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Digital solutions and interventions in agriculture value chain and their measurable effectiveness

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Abstract

The effect of digitalization on corporate execution is restricted in view of the low degree of digitalization. The chain management link has improved performance significantly, reduced costs, and increased efficiency. Farm production processes, risk management, market trends, and strategic decision-making capabilities can all be improved with the knowledge and insights gleaned from an ever-increasing volume of digital data. On the other hand, advanced data analytics has the capability of reshaping the agricultural value chain as a whole. The relationships between technology and input suppliers, farmers, traders, processing units, retailers, and consumers may fundamentally shift as a result of digitization. Through the creation of a scientific model, this digitalization strategy investigates a variety

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of advancements, patterns, and strategies to improve farming efficiency in the computerized age. This paper aims to discuss the most significant opportunities and challenges presented by digitization processes for the rice production in northern India and south India. Predictive analytics, artificial intelligence, and the Internet of Things are widely regarded as promising new tools for ensuring a more sustainable resource use and increasing the agriculture-food industry's competitiveness and productivity. The introduction to this paper discusses several significant digital technologies, including Internet of Things. This paper also examines how computerized change can boost corporate execution & increase esteem creation. The research also evolved as digital transformation progressed. This paper presents a sensor-based strategy for the rice crops in India's north and south. To calculate the requirements for nitrogen, phosphorus, potassium, temperature, and humidity for rice crop agriculture in north and south India, an algorithm is proposed which uses approximately 2201 datasets. It makes it possible for farmers to cultivate a wide range of rice crops in their fields with minimal effort.

Subject Classification: *D46, 97K40.*

Keywords: *Data analyzation, IoT(Internet of Things), Smart cultivation, Agriculture technology, Smart farming.*

1. Introduction

In today's digital economy digitization can increase a company's value [1]. After constructing a digital system, a business can accelerate product innovation by connecting all links through a digital system, from design to sales [2]. Businesses accomplish digitalization and encourage innovation tasks [3]. The agricultural modernization is the comprehensive integration of the computerized economy and farming evaluation [4]. The incorporation of the Internet within entire facets of individuals' lives essentially affects the law of financial activity as well as the model of social evolution. [5].

Agriculture department information center released the "Assessment Report on the Development Level of Digital Agriculture and Rural Areas in the Country in 2020". It was noted that production in agriculture now accounts for 23% of total production, up from 18% in June 2019. When compared to other industries, agricultural businesses are not as digitally savvy However, in their respective sectors, agricultural companies have already implemented digital transformation [8]. Yin and others propose a realistic mechanism of digital transformation for agriculture industries [9]. The construction of a large digital center for agriculture and rural areas must be accelerated during the digital transformation [10] [11]. The digital system helps businesses more competitive, increase their economic benefits, and make them better able to deal with uncertainty. There are currently very few studies on agricultural listed companies' digital transformation performance.

The organization chose water as its entry point in 2019 and water conservation as its first step, relying on computerized innovation to find solutions to accurate water system, water and soil climate, and data innovation. The industrial chain includes large digital platforms for agricultural products, the traceability of agricultural products, farmers and rural areas, and the information of agriculture. The majority of research on the advanced transformation of horticultural endeavors focuses on hypothetical examination of the effects of digitalization on execution and value. Food and agricultural production face significant challenges worldwide. It will be necessary to provide a growing global population with nutritious food and clean water in order to combat climate change and its effects on agriculture, as well as to prevent further loss of biodiversity and preserve natural material cycles [12].

