AI In Agriculture

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CS60045 Project under

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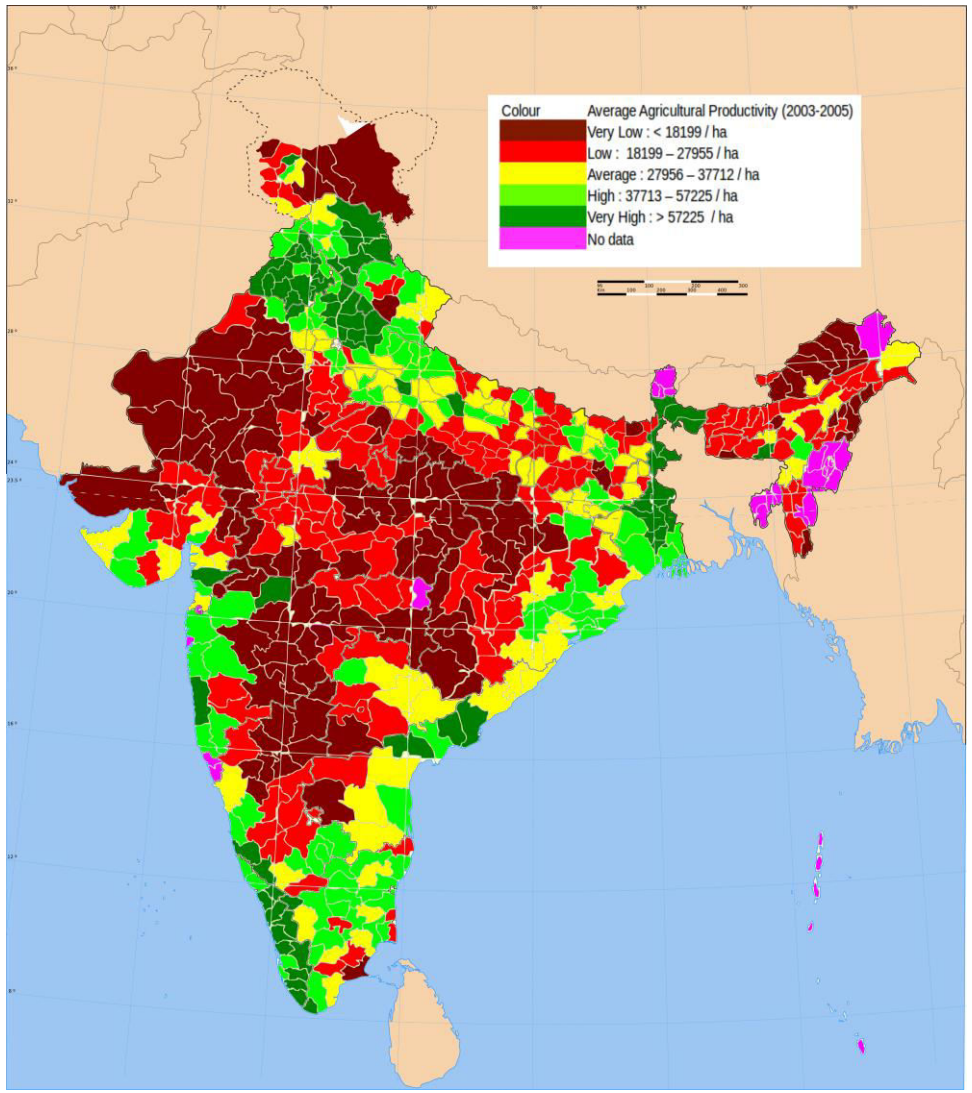

Fig 1: Average agricultural productivity based on 2003-2005 data

Motivation

In Indian economy, agriculture has important contributions. As per 2018, agriculture employed more than 50% of the Indian work force and contributed 17–18% to country's GDP.

Though due to Green Revolution agricultural intensification in the 1970s to 1980s saw an increased demand for rural labor that raised rural wages and, together with declining food prices and reduced rural poverty, agricultural growth in the 1990s and 2000s slowed down, averaging about 3.5% per annum, and cereal yields have increased by only 1.4% per annum in the 2000s. The slow-down in agricultural growth has become a major cause for concern. India's rice yields are one-third of China's and about half of those in Vietnam and Indonesia. The same is true for most other agricultural commodities.

