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Smart Agriculturing Based on KSK Approach: A Novel AI-Driven-IoT(AIIoT) Based Decision-Making Approach

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Abstract: *An enormous change is taking place in the agriculture industry as a result of the introduction of the Internet of Things (AIIoT), which is powered by artificial intelligence and provides farmers with unparalleled automation capabilities and insights. The purpose of this research is to present a comprehensive review of artificial intelligence and the internet of things (AIIoT) in smart agriculture, focussing on its applications, benefits, and consequences for decision-making. The concept of smart agricultural decision-making refers to a breakthrough method that enables farmers to optimise their farm operations while also making decisions that are well-informed. Farmers are able to increase crop yields while simultaneously reducing costs and hazards when they make use of advanced analytics, real-time data, and decision-making tools. The development of smart agriculture will result in farmers having increased decision-making authority, which will ultimately lead to an agricultural sector that is more sustainable and productive. The Internet of Things (IoT) and artificial intelligence (AI) in smart agriculture is a cutting-edge technology that has the potential to be a game-changer in terms of how we produce and consume food. Farmers may be able to improve agricultural yields and quality, streamline operations, and contribute to a food supply chain that is more efficient and sustainable if they use artificial intelligence and the internet of things. In spite of the fact that there are still certain problems that need to be cleared up, the Internet of Things (IoT) offers numerous advantages for smart agriculture, and its implementation is anticipated to increase in the years to come. The KSK technique, also known as the Knowledge-Sensors-Knowledge approach, is a suggestion made by Dr. Kutubuddin S. Kazi, who is also using his name. The output of the KSK technique results in an accuracy of 99.9% and a recall of 97.9%, respectively.*

Keywords: KSK approach, AIIoT, AI, Smart Agriculturing, KK approach, Sensors

I. INTRODUCTION

Technology is an area that is always evolving, and the agricultural industry has not been left behind in this regard. The production of food has been undergoing a transformation as a result of the implementation of smart agriculture, which is a term that encompasses the incorporation of advanced technologies into farming methods. The purpose of this review is to investigate the many facets of Smart Agriculture, including its advantages and the degree to which it has the potential to revolutionise the agricultural sector [1-6].

The Internet of Things (IoT), Artificial Intelligence (AI), and Big Data are some of the cutting-edge technologies that are essential to the implementation of Smart Agriculture. In order to collect, analyse, and interpret data from a wide variety of sources, including soil sensors, meteorological information, and satellite photos, these technologies are utilised. We use this information to make informed judgements about a variety of topics, including crop management, irrigation, and pest control, amongst others [13-20].

The capacity of smart agriculture to boost crop yields is among the most significant advantages of this method. The utilisation of data-driven insights enables farmers to optimise their crop management practices, which ultimately results in plants that are healthier and yields that are higher. In a world where the demand for food is rapidly increasing as a result of population expansion, this is of utmost significance [21-35].

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One additional advantage of Smart Agriculture is that it has the ability to lessen the negative effects that farming has on the environment. By utilising practices that are associated with precision agriculture, farmers have the potential to reduce their consumption of water, nutrients, and pesticides, hence lowering the environmental impact that their activities have produced. At a time when climate change and environmental degradation are among the most pressing concerns on a worldwide scale, this is of the utmost importance [36-45].

Additionally, there is the possibility that smart agriculture will improve the livelihoods of farmers. Farmers have the ability to raise their standard of living and boost their profitability by raising crop yields and reducing the costs of inputs. In addition, the utilisation of technology has the potential to assist in luring younger generations to the agricultural industry, which is now experiencing a scarcity of proficient labourers [46-55].

It is important to note that the implementation of smart agriculture is not without its difficulties. The initial investment in technology can be rather substantial, and there may be a learning curve for farmers who are not familiar with the processes involved in the use of advanced technologies. There are concerns regarding the privacy and security of data, in addition to the likelihood that automation would result in the replacement of jobs[56-67].

Taking into consideration the current state of affairs, Smart Agriculture is a huge step forward in the agriculture sector. It is possible for farmers to enhance their livelihoods, raise agricultural yields, and lessen their influence on the environment if they make use of increasingly advanced technologies. Despite the fact that there are obstacles to be conquered, the potential advantages of Smart Agriculture make it an investment that is worth making for the further development of agriculture [68-78].