In this context, digitalization is seen as a promising strategy for improving existing agrifood systems and increasing sustainability. Precision farming, which can reduce the negative effects of agriculture on the environment while simultaneously increasing farmers' levels of productivity, profitability, and efficiency [13], is made possible by digital technologies, among other things. Additionally, by increasing transparency throughout value chains, block chain management may increase consumer trust [14] [15][16]. However, empirical research into the possible advantages and disadvantages of digital transformation has only recently begun [17] [18]. However, it is still unclear whether digitalization will fulfill all of its promises for agricultural production that is better for the environment. Previously, major mechanical changes in agribusiness, similar to motorization or hereditary designing [19], were constantly connected to various adverse results, as ecological debasement. It will, thusly, be pivotal for shape the electronic change in a viable way. We contend that the degree to which digitalization will significantly contribute to the resolution of the pressing sustainability issues will be determined by the design of economic, legal and political frameworks. In this setting, little attention has been paid to building socially responsible innovations to drive the digital transformation of agriculture [20] [21]. However, computerized change is a continuous cycle whose future mechanical turn of events and components are highly speculative and difficult to predict. It's possible that things will progress in very different directions, which will result in very different outcomes in the future [22].

The expressions “advanced change” and “digitalization” are used in Digital transformation [30]. A fundamental and ongoing process of socio-technological change marked by an increase in digitization over time. Digitization is the process of changing from analog to digital form. The methodology includes scientific analysis, which includes logical and comparative analysis, as well as generalization of the earned knowledge [31]. A digital penetration rate assessment in agricultural sectors of the constituent entities of the Russian Federation is carried out using statistical and qualitative methods.

As the development of computerized change expands, organizations will decrease expenses and increment productivity, make worth, and increment corporate worth in the whole business chain of the hydroponics business [32]. The problematization of moral issues in shared regimes related to the digitalization of agricultural systems makes possible a process of responsibility and the development of suitable governance strategies [33]. Recent advances studies on ethical issues and social ramifications of digitalization throughout the food chain [34] [35] [36] have a lot in common. A dataset [37] is used in this paper to improve India’s rice farming process.

This paper provides a summary of information that can be of assistance to farmers cultivating rice crops through the use of IoT-based agricultural practices. The background study and related work on rice cultivation using IOT in agriculture, as well as the outcomes that can be achieved with these technologies, are discussed in the second section. In the third section, the sensor-based framework for rice crops is discussed. The data on rice crop agriculture in the north and south of India that were gathered with the help of IOT are highlighted in Section IV. These data include the requirements for nitrogen, phosphorus, potassium, and temperature as well as humidity for rice crop agriculture. Also, last segment examines the end.

Background and related work:

The Internet of Things is used to control electronic devices [38]. The Internet of Things is utilizing in agriculture by combining automation with sensors [39]. The Internet of Things is also use for climate change. In a real-time environment, sensors can be used for inter communication of data [40]. Users can receive real-time environmental parameters using sensors and data stored in the cloud and monitored by Android applications using of Internet of Things. , IoT frameworks can permit the executives divisions and ranchers to control water system from any place [41].

Rice cultivation used high water supply, altered water control strategies [42]. Previously, farmers at the top of the system received more water than farmers whose fields were watered by long canals [43]. The area of a land regarding the water channel, fundamentally impacts the accessibility of water using IoT [44]. In addition, machines make human labor simpler and more productive. As technology advanced, devices were eventually designed to function automatically. An IP address recognition machine has been integrated into an Internet of Things system in order to address this issue and enable long-distance operation [45].

Advance irrigation system prototype has been developed for farmers to use water effectively and with minimum drain performance, so that the prototype can facilitate the work of the farmers [46]. In the aquaculture sector, water quality monitoring techniques are utilized to reduce fish mortality rates and prevent incidents of pollution [47]. The drainage gate can open automatically if there is more water than the limit in the irrigation channel [48]. Additionally, data can be directly retrieved from connected servers and displayed in the Android application section. A system that can adjust the level of soil moisture was developed to make farmers' jobs easier [49]. Every gadget can work appropriately as per the plan. Depending on the actual conditions, the sensor can read the moisture data of soil [50]. To regulate the condition of agricultural land's soil, IoT technology is combined with several sensors, including soil wetness, humidity and pressure sensors and connects the sensors to the Internet [51][52][53].

