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# ROLE OF ARTIFICIAL INTELLIGENCE AND AUTOMATION IN MODERN AGE AGRICULTURE

Editor-in-Chief Dr. Raman Maini

Editors: Dr. Sikander Singh Cheema, Er. Lal Chand,
Er. Navneet Kaur, Dr. Dhavleesh Rattan, Er. Gurpreet Singh

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
PUNJABI UNIVERSITY, PATIALA

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# Honourable Vice Chancellor's Message

It gives me immense pleasure to write the foreword to the proceedings of the seminar on "Role of artificial intelligence and automation in modern age agriculture" being published by the Department of Computer Science and Engineering, Punjabi University, Patiala.

Artificial intelligence is an emerging technology that is shaping the future of humanity across every field. It has already become the main driver of emerging technologies such as big data, robotics and IOT, and it will continue to act as a technological innovator for the foreseeable future. In the sector of agriculture, artificial intelligence and automation have the potential to significantly improve food quality, produce, and other aspects of the industry.

The National Seminar, which attracted a sizable number of delegates from throughout the nation, focused on the role of artificial intelligence and automation in modern agriculture. Its cutting-edge presentations and ideas will undoubtedly inspire new research projects that will contribute to the advancement of research in this area.

My appreciation goes to the Seminar Chair Dr Raman Maini, the Convenor Dr Sikander Singh Cheema, the Co-ordinators Er Lal Chand and Er Navneet Kaur and all committees of the seminar for doing a commendable job at making it a success.

**Prof (Dr.) Arvind**

# Dean Academic Affair's Message

One of the most cutting-edge technologies that has the ability to change the world and open up a plethora of new possibilities is artificial intelligence. Today, the agriculture sector is suffering due to insufficient knowledge and equipment. These new, promising technologies have the potential to revolutionize the agriculture sector for the better, leading to better product, high-quality crops, and other changes in the industry.

This book on "Role of artificial intelligence and automation in modern Age agriculture," is a stepping stone towards bringing the students, researchers, experts, scientists of the field together to present their innovative ideas on how these cutting-edge technologies might aid the agriculture sector.

I have a great conviction that this seminar will open up new avenues for scientific research areas, luring numerous researchers and scholars from all over the country. The contents of the book will be extremely beneficial to the researchers in their future endeavours.

**Prof (Dr.) Ashok Tiwari**

# Chief Editor's Message

I'm delighted to announce that the seminar's core emphasis was on the "Role of artificial intelligence and automation in modern age agriculture," which offered researchers, engineers, scientists, and specialists a chance to put forward their innovative research ideas.

Prof. Rajeev Ahuja, Director at IIT Ropar, addressed as the keynote speaker, Dr Neeraj Goel, Assistant professor in Department of CSE at IIT Ropar and Dr Mukesh Kumar Saini assistant professor in Department of CSE at IIT Ropar joined as Resource Persons. Speakers have explained the importance of AI in the field agriculture and need of such technologies in this sector so that farmers can produce a good amount of food with limited resources.

The seminar's evident success will inspire everyone to conduct similar initiatives frequently in the upcoming years.

Prof. (Dr.) Raman Maini

(HOD, CSE)

# Words from Convener

This publication comprises the post-seminar proceedings of the national seminar on "Role of artificial intelligence and automation in modern age agriculture" which was organized by the Department of Computer Science and Engineering, Punjabi university, Patiala on 12th July 2022.

With the guidance of our Vice Chancellor, Dean Academic Affairs, Head of Department and Colleagues we were able to make the seminar a huge success. Many students, researchers, scientists and engineers from all over the country submitted their innovative ideas on how to improve the agriculture sector using artificial intelligence techniques and automation. The papers were focused on how AI and automation can be used in the agriculture field.

We are pleased to inform that 44 research papers, each of which discusses a novel technique for enhancing the agriculture sector, have been chosen for publication in this proceeding.

**Dr. Sikander Singh Cheema**

# Words from Co-Conveners

It's very exciting to share with you that a great event had taken place at the National Seminar "Role of artificial intelligence and automation in modern age agriculture" Department of Computer Science and Engineering, Punjabi University Patiala. This seminar played a role to get together researchers, experts and students from different parts of India.

Our leading speakers Dr. Neeraj Goyal and Dr. Mukesh Sani from Department of computer Science and engineering, IIT Ropar illustrated the "Role of AI and automation in modern age of agriculture". They both and many researchers explained how AI and ML can improve the quality and quantity of crops. As present situation and time demands the automation to improve the way of agriculture so that our non-renewable resources can be used in a very efficient manner.

The successful ending of the national seminar gave an enthusiasm to the researchers to take more forward steps in this field.

**Er. Lal Chand**

**Er. Navneet Kaur**

# CONTENTS

# ATTACK OF PINK BOLLWORM ON COTTON CROP IN PUNJAB

**Gurleen Kaur Sandhu**
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Punjabi University, Patiala

## *Abstract:*

*Pink bollworm (Pectinophora gossypiella (Saunders), PBW) is a major pest deteriorating cotton crop not just in Punjab but worldwide. The prominent solution to regulate the power of a pest outbreak is to observe the crop at proper intervals in order to detect the arrival of pest and to take precautionary and mitigating actions if the pest is present. Monitoring can be done on the basis of local understanding and up-to-date and trustworthy global knowledge. Reduction in loss caused by pests by taking timely and effective mitigation actions can significantly add to cotton production in the state. Monitoring of this pest is normally commenced through consistent field inspections, which is labour intensive, time consuming and error prone. So there is a need to automate this system of monitoring this crop so minimize the chances of pest attack at a very early development stage. The purpose of this research is to study the lifecycle of pink bollworm and its infestation pattern in cotton plant.*

***Keywords-*** *Cotton Crop; Pink bollworm; Kharif Crop*

## INTRODUCTION

Cotton is a vital crop of commerce in India and is popularly known as ‘Whitegold’ or ‘King of fibres’. It is a major kharif crop for the semi-arid region of Punjab. It is sown in seven districts, but cotton is an economic lifeline for farmers of four districts in Punjab namely, Fazilka, Bathinda, Mansa and Muktsar. According to the Department of Agriculture and Farmer Welfare by Government of Punjab, the yield of cotton in year 2019- 2020 was 827 kg/ha and that in the year 2020-2021 was 750 kg/ha respectively. These figures make it clear that the yield has decreased tremendously in this year because of the attack of a pest called pink bollworm which was first seen in America in the year 1917 [1]. Since then researchers have been trying to figure out the best possible way to avoid such a pest. Cotton seed has been genetically modified such that it can itself repel bugs. This genetic modification was done by adding a small protein called Bacillus thuringiensis (Bt) to the seed. Recently in 2021, the Bt-cotton was attacked by a pest called pink bollworm in Bathinda district affecting more than 70- 80 acres of area.

This paper aims to study development cycle of the pink bollworm pest and its attack and symptoms on cotton plant so that a counter measure can be generated to avoid such bugs even before they attack the crop and so that more yield of cotton can be produced.

## GROWTH AND DEVELOPMENT OF COTTON

The development cycle of cotton can be sub-divided into some phases each provisioning different management challenges that can affect the yield. Early- season phase is symbolized by planting conditions, which is extremely important in establishing the stand of the crop. This phase represents early seedling and root growth and is entirely vegetative. Next is the reproductive phase that begins with the initiation of fruiting structures, called squares that develop into blossoms or flowers and then into bolls as shown in the figure 1. This phase normally begins 35 crop as all fruiting bodies may be destroyed [3].

## PINK BOLLWORM

Pink bollworm is a very noxious pest of cotton in the Punjab, Haryana and Pakistan.

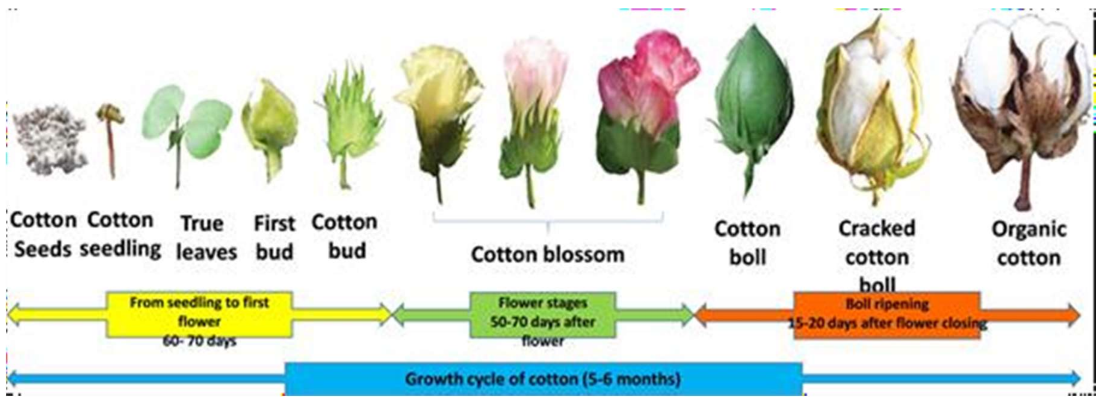


*Figure 1 Growth cycle of Cotton crop*

days after planting. The final late-season phase is depicted with the opening of mature bolls and the crop being prepared for harvest. This is often facilitated with the use of harvest aid products which enhance leaf drop and boll opening [2].

## ATTACKS ON COTTON

Cotton crop is infested with different kinds of pests throughout the production cycle. Soil fertility, moisture, and early-season pest damage are generally the dominant stress factors impacting plant structure prior to flowering.

This crop gets affected by a number of pests and insects such as jassid, whitefly, thrips, aphids and bollworms etc. Bollworms are the most damaging pests of all fruiting bodies including squares, buds, flowers and bolls. Bollworms can cause upto 40-50 % crop losses in severe incidences. Severe bollworm attack, if not properly managed, may mean complete failure of the cotton. The damage is caused by the caterpillars only. They are pink and are found inside flower buds, panicles and the bolls of cotton or the fruits of okra and other allied plants. The adult is a deep brown moth, measuring 8-9 mm across the spread wings.

The life cycle begins with the onset of moths in summer. The females lay whitish, flat eggs singly on the underside of the young leaves, new shoots, flower buds and the young green bolls. The eggs hatch in about a one week and the caterpillars on emergence, are white. They turn pink, as they grow older. Soon after emergence, the larvae enter the flower buds, the flowers or the bolls. The holes of entry close down, but the larvae continue feeding inside the seed kernels [4]. They become full-grown (8-10 mm) in about two weeks and come out of the holes for pupation on the ground, among fallen leaves, debris, etc. Within one week, the moths emerge to start the life cycle all over again. By October- November, 4-6 generations are completed.

Full-grown larvae of the last generation do not pupate. Just a few of them reach the ground, but the great majority continue feeding inside the bolls. They cut window holes in the two adjoining seeds and join them together, forming what are known as the 'double seeds'. Such damaged bolls are generally left unpicked in the field. Later, they fall to the ground and form a major source of infestation for the next year. Some are picked along with healthy cotton and reach the ginning factories, from where just a few return to the fields along with the seed. The hibernating larvae lie curled in double seed for many months and after passing the winter, they emerge as moths [5]. The last life-cycle is very long covering 5-10 months, although during the active season, the life cycle is short, taking only 3- 4 weeks.

*Figure 2: Image of Pink Bollworm as a larvae*

## FACTORS AFFECTING ATTACK ON COTTON

Temperature above 33°C, moisture early in the morning below 70%, and that in the evening more than 40% during the phase of development around 40, 41 and 43 weeks of cotton crop, and temperature below 12°C in 48 and 49 weeks of cotton crop development phase, respectively result in Pink Bollworm in cotton severly [6]. The key basis of host-insect relationship considered generally between cotton crop and pink bollworm pest is the phase of cotton crop lifecycle when the first square appears in the crop to the appearance of first opened flower in the crop and the number of days lapsed between oviposition to completion of mid-stage larval development (may be second instar or early third instar) of pink bollworm.

*Figure 3 Image of Pink Bollworm as a moth*

Generally, the appearance of first just visible square happens to fall between 43– 45 days as shown in the figure. The most vulnerable age of squares is considered to be 8–10 days old for pink bollworm attack. Commonly, it takes 12–14 days from most vulnerable square stage to appearance of first open white flower and this time falls in sync with the time elapsed between oviposition to mid larval development of pink bollworm [7].

Correlation studies revealed that the maximum temperature and sunshine hours were significant and positively correlated with the male moth catches of spotted bollworm. Whereas, minimum temperature was the main contributing factor for the pheromone trap catches of pink bollworm male moths. There is an indication of increasing in population of male moth catches and larvae of pink bollworm. In Bt cotton there was a comparable larval population of pink bollworm was noticed.

## NATURE OF DAMAGE BY PINK BOLLWORM

Financially, pink bollworm causes the maximum loss to cotton crop in terms of production and quality of lint. Pink bollworm is usually seen with the onset of winter and continues to sustain on the crop till flowers and bolls are approachable. Long life-span cotton allows the pest to proliferate for an elongated period through multiple generations, whereby influencing the next session of cotton crop.

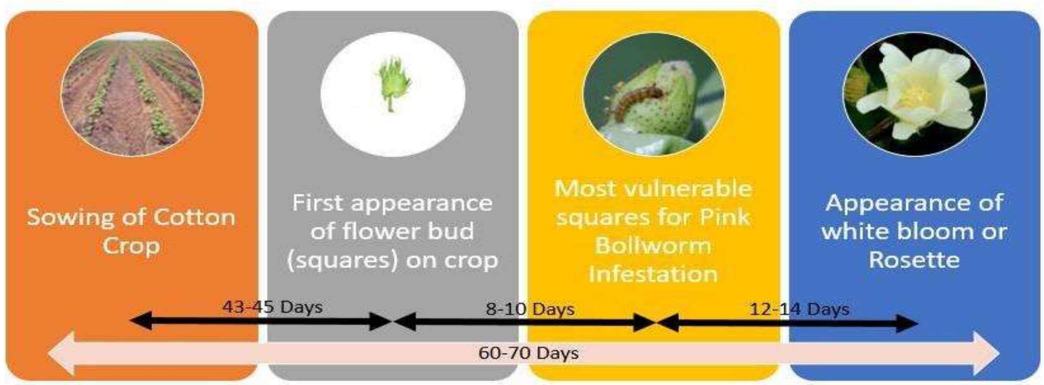


*Figure 4 Stages of growth of Pink Bollworm and Cotton crop*

During the months of the year when cotton crop is not present, the pink bollworm persists pupating for around 6-8 months. Pink bollworms generally damages squares and bolls, where the damage to bolls being the most significant. The larvae makes its way into the bolls passing through the lint and sustains on the seeds as their source of food. As the larvae passes through the lint, it makes the lint stained and no more useful to the farmer. So, the quality and quantity loss is directly proportional to the number of bolls infected and the number of larvae per boll

[8]. The lint gets yellow spots in its fiber due to the pest. As these pests feed on the seed hence, affect the germination quality as well and as a result there is loss in weight of cotton seed thereafter affecting the oil content. The seeds that are damaged by pink bollworm cannot further germinate. The symptom is seen later when the damage is done and the boll opens up and the stained lint is visible.

During the season of cotton crop, pink bollworm completes four generations and the larvae of the fifth generation start going into hibernation phase when winters begin. Hibernation is a state in which the pest continues to be inactive for months due to the cold weather. The activeness of Pink Bollworm is dependent on some factors like oil contents, temperature and the day's length. By the end of the cotton season, the left over bolls act as larvae's home for hibernation as these bolls do not open and stay on cotton sticks. Hence, this pest carries itself to the next season due to such bolls [9].

The amount of damage varies substantially and is dependent on climatic factors mostly such as the temperature and rainfall. Rainy season around August and September tend to be favorable conditions for pink bollworm attack. Its larvae leave the bolls for pupation on soil during different times of the day. Pupation occurs either in the top 5 cm of soil or in the soil crevices, mostly under the plant periphery. Depending on the amount of damage and weather conditions, this pest can cause about more than 50 percent crop loss.

## SYMPTOMS OF ATTACK

'Rosetted flower' (improper opening of petals) is typical of bollworm attack. Small burrows can be noticed on developing green bolls. In open bolls, the stained lint around feeding areas is visible. Improper boll opening with damaged seeds are also an important symptom. Small round holes are seen on the open bolls. The quality of lint of cotton attacked by pink bollworm is very poor.

## PEST CONTROL

During off-season, it is utmost important to maintain a host free period in order to avoid this pest in the coming season. Hence, the actions for prevention from pink bollworm attack require measures in post-harvest, off- season and pre-planting phases as well.

**Off-season Measures:** By permitting cattle to graze the cotton fields at the end of crop season shall reduce the amount of left over green bolls on the field. In time crop termination is mandatory along with getting rid of cotton stubbles immediately after harvesting the crop. These measures if adopted on a field-to-field basis over large areas of cotton growing regions by the farmers shall largely bring down the attack of pink bollworm in the forthcoming seasons.

**Cultural Measures:** The minimum emergence of PBW was observed when seed was buried at 15 cm depth [10]. While planning for the next season selection of varieties with early maturity, drying of seeds under sun for 6-8 hours and sowing of acid delinted seeds are effective and economical to prevent the carry-over of pink bollworm to the next cotton season. Assured mortality was witnessed when seeds were exposed for 20 min at 48.9°C temperature [11].

**Physical Measures:** During the active season, measures must be taken to monitor pink bollworm attack on the crop. This can be done easily through the use of some traps of pheromones that attract the males. Once few male moths are found in the traps, this is a manifestation of the occurrence of pest in cotton field. One approach of pink bollworm repression is to trap most of the male moths in the crop ecosystem by using large number of pheromone traps @ 20traps/ha [12]. For this method to be efficient, multiple traps should be placed over various fields covering larger areas. This way the population of pink bollworm can be controlled.

**Chemical Measures:** There are various pesticides and insecticides available in the market that claim to control the infestation of pink bollworm upto some extent.

## CONCLUSION

Pink Bollworm is a crucial issue in Punjab state, mostly due to long life-span varieties of cotton seed and absence of any significant control measures. The need of the hour is an automated system that not only detects but predicts the attack of Pink Bollworm on cotton crop depending on the biological, climatic and environmental conditions around the field. The future scope of this study is to use the IoT devices and other oppurtunities available to create a model that predicts and detects any sort of pest attack on the crop.

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# TECH DRIVEN HIGH YIELDING AGRICULTURE: AUTOMATION POWERED BY IOT AND AI

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## *Abstract*:

*Evolution is the most certain and the most valuable thing that human life is gifted with. We have seen some amazing evolutions since life has come to existence on this beautiful planet. With increase in human population and more acceptance towards technology we have started experiencing drastic change in climate, moreover the demand for basic necessities like food, shelter, clothing and water is at surge. In most of the places where extension of agriculture land is nearly impossible, cultivating sufficient food is a challenge. It has become very important to discover and develop technologies that can yield maximum with limited number of resources. In past few years world has seen power of data and how data can enable some of the highly intelligent systems. Data is being used to make Machine learning models smart, it is being used to drive analytics giving never like before statistics around data. Data is being used to automate operations using Artificial Intelligence enabling our machines to be smart. With advances in technology, we have seen how data is enabling Intelligent Machines. For deriving intelligent machines for agriculture, information like temperature, speed of wind, humidity, rainfall, content of soil and infestation of pest can help take important decision. It can be used to enhance the qualitative as well as quantitative approaches. The lands for agriculture can be made more productive by several orders of magnitude. To be able to address such informative data IOT devices come to rescue. IOT gained information's or data can be used to formalize accurate fertilization programs. Combination of IOT and AI is deadly for automation and achieving highly productive results. This article is a contribution to identifying various researches already done for applications of IOT and AI in Agriculture.*

***Keywords:*** *Introduction, Survey Methodology, Existing Work Survey, Agriculture, Artificial Intelligence, References*

## 1. INTRODUCTION

Improved quality of life is the end goal of everyone working hard. Every human being wants to get adequate shelter, food, water and clothes for themselves and their families, but with this ever and continuous increase in population need for basic necessities of life will be at surge.

Nobody would even want to imagine that one day they have to live without water or food. With increasing demand of land for personalised families shelter there has been a drastic decline in agriculture field. Imagine if there is no agriculture land left where will we get food from. Hence it has become very important to find out new ways via which we can yield maximum production of grains, foods, fruits only on a restricted amount of land. Such a solution of analysing and taking right decisions at right time can only come from tech and that too from AI powered tech. Training models too require data. There are several characteristics like soil moisture, weeds, temperature, rain that need to be considered before reaching onto decisions and to get these kind of data, IOT devices come to rescue. IOT devices with sensors and having mini processing devices like raspberry pi helps in fast processing and shipping of data to cloud. Moreover, with evolution of mobile broadbands, improvement in internet speed at cheaper rates it has become easier and more accessible to use IOT devices. Moving forward we will first understand basics and then understand various researches done on leveraging power of agriculture with intelligent systems.

## 1.1 Agriculture

Agriculture is an art and science ofgrowing crops, cultivating soil, raising livestock. End goal of agriculture is to generate ample amount of food so as to fulfil human basic necessity of survival. Agriculture can be subsistence or industrial based on what motive it is being done for. It mostly involves processes like preparation of soil, sowing, adding manures and fertilizers, irrigation, weeding and storage.

## 1.2 IOT

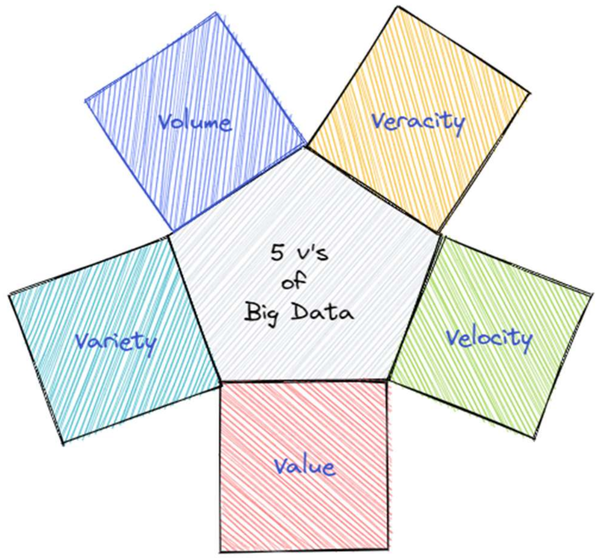
IOT stands for internet of things. It consists of electronic devices known as things that are capable of sensing or actuating based on their use that connect using standard protocols to shared data and generate maximum value out of it. Example of an IOT system is Cultivar's raincloud. Cultivar's raincloud is a IOT platform that helps in detection of moisture in soil and to help farmers with water management. IOT devices are capable to communicate machine to machine and to send data to external cloud for further big data processing and analytics so that value can be derived from data.

### 1.3 ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) refers to the machines simulating of human intelligence that can be programmed to think like humans and mimic their actions. Such machines are capable of showing human traits like self-learning and problem-solving. AI devices to do lifelong self-learning are powered by powerful neural network algorithms that can optimize themselves to achieve accurate results. For example, Convolutional Neural Network is an algorithm that can be used to detect disease in plants

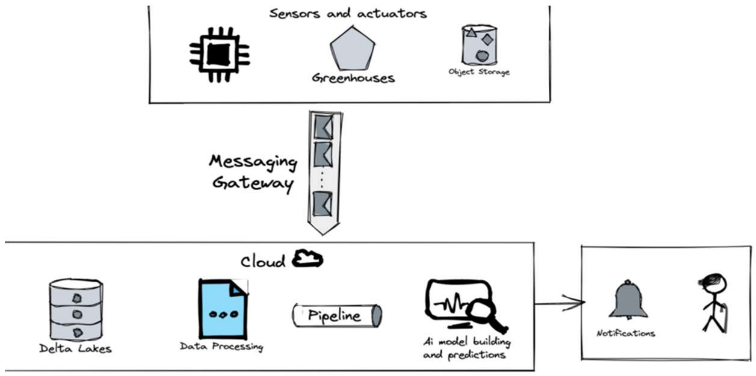
## 1.4 BIG DATA

Big data refers to data sets that can be structured or unstructured, have large volume and incur high storage and compute capacities. Data is the base to feed intelligent AI Algorithms, right datasets can power super powerful statistics. velocity, volume, value, variety and veracity are the main characteristics of Big Data. IOT systems are capable to generate hundreds to thousands of records per second and hence leading to big data. This large amount of data need powerful processing systems and fast data stores like spark/Hadoop is used for big data processing and data/delta lake for storage of big data.




## 2. GENERIC BLOCK DIAGRAM FOR AI POWERED IOT SYSTEMS

An AI powered IOT system necessarily consists of multiple technologies that work together to derive value. The main start points of these systems are IOT sensors deployed on target sites. These could be installed in farms, tagged with cattle's, fixed inside soil, deployed in greenhouses and so on. These IOT devices can be powered up by compute power like raspberry pi, Arduino, Beagle Bone etc. These devices can send and receive data passing from IOT Gateway. The servers are responsible for data management. Data are stored in delta lakes/data warehouses. Features like availability, security, scaling makes cloud a good choice for storage and processing for IOT based systems. The data platforms powered by cloud perform ETL perations they transform the data and make data available as required by Models. The models predict the results and then data platform again captures the produced results and sends notification/information to farmers on mobile phones as per use case so that they can take necessary steps for their farms.




## 3. SURVEY METHODOLOGY

We followed the systematic literature review for finding out various researches done in the area of how AI and IOT are enabling automation in Agriculture sector. In this section we describe step by step the way to select and filter papers, analyze the research proposals and contributions in the papers. As well as synthesized the results. We defined that our work should cover all the aspects of data.

Firstly, older papers were only selected whenever they were important for understanding definitions as were looking for the most recent and most up to date techniques the authors were using.

Finally, preferred papers having deep description of techniques, experiments and concepts. Having selected our study set, we analyzed those papers by first reading the abstract, introduction, conclusion to separate different and most interesting ones. Having those most interesting ones, we proceed to second deeper reading those, in order to review their techniques, definition, related work done and results. During our preliminaries reading theme related papers, we found that many authors used social aspects of the entries in order to better classify them, those aspects varied from comments, entry sharing, relationships between consumers of those entries to the writer's profile information and pictures. We classified those aspects as relevant also, hoping to find new and better practices on how to use that external contextual information in favor of better predictions.

## 4. IDENTIFYING DIFFERENT ALGORITHMS AND AI POWERED AUTOMATION SYSTEMS FOR AGRICULTURE

| Role in Agriculture | Application | Authors/Years |
|---|---|---|
| Soil Monitoring | Soil moisture and temperature monitoring in the fields using WSN | [10] Chen, K.T.; Zhang [2014]] |
| Air Monitoring | IoT-based agricultural air, humidity, and temperature monitoring system | [11] Watthanawisuth, N.; Tuantranont |
| Disease Monitoring | Plant Disease Classification | [12] S. Ashwinkumar, S. Rajagopal, V. Manimaran, B. Jegajothi |
| Water Monitoring | Irrigation Area Automatic System | [13] Xijun, Y.; Limei, L.; Lizhong, |

| | | |
|---|---|---|
| | | X |
| *Disease Monitoring* | Precision Agriculture using Sensor Network | [14] Langendoen, K.; Baggio, A.; Visser |
| Soil Monitoring | Soil Moisture Estimation | [15] D. Liu, A.K. Mishra |
| Temperature Monitoring | Smart Nitrate Sensor for monitoring temperature | [16] Alahi, M.E.E.; Xie, L.; Mukhopadhyay, S.; Burkitt |
| Humidity Monitoring | Smart Sensor for Humidity Monitoring | [17] Krishna, K.L.; Silver, O |
| *Fertilization and Pest Control* | Online climate monitoring system | [18] Pahuja, R.; Verma, H.K.; Uddin |
| Greenhouse Monitoring | Sensors for Green House Monitoring | [19] Malaver Rojas, J.A.; Gonzalez, |
| Location tracking | Tracking and tracing of animal locations | [20] Keele, S. |
| Disease Monitoring | Weeds Detection | [21] Fourth International Conference |
| Price Forecasting | Agriculture yield and pricing forecast | [22] S.A. Haider, S.R. Naqvi, T. Akram |

## CONCLUSION:

This article has presented various high-quality researches that have been published on AI and IOT domain. Many researches have been done to develop intelligent systems for high yielding agriculture. Researchers are continuing to develop efficient AI Algorithms and powerful intelligent systems to empower high yield in agriculture sector. Various private and government organizations are also showing interest and funding various research projects for agriculture. Evolution is certain and therefore in future we will be able to derive efficient agriculture automation systems

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# A SURVEY ON AGRICULTURAL AUTOMATION USING IOT DEVICES

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## *Abstract-*

*Internet of things (IoT) has vital significance nowadays, with an exponential escalation in the number of smart devices connected through the internet. Data is grasped from the interconnected network devices in abundance. However, the challenges involved are comparatively less and indifferent to the traditional data collection approach. Moreover, smart devices are readily installed everywhere in almost all domains. This innovative technology has been a blessing in the fields of healthcare and medical science, security, home appliances, automation, and many more. These smart internet-connected systems have wide applications in agriculture also. Agriculture automation includes smart farming, sophisticated irrigation systems, and sensors that are becoming straightforward and effortless in modernizing farming. The modern era of agriculture has boomed in the last decade aiding the food production process. This paper translates the matter of interest into a well-structured survey discussing the use of smart devices in the domain of agriculture along with various challenges in adapting this advanced method. The survey discusses different smart devices in the agriculture industry, their benefits, and difficulties.*

***Keywords-*** Smart Devices, Agriculture, Internet of Things, Cloud Server, Architecture

## 1. INTRODUCTION

Technology has reached the peaks of advancements certifying human intelligence to an unimaginable extent. Every discipline has technological advancements that keep growing day by day. Automation has become a massive interest area across all domains like security, medicine, health science, transportation, etc. This increasing demand for exploring technology to make things easier has invented interesting products and served human lives immensely. However, Agriculture automation is an intense field that has grown curiosity among technologists. This area of interest needs more nurturing as food security is an alarming concern with the elevation in population growth rate. Traditional farming methods are failing for meeting this food demand. Innovations in the method of farming and inculcating smart agriculture practices are making difference to ensure food security. Fortunately, the internet of things helps in generating intelligent solutions to readily address challenges in the agriculture industry.

### 1.1. Challenges

Automation task can be combined with installing IoT devices to handle challenges in conventional agricultural methods. Some of the challenges are mentioned below:

- **Consumer Demands**– Food shortage is a very disturbing problem with the increase rate in world's population. Traditional farming methods fail to assure food security to all consumers affecting health of human lives.
- **Labour Shortage**– Conventional agriculture needs labour work in more number and to fulfil the consumer demands production has to be elevated. But farming has become a lowest income work for people as wages paid is very less comparing to other forms of employment. With high rate of inflation, farmers are willing to pursue high wages income methods rather than farming.
- **Degrading Climate Condition**– Farming highly rely on the weather conditions, soil quality and appropriate ecosystem. The worst climatic conditions adversely affect the crop production and weather forecasting is the only way to prevent it.

## 1.2. Motivation

Agriculture is the basic need for human lives to survive; it provides the main source of energy food. With the increasing rate of population, agricultural challenges have exponentially increased. To inculcate smart solutions in agriculture industry and improve the food productivity in a more efficient manner, internet of things is used. Internet of things leverages technology to improve the agricultural conditions with serving benefits such as:

- **Data Collection** – Collecting data for soil monitoring, measuring the soil quality parameters like temperature, moisture, PH value, NPK indicators nitrogen (N), phosphorus (P), potassium (K). This data can hugely help in inferring insights about soil and using it for better irrigation and fertilization.
- **Handling risks** – With availability of effective and qualitative agriculture datathe risk of losing crop to bad climatic conditions eliminates, and the quality of crops improved.
- **Business Benefits** – IoT devices installed can fasten the process of farming and automated systems saves the farmer's time and money.
- **Remote Accessing** – The crop fields can be accessed through IoT platforms, i.e. in the farmer's mobile devices which will help them to monitor the indicators for making smart decisions. Data analysis will be easy in turn, more better outputs.
- **Smart Harvesting** – Artificial Intelligence robots can be used to automate the crop sowing and prepared crops plucking. Monitoring the fields controlling them remotely can efficiently enhance the productivity cycle of crops.

## 1.3. Agricultural Automation

Smart solutions embedded in the agriculture industry have a wide range of applications shown in fig.1 and they can be discussed below:

1. **Precision Agriculture** – New age farming management method that utilizes digitization techniques to help farmers in decision-making on the crop production process. The sensor data helps them to forecast weather, to keep a check on the crop health, and manage the fields with real-time location asset tracking (RTLAT).

2. **Soil Monitoring** – The primitive need for a crop to grow in soil. Soil checking indicators such as moisture, temperature, PH value, salt and water concentration in soil, and NPK measure can be collected and monitored using sensors. Sensor data provides all the requisite knowledge about the soil and send the data to cloud servers where the parameter values can be analyzed and decisions can be taken.
3. **Crop Monitoring** – Smarts sensors, drones, AI robots, and satellites are of immense help in keeping trace on the crop growth, crops health status, any disease in plants, etc. The monitoring systems have data about rainfall, temperature, humidity, etc. helps in taking proper care of crops.
4. **Irrigation Management** – Monitoring water flow in the fields plays vital role in plant needs and saves resources.
5. **Livestock Monitoring** – Smarts sensors, Radio-Frequency Identification (RFID) tags are utilized to locate the livestock and taking proper care of their health eventually helps reducing cost of labours.
6. **Controlling Pesticides** – Detection of pests, insects and weeds is done through the sensors and use of pesticides and insecticides can be done in an automated and controlled manner. This prevents the wastage of pesticides and saves the humans to spray pesticides manually which eventually protect their lives from harmful chemicals. Machines can focus better target areas to spray the pesticides.
7. **Fertilizer Management** – Sensors are effectively responsible in searching for targeted locations in the crop yield where the need for fertilizer is more and can alarm the farmers to use the fertilizers in a better way.
8. **Weather Forecasting** – Farming needs of a crop solely depend upon the climatic condition, proper season and this can be predicted through weather forecast. Satellites and smart sensors at weather stations can broadcast effective data about the weather to farmers for well-informed decision making.

Additionally, these advance intelligent solutions and smart devices in agriculture industry is bringing changes, generating real perceptible outcomes and helping the farmers in taking complex decisions about crop productivity and farming methods.

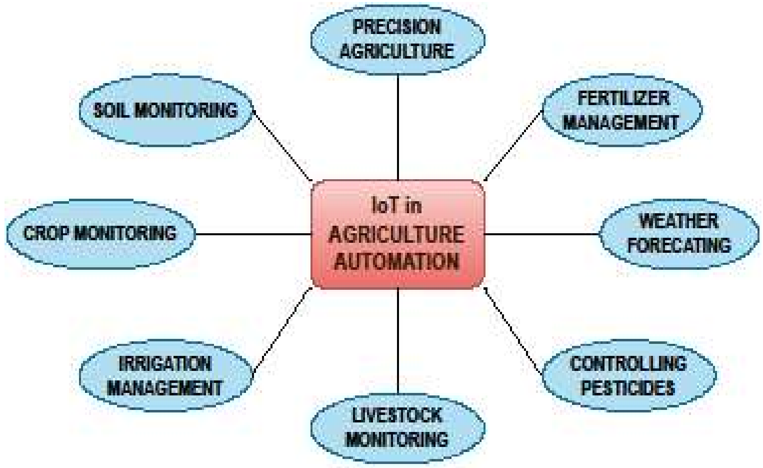


Fig. 1: IoT Applications in Agriculture

## 2. LITERATURE SURVEY

This section provides a survey on the developing areas of the use of the Internet of things, smart solutions in adapting modern agriculture technologies, and the benefits of smart devices. An overview of existing survey research is also included in this section.

[1] The author has proposed that Agriculture had played a major role in India's economic growth since then and continued to be there in the future. The farmers, on the other hand, are facing challenges in different phases of agriculture. The author tried to resolve the problem using IoT and automation which can manage most of the agricultural work and the farmers can strategize which crops to grow according to the market rather than spending most of the time on crop maintenance and production it can also help farmers give more time to their personal life hence increasing the average social standard of the society.

[2] The author proposed Traditional methods in agriculture have minor effects in this modern world. Water scarcity and flooding both are major problems farmers are facing using the traditional approach. Many loopholes in this system and the alarming need to protect agricultural land lead to the development of agriculture automation. The author represents an idea to make a system with the use of sensors, IoT, and machine learning to automate traditional agriculture practices.

[3] The authors proposed that the sensors and microcontrollers of all three Nodes are successfully interfaced with the raspberry pi and wireless communication is achieved between various Nodes. All observations and experimental tests prove that the project is a complete solution to field activities, irrigation problems, and storage problems using the remote-controlled robot, smart irrigation system, and a smart warehouse management system respectively. Implementation of such a system in the field can help to improve the yield of the crops and overall production.

[4] The author stated various challenges in the agricultural domain are identified and architecture was framed to meet the above-mentioned challenges. The knowledge base is structured with various crop details which speak about knowledge acquisition,

flow, and various inputs like market availability, geospatial data, and weather prediction. Monitoring contains modules like remainder, monitoring plant growth in various stages, irrigation planner, crop profit calculator, calamity check, and problem identifier. The evapotranspiration method is used to calculate the water need of a plant per day with devised algorithm's help. A comparative study was made between various applications available with the current developed system taking various aspects into account like knowledge base, monitoring modules, efficiency, and reliability.

[5] The author discussed about the Internet of Things (IoT) is a network of devices for communicating machine to machine (M2M) based on wired and wireless Internet. IoT in agriculture is a revolutionary technology that can be applied to agricultural production year-round. This study aims to summarize cases of IoT being applied to agricultural automation in the agricultural sector and to discuss the limitations and prospects for expanding the application of IoT technology in Korea.

## 3. IoT DEVICES IN AGRICULTURE

Internet of things smart devices are widely used in agriculture. Some devices are WiFi-based modules, Bluetooth modules, ZIGBEE modules, and long-range wireless area network modules as shown in fig.2.

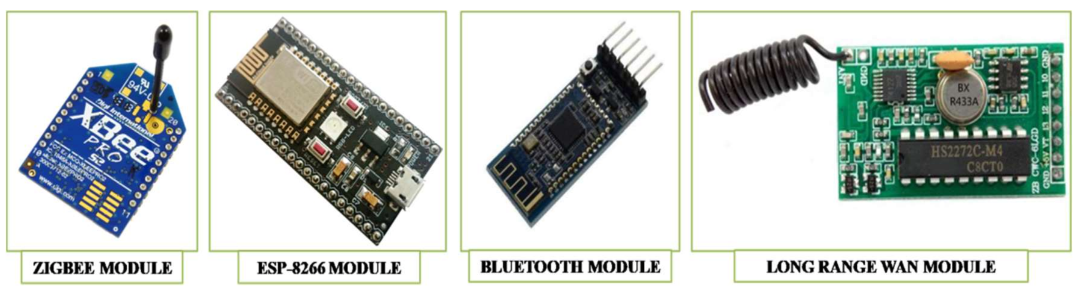


Fig. 2: Some IoT Devices in Agriculture

These devices are used as controllers which can read and access data from the sensor nodes and forward it to the cloud servers where data is analysed and processed to infer insights. The architecture in fig.3 describes the flow structure of data gathering collection, accessing data, and finally forwarding to the analysis module in the cloud server. With the sensor data, the analysts can help the agriculture industry by providing details about soil quality, weather conditions, ecosystem details, and other indicators.

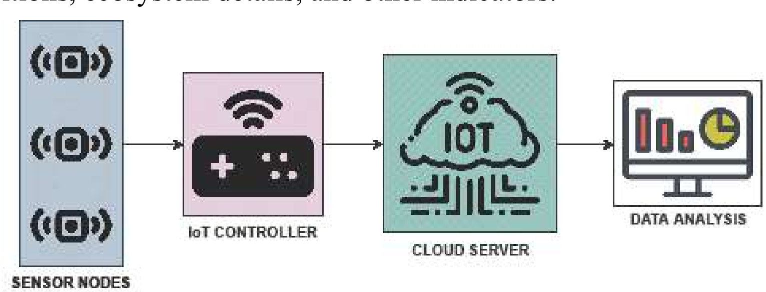


Fig. 3: Architecture of Data Collection Method

## 4. CONCLUSIONS & FUTURE DIRECTIONS

Agriculture has immense importance in human lives and this industry contributes majorly to the economy. Agriculture is the only domain where development in future aspects is huge. The phases in conventional farming involve lots of manpower and time, farmers nowadays are dealing with tough agricultural challenges. Technology has its magic in every domain, similarly, in agriculture, this technology can be leveraged to enhance the lives of farmers and to achieve agricultural advancements. Automation in agriculture can serve humankind with efficiency in the cultivation and harvest of crop productivity. Furthermore, by adopting IoT devices, sensor nodes, wireless sensing networks, satellite, and cloud servers agriculture data collection and analysis can be made easy. In the future, agriculture automation systems employing advanced technology will be able to minimize human work and time.

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# APPLICATION OF DATA MINING FOR INCREASING AGRICULTURE YIELD

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***Abstract:***
*With the advancement in technology and innovation in medicalscience, the average life expectancy of humans has increased significantly. The world's population is expected to reach around 9.7 billion by 2050 and 11 billion by 2100. However, the resources we rely on for our survival are expected to be similar or depleted if anything. The most important of them is the food resources, without which we shall cease to exist. Hence, the point of concern is the strain that the agriculture sector will have to bear and how will we be able to meet the future food demands. There are two ways through which we can increase the agricultural output; either by increasing the amount of land being cultivated or by increasing the yield of the land already in use. A large portion of the global land surface is already under crop production and pushing the boundaries even further can disrupt the natural balance of the ecosystem. Therefore, this paper focuses on the application of data mining along with other available modern technologies like IoT, and image detection that can help increase agriculture yield. The review encompasses two different approaches; 1) Improving the efficiency of current practices and 2) Progressing towards a unique concept i.e., Vertical farming (Indoor farming). In the first section special emphasis is given to irrigation, fertilizers, and plant diseases. Further, the next section shall discuss the implementation methods, advantages, and application of Vertical Farming.*

***Keywords:*** *Data Mining, Agriculture yield, Vertical Farming*

## 1 INTRODUCTION

Agricultural/Crop yield is the biggest and most important factor that has to be taken under consideration if we hope to ensure food security in the future. To further emphasize the potential that agriculture yield has in store, consider the case of India. According to [1] India has 82.6 million hectares of gross irrigated crop area (the largest in the world). It was ranked 2nd globally in terms of total agricultural output, whereas it was nowhere to be seen even in the top 50 if we talk about the global rankings of agriculture yield. Reasons are many, including wide usage of traditional methods, lack of modern agriculture infrastructure, over-reliance on monsoon, and overuse of fertilizers.

The Literature survey of this paper will be divided into two sections; The first section shall focus on enhancing the efficacy of current agricultural methods and processes by the application of various Data Mining techniques. The essence of this section will be formed by Smart Irrigation, avoiding overuse of fertilizers, prevention of plant diseases, and maintaining soil health. Further, the next section will be Seeking disparate farming practices. The practices that will be discussed shall include Indoor Farming; Vertical farming.

## 2 LITERATURE REVIEW

We live in a digital and connected world where almost every process or task we perform generates some kind of data. According to [2], the amount of data generated in the year 2020 was about 64.2 zettabytes and this value is projected to be around 180 zettabytes for the year 2025. Extracting useful information from this vast amount of data is no simple task, and is almost impossible to achieve using traditional statistical methods. This is where the concept of data mining comes in. Data mining is a process that is used to extract the required information from a vast amount of data. [3] describe this process as a combination of six steps: Problem Understanding, Data Understanding, Data Preparation, Modelling, Evaluation, and Deployment. Similarly, data mining can be used in the agriculture sector to increase its productivity (yield) and thereby ensuring food security for the future.

## SECTION-1

Irrigation is one of the most crucial factors that can affect agriculture yield. Keeping the water quantity at the optimum level according to different types of soil, weather conditions and the types of seeds sown is of utmost importance. [4] worked on a prediction model based on binary classification, that combined the usage of Decision Trees and Genetic algorithms to predict the occurrence of irrigation events. Various data features including hourly water consumption, climatic data, type of crop, farm size, farmer's behavior, and occurrence of precipitation were recorded for 1 year (1 January 2015 to 31 December 2015) using various sensors and devices. This data was shared to the central repository using mobile communication technology. The developed model was tested in a district in southwest Spain and had an efficiency of 68%-100% for positive irrigation events and 93%-100% for negative irrigation events.

Another important trait to monitor in the case of smart irrigation systems is the quantity of water being used, to avoid its wastage. Selecting this as one of the core ideologies for their work, [5] developed an automatic irrigation system that uses a Fuzzy logic Controller (FLC) to irrigate the crops while preserving water by using it discreetly. The proposed system uses a cluster, a Cluster head node for coordination, an irrigation controller using fuzzy logic, and an irrigation pipe network using drip irrigation. The sensors collect data about plant conditions, watering status, soil moisture conditions, and temperature. This data is processed and sent to the FLC section and based on the instructions received, the controllers open the valve to release water through the drip irrigation method. The amount of water that is released will be decided by the FLC-based remote node that instructs the amount of valve to be opened.

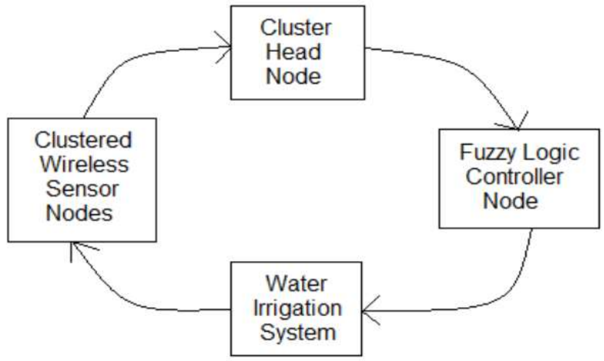


Fig. **1**. System Architecture [5]

Constant health monitoring of crops plays an important role to ensure that they are free from diseases as plant diseases can severely affect agriculture yield. To help in this regard various approaches using a combination of IoT-based sensors and data mining are being implemented. These types of approaches are also helpful in the case of big farms where manual testing by experts is not a viable option. Such approaches are generally based on the concept of Image Processing where the goal is early detection of disease symptoms. [6] proposed a system for the detection of plant leaf diseases. Further, the detected diseases are classified into 4 major categories of diseases; Bacterial Blight, Cercospora Leaf Spot, Powdery Mildew, and Rust. The entire methodology is divided into five major tasks: image acquisition, image preprocessing, segmentation, feature extraction, and classification. Diseased leaf images are captured and stored for the experiment. Then preprocessing is performed on these images for image enhancement. Further, the captured leaf images are segmented using the K-Means clustering method to form clusters. GLCM (Grey Level Co-occurrence Matrices) and LBP (Local Binary Pattern) features are extracted after K-Means and SVM have been used for the classification and detection of plant leaves diseases.

Soil to plants is what food and nutrition are to us, humans. Hence, making sure that the soil quality is maintained, becomes an absolute necessity. Various factors constitute soil quality and some of them are the amount of macro and micronutrients, water, and pH level. Different types of soil have different types of maintenance requirements. To keep nutrient levels in check, fertilizers are added to the soil in case of a deficiency of nutrients. Excess or insufficient addition of fertilizers can harm plant life and reduce the agriculture yield. However, the process of ensuring that the fertilizers are provided in the optimal amount and according to requirement becomes challenging, since a majority portion of farmers estimate the approximate quantity of fertilizers and add it manually. To deal with this situation various modern approaches are being implemented that help the farmer precisely judge the amount of fertilizer required and, in some approaches, the process is automated with help of IoT devices and data mining. [7] conducted research whose aim was to restore the levels of Nitrogen, phosphorous, and potassium in the soil by measuring the amount of nutrients present and thereby controlling the number of fertilizers added to avoid excess/ deficient fertilizers in the soil.