II. DECISION MAKING (KSK APPROACH) IN SMART AGRICULTURE

The field of smart agriculture is one that is expanding at a quick rate and makes use of cutting-edge technologies to improve crop yields and optimise agricultural operations. The KSK approach to decision-making is an essential component of smart agriculture because it enables agriculturalists to make informed decisions that are founded on real-time data and predictive analytics. The purpose of this study is to give a comprehensive analysis of decision-making in smart agriculture by investigating important ideas, approaches, and applications [79-90].One of the authors, Dr. Kutubuddin S. Kazi, is the one who proposed and called the KSK method.

- Effective decision-making in smart agriculture is dependent on the availability of accurate and timely data. This is accomplished through the collection and integration of data. There are many sensors and Internet of Things devices that are used to collect data on the conditions of the soil, the health of the crop, the weather, and other pertinent information. It is possible to achieve a comprehensive understanding of the farming system by utilising data integration technologies, which allow for the seamless amalgamation of data from a variety of sources [26].
- Data Analytics and Modelling: Once the data has been acquired, this information is subjected to a variety of analytics and modelling approaches in order to derive useful insights. This is accomplished through the utilisation of machine learning algorithms, statistical models, and predictive analytics in order to recognise patterns, forecast crop yields, and optimise inputs. The knowledge that these models provide to farmers is extremely helpful in guiding their decision-making and [27]
- Decision Support Systems are software tools that provide assistance to farmers in the process of making decisions based on accurate information. DSSs are designed to integrate data analytics, modelling, and user interfaces in order to deliver individualised recommendations that are tailored to the specific circumstances of the farmer. They give farmers the ability to examine different possibilities, take into consideration trade-offs, and finally make decisions that are optimal [28].

For the purpose of decision making, Dr. Kutubuddin S. Kazi has developed a more recent approach. This method is usually referred to as the KSK technique. When it comes to decision-making systems of any kind, this technique is the most suitable option. Additionally, in order to ensure the safety of the Internet of Things framework, they suggested a way that they referred to as the KK strategy for Internet of Things security [29].

A wide variety of applications can be found for decision-making in smart agriculture, including the following:

- Crop management involves optimising irrigation schedules, fertilisation tactics, and pest control procedures in order to achieve the highest possible rates of crop yields.

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- Resource allocation refers to the process of effectively distributing resources like water, fertiliser, and labour by using data that is collected in real time.
- The process of classifying possible risks and developing mitigation procedures in order to avoid financial losses is referred to as risk management.
- Supply Chain Management: Increasing the level of coordination and collaboration within the agricultural supply chain in order to improve both efficiency and responsiveness to various market conditions.
- There are still a number of obstacles to overcome in smart agriculture, notwithstanding the progress that has been made in decision-making:
- Data Quality and Reliability: It is essential for efficient decision-making to guarantee the appropriateness and dependability of the data that is compiled from sensors and Internet of Things devices.
- Model Development and Validation: The process of developing and validating models that are accurate and resilient for the purposes of developing predictive analytics and making decisions is a continuing problem.
- User Adoption and Training: It is crucial for widespread adoption to provide farmers with the knowledge and skills necessary to make good use of decision support systems.

The decision-making-KSK technique in smart agriculture is a game-changing instrument that gives agriculturalists the ability to make informed decisions and improve the efficiency of their operations. Through the utilisation of decision support systems, the utilisation of sophisticated analytics, and the utilisation of real-time data, farmers are able to increase crop yields, decrease costs, and limit risks. The capacities of farmers to make decisions will continue to improve as the field of smart agriculture continues to develop, which will ultimately result in an agricultural sector that is more sustainable and productive [91-120].

III. PROPOSED METHODOLOGY

The integration of AI and IoT in the agricultural sector, often termed AIIoT, has revolutionised the domain of smart agriculture. This groundbreaking technology has revolutionised the management of crops, livestock, and overall farm operations, resulting in enhanced efficiency, productivity, and sustainability. The illustration in Figure 1 depicts the proposed system for Smart Agriculture, which is driven by AI and IoT technologies.

