Simplex Algorithm support system for Optimization of crop yield monitoring system using Internet of Things (IOT)

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***Abstract*: The challenges facing the enhancing production of agricultural sectors in spite of endowed natural resources for necessary crop production are key issues to crop yield. Information and Communication Technology (ICT) plays a central role in improving the lives of the populace in the rural areas using a computer based agro information system. The simplex algorithm support for optimization crop yield monitoring of Internet of Things in improving the current practice in agriculture.**

An intelligent system that will help farmers to perform their duty automatically without much manual inspection was created. The system suggest some agro information that are relevant to the crop like varieties and soil types, planting time, maturity time, temperature, distance between crops, pest, disease, pest/disease control measure , rainfall, amount of sunshine, quantity and type of fertilizer to mention but few with its geographic information system. The application will help famers to have increase productivity and the efficiency of the crop yield.

The simplex algorithm using IOT will optimize the level of crop yield in the agricultural sector of Nigeria

***Keywords*— Agriculture, IOT, Simplex Method, Soil ph, Soil Humidity, Crop Yield**

I. INTRODUCTION

In Nigeria, before the discovery of Oil, agriculture is the most prominent sector where the country's major income depends on these fields. About 70% of the land mass in the country is used for the agriculture and about 70% of population depends on agriculture.

Agricultural Automation especially in under developed countries can help on effective yield and reduce human intervention. Information and communication technology in agriculture (ICT in agriculture), which is generally called e-agriculture, aimed at enrichment of agriculture and rural development through enhanced information and communication processes.

More distinctively, e-agriculture comprises of conceptualization, construction, development, assessment and application of ground-breaking ways to employ information and communication technologies (ICTs) in the rural area, with a principal focus on agriculture. [1] ICT includes mobiles, networks, devices, services and applications; these vary from inventive Internet-era technologies and sensors to other pre-existing aids such as installed radios, telephones, televisions and satellites.

Provisions of principles, norms, methodologies, and apparatus as well as development of individual and organizational capacities, and policy support are all key components of e-agriculture. Now-a-days Internet of Things (IOT) was being used in various sectors. India being an agricultural country it needs some innovations in the field of agriculture. For Remote Monitoring of the soil properties we need an IOT based system.

Internet of things sometimes recognized as the Internet of Everything (IOE) which comprises of the entire web enabled devices that collect, send and act on data obtained from their surrounding environments with embedded sensors, processors and communication hardware. Various sensors are embedded in the farm to know the soil information. Basically the soil parameters are Soil pH, soil Moisture, Temperature and Humidity.

These basic parameters of the soil will help in characterizing the soil and therefore in taking proper decisions. The design and realization of precision agriculture or site-specific farming has been made feasible by combining the Global Positioning System (GPS) and Geographic information systems (GIS).

These technologies enable the assembling of real-time facts collection with precise location information, leading to the resourceful manipulation and analysis of vast amounts of geospatial data. GPS-based applications in meticulous farming are being used for field mapping, farm planning, soil variety, tractor control, crop exploration, variable rate applications, and yield mapping.

II. REVIEW OF RELETAD LITERATURE

The dispute for developing nations to globalize is important and is intended to improve access to overseas capital, boost technology in order to boost the prospect for larger markets [2]. The continued raise in globalization and integration of food markets has intensified rivalry and efficacy in the agricultural sector, and has brought unique opportunities to embrace more smallholders into supply chains.

With the speedy development of Information and Communication Technologies (ICTs), data and information can be successfully generated, analyzed, stored, disseminated and used to sustain farmers and farming communities to progress agricultural productivity and sustainability. Globalization has led to several innovations in technology, example of the internet (ARPA 1962), mobile phones (1990s), radios, television sets, personal computers, and mention but few, that have made communication anywhere around the countries of world easier and faster. [3] opined that with the internet use farmers can access information concerning; crop yields increase, crop varieties, food production, prices and makers, and other agricultural issues is a key to food security. This will improve production, marketing and economy growth, if farmer are able to use the Internet in sharing information. Zimbabwe (e-Hurudza phones), India (Reuters Market Light), Zambia (prepaid voucher, MRIAgro), Kenya (MPesa, iCow), Ghana (mFarms) have made use of ICT innovations and have had increased agricultural outputs. India for example; the Reuters Market Light (RML) has improved farmers' productivity by 14-16 percent with farmers selling even more profitably [4].