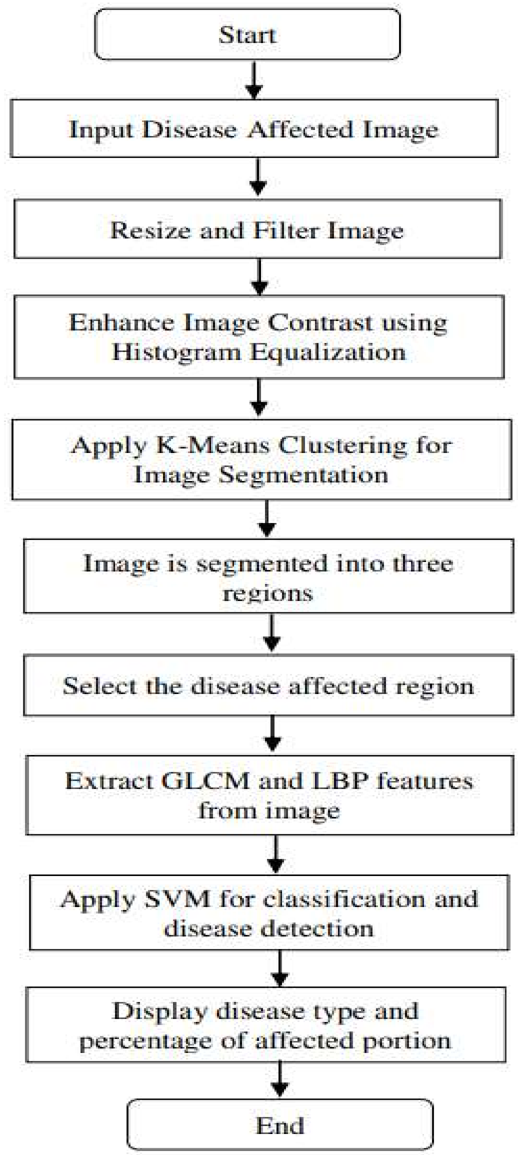


**Fig. 2.** Flowchart of the proposed system [6]

To achieve these results an automated system was proposed that consisted of two subparts: The development of a Sensor system for estimation of nutrients present in the soil and the Development of an intelligent system for estimation and control of the flow of the required number of fertilizers. The principle used for the identification of the NPK (Nitrogen, Potassium, and Phosphorous) nutrients in the soil is 'colorimetry'. The control system estimates the number of fertilizers to be added based on the results of the soil test. Depending on the amount of nutrients present, the fertilizer is estimated and added accordingly.

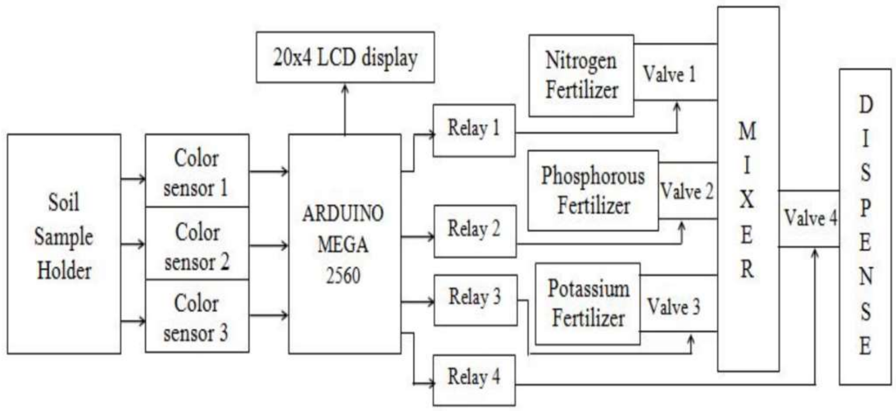


**Fig. 3.** Block diagram of the proposed system [7]

### 2.1 SECTION-2

The previous section discussed how can we implement data mining along with other technologies to improve the efficacy of our present approach to agriculture and crop production. However, this section will discuss a few unique approaches that may seem unfeasible at this moment, but are already being implemented in some parts of the world, and will continue to expand their scale of application in the coming years. The approach being talked about is Indoor farming, also popularly known as Vertical farming.

[8] Vertical farming is described as the farming of crops in urban areas, particularly inside a building in a city in which floors are designed to accommodate certain crops using hydroponics (water with nutrients). Currently, the idea of vertical farming is limited to only a few particular types of fruits, vegetables, and grains. However, with advancements in technology, it may become possible to grow other crops as well in the future. Many related works suggest that vertical farming is the future of farming as it will play a major role in ensuring food security for the future generation, especially since it is projected that the majority of the population will be residing in urban areas. There are various advantages to vertical farming when compared to traditional farming, and these advantages have a major role in the inclination of interest toward this emerging approach. Some of the advantages include: the year-round crop production; since the growth of crops is independent of the outside weather conditions, minimal water usage; as the irrigation is completely automated based on various data features of the available environment, no use of chemical fertilizers and pesticides, lower and efficient land usage, and higher agriculture yield. Minimal to no dependence on the outdoor conditions also means that similar types of crops can be grown in almost any part of the world, even where agriculture was not possible earlier due to harsh weather conditions and other unfavorable environmental features. [9] Vertical/Indoor farming works by using high-efficiency light-emitting diode (LED) grow lights, along with computer-assisted control systems for monitoring and delivering precise amounts of nutrients, adjusting the pH, temperature, and oxygen content of the nutrient solution, and assessing the growth and overall health of each crop. One another approach that is being considered as an alternative to hydroponics is that of aeroponics. [10] Aeroponics works by exposing plant roots to nutrient-containing aerosol droplets. It atomizes the nutrient

solution, which is then deposited on the root surface of the plants. This approach is different from hydroponics, as in the latter the roots are dipped in a nutrient solution, and drip irrigation is used to replenish the nutrient solution.

## 3 CONCLUSION

This paper discussed how data mining in combination with other modern technologies can prove to be useful in increasing agriculture yield. The first section of the literature survey discussed the application of data mining to increase agriculture yield by improving our present practices. It focused on inculcating the modern methods available into regular practices. Whereas in the second section, an entirely different concept of indoor farming was considered. The section also shed light on the advantages of this approach which has led to its gaining popularity in recent times. The fact that this may play a pivotal role in our goal of future food security was also established.

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# ARTIFICIAL INTELLIGENCE IN AGRICULTURE: A REVIEW

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***Abstract-***
*The present paper emphasizes the applications of Artificial Intelligence practices in different areas of agricultural science, the industry insights, and the challenges to adopting AI in agriculture sector. According to the United Nations Food and Agriculture Organization, the global population will expand by 2 billion people by 2050, but the increased land area available for farming will only account for 4% of that increase. In the aforementioned situation, more consistent farming methods must be achieved by the application of new technical breakthroughs, as well as an explanation of the ongoing challenges in the agriculture industry. A consistent use of Artificial Intelligence and its subsets in agriculture can serve as a blueprint for a transformation in how farming is practised today. Disease, inappropriate soil analysis, pest infestation, irrigation, and inadequate drainage are just a few of the challenges that the agricultural sector encounters. As a result of the use of duplicate pesticides, these difficulties result in serious environmental concerns and significant agricultural loss. Artificial Intelligence has emerged into a vital strategy for dealing with a variety of farming-related challenges, thanks to its thorough learning skills.*

***Keywords***– *Artificial Intelligence, Expert Systems, Artificial Neural Networks, Machine Learning, Deep Learning, Applicationsof AI, Fuzzy Systems, Agriculture, improper soil analysis, pest infestation, environmental hazards.*

## 1. INTRODUCTION

In the nineteenth century, machines were used as a substitude for human labour during the Industral revolution. With the advancemetn of information technology in the twenteeth century, and the introduction of computers, the development of Artificial Intelligence powered machines began. Artificial Intelligence is gradually but firmly replacing human labour in the current context. Artificial Intelligence refers to the replication of human intellect in computers that are programmed to think and act like humans, inlcuding learning and problem-solving.

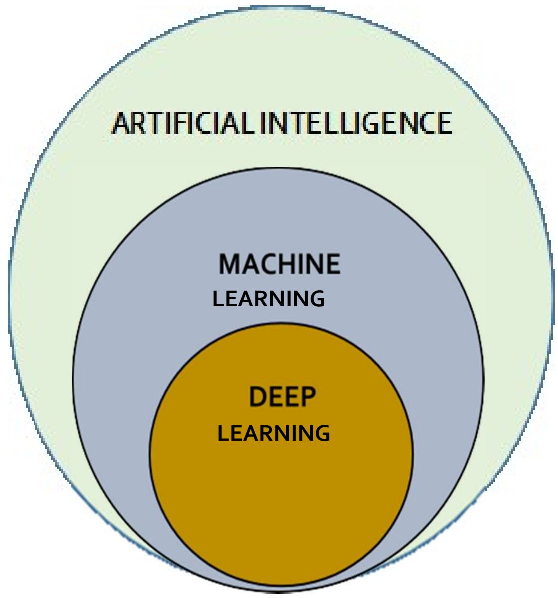


Fig.1. Subsets of AI

Machine learning is a subset of artificial intelligence as shown in Fig. 1. Machine learning is the tool used to identify, understand and analyse a pattern in the data. Artificial intelligence is one the important domains of research in the present advanced technological world of computer science. This technology is becoming persistent very quickly because of its speedy technological advancements and its stout applicability in problems, mostly that cannot be resolved well by traditional computing structures and also humans [1]. A similar field of much priority is farming where around 30.7% of the entire world's population is precisely committed to 2781 million hectares of agricultural land [2]. As a result, farmers confront several obstacles from planting through harvest. Yield protection, insufficient chemical usage, insect and disease infestation, poor irrigation and drainage, and weed management are all major issues in agriculture. Agriculture is a dynamic area in which it is impossible to predict future events in order to create a communal experience. Artificial Intelligence approaches have enabled us to grasp the intricate details of each situation and give the best solution for that unique problem. With the advancement of several AI tools, progressive suitable complex difficulties are being unravelled. The focus of this study is on the important Artificial Intelligence (AI) approaches that are being used to address agricultural concerns. The three essential AI techniques: Expert Systems, Fuzzy Systems, and Artificial Neural Networks are measured as the concentrated areas. This paper dissertates the use of Artificial Intelligence techniquesin a vast subdomain of farming to capture the measured growth of the agro-intelligent systems.

## LITERATURE REVIEW

Agriculture's and the agricultural industry's future prospects rely greatly on novel concepts and technology breakthroughs to increase yields and better resource utilisation via the use of cutting-edge computer technologies. Crop models and decision-making tools are increasingly being utilised in agriculture to boost productivity and resource efficiency. Artificial Intelligence has huge potential to change agriculture by combining innovative technology to anticipate agricultural productivity [2]. In agriculture the first use of agriculture was conveyedin 1983 [3]. Many techniques have been proposed to address the present challenges in agriculture, ranging from databases to decision support systems [4]. Among these elucidations, Artificial Intelligence-based solutions outperform the competition in terms of robustness and accuracy. Climate change, rising production costs, dwindling irrigation water supplies, and a decline in the agricultural labour have all wreaked havoc on agriculture production systems during the previous few decades. [5]. Furthermore, the COVID-19 pandemic threatens supply networks and food production, [6]. Such elements pose a threat to the environment's long-term viability, as well as the current and future food supply chains [7]. To keep abreast of the constant climate change, significant inventions are always required [8]. The obvious issue here is how to collect an appropriate quantity of food for the rapidly rising population. The research scientists are continuously applying state-of- the-art expertise and discovering new ways to assimilate them into agricultural system[5].

## I. GENERAL CROP MANAGEMENT

Generally, the universal crop management system delivers an interface for the global management of crops that cover every feature of agriculture. The first Artificial Intelligence technique in the management of crop was first recommended by McKinion and Lemmon in 1985, in the paper "Expert Systems for Agriculture" [9]. Additionale xpert system was planned by Boulanger for the corn crop protection in his own thesis [10]. An expert system named POMME was proposed by Roach in 1987, which was made for the apple plantation management [11]. COTFLEX was another expert system developed by Stone and Toman for the management of the crop [12]. A new rule-based expert system proposed by Lemmon which was also developed for the management of cotton crop is called COMAX [13]. 3-D Laser scanning, hyperspectral imaging, and Remote Sensing techniques are important to create metrics of crops over acreages of land that can be cultivated. It is capable to bring an innovative shift in how the lands are supervised by the farmers from the viewpoints of both time and effort. Robinson and Mort proposed a multifaceted feed forward neural network-based system which was designed to guard crops which citrus from any kind of damage in the Sicily island of Italy [14]. The parameters of the input and output were coded in the binary format for the training and testing of the network. Dissimilar patterns of inputs were used by authors to achieve a prototype with maximum precision. The finest prototype achieved so far had a 94% precision with six inputs and two output classes. The unsurpassed network that was achieved contained five concealed layers that were educated up to 300000 reiterations and attained 85.9% accuracy on average [15]. The management of the soybean crop proposed by Prakash was based on Fuzzy Logic and delivered guidance about selection of crop, pest issues and fertilizer application [16].

## II. PEST MANAGEMENT

Pest infestation is one of the most distressing problem in farming that eventually leads way for hefty economic loss. For a long time, the scientists have struggled to lessen the same threat by the advancements of the computer systems which are capable to classify the vigorous pests and therefore advise measures to control them. Most of the time, the information involved in agricultural management is vague, imperfect, and unfocussed, and the result of this is that the rule-based expert system may tip towards indecision [17]. For apprehension of this indecision, numerous logic-based expert systems were put forward by Saini and Kamal[18] and Siraj and Arbaiy [19]. An objected-oriented methodology to structure a rule based expert system was in use by Ghosh and Samanta who developed TEAPEST for the management of pest in tea [20]. For this, a step by step consultation and identification procedure was implemented. Far ahead, Samanta and Ghosh restructured the system by using a multifaceted back proliferation neural network [21] which was in turn reformed by Banerjee, with the help of a radial basis function prototype to attain advanced sorting rates [22]. Companies involved in pest control use Artificial Intelligence to programme and advance a whole lot from the pest route plan to pest prediction. With the help of drone technology, the pest control companies and the farmers can virtually visit all the crops and deliver almost full-time monitoring with the motive to find pests, diseases, dead soil, or irregular degradation of the crops. Based on this information, the farmer can then gather the data from any particular crop area and therefore stop the further spread of the disease.

## III. DISEASE MANAGEMENT

Plant disease is a major risk to the global economy, environment, consumers, and farmers. In India alone, 35% of the crops are destroyed because of pests and pathogens triggering a major loss to the farmers. The unselective practice of pesticides is a threat to human health as some of them are biomagnified and toxic. These effects can be evaded by surveillance of the crop, detecting the disease, and providing the applicable treatment. Substantial experience and expertise are needed to recognize an indisposed plant and then take the required action for its recovery. Computerized systems are utilized worldwide to analyse the disease and then recommend methods to control it. For detection of disease, the sensing, and analysis of the image is done to ensure that imageries of the leaves are partitioned to the externa l regions like the non-diseased area, background, and diseased area of the leaf. The infected part of the leaf is then reaped and sent to the lab for additional analysis. This helps in the assistance for the recognition of pests and then sensing nutrient deficiency. A detailed structure is demonstrated below in Fig. 3. In the early years, Byod and Sun established the rule based systems [23]. Artificial neural network model was premeditated for the control of diseases in diverse harvests by Panigrahi and Francl [24]. Certain fusion systems correspondingly existed. An image dispensation prototype combined with a neural network model to categorise the phalanopsis sapling disease was proposed by Huang [25].

## IV. IRRIGATION AND SOIL MANAGEMENT

Irrigation is rigorous labour intensive process in agriculture sector. Problems revolving around irrigation, soil are important for cultivation. Inadequate soil management and irrigation resulted in crop loss and polluted characteristics. Trained AI computers that are aware of historical weather patterns, the types of crops to be cultivated, and soil condition can automate the watering process and boost total productivity. Irrigation uses around 70% of the world's fresh water supply. As a result, automating this procedure can conserve water while also assisting farmers with their water issues. Companies such as Crop In, which uses Artificial Intelligence to enhance per-acre value, and Intello Labs, which uses Deep Learning to analyse photos, are developing AI-based tools and sensors to monitor soil health. This segment highlights specific researches done in the field of irrigation and soil management aided by artificial intelligent techniques. Sicat and John [26] utilized agriculturalists' information to design some fuzzy system to acclaim harvests dependent on the suitability of land maps produced with the help of the system. The neural network system for assessment of topsoil moistness in the paddy was calculated by Arif [27]. Some neural network designs in the forecast of rainwater were compared by Manek and Singh with the help of four distinctive inputs [28]. The research established that the radial basis function of the neural network accomplish the finest as compared to the former models.

## V. WEED MANAGEMENT

Weed control is a great challenge in agriculture sector. Herbicides outnumber all other pesticides, including insecticides. No farmer likes to apply pesticide, but no farmer wants to watch weeds sucking up all of the water and nutrients meant for the crops. Herbicides have a negative impact on both human and environmental health. There are a slew of businesses and initiatives that aim to use computer visualisation, robotics, and machine learning. Advanced AI practises have been developed to limit the usage of pesticides via weed control that is exact and suitable. Pasqual [29] developd an expert system for recognizing and abolishing the unwanted plant in harvests like wheat, barley and oats. Also, Burks [30] matched three dissimilar neural networks mostly backpropagation, counter dissemination, and radial based function model by means of the alike set of contributions as the preceding paper, and established that the backpropagation setup performs best with 97% accuracy.

## VI. YIELD PREDICTION AND MANAGEMENT

Crop yield prediction is extremely important for crop cost predictions as well as marketing tactics. Furthermore, in the era of precision agronomy, prediction models may be used to examine relevant factors that have a consistent impact on yield. With the emergence of new technologies such as artificial intelligence, satellite imagery, cloud machine learning, and sophisticated analytics, an ecosystem for sustainable, efficient, and smart farming is emerging. The combination of these modern technology is assisting farmers in achieving maximum average yield as well as improved control over the amount of food grains produced, ensuring that they stay profitable. Liu and Minzan [31], utilized an AI neural network model engaging a backpropagation knowledge algorithm to forecast harvest from the topsoil constraints. Climate statistics, optimal planting seasons in different seasons, and real-time data Sufficient Moisture With the use of AI algorithms, data from regular raindrop statistics and soil moisture can be detected to develop forecasts and also give farmers with feedback on the best planting time.

## VII. INDUSTRY INSIGHTS

Global AI in the agronomy market scope was treasured at USD 608.9 million in 2018 and is predicted to record a CAGR of 25.4% from 2019 to 2025 [32]. AI practises employed in cultivation can be helpful for the growth of yield and productivity. Consequently, agribusiness organizations implement AI technologies in the form of predictive analytics-based solutions. The Artificial Intelligence-based techniques and applications benefit by controlling pests, monitoring the soil, yielding healthier crops, and improving the agriculture-related responsibilities that are involved in the all-inclusive food stock. AI is progressively increasing in the farming industry aimed at the enhancement of yield significance and accurateness as it aids in analyzing the farm data. The quickly increasing populace requires the necessity for the enactment of AI in the industry of agriculture sector. Inadequate arable availability of the land and the requirement for amplified production of food, because security of the food determines the requisite for a green uprising fuelled by the Internet of Things, artificial intelligence, and data. Applications assisted with AI supply to numerous regions in the farming business, for instance, recommendation and predictive analytics, detection of pest infestation, monitoring of soil, and identifying plant diseases. AI-inspired resolutions encompassing drones, robots, and ground centered wireless sensors are progressively being positioned in the agri-business. For example, Microsoft co-operated with ICRISAT (International Crop Research Institute for the Semi-Arid Tropics) to manufacture an AI grounded planting app. Additionally, Nature Fresh Farms, an American technology firm, is occupied in evolving a technology based on AI to evaluate data about the plant at scale to yield precise forecasts and harvest. This particular technology calculates how much time blossom would take to mature by means of an AI algorithm. The various advantages of AI applications inspire numerous technology based start-ups and companies to manufacture IoT-based equipments for disposition of Artificial Intelligence enabled applications for farming on a large scale.

## VIII. CHALLENGES TO ADOPT AI IN AGRICULTURE

Great opportunities are presented by Artificial Intelligence in the field of agriculture. However, there is insufficient knowledge when it comes to advanced high techmachine learning solutions in farming. Divulging farming with exterior factors like soil conditions, weather conditions and susceptibility to the outbreak of pests is high. When the harvesting is started, the planned schedule of crop raising at the beginning of the season might not appear to be good because it gets predisposed by the exterior parameters. A lot of data is needed by the AI system to train the machines, for making accurate predictions. In cases of enormous land area for farming, it is easy to collect spatial data whereas the accomplishment of temporal data is challenging. It is also problematic to develop the knowledge-based rules and put them in a correct sequence for a huge number of parameters. Numerous crop-specific information could be attained once in a year only when the crops are grown. Because it takes time for the database to mature, it comprises a considerable amount of stretch to build a robust AI ML model. This is the foremost purpose for the application of AI in agriculture-related products like pesticides, fertilizers, and seeds. Another decisive factor is the expensive cost of many cognitive solutions for agriculture that is readily accessible in the market. The AI-inspired solutions have to be more feasible to ensure that the technology influences the agricultural community. The AI cognitive solutions if offered in some open-sourced platform then that would helpto make the solutions additionally reasonably priced, which will then lead to earlier adoption and better insight amongthe farmers.

## CONCLUSION

After all is said and done, we can conclude that In the realm of real-time data monitoring, Artificial Intelligencehas shown to be valuable. Crops, pests, weeds, and yield have all been managed using this method. The machines talk to each other to figure out which crops are best for selling and harvesting. Farmers may rely on the effective strategies to ensure proper field management and better harvests. Timely information is provided by the AI from the right channels and can therefore build resilience among the users. The present paper demonstrates beyond doubt the use of Artificial Intelligence in agriculture sector during the previous years starting from 1983. The paper has been devised to furnish as much information as possible, about the different AI techniques that have been used in agriculture sector. The expert systems based on rules were comprehensively utilized from the 1980s to the 1990s, whereas from the onset of 1990, fuzzy inference systems and the artificial neural network took the major role. In the current years, the practice of hybrid systems such as image processing or neuro-fuzzy combined with artificial neural networks is in use. The usage of AI will, undoubtedly, benefit the farmers to attain their objective of a healthier harvest by taking improved decisions in the field. The supremacy of data can be utilized more resourcefully to predict risk and analyze scenarios and therefor take necessary action before hunger lingers as ahumanitarian crisis. The constant and steady use of artificial intelligence in agriculture sector can help in the complete development of the world because food is the mostimportant necessity for human beings.

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# A REVIEW: MACHINE LEARNING APPROACH IN THE CROP YIELD PREDICTION

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***Abstract:***

*Machine Learning is the field that is widely used now in a day, in every field we can say that machine learning is using. In this research paper we had found some research papers that defined the role of machine learning algorithms in agriculture fields. As we all know that food is the basic necessity of everybody. The population is increased day by day similarly the resources of food are very limited. Due to various parameters (soil, weather, ph level, phosphorous, potassium, humidity, rainfall etc.) the crop production may vary. To fulfill the increased population demand for food, various researchers are done so that we can increase the production of our crops. Various research papers are studied in this research paper to under which algorithm is best for crop yield prediction.*

***Keywords**: Machine learning, agriculture, CNN, Random Forest Method, SVM, RNN, Decision tree.*

## 1. INTRODUCTION

Agriculture is India's economic center. The farmers usually in India are not achieving the projected crop output due to a variety of factors. Weather conditions have a major impact on agricultural productivity. Rice farming is also influenced by rainfall conditions. In this situation, farmers apply prompt assistance in order to forecast future crop productivity and an analysis in order to assist farmers in maximizing crop production in their crops [3]. As we all know that people in India have been working in the field of agriculture for a long time, but the targeted values have never been achieved due to a variety of parameters that can affect the crop productivity. It is difficult to have a large number of crop output in services to fulfill the need of the world's population. Crop yield can be calculated on the various parameters such as soil types, seed quality, humidity, lack of technical advancement in agriculture. Due to these factors we need new technologies that fulfill the demand of the population. The farmer can work smartly if they adopt new technologies instead of ineffective ways. Machine Learning is the branch of artificial intelligence, in simple we can say that Machine learning is the subset of artificial intelligence; it is basically the study of various algorithms that can helps to improve their output without being programmed through humans.

The algorithm learns through past experiences and by using input data sets. Machine learning allows us to generate a model based on some dataset, that sampled dataset is called as “training dataset”. The model use this sample training set to give us output, the algorithm simply do not just predict the output based on the given training set. [1] The training dataset that we provide to our algorithm is basically divided into two parts. The first part is called the training dataset and the second part is called as testing dataset. It can be in the ratio of 80-20 that means the 80% of the dataset is used for training purpose and 20% of the rest dataset is used for the testing purpose to check whether the model gives us desired output or not.

The various types of machine learning techniques are supervised learning in this type of learning the input dataset is provided in the form of labeled data, unsupervised learning in this type of learning the model has to learn by itself. Because the data is provide in the form of unlabeled, the model has to organized the data by itself and then predict the outcomes. And last but not least reinforcement learning this is basically a hit and trail method. In this learning the model through its past experienced and human learn from his past experiences. Every time the output is improved from its past. [2]

## 2. EXISTING TECHNIQUES USED IN MACHINE LEARNING

Machine learning is field in which there are number of techniques and algorithm which may help to build a model. The detail description of various techniques used in agriculture are described below:

### 2.1 Convolution Neural Network algorithm used for crop yield prediction

CNN algorithm is a type of neural network which is multi-layered feed-forward, in which many hidden layers are placed on each other in a sequential order, The strength of this network comes from a particular layer are called as convolution layer.[14]

Ghazaryan [7] In this research paper the author defines the multiple methods and several remotely sensed time-series dataset, the dataset used is from USA. The used a CNN and LSTM to calculate the crop yield prediction. The yield estimated on the basis of surface reflectance, Land Surface Temperature and evapotranspiration. The CNN-LSTM model defines the best accuracy, mean error percentage is 10.3 for maize and 9.6 for soybean.

Nida [5] in this research paper the author defines the importance of crop yield prediction as well as how developing countries are implementing various machine learning techniques. In this research paper total 37 research papers have been chosen in which the SLR has been confirmed that it gives accurate result as compare to others. According to the report, the most common algorithms for crop yield prediction are RF, SVM and CNN.

### 2.2 Decision Tree algorithm used for crop yield prediction

Decision Tree is very popular and powerful tool that is used for classification and prediction. In decision tree basically a flowchart-like tree structure is used to represent the situation. The tree contains root node and leaf nodes. The root node defines the test attributes and each brand shows an outcome of the test, and leaf nodes contain a class label. [15]

Keerthana[4] In this research paper the researcher takes the characteristics, analyzed method and made many recommendations for further research. The author defines many important characteristics such as temperature, rainfall and crop types. We can learn so many new technologies such as neural network, decision trees and adaboost regressors. The authors defines that the decision tree gives the most accurate and appropriate result as compare to other techniques. Crop yield prediction can be depend upon meteorological parameters of the field location, the various types of location has variety of temperature, soil type and temperature these parameters can help the model to provide accurate outcome.

Kavita [6] in this research paper defines that the crop yield prediction can be achieved by using area, yield, production, and irrigation region. The agricultural yield can be estimated by using these four ML techniques such as Decision Tree, Linear Regression, Lasso Regression, and Ridge Regression. The author performs cross validation Method for checking the mean absolute error, root mean squared error and mean squared error. The Lasso regression can be done by linear regression and ridge regression. The linear regression technique gives the accuracy of 89.38 and where as ridge regression can give the accuracy of 89.53. Last but not the least the decision tree can give maximum outcomes which is 98.62%. These are the various techniques that are discussed in this research paper.

Sharma [8] the author develops a system that can forecast the sort of crop that can be produced in particular regions. The author defines the result that the crop which probable provides higher production for a particular land where it may be grown. The farmers can optimize the resources and hard work. If they work hard the crop yield production may increase. These methods can also helps in seed marketing because the prediction for the appropriate crop can allow the suppliers to provide best crop seed in proper quantities to the farmers. The farmer can get the benefit as well as the suppliers got the maximum benefit by analysis the seed quality.

## REGRESSION ALGORITHMS USED FOR CROP YIELD PREDICTION

Regression is a statistical technique in which the model defines the relation between the dependent variable and independent variables. This is used to helps us to understand that how the value of target variable is changes the predictors variable even the predictors variables are not fixed. [17]

Jambekar [12] in this research paper, the author works on the use of data mining techniques to forecast the future agricultural production of various crops such as rice, wheat and maize, there are various types of factors that can help to predict the crop yield these factors are rainfall, area, soil type, irrigation, mean temperature, humidity all these parameters are discussed in the article and the author perform various algorithms such as random forest regression methods, multiple linear regression method, multivariate adaptive regressive splines techniques. The author finds that multivariate adaptive regression splines for wheat and rice dataset. Whereas for maize dataset multiple linear regression outperforms random forest regression method (Earth).

## 2.3 Classification algorithms used for crop yield prediction

The classification algorithms are a supervised learning technique in which the model is built to identify the category of new observations on the basis of the training dataset given to the model. The model learns from the given training dataset and classifies new outcome into a number of group. This group is known as target dataset. The main goal of this algorithm is identify the category of the dataset and predict on the basis of identified category. [18]

Chandraprabha [9] the author uses various methodologies like Support Vector Machine (SVM), K nearest neighbor regression also called as KNN-R, Naïve Bayes and SVR. The author produce the result by using various methods such as accuracy level and error rate. The higher the accuracy and lower the error rate can produce a targeted model. The author conclude that the BayesNet has a greater precision which is about 97.53 % and whereas RNN has very lower percentage error rate than any other yield prediction algorithms. Jude Immaculate [10] discusses the farm sector's Machine Learning techniques. The author defines various machine learning methods that can predict the crop yield prediction. This is all discussed in the research paper and implementation is also discussed in this research paper. The author defines that the machine learning approaches are suitable for agriculture yield prediction.

## 2.4 K-mean clustering algorithm and Apriori algorithm used for crop yield prediction

K-MEAN clustering is an unsupervised machine learning technique that is used to form clusters where data is unlabeled, the algorithm make a group of unlabeled similar type of dataset and form a cluster. With the help of this cluster the model is able to predict the solution of a particular problem. This is basically a iterative algorithm that make cluster of similar type of clusters. [16] Apriori algorithm is used to generate an association rules that uses frequent item sets, it designs to work on the dataset that having transactions. This association rule tells the model that how weakly or strongly these two objects are connected. This is an iterative process for finding the frequent items from the complex dataset. [11]

Bhosale [13] in this research paper the author try to discovered or researched on the agriculture dataset that is available in India. The author use the Tableau data visualization tool to connect the dataset based on various parameter. The author looked into the K-means clustering to make the clusters. The cluster hypothesis can kept the information in clusters that can help to search very fast in lesser periods. The farmers can get the maximum benefit this techniques can helps the farmer to enhance their crop yield. Big data is used to store in clusters by using K-means clustering algorithms that is used to reduce the unwanted material only appropriate or valid dataset is used. The Apriori algorithm is used to count the frequently occurring features and forecast in the agriculture productivity for a particular region. Another technique of machine learning is Naïve Bayes that is used to identify the accurate crop. As a result of this author develop a system which can help to forecast the crop name as well as yield in a specific region.

## CONCLUSION

In this research paper, we found that the various parameters such as temperature, rainfall, humidity, soil type, ph level of the soil, and various minerals present in the soil can help to predict the soil production. Various algorithms are used by the researchers to found which algorithm gives the best result, the various algorithms such as decision tree regressions and adaBoost regressions gives the accurate to predict the crops production. The various algorithms such as SVM, RNN, K nearest neighbor regression, Naïve Bayes, SVR, are evaluated the author found that BayesNet is more accurate than RNN. Many types of algorithms are used to improve the crop yield prediction. So that the need to increase the productivity is increased and in future the farmer may know in advance that which crop suits their soils. According to the prediction the farmer can get maximum benefit from their land.

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# INSECT PEST CLASSIFICATION AND MONITORING USING CAMERA-EQUIPPED TRAPS: A LITERATURE REVIEW

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## *Abstract:*

*Agriculture sector has a huge potential of improving crop health and quality. But one of the many reasons in the decreased crop quality is the unwanted insect pests that eat and destroy the plants. Another major reason could be the use of pesticides and insecticides to manage and control these harmful insect pests. Decrease in the use of these chemicals can result in better quality crops. The current method to identify the insects and monitor them is manual. The farmers have to keep an eye for these crop eating insects and themselves think of the remedy. But this process can be done automatically with the use of Internet of Things and Machine Learning. This review paper discusses some of the new technologies for pest monitoring and management and insect classification and detection. The paper focuses on using camera-image based classificationand few machine learning algorithms for insect identification. This paper also explores the various types of automatic camera equipped traps used.*

## INTRODUCTION

Agriculture is one of the sectors in which the involvement of technologies like Machine learning and Internet of Things can result into reduced human labor, increased productivity, natural resources management optimization, water usage optimization resulting in saving groundwater, controlled use of pesticides and insecticides and better qualitied crops. Massive research has been going on to develop technologies to achieve above said benefits in agriculture sector. The agriculture is the backbone of the economy that determines the standard of living. The decreased quality of crops directly leads to less market value, low sale and can also cause human health related issues.

One of the major reasons for the decreased quality is the harmful insect pest and use of pesticides to kill those pests in the fields. The quality is indirectly proportional to the use of pesticides and the damage already done by the pests. More the amount of pesticides used in the field lesser will be the quality of crops. International Agency for Research on Cancer have classified insecticides as carcinogenic i.e., cancer causing. Using these pesticides increase the risk of life-threatening diseases in humans.

The traditional identification method for insects involves the manual approach in which a person has to keep an eye out for insects and classify it to a particular species to classify the apt pesticide to kill it. This method involves a lot of time-consuming hours of labour. The introduction of new technologies has made insect classification easier. Integrated pest management systems are being developed to improve pest management and reduces the use of pesticides. Recent modern technologies have been used in field surveys of a variety of pests like thermal infrared imaging and chemiluminescent tags to track insect movement at night, video equipment to observe flying insects, radar technologies monitoring pest migration, echo-sounding detection and habitat mappingof larvae movement. However, these techniques are highly expensive. The cost of insect automatic detection and monitoring systems was reduced thanks to developments in digital processing techniques, telecommunications engineering, miniature sensors and microprocessors. These new gadgets are easy to link to the internet, enabling on-site real-time surveillance at field level. Some of these gadgets have the ability to employ cloud computing services to assist in decision-making, link to wireless sensor networks (Internet of Things) to monitor field regions. This paper provides a review of current works in the area of automated insect identification and monitoring using camera-equipped traps. Various machine learning algorithms recently used are also discussed.

## 1. Machine Learning Algorithms

Xia (2018) used an improved network architecture of 19 layered self-learning CNN network. The 16 convolutional layers were used for feature extraction. The Region Proposal Network in the first 16 layers could recommend the location of insect on feature map and remove unrelated background influence on results. The higher convolutional layer can help in resolution reduction of feature map and abstraction of more abstract high-level features. The last two full connection layers could capture complex comprehensive feature information. It was observed that the proposed model gave highest accuracy in comparison to SSD and Fast RCNN models and took least training time.

Kasinathan (2021) performed the insect classification by using various machine learning techniques: ANN (Artificial neural networks), SVM (Support Vector Machine), KNN (K-Nearest Neighbour) and NB (Naïve Bayes).

1. ANN Classifier: It is simple neural network that contains three layers: input, hidden and output with random weights assigned. A feed forward multi-layer artificial neural network automatically identifies and classifies adult-stage whiteflies and thrip in greenhouses. A back propagation ANN model has the improved ability to identify Beet armyworm from other species.
2. SVM Classifier: It is a supervised machine learning technique. The hyperplane best differentiates the classes. It overall decreases the interspecific error rates for identifying mosquitoes and fruit flies.
3. KNN Classifier: It is a lazy learning algorithm that doesn’t make use of any parameters. In this the nearest neighbour contributes more to the average than the farthest one. It has a better identification rate for butterfly species when dealing with a large number of features and small samples.
4. NB Classifier: It is based on Bayes theorem of probability. In this it is assumed that the presence of particular feature is not related to the presence of any other feature in the insect class. It identifies that a given tuple from a soybean crop insect belongs

to a particular insect class.

CNN model: The CNN model was developed to train with RGB insect images from Wang and Xie dataset. It falls under the class of deep, feed-forward neural network applied to analyse visual imagery of insect images and computationally efficient due to automatic feature learning and weight sharing. The CNN model contains 5 convolutional layers and 3 max-pooling layers, a flatten layer, a fully connected layer and a SoftMax output layer to classify insect images. The model can run over each image of insect very fast with reduced computational operations per layer and memory needs. Each convolution and max-pooling layer use 3 x 3 and 2 x 2 filter sizes, respectively. A fully connected layer is designed in a way to learn high level features for final insect classification.

The order of classification accuracy that was checked by nine-fold cross validation was:

Propose CNN> SVM> KNN> ANN> NB

Zhang (2022) used Modified Capsule Network which is composed of convolutional layer that captures the features from input layer and output feature graphs, primary capsule layer (PrimaryCaps) transforms the feature graphs into vector capsules, digital capsule layer (Digitalcaps) that is similar to full connection layer of CNN and concatenation layer with Local DRA. LeakyReLu is used as the activation function. Capsule Network doesn't discard the location information. The modified Capsule Netwrok with LeakyReLu returned highest precision and recall rate in comparison to ICNN, RepsNet, Capsule Network, Modified Capsule Network with ReLu activation function.

## 2. Cameras used

The camera-based instrument contains an electronic box containing a modem for data transmission, an external power supply, a battery, and digital camera. Choosing the type of camera is an important step to guarantee qualitied images. The camera should be cost efficient and power efficient. Lopez (2012) used a low-cost, high resolution, and low power consuming C328-7640 colour camera from Comedia that was able to produce raw or JPEG compressed images at a maximum resolution of 640 x 480 pixels provided by the OmniVision OV7640 image sensor. In 2017 Fouskitakis used a 2-megapixel camera to monitor B. oleae and in 2018 A. Amore used a 5-megapixel camera (Omni Vision OV5647 NOIR Rasp Pi) to monitor C. captitata. Stefano Maini (2011) used a camera of 3 megapixel with 2-megapixel resolution which is higher than the minimum resolution. Shelby (2014) made use of cameras via pyroelectric sensors initially designed to monitor mammals. Cameras already had a motion triggered mechanism, could take and store excellent pictures, had long battery life, high availability and low cost. They made use of two types of cameras: wildview took 0.3 megapixels and Moultrie camera took 2.0 megapixels in resolution with a date-time stamp. It had a storage of 4 gigabytes (memory card). It always recorded the presence of arthropods in the photo space.

In 2016, Rassatiused a two-camera integrated trap model. The first one RedEye (iDefgo/Mi5 Security), was modified security camera with wide angle lens, a general packet radio service (GPRS) modem for connectivity, rechargeable battery,1 megapixel sensor, and a subscript identity module (SIM) card. The interval for taking photos was programmable and images could be stored in SD card and transmitted via internet. The camera was set to take up to 4 photos per day. The second camera BioCam (iDefgo/Mi5 Security) has some improvements like waterproof body, 3-megapixel sensor, built in flash, solar panel and 2 rechargeable batteries. The camera could take multiple shots, up to 3 photos a day.

Lucchi (2018) made use of a high-resolution camera equipped with larger solar panels and batteries with high capacity that could shoot up to 48 pictures everyday. The camera took images of the sticky trap it was attached to every 30 mins.

Akdemir (2019) used a high-definition camera for high resolution images.

The quality of the camera to be chosen for the implementation is an important step. Better the quality of the camera, better will be image classification results as better-quality camera results in better quality images with good resolution. The picture acquisition can depend on how the camera is programmed. It can be set to take photos at specific intervals of time and can be set to click a target number of photos in a day. The camera can be set to click the photo every time a sensor goes off or senses something. For example, in thermal sensors, as soon as it detects the presence of something in its range, the camera will take some pictures. This is better choice from research perspective. The installation of camera at right place is also important. The place having maximum light making it possible to click better pictures is probable a good option. The other conditions such as weather conditions of the place, the direction of sun, wind, and the level of moisture in air also matters while installing the camera.

## 3. Problems with the cameras

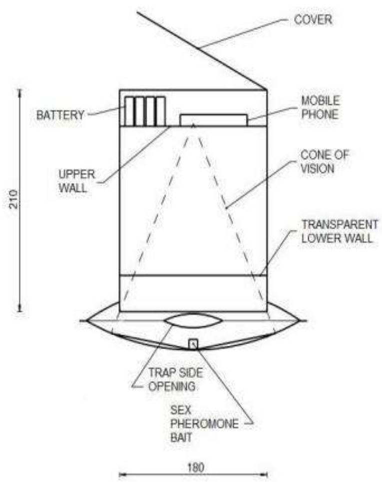
Lopez (2012) used the camera for large size weevil R. ferrugineus but for smaller insects'high-resolution camera was required. The problem with the camera Shelby (2014) used was that it took multiple shots once triggered in a quick succession and could not be triggered again for next 60 sec thus leaving that a gap in picture record. Rassati (2016) reported that RedEye and BioCam, the two security cameras used in his research has an equivalent cost of that of medium-high range smartphones. It is considered that the cost of the device will increase with the optical quality of camera. This can be a problem for small scale farmers as they can't spend such amount of money. The use of such models becomes limited as a smaller number of purchases will be made. To enable mass usage, the model should always be cost effective and highly available in the marketplaces. The photo collecting time is often controlled at predetermined intervals, resulting in a finite number of records each day, in order to minimize energy consumption and ensure adequate operation longevity. In fact, power consumption—which is primarily related to data transmission—is the greatest limitationof taking repeated photos.

## 4. Camera equipped traps

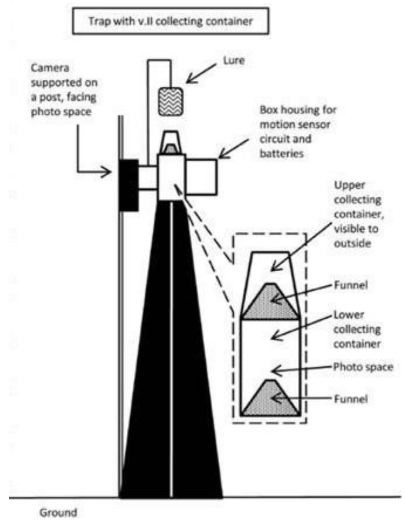
- Lopez (2012) made use of RPW (Red Palm Weevil) traps with wireless image sensors which form the Wireless Image Sensor Network. The wireless image sensor fixed at the top in the inside of trap periodically takes picture of the contents of the trap and delivers to control station. To provide enough light in the trap the body is made up of translucent plastic material with some holes on the top.


RPW Trap with the wireless image sensor

- Stefano (2011) designed electronic trap for C. pomonella consisting of an envelope containing sticky pad and sex pheromones as bait. There are two openings in the trap to allow male moths to enter. The parallelepiped has two walls, lower one is transparent and upper one supports the image detection system and power supply. In order to get a complete vision of the trap, the upper side is at some distance from the sticky pad. The trap is isolated from environmental factors. Schematic diagram of electronic trap as well as experimental prototype of camera based sticky trap by Stefano (2011) are shown below.

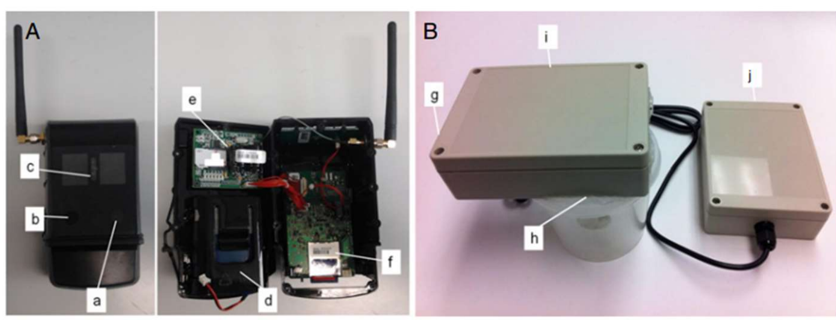


- Shelby (2014) used a pyramid trap that attracts plum curculio with a lure at the top of the trap. From the pyramid base the insect goes up towards the lure entering a funnel with 0.4 cm diameter first. The funnel is surrounded by a container which has the same entry-exit point. The insect is trapped indefinitely in it as the insect rarely traces its step backwards i.e., it rarely will go back the way it came from. The design was based on narrow-tube-and-motion-sensor system concept with a motion sensor triggered camera to click multiple photos. (Refer to diagram below.)




Automatic trap using a v.II collecting container and camera

- Rassati (2016) coupled the cameras with 12 black overlapped funnels connected to a drainage collector. To drain the water the trap was modified by connecting a transparent plastic pipe ending with a wire net. With RedEye camera, an insecticide was used to instantly kill the trapped insect whereas in BioCam no insecticide was used as the aim was to keep them alive for further research purposes.




- A. Amore (2017) modified the jackson trap into medfly e-trap with a 5-megapixel camera on the top of the roof of trap to cover the sticky platform. It was designed to monitor medflies. The e-trap is composed of 3 rectangular hard plastic surfaces out of which two creates a roof and the third one is the sticky base of the trap. The camera is connected with a single board processor with a slat ribbon which is placed inside a waterproof plastic box. The box is connected to a metal pole with a power supply compartment fixed on it. A solar panel is also installed on the top of the metal pole and a wireless antenna that covers a distance of 300m.



- Luchhi (2018) used traps baited with standard pheromones to lure L. botrana and the pheromones were changed after every four weeks. The trap was equipped with a high-resolution camera, temperature sensor and relative humidity sensor. The trap transferred data and photos to the cloud for processing through the cellular network.
- Akdemir (2019) integrated the standard pheromone trap of delta shape with a high-definitioncamera, solar cell, battery, charging unit and three GPRS modem (to remote monitor the image or convert it into picture format). The trap was attached to an aluminium pole. The solar panel is located at the top. The camera is at the top of the trap to cover the entire trap for better images. The pheromone lure was changed once a month.

## CONCLUSION

The aim of the upcoming new technologies is to ease the human lifestyle. The technology can also help in agriculture domain to decrease the human labour at reduced costs and time with effective and efficient means. The traps discussed in this paper showed less human intervention and easy pest monitoring techniques. The chance to detect an insect pest by creating digital records gives the user a highly effective instrument to handle upcoming issues in the monitoring and management of pests. The trap should be designed in such way to ensure image capture and trapping efficiency. Dry traps or clear liquid traps are preferable for clear images. The electronic components used in the traps should be compact in size for easy implementation in the fields. The trap should be designed in such a way that the environment temperature doesn't affect the electronic components of trap such as overheating them etc.