One report from 2008 claimed that India's population is growing faster than its ability to produce rice and wheat. While other recent studies claim that India can easily feed its growing population, plus produce wheat and rice for global exports, if it can reduce food staple spoilage/wastage, improve its infrastructure and raise its farm productivity like those achieved by other developing countries.

Raising productivity per unit of land will need to be the main engine of agricultural growth as virtually all cultivable land is farmed. Water resources are also limited and water for irrigation must contend with increasing industrial and urban needs. All measures to increase productivity will need exploiting, amongst them: increasing yields, diversification to higher value crops, and developing value chains to reduce marketing costs.

From table 1, it is clear that productivity rate is very low than other countries. So with use of AI and modern technology, we can increase our productivity rate and use properly limited source of natural resources like water.

Table 1: **Agricultural products in India**

Serial No.	Commodity	Value (US $,2016)	Average yield (Tonnes per hectare, 2017)	Most productive country (Tonnes per hectare, 2017)	
1	Rice	$70.18 billion	3.85	9.82	Australia
2	Wheat	$26.06 billion	1.2	10.3	Israel
3	Cotton (Lint + seeds)	$ 23.30 billion	1.6	4.6	Israel
4	Mangoes, Guavas	$14.52 billion	6.3	40.6	Cape Verde
5	Fresh Vegetables	$11.87 billion	13.4	76.8	USA
6	Potatoes	$8.23 billion	19.9	44.3	USA
7	Banana	$8.13 billion	37.8	59.3	Indonesia
8	Sugar Cane	$7.44 billion	66	125	Peru
9	Maize	$ 5.81 billion	1.1	5.5	Nicaragua

Problems in Traditional way of Farming

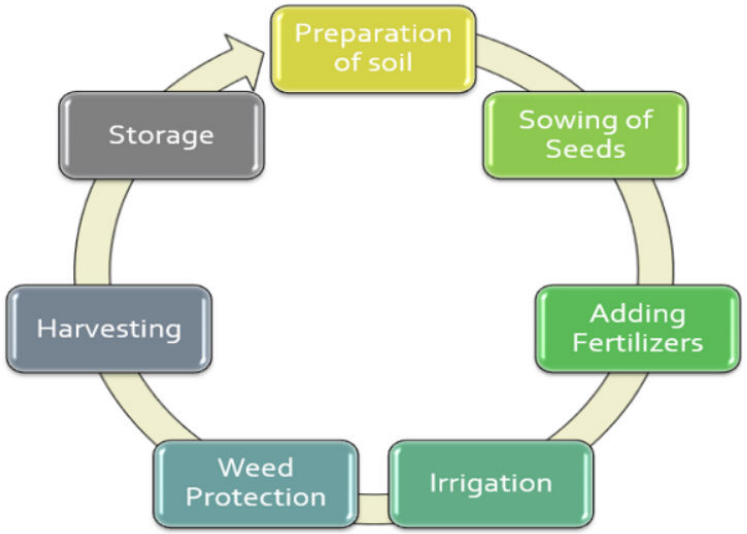

Fig 2: Lifecycle of Agriculture

1. In farming climatic factors such as rainfall, temperature and humidity play an important role in the agriculture lifecycle. Increasing deforestation and pollution result in climatic changes, so it's difficult for farmers to take decisions to prepare the soil, sow seeds, and harvest.
2. Every crop requires specific nutrition in the soil. There are 3 main nutrients nitrogen(N), phosphorous(P) and potassium(K) required in soil. The deficiency of nutrients can lead to poor quality of crops.
3. As we can see from the agriculture lifecycle that weed protection and pest control plays an important role. If not controlled it can lead to an increase in production cost and restrict the growth of crop.