Methodology:

The primary objective of this observation is to discover a high-tech but affordable solution to precision agriculture. Both the prototype and the framework include a bespoke rice crop monitoring and response system. Figure 1 depicts the conceptual framework for the proposed system. The system consists of four components: specifically, sensors, an Arduino box, a cloud-based database, and an Android application. The Arduino box is connected to a water pump sensor, a temperature detector, a water level detector, and a soil moisture detector. The sensors keep an eye on the environment. The crop undergoes transformation, and its sensing data are continuously uploaded to the cloud firebase via the internet. When any unwelcome issues are discovered, the farmer will receive a notification

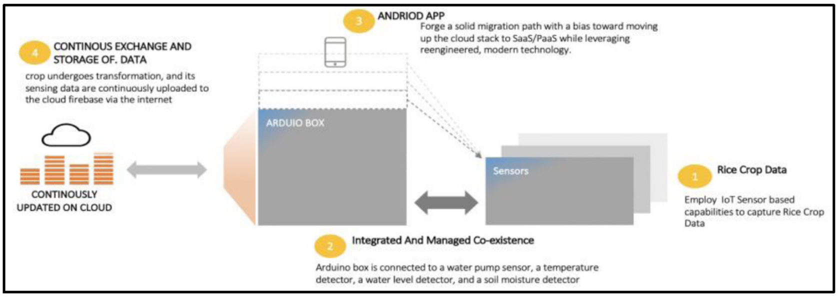

Figure 1

Sensor based framework for Rice crops

through the application. Depending on the type of alert, the farmer can make the arrangement as quickly as possible.

The Internet of Things system uses centralized processing servers to collect and process data from various sensor outputs and provides real-time input to green fieldwork devices. Consequently, all other sensor infrastructure is being incorporated into Internet of Things devices. For display output of the system, audio and video interfaces are used. The Internet of Things central processing unit processes the sensor data, which is made from raw data from the soil or other reasonable areas, at the best scheduled time. For rice crops, the threshold value for fertilizer is TH. N1, N2, and Nn are the sensor values

This methodology demonstrates that an IoT sensor network for continuous farm monitoring can be established. Sensors on the farm collect real-time information about the land, crops, livestock, and equipment, as well as fertilizer, soil moisture, temperature, humidity, acidity, and lighting. Farmers can decide where to divert their water supplies by utilizing data gathered from distant sensors. The smart agriculture model is based Wireless Mesh Sensor Network (WMSN). Due to its embedded networking intelligence and low power consumption, WMSN is also very efficient. Zigbee 5.8 (ALT5802) was our wireless communication protocol. It is a smaller 5.8 GHz ISM band remote handset module with a transmit power of +30 dBm and support for every Zig Bee and IEEE 802.15.4 feature. The use of WMSN applications in agriculture has the potential to boost productivity, profitability, and efficiency at the same time as reducing adverse effects on crops and the changing climate. The system includes a temperature sensor, a moisture sensor, and an active RFID sensor. It will be possible to make decisions based on an anticipated average state using real-time data from the cultivation area.