Despite the fact that studies have shown e-agriculture increases total agriculture output in developed nations of the world and the reality that Nigeria has the mandatory labour to carry out such vast agriculture exploit tied to one of the most arable fertile soil for crops growing, in all of these Nigeria still partly relies on the importation of various agricultural goods to battle food insecurity.

Many studies in connection with information and communication technology on agricultural productivity have been conducted in Nigeria, but few of them have attempted to offer all-inclusive review and analysis of diverse information propagation models and their effects on agricultural productivity in Nigeria using quantitative secondary data. Hence, this study intends to establish the effect of ICT on agricultural productivity (Crop Production) in Nigeria.

ICT acceptance is now raising a lot of interest among economists. Literature is now experiencing whole lot of speculative and experiential debate on ICT and economic growth [5,6,7], inclusive growth [17].

Some papers investigated ICT penetration and agriculture sector [8,9,10,11,12,13,14], [15,16).

Furthermore, the challenges and opportunities in Technological flow and Economic growth in Africa [17]; ICT and Productivity [18] were explored. The exploit of ICT in crop growing can bring changes to the deprived and needy areas in an economy such as food security [19]. ICTs have all-encompassing advantage buildup, information storage and diffusion; makes things faster and easier [20].

Mobile technology might be used to surmount problems related to physical distance and mobility of people, allowing them to enlarge areas of practices and maintain links outside the pressing space of their homes, work, other local areas and increase access to timely and relevant information [21]. ICT might be used to transmit agricultural monetary transactions. The e-wallet modernism in Nigeria is a way of using SMS to order and pay for seeds and fertilizers.

Financial transactions are even made easier with the use of ICT as discount rates are given. This makes agricultural transactions timely and effective. A study carried out exposed that ICT is a genuine tool and necessity for agricultural and rural revolution even though it is not commonly accessed by farmers in these communities. It was recommended that information and communication technology facilities be made available in most rural localities in the state such as internet facilities, overhead projector, and the Agricultural extension staff should be trained properly in this area to be able to train farmers using ICT facilities [22].

Governments should train and retrain farmers to enlighten them on the current trends in agricultural farming through the extension workers which will go a long way in achieving ample crop production [3]. Labour, as well as capital and technology have a straight relationship with total agricultural productivity. From the results in the analysis done on the role of ICT on Agriculture in West Africa; labour and capital were elastic.

This implies that, for any change in Labour and Capital, agricultural yield increases more proportionately. These results were statistically significant [23]. Empirical evidence shows that ICT has a positive force on agricultural productivity. Most of the works used primary data which includes the use of questionnaires for data gathering [24,25, 26]. [27] put further that ICT has been confirmed to be the engine of development in the 21st century.

It has instituted its place in many sectors in West African economies and its magnitude cannot be over emphasized. However, [28] noted that there are risks involved in ICT implementation and no ICT resources can guarantee 100 percent protection. In sum, literature gaps have revealed that ICT use in agriculture has shown mixed results (positive and negative).

The outcome of this study contributes by validating one of the views with statistical backing to that debate.

III. APPLICATION OF IOT IN AGRICULTURE

Internet of Things (IOT) refers to the use of intelligently attached devices and systems to leverage data collected by embedded sensor actuators in technology and other physical objects. Internet of Things is a concept which enables interaction among the objects that are present in environment. Now-a-days IOT is being used in the agriculture. Quite a few sensors are provided to recognize the values of soil pH, soil moisture, temperature and humidity. [29], planned work on IOT based monitoring device in smart agriculture [39]. The aim of the paper is to make use of emerging technology i.e. IOT and smart agriculture via automation.

To advance the yield of the crop all the environmental factors plays a significant role. In this paper it provides the temperature monitoring and humidity in the field all the way through the sensors. In the proposed system CC3200 is the main block which consists of micro controller, network processor and Wi-Fi unit on the same line. Real time temperature values are sensed by infrared thermopile sensor-TMP007 which is used to sense the temperature value in the farm on a real time bases. This sensor has a built in digital control and math engine. To know the moisture of air with in the farm it uses the humidity sensor -HDC1010. Camera is interfaced with CC3200 to take images and launch that pictures through MMS to farmers mobile using Wi-Fi. For this it uses the camera booster pack via PCB using MT9D111 camera sensor. This article gives the ecological facts in the farm to farmer by the MMS. This reduces the human involvement and assist in taking suitable decisions for increase in the crop productivity. [30] built a IOT based system using sensors to monitor the crop. The author uses the diverse sensors like soil moisture, light, temperature and humidity.