AI’s helping hands

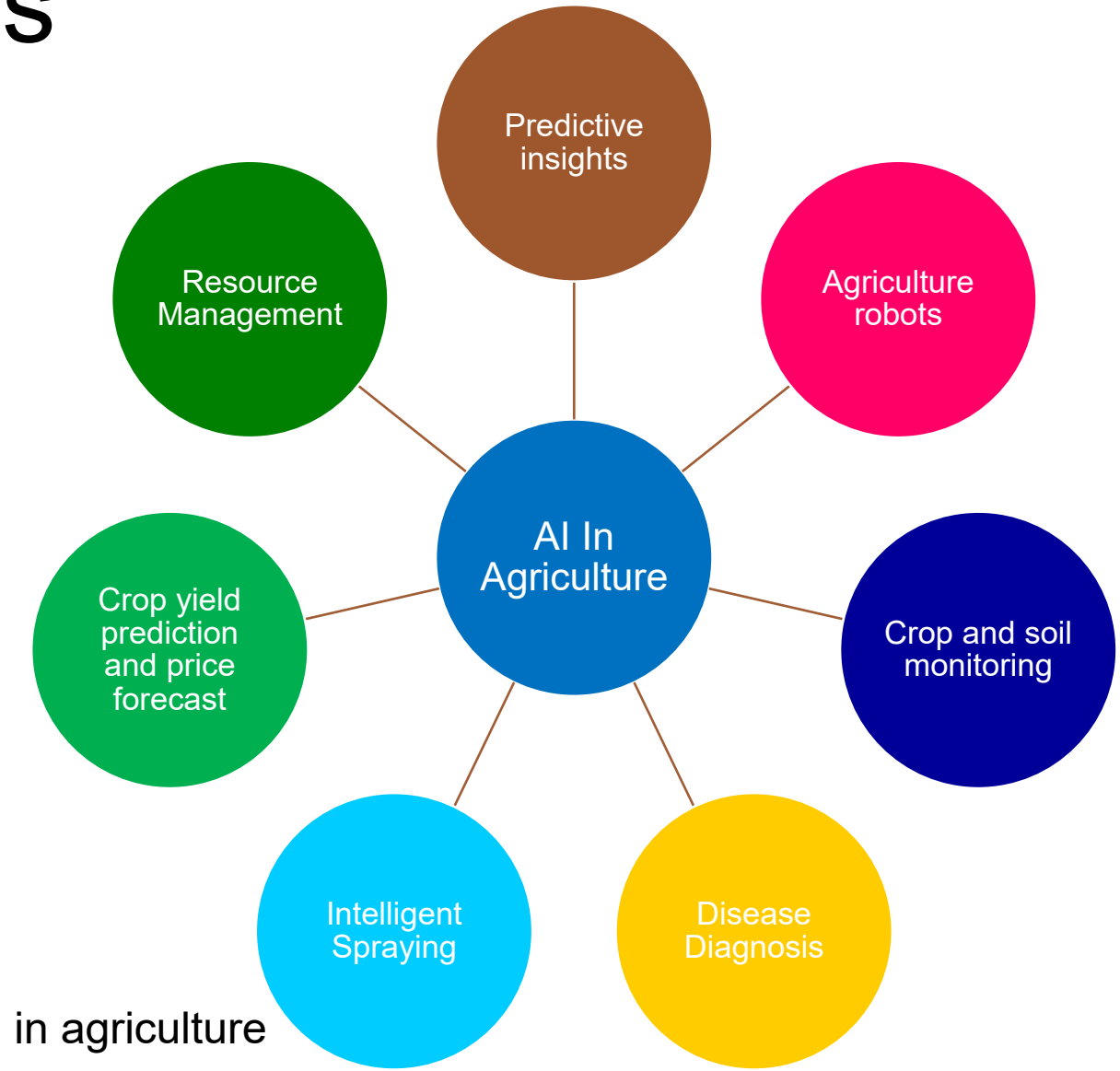

Fig 3 : Different roles or usages of AI in agriculture

In modern days artificial intelligence (AI) can help to yield healthier crops, control pest and weeds, monitor soil

A. Predictive Insights :

i. Weather forecasting for prediction of right time to sow : It is important to sow seeds at proper conditions because every crop has its specific weather conditions like rainfall, humidity, sunlight etc. With the change in climatic condition and increasing pollution it's difficult for farmers to determine the right time for sowing seed, with help of Artificial Intelligence farmers can analyze weather conditions by using weather forecasting which helps they plan the type of crop can be grown and when should seeds be sown.

