with a brief future work.

2 LITERATURE REVIEW

In this section of the paper, we will discuss the previously done works related to this proposed simulator.
Soledad Escolar et al., 2011 propose a wireless sensor network-based methodology for monitoring vineyards, but it can also apply to other crops. This methodology states various steps for monitoring of vineyards like, i) study of terrain, ii) architecture design iii) role and functionality iv) implementation v) simulation vi) deployment or exploitation, and vii) maintenance.
This methodology gives different choices among the set of recommended options according to collected data by using the WSN network to increase the productivity of the crop.[6]
Bayu Tarunaet al.2021 tries to analyze the uses of hydroponics with the help of s smart farming system incorporated with useful technologies like a wireless sensor network on paddy farming. This study concentrates on plum allometry, water requirements, and environmental information which support decision-making in determining nutrient application and water needs through an automated system. This system has been equipped with IoT enabled with public static IP for communicating globally or outside the local network. In this paper, various soil parameters like moisture, temperature, water level, humidity, and light intensity are measured with the help of various types of sensors. And on the other side, there is a spectrometer to monitor the color level which is the greenness of the leaf. Leaf colors usually associate with the chlorophyll and nitrogen percentage of the leaf. The leaf color has been captured by an RGB camera of different plots of the deployment area.
Two types of distinct procedures have been carried out for measurement purposes. In the first method, a light sensor has been incorporated to judge and extract the RGB value of the paddy leaves of each deployment area plot. In the second method extraction of RGB values of the paddy crop and segmented background of each deployment area are analyzed. These collected data are then validated with the nitrogen status of the plant using the Kjeldahl method of chemical analysis. From these measurement results has been further analyzed by graphical representation. [7]

María Culmana et al.,2018 try to focus on the problem of unawareness of Colombian farmers of the proper climate and weather conditions and how to make proper decisions for their crop farms of oil palm. Side by side researchers try to develop an intelligent system that can make proper decisions depending on site specifications and environmental conditions.
So, to achieve this target gathering information related to the agricultural aspect as well as the metrological aspect is very much necessary, and this target can be fulfilled with the help of a wireless sensor network (WSN).
Here researchers considered water management as one of the major facets of oil palm farming and for the governance of the irrigation system it describes an inference method based on parameters like vapor pressure deficit data and moisture content of soil. Inference or Dempster-Shafer inference is a data fusion technique that is very relevant for the analysis of data collected by the wireless sensor network which are uncertain data with different levels. Mainly there are two different types of simulation has been implemented to analyze the effectiveness of inference method on the yield. Firstly Castalia, WSNs simulator is used to analyze collected site-specific data of wireless sensor network and secondly, APSIM (Agricultural Production Systems Simulator) is used for simulating two types of oil palm plot's data that is data of plot managed by inference method and data of plots without irrigation. It has been observed there is an inflation of yield of 27% with a smart irrigation system. [8]

Doko Bandur et al. November 2018 proposes work which is one comparative study. It has been done based on energy efficient wireless sensor network protocol and also one application based on smart agriculture using WSN has been simulated in an artificial environment or simulator. This work is very helpful for the practical implementation of wireless sensor networks.

This paper gives an overall idea of a few things like the main energy-consuming component of any wireless sensor network, and various protocols across the various layers of a wireless sensor network. These are the additional factors to design as well as implementation of energy efficient Wireless Sensor Networks in smart agriculture applications finally, an analysis of various parameters like average power consumption and average duty cycle for all the nodes under the network are done based on a simulation of a wireless sensor network using Cooja simulator.
During this analysis, it has been observed that the main energy-consuming components of wireless sensor networks are the RF trans-receiver and flash memory components. According to the survey of the Tmote Sky sensor node it has been observed that maximum power is consumed by the MCU when it is operating in receiver mode and minimum power is consumed by MCU in the sleep mode. Now the interesting factor that has been observed is the operation of these radio sensors is highly dependent on medium access protocol (MAC). Hence an efficient MAC protocol can minimize the power consumption of the sensor node resulting in the enhancement of the lifetime of the whole sensor network.[9]

U K Paul et al. April 2017 tries to focus on developing an interactive computer simulator. They have developed a simulator for testing various roughing schemes which have been already developed. This simulator tool allows users to customize the various operational parameters like the number of sensor nodes, area of development, position of monitoring stations and the routing scheme in a very superlative manner and they have validated its simulated output with MATLAB simulation results also.[10]
Sathiya Priya R et.al proposed a system where paddy crops has been monitored from satellite using image processing methodology [23]. This work utilizes cluster algorithm based on deep learning. They addressed crop growth, soil degradation, soil availability, etc. Anisa Dzulkarnain el. al focused on harvesting mechanism to improving the rice production using system dynamic approach with complex system feedback method [24]. In year 1996, APSIM [25] has been developed works on predictive modelling. Roger Martin-Clouaire and Jean-Pierre Rellier developed a framework and try to mitigate work organization issue in agriculture system. This system relies on frame based ontology agricultural production system [26].

3 THEORETICAL BACKGROUND

Fertile riverine alluvial soil is best for rice cultivation due to its superior water-holding capacity. According to well-known soil chemist and former principal soil chemist Dr. F. N. Ponnamperuma. IRRI, Los Banos, Philippines drew some conclusions on the suitable range of chemical amounts in soil are tabulated in Table 1.
According to the article proposed by Ponnamperuma above chemical parameters have been considered to be ideal for paddy crop agriculture. [11] A brief explanation of these chemicals and their values dependency on the subjected soil has been discussed below:
1. **Ph (potential of Hydrogen**): It is the measure of acidity and basicity of the soil. Again, the effect of the chemical equilibrium of sulphides and ferrous iron has a direct relation with the pH of the soil which depicts the consequences on the growth of rice crops. The values for pH2S and pS2- are linearly related to the pH value of soil, which concludes that pH is the principal parameter of the paddy crop soil [12].

2. Ece (Electrical Conductivity of a saturated soil Extract): It is the electrical conductivity of the soil extract also known as salinity. Higher salinity caused half of the yield in the case of rice and cotton [13]. About 380 million hectares of land in the earth's crust are occupied by saline soil. The higher the salinity lesser the pH value of the soil which leads to an increase in redox potential. But by increasing the salinity ammonification and nitrate reduction have been decreased [14]. The ions responsible for salinity are Na+, K+, Ca2+, and Mg2+ etc. So, for better yield soil salinity (ECe) should maintained at <2milliSimon per centimeter.

3.Eh (Redox potential): It is the Reduction-Oxidation potential of soil extract. In this fact, flooding plays the key role in soil characteristics changes in both the physical and chemical domains, which affects the redox potential (Eh) of the soil also. Flooding commonly results the lowering of Eh which causes the high demand for oxygen to maintain the natural metabolism of plant roots. So, the range between -0.2 to +0.2 volts is considered acceptable for paddy agriculture. Eh can be maintained with the mentioned range by introducing O2 to raise the Eh value and by imposing inert gas such as Ar, He etc. to lower the value.

4. Soil Organic matter (SOM): It is the residual decomposition of plant roots, insects, animal tissue, microorganisms, etc. Soil quality parameters like nutrient status, rhizodeposition, root growth, and microbial composition is primarily depends on the SOM content of soil. The major source of SOM is the rotten roots of sod crops which leave behind after harvest. Since addition of manure to the soil is an excellent way for proper buildup of organic matter, it used to maintain the SOM level between 2.0 to 3.5 %.

5. Total Nitrogen (N): Nitrogen is responsible for the rapid growth of the plant and also promotes the high yield of the grain. Essential chemicals like amino acids, nucleotides, and nucleic acids contain nitrogen which is responsible for proper leaf area, grain formation, protein synthesis, etc. A deficiency of nitrogen reflects the color of the leaf. The leaf becomes faded and goes dull in inadequate nitrogen. Leaf Color Chart (LCC) technique is used to predict nitrogen deficiency in soil. A country like India where the nitrogen content of soil is not up to the mark. Hence before starting farming the land has been treated with either a natural but slow process or fertilizer (chemical or bio fertilizer). The natural process is to plantation nitrogenfixing plants like peas or beans earlier to start paddy farming. Artificial fertilizer like ammonium sulfate, di-ammonium phosphate, urea, or properly calibrated N-P-K fertilizer is also used. N-P-K chart has been tabulated in Table 2.