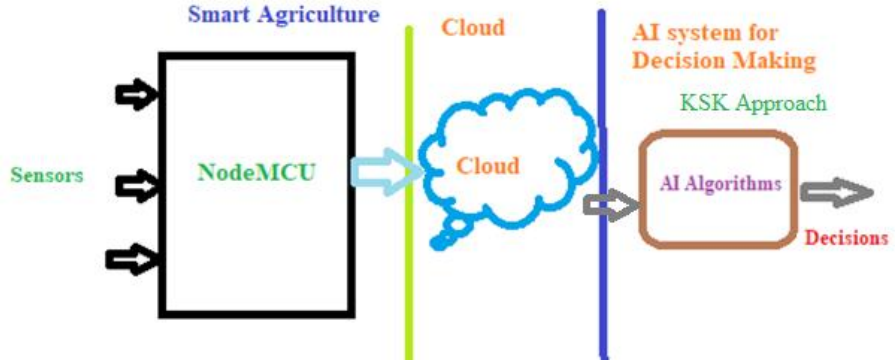

Figure 1- Proposed Smart Agriculture system employing KSK approach

The proposed system is divided into three components: the IoT section, the Cloud section, and the AI decision-making section. All sensors connect to the IoT section through NodeMcu. All gathered data from the farm, including moisture, temperature, and humidity, is linked to the IoT section through NodeMcu.

This information is stored and transmitted to the cloud, and it will be accessed for operations and analysis whenever necessary. In the proposed decision-making framework, the KSK approach recommends utilising ANN, DT, and K-NN classifiers. The ultimate result of the KSK method is the increased performance of all classifiers. The results are expressed in terms of accuracy and recall.

The integration of AIIoT in smart agriculture represents a sophisticated framework that employs sensors, drones, and various IoT devices to gather real-time data on multiple facets of agribusiness, including temperature, humidity, soil

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moisture, and crop health. This data undergoes analysis through advanced algorithms, yielding significant insights and recommendations for farmers, enabling them to make informed decisions and enhance their strategies.

The most significant advantages of AIIoT in smart agriculture lie in its capacity to enhance both crop yield and quality. Through the observation of soil conditions and weather patterns, farmers are able to modify their irrigation and fertilisation methods, thereby guaranteeing that their crops obtain the ideal amount of water and nutrients. This approach results in increased yields while simultaneously reducing the ecological footprint of agriculture, as it conserves water and curtails over-fertilization[121-130].

AIIoT significantly contributes to livestock farming alongside crop management. Utilising IoT devices, GPS trackers, and health monitors enables farmers to monitor the location, health, and overall well-being of their animals effectively. This enables the identification and management of potential health concerns at an early stage, thereby minimising the risk of disease outbreaks and enhancing overall instinctive welfare.

Furthermore, AIIoT in smart agriculture has the potential to revolutionise how farmers manage their resources. Through the examination of data regarding crop yields, weather patterns, and market trends, AI algorithms can offer farmers essential insights on optimal times for planting, harvesting, and selling their crops. This approach aids farmers in enhancing their operations while also fostering a more stable and efficient food supply chain[131-134].

Nonetheless, in light of the various advantages that AIIoT offers in the realm of smart agriculture, certain challenges remain that require attention. The primary issues revolve around the expenses and intricacies associated with the adoption of these technologies, especially for farmers operating on a smaller scale. There are significant concerns about data security and privacy, as the collection and analysis of sensitive agricultural data may be subject to misuse.

In conclusion, AIIoT in smart agriculture represents a transformative technology with the potential to revolutionise food production and consumption. Utilising the capabilities of AI and IoT, farmers can enhance their operations, boost crop yields and quality, and play a role in creating a more sustainable and efficient food supply chain. Despite the existing challenges, the advantages of AIIoT in smart agriculture are clear, and its adoption is likely to continue growing in the coming years.

Essential Elements for a Smart Agriculture System:-

- NodeMcu-2
- PCB
- 4 channel ADC
- Moisture sensor
- DHT11

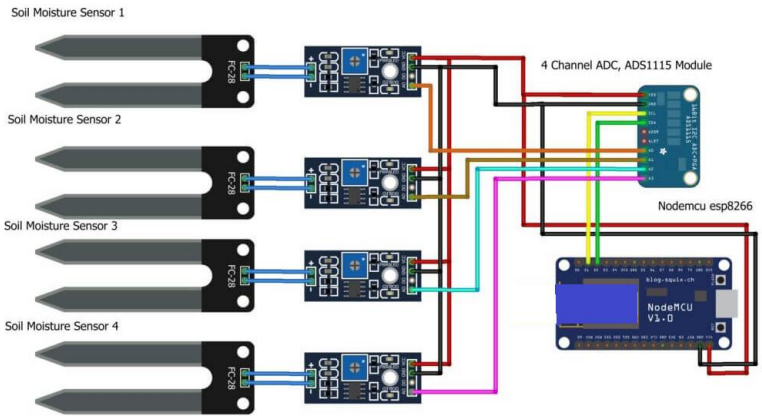

Figure 2- Soil Moisture connection

Steps in the Connections and experimentations –

- Must upload the code after creating all of the connections.
- Attach the Nodemcu Vin to every Soil Moisture Sensor Vcc.
- Attach the Nodemcu Vin to the Multiplexer Vcc;