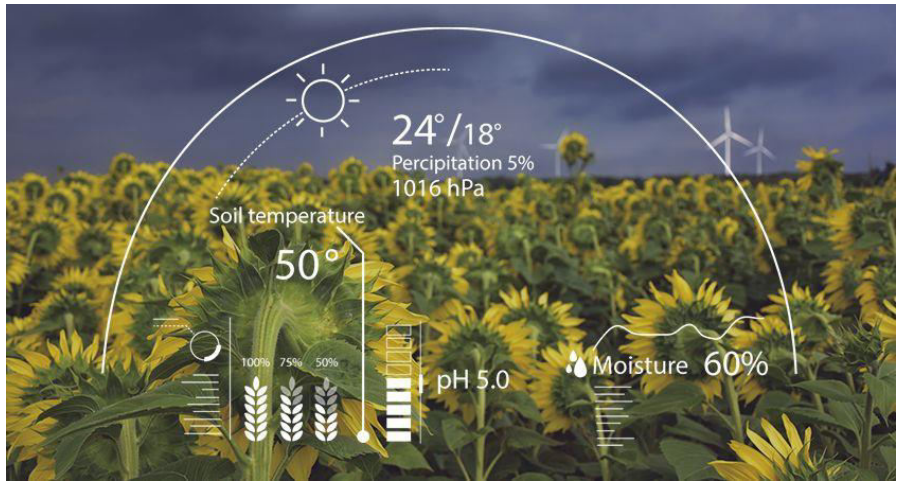

Fig 4: Weather forecasting using AI model

To combat this, scientists of ICRISAT used a predictive analytics tool to arrive at a precise date for sowing the seeds to obtain maximum yield. It even gives insights on soil health and fertilizer recommendations in addition to a 7-day weather forecast.

A. Predictive Insights :

ii. Precision Farming and Predictive Analytics: AI applications in agriculture have developed applications and tools which help farmers inaccurate and controlled farming by providing them proper guidance to farmers about water management, crop rotation, timely harvesting, type of crop to be grown, optimum planting, pest attacks, nutrition management.

While using the machine learning algorithms in connection with images captured by satellites and drones, AI-enabled technologies predict weather conditions, analyze crop sustainability and evaluate farms for the presence of diseases or pests and poor plant nutrition on farms with data like temperature, precipitation, wind speed, and solar radiation.

Farmers without connectivity can get AI benefits right now, with tools as simple as an SMS-enabled phone and the Sowing App. Meanwhile, farmers with Wi-Fi access can use AI applications to get a continually AI-customized plan for their lands. With such IoT- and AI-driven solutions, farmers can meet the world's needs for increased food sustainably growing production and revenues without depleting precious natural resources.
In the future, AI will help farmers evolve into agricultural technologists, using data to optimize yields down to individual rows of plants

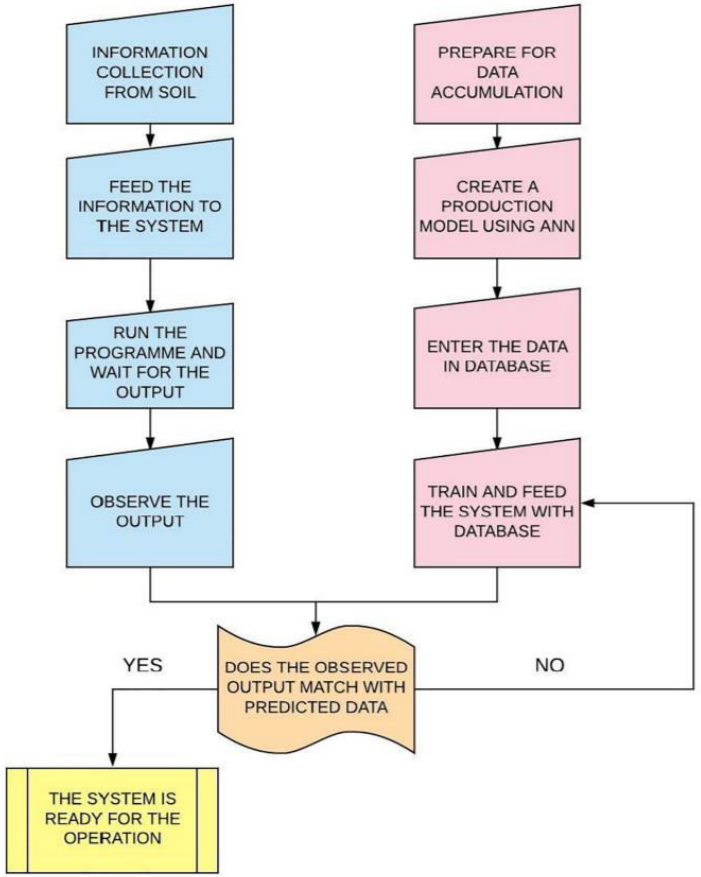

Fig 5: Flowchart of ANN-based crop predictor using smartphones for purpose to predict the condition of soil

