A Project Report,
on
"AI-Assisted Farming for Crop Recommendation & Farm Yield Prediction Application"

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1. Introduction

1.1. Overview

Agriculture in India is a support for most people and will never be under estimated. Although its share to gross domestic product (GDP) fell to less than 20 percent and contribution to other sectors increased , agricultural production is also growing. This has enabled us to become self-sufficient and has taken us from being post-independence food suppliers to farming retailers and integrated products. Total grain production in the country is estimated at a record 291.95 million tons, according to the second quarter prior to 2019-20. This is exciting news but according to a report by the Indian Agricultural Research Council (ICAR), demand for a food cup will increase to 345 million tons by 2030.

Population growth, increased income and global outcomes in India will increase demand for value, quality, and nutrition, as well as a mixture of foods. Therefore, the pressure to reduce the usable farming land to produce quantity, diversity, and food quality will continue to grow. India is blessed with vast arable land with 15 agricultural climate zones as defined by ICAR, which has almost a wide variety of climates, soils, and the ability to grow a variety of crops. India is a leading producer of milk, spices, pulses, tea, cashew and jute, and is the second-largest producer of rice, wheat, oil seeds, fruits and vegetables, sugarcane, and cotton.

Despite all these facts, the average production of many plants in India is meager. The people of the country in the next ten years are expected to be the largest in the world and providing them with food will be the most important thing. Farmers have not yet been able to earn decent wages. Even after more than 70 years of planning since independence, most farmers still face problems with poor production and/or poor returns.

1.2. Purpose

To help farmers in downplay the risk of agriculture, we propose creating a diligence that recommends the farmers about the best crops to be cultivated based on climatic parameters and also predicts the yield and revenue that would be generated for cultivated land. We use IBM Services to build Machine Learning models and integrate them with a User Interface for inputs.

2. Literature Survey

2.1. Existing Problem

- According to the 2010-11 Census of Agriculture, the total number of participants was 138.35 million with an average size of 1.15 hectares.
- Of the total catch, 85 percent in the low-lying and low-income farm sectors are less than 2 ha (GOI, 2014).
- Subsistence farming creates an economic measure that is referred to in the abundance of small areas.
- Low credit availability and the prominent role of informal lenders affect farmers' decisions in purchasing inputs and outbound sales.
- Less use of applied science, use of machinery, and less efficient production where the first two points are most troubling
- Increased quantity compared to developed countries and neglected processing of low levels at the farmer's level.
- Poor farming base that makes climate reliability, marketing, and supply chain suitable for high-value crops