It undergoes in 3 phases. 1. Data collection phase 2. Storing in database 3. Data processing. The information gathered from the sensors is sent to the micro controller, here it uses the arduino board and the data is stored in the database through the wireless transmission. The data will be processed in the last phase and the decision will be taken.

If the principles are lower than the anticipated level, a message will be sent to the farmer. [38] main goal is to supply the essential water to the farm at the right time. In this the researcher uses the humidity sensor, soil moisture sensor, temperature sensors and also calculates the duration of sunshine per day.

Based on this calculations required amount of water will be supplied to the farm. A Raspberry Pi and a cloud based IOT system is used to monitor the real time data of the crop field.

IV. METHODOLOGY

A range of options exists for good farm management practices, approaches and technologies that are based on biological processes. Examples include: conservation agriculture; integrated plant nutrient management; integrated pest management; and pollination management. These farm management practices are being progressively more, used to achieve sustainable crop production strengthening which has a key function in feeding humanity, today and in the future. Building a sustainable cropping system is a difficult multifactorial decision setback [31] that desires the conception, framing, building and review of planned cropping systems. Due to the multidimensional facet of the problem and, as a result, the enormous set of possible solutions, field experiments are not well-suited for their option and evaluation.

Given that sustainability encompasses economic, social and environmental dimensions, these dimensions are usually evaluated through special tools based on diverse multi-criteria decision-aid methods [31]. The term “Maximization” implies an optimization-related issue. Basically, optimization approach is searching procedures.

They entail evaluating a myriad of possible problem solutions in order to find the most excellent or optimal one. The dilemma, of course, is that there are infinitely many solutions to search. That is, extensive search of all possibilities is just unimaginable. This is why conventional optimization approach, such as 'linear programming' [32] and 'non-linear programming', seek to trim down the number of solutions to be searched - they trim the 'search space'. They rule out infinite swathes of possible solutions because of the constraints that constantly surround any problem. They then search only the enhanced solutions amid those remaining. This leads again to the dilemma of having to appraise all likely solutions - an impossible task. In other words, conventional optimization and extensive search are, regularly, simply impractical.

On this basis, an 'Evolutionary Computing' known as the 'SIMPLEX ALGORITHM' will be most suitable. It concedes that finding the demonstrably most favorable solution is impossible - it can only offer solutions that will keep getting better and approaching the universal optimal solution.

In general, Simplex Algorithms can further be understood as an “intelligent” probabilistic search algorithm which is helpful on such kind of complex crop yield optimization problem. Therefore, a model through hybrid Simplex algorithm approach is developed with a local search mechanism to give out an optimal or near optimal solution of the problem. Modelling itself provides a logical procedure for predicting process outcomes in conditions other than those that have been experiential. Decision modelling aims to establish the optimal decision, define the trade-offs between different outcomes that are intrinsic in a variety of decisions or forecast the likely decisions that will be taken by farmers in a range of practical situation.

Such models encapsulate knowledge of how a system is constructed of interacting processes and how each process works. They often combine experimental observations, expert knowledge and logic. In the physical world, models are normally very precise and allow us, for example, to send probes to the moons of Jupiter. In the biological world not only are processes less well understood, often because they are made up of many sub-processes, although the systems themselves are stochastic. Modelling assist decision making in sustainable agriculture does not require explanation of all essentials in fine detail-the approach needs to be adapted for the purpose.

Comparatively, plain descriptions of precise processes are sufficient if the processes are known to react to a limited subset of external conditions, or if other unmodelled effects can be dealt with during suitable adjustments to hold drift or errors. Early attempts at decision support systems in agriculture, such as Pro-Plant [33], relied entirely on expert knowledge base to train the user in what to do. Pro-Plant Expert continues to function as an expert counseling system and covers a range of crops, pests and diseases. PC-Plant Protection, developed in Denmark [34], also uses expert scoring rules and covers control of weeds, pests and diseases in wheat, with an emphasis on reducing chemical use. EPIPRE in The Netherlands [34,35] used experimental models to relate observed disease levels to credible losses, but use of the scheme has now declined as farmers have become educated about the significance of observations.