These camera-equipped traps can help in early detection of a harmful species of pest in the field, thus providing time to deal with it. The images captured by the cameras attached to the traps are sent to the control centre or to a database where machine learning algorithms come into play. These algorithms are trained to classify insect pests to their respective classes and can also be programmed to suggest effective preventative methods to control the insect pest in the farm. They can also suggest various control methods. For example, so far CNN showed better accuracy than KNN, SVM, NB etc. Recent use of Capsule Networks has also shown better accuracy results. The automatic traps also help in reducing the use of insecticides in the fields thus reducing the risk to the crop quality and human health. This also results in less expenditure on insecticides and pesticides. These camera prototypes are flexible and adaptable to different pests. For example, Shelby (2014) could be used to monitor different species of pest by simply changing the lure. This camera equipped trap technology opens up the future possibility to assess the pest population in different scenarios and real-time operation, thus minimizing the human power needed for pest monitoring system. The overall cost pf the automatic trap should be less or minimal to encourage maximum usage of it in fields by small scale farmers as well. The goal of these traps is to minimize the human intervention and early detection of pest in the fields thus helping the farmers in taking better preventative measures. Further these pest monitoring methods can also be developed to monitor and count the number of flying insects at a particular time in an area of field. This can help in determining which part of the field is densely populated with the pests and measures can be taken to identify the reason and to prevent the pests from entering in that area. Plant protection services in agriculture and forestry could usethese monitoring methods at the regional or national level. The material purchase, assembly and maintenance cost of an automatic trap prototype should be considered to compete with the standard man-powered on-site trap check and guarantee economical sustainability.

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# DETERMINATION OF RADIATION INTERACTION CHARACTERISTICS OF SOME AGRO-CHEMICALS USING NON-DESTRUCTIVE TESTING MACHINE AT DIFFERENT GAMMA-RAY ENERGIES

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## *Abstract:*

*The induced mutations in breeding the plants with gamma radiations has provided an excellent outcome for several decade and this has resulted in high yield of crops. With use of gamma emitting sources, one can analyze the quality of the ingredients to be used for the growth of the crop plant. The various interaction parameters, in terms of, mass attenuation coefficient, shielding parameters and partial interaction cross-sections for different pesticideslike Algaecide, Antimicrobial, Carbendazim, Isodrin, Organochloride, Potassium ethyl xanthate, 2,4-Dinitrophenol and Pyrogallol have been studied at different gamma radiations using incoherent scattering technique at various gamma energies. The variations of these parameters have been checked against energy, density and effective atomic number. The software package called WinXCom has been utilized to produce theoretical results in the energy range of 1 keV-7.0 MeV for the agro-chemicals listed in the present investigations.*

***Keywords:*** *Gamma irradiation, pesticides, insecticides, WinXCom software.*

## 1 INTRODUCTION

The nuclear radiations are being utilized in agricultural fields extensively by researchers on large scale to get better production at low cost and to get good quality breed for the generations. Since γ-rays are carrying highly energetic photons that penetrate through the cell and cause ionization of it: ionization process within the plant cells results in the disruption of the normal processes of the cell and affects crop yield. Till now, about 3200 new crop and fruits varieties have been evolved in this way. Neutron/Gamma irradiation is often used in conjunction with other methods in order to produce new genetic lines of root and tuber crops, oil seed crops and cereals. The γ-rays are also dose dependent, where a low dose has fewer demerits in contrast to a higher dose affecting plant phenotype, along with some biochemical components and cell organelles; however, in order to identify the damage owing to irradiation, there are various biochemical parameters that can be taken under consideration [1, 2]. In this study, scintillation gamma detecting machines are good examples to investigate such kind of parameters. These detectors are very useful to study the soil characteristics such as presence of air, water, minerals, density as well as porosity which have considerable influence for the effective growth of the plants. The theoretical findings of various γ attenuation and absorption coefficients for different elements/mixtures can be evaluated as in [3] and Gerward et al. [4] has provided tables of these using XCom and WinXCom software programs for this. Pesticides finds valuable list in wide range of agro-chemicals used to prevent weeds, fungi, insects, bacteria, etc. They are further classified in various forms namely; fungicides, insecticides, bactericides, herbicides or rodenticides. These are capable for the destruction of various pests or weeds as well as pathogens. These chemicals are being used extensively on farms and have multifarious uses: Algaecide is used to control the algae in the water; Antimicrobial has a significant role as an antimicrobial agent, an anti-bacterial drug, an anti-microbial drug, a protein-synthesis inhibitor, and an antifungal agrochemical; Carbendazim is used to control Fungal Imperfections and ascomycetes on a wide range of crops, for example, bananas, cereals, fruits, grapes, cotton, ornamentals, mushrooms, sugar-beet, peanuts, soybeans and vegetables; Isodrin is a type of solid and is no longer used as a pesticide, that was formerly used as an insecticide, a proper care is to be needed to carry out experiment; Organochloride is a type of insecticides that has two main groups of organochlorine insecticides (DDT and chlorinated alicyclics); Potassium ethyl xanthate is a major element to determine the amounts of cadmium in water samples in micrograms by sub-stoichiometric radiochemical method; 2,4-Dinitrophenol has an effective role as an oxidative phosphorylation inhibitor, an antiseptic drug and a bacterial xenobiotic metabolite: it is also utilized in manufacturing wood preservatives, dyes and is also used as a pesticide and Pyrogallol is a type of insecticide that has an influential role as a plant metabolite.

The objective of present investigations is to demonstrate the determination of radiation interaction parameters like mass attenuation coefficients and shielding parameters (tenth value layer) for the gamma ray energies ranging from 241.8, 262.7, 288.4, 319.8, 357.6 and 401.8 keV procured by incoherent scattering of 0.662 MeV γ radiations, originally obtained from 222 GBq $^{137}Cs$ radioisotope, at different scattering angles of 110°, 100°, 90°, 80°, 70° and 60° respectively for various chemicals Algaecide ($CuSO_9H_{10}$), Antimicrobial ($C_{21}H_{39}N_7O_{12}$), Carbendazim ($C_9H_9N_3O_2$) Isodrin ($C_{12}H_8Cl_6$), Organochloride ($CH_3CH_2Cl$), Potassium ethyl xanthate ($C_3H_5KOS_2$), 2,4-Dinitrophenol ($C_6H_4N_2O_5$) and Pyrogallol ($C_6H_6O_3$) used at agricultural works. Besides this, the above chemicals have also been studied theoretically with the help of WinXCom software package at the wide range of energy from 1 keV to 7.0 MeV. Apart from this, in order to check the reliability of the experimental design, there has been shown two findings; one at 357 keV energy emitted from $^{133}Ba$ (standard radioactive source) and other at 357.6 keV energy (obtained at scattering angle of70°). The experimental procedure is carried outto obtain scattered gamma radiation from aluminium cylinder placed on an manual scanning machine by using 2″ × 2″ NaI(Tl) scintillation spectrometer, the scanner can be operated either in vertical direction or in horizontal direction to visualize the specimen throughout the area. This method is totally non-invasive as it examines the object without harmingit, thus there occurs no changes in the physical properties of the medium to be exposed.

# 2 THEORETICAL BACKGROUNDS

## 2.1 Incoherent scattering technique

The interactions within the material by gamma radiation results in either absorption within the target or scattering (elastic or inelastic) of incident photons. The principle of present investigations is based upon the determination of the total gamma flux transmitted out of the system, with the incident gamma beam either arising from interactions of primary gamma-rays with the aluminium cylinder or from the radioactive source in a direct manner producing scattered photons of required energy, these energies are especially not available from the standard radioactive isotopes. In incoherent scattering, the energy of scattered photonschanges with changing angle between incident and scattered γ-rays. These incoherently scattered photons are further collected by NaI(Tl) detector of higher efficiency is used to study attenuation parameters from the direct gamma flux transmitted through the chemicals (samples) under investigation. Then, the intensities for the container (taken with and without samples) are recorded. Eventually, the PC based ORTEC Mastreo-32 multi-channel analyzer (MCA) is used to accumulate the experimental data for each chemical.

**2.2 Interaction parameters of agro-chemicals**

The radiation interaction parameters find a remarkable role in order to identify and characterize the material to be used in variety of areas. The primary one is called mass attenuation coefficient ($\mu_m$) which is used to describe as an effective area exposed to the incoming radiation per unit mass instead of per particle. It is helpful to evaluate all other parameters related to attenuation occurring throughout the material.

It is, mathematically, written by the following relation

$$(\mu/\rho)_{chemical} = \sum_i \omega_i \left(\frac{\mu}{\rho}\right)_i \quad (1)$$

where $(\mu/\rho)_i$and $\omega_i$are photon mass attenuation coefficient of the i^th constituent element and weight fraction of i^th elements in a molecule of organic compound respectively. For a chemical compound the fraction by weight ($\omega_i$) is given by; $\omega_i = \frac{n_i \cdot A_i}{\sum n_j \cdot Aj}$ where $A_i$ is the atomic mass of the i^thconstituent and $n_i$ is the total number of formula units satisfying the condition$\sum \omega_i = 1.$

For better understanding of shielding effectiveness of the various targets is quite helpful in order to study the design of the γ radiations shielding materials; therefore, evaluation of various shielding effective parameters; half value layer (HVL)and tenth value layer (TVL) becomes important. In this case TVLhas been determined using values of $\mu_l$ at different energies for different chemicals used in agricultural products. The relations for these parameters are HVL = Ln(2)/$\mu_l$ and TVL = Ln(10)/$\mu_l$, where linear attenuation coefficient, $\mu_l = \mu_m * \rho$ and ρ is density of the specimen.

The K-shell absorption energy is a specific part of each element. With increase in atomic number (Z), its corresponding K-edge. For K- and $L_I$ there is a creation of vacancy in the corresponding 1s and 2s atomic subshells. It helps to investigate the matter from the point of view of the element sunder consideration and is thus particularly finds a greater role in the atomic and electronic structures along with the chemical bonding. Elements with larger K-edge valuesare having an interest to a greater extent in radiology. The characteristics related to K-edges for certain materials can be specifically selected in order to utilize them in contrast media, beam filters

## 3 EXPERIMENTAL AND COMPUTATIONAL WORK

This experimental part is composite of incoherent scattering and conventional transmission set-up, as desired range of energy is procured by photon scattering process and then the scattered energy is thus utilized to evaluate mass and linear attenuation coefficients, half-value layer and tenth-value layer for the agro-chemicals in the transmission geometry. The detailed experimental procedure, theoretical formulations and methods of measurements have been described in brief in the paper [5]. The chemicals are classified according to their molecular mass, chemical formulae and density, and are shown in the table [1]. All the computer-oriented data is taken with the help of WinXCom (an extended version of XCom). The experimental data were checked regularly after certain period of time to avoid any shift in the final gamma ray spectrum, along with this linearity and stability of the instrument has been taken care appropriately in order to avoid any error.

**Table 1:** Classification of various pesticides and insecticides

| Sr. No. | Chemicals | Formula | Molar Mass | Density |
|---|---|---|---|---|
| **1** | Algaecide | $CuSO_9H_{10}$ | 275.26 | 1.1 |
| **2** | **Antimicrobial/** Streptomycin | $C_{21}H_{39}N_7O_{12}$ | 581.6 | 2.0 |
| **3** | Fungicide/ Carbendazim | $C_9H_9N_3O_2$ | 191.19 | 1.45 |
| **4** | Isodrin | $C_{12}H_8Cl_6$ | 364.9 | 1.6 |
| **5** | Chlorocarbon/ organochloride | $CH_3CH_2Cl$ | 64.51 | 0.92 |
| **6** | Potassium ethylxanthate | $C_3H_5KOS_2$ | 160.30 | 1.56 |
| **7** | **2,4-Dinitrophenol** | $\mathbf{C_6H_4N_2O_5}$ | 184.11 | 1.68 |
| **8** | Pyrogallol | $C_6H_6O_3$ | 126.11 | 1.45 |

## 4 RESULTS AND DISCUSSION

Since the mass attenuation coefficient is a fundamentalphysical quantity which is helpful to evaluate other radiation attenuation/shielding parameters and its values of are found to increase with decrease in gamma photon energy. The figure [1] shows the variation of $\mu_m$ as a function of energy and there one can find exponential decay of these values for all chemicals. These values are also shown in tabulated form in the table [2].

**Table 2***:* The mass attenuation coefficient values (theoretical and experimental) for chemicals

| Chemicals | $\mu_m$(x$10^{-2}$cm$^2$/gm)at different energies (in keV) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **241.8** | **262.7** | **288.4** | **319.8** | **357** | **357.6** | **401.8** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Algaecide | 12.47[a] | 11.98 | 11.48 | 10.95 | 10.43 | 10.42 | 9.90 |
| | 12.53[b] | 11.89 | 11.34 | 11.10 | 10.33 | 10.22 | 9.91 |
| Antimicrobial | 12.31[a] | 11.95 | 11.55 | 11.12 | 10.66 | 10.65 | 10.17 |
| | 12.38[b] | 11.88 | 11.20 | 11.01 | 10.24 | 10.54 | 10.10 |
| Carbendazim | 12.08[a] | 11.73 | 11.33 | 10.91 | 10.46 | 10.45 | 9.98 |
| | 12.09[b] | 11.67 | 11.23 | 10.89 | 10.43 | 10.43 | 9.89 |
| Isodrin | 11.81[a] | 11.42 | 11.00 | 10.54 | 10.08 | 10.07 | 9.60 |
| | 11.79[b] | 11.23 | 10.90 | 10.43 | 10.03 | 10.08 | 9.57 |
| Organochloride | 12.44[a] | 12.03 | 11.59 | 11.12 | 10.64 | 10.63 | 10.13 |
| | 12.34[b] | 12.01 | 11.43 | 11.10 | 10.43 | 10.54 | 10.10 |
| Potassium ethyl xanthate | 12.16[a] | 11.75 | 11.31 | 10.84 | 10.36 | 10.35 | 9.86 |
| | 12.10[b] | 11.65 | 11.31 | 10.79 | 10.37 | 10.34 | 9.88 |
| 2,4-Dinitrophenol | 11.80[a] | 11.46 | 11.07 | 10.65 | 10.21 | 10.20 | 9.75 |
| | 11.73[b] | 11.43 | 11.07 | 10.43 | 10.22 | 10.29 | 9.82 |
| Pyrogallol | 12.09[a] | 11.74 | 11.34 | 10.91 | 10.46 | 10.46 | 9.99 |
| | 12.00[b] | 11.83 | 11.11 | 10.90 | 10.50 | 10.42 | 9.92 |
| a – Theoretical values<br>b – Experimental values | | | | | | | |

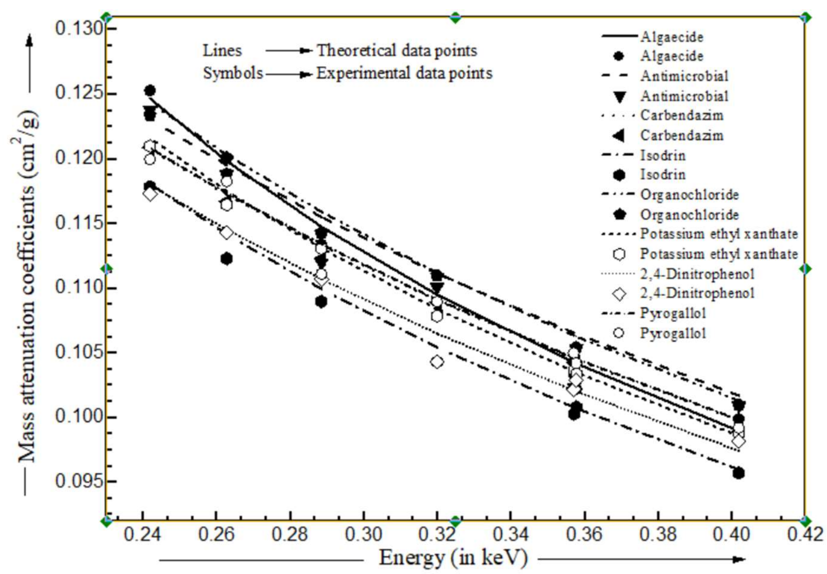


*FIG. 1:* ***THE VARIATION OF MASS ATTENUATION COEFFICIENTS (IN CM²/GM) FOR PESTICIDES IN ENERGY RANGE 241.8-401.8 KEV FOR ALL AGRO-CHEMICALS.***

In the figure [2], the pesticide called Algaecide shows two K and one $L_I$ edges at 2.472 keV and 8.979 keV, and 1.096 keV respectively which is clearly visible in the theoretical data taken from WinXCom software and is presented as a picture in the form table [3]. Additionally, table [4] represents the theoretical data for Algaecide for the remaining values of energies. This data has been plotted for partial interaction coefficients and gamma-ray energy; thereby, results into various curves (for experimental and theoretical data points) in the figure [3].

The data from the figure [3] and table [3, 4] indicates that at lower values of energy, the photoelectric absorption is maximum and found to decay exponentially with increase in energy and also true for other processes occurring within the specimen owing to interaction with gamma-rays, while coefficients of incoherent scattering increase at slow rate then found to decrease with energy starting from around 8 keV. In addition, pair production processes occur at 1.022 MeV or more below this the material can exhibit scattering (coherent and incoherent) and photoelectric absorption. The values of tenth value layer, a shielding parameter, are found to increase with increase in incident gamma energy and the data is plotted for all chemicals shown in figure [4]. The experimental results are compared with theoretical results calculated from WinXCom and are found in good agreement within experimental estimated errors. The uncertainties in these parameter calculations range from 0.07 to 2.35% at all energies considered in the present study.

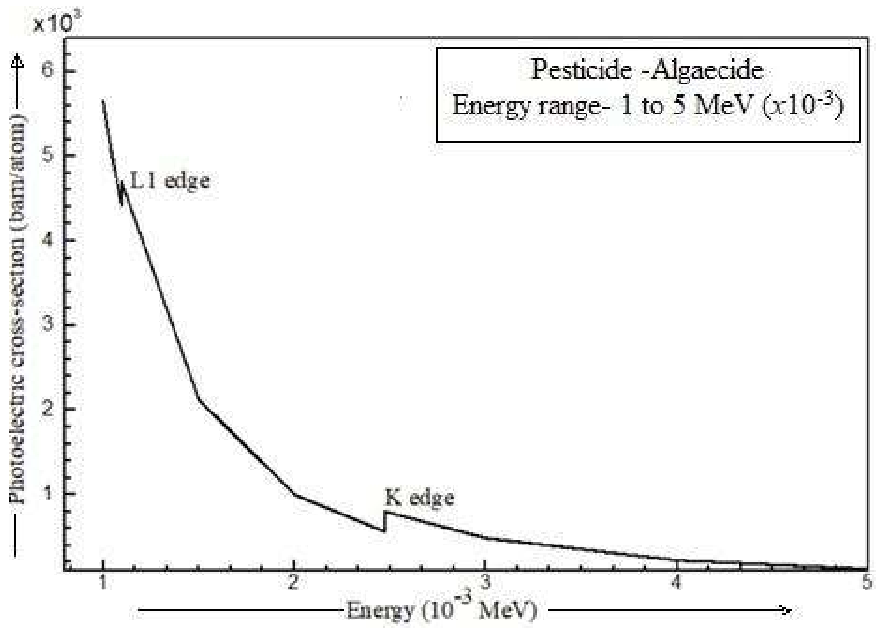


*FIG. 2:* ***THE PHOTOELECTRIC CROSS-SECTIONS AS A FUNCTION OF GAMMA ENERGY RANGE FROM 0.001 MEV TO 0.005 MEV OBTAINED USING WINXCOM SOFTWARE.***

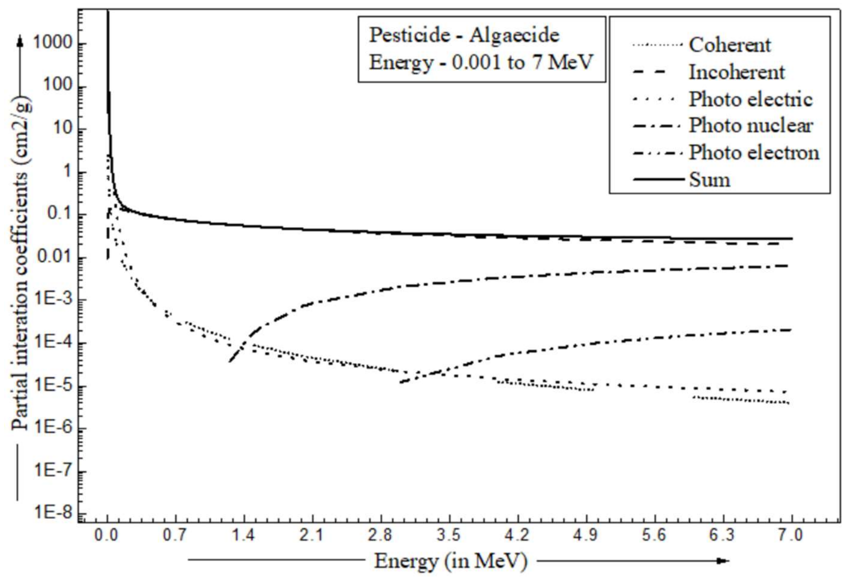


*FIG. 3:* ***THE PARTIAL INTERACTION COEFFICIENTS AND TOTAL ATTENUATION COEFFICIENTS VERSUS GAMMA RAY ENERGY FROM 1 KEV TO 7 MEV FOR ALGAECIDE (PESTICIDE) AS A SAMPLE.***

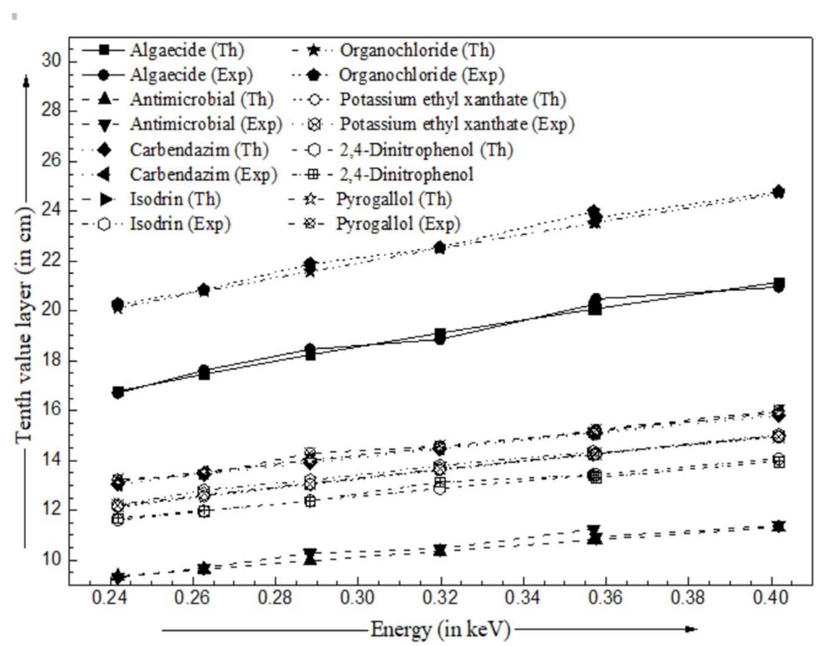


***FIG. 4:*** *THE VARIATION OF TVL (IN CM) FOR DIFFERENT PESTICIDES FOR ENERGIES 241.8 - 401.8 keV.*

**TABLE 3: *THE THEORETICAL DATA FOR ALGAECIDE, ONE OF PESTICIDES, OBTAINED FROM THE WINXCOM SOFTWARE PACKAGE AND DEPICTING SOME OF THE ABSORPTION EDGES (IN SHADED REGIONS).***

WinXCom - C:\Users\MYPC\Desktop\Book chapter\Agro-chemicals.wxc

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Substance Definition List: WinXCom; Elements; Compounds: Algaecide, Antimicrobial, Carbendazim, Isodrin, organochloride, Potassium ethylxa, Dinitrophenol, Pyrogallol; Mixtures

Partial Interaction Coefficients and Total Attenuation Coefficients

| | | Energy (MeV) | Coherent (cm2/g) | InCoherent (cm2/g) | Photo Electric (cm2/g) | PAIR Nuclear (cm2/g) | PAIR Electron (cm2/g) | Sum (cm2/g) | Sum NonCoherent (cm2/g) |
|---|---|---|---|---|---|---|---|---|---|
| | | 1.000E-003 | 2.54E+000 | 9.75E-003 | 5.65E+003 | 0 | 0 | 5.65E+003 | 5.65E+003 |
| | | 1.047E-003 | 2.53E+000 | 1.06E-002 | 4.99E+003 | 0 | 0 | 5.00E+003 | 4.99E+003 |
| | | 1.096E-003 | 2.51E+000 | 1.14E-002 | 4.42E+003 | 0 | 0 | 4.42E+003 | 4.42E+003 |
| 29 | L1 | 1.096E-003 | 2.51E+000 | 1.14E-002 | 4.70E+003 | 0 | 0 | 4.70E+003 | 4.70E+003 |
| | | 1.500E-003 | 2.38E+000 | 1.94E-002 | 2.12E+003 | 0 | 0 | 2.12E+003 | 2.12E+003 |
| | | 2.000E-003 | 2.20E+000 | 3.02E-002 | 9.96E+002 | 0 | 0 | 9.98E+002 | 9.96E+002 |
| | | 2.472E-003 | 2.03E+000 | 4.03E-002 | 5.60E+002 | 0 | 0 | 5.63E+002 | 5.61E+002 |
| 16 | K | 2.472E-003 | 2.03E+000 | 4.03E-002 | 7.98E+002 | 0 | 0 | 8.01E+002 | 7.99E+002 |
| | | 3.000E-003 | 1.84E+000 | 5.11E-002 | 4.86E+002 | 0 | 0 | 4.88E+002 | 4.86E+002 |
| | | 4.000E-003 | 1.53E+000 | 6.89E-002 | 2.22E+002 | 0 | 0 | 2.24E+002 | 2.22E+002 |
| | | 5.000E-003 | 1.28E+000 | 8.32E-002 | 1.19E+002 | 0 | 0 | 1.21E+002 | 1.19E+002 |
| | | 6.000E-003 | 1.08E+000 | 9.45E-002 | 7.14E+001 | 0 | 0 | 7.26E+001 | 7.15E+001 |
| | | 8.000E-003 | 7.94E-001 | 1.11E-001 | 3.13E+001 | 0 | 0 | 3.23E+001 | 3.15E+001 |
| | | 8.979E-003 | 6.95E-001 | 1.17E-001 | 2.24E+001 | 0 | 0 | 2.33E+001 | 2.26E+001 |
| 29 | K | 8.979E-003 | 6.95E-001 | 1.17E-001 | 8.35E+001 | 0 | 0 | 8.44E+001 | 8.37E+001 |
| | | 1.000E-002 | 6.11E-001 | 1.22E-001 | 6.41E+001 | 0 | 0 | 6.49E+001 | 6.42E+001 |
| | | 1.500E-002 | 3.65E-001 | 1.40E-001 | 2.14E+001 | 0 | 0 | 2.19E+001 | 2.15E+001 |
| | | 2.000E-002 | 2.48E-001 | 1.49E-001 | 9.58E+000 | 0 | 0 | 9.98E+000 | 9.73E+000 |
| | | 3.000E-002 | 1.36E-001 | 1.58E-001 | 2.99E+000 | 0 | 0 | 3.28E+000 | 3.15E+000 |
| | | 4.000E-002 | 8.49E-002 | 1.60E-001 | 1.28E+000 | 0 | 0 | 1.53E+000 | 1.44E+000 |
| | | 5.000E-002 | 5.83E-002 | 1.59E-001 | 6.59E-001 | 0 | 0 | 8.77E-001 | 8.18E-001 |
| | | 6.000E-002 | 4.26E-002 | 1.57E-001 | 3.81E-001 | 0 | 0 | 5.81E-001 | 5.38E-001 |
| | | 8.000E-002 | 2.57E-002 | 1.52E-001 | 1.59E-001 | 0 | 0 | 3.37E-001 | 3.11E-001 |
| | | 1.000E-001 | 1.72E-002 | 1.47E-001 | 8.02E-002 | 0 | 0 | 2.44E-001 | 2.27E-001 |
| | | 1.500E-001 | 8.09E-003 | 1.34E-001 | 2.31E-002 | 0 | 0 | 1.65E-001 | 1.57E-001 |

***TABLE 4: THE REMAINING THEORETICAL DATAUSING WINXCOM ALONG WITH ENERGIES PROCURED COMPTON SCATTERING TECHNIQUE AND AT 357 KEV FROM STANDARD RADIOISOTOPES (IN SHADED REGIONS).***

WinXCom - C:\Users\MYPC\Desktop\Book chapter\Agro-chemicals.wxc

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Substance Definition List: WinXCom; Elements; Compounds: Algaecide, Antimicrobial, Carbendazim, Isodrin, organochloride, Potassium ethylxa, Dinitrophenol, Pyrogallol; Mixtures

Partial Interaction Coefficients and Total Attenuation Coefficients

| | | Energy (MeV) | Coherent (cm2/g) | InCoherent (cm2/g) | Photo Electric (cm2/g) | PAIR Nuclear (cm2/g) | PAIR Electron (cm2/g) | Sum (cm2/g) | Sum NonCoherent (cm2/g) |
|---|---|---|---|---|---|---|---|---|---|
| | | 2.000E-001 | 4.67E-003 | 1.23E-001 | 9.64E-003 | 0 | 0 | 1.38E-001 | 1.33E-001 |
| | | 2.418E-001 | 3.24E-003 | 1.16E-001 | 5.46E-003 | 0 | 0 | 1.25E-001 | 1.21E-001 |
| | | 2.627E-001 | 2.76E-003 | 1.13E-001 | 4.27E-003 | 0 | 0 | 1.20E-001 | 1.17E-001 |
| | | 2.884E-001 | 2.30E-003 | 1.09E-001 | 3.25E-003 | 0 | 0 | 1.15E-001 | 1.12E-001 |
| | | 3.000E-001 | 2.13E-003 | 1.08E-001 | 2.90E-003 | 0 | 0 | 1.13E-001 | 1.11E-001 |
| | | 3.198E-001 | 1.88E-003 | 1.05E-001 | 2.41E-003 | 0 | 0 | 1.10E-001 | 1.08E-001 |
| | | 3.570E-001 | 1.51E-003 | 1.01E-001 | 1.76E-003 | 0 | 0 | 1.04E-001 | 1.03E-001 |
| | | 3.576E-001 | 1.51E-003 | 1.01E-001 | 1.75E-003 | 0 | 0 | 1.04E-001 | 1.03E-001 |
| | | 4.000E-001 | 1.21E-003 | 9.67E-002 | 1.28E-003 | 0 | 0 | 9.92E-002 | 9.80E-002 |
| | | 4.018E-001 | 1.20E-003 | 9.65E-002 | 1.27E-003 | 0 | 0 | 9.90E-002 | 9.78E-002 |
| | | 5.000E-001 | 7.79E-004 | 8.84E-002 | 7.05E-004 | 0 | 0 | 8.99E-002 | 8.91E-002 |
| | | 6.000E-001 | 5.43E-004 | 8.18E-002 | 4.45E-004 | 0 | 0 | 8.28E-002 | 8.23E-002 |
| | | 6.620E-001 | 4.47E-004 | 7.84E-002 | 3.49E-004 | 0 | 0 | 7.92E-002 | 7.87E-002 |
| | | 8.000E-001 | 3.06E-004 | 7.19E-002 | 2.27E-004 | 0 | 0 | 7.25E-002 | 7.22E-002 |
| | | 1.000E+000 | 1.96E-004 | 6.47E-002 | 1.41E-004 | 0 | 0 | 6.50E-002 | 6.48E-002 |
| | | 1.022E+000 | 1.88E-004 | 6.40E-002 | 1.34E-004 | 0 | 0 | 6.43E-002 | 6.42E-002 |
| | | 1.250E+000 | 1.26E-004 | 5.79E-002 | 9.06E-005 | 3.71E-005 | 0 | 5.81E-002 | 5.80E-002 |
| | | 1.500E+000 | 8.75E-005 | 5.26E-002 | 6.53E-005 | 1.94E-004 | 0 | 5.29E-002 | 5.29E-002 |
| | | 2.000E+000 | 4.92E-005 | 4.49E-002 | 4.02E-005 | 7.46E-004 | 0 | 4.57E-002 | 4.57E-002 |
| | | 2.044E+000 | 4.71E-005 | 4.43E-002 | 3.88E-005 | 8.03E-004 | 0 | 4.52E-002 | 4.52E-002 |
| | | 3.000E+000 | 2.19E-005 | 3.53E-002 | 2.18E-005 | 2.09E-003 | 1.24E-005 | 3.75E-002 | 3.74E-002 |
| | | 4.000E+000 | 1.23E-005 | 2.95E-002 | 1.47E-005 | 3.35E-003 | 5.05E-005 | 3.29E-002 | 3.29E-002 |
| | | 5.000E+000 | 7.88E-006 | 2.54E-002 | 1.10E-005 | 4.47E-003 | 1.01E-004 | 3.00E-002 | 3.00E-002 |
| | | 6.000E+000 | 5.47E-006 | 2.25E-002 | 8.72E-006 | 5.47E-003 | 1.54E-004 | 2.81E-002 | 2.81E-002 |
| | | 7.000E+000 | 4.02E-006 | 2.02E-002 | 7.23E-006 | 6.37E-003 | 2.08E-004 | 2.68E-002 | 2.68E-002 |

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# ARTIFICIAL INTELLIGENCE: ROLEIN THE AGRICULTURE

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***Abstract:***
*Artificial intelligence(AI) is an emerging technology in the field of agriculture revolution. The fundamental idea behind AI is to create technology that works similarly to the human brain. It is a ability of a machine with which the machine mimic the behavior of human being by using old experience. It does all the tasks that are done by the human being on the farming. The world's population is assumed to be nearly 10 billion by 2050. To fulfill the needs of food for population is a major challenge for farmer. It overcome the traditional challenge in the field by improving the efficiency of farmers. AI protects the agriculture industry from a number of concerns, including food safety, population increase, climate change, and job issues. It helps the farmers by giving prior knowledge about weather and disease or pest identification. In this paper, we will discuss about the application of AI in agriculture, future of agriculture and the challenged ahead.*

***Keywords:*** *Agriculture revolution, Bright Future, Traditional Challenge*

## 1. INTRODUCTION

One of the oldest and most significant professions in the world is agriculture. It played a significant part in the economic sphere. It is typically a primary occupation that requires a lot of effort, perseverance, little pay, and an inconvenient way of living. Farmers put a lot of time and effort into growing crops, but because of their poor income and occasionally inability to profit from their land due to weather conditions, farmers often experience losses that lead to sadness and eventually a reason for suicide of farmer. Due to so much time and effort requires for farming, farmers are unable to select a supplementary employment. Indian agriculture faces unique difficulties such as inadequate infrastructure, ignorance, reliance on traditional practices and a lack of farmer capital. Due to their ignorance, farmers frequently have trouble selecting the ideal seeds, planting schedules, and crop-enhancing practices.

## 2. ARTIFICIAL INTELLIGENCE WITH AGRICULTURE

Before the artificial intelligence farming is done using traditional techniques and methods. In India because of deforestation and pollution result in climatic changes, we found different environments, weather, soils which are suitable for different crops. There are many regions in India who are totally depends on rain or water availability. In the cycle of agriculture, protecting our crops from weeds is essential. Unless it is regulated, it can raise production costs and deplete the soil of nutrients by absorbing nutrients from the soil. Every crop needs a particular type of soil nutrition. The three main nutrients that soil needs are nitrogen (N), phosphorus (P), and potassium (K). Poor quality of crops may result from nutrients insufficiency. Additionally, agricultural weed identification and prevention using conventional methods are ineffective. The farmers can better interpret the data within, such as temperature and wind speed, and identify weed diseases or pests in the crops by combining AI with culture. It can identify a disease in crops with about 98 percent accuracy by using AI. Nowadays less people are entering in the profession of farming so this is the challenging process for existing farmer to feed the world with shortage of manpower. But by the use of AI farmers improve the harvesting quality with low cost and easy processing. There are many robots are available that helps the farmers to detect weed, pick and pack the crops etc. The agriculture sector is utilising artificial intelligence (AI) to improve a variety of agricultural-related processes along the food supply chain, including healthier crop production, pest management, soil and growing conditions monitoring, data organization for farmers, and labor-saving measures. Artificial Intelligence-based agri-tech applications are set to unleash value in agriculture, especially in wake of the recent farm reforms that have opened doors to private sector investments in agriculture. It also helped the farmer to provide the easy knowledge about the weather which help the farmers if they have idea about the weather change.

## 3 APPLICATION OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE

**3.1 Weather forecasting system:** Farmers find it challenging to determine the best time to plant seeds due to climate change and rising pollution. With the aid of artificial intelligence, farmers can analyse weather conditions by using weather forecasting, which aids in planning the type of crop that can be grown and when seeds should be sown. Empirical data collected by Doppler, radar, radiosondes, weather satellites, buoys and other instruments are loaded information into computerized National Weather Service numerical forecast models. The models use equations, along with new and past weather data, to provide forecast guidance to our meteorologists. As well as 'Mausam' and 'Meghdoot' are two apps from the India Meteorological Department (IMD) for public users and those involved in agriculture to track weather updates and other features. These apps will allow smartphone users on Android and iOS to access real-time weather updates, forecasts, radar images and be farsightedly will warn of impending weather events etc.

**3.2 Soil and crop health monitoring system:** The type of soil and nutrition of the soil have a significant impact on the quality and type of crop. But as the rate of deforestation rises, the quality of the soil is deteriorating day by day, making it difficult to assess. To overcome this issue, German based AI has come up with a new application called Plantix. A mobile crop advising app for growers, extension personnel, and gardeners is called Plantix. PEAT GmbH, an AI startup with offices in Berlin, created Plantix. The software makes the claim that it can identify crop-damaging pest infestations, plant diseases, and nutrient deficits and provide appropriate remedial action. This application can give farmers ideas on how to apply better fertiliser to increase the quality of their harvest.

Farmers can use this app to take pictures of their plants and learn information about their quality.

Contrarily, Trace Genomics, another machine learning-based business, assists farmers in doing a soil analysis. With the aid of these kinds of apps, farmers can monitor the quality of their soil and crops, resulting in healthier, more productive crops are produce.

**3.3 Analyzing crop health by drones:** Drones, equipped with cameras or LIDARs, can collect high resolution, accurate, digital data about the crops from the farm. For crop health monitoring, SkySqurrel Technologies has adopted drone-based Ariel imaging technologies. This method uses a drone to collect data from fields, which are subsequently sent through USB drive to a computer for expert analysis. Digital data collected by drones can be processed using photogrammetry software and AI algorithms that interpret the data and provide detailed information about 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.

**3.4 Predictive analytics and Precision Agriculture:** Numerous AI-based tools and software have been developed to assist farmers in precise and regulated farming by giving them appropriate instructions on when to harvest their crops, what crops to produce, how to manage their water use, and how to rotate their crops. Additionally, it provides information on effective planting, pest infestations, nutrition management, and many other topics. Incorporating machine learning algorithms with satellite and drone imagery, AI-enabled solutions forecast weather, analyse agricultural sustainability, and inspect fields for the presence of diseases, temperature, wind speed, and sun radiation. Without an internet connection, farmers can still benefit from AI by using the Sowing App and a simple SMS-enabled phone. Farmers that have access to the internet can utilize AI programmes to acquire a constantly personalised plan for their holdings. Farmers can fulfil the increased demand for food in the globe with these AI-driven solutions by increasing productivity and profits while preserving priceless natural resources.

**3.5 Using AI-based robots for farm harvesting:** Many companies are working on improving agricultural efficiencies. They are creating robots that can effortlessly carry out a variety of duties in agricultural settings. After the military, agriculture is the industry with the second-largest market share for service robots. When compared to people, these robots are trained to harvest crops more quickly and in greater quantities while controlling weeds. These robots are taught to harvest and pack crops while simultaneously inspecting the crops quality and looking for weeds. These robots can also overcome the difficulties experienced by agricultural labourers. These devices locate the harvestable produce and assist in fruit selection using sensor fusion, machine vision, and artificial intelligence models.

**3.6 AI-enabled pest detection system:** Pests are one of the main enemies of farmers who cause crop damage. AI works using image classification, detection, and segmentation methods to build replica that can “keep an eye” on plant health.

AI systems employ satellite photos and historical data to detect changes in crops and identify pests of various kinds, such as grasshoppers and locusts. Following image capture, it sends notifications to farmers' smartphones so they may take the necessary safety precautions and apply the necessary pest management. AI therefore aids farmers in their battle against pests.

## 5. CHALLENGES FOR IMPLEMENTING AI IN AGRICULTURE

Although there are many potential applications for AI in agriculture, most farms throughout the world still aren't aware of these cutting-edge solutions. The major challenge with an adoption is the gap between farmers and engineers. The majority of farmers have lack of time or expertise that is necessary to investigate AI option. Agriculture technology services must put a strong emphasis on making data actionable so that farmers can prioritise problems in their fields more effectively. AI also does not have simple solution to the problem of agriculture. So it is challenging process for farmers to solve the problem in the field of agriculture. Today, majority of the farmers are not well educate so to know these new technology they have to take training about it. Without proper knowledge they can not adopt the AI in agriculture. On the other hand, For implementing AI in agriculture it requires a super computer' s computing power and which are not cheap. So, Every farmer is not rich enough to buy these computer to fullfill their need.

## 6. FUTURE OF AI IN AGRICULTURE

Artificial Intelligence holds the guarantee of thrust in an agricultural revolution at a time when the world must produce more food using fewer resources. With the rising complexity of modern agriculture, AI will be a potent instrument that may assist organisations in coping with the shortage of resources and labour. It is high time for large corporations to make an investment here. The future of agriculture is very bright with better by using artificial intelligence in it. By better use of soil monitoring system, pest control device, weed control system and many more, we can get better crop and fulfill the need of our increasing population.

## 7. CONCLUSION

Farmers need to find a strategy to boost output since they are under a lot of pressure to satisfy the rising demand. There will be more people to feed in around three decades. Additionally, since there is a limited supply of fertile soil, standard farming methods will need to be modified. One of the most interesting possibilities is the global application of artificial intelligence in agriculture. AI can potentially transform the way we think about agriculture, providing several advantages and allowing farmers to produce more with less work.

**AI will assist farmers in becoming agricultural technologists in the future, using data to modify yields right down to individual rows of plants.**

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# ROLE OF ROBOTS IN THE SMART AGRICULTURE SYSTEM

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## *Abstract:*

*The agricultural production system has changed dramatically over several generations as robots and artificial intelligence-based innovations have advanced. During the peak planting season, labour constraints also emphasize the necessity for a more secure and sustainable agricultural system based on IoT, artificial intelligence, and agricultural robots. Technology and telecommunication applications have increased in popularity and enabled the management of a robotic system for various field tasks, including transplantation, harvest, and variously different, etc., for various agricultural and horticultural crops. This technology is compatible with vision-based systems and can be used with them. GPS technology enables more accurate applications. A robotic transplanter for plug-type seedlings may be a viable solution. Agriculture in the future It can conduct the procedure by utilizing a robotic arm, manipulator, and end-effector—an algorithm for computer vision and trajectory planning, or an ai-powered system. Robotics will be applied in various ways to assist in a variety of field activities by assisting with mobility, localization, capturing, targeting, and moving to the next target through the use of drones for farming methods on a geographical and temporal scale. The same procedure may be used for spraying weeds and fruit harvesting. However, robotics technology appears to be in its infancy, and there is a need to accept these technologies owing to the scarcity of labour and their higher costs and to assure that they remain timeless in operations on the ground. Although several research efforts have been undertaken to produce agricultural robots, more research should be directed toward creating next-generation robots for demanding and dangerous tasks. Farm activities are laborious.*

***Keywords:*** *IoT; Agricultural Robotics; Artificial Intelligence; Precision Agriculture; Machine Learning.*

## Scope of AI in Agriculture

Artificial Intelligence (AI) and Deep Learning (ML) are being rapidly used in agro, both in terms of agricultural goods as well as in farming practices. Contextual intelligence, for example, is poised to become the most disruptive technology in agricultural services since it is capable of comprehending, learning from, and responding to a variety of scenarios (based on learned responses) to maximize efficiency. By offering some of these solutions as a service, such as a chatbot or other interactive interface, we can assist farmers to stay current with technology breakthroughs while also incorporating them into their everyday agricultural practices to enjoy the benefits of this service. Microsoft is advising 175 farmers in Andhra Pradesh, India, on planting, land acquisition, and fertilizer use. This approach has already resulted in an average increase of 30% yield per hectare over the previous year.

The following are the most essential five areas that yielded positive may assist agriculture.

Agriculture is the backbone of our country, and we cannot survive without food—agriculture gear and procedures used in the past demand a considerable quantity of labour. Farming must pursue all viable avenues, encompassing existing agricultural practices and technology, along with specialized systems such as robotic systems, to ensure adequate care for continuous agricultural output without jeopardizing farmer and farm labour safety. Robotics is being used in growing crops for transplanting, weeding, spraying, and harvesting, among other tasks. Numerous agricultural robots have been built in wealthy nations, while research has begun in poorer countries such as India. A little research has been conducted on crop mapping and fruit identification and illness through vision-based technologies. Drones (UAV) have indeed been widely employed to monitor crop

**Table 1.** Studies carried out on the application of robotics in agriculture (Bechar and Vigneault, 2016) [1]

| Agricultural operation | Crops | Research attempts |
|---|---|---|
| Harvesting | Apples, citrus, strawberry, melons, etc | 302 |
| Transplanting and seeding | Tomato, chilli, eggplant, etc. | 255 |
| Plant protection and weed control | Field crops | 326 |
| Grasping of fruits and vegetables | Apples, strawberry, tomato, capsicum, etc. | 125 |
| Navigation and Mapping& Multi | - | 700 |
| - Robot interaction | - | 60 |

Performance and conduct pesticide operations. Table 1 summarises research programs on However, the majority of technology advancements are at the prototyping stage, they require significant research and development to bring them to farmers' fields, and output is converted into agricultural output with minimum labour.

Due to the paucity of research on robotics applications in agriculture and the satisfactory development of just a few functions, this article focuses on the available robotic systems for diverse farm tasks, whether in plantation crops or horticulture. The current study briefly describes these methods for performing different agricultural activities.

## IoT drove growth

Every day, massive amounts of data are created in organized and unstructured formats. These include previous weather systems, soil reports, new studies, rainfall, insect infestation, and photographs captured by drones and cameras, among other things. This data may be sensed by cognitive IoT systems, which can deliver actionable insights to increase yield. Proximity and remote sensing are two technologies primarily employed for data fusion intelligence. Soil Testing is one application of this high-resolution data. Although remotely sensed data requires sensors to be integrated into aircraft or satellite systems, proximity sensing requires sensors to be close to the ground or at a very close range—this aids in classifying soils depending on the soil under the surface in a specific location. Robot (for corns) is already combining data-collection software and robots to create the optimal fertilizer for producing corns, in contrast to other operations that maximize productivity.

## Image-based insight generation

Precision farming is one of the most hotly debated topics in agriculture today. Uav photos may be used for in-depth field analysis, crop scouting, and field scanning, among other applications. Computer vision, IoT, and drone data may enable landowners to act quickly. Real-time warnings may be generated by feeds from drone picture data, hence accelerating precision agriculture. Industries such as Aerialtronics had already integrated the IBM Watson IoT Infrastructure and Graphic Identification APIs into drone technology to perform real-time image assessments. The following are some applications of information visualization:

### Field management

By developing a field map and pinpointing where crops require water, fertilizer, or pesticides, real-time estimations may be created during the cropping season utilizing high-definition photos from aerial devices (drones or copters). This significantly aids in increasing efficiency.