2.2. Proposed Solution

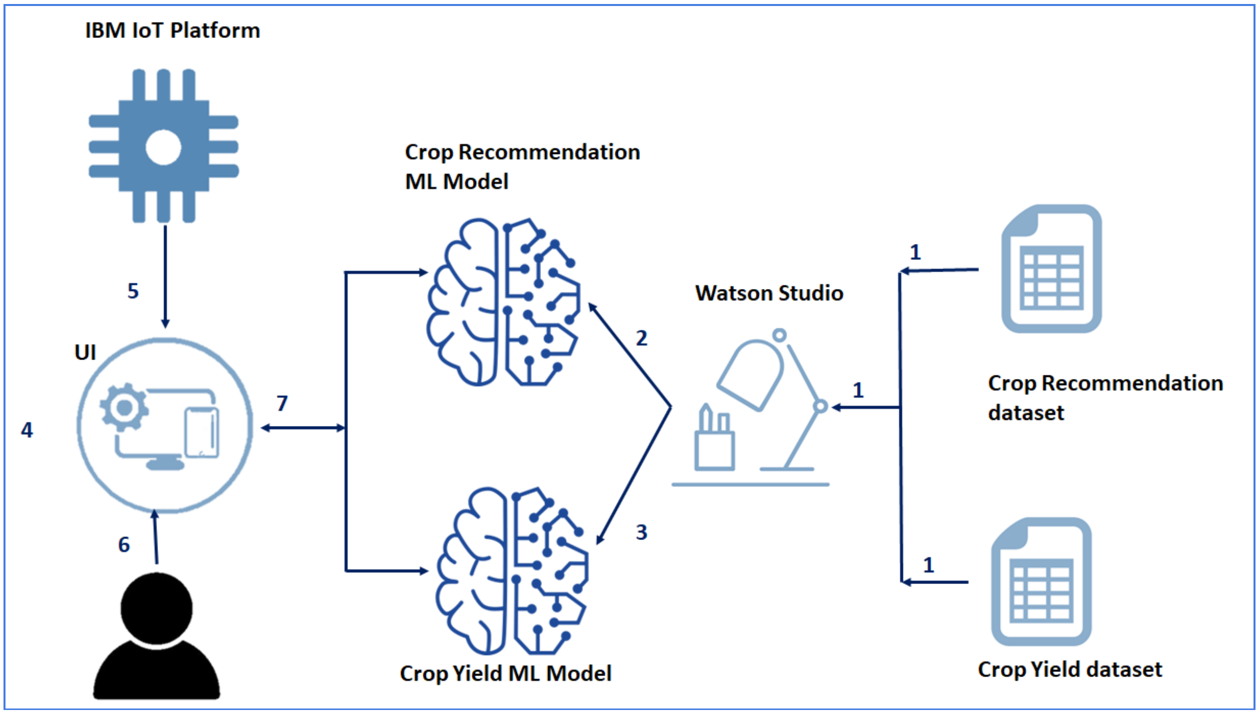
- To solve the problem, we have proposed a solution where we build a webpage/web dashboard, which is accessible to all.
- On the webpage user can input its field N,P,K levels, humidity, pH of soil, rainfall in the area or user got to IoT Input tab where based on user device and its location we get the required inputs. Based on these inputs, a crop which can be grown in that region is predicted.
- For prediction of profit there are field which takes input from user, which predicts the minimum support price based on input.
- To calculate profit a formula is used as

  Profit = (Production * Support Price) - (Cost of Cultivation * Support Price)

- All results are shown on that webpage, based on which the user can make its decision to which crop to grow in that particular season in his area.

3. Theoretical Analysis

3.1. Block Diagram



3.2. Hardware and Software Designing

As per the above block diagram we are creating a user interface which will be collecting data from the IoT device. We have created a simulation of an IoT device which will send data like a real IoT setup, for that we have used IBM Cloud IoT platform. For collecting Inputs from users we have used Node-Red. Then we have connected IoT platforms with Node-Red. Then models for crop recommendation and crop yield were created with the help of IBM cloud service called Auto-AI. Then after model was deployed on cloud later connected to Node-Red dashboard. Node-Red flow diagram is shown below in the flowchart section.

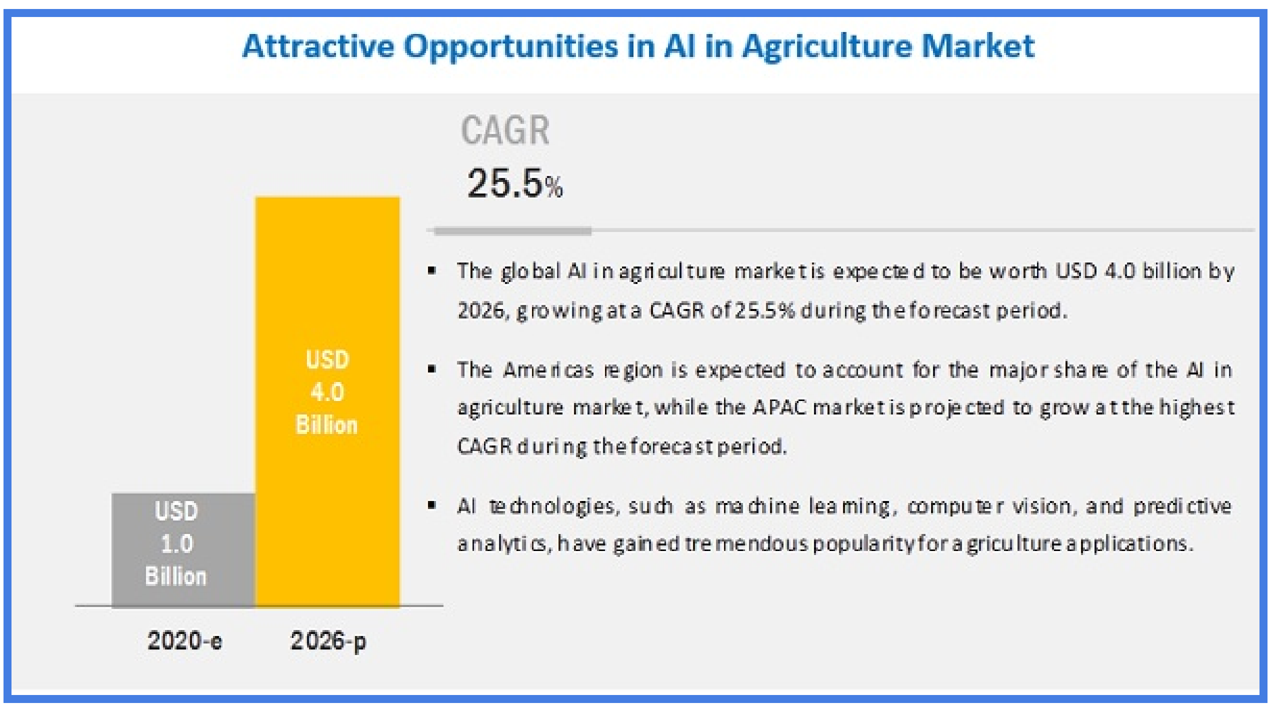
The following services are used to complete the project:

- Watson Studio
- Machine Learning
- Cloud Object Storage
- IBM Watson IoT
- Node-Red

4. Experimental Investigation

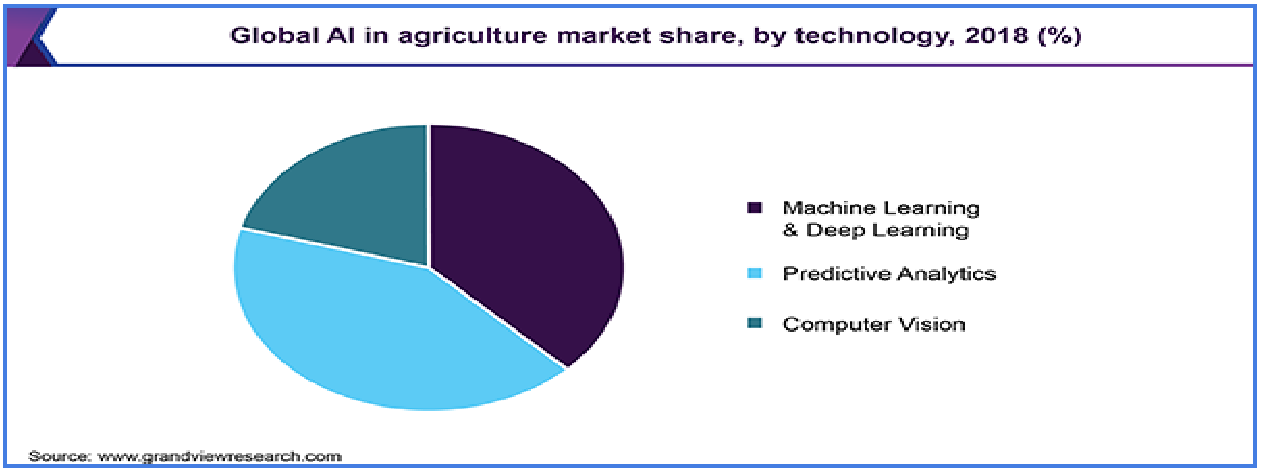
AI makes a huge impact in all areas of the industry. Every industry is looking to change certain jobs through smart machines. Agriculture is one of the oldest and most important lines of work in the world. It plays an important role in the economic sector. Globally, agriculture is a $ 5 trillion industry. The world's population is expected to reach more than nine billion by 2050 which will require a 70% increase in agricultural production to meet demand. As the value of land increases because water and land resources are inadequate to drive procurement. Therefore, we need a smart and efficient approach to how we cultivate and how we can produce the most.