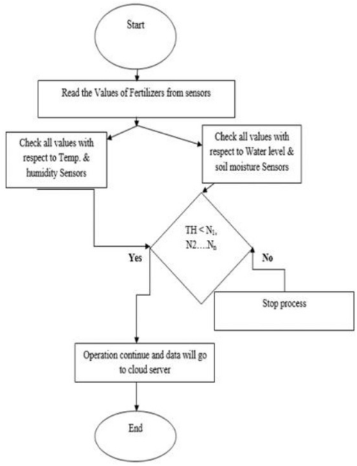

Figure 2

Rice Crop System using IoT Technology

In the simulation, we use a buzzer, four sprinklers, two temperature monitors, two water level monitors, and two motion detectors Figure 2. A home gateway connects all of the devices using Wi-Fi. Certain requirements must be met before those devices can be activated. As the minimum, the water level has been set at 5 cm. When the water level drops below this point, the sprinklers will automatically turn on. When the water level reaches 10 cm, the sprinklers will automatically shut off. The maximum temperature is set at 35 degrees Celsius. When the temperature reaches 35 degrees Celsius, the sprinklers will automatically turn on, and when it drops to 25 degrees Celsius, they will automatically turn off. Sprinklers one and two are controlled by the primary temperature screen and the first water level screen, while sprinklers three and four are controlled by the subsequent temperature screen and second water level screen. When any of the motion detectors detects any movement, the buzzer goes off by itself. Figure 3 calculate the rain fall needed for rice crop.

The north India dataset [54] taken for rain fall ETo = 6 mm/day, Kc = 1.1, · PERC = 5 mm/day, the water layer (100 mm) needs to be established · Pe = 135 mm/month. IN = ET crop + SAT + PERC + WL – Pe, ET crop = ETo × Kc = 6 × 1.1 = 6.6 mm/day = 6.6 × 30 = 198 mm/month, SAT = 0 mm, PERC = 5 mm/day = 5 × 30 = 150 mm/month,WL = 100 mm, Pe = 135 mm/month, IN = 198 + 0 + 150 + 100 - 135 = 313 mm/month. For 177 days rain fall is 185 cm.

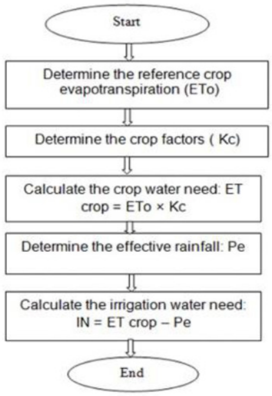

Figure 3

Calculations of Rainwater Needs for Rice Crop

TH vale of Nitrogen 50 : Phosphorus is 12 for Northern India. TH value of Potassium is 12 for Northern India and rain fall is 200. TH value of Nitrogen is 55 and Phosphorus is 14 and rain fall is 200 for South India. TH value of Potassium for south India is 13.

Result and discussion :

The proposed algorithm uses approximately 2201 datasets [37]. It enables farmers to cultivate a wide variety of rice crops with minimal effort in their fields. Enhance a variety of characteristics, including quality, competitiveness, and the global economy. Ranchers might have the option to acquire the important information or data about their harvests, and so on. The rice production in India from 1961 to 2021 is depicted in Figure 4.

The information gathered for IoT-based rice cultivation in India is outlined in Table 1. It demonstrates that the anticipated outcome is enhanced when the proposed algorithm is utilized for cultivation.