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- Attach the ADC multiplexer's GND to the Nodemcuo GND and all of the soil moisture sensor's ground to the Nodemcuo GND.
- As shown in the above Figure 2, the multiplexer is connected to the output of the soil moisture sensor.
- Connect other sensors like temperature and humidity to Nodemcuo as shown in figure 3.
- Attach Nodemcu d3's DHT 11 output pin to it.
- The output of the soil moisture sensor is connected to the A0;
- Attach Nodemcu Vin to the DHT 11 Vcc.
- Link Nodemcu GND to the DHT 11 Gnd;

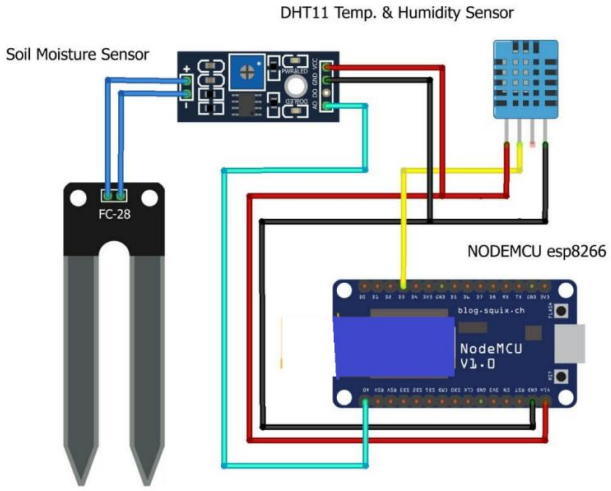

Figure 3- NodeMCU Connection with sensors

IV. RESULTS AND DISCUSSION

Upon completing the connections illustrated in Figure 2 and Figure 3, proceed to transfer the designated code (refer to Figure 4) to the Nodemcu.

```
#include <ESP8266WiFi.h>
#include <ESP8266HTTPClient.h>
#include <Adafruit_ADS1015.h>
WiFiClient client;
String thingSpeakAddress= "http://api.thingspeak.com/update?";
String writeAPIKey;
String tsfield1Name;
String request_string;
HTTPClient http;
 Adafruit_ADS1115 ads;
void setup()
{
 Serial.begin(115200);
 delay(3000);
 WiFi.disconnect();
 Serial.println("START");
 WiFi.begin("DESKTOP","asdfghjkl");   // Wifi ("ID","Password")
 while ((!(WiFi.status() == WL_CONNECTED))){
 delay(300);
 Serial.println("...");
```

Figure 4- NodeMCU initialization Code

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Initially create the ThingSpeak Channel for Smart Agricultureing system using IoT. The Sensors output is displayed on the created channel as shown in Figure 5.