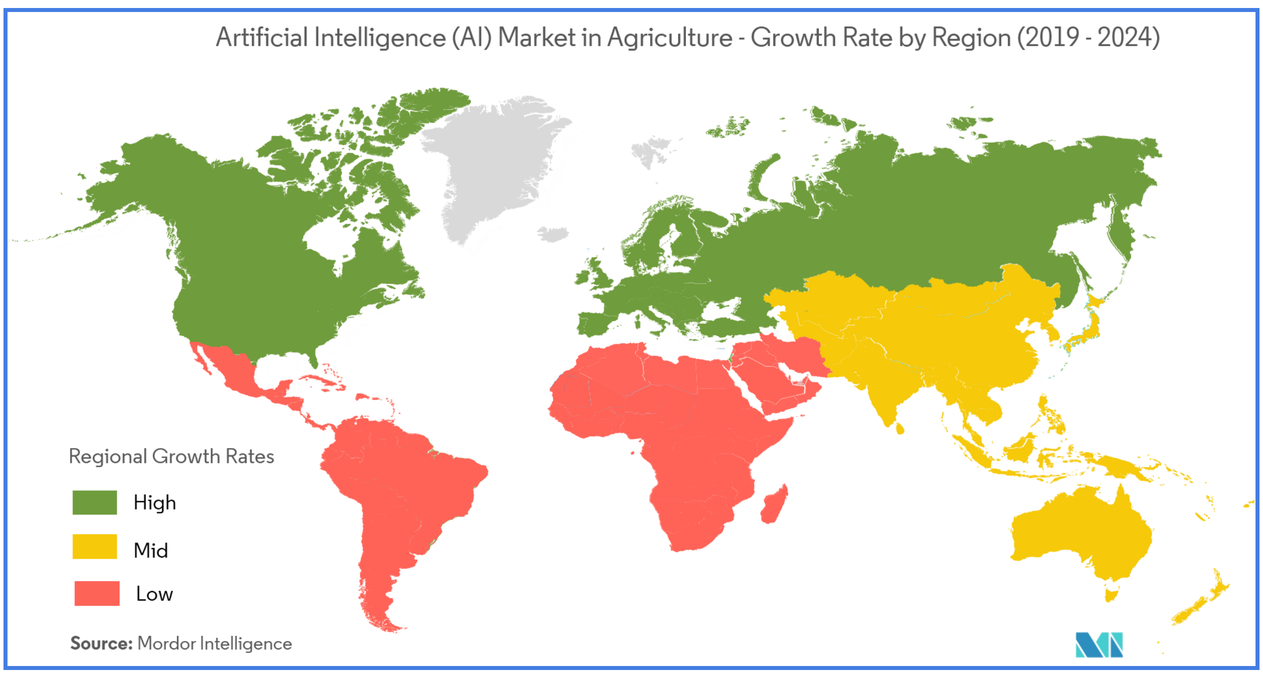
In agricultural conditions such as rain, temperature and humidity play an important role in agricultural life. Deforestation and pollution are causing climate change, so it is difficult for farmers to make decisions on soil preparation, seeding, and harvesting. Every crop requires specific nutrition in the soil. There are 3 main nutrients nitrogen(N), phosphorous(P) and potassium(K) required in soil. The lack of nutrients can lead to poor quality of crops. Agricultural AI applications have developed applications and tools that help farmers to have a fair and controlled farm by providing suitable guidance to farmers on water management, crop rotation, timely harvesting, the right crop to plant, good planting, pest control, and food management.