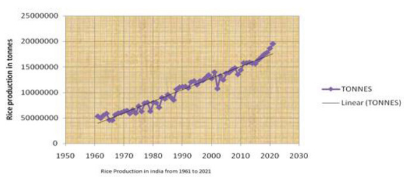

Figure 4

Rice production in India

Table 1

SerialNo.	Nitrogen(kg/acre)	Phosphorus(kg/acre)	Potassium(kg/acre)	Temperature (in degree celcius	Humidity (in percentage)	Rainfall(in cm)
1	90	42	43	20.87974371	82.00274423	202.9355362
2	85	58	41	21.77046169	80.31964408	226.6555374
3	60	55	44	23.00445915	82.3207629	263.9642476
4	74	35	40	26.49109635	80.15836264	242.8640342
5	78	42	42	20.13017482	81.60487287	262.7173405
6	69	37	42	23.05804872	83.37011772	251.0549998
7	69	55	38	22.70883798	82.63941394	271.3248604
8	94	53	40	20.27774362	82.89408619	241.9741949
9	89	54	38	24.51588066	83.5352163	230.4462359
10	68	58	38	23.22397386	83.03322691	221.2091958
11	91	53	40	26.52723513	81.41753846	264.6148697
12	90	46	42	23.97898217	81.45061596	250.0832336
13	78	58	44	26.80079604	80.88684822	284.4364567
14	93	56	36	24.01497622	82.05687182	185.2773389
15	94	50	37	25.66585205	80.66385045	209.5869708
16	60	48	39	24.28209415	80.30025587	231.0863347
17	85	38	41	21.58711777	82.7883708	276.6552459
18	91	35	39	23.79391957	80.41817957	206.2611855
19	77	38	36	21.8652524	80.1923008	224.5550169
20	88	35	40	23.57943626	83.58760316	291.2986618
21	89	45	36	21.32504158	80.47476396	185.4974732
22	76	40	43	25.15745531	83.11713476	231.3843163
23	67	59	41	21.94766735	80.97384195	213.3560921
24	83	41	43	21.0525355	82.67839517	233.1075816
25	98	47	37	23.48381344	81.33265073	224.0581164
26	66	53	41	25.0756354	80.52389148	257.0038865
27	97	59	43	26.35927159	84.04403589	271.3586137
28	97	50	41	24.52922681	80.54498576	260.2634026
29	60	49	44	20.77576147	84.49774397	240.0810647
30	84	51	35	22.30157427	80.64416466	197.9791215

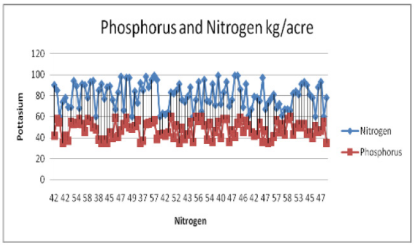

Figure 5

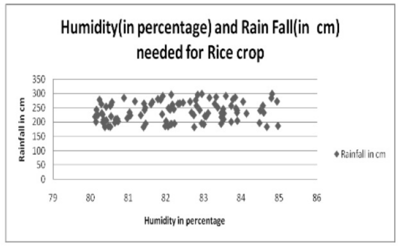

Figure 6

- Figure 5: need of nitrogen and phosporus per kg in one acre of land.
- Figure 6: need of humidity and Rainfall needed for rice crop cultivation in india.

We discussed macroeconomics, changing purchaser inclinations, arising advances and changing stockpile chains as the critical drivers for computerized change in agribusiness and how the difficulties confronting the farming business overall could be successfully handled by following the right methodology and utilizing innovation to satisfy the developing need for food. Climate change, population growth, and concerns about food security have prompted the industry to look for additional creative ways to increase crop yield up until this point. However, the current COVID-19 crisis has further highlighted the agricultural landscape's vulnerability and raised concerns about how to sustainably meet global food demand.

Conclusion:

Researchers from all over the world are looking into technical ways to use Internet of Things technology to improve farm efficiency in addition to the services that are already in place. This paper discusses the research on rice crop using IoT in north and south India. Agriculture will play a crucial role in the coming years. Therefore, Advance farming is required. The Internet of Things will assist advance farming, Time management, water monograph, crop supervision, soil monograph, disinfectant and pesticide control, and other aspects all benefit. In general, IoT technology is being used as a supplement to existing administrations by researchers to investigate novel solutions for increasing agricultural production. Farming assumes a significant part in the improvement of countries. As a result, IoT-based smart agriculture is required. Predictive analytics can assist you in making better decisions regarding harvesting in the forthcoming of the Internet of Things in farming. This paper calculates the rain fall, Nitrogen's, Potassium and phosphorus needed for north and south India. In the northern part of India, 185 cm of rain fell in 177 days. Nitrogen's TH value is 50; Northern India has a phosphorus level of 12. TH worth of Potassium is 12 for Northern India and rainfall is 200. For South India, the TH value of nitrogen is 55, that of phosphorus are 14, and the amount of precipitation is 200. The potassium TH value for South India is 13.

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