B. Soil and crop health monitoring system: The type of soil and nutrition of soil plays an important factor in the type of crop is grown and the quality of the crop.

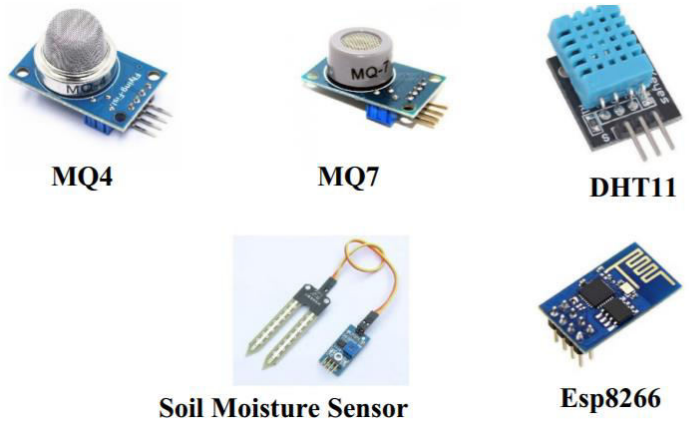

Fig 6: Different types of sensors for different purposes

Sensors such as MQ4 and MQ7 are used for Natural Gas sensing and Carbon Monoxide sensing respectively. DHT11 is used for Temperature and Humidity monitoring of the environment, soil moisture sensor is used for measuring soil moisture level and have continuous monitoring. Esp8266 is a WIFI module which helps in communication between the hardware system and the device which users use.

Fig 7: Agricultural robot for crop management in India
[Source : Niti Ayog India]

C. Agricultural AI trained robot :

In agriculture AI trained robots are capable of doing bulk harvesting with more accuracy and speed than traditional farm workers. *They can perform various types of works like rowing, weeding, seeding, applying pesticides and herbicides, harvesting fruits and vegetables, thinning plants and tilling soil.*

SkySqurrel Technologies has brought drone-based Ariel imaging solutions for monitoring crop health by capturing data from fields with help of drones and then data is transferred via a USB drive from the drone to a computer and analyzed by experts.

This company uses algorithms to analyze the captured images and provide a detailed report containing the current health of the farm. It helps the farmer to identify pests and bacteria helping farmers to timely use of pest control and other methods to take required action

D. Disease diagnosis and intelligent spraying :

A German-based tech start-up PEAT has developed an AI-based application called Plantix that can identify the nutrient deficiencies in soil including plant pests and diseases by which farmers can also get an idea to use fertilizer which helps to improve harvest quality. This app uses **image recognition-based** technology. The farmer can capture images of plants using smartphones to get benefit from this app.

A Berlin-based agricultural tech startup developed a multi-lingual plant disease and pest diagnostic app, which uses various images of the plant to detect diseases; a smartphone collects the image that is matched with a server image and then a diagnosis of that particular disease is provided and applied to the crop using intelligent spraying technique. In this way, the application uses AI and ML to solve plant diseases.

E. Crop yield prediction and price forecast :

For many farmers, the biggest worry is the price fluctuation of the crop. Due to unstable prices, farmers are never able to plan a definite production pattern. This problem is highly prevalent in crops like tomatoes that have very limited shelf time. Companies are using satellite imagery and weather data to assess the acreage and monitor crop health on a real-time basis. With the help of technologies like big data, AI and machine learning, companies can detect pest and disease infestations, estimate the tomato output and yield, and forecast prices. They can guide the farmers and governments on the future price patterns, demand level, type of crop to sow for maximum benefit, pesticide usage etc.