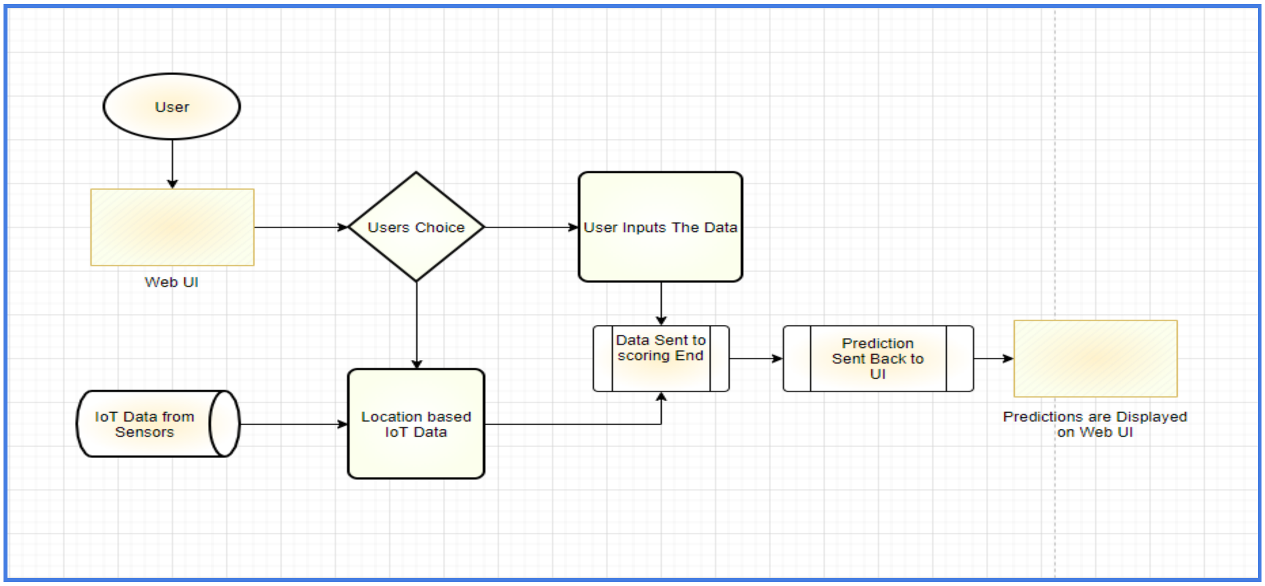
Global surveillance for agricultural market size was appraisal at USD 608.9 million in 2018 and is expected to register a CAGR of 25.5% from 2019 to 2025. Therefore, agribusiness companies adopt artificial intelligence applied science based on predictable statistical solutions. Applications and strategies based on AI help to control pests, produce healthy plants, monitor soil, and improve agricultural-related activities throughout the food chain. Artificial intelligence is being adopted by the agricultural industry to improve harvest quality and accuracy because it helps to analyze farm data.

Based on application, the market is divided into precision farming, drone analytics, agricultural robots, livestock monitoring, and more. The precise agricultural sector is expected to address a substantial market share in the medium term. Precision Farming is one of the fastest growing applications for AI in farming. It helps farmers reduce costs and improve productivity. Proper farming uses AI to collect data, interpret and analyze digital data.