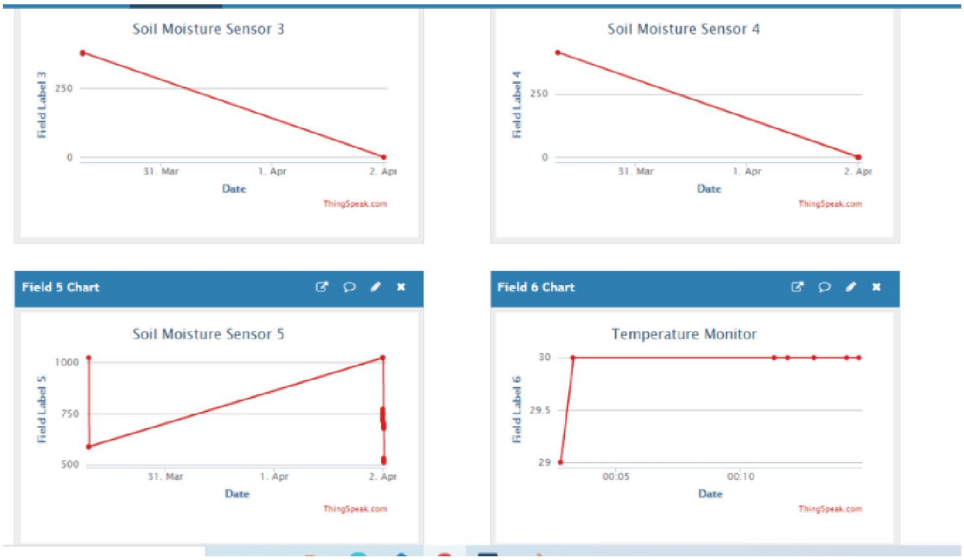

Figure 5- ThingSpeak Output

The effectiveness relies on the data obtained from the IoT-based smart agriculture system, which is linked to an AI system to facilitate informed decision-making. For that purpose, we will propose an approach known as the KSK approach. This method will inform the decisions, and based on these decisions, actions will be recommended to the user farmer. The choices involve watering, fertilisation, and similar actions.

Smart Agriculture leverages AIIoT to revolutionise conventional farming methods, improving productivity, sustainability, and profitability. Smart Agriculture utilising AIIoT is transforming farming by offering farmers unparalleled insights and control over their operations. Utilising AI algorithms and IoT sensors allows farmers to enhance crop production, minimise waste, improve sustainability, and ultimately boost profitability and resilience. As expertise continues to develop, AIIoT is expected to play an increasingly significant role in shaping the future of agriculture and ensuring food security for a growing population.

The integration of AIIoT in smart agriculture holds significant promise for transforming the agricultural industry. Utilising AI algorithms and IoT sensors allows farmers to optimise their operations, boost sustainability, and address the increasing food demand. It is crucial to tackle the challenges associated with data privacy and the digital divide to guarantee fair adoption and significant influence of AIIoT in the agricultural sector.

Here are several important advantages of Smart Agriculture utilising AIIoT:-

- Crop Monitoring and Optimisation: Sensors track soil conditions, plant health, and weather patterns, offering agriculturalists real-time data to make informed decisions regarding irrigation, fertilisation, and pest control.
- Precision Farming: Advanced algorithms evaluate sensor data to identify the ideal timing and dosage for crop inputs, reducing waste and mitigating environmental effects.
- Yield Prediction: Machine learning models forecast future yield by analysing historical data and current conditions, allowing farmers to strategically plan and adapt their operations as needed.
- Conservation of Resources: AIIoT systems track water and energy usage, enhancing efficiency and minimising waste.
- Monitoring and Assurance: Sensors monitor crop development and harvest records, guaranteeing clarity and accountability across the supply chain.

Figure 7 illustrates the results obtained from the KSK approach. The results of ANN, DT, and K-NN are presented in Figure 6, illustrating both Accuracy and Recall metrics. According to Figure 6, the ANN demonstrates an impressive accuracy of 99.9%, while the DT exhibits a notable recall of 97.9%. Consequently, the output of the KSK approach demonstrates an accuracy of 99.9% and a recall of 97.9%.

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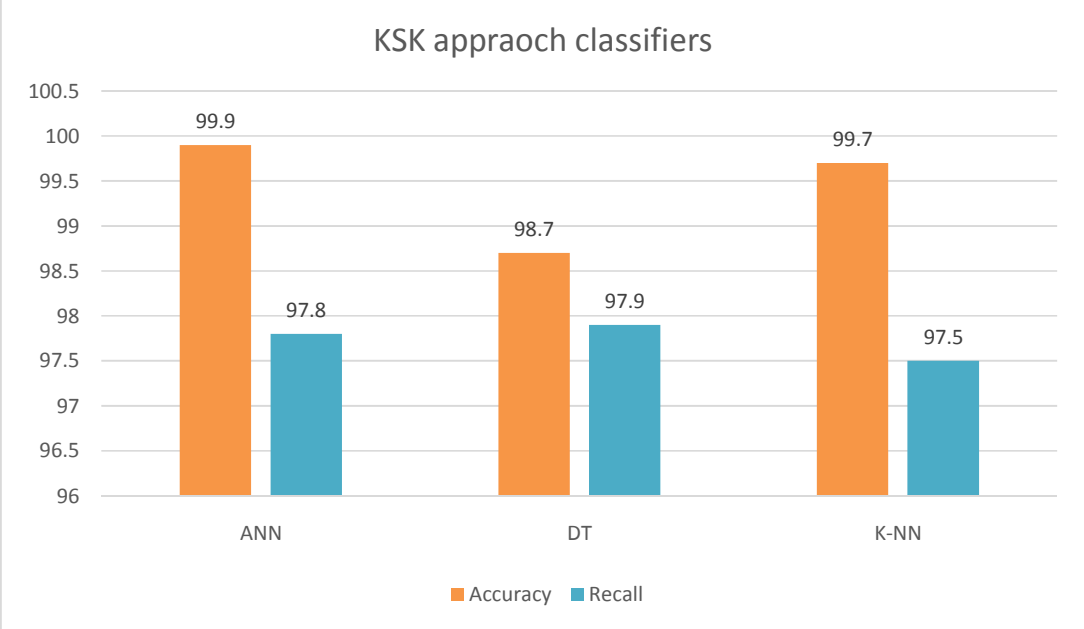