6. Total Phosphorus (P): Opposite amount of P content of soil results in healthy roots, better flowering, and ripe punctuality in crops. Improper phosphorus is mainly found in sandy soil having low organic matter. Symptoms of deficiency in phosphorus amount in soil have been predicted by a thin stem, no flowering, immature grain, and delayed ripping. P2O5 or super phosphate fertilizer is used to maintain the required level of P 10 to 15 days after direct seeding. N-P-K fertilizer is also used for this purpose with configuration as tabulated in Table 3.

7. Potassium (K): Potassium is another limited element after nitrogen in soil. It is responsible for healthy roots and also provides resistance to the plants against diseases and pests. The symptom of K deficiency is reflected in the leaves of crops. Leaves become yellowish, sometimes seems to brown due to dryness due to the lack of potassium presence in the soil. Excessive application of nitrogen and phosphorus sometimes causes potassium deficiency in soil. For smooth paddy agriculture, K level should be maintained at>2 milli moles/Kg of soil. K2O, foliar straw, ash of brunt straw, or N-P-K fertilizer are used to increase K into the soil.

8. Sulphur (S): It is a rare deficiency element in regular paddy fields. However, its deficiency affects plants' metabolism systems like the production of chlorophylls, and structural disorders, which results in delay in plant development and late production. It is observed by the color of leaves which becomes pale green due to lack of sulphur content in soil. Single superphosphate and S- S-coated urea are used to fix the deficiency.

9. CEC (Cation exchange capacity): The Cation Exchange Capacity is the measure of cation cherished on the particle of the soil. It also reflects the capacity of the soil to perpetuate soil nutrition like K+, NH4+, Ca2+, etc.

10. Clay Composition: The composition of clay should contain organic matter but free from iron and aluminum oxides which help the soil to become puddled soil. According to de data (1981), the puddled soil helps paddy in the following manners:
- Easy weed control.
- Transplantation becomes easier.
- Good water conservation in the plant roots.
- Increases the nutrition's availability in the soil.

11. Iron (Fe): Crops become dry and also affect production yield due to improper photosynthesis and plant metabolism due to inadequate amount of iron in the soil. Pale yellowish and chlorotic leaves are a symptom of iron deficiency in soil. Toxin-free industrial residue or fertilizer like ammonium sulfate is used to increase the iron content of soil [15].

12. Magnesium (Mn): Assimilation, protein synthesis, and enzyme activities of plants are controlled by magnesium. Its deficiency affects the grain quality. The main source of Mn is irrigation water. Upland and lowland fields mostly suffered with Mn deficiency because of soil erosion and soil minerals are washed out with rainwater during the rainy season results in low CEC. Mg containing fertilizer like kieserite, and MnSO4 are used to increase the Mn content and maintain> 0.05% with soil for healthy paddy agriculture.

13. Zinc (Zn): Zn deficiency is an uncommon syndrome of soil but in flooded and heavily cropped soil it may occur. Dusty brown spot marks appear on leaves due to a deficiency of zinc after transplanting. It plays many roles in biochemical processes and chlorophylls in rice plants. Zinc Sulfate or Zinc Chloride-based fertilizers are used with water to maintain the level of zinc in rice-cultivated soil.

14. Boron (B): The short height of plants and leaves rolled up is the first symptom of boron deficiency in soil and it continues throughout the crop cycle. This issue is rare but commonly found in high organic matter and low pH soil. Anhydrous Borax, fertilizer borate, and foliar spray are used to perpetuate the level of boron in the soil.

15. Water: For rice cultivation, water is one of the most essential parameters as to produce one kilogram of rice almost 1432 liters of water is needed. Typical paddy crop agriculture demands seven to ten days to flood the deployment field before harvesting of paddy rice. Paddy crop needs from 400mm to 2000mm of water depending on different soil types and texture. [From website Rice Knowledge Bank]

In Table 1. the list of fertilizers required to adjust soil parameters in both positive and negative aspects has been tabulated.

Table 1: List of Soil Parameters

Parameters	Quantity	Safe Range	Role	Fertilizer for negative adjustment	Fertilizer for positive adjustment
pH	pH of soil	5.0 to 6.5	The effect of chemical equilibrium of sulfides and ferrous iron has direct relation with pH of soil which depicts the consequences on the growth of rice crop. The values for pH2S and pS2- are linearly related to the pH value of soil, which concludes that pH is the principal parameter of the paddy crop soil [12].	Limestone	Sulphur
ECe (Salinity)	Electrical Conductivity	< 2 mS/cm	It is the electrical conductivity of the soil extract also known as salinity. Higher salinity caused the half of the yield in case of rice and cotton [13].	Epsom Salt	Water Organic Matter
Eh	Reduction – Oxidation Potential	-0.2 to +0.2 volts	It is the Reduction-Oxidation potential of soil extract. flooding plays the key role in soil characteristics changes in both physical and chemical domain, which effects the redox potential (Eh) of the soil also. Flooding commonly results the lowering of Eh which causes the high demand for oxygen to maintain the natural metabolism of plant roots.	Epsom Salt	Water
Soil Organic Matter	Organic matter present in soil	2.0 to 3.5 %	It is the residual decomposition of plants roots, insects, animal tissue, microorganism etc. Soil quality parameters like nutrient status, rhizo-deposition, root growth, microbial composition is primarily depends on SOM content of soil.	Manure	-
Total N	Average Nitrogen content of Soil	>0.2 %	Nitrogen is responsible for the rapid growth of the plant and also promotes the high yield of the grain. Essential chemicals like amino acid, nucleotides, and nucleic acids contain nitrogen which are responsible for proper leaf area, grain formation, protein synthesis etc. Deficiency of nitrogen reflects the color of leaf.	N-P-K Di-ammonium Phosphate Ammonium Nitrate	Water
Total P	Average Phosphorus content of Soil	>0.02%	Apposite amount of P content of soil results healthy root, better flowering, ripe punctuality in crops. Improper phosphorus mainly found in sandy soil having low organic matter. Symptom of deficiency in phosphorus amount in soil has been predicted by thin stem, no	i. N-P-K ii. Rock Phosphate Pig Manure	Water

Parameters	Quantity	Safe Range	Role	Fertilizer for negative adjustment	Fertilizer for positive adjustment
			flowering, immature grain and delay ripping.		
Exchange K	Potassium	>2mmol/Kg	Potassium is another limited element after nitrogen in soil. It is responsible for healthy roots and also provides resistance to the plants against diseases and pest. Symptom of K deficiency is reflected on leaves of crops. Leaves becomes yellowish, sometime seems to brown due to dryness due to lack of potassium presence in soil.	N-P-K	Water
Available S	Sulfur content of soil	>10 mg/Kg	It is the rare deficiency element in regular paddy field. But its deficiency effect plants metabolism system like production of chlorophylls, structural disorder, which results delay in plant development and late production.	N-P-K Burnt straw ash	
CEC	**C**ation **E**xchange **C**apacity of soil	>200 mmol/Kg	The Cation Exchange Capacity is the measure of cation cherish on the particle of the soil. It also reflects the capacity of the soil to perpetuate soil nutrition like K+, NH4+, Ca2+, etc.	Super Phosphate Potassium phosphate S coated urea	Water
Clay Composition	Degree of montmorillonite of soil	>50% montmorillonite	The composition of clay should contain organic matter but free from iron and aluminum oxides which help soil to becomes puddled soil.	Clay compound	Water
Active Fe	Content of Fe_2^+ in soil	>0.5%	Crops become dry and also effect the productions due to improper photosynthesis and plant metabolism in inadequate amounts of iron in soil. Pale yellowish leaves are symptom of iron deficiency in soil.	1. $FeSO_4$ 2.	Water
Active Mn	Content of Mn_2^+ on soil	>0.05%	Assimilation, protein synthesis and enzyme activities of plants are controlled by magnesium. Its deficiency effects the grain quality.	3. $MnSO_4$ 4. 5.	Water
Avail Zn	Amount of Zinc in soil	>1 mg/Kg	Zn deficiency is uncommon syndrome of soil but in flooded and heavily cropped soil it may occurs. A dusty brown spot marks appears on leaves due to deficiency of zinc after transplanting. It plays many roles in biochemical process and chlorophylls in rice plant.	Zinc Sulphate 6. Zinc Oxide	Water