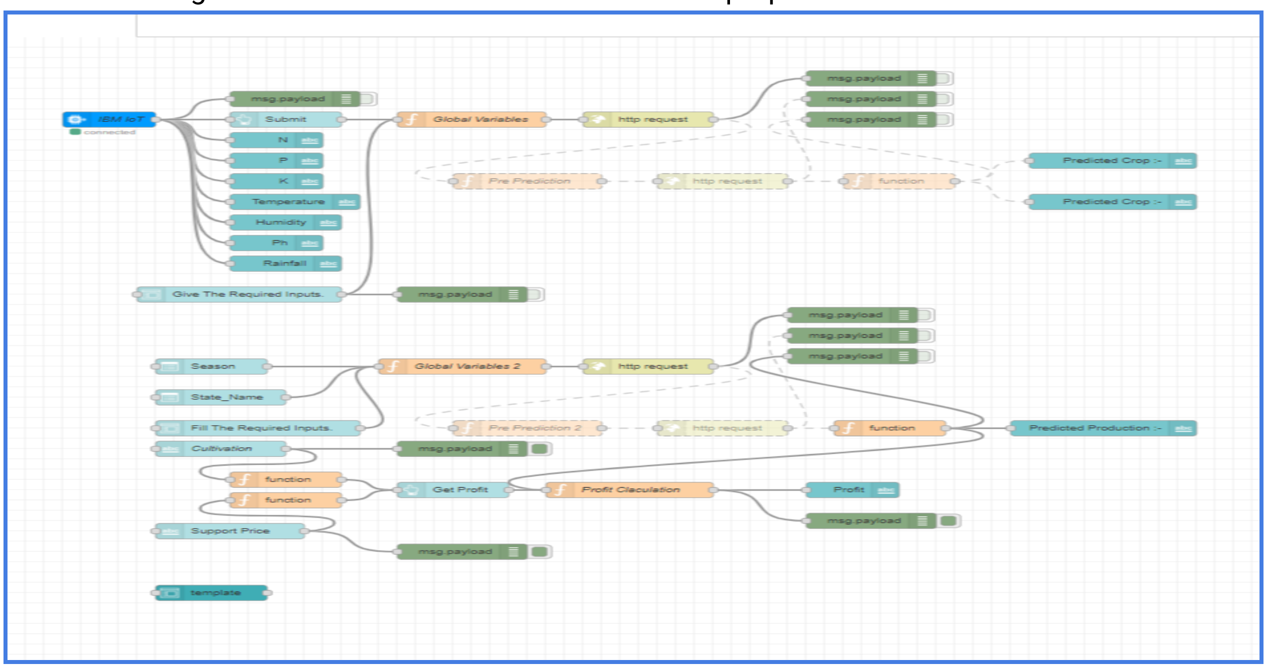




5. Flowchart



The flowchart given below shows the actual flow of the proposed solution.