### Crop readiness identification

Different crops are photographed in white/UV-A light to assess the ripeness of the green fruits. Farmers can develop distinct degrees of readiness for each crop/fruit category and stack them separately before delivering them to market.

### Disease detection

Preprocessing the picture ensures that the leaf images are split into background, healthy tissue, and damaged tissue categories. Cropping the sick area then sends it to faraway laboratories for further diagnosis. Additionally, it aids in pest identification, vitamin shortage detection, and other tasks.

## Transplanting

Manually transplanting vegetable core seedlings is the most time-consuming and arduous task[1]. Robotic transplantation may well be the best option because it not only saves time but also requires less labour.  Robotic transplanters simulate transplantation operations using computer graphics or machine vision systems [2][1].

## Intercultural

Mechanical weeders or chemical spraying are used in intercultural operations such as harvesting to eliminate weeds. Manually controlled plucking is regarded as the most dangerous farm job since it requires a great deal of human labour. Herbicide plucking is not only expensive in terms of inputs, but it also degrades the environment, lowering total production. Robotic watering may be a viable replacement for manual weeding. Additionally, because of the stringent rules and restrictions on herbicide usage, robotic weeding is the superior option to hand weeding. The robotic weeder makes use of vision-based technologies to identify weeds, guide the weeder, and mechanically remove weeds [1].

## Spraying

Contamination is a significant issue during agrochemical spraying, posing a threat to human health if necessary precautions are not followed. Robotic sprayers are being researched and are already in use widely in orchards such as apple, grapevine, and cherry plantations, as well as in greenhouses to a lesser extent. Such sprayers have been designed for correct execution and to maximize input consumption efficiency [3]. According to the report, "existing farming practises often apply pesticides evenly throughout fields, despite several pests and illnesses having uneven spatial distributions and evolving around distinct foci." The number of pesticides needed in accurate horticulture may be lowered significantly with effective site-specific chemical control.

## Aerial robots or drones

Aerial robots also referred to as drones or unmanned aerial vehicles (UAVs), are a new approach to doing agricultural tasks such as crop mapping, scouting, spraying, and more in times of labour scarcity and precise control of agriculture products such as pesticides, fertilizer, and so on. Unmanned aerial vehicles, drones, and radio-controlled model aircraft can be flown at lower altitudes to enhance spatial resolution at a reduced cost. The advantages of using a UAV platform for crop cultivation over traditional satellite images include extremely high pixel resolution, independence from cloud cover during important growth times, and immediate data transfer. The images obtained by the UAV are being used to determine shrub utilization in vineyard maintenance, record grass species, quantify shrub biomass, and assess crop vigour. [4]

### Automation techniques in irrigation and enabling farmers

Irrigation is one of the more labour-intensive procedures in agriculture. Automating irrigation and increasing total productivity may be accomplished using systems educated on past weather patterns, soil conditions, and the type of crops to be cultivated. With irrigation consuming about 70% of the world's freshwater, automation can assist farmers in better managing their water challenges. [5]

### Challenges in AI Adoption in Agriculture

While Artificial Intelligence has enormous potential for agricultural applications, there is currently a lack of expertise with high-tech machine learning solutions on the majority of the world's farms. Agriculture is exposed to a variety of external influences,[6] including seasonal changes, soil conditions, and the existence of pests. Thus, what appears to be a suitable option during the planning phase of harvesting may not be ideal due to changes in external parameters. Additionally, AI systems require a large amount of data to train machines and generate exact forecasts. While geographical data may be acquired readily in the case of huge agricultural areas,[8] chronological data is more difficult to get. In contrast, the majority of crop-specific data may be gathered just once a year during the planting season[7]. Due to the maturation of the data infrastructure, it takes a substantial amount of time to construct a strong machine learning model. This is one of the reasons why AI is increasingly being used in agronomic items including seeds, fertilizer, and insecticides instead of inaccuracy alternatives.

## LIMITATIONS IN THE USE OF ROBOTS

Although the feasibility of agrobots for a broad variety of agricultural applications has been widely investigated, commercial uses of robots in field circumstances have not yet been developed.[9][10] Due to the constraints discussed below, field applications of robots are still in their infancy.

1. AI-based techniques for sensing, mapping, and control must operate under harsh, unorganized, and unpredictable field environments.
2. Agriculture's time-sensitive nature makes it difficult to achieve the high level of utilization observed in manufacturing or industrial industries.
3. Restricted mechanization and man-robot interconnections resulted in low productivity, which resulted in procedures being delayed, detection rates being low, and the difficulty to conduct field activities in uncontrolled conditions.
4. Due to the restricted container ships and battery capacity of aerial robots or drones (UAV), their utility in agricultural activities is limited. Additionally, high initial and ongoing costs, a fragile construction, a competent operator, and a lack of expertise are significant barriers to using aerial robots at the farm level.

While the employment of robots in farm crops may appear impractical initially, it has become critical to ensuring food security for the world's rising population and dealing with the issue of farm labour shortages. Due to labour migration from agriculture to other industries, there is a labour shortage and daily increases in the availability of food.[11][12] These technologies must be evaluated, enhanced, popularised, and widely used in order to alleviate future labour shortages. The process of developing these intelligent drones demonstrates the critical importance of collaboration in human-robot systems. As a result, a multi-stakeholder effort might accelerate the deployment of robots in agriculture.

## CONCLUSION

Robotics technologies must be employed in agriculture to provide efficient field activities in light of rising labour costs. The integration and current computer devices into agricultural systems in order to identify, evaluate, and control crucial temporal and geographical aspects affecting farmers' income, sustainability, and environmental conservation is a major need of the hour. Aerial, ground and submerged robots can all play a significant role in this environment. Aerial Robots are frequently referred to as Unmanned Aerial Vehicles (UAVs) or Drones. It might be a benefit for agricultural production control since it can fly closer to tiny crop fields at lower flying altitudes than other conventional aerial vehicles, allowing for a more precise site-specific farm management system.

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# IMAGE PROCESSING IN AGRICULTURE: A REVIEW

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***Abstract:***
*Indian economy is mostly dependent on agricultural activities. So to strengthen the Indian economy it is necessary to integrate agricultural activities with image processing technologies. Various parameters in agricultural activities influence the overall efficiency of a farmer's work. From a farmer's point of view, these parameters can be canopy, yield, quality of product, and detection of weed. This paper aims to represent the survey of work done by using image processing techniques in the agricultural field. This paper also highlights the application of image processing in an agriculture-based industry context.*

***Keywords***: *Image Processing, Review, Agriculture.*

## 1. INTRODUCTION

Emerging technologies play an important role in evolutions made in sustainable agricultural systems. These technologies incorporate various tools and techniques which enables the farm inputs more profitable [1]. Image processing is one of the emerging technologies which uses several tools and algorithms to reduce the efforts, errors, and costs to achieve economical and sustainable agricultural systems [2]. Image processing in the agriculture field consists of steps like image acquisition, image pre-processing, image segmentation, Representation and description, and Image recognition [3]. The image Processing process is shown in Figure 1 [4]. Image processing techniques enable the farmers to monitor, assess, and control farming practices, like adequate fertilizers, pesticides, and water usage. In traditional techniques, farmers used to monitor manually [5]. Sometimes the expertise was needed to analyze the problems like water stresses, pesticides effect, and quality of yield in an agricultural field. This is a time-consuming and costlier issue in India like in other developing countries. Image processing is an emerging tool which can replace the traditional methods of inspection and analysis [6].

This paper focuses on the survey of the literature available for the application of image processing in the agricultural field. This paper also highlights the application of image processing in an agriculture-based industry context.

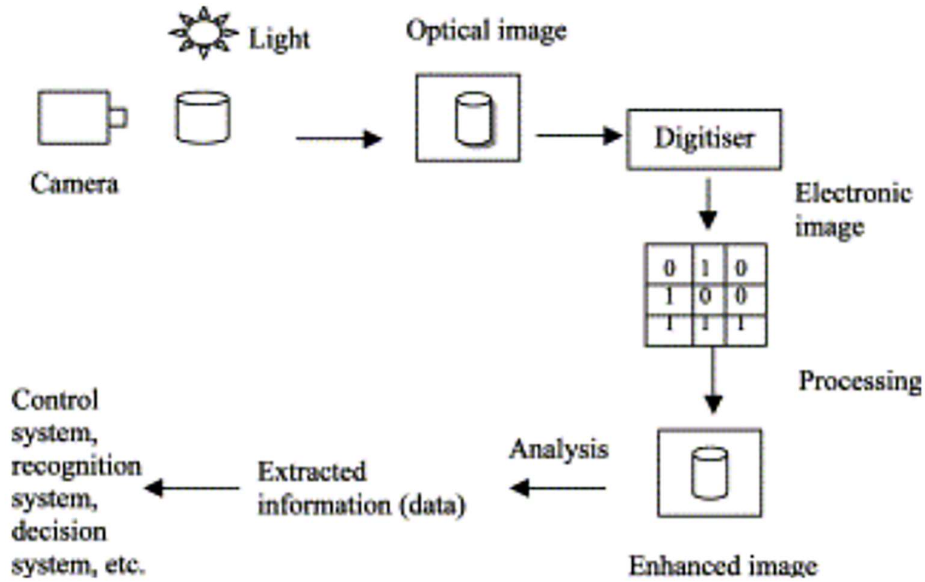


**Fig. 1:** Image Processing Process [4]

### 1.1 TYPES OF IMAGE CLASSIFICATION TECHNIQUES :

1. Artificial Neural Network: It is a type of artificial intelligence. It has three layers interconnected with each other namely input neurons, send data, and output neurons [7][8].
2. Clustering method: In this technique, an image is partitioned into clusters. These Clusters can be selected manually, in random order, or based on some conditions. Then, the distance between the pixel and cluster center is calculated by the squared or absolute difference between a pixel and a cluster center. Clusters can be selected manually, randomly, or based on some conditions. The difference is typically based on pixel color, intensity, texture, and location, or a weighted combination of these factors. Some of the clustering algorithms are K – means algorithm, fuzzy c-means algorithm, expectation-maximization (EM) algorithm[7][8].
3. SVM (Servo Vector Machine), It builds a hyperplane or set of hyperplanes in a high- or infinite-dimensional space which is further used for classification and generalization of the error of the classifier [7][8].

## 2. LITERATURE REVIEW

Petrellis N. [9] presented an image processing technique that uses smartphones along with a cloud database for the recognition of vineyard diseases based on photographs with grape leaves. During this technique number of features have been detected like the number of spots, grey level, and area and then extracted a histogram indicating the number of pixels that have a specific red, green or blue color level. This technique was implemented in the Windows Phone application in Visual Studio 2015 using the Silverlight library. The weather data was also utilized to determine the diseases. Diseases like Downy Mildew, Powdery Mildew, Phomopsis, Esca were detected with more than 90% of accuracy by using this technique at the same value of Threshold.

Lee S. et al., [10] implemented an image processing and neural network technique to detect pest birds in an agriculture environment. They used the background subtraction method in three steps -GMM, color extraction, and median filters. Then the object classification was done by using a neural network from deep learning models. During the classification with pre-trained deep learning models, the accuracy was increased by inserting the cropped images from the subsections. By using the refined dataset of seven classes with each class of 10,000 images showed the maximum accuracy of 100% and minimum accuracy of 92%. They concluded that applying the neural network retrained by the refined dataset to the cropped areas worked better than the existed methods.

Namradha R.P. et al., [11] purposed a methodology to detect Blast Disease, Brown spot, Narrow Brown spot disease in paddy crops. The purposed image processing technique worked by using the Matlab application and utilizing the k-means algorithm. They concluded that the purposed technique worked with more accuracy as compared to the available techniques.

Singh V. et al., [12] implemented the K-mean clustering, texture, and color analysis in Matlab application to detect the bacterial disease in rose, beans leaf, lemon leaf with Sunburn disease, banana leaf with early scorch disease, and fungal disease in beans leaf. The output images were in the form of segmented images. They concluded that the optimum results were obtained with very little computational effort. They also defined that another advantage of using the purposed method is that the early detection of plant diseases is possible.

Zhang Jianhua et al. [13] proposed an automatic segmentation model which contains detection of diseases of cotton leaves with active gradient and local information. They proposed a segmented monotone with decreasing edge composite function, which accelerates the evolution of the level set curve. This method gives better results with the Local Binary Fitting algorithm and Geodesic Active Contour as compared to other algorithms. The main advantage of the proposed model is that it not only helps in image segmentation of the leaves but also in the identification and rectification of cotton diseases.

A. Soleimanipour et al. [14] suggest a novel image processing algorithm that identifies the proximal and distal ends of the flower. In this algorithm, they calculated the first and second derivatives of the curve concerning the mathematical critical points. Then the perimeter, area, curvature, area, length, width, and derived angle of the flowers were calculated. The work can play a major role in the calculation of the geometrical information of the flowers with irregular shapes which helps in real-time inspection of the grading system.

Jin X. et al., [15] proposed deep learning and image processing technology to detect the vegetables and weeds in fields. Firstly, a trained CenterNet model detected vegetables and draw bounding boxes around them. The objects falling out of these bounding boxes were considered weeds. The algorithm reduces the size of the training image dataset as well as the complexity of weed detection, thereby enhancing the weed identification performance and accuracy. To extract weeds from the background, a color index-based segmentation was performed utilizing image processing. The employed color index was determined and evaluated through Genetic Algorithms (GAs) according to Bayesian classification error. The trained CenterNet model achieved a precision of 95.6%, a recall of 95.0%, and an F1 score of 0.953, respectively during the field test.

Jahanbakhshi A et al., [16] classified carrots based on regular and irregular shapes by using image processing techniques. They took 135 samples for study. Afterimage acquisition and preprocessing, some features were extracted like length, width, breadth, perimeter, elongation, compactness, roundness, area, eccentricity, centroid, centroid nonhomogeneity, and width nonhomogeneity. Then, linear discriminant analysis (LDA) and quadratic discriminant analysis (QDA) methods were used to classify the different features. The classification accuracies of the methods were obtained as 92.59% and 96.30%, respectively.

Zhang et al. [17] developed a fusion method from combinations of superpixels, expectation-maximization algorithm, and logarithmic frequency with pyramid of histograms of orientation gradients, for detecting cucumber diseases. They detected scab angular, powdery mildew, downy mildew, anthracnose, and scab diseases. In the proposed technique, they divided the targeted leaf into smaller areas by using the superpixel techniques. Then, they identified the infected area of the infected leaf at an accelerated speed as the superpixel increased the rate of convergence of the EM algorithm. PHOG features were obtained from the infected regions of the leaf based on their logarithmic frequency. Then the different diseases were classified and identified by using the SVM. After experimenting and validating the algorithm, they found that the algorithm performed quite well in real-life and robust scenarios in identifying cucumber diseases.

Shao Y. et al. [18] proposed a technique to identify and detect various diseases in tobacco plants. They detect these diseases using the methodology which comprises of three stages, firstly, the Otsu method obtains information about the disease location, and then the GrabCut function extracts the diseased area efficiently. They calculated the color moments, disease contour, and grey-level co-occurrence matrix (GLCM) of the extracted areas. The back-propagation (BP) neural network was optimized by using the genetic algorithm. Then the optimal initial weights and thresholds were obtained, which shortened the training time and improved the accuracy of disease identification. Finally, a diagnosis system was established with the mobile client as input and the user services as output. They diagnosed eight types of tobacco diseases effectively and automatically. Better disease recognition results in correspondence with different features sets, namely, (i) color, contour feature, (ii) color, contour, texture feature, and (iii) color, multi-contour, texture feature were obtained. The average recognition accuracy rate of selected tobacco diseases was about 92.5%.

Lu H. et al., [19] proposed a method for the detection of cultivated land information based on Deep Convolutional Neural Network and Transfer Learning (DTCLE). Initially, the linear features (roads and bridges, etc.) were extracted based on Deep Convolutional Neural Network (DCNN). Then the feature extraction method learned from DCNN was used to extract the cultivated land information by introducing a transfer learning mechanism. In end, the extracted results were completed by the DTCLE and eCognition for cultivated land information extraction (ECLE). They selected the location of Pengzhou County and Guanghan County, Sichuan Province for the experimental purpose. They got the overall precision of 91.7%, 88.1%, and 88.2% with the DTCLE method respectively, and 90.7%, 90.5%, and 87.0%, with ECLE respectively. They concluded that the accuracy of the DTCLE was equivalent to that of ECLE, and also outperformed ECLE in the performance measures of integrity and continuity.

Marsujitullah et al [20] carried out a drone-based image study for rice growth stage estimation. They estimated the four different stages of growth from RGB images. The leaf color chart features were extracted by using a histogram method. Then the SVM classifier was utilized for the classification of growth stages. This method achieved an accuracy of 93% for the classification of four different growth stages. They concluded that by using the purposed methodologies, operators can quickly identify the age-growth stage of rice by utilizing images from drone devices which can aid the government's information needs.

Es-saady et al. [21] purposed a system that detects diseases in vegetable crops by utilizing the serial grouping of two SVM classifiers. They converted the images from RGB to LAB color space. Then for extracting the lesion region, they segmented the images by using k-means clustering. they evaluated the difference between the classes based on the color first classifier. Then in the same class, the damages having the same or an adjacent color are considered. Then the second classifier is used to evaluate the difference between classes based on shape and texture characteristics. They verified the technique on four classes, including the damages of six classes of plant leaf diseases. They concluded the serial classifiers combination is interesting, can resolve the difficulties of the individual classifiers, and can be improved further by using relevant features.

K. Jagan Mohan et al. [22] proposed the system for the classification and identification of paddy leaf diseases. They detected leaf blast disease, brown spot disease, and bacterial blight disease. They divided their work into two parts. In the first part, they locate the diseases with the help of HAAR features. Then, with the AdaBoost classifier, they identified the disease portion of the paddy plant. In this system, their identification proportion rate is 83.33. Secondly through SIFT (Scale Invariant Feature Transform) feature distant diseases recognized and local features extract through extraction method and image categories with k-NN (k-Nearest Neighbours) and SVM (Support Vector Machine) their recognition rate 91.10 and 93.33 respectively. At last, they pointed out that by utilizing this methodology one can find the disease at an early stage and can minimize the loss of production with this system.

Amar Kumar dey et al., [23] proposed the system locate leaf rot disease by specifying the color features of the betel vine rotted leaf region. They converted the RGB images into HSV color spaces. Then the threshold was calculated by applying the Otsu method on the H component of HVS color space for image segmentation in MATLAB software. They use precision and recall as performance measures. They obtained high precision of the technique, but the recall value is low in some cases.

Vijai Singh [24] presented an algorithm for the segmentation of plant leaf images. Author proposed an image recognition and segmentation process. First, devices were used to capture an image of different types and applied different segmentation methods to process images. The author took an image of size m*n & every pixel has R, G, B components. The color co-occurrence method was used for feature extraction. The above experiments are done in MATLAB. The author demonstrated the results only for beans, leaves, lemon, and banana leaves. Further research is needed for all types of leaves.

Tsung-Han Tsa et al. [25] developed a technique to detect Rice Planthopper (RPH) infestation in the paddy field by using the region of interest (ROI) method to detect RPHs. Initially, they obtained the rectangle ROI in HSV space and then performed color analysis. By using a decision tree algorithm, they classified the analytic data to get a binary image of RPHs. They presented that the outcomes were useful to reduce executing time and loading and obtain an image of RPHs.

Mehra et al. (26) proposed the detection of tomato maturity based on color and fungal disease. They evaluated the fungus attributes and stem depth of tomatoes and identified fungus by using segmentation. In this work, thresholding and the k-means clustering algorithm technique were used. They evaluated that 32.7% and 26.37% infections were detected by using Thresholding and K means clustering. They concluded that K-mean clustering does not perform well with the cluster that is nonglobular and a variety of initial partitions can result in variations in final clusters.

Jhawar (27) proposed an automatic grading of orange using pattern recognition technique in which two novel techniques: edited multi-seed nearest neighbor technique and linear regression-based technique results in 89.90% and 97.98% accuracy, although the nearest neighbor technique is also extended with 92.93% accuracy.

Pereira et al. (28) proposed an approach to predict the ripening of the papaya fruit using digital imaging and random forests. They utilized ROI and NDI in MATLAB along with the ANOVA technique during the entire experiment. They concluded that while concerning all image features, 94.3% classification performance was obtained over the cross-validation set, 94.7% misclassifying only a single sample, and for the group comparisons, the normalized mean of the RGB (red, green, blue) color space was achieved better performance (78.1%).

Larijani M.R. et al., [29] purposed an image processing technique for rapid diagnosis of rice blast. KNN algorithm by K-means was used to classify the images in Lab color space to detect disease spots on rice leaves. The squared classification was based on Euclidean distance, and the Otsu method was used to perform an automatic threshold histogram of images based on shape or to reduce the gray level in binary images. Sensitivity, specificity, and overall accuracy were examined to determine the efficiency of the designed technique. They obtained the overall accuracy of the designed algorithm was 94%. They concluded that the purposed method was faster, cheaper, and nondestructive.

Nandi C.S. et al., [30] proposed a technique to detect the grading of mangoes in four different categories. They used Support Vector Regression (SVR) for maturity prediction in terms of actual-days-to-rot and for estimation of quality from the quality attributes, Multi-Attribute Decision Making (MADM) system was utilized. Finally, a fuzzy incremental learning algorithm has been used for grading based on maturity and quality.

They revealed that about 87% performance accuracy was achieved using this proposed system.

**Table 1:** Recent trends of image processing techniques in the agriculture field

| Author/ References | Application/Model /System | Developed for/ Applied for | Accuracy | Results |
|---|---|---|---|---|
| Petrellis N. [9] | Extracts the lesion features like number of spots, their grey level and area and then extracts a histogram indicating the number of pixels that have a specific red, green or blue color level using a windows phone application | Vineyard diseases based on photographs with grape leaves | Exceeds than 90% using small training sets | On using same TH Downy Mildew, Powdery Mildew and Phomopsis is classified successfully with an average accuracy of 90% while with 10% higher or lower TH with an average accuracy of 80%. |
| Lee S. et al., [10] | Background subtraction in three steps- (1) Gaussian Mixture. (2) Color extraction techniques (3) Median filters and object classification using the neural network Deep Learning Model | Bird Detection in Agriculture Environment | Maximum - 100% Minimum - 92% | Applying the neural network retrained by the refined dataset to the cropped areas worked better than the existed methods. |
| Narmadha R.P. et al., [11] | Matlab application using k-means algorithm. | Paddy leaf disease - Blast Disease, Brown spot Disease, Narrow Brown spot disease | | Using a k-means clustering algorithm, the paper analyzesthe techniques in digital image processing for automatically detecting, diagnosing, and recognizing crop leaf diseases. |

| | | | | |
|---|---|---|---|---|
| Singh V. et al. [12] | K-mean clustering, texture and color analysis. | Rose with a bacterial disease, beans leaf with the bacterial disease, lemon leaf with Sun burn disease, banana leaf with early scorch disease and fungal disease in beans leaf | | Optimal results were obtained with very little computational effort. This demonstrates the efficiency of proposed algorithm in identifying and classifying leaf diseases. Another advantage of using this method is that the plant diseases can be identified at early stage or the initial stage. |
| Zhang Jian-hua et al.[13] | The Active Contour model based on global gradient and local information | The seven kinds of cotton disease leaves segmentation, including uneven lighting, leaf disease spot blur, adhesive diseased leaf, shadow, complex background, unclear diseased leaf edges, and staggered condition | | The running time of the proposed model for the dataset is about of 36.40 seconds which is very less as compared to other algorithms. |
| Soleimanipour A. et al., [14] | An algorithm developed in MATLAB R2015a | Geometrical features of Anthurium flowers | Values for calculated angles were very accurate and close to the expected values of the angles. | It is possible to acquire geometrical information immediately and without human intervention in real-time sorting systems. |

| | | | | |
|---|---|---|---|---|
| Jin X. et al., [15] | Centrenet and genetic algorithm | Vegetable detection and weed detection | Precision and recall of about 95% | To extract weeds from the background, a color index was determined and evaluated through Genetic algorithms (GAs) according to Bayesian classification error. In this way, the model focuses on identifying only the vegetables and thus avoid handling various weed species |
| Jahanbakhshi A et al., [16] | Linear discriminant analysis (LDA) and quadratic discriminant analysis (QDA) methods | Regular and Irregular shapes of carrot | 92.59% and 96.30% | The quadratic discriminant analysis method can sort carrots with high accuracy based on their shapes. |
| Zhang et al. [17] | Superpixels, expectation maximisation (EM) algorithm, and logarithmic frequency pyramid of histograms of orientation gradients (PHOG | Scab angular, powdery mildew, downy mildew, anthracnose and scab diseases in cucumber | Average Recognition rate of 91.48% | The algorithm performed quite efficiently in identifying the cucumber diseases in practical and robust scenarios. |
| Shao et al., [18] | Multi-feature and genetic algorithms optimizing BP neural network | Eight types of tobacco diseases | Average Recognition rate of 92.5% | Genetic algorithm can reduce the BP neural network training times, avoid coming into a local minimum point defect and improve the tobacco disease ecognition accuracy effectively |
| Lu H. et al., [19] | Deep Convolutional | Extract information about | 88-91% | As compared to shallow target |

| | | | | |
|---|---|---|---|---|
| | Neural Network and Transfer Learning (DTCLE) | cultivated land | | recognition methods, the depth of target identification methods using end-to-end training, feature extraction of autonomous learning, the model has good effect. |
| Zainuddin Z. et al., [20] | Histogram feature extraction SVM classifier | Four growth stages estimation of rice crop | 93% | Using the Histogram and Support Vector Machine methodologies, operators can quickly identify the age-growth stage of rice by utilizing images from drone devices to aid the government's information needs |
| Es-saady et al. [21] | K-means clustering | Vegetable diseases like Leaf miners, Thrips Tuta absoluta, Early blight, Late blight & powdery mildew | 87.80% | The author concluded that the proposed system using serial classifiers combination is interesting, and can resolve the difficulties of the individual classifiers and can be improved using relevant features |
| K. Jagan Mohan et al., [22] | k-NN (k-Nearest Neighbors) and SVM (Support Vector Machine) classifier | Paddy leaf diseases - leaf blast disease, brown spot disease and bacterial blight disease | 91.10% and 93.33% | By utilising this methodology one can find the disease at an early stage and can minimise the loss of production with this system. |
| Amar Kumar dey et al., [23] | Otsu method on H component of | Leaf rot disease of the betel vine | 100% with 0.5 recall in some | They obtained high precision of the |

| | | | | |
|---|---|---|---|---|
| | HVS color space for image segmentation in MATLAB software | rotted leaf region. | cases | technique, but the recall value is low in some cases. |
| Singh V et al., [24] | Minimum Distance Criterion and then SVM classifier | Rose with bacterial disease, beans leaf with bacterial disease, lemon leaf with Sun burn disease, banana leaf with early scorch disease and fungal disease in beans leaf | 97.60% | They concluded that the detection accuracy is enhanced by SVM with proposed algorithm compared to other approaches reported in traditional methodologies. |
| Tsung-Han Tsa et al., [25] | A region of interest (ROI) method and decision tree algorithm | Rice Planthopper (RPH) infestation in paddy field | | According to preprocessing and color analysis, experimental result shows well performance of ROI about RPHs and concluded that this method was fast and effective method to find RPHs |
| Mehra et al. [26] | Thresholding and k-means clustering algorithm | Tomato maturity based on color and fungal disease | 32.7% and 26.37% infections were detected by using Thresholding and K mean clustering | K-mean clustering do not perform wellwith the cluster that are non globular and variety of initial partition can results in variations in final clusters |
| Jhawar [27] | Nearest neighbor technique and linear regression based | Automatic grading of orange | 89.90% and 97.98% accuracy | Linear regression proved to give best results and this technique can be used to detect the life span of the fruit. |
| Pereira et al. [28] | ROI and NDI in MATLAB along with ANOVA technique | Ripening of papaya fruit | About 94% | They concluded that while concerning all image features, 94.3% classification performance was |

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|---|---|---|---|---|
| | | | | obtained over the cross-validation set, 94.7% misclassifying only a single sample and for the group comparisons, the normalized mean of the RGB (red, green, blue) color space achieved better performance (78.1%). |
| Larijini M.R. et al., [29] | KNN algorithm by K-means | Rapid diagnosis of rice blast | 94% | Purposed method was faster, cheaper and nondestructive. |
| Nandi C.S et al., [30] | Support Vector Regression (SVR) and Fuzzy incremental logic algorithm | Maturity and quality of harvested mangoes | 87% | Results show that the mango grading algorithm is designed viable and accurate. Mango size error is less than 3%, the actual-days-to-rot prediction accuracy is 84%, accuracy for measurement of shape is 91% and the accuracy for measurement of surface defect is over 90%. |

## DISCUSSION AND CONCLUSION

Image processing methods/techniques have been proved as an effective machine vision system for precision agriculture. Many types of imaging techniques with a varying spectrum like infrared, hyperspectral imaging, X-ray were useful in determining the vegetation indices, canopy measurement, irrigated land mapping, etc with greater accuracies. The accuracy of classification varied from 85% to 96% depending on the proposed algorithms. Thus it can be concluded that the image processing techniques are non-invasive and are very effective tools that can be applied for the agriculture domain with great accuracy for analysis of agronomic parameters.

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# REVIEW ON IMPORTANCE OF IOT BASED VISIBLE LIGHT COMMUNICATION IN AGRICULTURE AUTOMATION SYSTEM

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## *Abstract:*

*Internet of things contributes an innovative portion of smart farming and agriculture territory. With the growth of the present world, internet of things (IoT) has peaked with modern technology. IoT is used in each domain like smart city, smart educational institutes, smart transportation system and smart farming etc. Modern cultivators in this era have applied the cutting-edge technologies to raise the proficiency of horticultural products. The role of technology has to play in agriculture region is becoming more and more visible day by day. Automation of numerous machines is already using RF bands but now VLC is used to implement indoor farming as well. VLC not only gives the great bandwidth, it also ensures data security. With the help of VLC the indoor farming is on rise and it helps to ensures faster plant growth, allow production on large scale, and enable agriculture to be carried out all year round irrespective of climate and location. The Visible light communications( VLC) is arising and promising formation hat is working on the major issues for Internet of Things( IoT) communication systems. VLC is enhancing massive connectivity for colorful types of massive IoT transmitseries from machine to machine, vehicle to structure, structure to-vehicle, chip to chip as well as device to device. In this paper, the author takes the comprehensive review of IoT based on VLC. The benefits and architecture of smart farming system is described in this paper. The different researcher's research work is studied and the problems faced in this work is further implemented and improved in future.*

***Keywords:*** *Internet of Things (IoT), Visible light communication, Smart Farming, Temperature and humidity sensor, Soil moisture sensor.*

## I. INTRODUCTION

IoT is an advance automation system that deals with sensor, networking, artificial intelligence, electronic and cloud massaging and to deliver complete systems for the product or services. Agriculture is another important domain in IoT. The IoT systems play a vital role for smart farming. Using IoT, farmers can minimize waste and increase productivity. It gives proper solution for crop and soil monitoring. The system allows the observing of fields with the help of sensors. The Visible light system can provide data communication function as well as lighting. It is widely used in automated and sustainable farming for its energy efficiency, reliability, security without degrading the crop growth compared to radio frequency communication. Wi-Fi connectivity “effects” through network geometry as a means of expanding the geographic area of the network in new ways in the generality of smart megacities, smart grids, smart manufacturing, and smart transportation. The exponential growth of the Internet of Things (IoT) and the development of Wi-Fi communications have led to excessive growth among the many consequences of radio frequency (RF) failures in the IoT[1]. It's really difficult for explorers who are currently panic to investigate new Wi-Fi conversation drivers that can hand over excellent connectivity, outstanding recording speed, low silence, excessive capacity and efficiency, and excessive security. Visible light communication (VLC), a new and highly capable mode of wireless communication, can be seen as meeting the critical challenges of wireless transmission structures in wireless communication activities[2]. For the sake of explanation, most of the biggest challenges you are currently facing with 5G technology can be mitigated by using VLC. However, the most desirable function of VLC is to provide a previously congested radio frequency (RF) signals many times the capacity of the RF signals [2]. Similarly, VLC is restricted and unlicensed. Currently, this is the only safely available bandwidth result that can reduce the RF Signals dropout problem. VLC can also be co-located with other important communication systems and biases. Airplanes and sanatoriums do not transmit the electromagnetic fields generated by RF bias. Currently, there are several ongoing studies aimed at transferring medical data similar photopretismograph, electrocardiography, and body temperature using VLC manipulation [3]. Unlike RF signals, visible light cannot penetrate walls and is uncontrolled and outspread, making it suitable for secure connections where wireless data transmission needs to be within the range of an access point. For a lot of these reasons, VLC may be carried out to utmost IoT- grounded smart structures [4]. As an end result, a brand new paradigm in Wi-Fi conversation called the net of light- emitting diode (LED) which integrates IoT with VLC the use of LED has been delivered and is being explored.

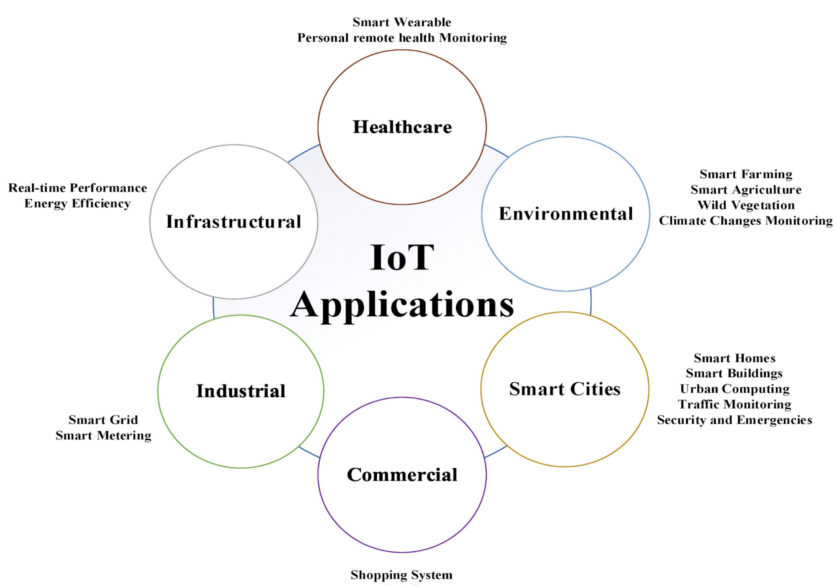


Figure 1: Internet of things[2]

For case, this era has been carried out in internal navigation and artwork gallery tracking in which arrays of LEDs at the ceiling of departmental shops and galleries which act as a supply of illumination are used to transmit the placement of positive merchandise and works of art to a stoner cell device [5]. Another region of operation is with inside the automobile assiduity in which LED headlights and hind lights of ultramodern buses had been utilized in system collision forestallment structures thru vehicular VLC. In addition, VLC- IoT may be carried out to transmit clinical statistics in biomedical seeing and statistics transmission. These and similarly attributes have made VLC seductive volition end result to RF indicators for excessive statistics charge transmission and measureless broadband consequences. As a end result, there`s a brand new upsurge in exploration benefactions on VLC and on a way to ameliorate special components of VLC dispatches. Also, several scientists and researchers are tries implementing VLC for special operational regions to conquest over unique transmit demanding situations. Unfortunately, there is a lack of benefactions imperative the capabilities, prospects, procedures, demanding situations, and consequences at the perpetration of VLC for IoT dispatches. The contribution of this paper are tried to provide a complete assessment of the VLC- IoT paradigm and that is as follows [6]:

1. A factor- by- factor conversation on IoT desires VLC for most fulfilling community performance or now no longer is offered.
2. A group of peopleframeworksample for the deployment of potential VLC- IoT networks is proposed.
3. The being and proposed procedures used within the fulfillment of VLC for IoT are accessible.
4. The approval and demanding situations of implementing VLC for IoT are offered and consequences are counseled in which applicable [7].
5. Expected exploration instructions are connected and discussed on special components of VLC and the operation of VLC era with including populace throughout the ground, meals product and farming desires to get decreasingly efficient of excessive yields in restricted time.

According to the UN Food and Agriculture Organization, “the arena will want to provide 70 similarly ingredients in 2050 than it did in 2006.” To meet this demand, growers and agrarian businesses will need to push the discovery limits in their modern-day practices. Just because the Industrial Revolution farming to the approaching function within the 1800s, new technologies, on Internet of effects (IoT) are more important in future[8].

## II. INTERNET OF THINGS

The term, IoT became delivered via way of means of the British pioneer Kevin Ashton with inside the year 1998 to explain a machine with big variety of gadgets or sensors that might be related to the net thru communications to offer a few offerings. A manually controlled system requires a lot of care and attention[5]. New technologies such as the Internet of Things (IoT) and sensor networks (SN) can be used to overcome this limitation. Case studies show that the use of electromagnetic or radio frequencies for communication affects plant growth and quality. Visible Light Communication (VLC) uses the visible light spectrum for communication to provide an effective solution to this problem. VLC is superior to traditional communication technologies in terms of available frequency spectrum, reliability, security, and energy efficiency[6]. The LED light source used in VLC acts as a communication element and is used for lighting. In this paper, we propose to use a sensor network as a communication medium from a node to a network gateway to collect data such as temperature, humidity, soil moisture, and brightness together with VLC.

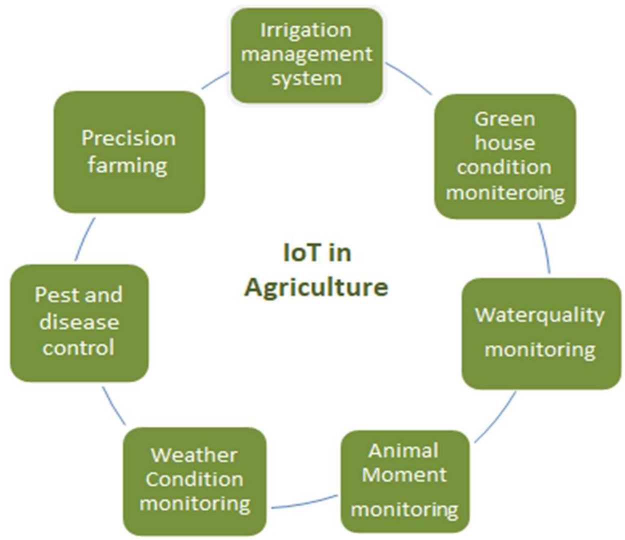


Figure 2: Features of IoT in agriculture[3]

IoT have become extra famous for characterizing the eventualities like connectivity and computing functionality that extends to one-of-a-kind gadgets and regular items. The thing in IoT refers to any of the speaking or non-speaking item on earth [9, 10]. This item represents each bodily entities and virtual entities via way of means of doing some computational responsibilities for people. IoT helps the interplay among "things" and lets in extra-complicated systems via way of means of growing disbursed programs and disbursed computing[11]. The operating of IoT is executed on the idea of Machine–to-Machine (M2M) conversation and this M2M is described for speaking among machines without the related to manpower. Even non-related entities in IOT can flip as IOT components. This era once in a while understood as being same with clever structures including clever homes, clever enterprises, clever wearable, clever metropolis and clever surroundings. The improvement of the contemporary Internet yields facts from the sensing surroundings and interacts with the bodily international via way of means of making use of present Internet requirements for supplying offerings like conversation, information switch and programs[11].

## III. SMART FARMING

The important intention of this Smart Farming is to optimize the harvesting land in line with unit with the aid of using the use of cutting-edge strategies to acquire high-quality in phrases of quality, amount and economic return. The time period clever farming is likewise called Precision Farming which makes use of a huge variety of technology, inclusive of GPS offerings, sensors and etc. These technologies are very a good deal required in agriculture zone consists of with weather forecasting, robotics; technology primarily based totally solutions, environmental controls and etc.[3]. An M2M device is essential to research the statistics and initiates the responses to the statistics received. In this angle of the Machine-to-Machine communique device, this era round it imaginative and prescient permits a few key modifications of the agriculture in the direction of the imaginative and prescient of clever farming. The effect of this era in farming supplies the connectivity among the sensors and communique structures and those sensors spreads in special regions like meals traceability, land control and environmental monitoring [4]. The intricacy of clever farming can replicate the rural surroundings within side the following ways. Wireless Services: The Wi-Fi offerings encompass a group of Wi-Fi sensor gadgets used to display the bodily and environmental conditions. Machines and Equipments: The machines are the factors used to direct the paintings in agriculture in enhancing the manufacturing and farming techniques. The maximum extensively used equipment in agriculture paintings fields are Tractors, combines and etc. The equipment'sw1 with inside the discipline of agriculture are designed to open furrows with inside the earth. The diverse kinds of equipment's are ploughs, fence, blade, handlebar and etc[6].

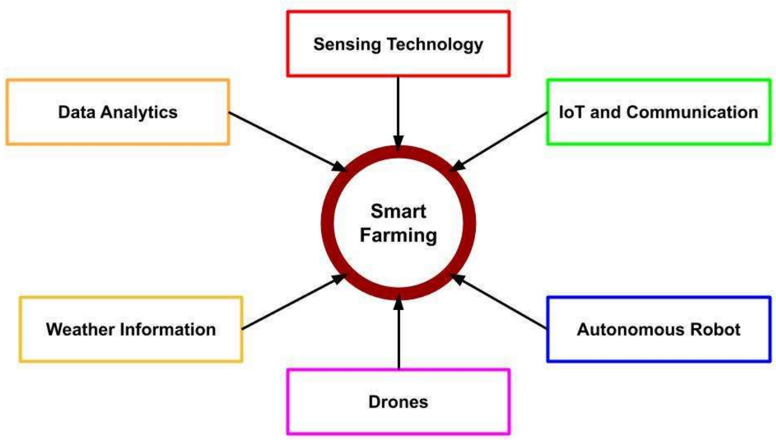


Figure 3: Characteristics of Smart Farming [4]

End Users: The end users in smart farming are the growers and managers at the back office systems. They are also considered as a farmer's co-operatives which can help smaller farmers with advice and funding. Cost: In spite of larger farms, the cost would be a major problem. The factors like soilmapping, fertilizer applications, machinery, weather data generates vast quantities of information. This information is collected by farm offices by these factors are in the field of farming. Stakeholders: Stakeholders role in agriculture is broad. The range of these stakeholders starts from large business fields like finance, engineering, retailers to industry are well expertise in farming with the contribution of small suppliers. Influencers: Influencers plays an important role in word-of-mouth marketing in the field of agriculture. The benefits of influence marketing are numerous. Partnering with an influencer can be a cost effective form of high-quality content with built in distribution[11].

## IV. BENEFITS OF USING IOT IN AGRICULTURE

As in specific industries, the software of the Internet of Things in agriculture ensures in advance unavailable efficiency, discount of sources and cost, automation and data-driven processes. In agriculture, but, those blessings don`t act as improvements, but rather the alternatives for the entire agency confronting a range of dangerous problems[3].

**Excelled efficiency:** Today's agriculture is in a race. Farmers need to increase extra products in deteriorating soil, declining land availability and developing weather fluctuation. IoT-enabled agriculture allows farmers to show their product and stipulations in real-time. They get insights fast, can expect problems in advance than they arise and make informed picks on the way to avoid them. Additionally, IoT alternatives in agriculture introduce automation, for example, demand-primarily based totally irrigation, fertilizing and robot harvesting Expansion. By the time we have nine billion human beings at the planet, 70% of them will live in metropolis areas. IoT-primarily based totally greenhouses and hydroponic systems permit short food furnish chains and need to be successful to feed the people. Smart closed-cycle agricultural systems permit growing food basically anywhere in supermarkets, on skyscrapers' walls and rooftops, in shipping boxes and, of course, within side the relief of everyone's home[6].

**Reduced assets:** Plenty of age IoT alternativesare targeted on optimization using assets water, energy, and land. Precision farming using IoT relies upon at the facts collected from diverse sensors with inside the region which enables farmers exactly allocate without a doubt ok reasserts to interior one plant.

**Cleaner process:** Not completely do IoT-primarily based totally systems for precision farming help manufacturers store water and electricity and, thus, make farming greener, but moreover significantly diminish on using insecticides and fertilizer. This approach allows getting a cleanser and extra herbal last product in comparison to conventional agricultural methods[6-7].

**Agility:** One of the benefits of using IoT in agriculture is the prolonged agility of the processes. Thanks to real-time tracking and prediction systems, farmers can rapidly respond to any big exchange in weather, humidity, air excellent as well because the health of each crop or soil with inside the field. In the conditions of immoderate weather changes, new capabilities help agriculture government store the crops.

**Improved product quality:** Data-pushed agriculture enables every increase greater and better products. Using soil and crop sensors, aerial drone tracking and farm mapping, farmers better understand one-of-a-kind dependencies among the stipulations and the nice of the crops. Using associated systems, they could recreate the superb conditions and increase the nutritional value of the products[6][7].

## V. IOT AGRICULTURE SENSORS

There's a tremendous change of IoT sensors utilized in farming, like soil, mugginess, dampness, light, air temperature, $CO_2$, photograph voltaic power sensor, and numerous others. Introduced during the fields, in the IoT-based checking frameworks, on cunning agribusiness vehicles and environment stations, sensors persistently collect measurements and oversee into horticulture tasks. The total of records coming from different sensors allows in ranchers to build crop forms and anticipate how vegetation will foster in the given circumstances, consolidate accuracy cultivating rehearses, formulate gathering procedures, and so on[10].

## Gyrator and picture

Gyrator and photo sensors are comprehensively utilized in robots, autonomous autos and drones for region wellness checking, geo-planning and land examination, confident water system and harvest treatment.

## Close to infrared and EC

One more noteworthy Red Dot awardees, Soil Cares is a helpful case of how IoT can be utilized in farming at a limited scale. This movable soil scanner utilizes close infrared and EC detecting for continuous soil diagnostics and clues on floor preparing and treatment. IoT horticulture sensors utilized by utilizing the scanner transport measurements to the records handling focus, which sends the experiences legitimate to the rancher's telephone[10].

## Humidity and temperature

One more case is a lot of humidity sensors through Cropx. These sensors award programmed dampness, temperature and EC observing and permit climate amicable and squander less water system. This is furthermore an exact case of how the utilization of IoT in farming can limit water utilization[10].

# VI. RELATED WORK

In the related work section different researcher's research work is studied. There are different techniques are used in existing work. Based on existing work different problems are studied and the results produced by different researchers are also discussed. These are as below:

Maheswari, D. et al. [1] have studied Agriculture performs an essential function withinside the improvement of our country. The Issues regarding agriculture have usually hindering the improvement of the country. The goal of this paintings became to tracking system is beneficial of watering the plant life and to locate the moisture withinside the soil with the assist of moisture sensor and additionally reveals the humidity Measurement of the elements the use of those sensors in agriculture may be known as clever agriculture. A Wi-Fi answer for shrewd subject irrigation gadget and surveillance the whole agriculture subject with the assist of cameras, its saves the farmers time to reveal the gadget, primarily based totally on IOT era became proposed on this paper.

Sergio Muñoz et al. [2] have concentrated on the development of surrounding insight has carried a determination of late conceivable outcomes to upgrade individuals' prosperity. One of those prospects is the utilization of that innovation to embellish workplaces and upgrade representatives' comfort and efficiency. One of those advances is seen gentle discussion (VLC), which utilizes present gentle in environmental elements to communicate records. Its attributes make it a remarkable new period for IoT contributions anyway furthermore aggravate the interoperability challenge. This paper focuses to foster the realm of the fine art through offering a semantic jargon for a brilliant mechanization stage with VLC empowered, which benefits from the advantages of VLC simultaneously as ensuring the versatility and interoperability of all contraption parts.