Figure 6- KSK approach employed Classifiers accuracy

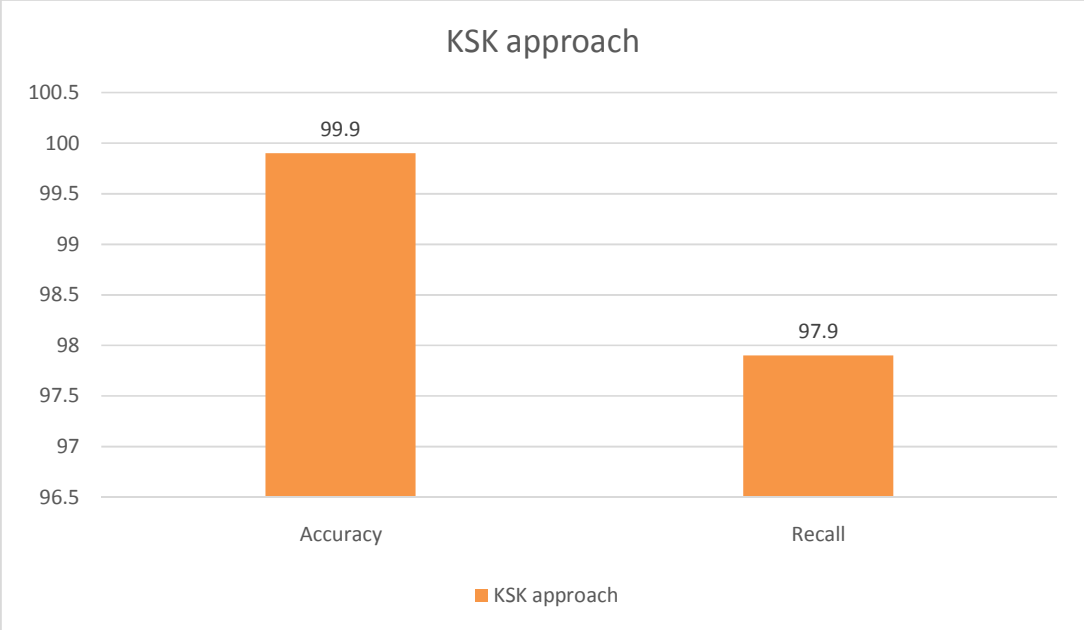

Figure 7- KSK approach accuracy

V. CONCLUSION

Agriculture encounters a variety of challenges, such as climate change, increasing population, and environmental degradation. Innovative agriculture, utilising the integration of AI, IoT, and various cutting-edge technologies, offers groundbreaking solutions. In the agriculture sector, the integration of artificial intelligence with the Internet of Things has emerged as a transformative influence, providing farmers with unprecedented insights and automation capabilities. This work aims to provide a comprehensive review of AIIoT in Smart-Agriculture, focussing on its applications, benefits, and impact on decision-making through the KSK approach. Smart agriculture employs decision-making as a

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pivotal instrument, empowering farmers to make informed choices and optimise their operations. Farmers can enhance crop yields, reduce costs, and mitigate risks by utilising real-time data, employing sophisticated analytics, and implementing decision support systems effectively. The evolution of smart agriculture will enhance farmers' decision-making capabilities, leading to a more productive and sustainable agricultural sector. AIIoT in smart agriculture represents an advanced technology that has the potential to transform the methods by which humans cultivate and process food. By leveraging AI and IoT, farmers have the potential to optimise their operations, enhance crop yields and quality, and contribute to a more efficient and sustainable food supply chain. The advantages of AIIoT in smart agriculture are clear, and its adoption is likely to keep growing in the future, despite the presence of certain challenges that need to be addressed. The KSK approach demonstrates commendable accuracy when evaluated against other advanced technologies. The KSK approach demonstrates an accuracy of 99.9%, with a Recall rate of 97.9%.

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