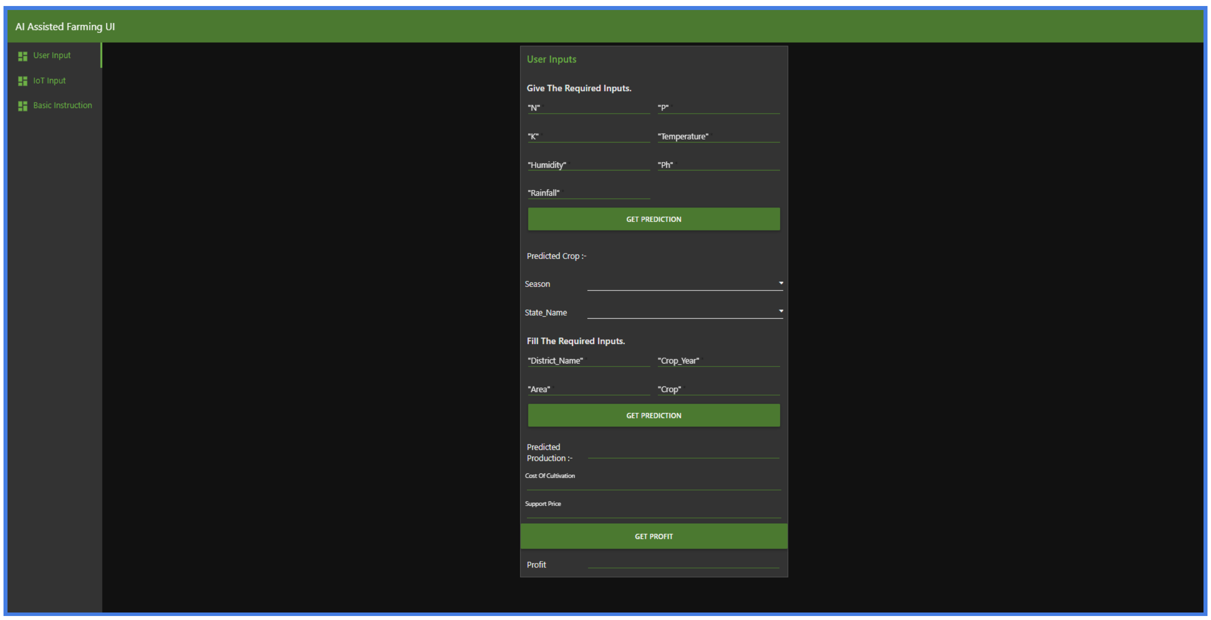


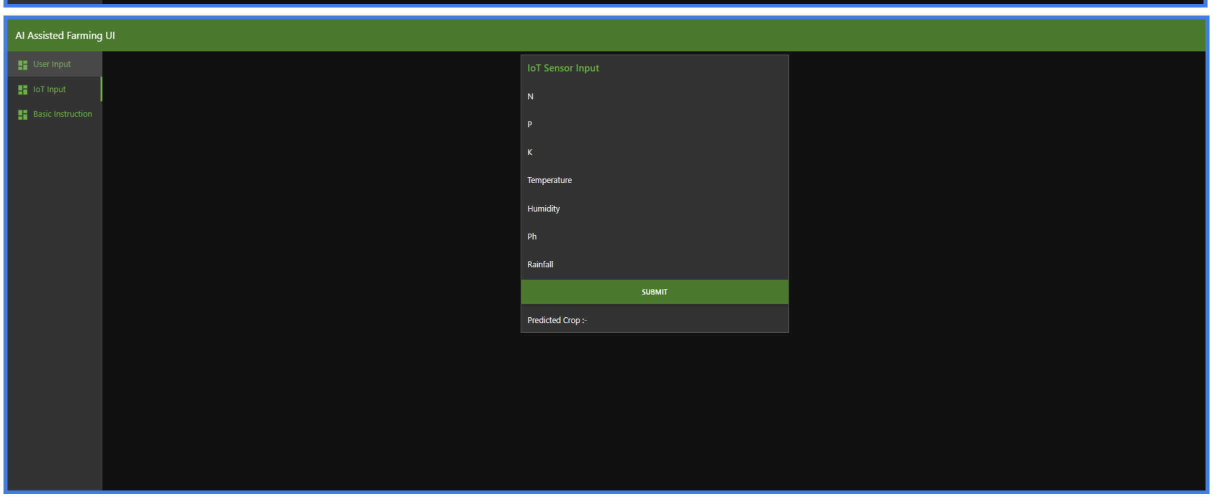
The above flow diagram is created in Node-Red. We have created two tabs on the dashboard named User-Inputs and IoT-Inputs. In IoT Input tab user is not required to any thing. We are considering that inputs are coming from IoT Sensors placed in users farm and the user is at the location. So we are getting inputs from user's farm directly into the web page. Those Inputs are passed to function node, global variables are created then on pressing the button http request is sent to the IBM cloud to get access token which is used to pass the data to scoring end at second http request then the predicted results are displayed on the dashboard. The another flow in the diagram is for yield prediction which follows the same steps as for crop prediction. The UI view and results are shown in results section.

6. Result

From our proposed solution user can get the predictions on which crop to grow for getting the best production from their land area depending on climatic condition and season.

Shown below is the UI where user inputs every information to get required prediction.





7. Advantages and Disadvantages

The recent global epidemic has highlighted the importance of the connection between food and goods. What we once thought was ‘infinite’ could quickly turn into very short when it comes to chain sales.

Fortunately, machine learning and AI change outdated ways of planning and predicting intelligent ways. By adapting the predictions, AI can reduce anxiety when it comes to food security. Let's look at some of the benefits of AI in agriculture.

Advantages:

- Improved forecasting and planning with machine learning.
- Increased productivity and yield in AI-enabled farming and food preparation.
- Greater food safety in storage, compliance and auditing.
- Analyzing and optimizing soil.
- Breeding specific plant species.
- Detecting and preventing disease and weeds.
- Managing irrigation.
- Precision agriculture.

Disadvantages:

- It costs a lot of money to make or buy robots.
- They need maintenance to keep them running.
- The farmers can lose their jobs.
- Energy cost and maintenance.
- The high cost of research and development.
- Lack of access to poor farmers.

Agriculture has witnessed an accelerated adoption of Machine Learning and Artificial Intelligence algorithms both in terms of field farming techniques and agricultural products. The implementation of this AI technology has transformed the complete journey of food, with some huge benefits.AI in agriculture is redefining the conventional pattern of agriculture. The future of AI in agriculture is becoming progressive in developing comprehensive transformation with different advanced strategies.

8. Applications

The science of training equipment for learning and producing models for future predictions is widely used, not in vain. Agriculture plays a significant role in the global economy. With the growing population and understanding of global yields it is central to addressing food security challenges and reducing the impacts of climate change.

Crop yield prediction is an important agricultural problem. The Agricultural yield primarily depends on weather conditions (rain, temperature, etc), pesticides. Accurate information about the history of crop yields is important for making decisions related to agricultural risk management and future predictions.

As discussed above, AI based farming techniques are very beneficial for the farmers. Farmers can easily make decision about what type of crop to grow in their fields based on their location. They can easily get an idea of how much profit they can get.

9. Conclusion

Crop yield prediction has been a challenging issue for farmers for many years. This work mainly focuses on analyzing the production of crop yield in India, and to predict the yield for the next coming years using machine learning techniques. Based on the climatic input parameters the present study provided the demonstration of the potential use of IoT data in predicting the crop yield based. The developed Web UI is user friendly and the accuracy of predictions are above 75 percent in all the crops and districts selected in the study indicating higher accuracy of prediction. So the proposed solution for the given problem statement is precise and effective and can be very beneficial for farmers and farming industries.