FengxianGuo et al. [3] have describe many disruptive Internet of things (IoT) packages emerge, including augmented/digital reality (AR/VR) on line games, independent using, and smart everything, which can be huge in number, records-intensive, computation-intensive, and delay-sensitive. Due to the mismatch among the 5th generation (5G) and the necessities of such large IoT-enabled packages, there may be a want for technological improvements and evolutions for Wi-Fi communications and networking closer to the 6th generation (6G) networks. Motivated through the aforementioned facts, on this paper, they present a complete survey on 6G-enabled large IoT. At the end, a use case of absolutely independent using became provided to expose 6G helps large IoT.
T. Kavitha[4] have proposed Li-Fi primarily based totally irrigation gadget specifically includes Wi-Fi sensor networks and the tracking center. The sensors within side the tracking region gather the facts of soil moisture and temperature collectively with the increase facts of vegetation in one of a kind period. A set of rules became evolved with threshold values of temperature and soil moisture that became programmed right into a microcontroller primarily based totally gateway to manipulate water quantity. Automating the records acquisition method of soil moisture and temperature that govern plant increase permits facts to be accumulated at excessive frequency with much less exertions necessities. The gadget has a dependable duplex conversation hyperlink and irrigation scheduling to be programmed via an internet web page which achieves real-time tracking of soil on crop increase.

Armin et al. [5] characterized a seen gentle discussion (VLC) contraption for indoor Internet of Things (IoT) bundles, known as VLC-IoT, became proposed. The proposed contraption turned out to be principally founded absolutely on kind I of the IEEE 802.15.7 popular physical (PHY) layer. The PHY I provided for low records expense bundles from 10 to one hundred kb/s, which seems proper for the standard IoT bundles. The on-off keying suggested tweak plot through the PHY I that is simple and calls for low-charge equipment for execution is thought about. They did VLC-IoT contraption is solid towards indoor surrounding gentle impedance. Utilizing the recurrence division various access, various VLC organizations can work at stand-out frequencies in the space of each unique without impedance. In this paper, decide of legitimacy (FoM) became proposed, wherein the greatest fundamental boundaries for IoT bundles are thought about. A total difference of VLC-IoT to various suitable VLC structures for IoT bundles became done. The outcome shows that the VLC-IoT accomplishes the excellent FoM and became fitting for indoor IoT bundles.

Mohammad Furqan Ali et al. [6] described underwater seen mild conversation (UVLC) has turn out to be a capacity Wi-Fi provider candidate for sign transmission in distinctly critical, unknown, and acrimonious water mediums including oceans. Unfortunately, the oceans are the least explored reservoirs in ocean geographical history. However, natural failures have aroused vast hobby in looking at and tracking oceanic environments for the remaining couple of decades. Therefore, UVLC has drawn interest as a dependable virtual provider and claims a futuristic optical media in the Wi-Fi conversation domain. This examine presents an exhaustive and complete survey of new improvements in UVLC implementations to deal with the optical sign propagation issues. In this regard, a huge certain precis and destiny views of underwater optical signaling toward 5G and beyond (5GB) networks alongside the contemporary venture schemes, channel impairments, diverse optical sign modulation techniques, underwater sensor community (UWSN) architectures with power harvesting approaches, hybrid conversation possibilities, and improvements of Internet of underwater things (IoUTs) have been concluded on this research.

Sana Javed et al. [7] have proposed a power-green response changing or expanding the contemporary RF framework through using gentle transmitting diodes (LEDs) on the grounds that the foster lighting and taking on seen gentle correspondences and optical computerized dig cam discussion for the astute cultivating structures. Specifically, within side the proposed framework, discussion records is regulated through an extra unpracticed foster LED gentle that turned out to be moreover respected to be helpful for the increment of the greens. Optical cameras seize the tweaked unpracticed gentle reflected from the greens for the uplink association. A total of white roof LEDs and photograph identifiers presents the downlink, empowering a sans rf discussion local area in general. In the proposed structure, the sharp cultivating units are modularized, fundamental to adaptable versatility. Following hypothetical assessment and reenactments, a proof-of-thought exhibit gives the possibility of the proposed structure through productively showing the most records charges 840 b/s (uplink) and 20 Mb/s (downlink).

R. Mythili et al. [8] have describe Internet of Things (IoT), a famous branch of pc technological know-how has introduced smart farming to every and each farmer's community whilst presenting positive inexperienced agriculture. IoT depicts a self-configuring chain of components. The green implementation allows agriculture, strength of will as well as decreasing human paintings and growing crop cultivation. This paper endorses practical IoT primarily based totally Agriculture Stick as farmers' useful resource through acquiring live knowledge (Temperature, Soil Moisture) of farm records. These stay readings assist the farmers to attempt smart farming and to boom their common crop yields, additionally the pleasant of plant life. The Smart Agriculture with Arduino Technology helps the farmers to govern the stay farm records and get the preferred crop cultivation results.

Saeed UrRehman et al. [9] have studied Visible mild conversation (VLC) is a brand new paradigm that would revolutionize the destiny of Wi-Fi conversation. In VLC, transmitted via modulating the seen light signals (400–seven hundred nm) this is used for illumination. An analytical and experimental painting has proven the capacity of VLC to offer excessive-velocity records conversation with the added advantage of progressed power performance and conversation security/privacy. VLC remains in the early segment of research. This paper offers a gadget angle of VLC alongside the survey on present literature and capacity demanding situations closer to the implementation and integration of VLC.

Mahadevaswamy H.S. et al. [10] described Internet of Things (IoT) is an interconnection of devices that could switch facts over the internet and to govern operations without human interference. Agriculture presents a wealthy supply of parameters for records evaluation which allows in higher yielding of vegetation. The utilization of IoT gadgets in agriculture allows within side the modernizing of facts and conversation in clever farming. The key parameters that may be taken into consideration for higher increase of vegetation are soil types, soil moisture), mineral nutrients, temperature, mild, oxygen and so on. Various sensors were used to sense those parameters and speak the identical to the cloud. This paper considers some of those parameters for records evaluation that allows in offering the customers to take higher agricultural choices the use of IoT. The proposed system done higher and is carried out at Thing Speak IoT cloud platform.

A.K. Saini et al. [11] studied the agriculture quarter farmers are going through essential troubles concerning irrigation. Due to over- irrigation and under-irrigation, the vegetation may be damaged. This paintings improvement of an IoT instrumented clever agricultural tracking and irrigation system. In this paper, an IoT platform based on Thing Speak and Node MCU is demonstrated, with a purpose to assist the farmer to govern the irrigation through the use of aPC or clever phone from everywhere and anytime, to tracking the moisture and temperature parameter and decrease his efforts and additionally to optimize the usage of water. Sensors value is sent to the IoT platform and if a fee is underneath the edge a notification might be dispatched to the person via E-mail to take appropriate action.

## VII. SMART-FARMING ARCHITECTURE

Figure 4 shows the proposed IoT Based smart-farming architecture. The architecture consists of several relocatable smart-farming units, white LEDs for ceiling lights, uplink receivers, the edge computer, and the cloud.

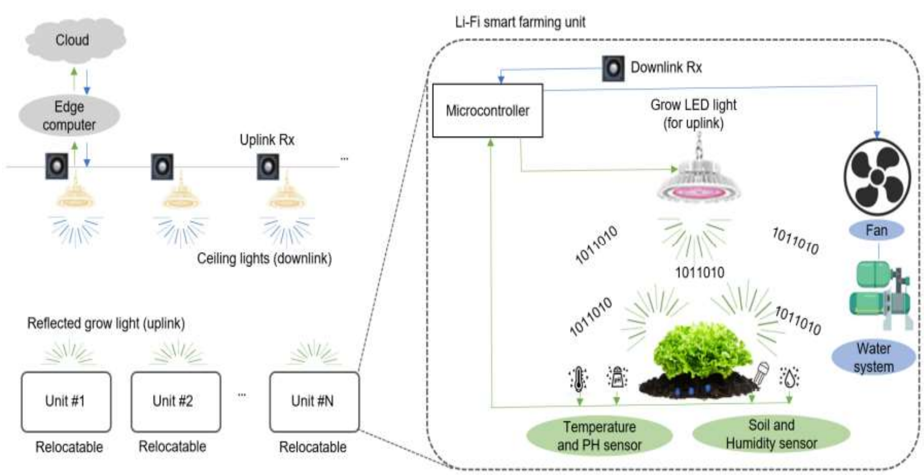


Figure 4: Proposed Diagram for smart-farming architecture[5].

For making a complete Radio Frequency free environment, uplink and downlink communication utilize VLC technology. For the uplink, modulated green LED lights from the smartfarming unit are detected by an uplink receiver deployed above the vegetables near the ceiling lights. As the main computing unit, the edge computer monitors and controls the smart-farming units[5]. To store the data for long-term use, the edge computer uploads it to the cloud. In this indoor smart-farming application, each smart-farming unit is composed of grow LED lights, a microcontroller, a receiver for downlink, and several sensors and actuators. A well-collimated RGB LED downlight is considered as the grow light for the vegetables. A key feature of the proposed smart-farming unit is that the green modulated light reflected from the leafy vegetables after photosynthesis is reused for uplink communication. Sensors monitor parameters such as PH, humidity, temperature, soil, and intensity. Actuators such as water pumps, fans, lamp drivers perform the action on the commands[13]. All these sensors and actuators are connected to the microcontroller. Based on these received commands, the microcontroller activates the required actuator devices. Since wired connections are limited in location and mobility, one of the main advantages of using wireless communication is achieving such locational flexibility for each smart-farming unit. Although the wired connections throughout the farming area can allow the RF-free environment, this can cause complex cable installation, difficulty in maintenances, and less flexible mobility of the individual farming unit[12].

## VIII. CONCLUSIONS

The Smart Farm Monitoring System can be used as future elements of agriculture. This would be a comfort for farmers seeing that it diminishes the heap of guide endeavors. A machine to show humidity levels inside the soil changed into fabricated and the endeavor outfits. In this article, the seen mild conversation community and IoT community shape alongside with advantages and present and proposed work is studied. The current literature is reviewed for VLC and IoT primarily based farming system. Currently, most of the lookup work is centered on the VLC and IoT primarily based farming gadget in Wi-Fi sensor community. There are many exceptional issues are studied in associated work and all these troubles are resolved in future with the assist of new science machine and current works outcomes are improved.

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# IMPROVING AGRICULTURE WITH MACHINE LEARNING : A LITERATURE REVIEW

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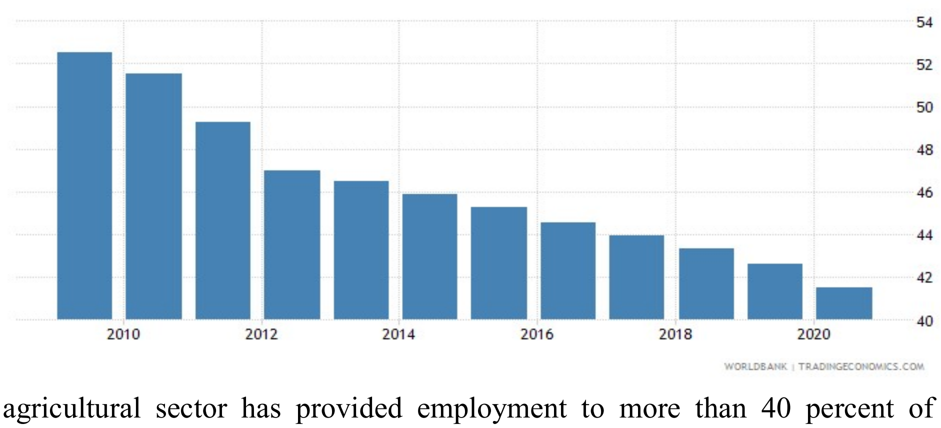
## *Abstract:*

As we know the demand for food is increasing day by day with the growth in the global population and it's increasing at a tremendous rate. This stresses upon the agriculture sector to provide food for all which not only can feed the increasing population around the globe Agriculture not only fulfills our basic needs but also provides employment around the globe. It is considered as the backbone of our economy. At present our population is increasing at tremendous rate and to meet the demands of the growing population, we need to produce more food and hence putting pressure on the farmers and enhancement in the quality and quantity of food. In this paper, we discuss how we can make the enhancements happen in real life through machine learning which can be cost effective and produce better quality of food with high efficiency and also saving our limited resources. It also describes the crop selection and management of the yield.

***Keywords:*** Soil, Crop, Machine learning model, classification, IoT devices, pests monitoring.

## INTRODUCTION

Agriculture is the most widely pursued occupation opted by people. The contribution of agriculture is growing day by day. Its contribution in GDP of India has reached upto 19.9 percent which is approximately 20 i.e, one-fifth of the total economy.

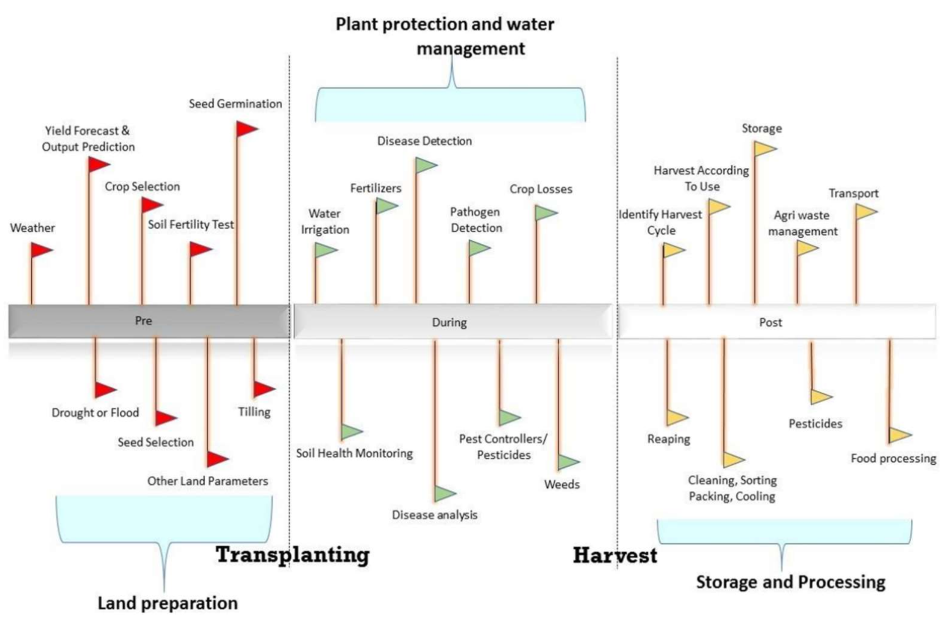



The agricultural sector has provided employment to more than 40 percent of India's population by 2020 as of the above image. In the graph above, the y-axis represents the percentage of Indian population working in the agriculture sector versus the x-axis representing the year in which it is calculated.


As we know, machine learning is a tremendous growing field in today's life and it can affect almost every field with its various applications which can help us grow our everyday work and make them more efficient by putting less effort.

## Agriculture As A Whole

There are various steps in which the whole process can be divided into and which can help us in understanding agriculture. This whole process can be divided into three parts as shown in the below figure.

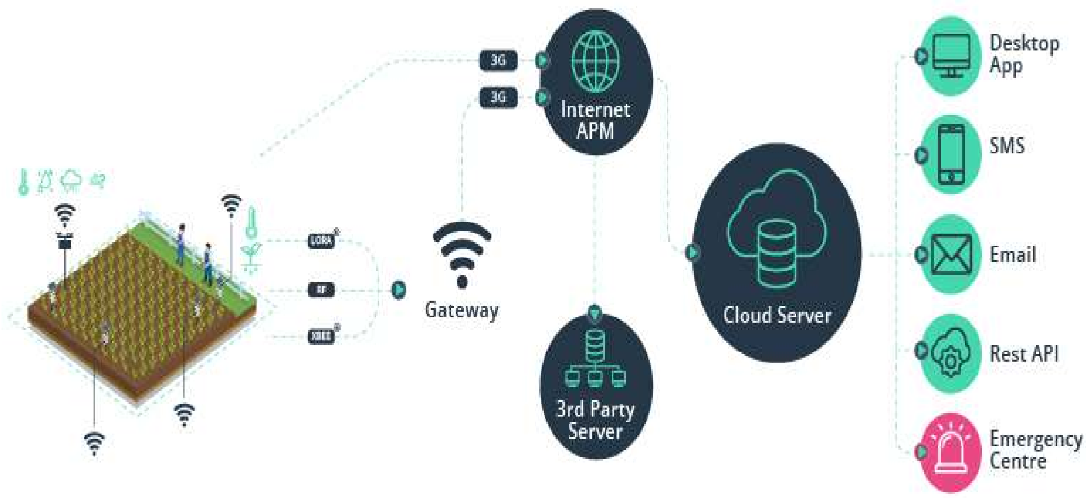



These 3 steps include:

**1. Preprocessing (Land Preparation):**

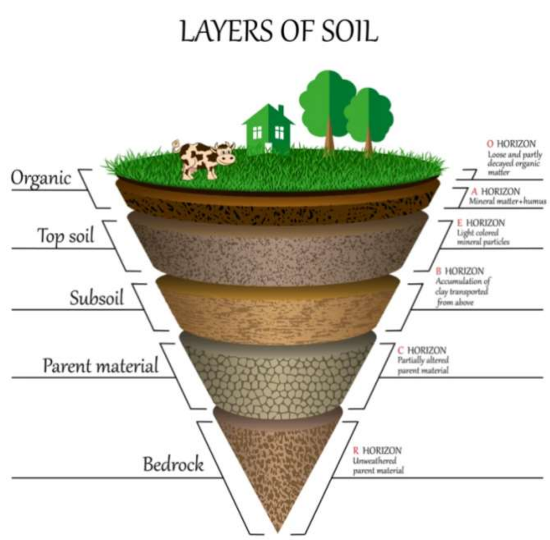
This step tells us various types of factors which can affect the crop and the field. These factors can also help farmers to understand the field and gain some experience about their own land. The preprocessing step includes various factors such as weather monitoring, drought detection, crop selection, etc. We will go through each step one by one and will see how we can implement machine learning in each of the different areas of agriculture.

**Weather Detection :** Weather is the major factor that affects the growth of a crop. Every area has a different weather which can help farmers to know how and what to do when. The detection of weather tells us how the crop would be affected by the surroundings and through weather detection we can have access to the data which tells us when it will rain or when the sun shines the most. We can monitor the weather from the internet and collect its data which will be helpful to us from time to time in the future. It can help cut costs, prevent crops from being overwatered or underwatered.




As shown above, a number of IoT devices can be connected to the field which tell us real time conditions and can monitor weather precisely.

**Soil Detection :**Soil detection in agriculture is the initial and most important step in farming. The soil detection can be done through different ways. There are a number of IoT sensors which can be placed on the field and can tell us the type of soil present at the field.



This detection can be also done by the help of cameras and drones. The drones are used to take pictures of the field from different angles and provide us with the data. The data collected then can be analyzed by different machine learning

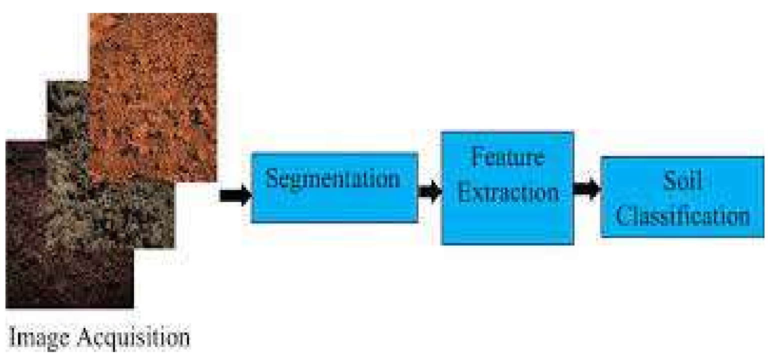
As shown in the figure above, there are many layers of soil, out of which the organic part of the soil holds the nutrients required for the crops.

The table shown below tells the types of the soil that can be found at different places. The table describes the color of the soil, the nutrients of the soil, tells us whether the soil holds the water or not, whether the water keeps standing on the soil or it drains fast. The model can be designed in which it tells us what type of soil it is by scanning the image of the field and by observing the soil for its properties.

| Soil Type | Holds Nutrients | Moves Water | Holds Water | Holds Air | Color |
|---|---|---|---|---|---|
| **Clay** | Good | Poor | Good | Poor | Depends on Mineral Content; Often Mottled Grey |
| **Silt** | Medium (at times Poor) | Medium (at times Poor) | Medium to Good | Medium to Poor (when compacted) | Brown to Black |
| **Sand** | Poor | Good | Poor | Good | Often Light Brown |
| **Loam** | Medium to Good | Medium to Good | Good | Good | Brown to Black |

The soil texture can be captured by different cameras through different angles and it can be analyzed then. There are different steps in which the image is processed and analyzed.

At first the image is captured. After then we should be doing analysis by using different types of models of image processing which includes rgb model, negative models, etc. These models are use to visualize the image and extract its properties.




After image identification, classification is done using different machine learning algorithms like decision trees, SVM, etc. The soil is identified using these techniques.

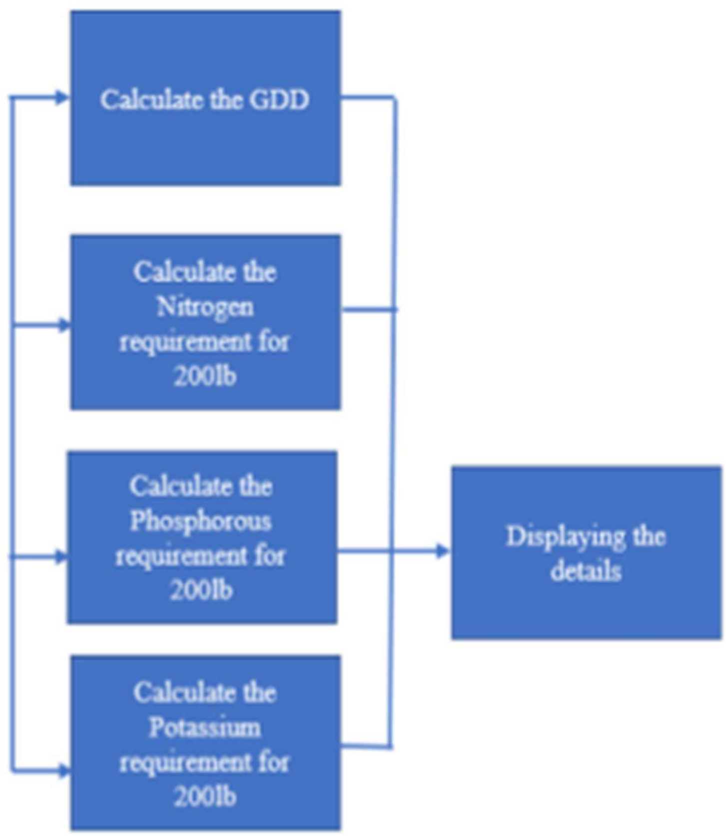
**Soil Fertility Test:** In soil fertility tests the fertility of soil is tested through different ways. Number of different parameters are tested in this step which contributes to the fertility of soil. The different parameters that are monitored are: nitrogen content, carbon content, phosphorus content, potassium content, pH of soil, etc.

Let us take an example of nitrogen content in the soil.

There are some species of crops that are known as nitrogen fixers of the soil. They increase the level of nitrogen in the soil which plants need to grow and have more chlorophyll so that they can photosynthesize. We can interplant these species with the other plants who need a lot of nitrogen and the soil is not capable of giving them so much. It is recommended to grow some nitrogen fixers species from time to time to preserve the nitrogen content of the soil. The fertilizers also enriches the soil with the nitrogen but it also has some disadvantages as it interferes with the nitrogen cycle in nature. By calculating the contents of the soil, the machine learning model can suggest to us the different types of crops which moves us to the next step.

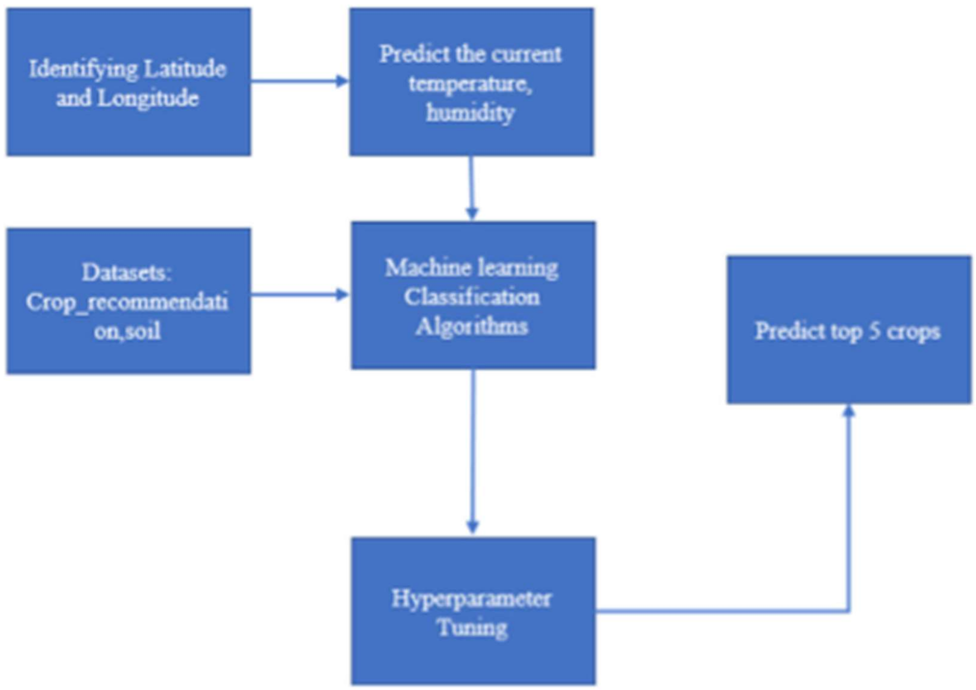
**Crop Selection:** In this step, the machine learning model predicts the types of crops that can be grown on the field considering all the factors. The crops can be chosen on the basis of the nutrients it requires, the sunlight it requires, the temperature it needs, etc.

The machine learning classification algorithms are used to decide what should be done or what crop should be chosen depending on the given conditions.




**Other Land Parameters:** Other land parameters consist of different features like temperature conditions, moisture content in the soil, pressure in the area, etc. The pressure in the area is measured by a device named a manometer that is placed on the field and by which the IoT device shares its readings to the cloud to share it with the machine learning model. The temperature is also synced with the model and the moisture content in the soil is measured by different IoT devices that are synced with the cloud and share all the information with the model. The flood and drought monitoring is also done in this process using different IoT devices and the farmers should be warned whenever it detects some kind of detection of the same.

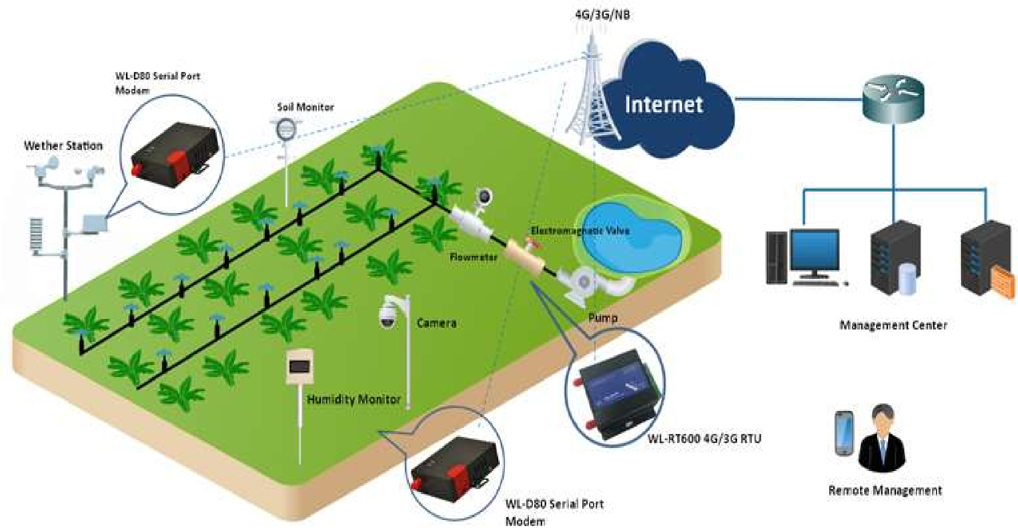
In this step, there can be more factors like seed selection, seed segmentation which can affect the output but the factors mentioned above affect the output the most. The model collects those im=nputs from various IoT devices that are synced with each other and the cloud on which the whole information is accessible. After that, we are ready to move on to the next step.




## 2. FARMING STAGE (PLANT PROTECTION AND WATER MANAGEMENT)

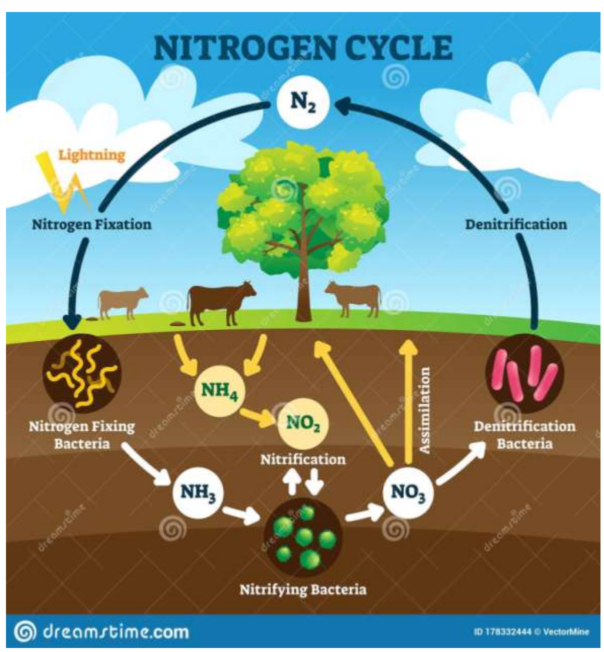
At this stage, the seeds of the plants are sowed in the soil and the crop is moving towards the harvesting step. This stage consists of the duration of the crop in the field. This stage consists of different factors that are needed to be monitored in the duration of the crop in the field. There are many factors on which the crop in this stage depends. Some of the factors are: water irrigation, fertilizers, disease detection, pesticides, weeds, pathogen detection, etc.

**Water Irrigation:** Irrigation in agriculture is the process of supplying sufficient water to the crops which is needed. The water irrigation system in agriculture is the most important topic in today’s terms as the groundwater is decreasing at a high rate and people are neglecting these issues. We need to plant some efficient irrigation systems that help us in saving the water and provide the crops the sufficient amount of water they need.




Smart water irrigation systems should be used to provide the amount of water they need. It is synced with the cloud through which various IoT devices are linked and it can control the supply of water based on the weather forecasting of that land. It is synced with the moisture detectors of the soil through which the moisture content of soil is checked regularly in the real time. It prevents the crops from overwatering or underwatering considering the weather conditions also and the need of the plants.

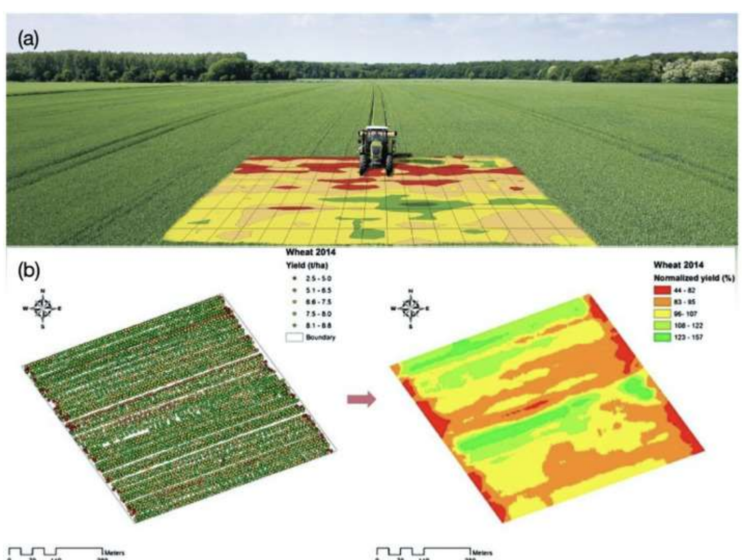
**Fertilizers:** Fertilizers nowadays are the most adapted methods to make the crop healthy and to provide the nutrients artificially. The fertilizers are used to fill the void of the nutrients of the soil which are required by the crop growing on that field. These are useful but in a limited manner only. When there is excessive use of fertilizers, it leads to depletion in the quality of the soil.



For example, we talked about the nitrogen fixers above, we can use nitrogen fertilizers instead of nitrogen fixers plants but it will lead to disturbance in the nitrogen cycle of nature. In the nitrogen cycle the nitrogen fixing bacterias that are present in the roots of the plants, consume the nitrogen content from the soil and use the nitrogen. But when we use fertilizers to complete the needed nitrogen then it disturbs the nitrogen cycle by killing the nitrogen fixing bacterias by excessive supply of nitrogen and hence it kills the denitrifying bacterias and the nitrogen cycle breaks here and next time the soil will require more and more nitrogen fertilizers every time a crop is sowed.

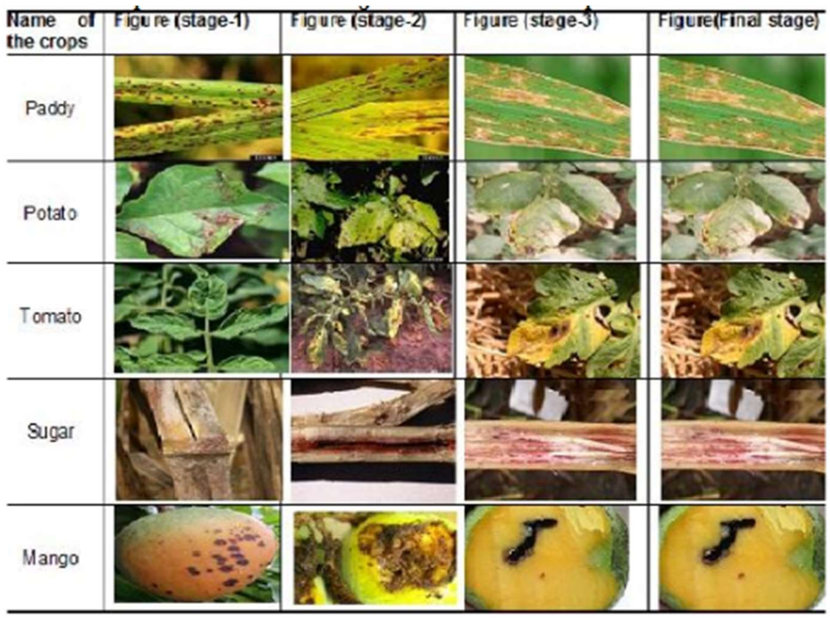
**Soil and Crop Health Monitoring:** Soil health monitoring includes the monitoring of the soil contents in real time. It measures the Soil moisture, Soil temperature, Air temperature, etc. The soil moisture is checked regularly to keep the record of moisture content of the soil and is synced with the cloud and the irrigation system to deliver required water to the crops and keep the moisture content under control.


The soil temperature is measured and is monitored by different IoT devices placed at different points in the field to track the condition of the soil and of the crops so that preventive actions can be taken if anything goes wrong.

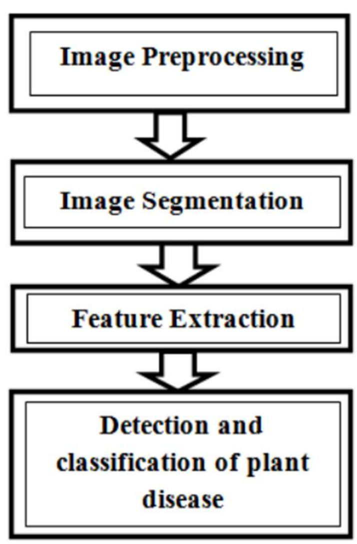


The health of the crop is monitored by different technologies. The drone cameras can be used to collect the data and to check the growth rate of the crop regularly after analyzing it to keep an eye on the record and to predict precisely when it would be ready for harvesting.

**Disease Detection and Analysis:** Disease detection and its analysis can be also done using different types of cameras and radars. The pictures of the field are taken from different angles to have the appropriate amount of data to be analyzed and so that processing can be done on it. The machine learning model analyzes the images that are captured by the cameras and predicts whether it matches with any of the disease or not.




Here in the images shown above, are the different diseases in the different fruits and it tells how the disease looks like. The model follows the steps as shown. The model informs the farmer whenever it sees any chances of crops getting disease.




- **Pesticides and Weeds :**


Aphids


Armyworm

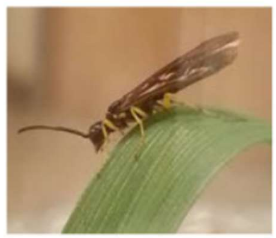

Beetle


Bollworm


Grasshopper

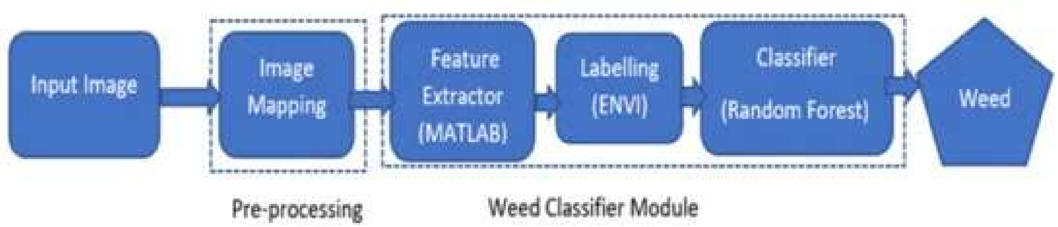

mites


Mosquito


Sawfly


Stem-borer

Insects and pests have always been the noise creator in the life of farmers. Controlling and maintaining the pests is an important task for the farmer and hence pesticides and insecticides are used for prevention of pests and insects from coming into the field. There are different types of cameras and sensors that can be used to detect them. Some of the sensors are : Gas sensors, Low light camera sensor, Fluorescent image sensor, etc. These sensors collect the data from the field and inform the farmer to take the immediate action, if needed. It predicts the duration of the pests which are based on the weather and can take preventive methods by using pesticides and insecticides. Also, use of too much insecticides and pesticides can also result in depleting the quality of the soil.




The image above shows the steps taken by the machine learning model to classify weeds on the field. This classification helps the farmers a lot. Traditionally, the farmers have to go through the field and take out all those weeds manually. Now by machine learning model, it can inform the farmer the location of the weed and also tell if it is a good weed or bad one.

**Pathogen Detection:** Pathogens are the fungi, bacteria, viruses that cause the disease symptoms in the crop and reduce the quality of the crop. PCR (Polymerase Chain Reaction) is the method used to detect pathogens. There are other methods too for detecting pathogens like thermography.

## 3. Post Processing (Storage and Processing)

Once both the steps are done, the last and the most important step from the earning perspective is Post Processing. At this stage the crop is ready to be harvested and we need a proper storage for our crop. It directly relates the management of the crop to the profit in the farming. There are some various steps in which this phase proceeds, which are :

**Harvesting:** Once the crop is ready, the most important step is harvesting. In this step the crop is ready to harvest and it is directly related to the profit in the agribusiness. This step ensures the quality and the size of food we have grown. This tells us the taste, firmness and state of the food and shows us how much worth our efforts were. There are 3 ways through which harvesting can be done:

- ➔ **Hand Harvesting:** As the name says, harvesting is done with hands, manually and it takes a lot of time and effort and manpower.
- ➔ **Harvesting with hand tools:** The different types of hand tools are used to cut the crops. This also takes too much time and manpower.
- ➔ **Harvesting with machines:** This type of harvesting is done with the help of different kinds of machines. These machines save the time and manpower that we invest in above two methods. Eg: combines are used nowadays to harvest the crops.

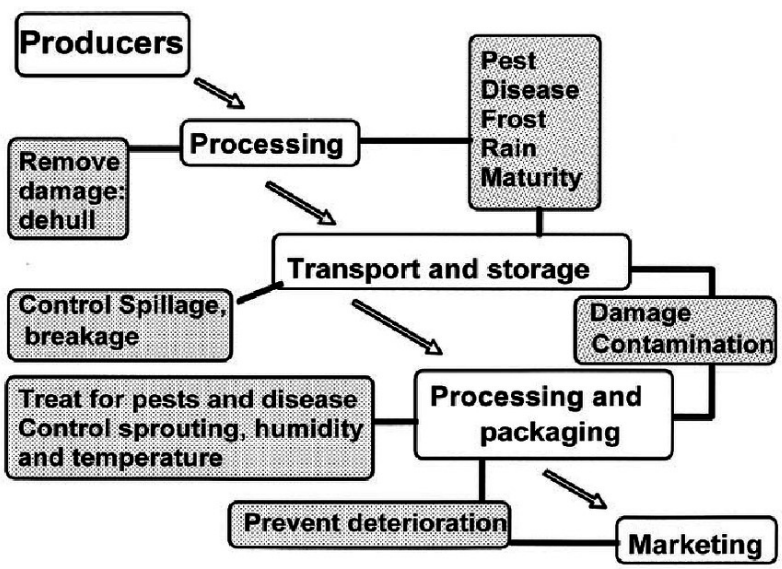
**Cleaning and Managing:** This step includes sanitation in agriculture. To keep the track of the health of workers. There should be proper space for cleaning out and other farm activities like tractor repair, etc. The cleaning up of space is necessary so that it won't attract unnecessary insects, etc. It is the most important post harvesting step. It also includes the minimal standing water in the field or anywhere near the crops as it will lead to produce disease in the crops.

It also includes the cleaning of surfaces with detergent for the removal of dirt. Sanitization is done to remove the microorganisms that can be still present on the surface even after cleaning.

**Agri Waste Management:** Agriculture waste includes three types of wastes: Natural Waste, Plant Waste and Animal Waste. If wastes are not handled properly, they can pollute the earth, water, air, etc. It is the crucial step to maintain the cleanliness at the farm or field and also prevents pollution.

There are different types of wastes needed to be managed. Composting can be done to decompose the waste by aerobically or anaerobically. The different types of waste can be separated first and then processed to the decomposition part so that no different types can get mixed.


**Storage and Transportation :**Storage is the most important part of crop management. The storage requires a lot of space which is the first issue that every farmer faces. In the storage step the farmer has to take care of the harvested crop from the different kinds of pests. This can be done by following different ways like using pesticides, cleaning the place and keeping a check on the crop. While using pests one should keep in mind that the use of too much pesticides can also cause to a decrease in the quality of the crop.




The pests are produced in specific conditions which can be monitored and prevented. For example, the pressure at the storage location, temperature, moisture content affects the crop a lot and can lead to produce pests that can be harmful to the crop which can further lead us to a loss if not taken care of.

In the case of transportation, the vehicle diagnosis can help in preventing the crop from getting wasted. The health of the vehicle, the storage quality in the vehicle, the cleanliness, etc are the things that matter while transportation which can affect the quality of the yield and hence contribute to a huge loss.

## CONCLUSION

The conclusion of this paper includes the application of machine learning techniques integrated with IoT devices which can lead to improving the quality and the quantity of the crops. At first we saw how the crops should be selected and which parameters should be kept in mind while choosing a crop, that all was included in preprocessing. After that, during farming time we saw what to do to prevent the pests and insects from reaching out to crops and also high use of pesticides and insecticide can lead to quality decrease in soil too. Use of cameras and IoT devices was too much to sync data and collect the data from time to time for analysis. Then we had the harvesting step at which we see how the harvesting is done and what are methods to do it. Then there were post harvesting management issues which included cleanliness and sanitation, Agri Waste Management and the storage and transportation issues and how they can be resolved to make good profit and protect our crop from being wasted.

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# IMPORTANCE OF GREEN COMPUTING IN ECO-FRIENDLY AGRICULTURE AUTOMATION

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## *Abstract:*

*To attain the food security in the 21st century and feed a population that is about to reach 10 billion, humanity needs to tackle the enormous challenge of increasing agricultural productivity. This needs to be done while maintaining a sustainable agricultural system and taking into account concerns such as climate change due to $CO_2$ emission and dwindling of natural resources. This can be achieved by using least toxic chemicals, economical friendly machinery as well as green technology to reduce $CO_2$ emissions and to make the agriculture operations automatize to cut back human intervention. This study advocates the importance and role of implementation of green computing for eco-friendly agriculture automation using green IOT, precision agriculture and solar photovoltaic PV panels based irrigation system.*

***Keywords:*** *Green Computing, Sustainable Agriculture Automation, Green IOT, Solar Computing*

## 1. INTRODUCTION

Green computing strives for effective equipment utilization, energy efficiency, and environmentally responsible technology use. In today's world, many changes in the climate are caused by greenhouse gas emissions, such asthe $CO_2$ footprint created by substantially burning fossil fuels to generate power, which reduces the oxygen content in the atmosphere and drastically lowers the crop quality and soil fertility [1]. Electricity is employed in agriculture for the automation of IT tools as well as for water pumping systems. Various technologies such as automation tools, IoT, sensor technology, cloud computing for virtual data storage, and machine learning for decision making are used in agriculture automation but they must be green in order to be sustainableand eco-friendly. In India, electricity consumption for agriculture was ~215,000.000 GWH in 2021 which is gradually increasing [2]. This can be accomplished by using renewable energy resources such as solar computing systems. Because agricultural growth has an impact on people's lifestyles and health as well as the nation's economy. Using wireless sensor technology, IOT devices were made green. Indeed, via their actions such as pollution avoidance, product stewardship, and the deployment of clean technologies, green IT helps to reduce the negative consequences of technology [3]. Numerous scholars investigated it and suggested frameworks, which will be addressed in the next section.

## 2. LITERATURE SURVEY

Maheswari R. et al. [4] proposed a intelligent system takes farmers into account receiving all pertinent information regarding the enhancement of soil fertilization and agriculture by supplying climate change information through IOT (Internet of Things) devices where websites and mobile phones are capable of handling that information. The data and information regarding soil fertilization and weather alerts are provided in their local language or a language of interest. His proposed system might foster greater teamwork among its participants and raise the bar for what's necessary to increase their output. In his system the order to balance the energy needs across the board, IOT gadgets are powered by solar system [4].

ET-TAIBI BOUALI et al. [5] proposed an integrated SA solution that makes use of cost-effectiveness. The three primary axes of the solution are 1. Using a cloud-based IOT (Internet of Things) system, smart water metering encourages the best use and conservation of groundwater (also known as water-table) through real-time data collecting and monitoring; 2. By lowering dependency on fossil fuels for water table pumping, the incorporation of renewable energy encourages energy-efficient agriculture. 3. Use of intelligent irrigation to encourage the growth of high-quality, abundant crops while protecting the ecosystems of the soil and water table. provides for better water level monitoring in the basin and, by completely relying on solar energy, complies with the typical eco-friendly trend of sustainable agriculture. According to their findings, implementing their SA system can cut down on water usage by up to 71.8 percent compared to using a conventional irrigation system. [5]

Mohammad Samunul Islam et al. [6] demonstrates the design and implementation of a solar energy-based precision agriculture using Internet of Things (IoT) architecture with wireless sensory network (WSN) to satisfy the requirement for extremely effective techniques for smart agricultural monitoring and management system. His suggested system would provide farmers with pertinent information on salinization, moisture content, water level, humidity, temperature, and the overall condition of the crop field in a user-friendly, efficient and reliable manner, with real-time data transfer through IOT[6].