Parameters	Quantity	Safe Range	Role	Fertilizer for negative adjustment	Fertilizer for positive adjustment
Avail B	Amount of Boron in soil	<5 mg/Kg	Short height of plant and leaves rolled up is the first symptoms of boron deficiency in soil and it continues throughout the crop cycle. This issue is rare but commonly found in high organic matter and low pH soil.	Anhydrous Borax Fertilizer Borate	Water

Table 2: N-P-K concentrations in different fertilizers used for Nitrogen

Fertilizer	% N content	% P content	% K content	Amount of application
Worm casting	1	0	0	10 - 15 lbs/100 Sq. Ft.
Feather Meal	12	0	0	4 - 8 lbs/100 Sq. Ft.
Fish Meal	9	4	1	5 lbs/100 Sq. Ft.
Bat Guano	10 (High N)	6	2	1 - 2 lbs/100 Sq. Ft.

Table 3: N-P-K chart for phosphorus concentration

Fertilizer	% N content	% P content	% K content	Amount of application
Soft rock phosphate	0	18	0	6 lbs/100 Sq. Ft.
Steamed Bone Meal	3	15	0	10 lbs/100 Sq. Ft.
Rock Phosphate	0	33	0	6 lbs/100 Sq. Ft.
Rock Dust (Crushed Granite)	0	3.5	0	8.5 lbs/100 Sq. Ft.

4 FRAMEWORK AND SYSTEM MODEL

In this section, the architecture of the proposed simulator for the land preparation of paddy crop fields has been framed and has been elaborated on the journey of development in the following sections of research paper.

1. Introduction of the front panel of the simulator: The proposed simulator has been developed in the swing Java platform [17] which provides users with a highly interactive simulator for land preparation which is needed for paddy rice cultivation. This work has been concentrated on designing a platform for monitoring and controlling the paddy crop field in a real-time manner. The front panel of the proposed simulator is shown in Figure 1. Front Panel has been divided into several sections “crop field area”, “setting up of the parameters”, “real-time monitoring”, “Soil composition monitor” and “controlling of the system”.

A brief discussion about the functions of each sector has been described in the following subsections:

(1) Field Area:

The grey plane area of the front panel is considered the crop field of the proposed simulator. This is the proposed land where the crop is to be placed.

(2) Chemical Monitor:

This section of the simulator tool is for monitoring the chemical parameters of the crop field along with the water level of the field. This part of the proposed tool has been programmed for the real-time monitoring system.

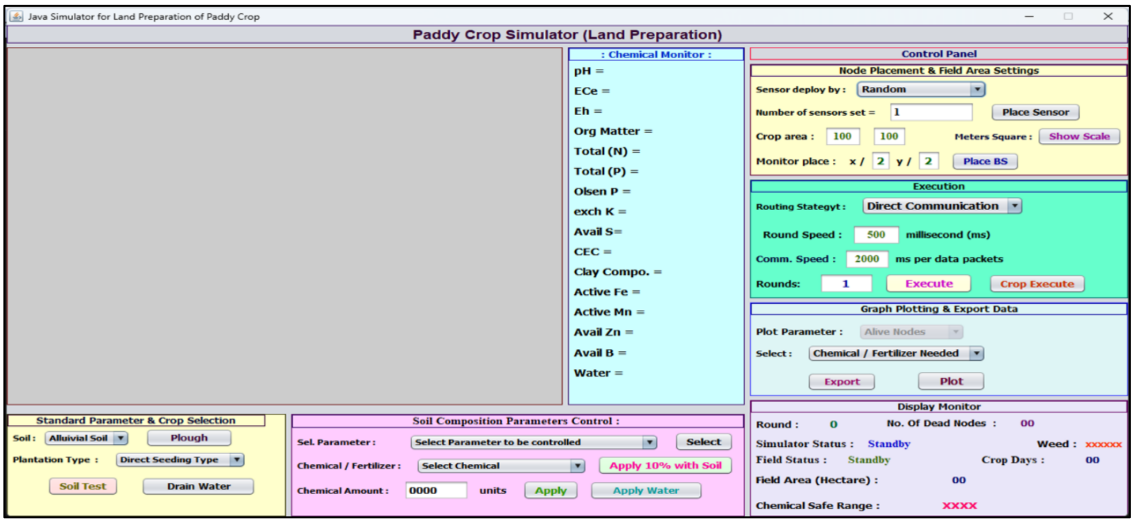


Figure 1: Front look of the proposed simulator

(3) Control Panel:

The control panel of this proposed Java simulator has been designed for parameter setting, monitoring, and controlling of the simulator. This part has been subdivided into four parts as below:

(i) Node placement and field setting: This is the first sub-part of the simulator control section where the user can predefine the area of the crop field in a meter square unit. Again, the user can place the sensor nodes randomly as depicted in Figure 2. In this same section of the panel, the user can select the number of sets of sensor nodes, and the position of the base station by entering the desired value in the parameter field. The "show scale" button is used to put a scale on the subjected field to extract the better knowledge of the position and location of nodes and base station as shown in Figure 2.

(ii) Execution section: This sector of the control panel determines the wireless communication routing strategy between the inter-sensor nodes and base station. Many routing protocols have already has been developed like Low Energy Adaptive Clustering Hierarchy (LEACH)[17], Hybrid Energy Efficient Distributed clustering approach(HEED)[18], Divide and Rule scheme (DR)[19], Threshold Sensitive Energy Efficient sensor Network (TEEN)[20], Grid Based Clustering(GBC)[21], etc. This simulator has been incorporated with two routing systems, one is "direct communication with the base station" and another one is a "Grid-based energy efficient routing protocol" [22]. Users can select any one from the drop-down menu provided in the execution section of the simulator labeled by the routing strategy option.

The second commodity is the "Round Speed", which is the time interval between two consecutive rounds of communication. In agricultural applications, this time is very long because the growth rate or rate of change of soil property is very slow, i.e., in terms of days or weeks.

Another parameter of this section is the "Comm. Speed", this is the time offered to the WSN system to send data packets from each sensor node to the base station. The base station then collects the data from all sensors aggregates the sensed value and puts it into the monitor panel. Both round and communication frequency are highly customizable as a user can set these values before the start of operation. Several rounds of communication are also customizable. Users can easily set the number of rounds of communication prior to starting the simulation.

"Execute" and "Crop Execute" buttons have been used to

Give the trigger to the WSN and Crop cycle procedure.

(ii) Graph Plotting and Data Export: This area of the proposed simulator tool is for plotting data sets like live nodes and, the power level of sensors with rounds of communications. This tool allows users to export after-simulation data in Microsoft Excel format for further analyses.

(iii) Monitor or Console: This is the output panel board of this simulator tool. Here, the user can monitor the parameterized and real-time data simultaneously. Live data like number of dead nodes, crop field status, area of deployment, safe range of selected soil nutrition level, rounds of communication, etc. Any abrupt or sudden change in field parameter is reflected on the console in a real-time manner and allows the user to take necessary action.

(4) Chemical Monitor:

This console screen has been designed to display the real-time reading of the level of chemicals, nutrition, water, etc. in the soil. This proposed simulator tool is equipped with various types of sensors for sensing several types of soil parameters.

Standard Parameter and Crop Selection:

This section of the proposed simulator has been designed for control the primary parameters of the agricultural process like selection of crop, plantation type and selection of soil. This sub part of the tool also offers the basic physical operation on the soil like plough, leveling and water level management. The soil test button has been used for testing the soil for all desired soil parameters and is displayed on the chemical parameter console panel. The console screen has been designed to display the real-time reading of the level of chemicals, nutrition, water, etc. of the soil. This proposed simulator tool is equipped with various types of sensors for sensing several types of soil parameters.