Predictive modelling of the outcomes resulting from actions enables a person to make a healthier decision. The methods to accomplish this range from education/training so that operators better understand the consequences of their actions, through analytical studies and reports which provide the decision maker with measures of the effect of various options, to computer based decision support systems that use the models interactively to recommend the best decisions to the operator. Modelling decisions for these systems wishes to combine a probabilistic approach to the series of possible outcomes with a deterministic description. The probabilistic approach could use stochastic modelling techniques but, for systems studies, express application of probability modelling techniques to repeated simulations is more likely.

The deterministic approach will generally describe component processes as logical relations or will use the fact that the overall system, the sum of the parts, often acts in a fairly conventional way. Optimization is a controlling adjunct to analytical modelling for both the user and the modeller. In principle, its aim, is to offer the farmer with the best choice. In this process, it is a very powerful experiment of the accuracy and completeness of a system model and, by connection, of the expert knowledge. In addition, these approaches are exemplified by a range of studies. In addition, farming system models provide the means to assess the implications for optimal crop yields and optimal soil fertility.

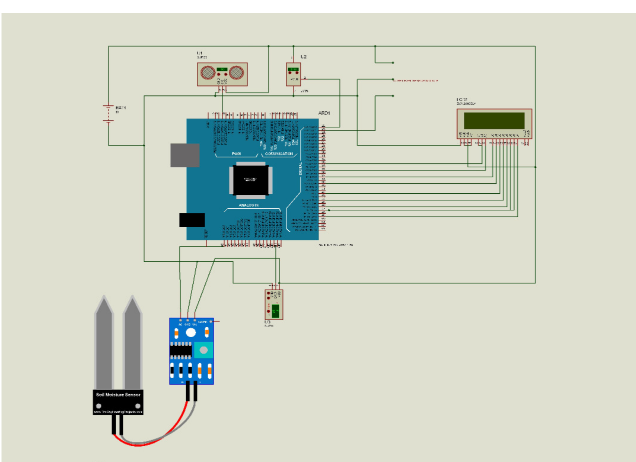

Fig 1: The circuit diagram which comprises of all the component used for the iot in agriculture

In the fig 1 above depict the complete circuit of the iot system, all components embedded in the circuitry each sensor has its functions in iterating the variable and feed back is generated for decision making.

Model outputs increase understanding of how strategic decisions, by farmer or regulator, affect system performance. This study intends to provide farmers with a decision model that makes crop yield maximization, as well as, the sustenance of soil fertility possible. From the discussion above and based on the paper work of [37], this study develops a nonlinear mixed-integer programming model to solve the maximization of crop harvest problem with supporting soil fertility. As it is an NP-hard problem, a Simplex Algorithms method is proposed to determine the crop yield maximization while sustaining soil fertility. The soil fertility depends on quite a few interconnected factors and these factors have their respective determinants.

Model formulation and specification

A model that captures the principal objective of this study is hereby specified with possible assumptions as follows:

1. Maximizing crop yield depends on the soil structure and soil fertility of the farmland.
2. Crop yield is being influenced, not only by soil fertility but also by myriads of other important factors such as water use, climatic condition, pests and diseases, weed competition, social factors to mention but a few.
3. The determinants of the crop yields are influenced by their respective exogenous variables.
4. Soil fertility, on the other hand, depends on factors such as soil depth, availability of water, drainage, aeration, pH, mineral composition, organic matter and soil organism.

V. CONCLUSION

One of the major findings of this study is that it is possible to have maximum yields resulting from controlled and scientifically managed interactions of different biophysical and technical components responsible to sustain soil fertility without depleting the soil nutrient.

The developed model with the use of Simplex algorithm approach helps to quantify various factors that influence soil fertility and relating them to the expected crop yields. The study identifies Soil depth, Availability of Water, Drainage System, Aeration, pH, Mineral Compositions, Organic Matter and Soil Organisms as factors influencing soil fertility. Also, it is observed that every factor identified has expected amount of crop yield associated with it.

The regression result shows that for every hundred percent alter in soil richness, holding other factors constant; the crop yield will change by 42%. It is pertinent to know that crop harvest can be maximized through proper sustenance of soil richness. This study depicts that when soil fertility and other farm related constraints are controlled, farmers can determine the magnitude of their farm outputs.

The relevance of this study cuts across every aspect of agriculture. This means that any problem in agriculture relating to maximization of farm output, minimization of farm expenses and other influencing factors in agriculture can be addressed by Simplex algorithm approach.

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