Rehan Qureshi et al. [7] proposed a fog-based architecture consisting of Single Board Computers operating as low-power fog nodes for processing information from IoT sensors, especially in the farming sector in eco friendly manner. The suggested system's minimal energy requirements may be readily supplied by incorporating renewable sources of energy, resulting in a more sustainable model. The suggested green fog-based architecture would contribute to the construction of a green environment not just for the smart agricultural sector, but for many other its application areas. [7]

Alhanouf Al-Zamil et al. [3] created a framework by combining two previously presented models: organizational green IT adoption (OGITA) Model and Integrated Model for Adopting Green Practices. This study highlights the drivers and constraints of implementing Green IT and improves knowledge and implementation of Green IT in Saudi Arabia's agriculture industry. The survey results-based study findings accept and affirm that there is an influence of drivers and difficulties in adopting Green IT for sustainable agriculture [3].

Aashir Waleed et al. [8] proposed a concept for a controlled irrigation system employing photovoltaic water pumping system for sustainable agriculture, as well as moisture sensors and a wireless system that can be operated from anywhere to automate solar computing based water pumping system. [8]

## 3. ROLE OF GREEN TECHNOLOGY IN AGRICULTURE AUTOMATION

Green Computing has seen considerable success in various challenges involving effective equipment utilization, environmentally friendly machinery, energy efficient technologies, and renewable energy supplies for agricultural automation. It plays vital role for various aspects of sustainable agriculture discussed as follows :-

### 3.1 GREEN IT IN AGRICULTURE AUTOMATION

Several technologies used in agriculture for make it automate and sustainable because depletion of natural resources and climate change effects the quality of the crops and increases the input due to usage of electricity based irrigation system, IT products and due to excessive usage of toxic chemical and artificial fertilizers. To rectify the problem in this section shed a light on some green computing based technologies and role played by them in sustainable agriculture automation.

#### 3.1.1 GREEN INTERNET OF THINGS (IOT)

Green IoT refers to the efficient energy ways to acquire the IOT devices to minimize the green house impact as well as reducing effect of existing products and to optimize the footprint of gases emission [9]. As per the report of BI intelligence report, in farming sector around 75 million IOT devices were used with 20% growth rate in usage annually and expected to reach its four times by 2025 [10]. For automation of agriculture IOT products used for crop automation, irrigation based on weather updates, prediction analysis of crop production and output, drones for monitoring, spraying, drone seeding which results into six times more results than human labour. To make these green and eco-friendly, energy required by these fulfilled by renewable resources like small solar panels installed on it and the data stored on the cloud which also help to reduce the e-waste adopt green Eco system illustrated in figure 1.

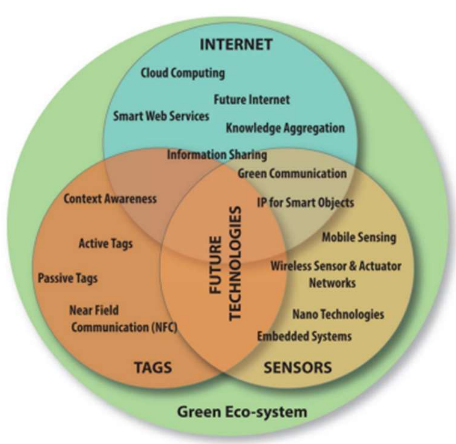


Figure 1: Green IOT ecosystem [9]

For wireless networking for IOT devices the radio frequency identification (RFID) technique is used which has small tags in it and works for transmitting as well as receiving the signal and close in a specified sticker. These RFID has singular identification method and storing the data as well, response after transmitting the signal RFID responds immediately back to the user. It has low transmission range likely in meters. RFID helps to promote green technology by reducing the emissions by vehicles, saving energy and e-waste [9].

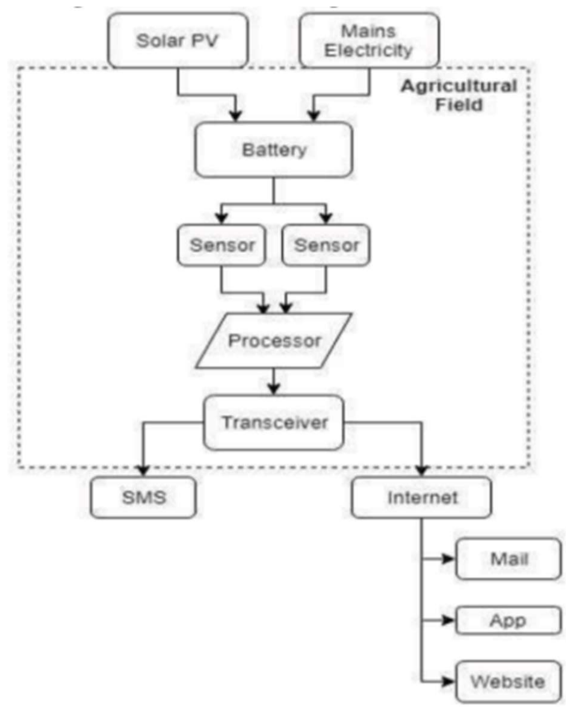


Figure 2 : Solar based IOT system [4]

Solar Based IOT system flowchart demonstrated in figure 2 where solar photovoltaic panels installed produced DC current and then converted to AC using converter which connected to battery to store electricity for night usage, sensors connected with battery further connected to processor to process the operations. Transceiver used for communication using internet and SMS service which helps to automate the system and promotes sustainable farming[4].

### 3.1.2 GREEN SENSOR TECHNOLOGY

In agriculture the crop quality and production relies on several factors like soil quality, humidity, moisture in soil, soil fertility, water quality, pressure, temperature, nutritious fertilizers, sunlight exposure, leaves colour and microorganisms in the soil [11]. All these factors can be scrutinize by various sensors like as follows:-

3.1.2.1 Moisture Sensor
3.1.2.2 Temperature and pressure Sensor
3.1.2.3 Humidity Sensor
3.1.2.4 Colour and Nutrient Sensor
3.1.2.4 Light Sensor [11]

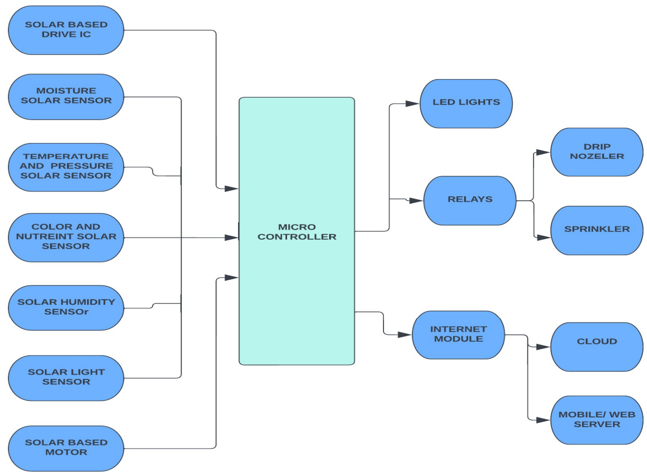


Figure 3: Block Diagram [11]

In the block diagram figure 3 illustrates the sensors (input) connected to a micro controller and then connected to led light, valves, sprinklers, and internet to send the data to the tenant. Even based on the information received the user send instruction to the processing to run different operations. These sensors are working based on solar energy and battery connected with them to work on night as well [11].

### 3.1.2.1 MOISTURE SENSOR

Solar based moisture sensor measures the water content in the soil. Based on the moisture present in the soil indicates the water pumping motor that level of water below the threshold value and the requirement of water in the field then motor starts and off through relay switches of micro controller. It also helps in proper irrigation management for agriculture and results into effective utilization of water [11].

### 3.1.2.2 TEMPRERATURE AND PRESSURE SENSOR

It checks the pressure in the atmosphere if less pressure in the atmosphere then there are less chances of rainfall because rainfall is inversely proportional to pressure and it also access the temperature because it also effects the crop germination, production and communicate to farmer through internet [11].

### 3.1.2.3 HUMIDITY SENSOR

Based on the humidity sensor it controls the water supply if the humidity is high then less water requirement and vice versa. Initiation of water is based on the humidity, moisture, pressure as shows in the figure 4 [11].

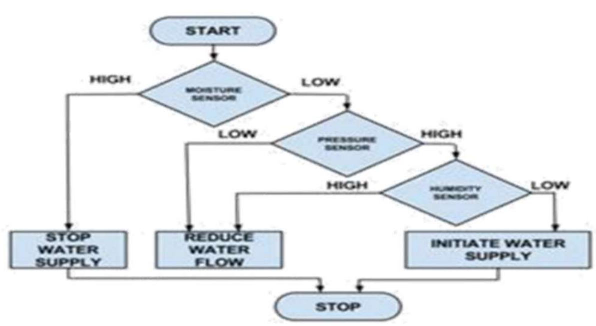


Figure 4: Water supply based on humidity, pressure and moisture sensor [11]

#### 3.1.2.4 COLOUR AND NUTRIENTS SENSOR

These both are two different sensor based on the colour and nutrient sensors it identifies the health of plant and fertigation will be done on the bases of colour whether it is dark green or light yellow. If colour is yellow green then it starts fertigation and if dark green then stops the fertigation process various techniques are there for fertigation (water soluble fertilizers). Fertilizers are crucial for soil fertility for crop quality, quantity and reproduction like nitrogen, phosphorus, potassium, zinc etc[11].

#### 3.1.2.5 LIGHT SENSOR

Light has various characteristics which effect the quality of plant growth as well as period of reproduction. In which wavelength and colour light reaching plant it effects its growth and photo period of plant depends on the amount light reached to plant. If intensity of light is less then it indicates controller to start the light projected arrays which set at different angles of field using reflectors it ensure that light reaches to every plant [11]. Hence, the solar based sensor technology helps to automate the system and provides effective utilization of resources for crop productions and help farmers to reduce manpower as well as in Eco friendly manner.

### 3.2 PRECISION CROP PRODUCTION USING GREEN IOT

As the demand of food is increasing day by day due to substantially rise in population around globe so precised and intelligent farming is necessary nowadays because agriculture also act as a backbone of economy of the nation. Precision farming is achieved proper monitoring and controlling the agriculture along with minimizing the effect on environment and maximizing the promised crop production and quality to a tenant. Nowadays with advanced wireless sensory network (WSN), mobile comping and global positioning system (GPS) it can be achieved along with sustainable approach [6].

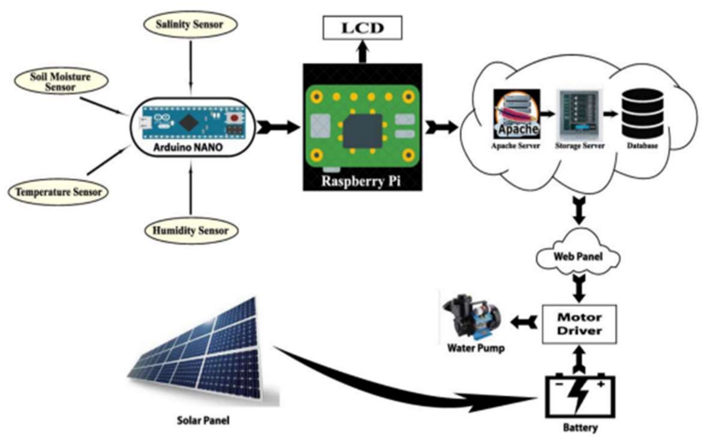


Figure 5: Framework for precision farming [6]

In figure 5, it shows the framework for precision agriculture. In the above setup the solar panels are installed for providing electricity for motor along with battery and then connected to raspberry pi follows arduino nano chip is connected to various sensor and the raspberry connected to server through wireless sensory network or GPS. In process, basically sensors analyse its functions and give output to with the help of arduino to raspberry and then deliver the message to farmer through internet user receives the message as push notification and farmer take necessary action from application [6]. Hence, it ensures the proper monitoring, controlling of crop to get best quality crop which also automates the system and leads to sustainable agriculture.

### 3.3 SOLAR COMPUTING IN SUSTAINABLE IRRIGATION SYSTEM.

As the natural resources decreasing day by day fossil fuels are also reaches to its end. As data provided by worldometer statistics ~ 18,526,028,867 CO2 emissions worldwide which shows the amount of fossil fuels used and ~ 4,982,321 Toxic chemicals released in the environment due to burning of fossil fuels, pollution etc. in only 7 months[12]. Worldometer statistics also tells us that ~148067 days left to end coal and ~14954 days to finish oil [12]. Thus, natural resources moving towards end which effects the climate change as well as lifestyle because health issues are drastically rising. So the need of the hour is to move towards renewable energy as soon as possible state and union governments also taking initiatives toward solar energy and wind energy. In agriculture maximum electricity consumption is used for water pumping system where electricity also a major source of $CO_2$ emission in environment. In order to rectify this problem need to adopt solar based electricity which results into Eco friendly agriculture. Solar energy can be used in various ways fro agriculture like Green IOT, Machinery, irrigation system etc.

#### 3.3.1 SOLAR PV PANEL SYSTEM FOR AGRICULTURE

Solar Panels in irrigation system for water pumping from groundwater, gets marvelous success to overcome the electricity problem in recent years. Solar Photovoltaic (PV) panels for irrigation is one of the easiest method for water pumping system or agriculture. Solar panels contains solar cells generally 72 cells in solar panel and it depends further these has different grades for different sheets of solar. These solar PV panels made up of semiconductor material which is available in large amount. The light strikes on the photovoltaic plates and it absorbs it which results into pair of electron hole [4]. Electrodes present there gathered the electrons and results into flow of electric current as shown in figure 6 [4].

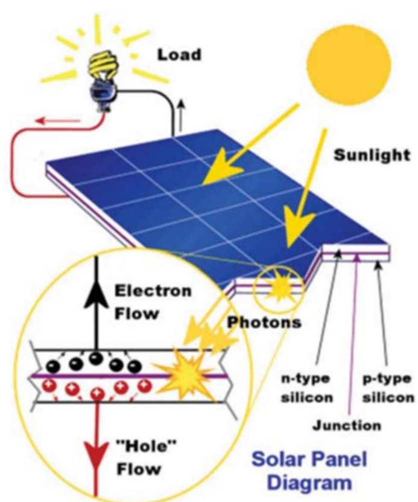


Figure 6: PV Solar panel [4]

This type of solar systems are generally used in water pumping system in rural area for irrigation of crops and field. PV solar system categorized into two types of solar system (i) Coupled with battery and (ii) directly coupled. The battery coupled system provides surplus electricity which stored in batteries, this coupled system helps to use the electricity at night without any electric failure or breakout [4]. Where other system connected directly produces DC current. The starter installed can be installed under panels also and gives reading as shown in figure 7 where it generates 35 HZ output frequency and 417 Bus Voltage for 7.5 Hp water pump.


Figure 7: Reading of AC drive electricity generation by directly coupled.

Solar photovoltaic panel used widely for various agriculture activities. For water pumping irrigation system using IOT enable wireless networking system which helps to automate the process. In this system battery couple PV panels installed and connected to motor for water supply.


Figure 8 : Remote Monitoring System (RMS) kit of Shakti

Further connected to RMS IOT enabled which provides wireless network to control the solar motor system from mobile using Remote Monitoring System(RMS) kit shown in figure 8 which connected to the internet and farmer can access the starter from home as well. If further enhancement can be done then IOT enabled devices will be installed to make it fully automate using sensors, drones, wireless sensor networks and mobile computing which also leads to sustainable agriculture automation.

## CONCLUSION

Nations all around the globe are focusing on sustainable development to combat climate change and sustainable agriculture since there is a growing need for precision and automated farming in an Eco-friendly manner. This study demonstrates the significance of Green Computing in sustainable agriculture automation through the use of various methods such as Green IOT, Wireless Sensor Networks, Precision crop production, and Solar Computing, which results in effective resource utilization, energy efficiency, cost effective for farmers, and manpower reduction, as well as effective agriculture growth.

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# ROLE OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE

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## 1. INTRODUCTION

Crop production currently accounts for around 37.7% of total land surface. Agriculture is significant in terms of job creation and contribution to national income. In countries such as India, the agricultural industry contributes for 18 percent of GDP and employs half of the country's workers. Rural growth will be boosted by agricultural development, which will then lead to rural transformation and, finally, structural transformation.

Many industries around the world have undergone significant changes as a result of technological advancements. With the advent of developing technology, workers who were formerly limited to only a few industrial areas are now able to contribute to a wide range of industries. A quick rundown of the current state of agricultural automation The report also discusses a potential IOT-based system for flower and leaf identification and irrigation in the botanical farm. The main idea behind AI is to create technology that works similarly to a human brain. AI encompasses a wide range of fields, including Machine Learning and Deep Learning. While AI is the science of creating intelligent computers and programmes, machine learning (ML) is the ability to learn anything without being explicitly programmed, and deep neural network learning (DL) is the learning of deep neural networks. The primary goal of AI is to make problem solving easier, which may include the usage of artificial neural networks (ANNs). Automation is necessary in the agriculture field and they try to reduce the human being intervention in the field. CNN many algorithm used in the automation agriculture CNN is used to detect and tells us to cut down the unnecessary and disease plant from the field. CNN can also help to detect the plants needed and identify the plants easily as well as there is R-CNN it is used for object Detection and fruit detection plants and fruit counting. In the sphere of agriculture, artificial intelligence (AI) is a new technology. Agriculture has been elevated to a new level thanks to AI-based equipment and technologies. In the agro-based sector, the latest technologies of automated systems using agricultural robots and drones have made a significant contribution. Various high-tech computer-based systems have been developed to identify a variety of critical factors such as weed detection, yield detection, crop quality, and a variety of other ways. This paper discusses the technologies that are used to automate irrigation, weeding, and spraying in order to increase output and reduce farmer workload. Various automated soil sensing systems are described, including combining temperature and moisture sensors to close the vehicle forecasts' loopholes. GPS modules were utilised to locate the sensing robots, The data was presented on a 16 2 LCD display that was built inside the LPC2148 microprocessor. The latest automated weeding techniques are addressed, as well as the use of drones for field spraying, as well as the several types of sprayers that can be used on UAVs.

## 2. AI's IMPACT ON AGRICULTURE

AI-based technologies aid in the improvement of efficiency in all fields and the management of difficulties faced by businesses, including crop yield, irrigation, soil content sensing, crop monitoring, weeding, and crop establishment in the agricultural sector. In earlier, Indian Prime Minister Narendra Modi introduced a scheme "KRISHI VIMAAN DROME". In this scheme 100 fledging-off drone are introduced in a sumeat. The main aim for these is to used in agriculture automation. This scheme is currently running in several states and various big cities of India such as Punjab, Goa, Jaipur, Golaghat, Kareemnagar, Kanauj, Nizaam in madhya pardeshGaruda Aerospace Pvt. Ltd. take responsibility to make approx. 1 lakh agriculture drones for India, 2 years bond is done between India government and Garuda Aerospace Pvt. Ltd. Farmers will use 75 million linked devices by 2020. Every day, the average farm is predicted to create 4.1 million data points by 2050. These following are the various charactertics that are used in the agriculture automation:

### 2.1. PERCEPTION AND RECOGNITION OF IMAGES

Autonomous UAVs and its applications, like as recognize, surveillance, body of human detection, geolocation, searches, detection of forest fire have sparked increased interest in some last years. Drones or unmanned aerial vehicles (UAVs) are becoming increasingly popular for reaching great heights and distances and carrying applications due to their versatility imaging technology that would cover each and every thing from photography to delivery, and it will be remote controller, which allows us to do a lot with these devices.

### 2.2. PERSONNEL AND SKILLS

There are some major features in Artificial intelligence which tells farmers and labour of the agriculture land to take vast amount of knowledge or you can say data from government as well as public e-websites that analyze your challenges and gives vast result and advices according to your challenges. It also tells about the agriculture tools which can be good for fields and other various result would be advised which would help you to improve your crop and also give training for agriculture automation in future. By analyzing it you can also take decision for reducing your cost as well as it give relief to farmers from the work load.

### 2.3. CHAT BOTS FOR FARMERS

Chat bots plays very important role in the $21^{st}$ century like in travelling, media, online shopping and many more but it is also doing vital role in the sector of the agriculture. It is the virtual assistant that is the automated interface between virtual assistant and the end users. We can make it with artificial intelligence, machine learning algorithms as well as deep learning. Chat bots are used to solve the unanswered queries, as well as providing guidance and varied recommendations.

## 3. ROBOTS IN AGRICULTURE

In vast areas of the economy with poor productivity, such as agri-food, robotics and autonomous systems (RAS) are being implemented. According to the UK Agri-Food Chain, which includes everything from primary farming to retail, the business produces approximately £108 billion per year and employs 3.7 million people in a truly global economy that generated £20 billion in exports in 2016. In agricultural production and administration, robotics has played a significant role. The major goal of developing this technology is to replace human labour and achieve effective results in both small and large-scale manufacturing. Robotic technology have greatly increased production in this industry. Robots plays very important role in the field of agriculture is that they can guarding the field, irrigating, watering and weeding it also check the unmannered environment in the agriculture field that may cause the crop as well as it also checks the need of water for the specific plant during mean time. The invention of a machine known as Eli Whitney's cotton gin sparked the notion for such a technology. Eli Whitney (1765–1825), a U.S.-born inventor, devised a system in 1794 that revolutionised cotton manufacturing by greatly speeding up the process of separating seed from cotton fibre. In one day, it produced 50 pounds of cotton. To determine the real position of seeds, a rudimentary automated model was devised. Seed planting with high accuracy is establish**.** Robot also guranttee that the seed will not bounceafter collision with the soil. Automated machinery kept track of the plant's state and progress. Various biosensors have been developed to track plant growth as well as identify plant illnesses. The manual weeding procedure was replaced by laser weeding technology, in which a mobile concentrated infrared light breaks the cells of the weeds and is controlled by computers. Automated irrigation systems were also installed to make efficient use of water.

### 3.1. IRRIGATION

Agriculture absorbs 85 percent of the world's available freshwater resources. And this fraction is progressively rising in tandem with population growth and rising food demand. As a result, we'll need to develop more effective methods to ensure that water resources are properly utilised in irrigation. Automatic irrigation scheduling systems have replaced manual irrigation based on soil water monitoring. While implementing autonomous irrigation equipment, the plant evapotranspiration was taken into account, that can be depend upon many climate parameters that can be wind speed, high temperature and aspects of crop like growth level, density of the plant, soil feature.

### 3.2. WEEDING

The amount of pounds of water used to create one pound of dry matter is the water demand for the aerial parts of the plant. To reach maturity**,** there is huge amount of water required for the some special plants that be developed under the special monitoring**.** Per acre water can be calculated by multiply the plants water need with the need of water in the per acre bywater that plant required**.** Light plays an important role in the growth of the plants as well as when the light will reaches to the plant. Shade-intolerant weeds such as green foxtail and redroot pigweed can be found, although shade-tolerant weeds such as field bindweed, common milkweed spotted spuroe, and Arkansas rose can also be found.

## 4. AGRICULTURE USES DRONES

In a mechanical context, unmanned aeronautical vehicles (UAVs) or unmanned ethereal frameworks (UAS), often known as automatons, are small aircraft which can be handled and used remotely. Drones works with the GPS as well as various sensors that are attached to them. The major work of the drones is to monitor crop, health monitoring, watering the agriculture, fertilization on crops, weed monitoring, as well as disaster management**.** The use of this aircraft is to use the clicking pictures, video clips as well analysis agriculture impacts significance**.** The agriculture industry appears to have embraced technological innovation with zeal, employing these propelled devices to alter present agricultural practices. Drones are would be compared with the simple cameras as well as they tell the info so soil moisture, plant health which would not visible by the drones because of visible range. These could aid in the removal of various barriers to agrarian productivity. Wireless Sensor Networks are used in the development of the UAS (WSN). The WSN's data allows the UAS to improve its use of them, such as limiting its spraying of synthetic substances to certain areas. Because ecological conditions are constantly changing, the control circle must almost surely respond as quickly as is reasonably possible. The reunion with WSN may be a step in the right direction. UAVs are mostly used in precision agriculture for tasks including soil and field analysis, crop monitoring, crop height estimations, and pesticide spraying. However, essential criteria such as weight, range of flight, payload, configuration, and costs are strictly adhered to in their hardware implementations. UAV technologies, methodologies, systems, and limits are investigated in this study. In order to identify an acceptable UAV in agriculture, more than 250 models are studied and summarised. In the following years, the agricultural drone market is predicted to rise by more than 38%.

### 4.1. CROP SPRAYING

These drones have been used as substance sprayers by farmers for many years, and they are believed to be effective and important in foggy climates, as well as solve the tall size crops problem to a agriculture field, such as maize. They're also thought to have a strong advantage over satellite aerial sensors with excellent picture resolution, and they've converted sprayer of plant with (MBSCS) control system of microcomputer-based sprayer. A framework of foliage volume estimate based on ultrasonic range transducers was interfaced to a PC, which used control calculations based on the amount of spray deposited to control the 3-nozzle manifolds on each side of the sprayer. Drones main work is to spray the fertilizers on the agriculture field and these drones are connected with horticulture applications. Drones are works with the help of various sensors called remote sensor networks (WSN) that were placed on the crops in the field and controlled the application of synthetic substances. Drones were only allowed to spray synthetic compounds in the designated areas based on the data collected by these distant sensors. For an autonomous helicopter, they created a low sprayer. Helicopter used diameter of 3 m to 5 m and weight 30 kg appx. 45 mins to 1 hour is used to spray the field one time. The system and methods gives the result that used to create UAV flying application frameworks for higher yields with a higher goal rate and larger VMD droplet size.

### 4.2. CROP MONITORING

Farmers now have a plethora of new options for increasing yields and reducing crop damage thanks to enhanced sensors and imaging capabilities. In recent years, unmanned aeroplanes that are utilised for practical purposes have assumed an unusual flight. New sensors mounted on UAVs, high-tech cameras serving as the client's eyes on the ground, and ideal survey, data collecting, and analysis techniques are all being developed and tested. In truth, aerial surveys are not new to the agricultural industry. Satellites have been used to scan big croplands and forests for a decade, but the advent of unmanned aerial vehicles (UAVs) has provided a new degree of precision and flexibility. UAV flights do not require the position of the satellite or the presence of favourable weather conditions, and because UAV photographs are shot 400–500 feet above ground level, they are of higher quality and precision.

## 5. CHALLENGES AND PROSPECTS FOR THE FUTURE

Agriculture has faced considerable challenges such as a lack of irrigation systems, temperature changes, groundwater density, food scarcity and waste, and much more. The reception of distinct cognitive solutions has a significant impact on the fate of cultivating. Despite the fact that large-scale research is still underway and some applications are now on the market, the industry remains underserved. Farming is still in its infancy when it comes to dealing with real-world difficulties and solving them with autonomous decision-making and predictive solutions. Applications must be more resilient in order to explore the vast potential of AI in agriculture. Only then would it be capable of handling frequent changes in external conditions, facilitating real-time decision making, and utilising a suitable framework/platform for efficiently collecting contextual data. Another significant factor is the high expense of many cognitive farming technologies available on the market. To ensure that technology reaches the masses, solutions must become more affordable. The solutions would be more economical if they were built on an open source platform, leading in faster acceptance and higher penetration among farmers. Farmers will benefit from the technology since it will help them achieve higher yields and a more consistent seasonal harvest. Farmers in many nations, including India, rely on the monsoon for their crops. They are primarily reliant on weather forecasts from several departments, particularly for rain-fed agriculture. AI will be useful in predicting weather and other agricultural circumstances such as land quality, groundwater, crop cycle, and pest assault, among others. Most of the farmers' concerns will be alleviated by precise projection or prediction using AI technology. AI-powered sensors are extremely beneficial for extracting critical agricultural data. The information will be helpful in improving output. These sensors have a lot of potential in agriculture. Data such as soil quality, weather, and groundwater level, among other things, can be derived by agriculture scientists and used to optimise the cultivation process. In order to collect data, AI-enabled sensors can be integrated in robotic harvesting equipment. It's been suggested that AI-based advisories could help enhance productivity by 30%. The most difficult aspect of farming is crop damage caused by natural disasters, such as pest attacks. The majority of the time, farmers lose their crops owing to a lack of sufficient information. In this cyber age, technology might be beneficial to farmers in protecting their crops from cyber-attacks. Drones have been used by a number of companies to monitor production and detect insect infestations. Such operations have shown to be beneficial in the past, providing motivation to develop a system to monitor and safeguard crops. A robotic lens focuses on a tomato seedling's bright bloom. Images of the plant go into an artificial intelligence algorithm that forecasts how long it will take for the bloom to mature into a ripe tomato ready for plucking, packing, and sale in a grocery store's produce area. Nature Fresh Farms, a 20-year-old company that grows veggies on 185 acres between Ontario and Ohio, is developing and researching the technique. According to Keith Bradley, IT Manager at Nature Fresh Farms, knowing exactly how many tomatoes will be available to sell in the future makes the job of the sales team easier and directly benefits the bottom line. It's just one example of AI's impact on agriculture, which is a growing trend that will help usher in a new era in agriculture. Artificial intelligence can help humanity meet one of its greatest challenges: feeding an additional 2 billion people by 2050, despite climate change disrupting growing seasons, turning arable land into deserts, and flooding once-fertile deltas with seawater. By the middle of the century, the United Nations forecasts that we will need to raise food production by 50%. Between 1960 and 2015, agricultural productivity tripled as the world's population rose from 3 billion to 7 billion people. While herbicides, fertilisers, and machinery played a part, much of the progress was made by simply ploughing additional land—clearing forests and channelling fresh water to fields, orchards, and rice paddies. This time around, we'll have to be more resourceful. In the coming years, artificial intelligence will certainly change agriculture and the economy. Farmers have been able to comprehend numerous forms of hybrid cultivations that would produce them more cash in a shorter period of time thanks to technology. The right application of AI in agriculture will aid in the growing process as well as generate a market environment. According to data from prominent universities, there is a significant amount of food waste around the world, which may be addressed with the correct algorithms, which will not only save time and money but also lead to long-term development. Agriculture has a better chance of embracing digital transformation thanks to the use of artificial intelligence (AI). However, it all depends on a large amount of data that is difficult to collect due to the production process, which occurs only once or twice a year. Farmers, on the other hand, are adapting to the shifting landscape by applying AI to bring digital transformation to agriculture. It's just one example of AI's impact on agriculture, which is a growing trend that will help usher in a new era in agriculture. This time around, we'll have to be more resourceful.

## CONCLUSION

The agricultural industry has a number of obstacles, including a lack of appropriate irrigation systems, weeds, crop height-related issues with plant monitoring, and extreme weather conditions. However, with the help of technology, performance may be improved, and thus these issues can be resolved. It can be improved with AI-driven techniques such as remote sensors for detecting soil moisture content and GPS-assisted automated irrigation. Farmers' difficulty was that precision weeding techniques were able to offset the high amount of crops lost during the weeding procedure. These self-driving robots not only increase productivity, but they also cut the use of unneeded pesticides and herbicides. Aside from that, farmers may use drones to successfully spray pesticides and herbicides on their farms, and plant monitoring is no longer a hassle. For starters, in agriculture difficulties, man-made brain power can be used to understand resource and job shortages. In traditional tactics, a significant amount of labour was necessary to get agricultural parameters such as plant height, soil texture, and content, which necessitated manual testing, which was time-consuming. Quick and non-damaging high throughput phenotyping would be possible with the help of the various systems investigated, with the added benefit of flexible and favourable activity, on-demand access to information, and spatial goals.

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# TO DETECT RICE LEAF DISEASES USING CONVOLUTIONAL NEURAL NETWORK

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### *Abstract:*

*The rice leaves allied defects often cause risks to the continual production of rice which is affecting many peasants around the globe. Pre-diagnosis and proper remedy of the rice leavescontamination is essential in aiding healthy growth of the rice plants to assuresufficient supply and food security to the vastly growing population. Therefore, machine-driven disease systems could solve the limitations of the conventional method that is often inaccurate, time-consuming and expensive. Nowadays, computer-assisted rice leaf disease diagnosis systems are in huge demand. The yield production quality and quantity of the rice grain gets affected by many reasons such as soil fertility, temperature, pests, precipitationetc. To mitigate the mentioned problems, convolutional neural network (CNN) is used for the detection of rice leaf diseases in this work. The proposed deep-learning-based approach is known to be efficient in the automatic diagnosis of three differentiative rice leaf diseases including brown spot, rice blast, and hispa. Furthermore, the model is able to recognize a healthy rice leaf with an accuracy of 99.8%. The results demonstrates that this model offers a high-yielding rice leaf infection recognition method that could determine the most common rice diseases precisely in real-time applications.*

***Keywords:*** *Rice leaf diseases, CNN, Deep Learning, Image recognition*

## INTRODUCTION

Convolutional neural network (CNN), a class of artificial neural networks that has become dominant in various computer vision tasks, is attracting interest across a variety of domains, including radiology. CNN is designed to automatically and adaptively learn spatial hierarchies of features through backpropagation by using multiple building blocks, such as convolution layers, pooling layers, and fully connected layers. This review article offers a perspective on the basic concepts of CNN and its application in the field of agriculture, and discusses its challenges and future directions in the field of diagnosis related to rice leaf diseases. Rice is amongst the highly consumed food in the globe with the total consumption of 493.13 million metric tons in 2019–2020 and 486.62 in the year 2018–2019 [1]. This has shown a rise in the production of rice when compared with the metric tons consumed for many years. However, lack of proper monitoring or absence of farmland often resulted in the destruction of a large amount of rice creating various diseases related problems. Several diseases frequently occur in the cultivation of rice which is the primary reason for major economic losses. Moreover, the plentiful utilization of chemicals, for example, bactericides, fungicides, and nematicides have created bad effects in the agro-ecosystem to oppose plant diseases [2]. Rice diseases are presented in leaves, which can be directed by leaf diagnosis [3] [4], it is worth noting that to date, a substantial progress has been made in the detection of plant diseases through the leaf features [5] [6] [7].

## DETECTING RICE LEAF DISEASE USING CNN

Fig. 1 shows the complete architecture of the proposed work. The data of this project comes from Kaggle.com. With data of infected rice leaf, we can build a CNN model and train the model with image to describe whether a leaf is infected or no.

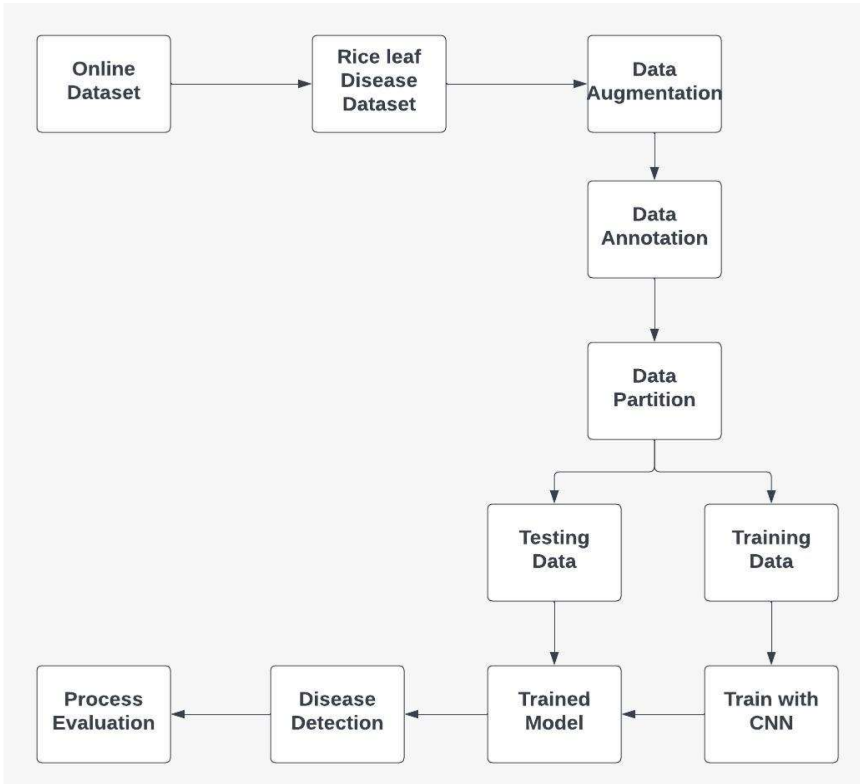


**Fig 1.** Complete Architecture of the Proposed Work

Now we normalize the data matrix, the range of a PGB pixel is (0,255) so divide by 255 is OK to let values in range of (0,1). Then shuffle and split data to train and test with sklearn.model_selection.train_test_split(). Keras is a powerful python library to set up neural network models. The model set is similar to VGG with fewer parameters and layers. The model has about 50000 parameters. The model receives an accuracy of about 99.8% on the test set. The user input his image for rice disease prediction, and stores it on the database and then predicts the output of the given image using the pretrained model and gives it to the html scripts. The html scripts then render the output on the screen of the web application. The user should have a stable internet connection and be able to upload the image on the web application. The web application can be accessed using any of the modern web browsers. The user can only input images in the web application of types .jpg, .jpeg, .png if the user tries to input images of some other types, then that might not work.


after prediction

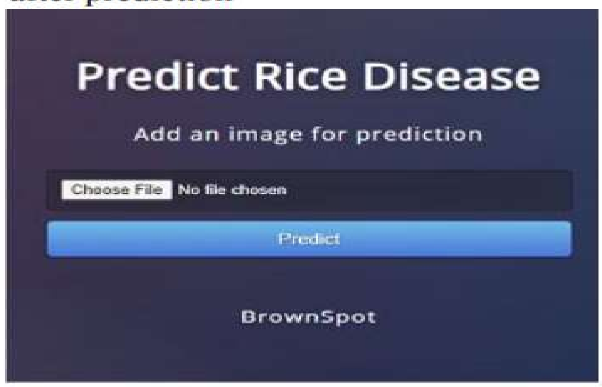


**Fig 2.** Web Application Interface before and after predicting Rice Leaf Diseases

Fig. 2 demonstrates the web application interface before and after predicting rice leaf diseases.

## CHALLENGES AND LIMITATIONS

Although the proposed workoutlinesrelated rice leaf diseases detection techniques, some of the limitations are also recognized. Certain drawbacks of this study with the prospective measures to address these challenges are as follows:

- The interface captures the whole image, and not in just one go but consecutively focus on part of the image. Thus, the algorithm needs many passes to extract all objects using a single image which is time-consuming. To mitigate this issue, a network should be advisable which can extract objects of an image in one pass.
- Since numerous procedures are dependent on each other, the performance of the further system depends on the previous system performed. Thus, a model should be trained carefully with proper datasets to achieve an optimal result.

## CONCLUSION

This paper presents a real-time rice leaf disease diagnosis framework based on the CNN technique. The rice leaf infected image database contains healthy leaf and three diseases, including brown spot, rice blast and hispa. In order to improve the accuracy of the proposed system, our own captured rice leaf image is integrated with a publicly available online database. The obtained results of the proposed work are very motivating to treat various types of infected leaves. Therefore, further study should be carried out to implement a dynamic and automatic system to identify large-scale rice leaf diseases in a real-field. This method could be made up of a mobile terminal processor and agricultural Internet of Things that may be a favourable approach to modernize the agricultural industry.

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# MORPHOLOGICAL FEATURE EXTRACTION OF WHEAT GRAINS USING PYTHON AND OPENCV IMAGE PROCESSING TECHNIQUES

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***Abstract***:
*Machine vision techniques has been proved effectiveto utilize morphological featureslike size, color, shape and surface texture from digital scanned images to describethe agricultural produce. In the present study, a computer algorithm was developed to classify the engineering characteristics like size and shape of the wheat grains of variety Unnat PBW 343. Different size and shape features such as "minimum bounding rectangle (MBR)", "perimeter(P)", "area(A)", "solidity", "major diameter(M)","minor diameter (m)", were extracted. The acquisition of wheat kernels images were taken with a flatbed scanner and the computer algorithm for image processing was developed using "open-source""Python"computer language and "OpenCV library" to extract "size" and "shape" for each kernel. The parameters expressing the axial dimensions such as average major diameter, average minor diameter, average projected area and average perimeter for all kernels varied from 58.098±2.27 pixels, 26.488±1.42 pixels, 1196.665±91.18 pixels and 144.084±5.09 pixels respectively. The bounding rectangle to perimeter andbounding rectangle fill depicted that image area may be considered as bulging out type shape without any indent (convex geometry as a rectangle). The calibrated areas cannot be assumed as square as reflected from compactness values for the kernels. The elongation of kernels varies between 0.374±0.02 depicting the shape as more elliptical than sphere. The ratio of the kernel area by counting pixels to area by MBR fill was found to be 0.750±0.02 showing image acquisition effectiveness and processing. Therefore, apart from size, shape features can also be used to provide useful information obtained from image processing. These which can utilize distinct deep and machine learning algorithms to properly classify these kernels for accurate identification of kernel conditions.*

***Keywords:*** *digital image processing; wheat; size; shape; morphological properties*

## INTRODUCTION

Wheat is a worldwide staple food widely cultivated for its seeds. The quality and hygiene of raw and processed food from wheat is of primary concern for ensuring fit for humans. The physical characteristics like size, shape, color and texture are vital parameter in assessing the food quality. A skilled person is also find big difficulty in assessing food quality. The training of the evaluators are also very challenging. Also, the time required for food evaluation for quality purposes is comparatively higher, thus creates hindrances in large-scale evaluation and quick decision making. Lot of research is being carried out for finding grain varietal dissimilarities using "machine vision systems" based on kernel size, color, texture and shape. The methodology for classification of kernels like oats, wheatand rye based on color and texture parameters was given to separate seeds [1]. Based on CVS, aquick estimation of head rice yield was conducted [2,3]. The uppermost area of bran layer on rice surface was estimated using "digital image analysis" [4]. Some other studies have also showed different methods for classification of food objects as different grades based on variations in kernel shape and size [5]. The SVM classifier was used for classification of rice kernels into different grades using variations in size and its ratio of individual seeds [6]. The whole and broken fractions in rice, wheat, soybeans and corn were also identified using "image processing" [7,8,9,10]. A simple, rapid and accurate method was developed for identification of head rice and brokens using digital image processing [11]. Therefore, machine vision technology (MVT) has immense potential to use characteristics like size, shape, color and texture attributes from digital images to characterize the agricultural produce. The current study is based on extracting quantifiable information on size and shape of selected wheat grains from the acquired digital images.

## MATERIALS AND METHODS

One hundred kernels of wheat varietyUnnat PBW 343 were collected from Punjab Agricultural University, Ludhiana experimental fields.

a) **Set up for image acquisition system:** The CCD 6-line color flat bed scanner model "Cannon scan 5600F" white fluorescent source light source was used. The images were scanned at 24-bit color format at 200 dots per inch (dpi) resolutionwith optical resolution of 4800*9600 dpi and 1.8-58.4 msec/line of scanning speed. The shadow effect was nullifies using black background and give more contrast to wheat kernels.

b) **Image Processing Software:** The Python language and OpenCV library was used to develop computer algorithm to extract size and shape parameters for each kernel. Python language was selected because it is freely available, open source, and is platform independent. The scanned image was converted into three "8-bit" "grayscale" images i.e., "blue", "green" and "red" bands. A filter of size 5x5 kernel was applied for removing small noises in the image, the algorithm for thresholding of "binary" and "triangle" was applied to perform the background segmentation using "opencv" threshold function [12] to segment the desired object from background image. After this, using a "mask" and "bitwise" operationwas applied over all the other pixels that do not lie in our described range of pixels. Later, using OpenCV CHAIN_APPROX_NONE function, detection of edges of each kernel was accomplished by detecting each contours for binary image of grainand stores all boundary points. The size, shape, color and texture features were extracted from each contour(cnt) and the whole data was saved in csv/html file. The ferret diameter (also called minimum bounding rectangle) is the minimum rectangle with the smallest area which encloses desired contourof each contour was determined. The “Python” programming language along with the “OpenCV4”, “Numpy”, “Scikit-Image” and “Scipy” scientific computing libraries were used in development of the computer algorithm [13]. OpenCV image processing library [14,15] was used for reading and pre-processing of images.

## RESULTS AND DISCUSSION

The size and shape features from the selected kernels has been estimated using the “python” software. A list of extracted features using “OpenCV” library has been given in Table 1.

Table 1. Size and shape features extracted from images using OpenCV library function

| **Extracted feature** | **Function used [12,14]** |
|---|---|
| Minimum bounding rectangle | cv2.boundingRect(cnt) |
| Area(A) | cv2.contourArea |
| Perimeter(P) | cv2.arcLength(cnt, True) |
| Solidity | cv2.contourArea / float(hull_area) |
| Eccentricity, Minor diameter (m), Major diameter(M) | cv2.fitEllipse(cnt) |

The cv2” commandwas used to load all the functions in the library. The image based feature extraction flow diagram is given in Figure 1. A total of one hundred segmented images were extracted using thresholding method (Figure 2).

Table 2. Size and shape derived features from image analysis

| **Derived Feature** | **Equation used [15,16]** |
|---|---|
| Boundary rectangle fill (Extent) | $\frac{\text{Pixel count}}{(\text{height} * \text{width})}$ |
| Bounding rectangle to perimeter | $\frac{\text{Perimeter}}{2 * (\text{height} + \text{width})}$ |
| Equivalent diameter (Feret diameter) | $2\sqrt{\frac{A}{\pi}}$ |
| Circulation factor | P/ $\pi$ |
| Compactness | $\frac{4\pi A}{P^2}$ |
| Elongation | $\frac{M-m}{M+m}$ |
| Aspect ratio | L/B |

## SIZE AND SHAPE ESTIMATION

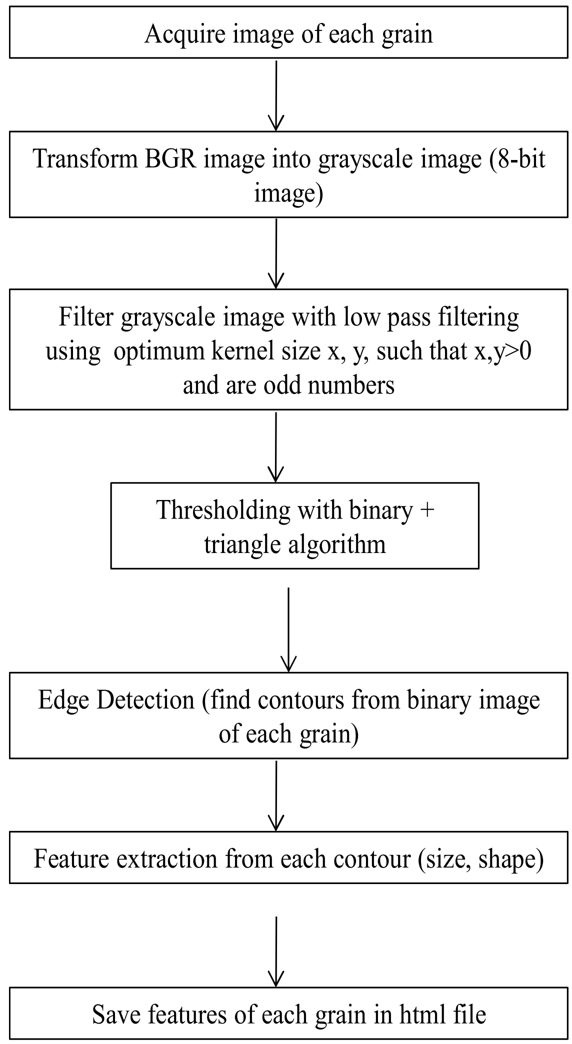



Fig. 1. Flow diagram for features extraction from acquired images

A total of one hundred wheat grainsselected based on its visual appearancehaving different sizes were chosen from a given lot. The shape of the selected kernels and its size has been computed using the open-source Python software. The parameters relating the size and shape of the object were broadly selected to describe the geometric make up of the kernels. The features like “minimum bounding rectangle (MBR)”, “area(A)”, “perimeter(P)”, “solidity”, “minor diameter (m)”, “major diameter(M)” were estimated from the image analysis[15]. These features were extracted using different functions available in “OpenCV library” (Table 1). The derived features from the image analysis is given in Table 2.