Soil composition parameter control:

This section of the proposed simulator allows users to maintain the soil quality which is preferable for paddy crop agriculture. The proposed simulator is enough equipped with the system, to add soil nutrients in the form of various fertilizers and chemicals. Again, this section of the simulator has been adorned with the in-build provision for adding water to the subjected land and draining out also if required. The operating process of this section has been elaborated below.

Select Parameter: By this option user could select the parameter to be controlled. As this option functions with the option menu, the work of user to just select the parameter which is much easier for newbies also.

(v) Chemicals / Fertilizer: User can select fertilizer or appropriate chemicals for the selected parameter which the user already select in option (a.). The proposed simulator has been trained earlier so that it can provide the desired list of only fertilizers that are needed for maintaining the level of nutrition of the soil.

(vi) Apply Process: This newly designed simulator offers two ways of imposing fertilizers on the soil. One is the "Apply 10% with soil" button, by which the simulator automatically sense the present level of selected nutrition with the help of appropriate sensor nodes and adds 10 percent of the present quantity to the soil. The second one is the direct process, in this process of adding chemicals to the soil, just put the quantity value in the provided text box and click on the "apply" button. After the application of the fertilizer simulator re-calculate the live status of soil quality and display on the "Chemical Monitor" panel.

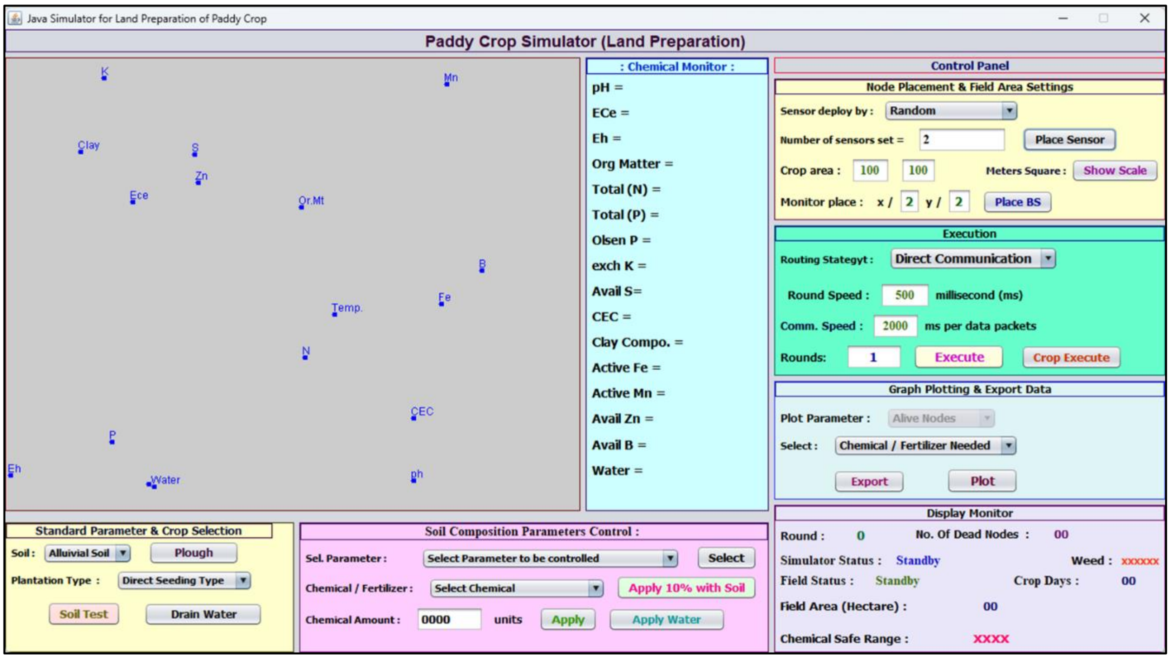


Figure 2 A crop field with 2 sets of sensor nodes and a base station at the center of the crop field in the simulator

2. Procedure to operate the Simulator

This section of this paper convoluted the procedure to set up and run this proposed simulator.

(a) **System Requirements:**

- Processor: 2.5 GHz (Dual Core) with 2MB Cache memory
- RAM: 4 GB (or more for better running of the simulator)
- Graphics Memory: 1 GB for better visualization
- Monitor Screen size: 21 inches (for better pictorial view)
- Operating System: Windows 8 onwards or Linux (64-bit)
- Java compiler: JDK 8
- IDE: Eclipse or NetBeans (updated version)

(b) Steps to start and run the simulator with a brief description:

The step-by-step procedure to start and run the simulator has been described below:

Step 1: Select the soil that is applicable for the crop and Plough the field properly by the soil select option and the “Plough” button in the standard parameter setting section of the front panel of the simulator respectively.
Step 2: In the Second step user has to select the plantation type, as this proposed simulator has been focused on paddy crop agriculture, the user can select either “Direct seeding type” or “Transplantation type” of plantation methods. In the case of paddy, the plant development, crop span, and maturity time depend on the plantation type of the crop.

Step 3: The third step for initializing the simulator is to fix the crop field area and sensor node placement. The proposed simulator offers high-profile customizability to preset the crop field area in a meter square unit and several sensor nodes to be placed in a selected node placement style. Simulators have three types of node placement strategies: Random, Manual, and Standard. The random option opts for the placement of nodes in a random manner. The Manual option is for the placement of nodes manually, the user can place a node just by clicking on the crop field area and the last standard style of node placement is that the simulator itself places the nodes in a symmetrical manner (concentric rectangular).

Step 4: This step is for estimating the quality of the crop soil which is considered for agriculture. So, the fourth job of the user is to test the soil by pressing the soil test button. This button triggers the sensor's plants in the field and by the communication method of the simulator, the initial aggregate value of sensed parameters is displayed on the “Chemical Monitor” as shown in Figure 3.

Step 5: Next job is now to observe the nutrition level of the soil which displayed in the chemical monitor panel. Proposed simulator is enough trained to judge the safe level of chemical presents in the soil. The chemical which are in the safe range in colored in green color and red font color depict unsafe range which may be due to the present access amount or inadequate quality with soil which is clearly shown in above Figure 3.

Step 6: This is soil correction stage. In this step, user have to select one by one parameters which are in red and correct them by adding appropriate chemicals suggested by the simulator shown in Figure 6(a) to Figure 6(f).
For a better understanding of operating the simulator in a user-friendly way, a flow chart has been shown in Figure 4.
Figures 6(a) to 6(f) show, how all five red-marked soil parameters have been corrected by adding chemicals suggested by the system. All soil parameters represented in red color are then one by one made normal by adding the appropriate fertilizer suggested by the simulator tool. Once the level reaches the safe range it automatically turns blue. The process of correcting the parameters with adequate as well as accuracy has been explained by the flowchart drawn in Figure 5.