10. Future Scope

AI, machine learning (ML) and IoT sensors that provide real-time data for algorithms increase agricultural efficiency, improve crop yields and reduce food production costs. According to UN estimates of population and hunger, the world's population will increase by 2 billion by 2050, which requires a 60% increase in food production. In the U.S.A. AI and ML are already demonstrating the potential to help close the food gap expected by an additional two billion people by 2050. The discussed Solution can further be modified and to get best results.

Farmers are deploying robots, ground-based wireless sensors, and drones to assess growing conditions. Many researchers and pilot projects have been conducted to test the implications of the involvement of AI applications in improving agriculture. Some of the best uses of AI in Agriculture are as follows:-

- Using AI and machine learning-based surveillance systems to monitor every crop field's real-time video feeds identifies animal or human breaches, sending an alert immediately.
- AI and machine learning improve crop yield prediction through real-time sensor data and visual analytics data from drones.
- Yield mapping is an agricultural technique that relies on supervised machine learning algorithms to find patterns in large-scale data sets and understand the orthogonality of them in real-time, all of which is invaluable for crop planning.
- Improving the track-and-traceability of agricultural supply chains by removing roadblocks to getting fresher, safer crops to market is a must-have today.
- Price forecasting for crops based on yield rates that help predict total volumes produced are invaluable in defining pricing strategies for a given crop.
- The UN, international agencies and large-scale agricultural operations are pioneering drone data combined with in-ground sensors to improve pest management.

With the recent changes in the agricultural sector, there are many opportunities for increased investment in agricultural contracts and the introduction of technology for better crop production. This will advance the adoption of AI in agriculture. The recently concluded AI Conference on Social Development - RAISE Conference - 2020 helped provide a platform for stakeholders around the world to come together to complete the road to using AI for the benefit of society. A total of 321 AI experts from 21 countries, as well as sectors including agriculture, have switched to the RAISE 2020 platform to strengthen plans to build tools that cross the AI path and improve AI adoption across all sectors including agriculture.

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12. Appendix

The main and important parts for implementing the whole project are as follows:-

- IBM Cloud
- Watson Studio
- Machine Learning
- Cloud Object Storage
- IBM Watson IoT
- Node-Red

IBM cloud computing is a set of cloud computing services for business offered by the information technology company IBM. IBM Cloud includes infrastructure as a service (IaaS), software as a service (SaaS) and platform as a service (PaaS) offered through public, private and hybrid cloud delivery models, in addition to the components that make up those clouds. Watson Studio, formerly Data Science Experience or DSX, is IBM's software platform for data science. The platform consists of a workspace that includes multiple collaboration and open-source tools for use in data science.In Watson Studio, a data scientist can create a project with a group of collaborators, all having access to various analytics models and using various languages. Watson Studio brings together staple open source tools including RStudio, Spark and Python in an integrated environment, along with additional tools such as a managed Spark service and data shaping facilities, in a secure and governed environment.Watson Studio provides access to data sets that are available through Watson Data Platform, on-premises or on the cloud.IBM Cloud Object Storage is a service offered by IBM for storing and accessing unstructured data. The object storage service can be deployed on-premise, as part of IBM Cloud Platform offerings, or in hybrid form. Node-RED is a flow-based development tool for visual programming developed originally by IBM for wiring together hardware devices, APIs and online services as part of the Internet of Things. Node-RED provides a web browser-based flow editor, which can be used to create JavaScript functions.

For implementing the project we used the IBM Cloud Services.We used IBM Watson Studio to build Machine Learning model using Auto-AI feature , which is saved in IBM Cloud Object Storage and it is deployed in IBM Cloud so that it can receive requests to generate predictions from data sent to the model. The Web UI is created using Node-red which takes various inputs processes it and send the collected info to our model which sends back the prediction which is displayed in the UI itself. The UI is simple and easy to use and can be used by anyone.We have also tried to simulate the IoT Device using IBM Watson IoT which is sends various data to UI if user does not gives input to the required fields. We have given users a choice to get prediction from data they input or the IoT sensors assumed to be placed in their location.