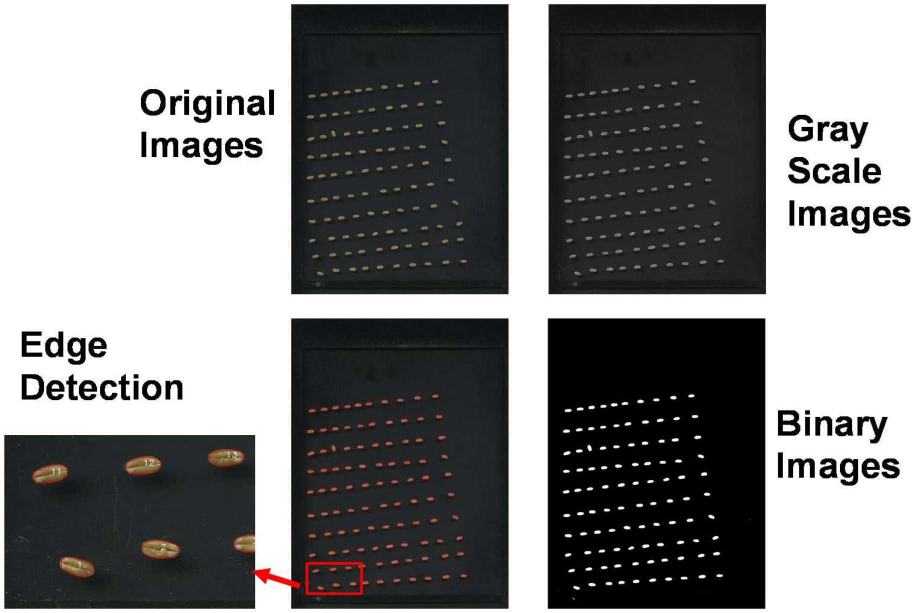
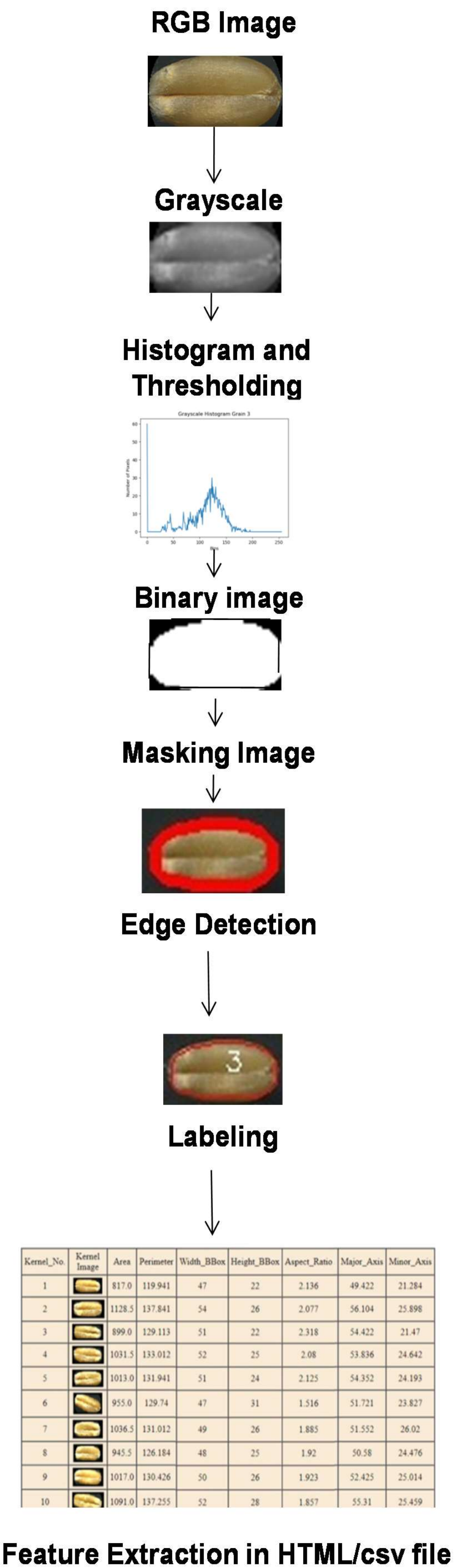



Fig. 2. Edge detection steps for feature detection

## Size and shape characteristics

The schematic diagram of overall features extraction steps from acquired images is shown in Figure 3. The important parameters describing the shape and size of the kernels through its image are presented in Table 3. The different physical properties like "major diameter, minor diameter, area, perimeter, bounding rectangle fill, bounding rectangle to perimeter, feret diameter, circulation factor, compactness, elongation, aspect ratio and minimum boundary rectangle fill"etc. were extracted using "OPENCV" library and "python" image processing software. The parameters expressing the axial dimensions such as average major diameter, average minor diameter, average projected area and average perimeter for 100 wheat kernels varied as 58.098±2.27 pixels, 26.488±1.42 pixels, 1196.665±91.18 pixels and 144.084±5.09 pixels respectively. The values of standard deviation for all parameters are also given in Table 3. The standard deviation was calculated in "Microsoft Excel 2019" software.

The "bounding rectangle to perimeter" and"bounding rectangle fill"depicted that image area may be considered as expanded type shape with similarity to "rectangle". The "compactness" values for the grains lie in the range of 0.724±0.02, therefore so the calibrated areas cannot be presumed as square. The "elongation" parameter of wheat grains varies between 0.374±0.02 suggesting elliptical shape. The ratio of the area evaluated by counting the pixels in the image to area of "MBR fill" was obtained to be 0.750±0.02 indicating the effectiveness in processing of image and its acquisition (Table 3). Therefore, apart from size, shape features can also be used to provide useful information obtained from image processing.




| Kernel_No. | Kernel Image | Area | Perimeter | Width_BBox | Height_BBox | Aspect_Ratio | Major_Axis | Minor_Axis |
|---|---|---|---|---|---|---|---|---|
| 1 | | 817.0 | 119.941 | 47 | 22 | 2.136 | 49.422 | 21.284 |
| 2 | | 1128.5 | 137.841 | 54 | 26 | 2.077 | 56.104 | 25.898 |
| 3 | | 899.0 | 129.113 | 51 | 22 | 2.318 | 54.422 | 21.47 |
| 4 | | 1031.5 | 133.012 | 52 | 25 | 2.08 | 53.836 | 24.642 |
| 5 | | 1013.0 | 131.941 | 51 | 24 | 2.125 | 54.352 | 24.193 |
| 6 | | 955.0 | 129.74 | 47 | 31 | 1.516 | 51.721 | 23.827 |
| 7 | | 1036.5 | 131.012 | 49 | 26 | 1.885 | 51.552 | 26.02 |
| 8 | | 945.5 | 126.184 | 48 | 25 | 1.92 | 50.58 | 24.476 |
| 9 | | 1017.0 | 130.426 | 50 | 26 | 1.923 | 52.425 | 25.014 |
| 10 | | 1091.0 | 137.255 | 52 | 28 | 1.857 | 55.31 | 25.459 |

Fig. 3. Schematic diagram of overall features extraction steps from acquired images

Table 3. Average mathematical values of morphological features extracted from wheat kernel images (n=100)

| Characteristics | Average mathematical values |
|---|---|
| Area ($px^2$) | 1196.665±91.18 |
| Perimeter ($px^2$) | 144.084±5.09 |
| Solidity | 0.977±0.00 |
| Major diameter ($px^2$) | 58.098±2.27 |
| Minor diameter ($px^2$) | 26.488±1.42 |
| Boundary rectangle fill | 0.750±0.02 |
| Bounding rectangle to perimeter | 0.852±0.01 |
| Feret diameter | 39.007±1.49 |
| Circulation factor | 45.863±1.62 |
| Compactness | 0.724±0.02 |
| Elongation | 0.374±0.02 |
| Aspect ratio | 1.982±0.14 |
| MBR fill | 0.750±0.02 |

## CONCLUSION

Machine vision image processing techniqueswereused to extract size and shape parameters of wheat grains of variety Unnat PBW 343 with the help of a flatbed scanner. The open-source Python imageprocessing software was used to obtain their size and shape features such as Area ($px^2$), Perimeter ($px^2$), Solidity, Major diameter ($px^2$), Minor diameter ($px^2$), Boundary rectangle fill, Bounding rectangle to perimeter, Feret diameter, Circulation factor, Compactness, Elongation, Aspect ratio and MBR fill. The parameters expressing the axial dimensions such as average major diameter, average minor diameter, average projected area and average perimeter for all kernels varied from 58.098±2.27pixels, 26.488±1.42pixels, 1196.665±91.18pixels and 144.084±5.09pixels respectively. The "bounding rectangle fill" and ratio of bounding rectangle and perimeter indicate that the calibrated area of the image may be considered as out expandedtype shape with similarity to "rectangle" by 0.750±0.02. The "compactness" values for the grainslie in the range of 0.724±0.02, therefore so the calibrated areas cannot be presumedas square. The "elongation" parameter of wheat grainsvaries between 0.374±0.02suggesting elliptical shape. The ratio of the area evaluated by counting the pixels in the image to area of "MBR fill" was obtainedto be 0.750±0.02indicating the effectiveness in processing of image and its acquisition (Table 3). Therefore, apart from size, shape features can also be used to provide useful information obtained from image processing. These which can utilizedistinctdeep and machine learning algorithms to properly classify these kernels for accurate identification of kernel conditions.

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# SMART VIDEO SURVEILLANCE FOR AUTOMATIC DETECTION OF AGRICULTURAL BURNING

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## *Abstract*:

*For the past several years, agriculture is the foundation of every economy's long-term viability. Traditional agriculture practices employed by farmers are insufficient to meet the increasing demand due to rapidly growing population all over the world. As a result, artificial intelligence technology has been introduced to automate the farming so as to minimize human labor and enhance agricultural profit. Moreover, with the modernization in the agricultural sector, farmers are taking certain unfavorable actions that harm the ecosystem. Agricultural land fires have also been related to a wide range of adverse consequences for ecosystem, rural livelihoods, as well as the farming industry. Therefore it is very necessary to automatically detect the agricultural burning and give alerts to the related authority. The study's main goal has been to look at the significance of artificial intelligence in agriculture. The current study also reveals the adverse impact of agricultural land fires. The literature review highlights the techniques introduced by numerous researchers to automatically detect burning location. The key properties of AI in agriculture, as well as its application areas, have also been discussed. Finally, the article addresses the report's ultimate conclusion.*

***Keywords:*** *Artificial intelligence, land fire, computer vision.*

## INTRODUCTION

Although economic growth has generally contributed to poverty reduction, but the development of diverse sectors has been also important with agricultural productivity growth. [1]. Agriculture is the primary occupation throughout several nations all across the globe. In the past few years, the agricultural industry has seen a significant impact due to technological advancements [2]. With the emergence of modern technologies in this digital era, the humans have expanded the limits of our thinking processes and are attempting to merge a natural brain with an artificial one. This on-going research spawned a brand-new area called Artificial Intelligence. It is the process by which a human can build a machine that is much smarter than the average person.

### Present Scenario of Agriculture

Agriculture productivity increased rapidly as a result of technical developments in this area.

Artificial intelligence is one of the most essential tool for improving crop productivity and other agricultural activities.

**AI in agriculture:** Owing to AI, today's agriculture system has advanced to a new level. AI protects the agriculture sector against a variety of threats, including climatic changes, labor shortages and fire safety of agriculture structures. Artificial intelligence is a key tool for improving the smart agriculture model. The technology has also played a major role towards the global agricultural revolution. The versatility, improved performance, precision, and significant cost are the four pillars of AI in agriculture. The artificial intelligence in agriculture not only assists farmers in automating their farming, but also moves to precision cultivation for increased crop yield and quality without utilizing much facilities[3]. In precision agriculture, artificial intelligence (AI) is utilized to improve harvest quality and accuracy. In the 1980s, research into the application of AI in fire mitigation and monitoring began [4].

**Agriculture Land Fire:** Crop residue burning (CRB), is the primary threat for the precision agriculture. However, burning agricultural leftovers in fields is a common farm management practice all around the world. Meanwhile, this is a substantial source of greenhouse gases and particle emissions, such as CO2, CH4, black carbon, PM10, and PM2.5, which have a considerable and harmful impact on local and regional air quality and human health. According to the Tribune news service, nearly every post-wheat season, approximately 7,000 to 10,000 farm fires are reported within Punjab, also the number increasing progressively from late April to mid-May. In an incident, wheat crops on approximately 20 acres and stubble on ten acres were destroyed in an unintentional fire in April 2022 Fig.1(a). Another incident occurred in the Gurdaspur area of Punjab, where a school bus carrying 32 children caught fire, apparently owing to agricultural fire Fig. 1(b) in May 2022. The bus became burned by flames in the field, as well as heavy wind gusts.

(a)

(b)

**Fig.** Examples of Agriculture Fire incidents: a) Wheat crop destroyed in an unintentional Fire. b) School bus caught agriculture Fire.

## LITERATURE SURVEY

Agricultural burning detection research may be classified into three main categories: i) sensor deployment, ii) computer vision, and iii) satellite data in the form of images and other factors.

In recent years, WSN technology has advanced to the extent that it may now be used for early fire detection. The author in [5] investigated several range-based and range-free localization methodologies and assessment methods using wireless sensor nodes. Further an author [6] proposed a technique based on similar technology, in which the author established a mesh network of sensors equipped with internet protocol (IP) cameras, which transmitted an alert signal to the sink when a fire was detected somewhere at start. The sink then sends a message to the nearest camera to turn it on and acquire real fire photos, avoiding false alarms. Due of its limited power, storage, and buffer, the system suffers from the bottleneck of transferring information across a wireless sensor network. To monitor forest fires, [7] designed a wireless sensor network with GPRS capability. The system gathered real-time data on smoke, temperature, humidity, and a few other environmental parameters, which were sent in a multihop fashion to the central node and then to the monitoring centre, where reports, graphs, and curves were generated to assist firefighters in making the best decision possible. [8] presented a two-network approach for distant fire detection, in which one network collects information from sensors and the second network uses sensor network data to inform farmers in a timely manner. Using Multisim, the author successfully simulated a system for detecting fire in agricultural areas. Heat is sensed predominantly in smoking fires, whereas temperature is recognised mostly in flaming fires, and the suggested technique seems to be more efficient at identifying flame fires.

It is commonly known that satellite remote sensing has become the sole effective means for the surveillance of large-scale fires [9]. One of the primary topics investigated by researchers is the utilization of aerial surveillance and other metrics gathered from various satellites. For the past 20 years, it has been utilized to precisely record and monitor fires throughout the world [10][11][12][13]. Active fire monitoring has been carried out using a variety of high-resolution and moderate-resolution satellite instruments. NASA's FIRMS, MODIS [14], ISRO's Geoportal - Bhuvan[15], and other key remote sensing agencies in the nation provide a wide range of products for researchers' usages. Such products offer a wide range of detecting capabilities, but they also have some significant drawbacks since their optical and radiometric specs were not designed for the fire detection [16]. The Moderate Resolution Imaging Spectroradiometer (MODIS) in the National Aeronautics and Space Administration (NASA) Earth Observing System (EOS) Terra and Aqua satellites has greatly increased the capacity to spot fire from space [17]. As a result, MODIS has become a vital tool for monitoring agricultural land fires across the world. Its data packages are designed to monitor active fires multiple times a day under cloudless circumstances. Accordingly, long-term satellite remote sensing data may be utilized to design and create prediction models with higher accuracy. According to the author in [18], a three-year analysis of MODIS Terra fire data from 2001 to 2003 shows that fire is widely utilized in agricultural activities across the world and is a prominent element of worldwide fires (8–11%). Cropland fires are common in Russia, Ukraine, India, and China, which account for more than 40% of all agricultural fires worldwide. Another related study [19] of satellite data from 2001 to 2004 reported that agricultural fire contributed for an average of 16 percent of annual fire activity in the southeastern United States. For detection, the author had used 1 km MODIS TERRA Active Fire Product (MOD 14). The article [20] used satellite pictures to test the notion of spatial outlier identification to identify fire locations. The applicability of this technique was evaluated using the Scatter plot and Moran's scatter plot, and the findings were compared to the MODIS fire product given by NASA MODIS Science Team. Moreover, the author [21] evaluated data from the Indian Remote Sensing Satellite (IRS-P6) Advanced Wide Field Sensor (AWiFS) during the months of May to October 2005 to determine the level of greenhouse gas (GHG) emissions from stubble burning in Punjab. The authors then compared their findings to emission factors proposed by [22][23][24] in the literature for calculating emissions. As a consequence, they discovered that paddy crop residue burning emits more emissions than wheat crop residue burning in Punjab.

During a catastrophic fire outbreak in north-central Alberta, [25] utilized satellite pictures and a multispectral approach that utilised AVHRR's channels 3 and 4 to locate flames and estimate fire magnitude. Similarly, [26] used thermal information given by the IARI Satellite Ground Station during the Kharif crop harvesting period (October-November) 2018 from three separate sensors to monitor and map the real-time active fire sites of three states.

Due to an increase in the agricultural fire incidents in recent decades, numerous researches have focused on video processing to detect fire, notably using AI and convolutional neural networks. The precision as well as effectiveness of sensors to detect fires is presently dependent on the proximity between the fire and the sensors [27][28][29][30]. A misleading result may be obtained if the threshold frequency is exceeded [31]. This problem has been partially solved by AI approaches that make it easier to identify fires at long distances. Consequently, the author [32] suggested a 9-layer convolutional neural network for detecting video fires and smoke. To identify fire and smoke in a video frame, a sliding window of size 12 x 12 was applied to the last feature map created by the network to increase classification time. The suggested system, on the other hand, could only identify red-fire and had little issues with smoke detection. In a similar vein, the author [33] uses deep learning algorithms and IoT sensors to construct a framework for precise and real-time identification of active fire spots in agriculture activities.

## SUMMARY

Agriculture is a significant contributor to the global economy. Agriculture has the potential to eradicate poverty worldwide, particularly those who live in rural areas and work primarily in agriculture. However, sustainable farming will benefit from technological advancements and innovation, which will increase profitability and production. But the fire is commonly used nowadays in agricultural activities around the world to burn crop leftovers during harvesting, prepare fields for sowing, and manage pests as a rapid, effective, and labour-saving way. Burning biomass from forest regions and agricultural crop leftovers may release significant volumes of particulate matter and other harmful emissions into the environment. A school bus and a crop were both burned and totally damaged by an agriculture fire, according to occurrences addressed in the research. After an analysis of several artificial intelligence-based, satellite-based, wireless sensors, optical,

and thermal camera systems for fire detection/monitoring, present review conclude that every technology has its own set of advantages and disadvantages. The present article also examined the limitations in agriculture fire detection utilising deep learning and unmanned aerial vehicles, as there have been relatively few studies carried out in the area.

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# DEEP LEARNING APPROACH IN SMART AGRICULTURE: A REVIEW

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***Abstract**:*

*Deep Learning (DL) is a branch of machine learning (ML) comprises of numerous algorithms such as Convolutional Neural networks (CNN), Recurrent Neural Networks (RNN), Generative Adversarial Networks (GAN) applied in number of fields as well as in the sector of agriculture. It is the need of the hour world-wide to switch the traditional way of agriculture to smart and automate the agriculture in terms of scaling down the unnecessary expenditure and enhance the quality of agricultural products. This article gives a terse view of various DL algorithms to better understand the fundamental concept of the algorithms, architecture, and limitations. Further, to get familiar with the applications of DL in smart agriculture, expected to swiftly understand the scope of implementation of DL in the real-life scenario of agriculture. In the recent period time, numerous DL frameworks have been used and applied in multiple disciplines, analysis of the most commonly used frameworks based on their network structure, variants and, applications such as TensorFlow, Caffe and PyTorch. Thus, the software frameworks can be used more effectively in the agriculture.*

***Keywords:*** *Deep Learning, Smart Agriculture, Artificial Intelligence, Neural Network, Convolutional Neural Network, Image Processing. DL Frameworks.*

## 1 INTRODUCTION

Deep learning is a collection of techniques from **artificial neural network** (**ANN**), which is a branch of machine learning. ANNs are modelled on the human brain; there are nodes linked to each other that pass information to each other [1]. Depending on the nature of the problem and neuron topology, proposed neural network consists of multiple level of processing layer to obtain the higher level of abstraction and how accurately credits to be assigned throughout the lower level to higher level. The artificial neuron is basic building block compute the summation of assigned credits and proposed activation function performed; activation function decides whether the perceptron to be fired or not. There are mainly three important reasons for the booming of deep learning today: the dramatically increased chip processing abilities (e.g. GPU units), the significantly lowered cost of computing hardware, and the considerable advances in the machine learning algorithms [2].

In the recent years, DL has gathered extensive attention due to great level of improvements in neural network structures. Recent advances, Self-Attention and Transformer Architecture notably used in the fields of Natural Language Processing (NLP) [3] and Computer Vision (CV) [4]. Transformers introduced in 2017 by Google Brain. A significant development in deep learning, especially when it comes to sequential processing, is the use of multiplicative interactions, particularly in the form of soft attention[5].

Generally DL algorithms, it can be divided into three categories to the basic method they are derived from: Convolutional Neural Network (CNN), Recurrent Neural Network (RNNs), and Generative Adversarial (GANs), described in the section 2 as well as scope, and limitations of these algorithms. In section 3, numerous applications of the deep learning where it can be applied into the real-life scenario will be discussed. Later advancements, in the DL models remove the obstacles and has drawn the attention of researcher's into the sector of agriculture likewise: robotic, mechanized agro industry and smart agriculture on small scale too. Section 4, include the description of frameworks most widely used by the researchers and professionals.

## 2 DEEP LEARNING ALGORITHMS

Broadly, here DL algorithms classified into three categories: Convolutional Neural Network (CNN)[6], Recurrent Neural Network (RNNs)[7], and Generative Adversarial (GANs)[8]. Figure 1 shown the broad view of algorithms along with sub-categories classified as following

Variants of DL algorithms

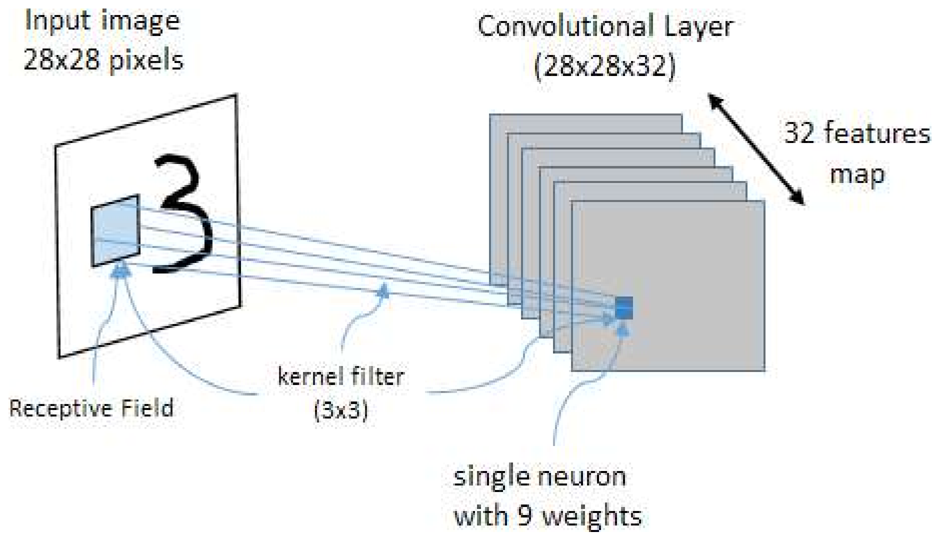
| CNNs | RNNs | GANs |
|---|---|---|
| LeNets | LSTMs | DCGANs |
| AlexNet | GRU | cGAN |
| VGG | | WGAN |
| GoogleNet | | |

Table. 1: Variants of DL Algorithms

***Convolutional Neural Networks (CNNs),*** In the recent years, CNN deep learning algorithm notably used by the researchers in various disciplines composed of multiple layers, pooling layers and fully connected layers which has resulted into many breakthroughs in speech recognition, face recognition, natural language processing, computer vision and so on[9]. The architecture of the CNN consists of broad two phases, first one consists of convolutional layers and pooling layers called feature extraction namely feature map, on the other hand second layer consists fully connected layers called classifier. There are many sub-categories of CNNs algorithms such as LeNets [10], AlexNet [11], VGG [12] and GoggelNet[13]. It is out of scope to summarize all of them in this paper.

*Convolutional layer:* Assume image (2-demensional 28*28) as input I and thirty two convolution kernels or filters K. The convolution kernel size is belong to each convolutional layer is h*w (3*3) and threshold of each convolutional layer is b. In convolutional layer each neuron connected to the certain region of input area of the image called *receptive field*. To effectively recognize an image, we need various different kernel filters to be applied to the same receptive field because each filter should recognize images from a different feature. The set of neurons that identifies the same feature defines a single **feature map** [1]**.** The process of convolution shown in the Figure 2.

At each convolutional layer number of convolutional kenel determines the number of features map and output. The convolutional layers in the cascaded form as input to the fully connected layer. To order to obtain the information from edge of image zero padding is used by applyindg zero in teh border input vector. Stride plays vital role in computing the convolution to turned and compress the images [14].




*Pooling Layer:* The pooling layer performs the function of compression of input data size. Therefore, it converting the sub-matrix of input data to specific value. The pooling applied alternatively after each convolutional layer to pool the feature extracted data in the compressed form. In pooling duo hyper-parameters required: Spatial *f* and Stride *s*. The pooling layer input is W*H*D, and output volume id $W_{-pooling}$* $H_{\_pooling}$ * $D_{\_pooling}$[14]. The main equations are listed below

$W_{\_pooling} = (W-f)/S+1$ (a)

$H_{\_pooling} = (H-f))/s+1$ (b)

$D_{\_pooling} = D$ (c)

*Fully Connected Layer:* The fully connected layer performed the same function as standard DNNs does, neurons of two adjacent layer connected to each other as nature of bipartite graph. The previous layer facilitate the fully connected the feature extracted as an input to overcome the need large computation complexities. The fully connected layer holds the neuron with are directed connected by convolutional layer. The classification done at this layer to obtain the desired outcomes. The softmax activation function applied on the outer layer to perform probability distribution to excel the efficiency of the neural network mode. The Figure.3 shown the architecture and data flow of the CNNs:

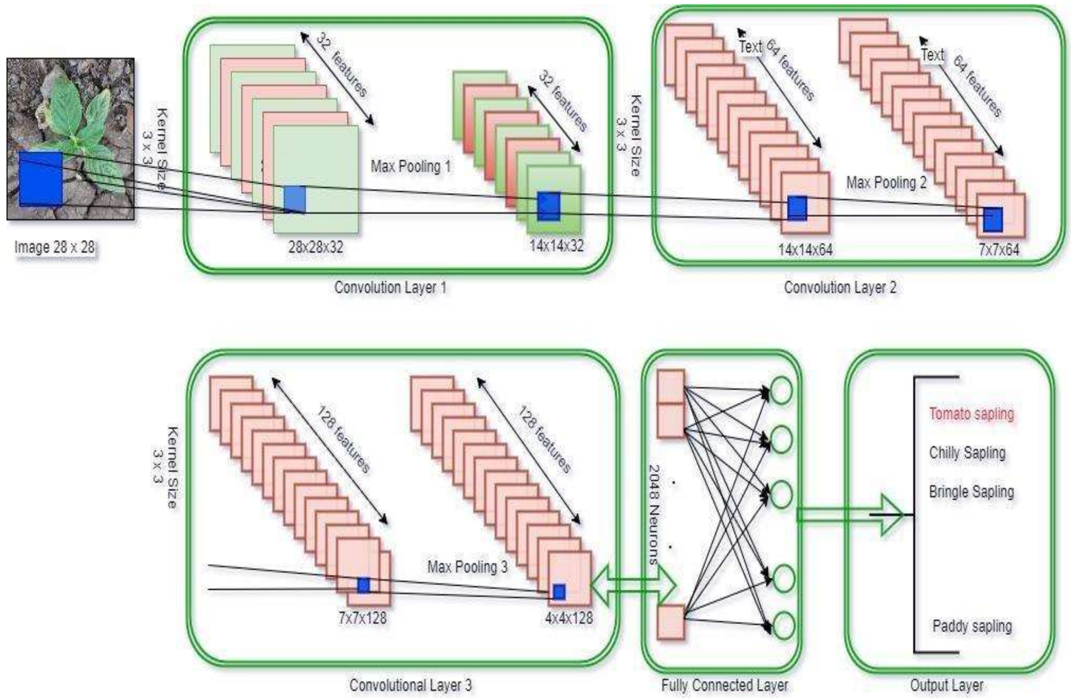



Figure. 2: Architecture and Data flow of CNNs.

CNNs is shining feather of cap of DL, in recent year's gives remarkable performance to mimic the human neuron system. MINIST, Microsoft COCO, Google OID, and especially ImageNet are signifying dataset applied on CNNs architecture in Image recognition, Computer Vision, face recognition and natural processing language (NLP) for training and test purpose. CNNs face limitations while usual tilt or rotation in the images while classification, on the other hand stride is common practice in the convolution layer which may trigger the problem of dismantle in the feature extraction crucial information. Nevertheless, people talking about the new emerging networks such as CapNets designed to overcome the limitations of the standard CNNs [15].

### 2.1 Recurrent Neural Networks:

RNNs belongs to the class of ANN, mines the information of past and current time period to mimic as human behavior use persisted long and short past memory information to make decisions. RNNs has model predictive networks to predict the information with high temporal dependencies. The persistence of information in the set of internal states of neural network with use of loops. In layman language, suppose X visits distinct places on different days of week, if Y stores the information and use stored past information to predict the next place to be visited by X. Figure.4 shown the unrolled representation of RNNs neural network:

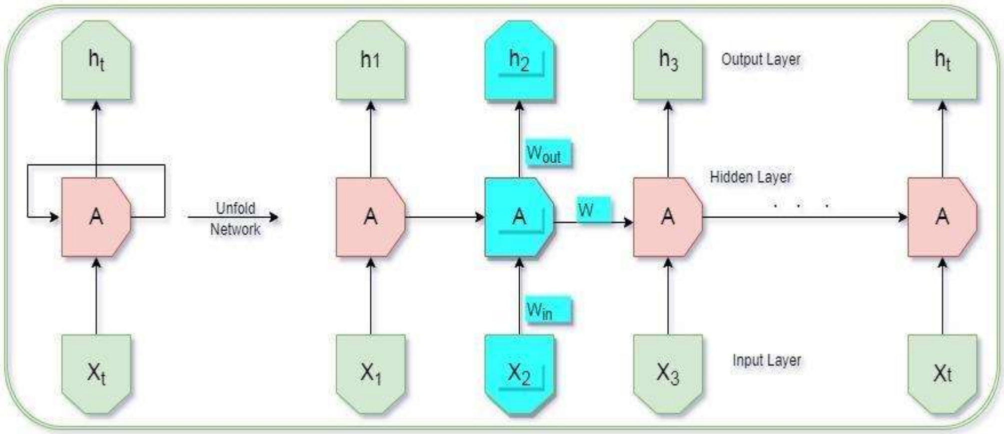



Figure. 3. An unrolled architecture of RNNs.

RNN is used because it is more efficient than the others for speech recognition, natural language processing and time series analysis [16]. In RNNs neural network Figure.4, output ($h_t$) obtained in two segments as following equations (a) and (b) at particular period of time e.g. using current day trend of stock market:

$$A(t) = X(t) \times W_{in} \quad \text{(a)}$$

$$h(t) = A(t) \times W_{out} \quad \text{(b)}$$

Or

$$h(t) = ((X(t) \times W_{in}) \times W_{out})$$

Therefore, it is better idea if pattern of last multiple week's and months' worth data to be used. The temporal shared learned weights W (hidden layer) to be used in addition to $W_{in}$ (input layer) and $W_{out}$ (output layer) at each period of time *t*. Neuron network connected in the form of directed graph. The following equations (c) formulations for algorithm:

$$h(t) = ((X(t) \times W_{in}) \times W_{out}) + W \times X(t-1) \quad \text{(C)}$$

Regular RNNs handle the short gap temporal to predict the next data element on the other hand larger temporal gap arose the barrier as vanishing and explode gradient over here. This is serious limitation of the RNNs algorithms [1]. Thus, LSTM [17], and GRU[18] overcome drawbacks of the regular RNNs algorithm.

***2.2 Generative Adversarial Networks:*** GANs neural network fathered by Ian Goodfellow, in 2014. It is an unsupervised algorithm comprises of two neural network as a discriminator (similar to binary classifier) and generative, simultaneously[1]. It use the set of noise to learn the distribution of real data and to generate new data. The generative part considered as a de-convolutional neural network and discrimination as a convolutional neural network. Analogy is like, generator as someone publish fictitious money and discriminator as police identifies it is fake. On the behalf of discriminator's feedback generator keeps improving the quality of money until discriminator fails to differentiate real and fake data. The following Figure.5 shown the architecture of GANs:

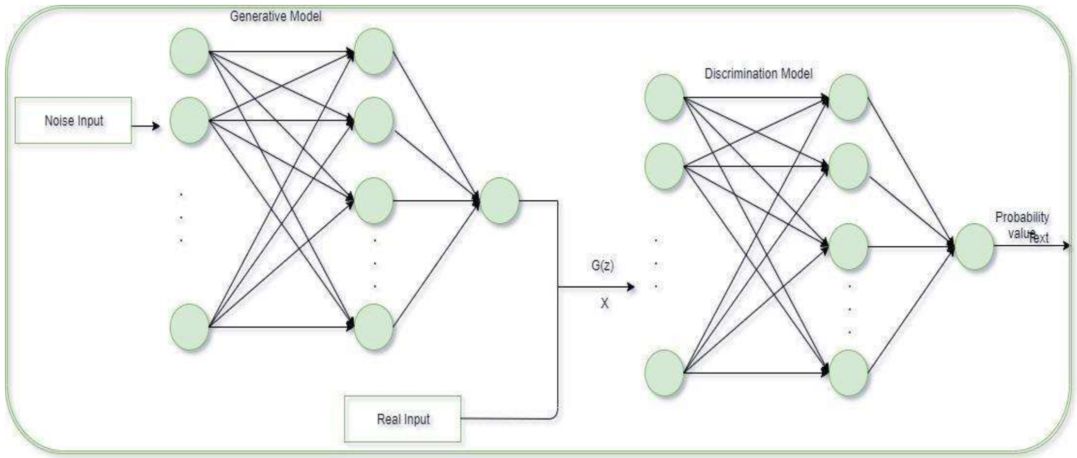



Figure. 4 GNNs Architecture.

Suppose that generative model generates a new vector called fictitious G(z) and discrimination model generates probability value D(z) as real data, whereas x is input data and y is output of distribution model. $E_d$, $E_g$, and E are loss functions of discrimination, generation and entire model (network structure shown in Figure.5), respectively [9].

Discrimination model loss function $E_d$:

$$E_d = ((1-y)\log(1-D(G(z))) + y \log D(x)) \qquad (a)$$

Discrimination model loss function $E_g$:

$$E_g = ((1-y)\log(1-D(G(z))) (2xD(G(z))-1) \qquad (b)$$

Total loss of model:

$$E = ((1-y)\log(1-D(G(z))) (2xD(G(z))-1) \qquad (c)$$

Optimization function after loss identification:

$$\min \max V(D.G) = E_{x \sim p\ data}{}^{(x)[\log D(x)]} + E_{z \sim pz\ (z)}{}^{[\log(1-D\ (G(z)))]} \qquad (d)$$

The optimization of above both models can be considered independent to each in term of optimization. The GAN generated images have some drawbacks such as counting, perspective, and global structures. This is currently being extensively researched to improve the models [1]. DCGAN [19], cGAN [20], and WGAN[21] are advanced variants of regular GANs widely used in image and video processing, image generation and resolution enhancement [22].

The following Table. 2 summarizes the DL algorithms:

Summary of CNNs,RNNs and GANs

| Type of Algorithm | Variant | Network Architecture | Applications | Year of Inception |
|---|---|---|---|---|
| CNN | LeNet [11] , ALexNet [12 ], VggNet [13], GoogelNet [14] | Input Layer, Convolution Layer, Pooling Layer, Fully Connected Layer | Image Processing, Speech Signals, Natural Language Processing | 1980s |
| RNN | LSTM [15], GRU [16] | Input Layer, Hidden Layer, Output Layer | Temporal series Analysis Emotional Analysis, Natural Language Processing | 1982 |
| GAN | DCGAN [17], cGAN [18], WGAN [19] | Discrimination Model, Generative Model | Image Generation Video Generation | 2014 |

# 1. APPLICATIONS OF DL IN SMART AGRICULTURE

In the recent years, AI has fathered many state of art technology which is to be used in agriculture. Modern technologies like ML, DL, Internet of Things (IoTs), Computer vision (CV), Edge Computing can be used in agriculture sector to build smart and automated models. Renowned term ”Data is new fuel and AI is accelerate”. Lack of appropriate information led to huge losses during three broad phases of agriculture process: Pre-harvesting, Harvesting, and Post-Harvesting. Each phase consists of multiple sub-tasks to be executed carefully and smartly to reduce extra cost and mitigate the scope of money and yield losses. The following Figure.6 shown the phases-wise applications in agriculture:

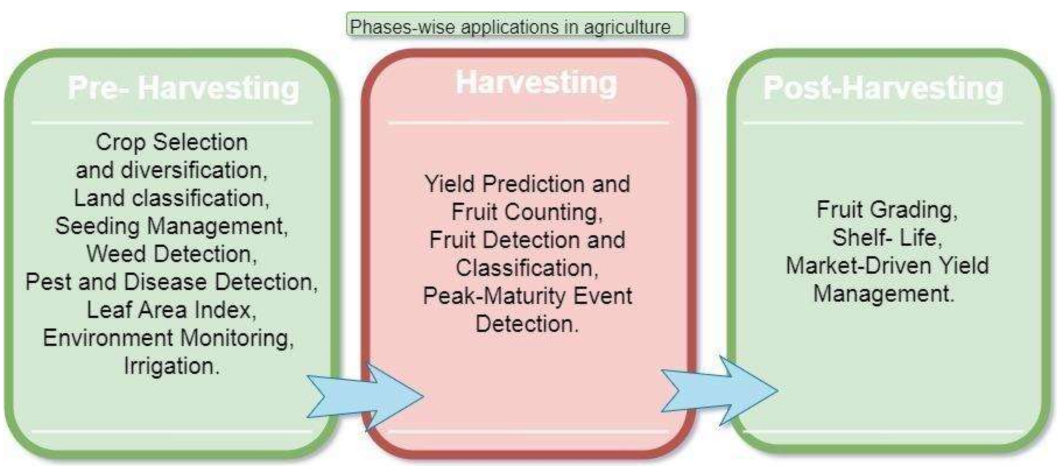



Figure. 5 Applications in Agriculture.

*3.1* ***Applications of CNN in smart agriculture****:* CNN has state-of –art capabilities in image processing intensively used in the agriculture. CNNs can be used for the image classification through which plant and crop classification, pest and weed control, robotic harvesting, yield prediction and fruit counting, and disaster monitoring etc. The foremost activity is to grading the seed, therefore quality seed enhance the yield from 5% to 20 %. Bakumenko, Alexey et al.[22] used the CNNs for seed classification based on the real time convolutional neural networks. Zhengjun Qiu et al.[23] builds the model for identification of variant of rice using single seed using hyper-spectral imaging combined with CNNs.

Plant diseases detection with impressive accuracy is breakthrough of CNNs. Sharma P. et al. [24] showed the feasibility of training a convolutional neural network (CNN) model using segmented and annotated images instead of full images. When the same CNN model is trained using the segmented images (S-CNN) as compared to training using full images (F-CNN), model performance on independent data increases from 42.3% to 98.6%. Bharathi, R. Jeya et al. [25] used AlexNet is another variant of CNNs widely used for plant diseases classification. AlexNet widely used to identification and classification of paddy diseases. Fruit Counting plays a crucial role in yield prediction. CNNs faces difficulties in solving this problem, a blob detection method has been proven to be much useful for fruit counting. A blob detection method cascaded with the fully connected neural network (FCN) trained with rich images data-set along with human generated labels. Then count convolutional trained to get segmented images and output generated[9]. Land classification is another key application of DL which involves the large land use and land cover (LULC), disaster and risk assessment. Remote sensing and unmanned aerial vehicles led to obtain imagery information, and CNNs to achieve higher accuracy for environmental and social applications. Manuel Carranza-García et al. [26] proposed a DL land use and land coverframework, presented a validation procedure to compare the performance between our convolutional neural network and other traditional machine learning techniques such as support vector machines, random forests, and k-nearest-neighbors. The cross-validation experiments carried out with all methods over five different datasets and the subsequent statistical analysis of the results, demonstrated that the proposed convolutional neural network achieved an improvement in performance with respect to the rest of models considered, in both overall and per-class accuracies. These methods were also evaluated at an online competition of the GRSS, and the convolutional neural network again provided the highest accuracy. Moreover, CNNs can be applied to classify the animal's behavior [9].

*3.2* ***Applications of Recurrent Neural Network**:* RNNs useful to time series and temporal data. It can be used in the land classification, weather forecasting, animal research, leaf area index, event-date estimation etc. Land cover classification is applied to identify the class of the particular piece of land. Before the RNNs, mono-temporal method used for the classification of piece of land which results ignores the time series events occurred due to the periodic change in weather and appearance of the vegetation's. Therefore, the variant of RNNs, LSTN widely used for such application. Dino Ienco et al. [27] observe that the LSTM-based classifier outperforms both RF and SVM approaches regarding all the three metrics. The more important gain is reached when the average F-Measure is taken into account, the LSTM-based classifier obtaining a score of 74.63% while the second best method (SVM), (LSTM)) attains a score equals to 73.31%. Interestingly, we can also highlight that, for the THAU dataset, the classifiers trained on the features (representation) learned by the Recurrent Neural Network RF (LSTM) and SVM (LSTM) exhibit better performances than the same classifiers coupled with the original time series data when the F-Measure is considered. In terms of Accuracy, the behavior is comparable considering the SVM vs SVM (LSTM) while the RF model clearly benefit of the new data representation.

Crop yield vary on the long time series data effecting various parameters. Prakash J et al. [28] works to predict the yield of the crop based on the suitable crop parameters like

Temperature Min, Temperature Max, Humidity, Wind speed, Pressure using neural network model like Feed forward Neural Network and Recurrent Neural Network. The performance of neural network model was evaluated using the metrics like Root Mean Square Error (RMSE) and Loss. Comparing the FNN and RNN based on loss of error RNN has low error rate at the same it is better for crop yield prediction. Leaf area index refers to address the health status of the plant. It indicates the multiple parameters to predict the plants status which led to the count of leaf area per unit ground or trunk surface. Chai, Linna et al. [29] established a model based on the NARX model called NARXNN to estimate time-series LAI. They trained the model on several datasets and made indirect and direct validation, both of which suggested that NARXNN is a promising tool for time-series LAI estimation. RNNs can be used in numerous discipline like, weather forecasting, event data estimation. It can be estimated that time series model has rich scope in the agriculture sector besides the CNNs –oriented models.

*3.3* ***Generative Adversarial Network****:* GANs has great capabilities in the image processing as well as generate new data sets of images. It can be used to enhance the image resolution, generate images and videos. It is not been applied to agriculture directly but great emphasis on all the models using the image processing. Remote sensing images much more processed in GNNs for agricultural field, optimization of realism of agricultural images. Gandhi Ritu et al.[30] used the GNNs to generate an augment to the small local data-set to cater the requirements of CNNs to deploy the smart phone app [30].

## 4 DEEP LEARNING FRAMEWORKS

Recent, emerging advances in the computing power accelerate the process of designing, training, and validation of ANNs and evolution of numerous DL frameworks.

***4.1 TensorFlow:*** Tensorflow is open source computing framework invented by Google in 2011. Tensorflow uses software libraries for numerical computation using data flow graphs, shared states, the operation that mutate state. Tensor processing units (TPUS), GPUS (Graphic Processing Units) and ASIC (Application-Specific Integrated Circuit) are computational devices to maps the node of data flow graph. It supports CNNs, RNNs, GANs, and other variants of deep learning algorithms on Linux, Windows, and Mac platforms. Tensorflow frameworks considered as most popular and widely used all over the globe. It offers rich set of deep learning application programming interface (API), comprises of vector matrix multiplication, optimization techniques, neural networks model and visual aids. TensorFlow Lite is another lightweight solution for the mobile based and embedded applications where it supports the android neural network application programming interface. Tensor flow supports C++ and Python programming language Google and Amazon cloud environments supports Tensorflow too.

Summary of DL Frameworks

| Traits | Tensorflow | Caffe | Pytorch |
|---|---|---|---|
| Inventor | Google Brain | Berkeley Vision and Learning Center(BVLC) | Facebook's Artificial Intelligence Research Lab (FAIR) |
| Inception | 2011 | 2013 | 2016 |
| Support Language | C++,Python, CUDA | C++,Python, MATLAB | C++,Python, Jullia |
| Input Format | Data,ImageData | Fedding, Data from file | ImageData |
| Support Model | CNNs, RNNs, GANs | CNNs | CNNs, RNNs, GANs |
| Support System | Linux, Mac OS X, Windows,Android, IOS | Linux, Mac OS, Windows | Linux, Mac OS X, Windows, Android |
| Loss Function | Cross-Entropy loss function, Mean squared area | Contrative loss, Softmaxloss, Hingle loss | Cross-Entropy loss function, Mean squared loss, Mean Absolute loss |

Table. 3 Summary of DL Frameworks.

***4.2 Caffe****:* Convolutional Architecture for Feature Extraction (Caffe) is the foremost devised open source deep learning framework used by industry professionals. It is developed by Yangquig Jia at Berkeley Artificial Intelligence Research (BAIR) in 2013. Caffe accepts input as texts instead of codes, handle huge amount of input data with high speed. Caffe supports C++, Python and MATLAB. Caffe-2 is lightweight modular DL framework developed by Yangquing Jia and Facebook team in 2018. The basic unit of computation in Caffe2 is the operator, which is a more flexible version of Caffe's layer. There are more than 400 different operators available in Caffe2, now merged into Pytorch in 2018[31]. PyTorch is open source machine learning framework based on Torch libraries under BSD licenses developed by Facebook's Artificial Intelligence Research Lab (FAIR) in 2016. It supports C++, Python and Julia programming languages. PyTorch defines a class called Tensor to store and operate on homogeneous multidimensional rectangular arrays of numbers. PyTorch Tensors are similar to NumPy Arrays, but can also be operated on a CUDA-capable Nvidia GPU. PyTorch supports various sub-types of Tensors [32].