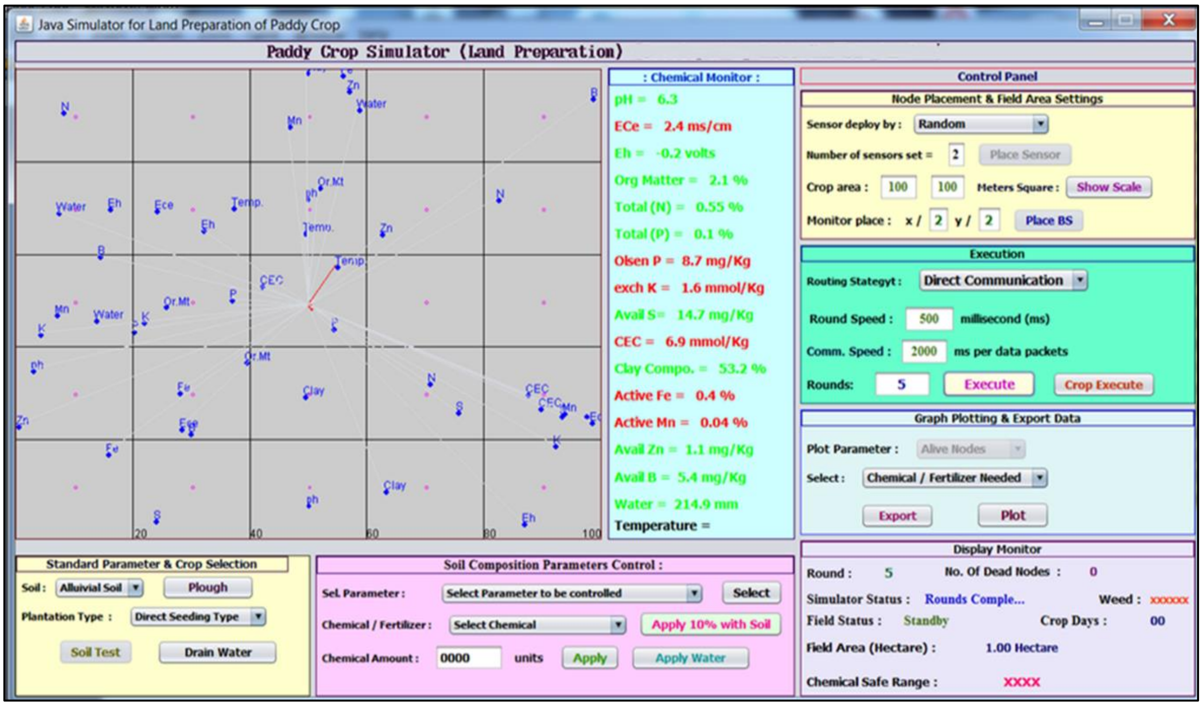


Figure 3: Front look of the proposed simulator

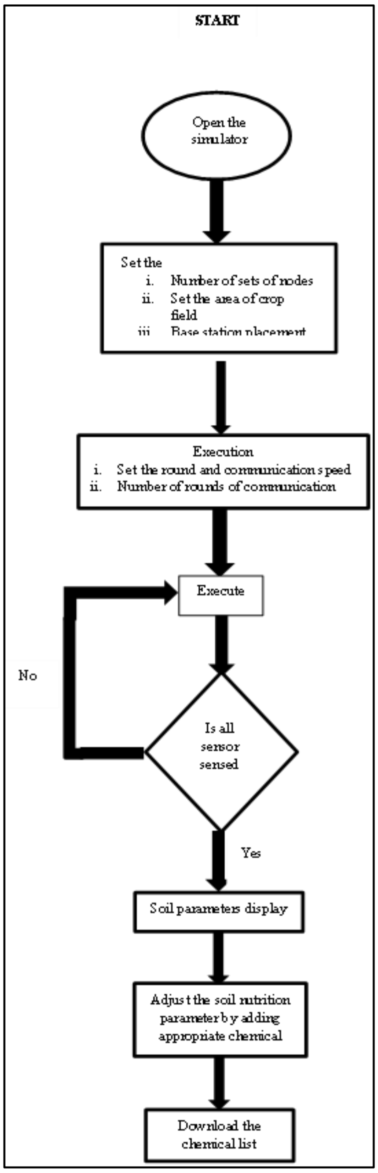


Figure 4: Flow chart of operation

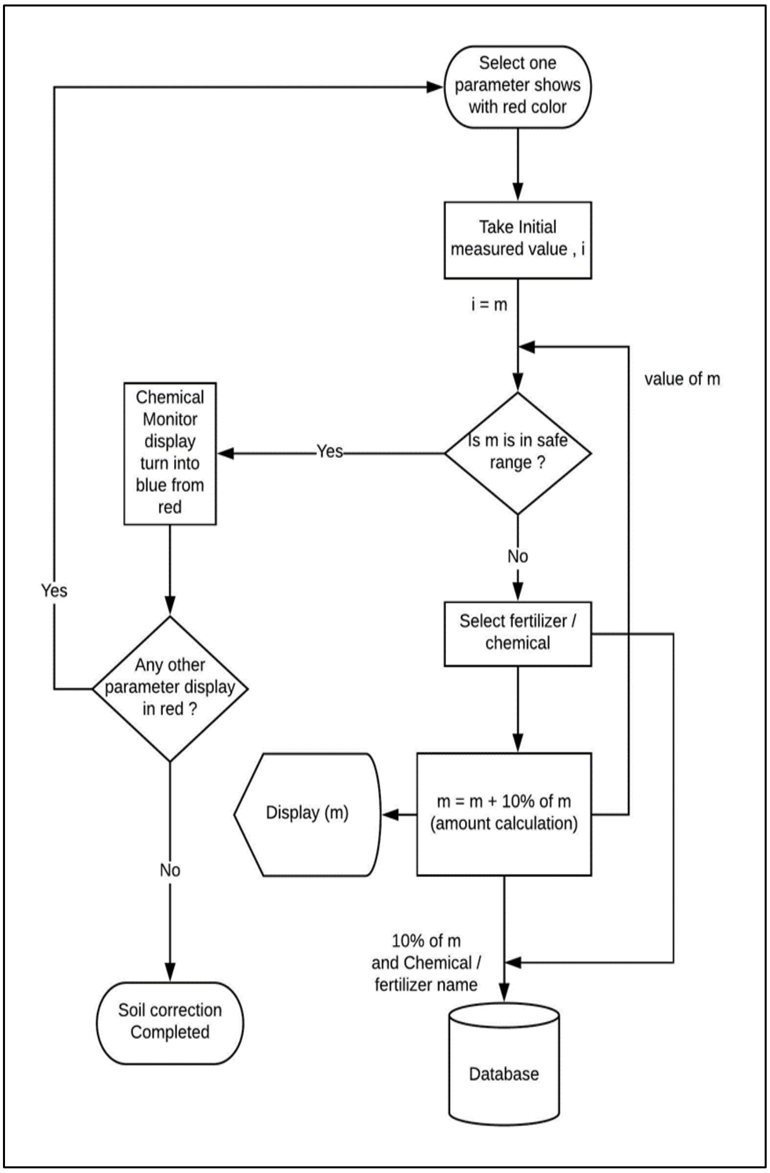


Figure 5: Flow chart of the soil correction process

5 EXPERIMENTAL SETUP AND SIMULATION RESULT

In this section, a thorough discussion has been done about how to operate the simulator as well as how one can get the exact details of soil parameters that are needed to fix for the preparation of land for paddy rice cultivation.

Experimental Setup: In this section of the paper an experimental demonstration has been carried out descriptively. In the first step, the jar (Java executable file) file is opened by double clicking over the icon, after that a window has been opened which is known as the front panel of the proposed simulator. In the First step, users have to select the soil variant, plantation type, and plough along with leveling the farm field with the help of the "Standard Parameter & Crop Selection" panel. Pre-set values of simulation parameter like number of sensor nodes, node placement strategy, crop field area and position of BS has been pre entered by user prior to start the simulation. Pre-set values of simulation parameters for this experimental setup are tabulated in Table 5.

Table 5: Simulation Parameters

Style Tag	Definition
Soil Type	Alluvial Soil
Plantation type	Direct Seeding type
Number of sensor nodes	50
Node placement style	Random
Crop Field Area	100 x 100 (1 Hectare)
Position of Base Station	Middle of Crop field
Round of Communication	1 (one)

[a] These are the parameters that are set before start the simulation.

In figure 5, the sensor nodes are represented by blue dots, which are being spread randomly throughout the crop field (represented by the grey-colored area). And the BS is located at the center of the field denoted by the red dot. After filling in all mandatory parameters for simulation in the desired parameter field, a soil test has been done by pressing the soil test button and the status of the targeted crop field has been shown in Figure 3.

The result of the soil test has been displayed on the “chemical monitor” panel with their respective appropriate unit. The measured soil nutrition which is adequately present in the soil is represented by green color and those that are present either in excess or deficient in quantity level are indicated by red color very clearly.