F. Resource management:

There is a major problem of water wastage and a dearth of water in conventional irrigation methods employed. To give an example, Egypt faces a problem of water distribution from the Nile river with neighboring countries. Ample research had been carried out to solve the problems faced in the irrigation, process. Many companies have developed a sensor-based smart irrigation system. These systems have been developed for optimal water usage, monitoring of water pollution, and to take care of some other grave problems. Soil moisture and temperature sensors interact directly with embedded components in the field and take care of required water distribution among crops without farmer's interaction. Water which is to be fed to the farms, either by the means of smart irrigation or any other conventional method, should be of a good quality. Researchers have started implementing IOT systems and Artificial intelligence techniques in aquaculture sector along with agriculture.

Fig 8: Drip Irrigation systems

If we supply nutrients and waters on perspective on weather conditions and soil conditions, we can save our water and also required nutrients. That supply is based on modelled with AI or Deep learning to estimate the required nutrients and water supply. Soil moisture sensor helps to monitor the moisture level of the soil and starts watering the farm as the value get below the threshold level set by the farmer. The embedded system and Internet of Things help to develop a compact system which monitors the water level of the farm without human interaction.

Different Research works In Agro AI

1. The highlighting features of the paper presented by **Gondchawar and Kawitkar (2016)** includes smart GPS based remote controlled robot to perform tasks like; weeding, spraying, moisture sensing, bird and animal scaring, keeping vigilance, etc. Secondly, it includes smart irrigation with smart control based on real time field data. Thirdly, smart warehouse management which includes; temperature maintenance, humidity maintenance and theft detection in the warehouse. Controlling of all these operations will be through any remote smart device or computer connected to Internet and the operations will be performed by interfacing sensors, Wi-Fi or ZigBee modules, camera and actuators with micro-controller and raspberry pi.
2. Thermal Imaging is a noncontact and nonintrusive technique which analysis the surface temperature of the agricultural field and provides valuable feedback to the farmer. **Roopaei et al. (2017)** discussed the use of cloud based thermal imaging system which helps the irrigation by incorporating the performance of the equipment's and determine the area of field which requires the water most. The paper by **Manickavasagan et al. (2005)** discusses various application of thermal imaging like Pre-harvest operations, Field nursery, Irrigation scheduling, Yield Forecasting, Green house gases, Termite Attack, Farm machinery

Different Research works In Agro AI

3. **Katariya et al. (2015)** discussed the use of robot in the agriculture field. The robot is designed to follow the track of white line where actually there is a need to work and other surface is considered as black or brown. Working of robot is for spraying of pesticide, dropping of seed's, water supply and ploughing.

4. R-CNN extensively used in object detection and in automation it is used for fruit detection and counting of fruits. **Bargoti and Underwood (2017)** discusses the use of R-CNN in fruit detection of orchards, while training the input to the network is 3 channel colour image (BGR) of arbitrary size. They have used VGG16 NET with 13 convolutional network and also ZF network which has 5 convolutional layers. Data augmentation is used because it helps in artificially enlarging the dataset and changing the variability of the training data. The results discussed by them are promising as for both mangoes and apples Faster R-CNN outperformed the ZF network approach. (R-CNN stands for regional convolutional neural network).

Different Research works In Agro AI

5. **Sannakki et al. (2011)** developed an innovative system for grading the leaf diseases. The system was segregated into five parts namely Image acquisition where the researchers have captured images of Pomegranate leaves, image pre-processing where the captured image is then resized, filtered, and processed according to the required parameter. Then comes colour image segmentation where k-means clustering is used to isolate the healthy part of leave with the disease infected part. Afterward from the resized image, total leaf area is calculated, and with the help of the third part, infected disease area of the leaf is calculated. Finally, in the last part, with the help of a fuzzy inference system, accurate grading of the disease can be taken out.

6. **Kavdir and Guyer (2003)** applied Fuzzy Logic model in determining the quality of Apple fruit. **Gottschalk et al. (2003)** developed fuzzy logic based air controllers to maintain the temperature of storage facilities for Potato. **Escobar and Galindo (2004)** came up with a simulation software (SCD) which came in handy for many fuzzy based controllers. The software used rule-based knowledge base with IF. THEN condition type. Its graphical characteristics make the software adaptable to any fuzzy algorithm simulations.

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Thank you

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