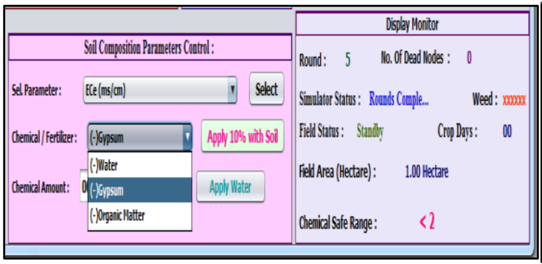


Figure 6(a). Soil Correction for Ece of soil

Figure 6(b). Soil Correction for Olsen P of soil

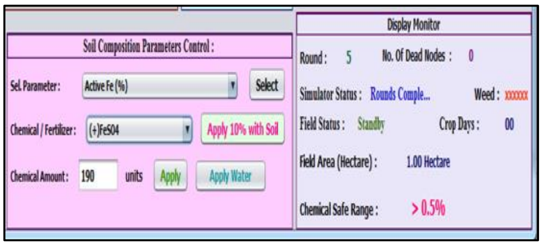


Figure 6(c). Soil Correction for Active Iron (Fe) of soil

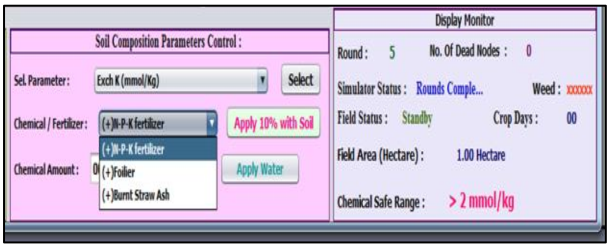


Figure 6(d). Soil Correction for Exchange Phosphorus of soil

Figure 6(e). Soil Correction for Active Manganese of soil

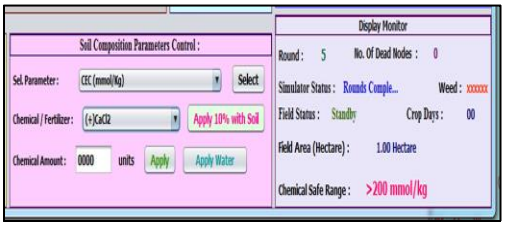


Figure 6(f). Soil Correction for CEC of soil

In this experimental test, after the soil test, six parameters are found to be insufficient and are mentioned in red colors are Ece (Electrical Conductivity), Olsen Phosphorus, Exchange potassium, CEC (i.e. Cation Exchange Capacity), Available Iron and Manganese content. The values and their safe range have been tabulated in Table 6. Now, users must make soil affable for the targeted crop by the application of appropriate fertilizer to the soil. The dynamic nature of the proposed simulator governs the fertilizer application system interactively and intelligently. It offers a suitable list of fertilizers for the user to select and apply to the soil by slow method. Users select the above six types of chemical parameters and correct the soil by adding suitable fertilizers one after another. The soil correction has been done by the algorithm charted in the below flow chart fig.6. Where i=initial value of soil parameter and m=updated value of soil parameter. All eight stages are shown in figure 6(a), figure 6 (b), figure 6 (c), figure 6 (d), figure 6 (e), and figure 6 (f). has been extracted from the lower part of the simulator. And right part of each figure shows the safe range of fertilizer.

The positive (+) sign before the chemical name depicts that the chemical is to raise the value and the negative (-) sign reflects that for lowering the value from measure one.

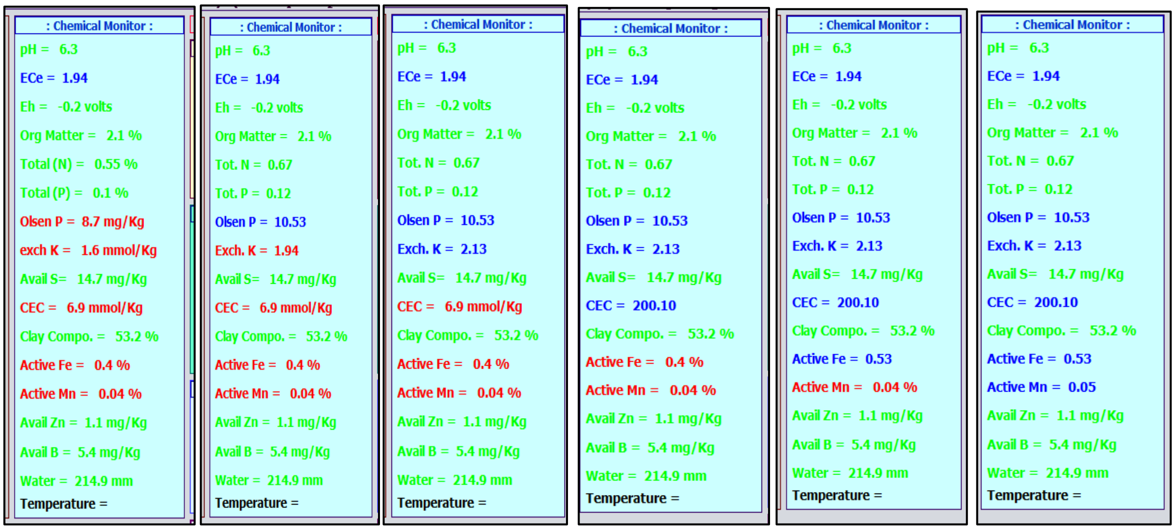
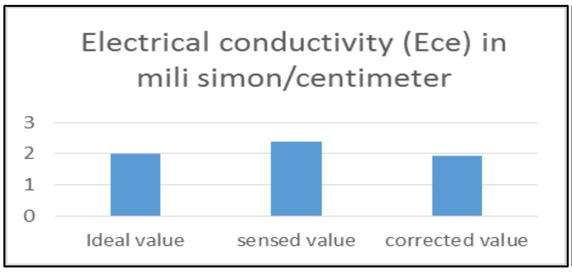


Figure 7. Step-by Step parameter wise Soil Correction

After adding chemicals/fertilizers in five stages, the chemical monitor at five different stages is shown below in Figures 7 and 8.



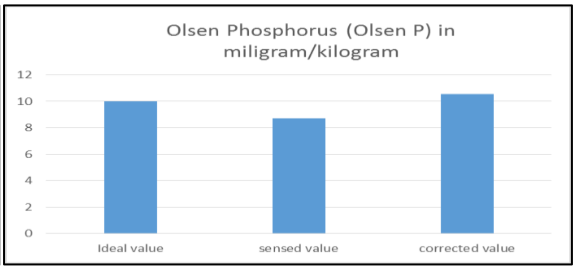
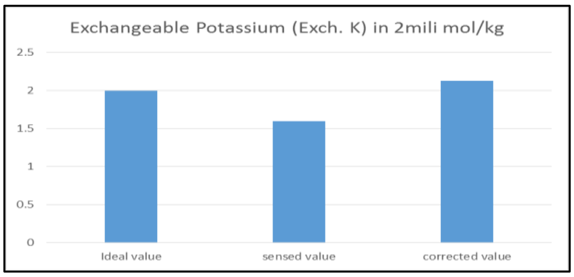


Figure 8(a) For Ece of Soil ***Figure 8(b) Olsen***



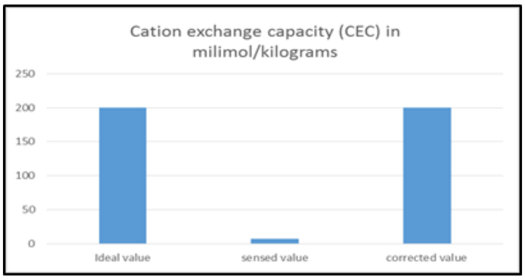
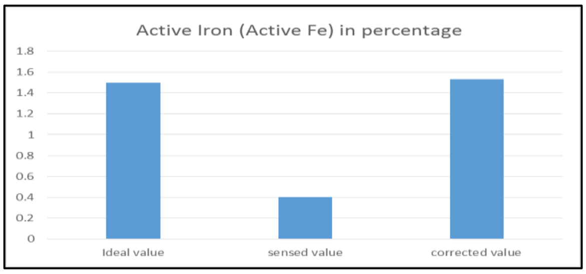


Figure **8(c) Exch. K.** **Figure 8(d) CEC.**



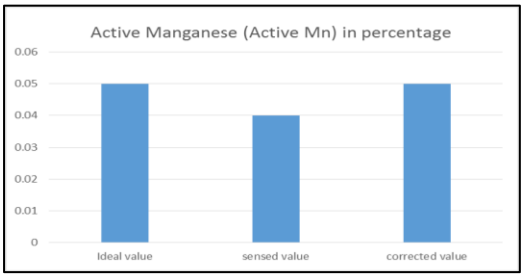


Figure 8(e) Active Iron. **Figure 8(F) Active Manganese.**

Table 6: The values and their safe range of those soil nutrition with inadequate value

Parameter	Sensed Value	Safe Range
ECe	2.4ms/cm	<2ms/cm
Olsen(P)	8.7 mg/kg	>10 mg/kg
exch K	1.6 mmol/kg	>2mmol/kg
CEC	6.9mmol/kg	>200mmol/kg
Avail Fe	0.4%	>0.5%
Active Mn	0.04%	>0.05%

This table showing the list of soil values which are not in the suitable range.

Mathematical Calculation:

A formula has been derived to calculate the amount of fertilizer needed for the adjustment of soil parameters

$$\text{Required amount of fertilizer} = \text{Required fertilizer application rate} \times \text{Respective chemical concentration in available fertilizer.} \ (1)$$

$$\text{Required fertilizer application rate} = (x \pm x')/10000 \text{ square feet area.} \ (2)$$

Where,

x = Safe range

x'= Sensed value

$$\text{Respective chemical concentration in available fertilizer} = 100 \text{ lbs of fertilizer}/\% \text{ of chemical present into the fertilizer.} \ (3)$$

5.1 Calculation to compute the amount of fertilizer to achieve the desired level of Electrical conductivity (Ece):

In this case, the safe range of Ece for the targeted application is less than 2 mili-siemens /centimetre (ms/cm) but the measured value is 2.4ms/cm. So, users have to add some catalysts to fix this difference. The proposed simulator shows an option of gypsum, organic matter, and water to add with the soil to reduce the Ece value and the option of Epsom Salt to increase the value of electrical conductivity as per requirement. After adding any one of the proposed fertilizers of chemical components to the soil, the targeted soil's Ece value can be corrected up to its desired level. Here Gypsum is applied to the targeted soil for the achievement of the desirable value of electrical conductivity (Ece). The targeted soil is now corrected in terms of Ece which has been monitored in the chemical display panel of the simulator as shown in Figure 6(a).

Mathematical Calculation:

Sensed Value = 2.4 milisiemens /centimetre

Corrected value =1.94 milisiemens /centimetre

Safe range < 2 milisiemens/centimetre

So the

Difference = (1.94 - 2.4) milli-siemens/centimetre

= -0.46 milli-siemens/centimeter

= -0.46 Deci siemens/meter

Now, as the value of electrical conductivity lies between 0.1 to 5.0 desi siemens per meter the multiplication factor for the conversion of unit from Deci-siemens to ppm is 640.

So the,

Difference= (-0.46 *640) ppm

= -294.4 ppm

= -294.4 mg/kg [As, 1ppm=1 mg/kg]

= -294.4 x 10^{-6} kg/kg

But our unit must be in pound units, so we need to convert this above value. Now as we know that

1kg=2.205 lbs

So, Difference = -2.94.4 × 10^{-6} lbs/lbs.

$$Required\ fertilizer\ application\ rate = (294.4 \times 10^{-6} lbs/lbs)\ /\ 10000\ square\ feet\ area.$$

Now 4300 lbs of Gypsum (CaSO4) contains 1000 lbs of soluble calcium.

So

$$The\ percentage\ of\ soluble\ calcium\ present\ into\ Gypsum = (1000/4300) \times 100 = 23.2\ \%$$

$$Respective\ chemical\ concentration\ in\ available\ fertilizer = 100\ lbs\ of\ fertilizer/23.2$$

$$Required\ amount\ of\ fertilizer = \frac{294.4\times10^{-6}\frac{lbs}{lbs}}{10000\ sq.ft.} \times \frac{100\ lbs}{23.2} = \frac{294.4\times10^{-4}}{23.2\times10^{4}}\left(\frac{lbs}{sq.ft}\right) = 12.689 \times 10^{-8}\left(\frac{lbs}{sq.ft}\right)$$

5.2 Calibration of Olsen Phosphorus (Olsen P):

For the adjustment of soil parameters Olsen phosphorus to the positive side N-P-K fertilizer can be used. In this particular simulation model tested value of Olsen P of the deployment area is 8.7mg/kg whereas the standardized value of this parameter is greater than 10mg /kg. So, the actual value we obtained after applying N-P-K fertilizer is 10.53 which we can see in the chemical monitor display panel section of the proposed simulator as shown in Figure 6(b).

Mathematical Calculation:

Sensed Value = 8.7 mg/kg

Corrected value =10.53mg/kg

Safe range >10mg/kg

So the,

Difference = (10.53-8.7) mg/kg of soil =1.83mg/kg of soil =1.83x10^{-6} kg/kg.

But our unit must be in pound units, so we need to convert this above value. Now as we know that
1kg=2.205 lbs
So, Difference = 1.83 × 10-6 lbs/lbs.

$$Required\ fertilizer\ application\ rate = \frac{1.83 \times 10^{-6} lbs/lbs}{1000\ square\ feet\ area}$$

$$Respective\ chemical\ concentration\ in\ available\ fertilizer = \frac{100\ lbs\ of\ fertilizer}{11.336\ lbs/lbs}$$

$$Required\ amount\ of\ fertilizer = \frac{1.83\ \times \frac{10^{-6} lbs}{lbs}}{10000\ sq.ft.} \times \frac{100\ lbs}{11.336 \frac{lbs}{lbs}} = \frac{1.83\ \times 10^{-4}}{11.336\ \times 10^{4}} \left(\frac{lbs}{sq.ft}\right) = 1.6144 \times 10^{-9} (\frac{lbs}{sq.ft})$$

5.3 The calculation to compute the amount of fertilizer to achieve the desired level of Exchangeable Potassium (Exch. K):

Soil parameter exchangeable potassium can be adjusted to the positive side using N-P-K fertilizer. In this simulation model, the tested value of Exch K of the deployment area is 1.6 mmol/kg whereas the standardized value of this parameter is greater than 2 mmol /kg. So, the actual value we obtained after applying N-P-K fertilizer is 2.13 mmol/kg which we can see in the chemical monitor display panel section of the proposed simulator as shown in Figure 6(d).

Mathematical Calculation:
Sensed Value = 1.6 mmol/kg
Corrected value =2.13 mmol/kg
Safe range >2 mmol/kg
So the

$$Difference = (2.13 - 1.6) \left(\frac{mmol}{kg}\right) = 0.53 \left(\frac{mmol}{kg}\right) = \frac{0.53}{0.0526\ \times 10^{3}} \left(\frac{gm}{kg}\right) = 10.0760 \times 10^{-3} \left(\frac{gm}{kg}\right)$$
$$= 10.0760 \times 10^{-6} (\frac{lbs}{lbs})$$

As,
1 gram of Potassium=1/mass no of potassium
=1/19 moles=0.0526 moles=0.0526 × 10^3mmol.
Again 1kg =2.205 lb

$$Required\ fertilizer\ application\ rate = \frac{10.0760\ \times 10^{-6} (\frac{lbs}{lbs})}{10000\ sq.ft.}$$

$$Respective\ chemical\ concentration\ in\ available\ fertilizer = \frac{100\ lbs\ of\ fertilizer}{21.58 (\frac{lbs}{lbs})}$$

$$Required\ amount\ of\ fertilizer = \frac{10.0760 \times 10^{-6 (\frac{lbs}{lbs})}}{10000\ sq,ft.} \times \frac{100\ lbs}{21.58 (\frac{lbs}{lbs})} = 0.467 \times 10^{-8} (\frac{lbs}{sq.ft})$$

5.4 Calculation to compute the amount of fertilizer to achieve the desired level of Cation exchange capacity (CEC):

Cation exchange capacity can be increased by adding clay matter to the tested soil and it can be reduced by adding water to the soil or by simply improving the drainage system of the crop field. In this particular simulation model tested value of the CEC of the crop field is 6.9mmol/Kg whereas the standardised value of this CEC is greater than 200mmol/kg. So the corrected value of CEC that we get after adding clay matter to the tested soil is 200.10mmol/kg which can be seen in the chemical monitor display panel section of the proposed simulator as shown in Figure 6(f).

Mathematical Calculation:
Sensed Value = 6.9 mmol/kg
Corrected value = 200.10 mmol/kg
Safe range >200 mmol/kg
So the

$$Difference = (200.10 - 6.9) \left(\frac{mmol}{kg}\right) = 193.2\ mmol/kg$$

$$Required\ fertilizer\ application\ rate = \frac{193.2\ mmol/kg}{10000\ sq.ft.}$$

$$Required\ chemical\ concentration\ in\ available\ fertilizer = \frac{100\ lbs\ of\ fertilizer}{35\ meq\ of\ clay\ matter\ per\ 100\ gm\ soil} = \frac{100\ lbs}{\frac{35\ meq}{100gm}}$$

$$= \frac{100\ lbs\ of\ fertilizer}{350\ mmol/kg}$$

$$Required\ amount\ of\ fertilizer = \frac{1932\ \frac{mmol}{kg}}{10000\ sq.ft} \times \frac{100lbs}{350\ \frac{mmol}{kg}} = 5.52\ \times\ 10^{-3}\frac{lbs}{sq.ft}$$

As, 1mili equivalent/100 gm =10 mmol/kg

5.5 Calculation to compute the amount of fertilizer to achieve the desired level of Active Iron (Active Fe):

If active iron is deficient (active Fe) in the soil of the deployment area, then it can be compensated by simply adding ferrous sulfate ($FeSO_4$) to it. A good irrigation system helps to balance out redundancies of active Fe in the soil of the deployment area. Here in this simulation model sensed value of soil parameter active Fe is 0.4% on the other hand standardized value of active Fe is greater than equal to 0.5% of the soil. After applying the fertilizer, we obtained the value of active Fe is 0.53% which can be seen in the chemical monitor display panel section of the proposed simulator as shown in Figure 6(c).

Mathematical Calculation:

Sensed Value = 0.4%
Corrected value =0.53%
Safe range ≥0.5%
So the,

$$Difference = (0.53 - 0.4)\% = 0.13\%$$

$$Required\ fertilizer\ application\ rate = \frac{0.13\%}{10000\ sq.ft.}$$

$$Required\ amount\ of\ fertilizer = \frac{0.13\%}{1000\ sq.ft.} \times \frac{100\ lbs}{36.5\%} = 3.5326\ \times 10^{-5} lbs/sq.ft$$

5.6 The calculation to compute the amount of fertilizer to achieve the desired level of Active Manganese (Active Mn):

Active manganese is one of the most important soil parameters. Inadequacy in active Mn can be normalized and solved by addition of manganese sulphate (MnSO4) into the deployment area. Here in the simulation instance, the sensed value of soil parameter active Mn is 0.04% on the other hand standardized value of active Mn is greater than equal to 0.05% of the soil. After applying the fertilizer, we obtained the value of active Mn is 0.05% which can be seen in the chemical monitor display panel section of the proposed simulator as shown in Figure 6(e).

Mathematical Calculation:

Sensed Value = 0.04%
Corrected value =0.05%
Safe range ≥0.05%
So the,

$$Difference = (0.53 - 0.4)\% = 0.01\%$$

$$Required\ fertilizer\ application\ rate = \frac{0.01\%}{10000\ sq.ft.}$$

$$Required\ chemical\ concentration\ in\ available\ fertilizer = \frac{100\ lbs\ of\ fertilizer}{6.2\%}$$

$$Required\ amount\ of\ fertilizer = \frac{0.01\%}{10000\ sq.ft} \times \frac{100\ lbs}{62\%} = 1.613\ \times\ 10^{-5}\frac{lbs}{sq.ft\ area}$$

In Figure 8, the graphical representation of the soil correction has been done for all five parameters in unsuitable ranges and needs to be corrected before starting farming.

6 RESULT ANALYSIS

This section concentrates on the final result achieved after the simulation process on land preparation for the paddy crop with proper soil parameters to get a better yield. Table 7 has been tabulated here for the various soil parameters that are sensed by the sensors and found not in the safe range for paddy agriculture. So, some chemical changes are needed to make this land suitable for cultivation. Our proposed simulation offers this technical support to make this unsuitable land into an affable one. So, to achieve this, the sensed values are being compared with ideal values and finally the amount of chemicals and fertilizers has been calculated in this table in per square feet areas of the cropland.

Table 7 is the final outcomes from this simulation in the form of datasheet, which has been provided to the farmers for the preparation of the cropland for paddy cultivation which helps farmers for the for the better yield, it can also be very helpful

to avoid the unwanted usage of fertilizers in the deployment area and also helpful for the maintain soil ecosystem of the cropland for the future agriculture.
The last column of the table contains the list of fertilizers' names and quantities required to correct the soil. This list helps our farmers to enhance their yield by providing technical support to them.

Table 7: Post Simulation Result

Soil Parameters	Ideal value	Sensed value	After correction	Deficiency	Amount of fertilizer required
Electrical conductivity (Ece)	<2mili Simon/centimeter	2.4 milisimon/centimeter	1.94 milisimon/centimeter	0.46 milisimon/centimeter	12.689×10^ (-8) (lbs/(sq.ft))
Olsen Phosphorus (Olsen P)	>10 milligram/kilogram	8.7 milligram/kilogram	10.53 milligram/kilogram	1.83 milligram/kilogram	1.6144×10^ (-9) (lbs/(sq.ft))
Exchangeable Potassium (Exch. K)	>2mili mol/kg	1.6 mili mol/kg	2.13 mili mol/kg	0.53 mili mol/kg	0.467 × 10^ (-8) (lbs/(sq.ft))
Cation exchange capacity (CEC)	>200 milimol/koilogram	6.9 milimol/koilogram	200.1 milimol/koilogram	193.2 milimol/koilogram	5.52 × 10^ (-3) lbs/ (sq.ft.)
Active Iron (Active Fe)	>0.5%	0.4%	0.53%	0.13%	3.5326 × 10^ (-5) lbs/(sq.ft.area)
Active Manganese (Active Mn)	>0.05%	0.04%	0.05%	0.01%	1.613 × 10^ (-5) lbs/(sq.ft.area)

This is the final table showing the list of soil fertilizers along with quantity.

7 CONCLUSION

This proposed work is drawing our attention towards land preparation for paddy crop agriculture in accounts to achieve the purpose of optimum yield of the production for the sustainable production and consumption pattern. The soil status of the targeted cropland is an important factor for preferable yield, so the preparation of such land before starting the plantation is the primary step to achieve a sustainable agricultural process. A Wireless Sensor network is one of the best-fitted technologies for collecting the soil parameters in terms of various chemicals like pH, nitrogen, phosphorus, etc. This simulator shall help farmers to identify the deficiencies or excessive in the soil parameters of the deployment area and also it provides a thorough list about how much and what type of fertilizer is needed to prepare crop fields for paddy crop agriculture efficiently. This proposed simulator also gives flexibility regarding the number of sensor nodes, the position of the base station, the number of rounds of communication between sensor nodes to the base station, the sleep time of each simulating cycle, the deployment area, etc. This simulator has the provision of thirteen different soil parameters collected from the targeted soil and calibrated properly for the purpose of good yield of paddy agriculture. For further proceeding of this work is to connect real sensors for collecting data from soil and transmit to the base station where the work of this java software is to calculate the amount and type of fertilizers applicable to that soil. Our future aspect of this work is to develop this simulator into a real-time application, where many real sensors are equipped with this software. Sensors are assembled in the crop field area where sensors are collecting the soil data and send to the system software where data are to be aggregate, process, and evaluate and create a list of fertilizer and soil chemical require for soil as a result. This result helps farmer to attain a sustainable production from agriculture to ensure food security which also assure the mitigation of poverty from the nation.

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