## CONCLUSION

DL is emerging and crucial technique to be used in the various dimensions of agriculture such as plant diseases detection, weed identification, soil and crop diversification, seed and plant classification, land classification, fruit counting, yield prediction, weather prediction, land use and land cover and animal behavior. The breakthrough in the computing power, implementation of deep learning algorithms has outperformed in multiple disciplines. Thus, it is implication of DL continuously growing. Along with DL, Block-chaining, IoTs and Edge computing can be used to transform the traditional way of agriculture to the smart and automated on especially for large populace of small and marginal farming in view to cut down the costing. Numerous, DL frameworks fathered and extended by researches in the last couples of years such as Tensoflow, PyTorch, Caffe etc.

CNNs, RNNS and GANs has outperformed as compare to the classic statistical oriented

ML algorithms. Image processing in DL is state-of –art technology to build model to process the large input data with less computational power and time under optimal conditions. GANs mostly used in agriculture for augmented purpose in the generation of images, to use the hyperspectral (HS) and remote sensing images captured by RADAR and unmanned aerial vehicle (UAV) for land use and land cover application. In the bird view, there are basically three segments of smart agriculture: agriculture information processing, automated agricultural machinery and agricultural economic system management. It is need of the hour, to use AI in agriculture at micro level, the daily decision of farming tasks from the scratch level must be data and knowledge oriented.

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# ANALYSIS OF CLASSIFICATION ALGORITHMS ON INTRUSION DETECTION SYSTEM

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***Abstract*:**
*IDS (Intrusion Detection System) become a critical concern for devices and network. Optimizing IDS performance is a significant open subject which is attracting increasing attention from researchers. With the rise of the Internet, the threat of spammers, attackers, and criminals has increased. Because of the frequency of such dangers, intrusion detection systems (IDS) have become a critical component of computer networks. The majority of prior IDS focused on classifying attacks as normal or intrusive. We show how to develop an effective intrusion detection system using a layered architecture and a neural network. The proposed approach can classify the different types of attacks. With a distinct set of features, we utilized various types of classifier models, some of them are Support Vector Machine (SVM), Artificial Neural Network (ANN), and Gradient Boost. The Knowledge Discovery & Data Mining (KDDcup99) dataset was used to test this system.*

***Keywords—****Machine learning, IDS, KDDcup99 Dataset, Feature Selection, Feature Extraction*

## I. INTRODUCTION

The software that detects system activity for malicious activity and creates management reports is recognized as intrusion detection system (IDS). IDS encompasses a variety of. approaches aimed at detecting traffic in a variety of ways. IDS focuses on recognizing logging information, potential events, and reporting efforts. IDS is being used by the groups with the goal of identifying faults with security policies and documenting current security risks.

IDS is now a must for practically every enterprise. It aids in the recording of data related with observed actions, as well as the alerting of security administrators and the generation of reports. This technology continuously scans the network for unusual behavior. The same convention-based assaults that the system is vulnerable can render network intrusion detection systems (NIDS) frameworks useless. TCP/IP stack attacks and inaccurate data might cause NIDS to crash.

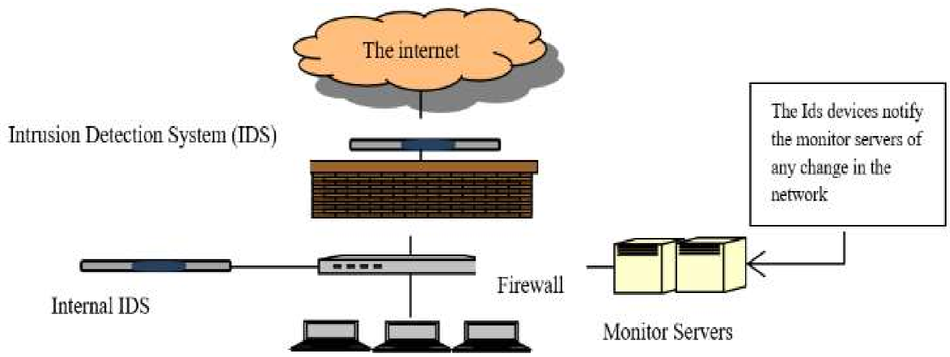


Fig 1. Intrusion Detection Systems [24]

The purpose of Intrusion Detection Systems is to monitor the effectiveness of control activities by obtaining evidence of an attack. Intervention detection procedures are often needed to help control the risks associated with common trends such as infected laptops, viruses carried by email, and personality traits as shown in Fig. 1. To be functioning, however, an IDS solution requires expert staff and disciplined processes, as well as a machine that is thoughtfully configured and has tuned observing configuration.

### I.1 Network Attacks & its Types

Network attack is often seen as interfering with network infrastructure that analyzes the site and collects data to use existing open holes or threats, which may also involve illegal access to the applications. It is called an attack because the purpose of the attack is to collect data from the frame only, and the frame assets are not altered or disabled in any way. An effective attack occurs when the perpetrator accesses the user's property or information and repairs, shuts down, or destroys it. Attacks can be carried out outside the company with an unauthorized object (Outside Attack) or within the organization "insider" who already has access to the system (Inside Attack).

Distributed attacks require the enemy to present the code in a trusted category or program that will later be distributed to different types and clients. Distributed attacks are focused on hardware changes or programming in a modern office or during a flow. In Phishing attack on identity theft, the editor created a fraudulent site that looks like a known real domain. Part of the crime of stealing sensitive attack information is that the editor immediately sends an email message trying to lure the client to click on a link that informs the fraudulent site. In Hijack Attack, the designer takes time between users and puts someone else out of writing. The user still hopes to chat with the first person and may automatically send confidential information to the editor. With the Spoof attack, the editors are trying to access the system's IP address. After accessing the system with a large IP address, the attacker may change, remove a new route, or delete the information. Buffer overflow point where the attacker sends more information to the frame than usual. In an Exploit attack, the attacker is aware of a security problem within the operating system or system and influences that information by harassing the real user. In a Password Attack, the attacker tries to separate the passwords stored on the system account site or the verified private key. There are three notable types of password attacks: dictionary attacks, aggressive attacks, and mixed attacks.

## II. RELATED WORK

Srivastav and Krishna [4] proposed a horizontal structure that was used with the neural system to provide an effective framework for detection of disorders. With the Discovery of Knowledge and Data Mining (KDD) 1999 data database, this framework has done a variety of things. The findings reveal that the proposed framework has a high level of precision in detecting assaults and a low percentage of false alarms. Bhavsar and Waghmare [17] proposed a SVM Entry Recovery Program with a short training period. They performed pre-data processing to reduce SVM training time. The NSLKDD'99 database was used in the study. They also looked at how SVM performance differs depending on kernel function. The results suggest that if the data is properly processed in advance, the Gaussian kernel can shorten the SVM reading time. Vector support equipment & additional machine learning algorithms like standard separation methods, hybrid algorithms, composite methods, and composite merging methods were compared by Chauhan et al. [19]. For training and testing, they have used a database of terrorist attacks. After multiple models have been trained, they are utilized to forecast which terrorist groups are responsible for terrorist attacks. The SVM method is the best, depending on the test results.

Stevanovic and Pederson [8] presented a novel stream construct discovery framework that depends on machine learning for distinguishing botnet system activity. The outcomes demonstrate that keeping in mind the end goal to accomplish precise identification activity streams should be observed for just a constrained time period and number of bundles per stream. This shows a solid capability of utilizing the proposed approach inside of the online location structure. Karim et al. [9] presented a complete audit of the most recent best-in-class procedures for botnet discovery. Identified with their far-reaching survey, they highlighted future bearings for enhancing the plans that comprehensively traverse the whole botnet recognition research field and recognize the tenacious and noticeable exploration open challenges. Livadas et al. [12] focused on checking system activity, distinguishing abnormalities and digital assault movement designs, and, a posteriori, fighting the digital assaults and alleviating their belongings.

Singh et al. [20] proposed a new scalable quasi real-time intrusion detection model. This model is designed for detecting attacks from peer-to-peer botnet traffic on Apache Hadoop environment using Hive and Mahout. They had divided their framework into three major components. The first module is called a Traffic sniffer used to pre-process the packet using Tshark and HDFS. Then in the second module, feature extraction is done to finalize the feature set using Apache Hive. In the last module machine learning algorithms are applied using Apache Mahout to detect malicious traffic. Feizollah et al. [10] presented 100 examination works distributed somewhere around 2010 and 2014 with the point of view to highlight choice in versatile malware recognition. They classified accessible elements into four gatherings, in particular, static components, dynamic elements, crossbreed elements, and applications metadata. Karim et al. [11] presented the investigation of mobile botnet attacks by investigating assault vectors and in this way display a very much characterized topical scientific classification. By recognizing the critical parameters from the scientific categorization they have analyzed the impacts of existing versatile botnets on business stages and open-source portable working framework stages.

## III. PROBLEM FORMULATION & METHODOLOGY

According to the literature review, it has been observed that in the present work, a 41-component set element is used which increases the processing time for the acquisition of entry. Second, feature selection is not based on gaining knowledge and correlation. This is why in previous methods, feature selection cannot provide information on different types of logins. In addition, reading is highly polynomial that does not provide high accuracy.

The goal is to create a network intrusion detector, which is a predictive model that can discriminate between malicious connections, often known as intrusions or attacks, and good connections. IDS keeps an eye on a network or system for harmful behavior and guards against unwanted access from users, including insiders. The learning aim for the intrusion detector is to create a predictive model (i.e., a classifier) that can differentiate among 'bad connections which may be intrusion attacks & good normal connections. The proposed method of designing IDS is divided into two modules viz. Module of Feature Selection, Module of Feature Extraction.

### Module of Feature Selection

The process of selecting a subset of suitable characteristics for use in model creation is known as element selection [20]. Decreasing the size is not the same as choosing a feature. Both methods aim to reduce the number of attributes in the database, but the size reduction method does so by generating a new combination of attributes, while the selection options simply add and remove existing attributes in the data. Feature selection is important, but it works best as a filter, silencing unnecessary features more than existing ones. Figure 2 shows the different classification of feature selection techniques, such as filter, Wrapper, and Hybrid methods.

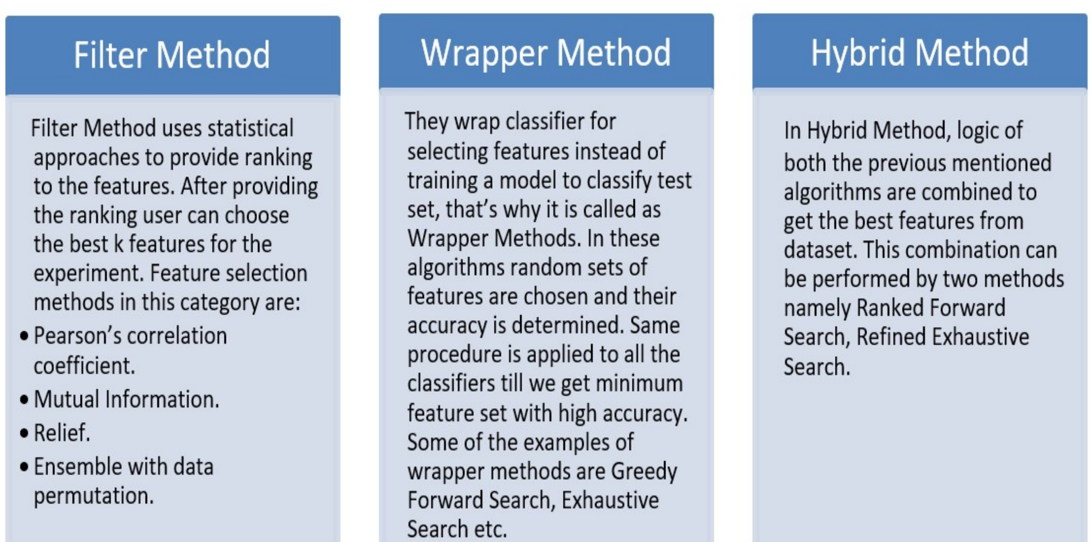


Fig 2. Feature Selection Techniques

Instead of using all 41 features and testing with various classifier algorithms& analysis results, feature selection was made using a combination to determine some of the best components. As by using the method of correlation since it shows the aspect of the equation based on the distribution while minimizing the negative rating of the element in the distribution method.

## Feature Extraction

As the practice of decreasing the amount of sources required towards define a substantial volume of information is known as feature extraction. The enormous amount of variables involved is one of the most difficult aspects of conducting a complete data analysis. A huge number of factors demands a lot of storage and computational resources, which might cause the classification model to become overburdened with training samples and perform poorly on fresh samples. Feature detection is a broad term that also approaches alternative integration methods to avoid these problems while accurately defining the data.

## Data set

The input vectors for training and validation are the KDD 99 data set. It was built on the intrusion detection assessment software of the Defense Advanced Research Project Agency (DARPA)[14]. This program's participant, MIT Lincoln Lab, has set up a simulation of a typical LAN network in order to obtain raw TCP dump data[28]. They created a LAN that functioned as a typical setting that was infested with various forms of attacks. Connection records were created from the raw data set. As shown in Fig 3, 41 characteristics were retrieved for each connection. Each connection was classified as either normal or under attack. There are 39 different sorts of attackers that can be categorized into four different categories, as shown in Fig. 4. The four primary types of attacks are:

- Denial of Service (DoS), By consuming bandwidth or taxing computational resources, a DoS attack prevents valid requests to a network resource. A hacker attempts to prevent genuine users from accessing a service. TCP SYN Flood and Smurf are two examples of DoS attacks.
- Probe attack: An attacker tries to learn more about the target host. These attacks gather information about the target system before launching an attack. For example, utilizing the Operating System, victims can be scanned to learn about available services.
- User to Root (U2R), In this scenario, an attacker gains access to the system using a normal user account and then exploits system weaknesses to gain root access. On the victim's host, an attacker creates a local account and tries to gain root access.
- Remote to Local (R2L), An intruder who doesn't have any access to a remote host sends packets to that system over a network and exploits certain vulnerability to gain access privileges as a user of that machine. An attacker attempts to gain legitimate access to the victim host without having a local account.

| | |
|---|---|
| Duration | • Continuous<br>• Length of the connection |
| protocol type | • Nominal<br>• Connection protocol |
| Service | • Nominal<br>• Destination service |
| flag | • Nominal<br>• Status flag of the connection |
| Srcbytes | • Continuous<br>• Bytes Sent from source to destination |
| Dst_bytes | • Continuous<br>• Bytes Sent from destination to source |
| Land | • Nominal<br>• 1 if connection is from/to the same host/port; 0 otherwise |
| Wrong fragment | • Continuous<br>• Number of wrong fragment |
| urgent | • Continuous<br>• Number of urgent packets |
| Hot | • Continuous<br>• Number of hot indicators |
| Num failed logins | • Continuous<br>• Number of failed login attempts |
| logged in | • Nominal<br>• 1 if successfully logged in; 0 otherwise |
| Numcompromised | • Continuous<br>• Number of compromised conditions |
| Root_shell | • Nominal<br>• 1 if root shell is obtained; 0 otherwise |
| Su_attempted | • Nominal<br>• 1 if "su root" command attempted; 0 otherwise |
| Num_root | • Continuous<br>• Number of root accesses |
| Num_file_creations | • Continuous<br>• Number of file creation Operations |
| Num_shells | • Continuous<br>• Number of shell prompts |
| Num_access_files | • Continuous<br>• Number of operations on access control files |
| Num_outbound_cmds | • Continuous<br>• Number of outbound commands in an ftp Session |
| Is_hot_login | • Nominal<br>• 1 if the login belongs to the hotlist; 0 Otherwise |
| Is_guest_login | • Nominal<br>• 1 if the login is a guest login; 0 otherwise |


Fig 3. Feature set of KDD'99 Dataset (41 features)

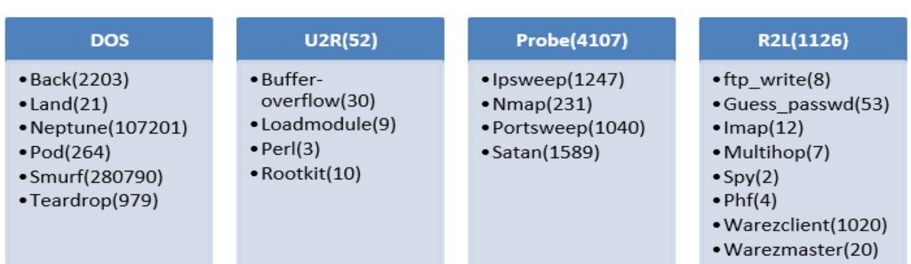


Fig. 4 Attacks Type in KDD'99 Dataset

## Data correlation

This variable which were highly correlated should be ignored for analysis. Only 32 columns were left out of 41 afterfinding the correlation between them and we have removed the columns which were highly correlated as shown in Fig 5.

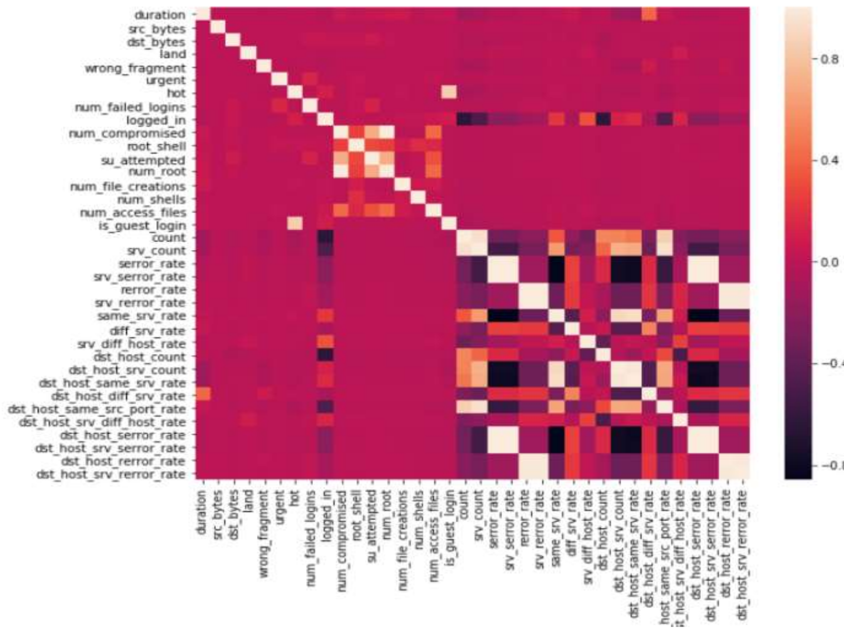


**Fig 5. Data Correlation of 41 features**

## Correlation Coefficient

A correlation coefficient is a metric to determine how closely two different movements are connected. The correlation coefficient has a range of values from -1.0 to 1.0. And an error occurred when the relative correlation is greater than 1.0 or less than -1.0. The absolute negative correlation is signified by the -1.0 correlation, while the absolute positive correlation represents the 1.0 correlation. If the correlation is 0, it simply means that the two variables are not related. After finding out the variables which were highly correlated and removing the variables in dataset for further analysis is shown in fig 6. After the feature extraction, we have trained the model using various algorithms. SVM [17] is a machine-readable algorithm for retrospective, split, and external detection. To separate the data, the concept of hyperplanes is used by the SVM classifier. The hyperplane is a subspace of a vector space with a slightly smaller size than the vector space itself. The maximum difference between two different aircraft is achieved using the ideal hyperplane. In hyperplanes, supporting vectors are the extremely crucial data points. SVM works with both direct and indirect data sets, although it takes longer to train the separator [15].

To develop alternative models, we used machine learning classification techniques like Support Vector Machines, Naive Bayes, Random Forest, Logistic Regression, Decision Tree and artificial neural network.

```
df.head()
```

| | duration | protocol_type | flag | src_bytes | dst_bytes | land | wrong_fragment | urgent | hot | num_failed_logins | ... | same_srv_rate | diff_srv_rate | srv_diff_host_rate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0 | 181 | 5450 | 0 | 0 | 0 | 0 | 0 | ... | 1.0 | 0.0 | 0.0 |
| 1 | 0 | 1 | 0 | 239 | 486 | 0 | 0 | 0 | 0 | 0 | ... | 1.0 | 0.0 | 0.0 |
| 2 | 0 | 1 | 0 | 235 | 1337 | 0 | 0 | 0 | 0 | 0 | ... | 1.0 | 0.0 | 0.0 |
| 3 | 0 | 1 | 0 | 219 | 1337 | 0 | 0 | 0 | 0 | 0 | ... | 1.0 | 0.0 | 0.0 |
| 4 | 0 | 1 | 0 | 217 | 2032 | 0 | 0 | 0 | 0 | 0 | ... | 1.0 | 0.0 | 0.0 |

5 rows × 32 columns

**Fig 6. Dataset After Feature Extraction**

## Kernel Principal Component Analysis (KPCA)

Huge volumes of high-dimensional data are a common difficulty in data mining. It's challenging to identify meaningful patterns in massive amounts of data. The answer is the 'KPCA' dimension reduction approach, which decreases the data's dimensionality while preserving the majority of the information. Kernel PCA has the following features:

- Identifies patterns (features) in the data.
- Preserves the subspace that contains these patterns and discards the remaining space.
- Finds nonlinear patterns in high-dimensional data.
- Can be used for the labeling of a partially labeled set.
- Competitive with other dimensionality reduction methods.

## IV. RESULTS AND DISCUSSIONS

One parameter for evaluating classification models is accuracy. Informally, accuracy refers to the percentage of correct predictions made by our model and other parameter is the computing time.

Everything will be slow, both in training and testing, if our input size (dimensionality) is too large for our machine to handle. If our machine is capable of handling it, then we can find out both training and testing time, logistic regression (or most types of simple regression) is typically the quickest. Because the training process is a quadratic programming problem, it is a well-known problem with a plethora of rapid approaches to optimize it, SVM can be extremely fast. SVM is also quite quick in testing. It all comes down to a few things when it comes to neural networks: we require a graphics processing unit (GPU) and must check the size of the network. We have shown the training accuracy in Table 1 and graphically in Figure 7 which shows the training accuracy of all the algorithms

### *A. Training Accuracy*

Table I shows Training Accuracy of all the algorithms.

**TABLE I. TRAINING ACCURACY**

| S. No. | Algorithm Name | Training Accuracy |
|---|---|---|
| 1 | Naïve Bayes (NB) | 87.951 |
| 2 | Decision Tree (DT) | 99.058 |
| 3 | Random Forest (RF) | 99.997 |
| 4 | SVM | 99.875 |
| 5 | Logistic Regression (LR) | 99.352 |
| 6 | Gradient Boosting (GB) | 99.793 |
| 7 | Artificial Neural Network (ANN) | 98.485 |

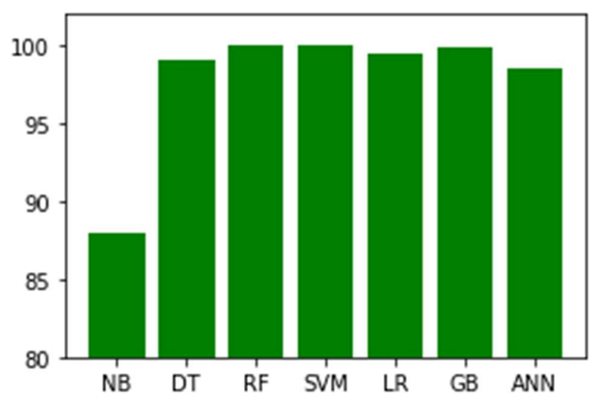


**Fig 7. Training Accuracy**

## *B. Testing Accuracy*

Table II shows Testing Accuracy of all the algorithms applied and Figure 8 shows the graph of testing Accuracy.

**TABLE II. TESTING ACCURACY**

| S. No. | Algorithm Name | Testing Accuracy |
|---|---|---|
| 1 | Naïve Bayes (NB) | 87.903 |
| 2 | Decision Tree (DT) | 99.052 |
| 3 | Random Forest (RF) | 99.969 |
| 4 | SVM | 99.879 |
| 5 | Logistic Regression (LR) | 99.352 |
| 6 | Gradient Boosting (GB) | 99.771 |
| 7 | Artificial Neural Network (ANN) | 98.472 |

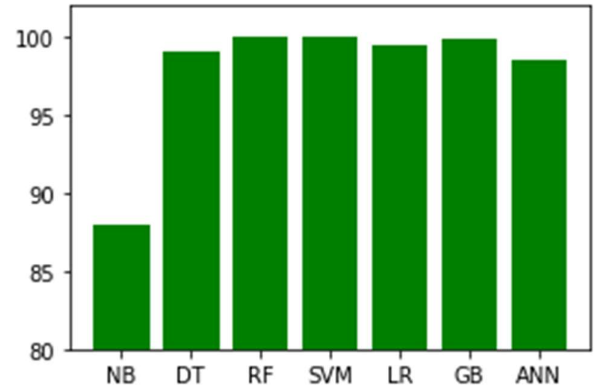


**Fig 8. Testing Accuracy**

## C. *Training Time*

Table III shows TrainingTime of all the algorithms applied and figure 9 shows the computing time required for training for all the algorithms.

**TABLE III. TRAINING TIME**

| S. No. | Algorithm Name | Training Time |
|---|---|---|
| 1 | Naïve Bayes (NB) | 1.04721 |
| 2 | Decision Tree (DT) | 1.50483 |
| 3 | Random Forest (RF) | 11.45332 |
| 4 | SVM | 126.96016 |
| 5 | Logistic Regression (LR) | 56.67286 |
| 6 | Gradient Boosting (GB) | 446.69099 |
| 7 | Artificial Neural Network (ANN) | 674.12762 |

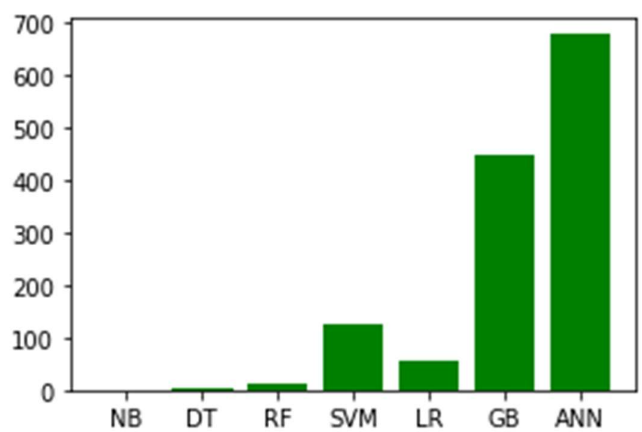


Fig 9. Training Time

### *D. Testing Time*

Table IV shows Testing Time of all the algorithms applied and figure 10 shows the computing time required for training for all the algorithms.

**TABLE IV. TESTING TIME**

| S. No. | Algorithm Name | Testing Time |
|---|---|---|
| 1 | Naïve Bayes (NB) | 0.79089 |
| 2 | Decision Tree (DT) | 0.10471 |
| 3 | Random Forest (RF) | 0.60961 |
| 4 | SVM | 32.72654 |
| 5 | Logistic Regression (LR) | 0.02198 |
| 6 | Gradient Boosting (GB) | 1.41416 |
| 7 | Artificial Neural Network (ANN) | 0.96421 |

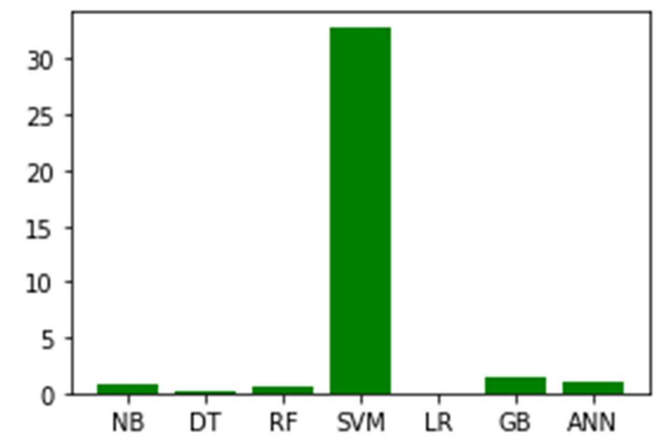


Fig 10. TestingTime

## CONCLUSION

IDS defends a computer network from unauthorized access from users, including insiders, by monitoring a network or systems for malicious activities. After using some feature extraction on the KDD Cup 1999 dataset from DARPA, the goal of this work is to present a predictive model (i.e., a classifier) capable of differentiating between 'bad connections' (intrusions/attacks) and 'good (normal) connections'. There are a total of seven models that have been trained and tested. All the algorithms performance is evaluated in terms of accuracy and computing time. Decision Tree beats the best on measures like accuracy and computational time, according to the data.

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# A LITERATURE REVIEW OF TOMATO PLANT DISEASE DETECTION BY USING MACHINE LEARNING TECHNIQUES ON DIFFERENT DATASET

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***Abstract:***

*Tomatoes are widely cultivated in the agricultural fields in India due to presence of ideal humid climate. In particular environmental conditions, number of factors affect the usual growth of tomatoes, resulting in diseases and other financial losses. The early detection of these diseases can show better results. But the conventional methods for detection of these diseases are very slow and not of efficient type. Hence many emerging computer-based technologies like image processing and machine learning are preferred to use for early detection of diseases. The present paper represents the thorough review of work performed during the recent years in the field of detection of diseases in tomato plants by using image processing techniques. In addition to it various datasets used in research works will be discussed along with the methods employed and adopted while implementing the different frameworks.*

***Keywords :****Neural Network, Machine Learning, SVM, Tomato, dataset*

## 1. INTRODUCTION

In recent years, major developments have been taking place in the agriculture and food industries in response to population growth and a greater need to satisfy the food requirements of growing population [1]. The agriculture fields face numerous challenges such as loss in yield and production. Leaf diseases and causing crop loss are the significant issue. These diseases are caused by several fungi, insects, bacteria and viruses, etc [2]. A key part of the world's agricultural trade and production relies on tomato cultivation, as tomato crops are rich in nutrients [3]. Leaf diseases usually cause significant losses in tomato production, as they are one of the major factors for losses in agriculture [4]. Infections of the tomato plant also affect its leaves, roots, fruits, and stems. It is frequently observed that early blight disease is the leading cause of reduced yield worldwide. Furthermore, late blight disease has severe effects on crops as well [5]. Hence, in order to maximize the quality and quantity of tomato crops, protection is essential to prevent diseases. When disease is predicted early, proper treatment can be selected in order to prevent serious consequences Identifying plant diseases early has the greatest importance in agriculture. The manual assessment is still done today in remote villages, but it does not pinpoint the disease's exact nature and variants. A person must have vast professional experience and expertise about the causes of disease on the crops before they can identify the disease at a glance with their naked eye. It is difficult and time-consuming to perform manual assessments on larger farms because there is so much manpower involved [6]. Computer technology advancements have enabled the identification of tomato leaf disease using technologies that can be applied to large tomato plants through artificial intelligence (AI) and machine learning concepts [7]. Several Machine learning methods have been shown in Figure 1.

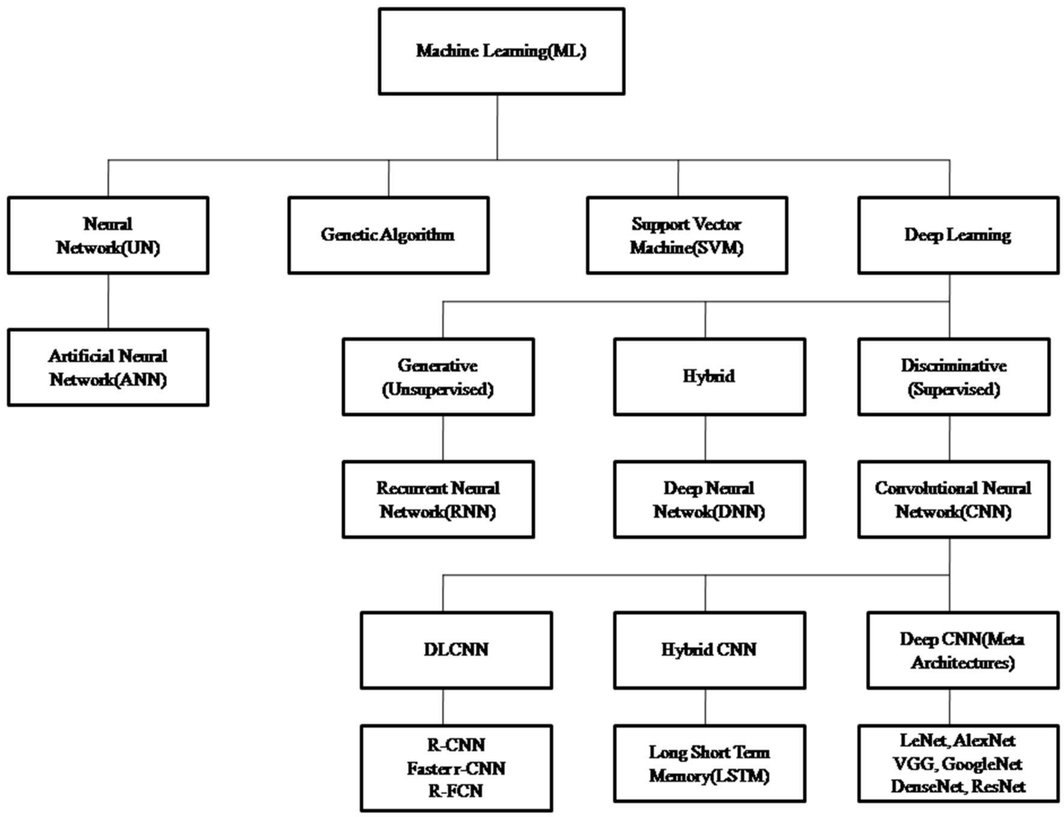


**Fig. 1.** Classification of Machine Learning Methods [8]

This paper focuses to the thorough review of work performed during the recent years in the field of detection ofdiseases in tomato plants by using image processing techniques. In addition to itvarious datasets used in research works will be discussed along with the methods employed and adopted while implementing the different frameworks.

## 2. DATASET FOR TOMATO LEAF DISEASES

Different researchers employed the real images of tomato leaves or plants datasets during the disease detection in tomato plants [9][14][15][20][28]. These images are collected by the placing the cameras at different locations. The number of images collected through cameras used as dataset in different studies are very less as compared to the studies which used dataset available at open-source sites. Many of researchers used the dataset from some open-source links. Table 1 enlists the different sources of dataset of tomato plants along with the number of images and number of classes used in different studies for detecting the infected and healthy tomato plants.

**Table 1:** Dataset employed in different studies

| S. No. | Author | Dataset Name/ Source | No. of images | No. of Classes |
|---|---|---|---|---|
| 1 | Vetal et al., | Sources of camera (used by author) | 320 | 4 |
| 2 | Durmus et al., | PlantVillage | 54.309 labelled images for 14 different crops | 10 |
| 3 | Mim et al., | Random | 6000 image | 6 |
| 4 | Ashok et al., | Real images | - | - |
| 5 | Prajwala et al., | Plant Village | 18160 images | 10 |
| 6 | Mokhtar et al., | real sample images | 200 | 2 |
| 7 | Mehra et al., | Real images | - | - |
| 8 | Wang et al., | Pictures from the Internet | 286 original and 1430 expanded | 11 |
| 9 | Mokhtar et al., | Random | 800 | 2 |
| 10 | ZHANG et al., | Laboratory data from AIChallenger | 4,178 image | 5 |
| 11 | Belal et al., | Plant village dataset | 9000 | 6 |
| 12 | Satish and Sabrol | Camera images | 383 | 6 |
| 13 | Brahimi et al., | PlantVillage | 14,828 | 9 |
| 14 | Agarwal et al., | Plant Village | 17500 | 9 |
| 15 | Luna et al., | Random | 4923 | 4 |
| 16 | Zhang et al., | Open access | 5550 | 9 |
| 17 | Liu et al., | Random | - | - |
| 18 | Agarwal et al., | PlantVillage | 14,529 labeled training images and 3,631 labeled validation images | 10 |
| 19 | Shijie et al., | CrowdAI. | 7040 | 11 |
| 20 | Fuentes et al., | Camera images | 5000 | 10 |
| 21 | Elhassouny et al., | Random | 7176 | 10 |
| 22 | Hlaing and Zaw | PlantVillage image | 3535 | 7 |
| 23 | Rangarajan et al., | PlantVillage image | 13,262 | 6 |
| 24 | Maeda-Gutiérrez et al., | PlantVillage. | 18,160, | 9 |
| 25 | Cengil and Cinar | Kaggle and Taiwan | 10000 and 4976 | 9 and 5 |

## 3. SURVEY OF DETECTION TECHNIQUES FOR TOMATO PLANT DISEASES

Vetal et al., [9] detected the four diseases, named as Early Blight, Septoria leaf spot, Bacterial Spot and Iron chlorosis in tomato plant by using the image segmentation and Multi-class SVM algorithm. Image segmentation was used for removing the damaged area on leaves. Then algorithm of Multi-class SVM was used for the classification of disease. The technique reported better accuracies while performing the classification for all the disease and percentage of accuracy was found about 93.75%. Durmus et al., [10] investigated tomato plant diseases named as leaf curl, spot disease, leaf mold disease, early blight, healthy leaves, mosaic virus, late blight disease, septoria spot, spider mites and target spot disease by using deep learning methods. They used two different deep learning network architectures AlexNet and SqueezeNet. The training and validation were done on the Nvidia Jetson TXI. they concluded that SqueezeNet is good candidate for the mobile deep learning classification due to its lightweight and low computational needs. It worked with inference time of 50s.

Mim et al., [11] predicted the tomato plant diseases named as bacterial spot, mosaic disease, late blight, septorial leaf spot, and yellow curved by using the algorithms of Artificial Intelligence, CNN and computer science. They reported the working of system with an accuracy of 96.55 %.

Ashok et al., [12] investigated tomato plant leaf disease by using the image processing techniques based on image segmentation, clustering, and open-source algorithm. They detected target spot, leaf miner and phoma rot with an accuracy of 98.12% by using the proposed method of CNN.

Prajwala et al., [13] adopted a convolutional neural network model with slight variations called LeNet for detecting and classification of various diseases in leaves of tomato plants. They detected the ten types of tomato plant diseases with an accuracy of 94-95% with little computational effort. They concluded that LeNet model issimple to understand and easy to implement.

Mokhtar et al., [14] applied amethod that used the gabor wavelet transform technique to extract relevant features from the images of tomato leaf along with Support Vector Machines (SVMs) and alternate kernel functions to detect and identify the type of disease that infects tomato plant. They employed kernel functions of Cauchy kernel, Invmult Kernel and Laplacian Kernel in their method. They detected Powdery mildew or early blight diseases in tomato plants. They concluded that proposed approach worked with an accuracy 99.5%.

Mehra et al., [15] determined tomato maturity based on color and fungal infection in the tomato leaves. They employed the thresholding algorithm and k-means clustering algorithm to determine the maturity of plants and comparative analysis has been performed. They also suggest an an unconventional machine vision system that scrutinized the leaves emerging out of the soil and depending upon leaf spots, it analyzed the nature of fungus and its depth into the stem of tomato. 32 % and 26.3 % infected area were detected by using the thresholding andk-means clustering algorithm respectively which were closed enough.

Wang et al., [16] employed the methods of Faster R-CNN to identify the tomato plant diseases. Along with it, Mask R-CNN methods was employed to detect and segment the locations and shapes of the damaged parts of leaves. Four different neural networks viz. VGG-16, ResNet-50, ResNet-101 and MobileNet were selected and combined with these two object detection models. They detected malformed fruit disease, blossom-end rot disease, gray mold, blotchy ripening disease, puffy fruit disease, dehiscent fruit, sunscald, virus disease, ulcer disease and anthracnose. At last, they concluded that, MobileNet detect the diseases inleast detection time, butResNet-101 worked with more accuracy.

Mokhtar et al., [17] used GLCMatrix for detecting and identifying the tomato leaf whether it is healthy or infected. The SVM based technique was used having varied classification phases of kernel functions. They used N-fold cross-validation technique to evaluate the performance of proposed system. At last they concluded that using linear kernel function classification accuracy of 99.83% was obtained.

Zhang et al., [18] employed improved Faster RCNN to detect the powdery mildew, blight, leaf mold fungus and ToMV diseases in tomato plants. They employed the VGG-16 and K means clustring methods to deeper feature extraction and to cluster the bounding box respectively. They concluded that improved Faster RCNN worked with 2.71% higher recognition accuracy and had a faster detection speed than the conventional Faster RCNN.

Belal et al., [19] demonstrated the deep convolutional neural networks with two approaches viz. full-color approach and gray-scale approach, to classify the tomato plant diseases. They detect the Bacterial Spot, Early Blight, Healthy, Septorial Leaf Spot, Leaf mold and Yellow Leaf Curl Virus diseases. They concluded that Full-Color approach showed 99.84% of accuracy while Gray-Scale approach achieved an accuracy of 95.54%.

Satish and Sabrol [20] detected the late blight disease, bacterial spot, septoria spot, bacterial canker and leaf curl diseases of tomato plants by using non-parametric supervised learning technique called as classification tree. The classification results showed that classification tree was resulting good accuracy of 97.3%.

Brahimi et al., [21] introduced the Convolutional Neural Network for detection of several diseases in tomato plant by using the large dataset. The authors used visualization methods to understand the causes and to detect the affected areas in leaf while evaluating the proposed model. The proposed model showed accuracy of 99%.

Agarwal et al., [22] proposed a model working on the basis of CNN to detect the disease in tomato crop. The CNN based architecture consisted 3 convolution and max pooling layers with varying number of filters in each layer. They detected Target Spot, Mosaic virus, Bacterial spot, Late blight, Leaf Mold, Yellow Leaf Curl Virus, Spider mites, Early blight andSeptoria diseases in tomato plant leaves. The proposed model worked with an accuracy of 91.2% which is far better than Mobilenet, VGG16 and InceptionV3 models.

Luna et al., [23] designed a system to identify the Phoma Rot, Leaf Miner, and Target Spo diseases in tomato plant leafs. They used Convolutional Neural Network to detect the diseases. They designed the detection network by using transfer learning in Alexnet and re-trained it using a Faster RCNN architecture which was optimized for object detection in an image. At end they concluded that, the entire system based on the actual implementation provided a 91.6 % accuracy from the 36 sample tests.

Zhang et al., [24] utilized the deep convolutional neural network to detect the diseases in tomato leaf by employing the transfer learning. They used AlexNet, ResNet and, GoogLeNet along with deep CNN. They detected corynespora leaf spot, late blight, early blight, leaf mold, septoria leaf spot, virus disease, spider mite, and yellow leaf curl diseases in tomato plants. The designed model changed the structure and explored the performance of full training and enhance the fine-tuning of CNN model. The study achieved 97% of accuracy for detection of tomato plant disease by using ResNet and the stochastic gradient descent.

Liu and Wang [25] developed an improved Yolo V3 algorithm is proposed to detect tomato plant diseases and insect pests. Yolo V3 network was improved by using multi-scale feature detection on the basis of image pyramid, object bounding box dimension clustering and multi-scale training. They detect the early and late blight, coal pollution, yellow leaf curl, brown spot, gray mold, leaf mold, navel rot disease, leaf curl, mosaic, leaf miner and greenhouse whitefly. The proposed model worked with accuracy of the algorithm is 92.39% and the detection time is only 20.39 ms.

Agarwal et al., [26] proposed a simplified CNN model is proposed comprising of 8 hidden layers for tomato crop disease detection. To increase the performance of proposed model, image pre-processing was used by changing image brightness by a random value of a random width of image after image augmentation. They detected the bacterial spot, early blight, healthy leaves, septoria leaf spot, late blight, leaf mold, spider mite, target spot, mosaic virus, and yellow leaf curl diseases in tomato plants by using this model. The proposed model is of light weight and performed better than the traditional machine learning approaches as well as pretrained models and achieved an accuracy of 98.4%.

Shijie et al., [27] developed the disease detection algorithms on the basis of images of leaves. They build the convolution neural network model to detect pests and diseases in tomato plants. They utilized the VGG16 and transfer learning while constructing the model. They detected the bacterial spot, septoria leaf spot, early and late blight, leaf mold, spider mite diseases, target spot, mosaic virus, Yellow leaf curl virus andgray spot diseases. The detection model was trained with TensorFlow packages of deep learning and achieved an average classification accuracy of about 89%.

Fuentes et al., [28] proposed a technique based on deeplearning for real-time detection of tomato diseases and pests. They considered architects of Faster Region-based CNN, Region-based Fully CRN, and Single Shot Multibox methods on combining with feature extractors of VGG net and Residual Network (ResNet) for their purpose. They detect the Gray mold, Canker, Leaf mold, Plague, Leaf miner, Whitefly, Low temperature, Nutritional excess or deficiency, and Powdery mildew diseases in tomato plants. They concluded that this model successfully recognized the nine different categories of diseases and pests, including complex intra- and inter-class variations.

Elhassouny et al., [29] proposed mobile application model worked on the basis of deep CNN to detect the leaf diseases in tomato plants. The used model focuses on MobileNet CNN model and has ability to detect xanthomonas campestris, pytophthora infestans, alternaria solani, passalora fulva, septoria lycopersici, mosaic, tetranychus urticae, corynespora cassiicola, and yellow leaf curl virus in tomato plants. Their adapted model with Stochastic gradient descent optimizer showed the accuracy of 88.4% accuracy on classification.

Hlaing and Zaw [30] new statistical feature of Kolmogorov-Smirnov to represent the image in dimensions of few numbers. Their proposed technique was a combination of statistical texture and color features which classified tomato plant disease by using SVM. They detected the diseases like bacterial Spot, late blight, leaf mold, septoria leaf spot, spider mite and target spot in tomato plants. The experimental performance on PlantVillage database was compared with state-of-art feature vectors to highlight the advantages of the proposed feature. Their model worked with an average accuracy of 85.1%.

Rangarajan et al., [31] proposed two pre-trained deep learning models - AlexNet and VGG16 net for classifying 6 different diseases and a healthy class of the tomato crop from the image dataset. The classification accuracy observed about 97.29% for VGG16 net and 97.49% for AlexNet.

Gutiérrez et al., [32] performed and evaluated AlexNet, GoogleNet, Inception V3, RsNet18 and 50. The authors focused on leaf mold, bacterial and Septoria leaf spot, early and late blight, spider mites, target and mosaic diseases, and yellow curl virus diseases in tomato plants. The study concluded that GoogleNet technique showed 99.72% of area under curve and 99.12% of sensitivity values.

Cengil and Cinar [33] proposed a hybrid-based model working by using the CNN for the classification of diseases on tomato leaf images. They used AlexNet, ResNet50, and VGG16 for the extraction of features. Initially the feature transfer method extracted the features from the last fully connected layers of the architectures of the model. Then, the minimum redundancy maximum relevance feature selection algorithm was applied the extrcated features for performing the optimization. Then the gathered features were concatenated. Concatenating features were classified by using the popular machine learning classification algorithms. The proposed model showed an accuracy of 98.3 % and 96.3 % for tomato leaf detection and Taiwan dataset respectively.

## CONCLUSIONS

This paper presents a literature survey of different datasets used during the tomato plant disease detection along with the algorithms and existing methodologies. From the literature survey, it can be concluded that plant leaf diseases are usually detected by CNN methods. The detection accuracies were seems to be better in deep CNN techniques. By using the object detection models, the classification process takes less detecting time. These implementations proved that CNN combined with additional features showed the better accuracy and also increases the performance of the model.

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# A REVIEW OF IMAGE PROCESSING TECHNIQUES FOR DETECTION, SEGMENTATION AND CLASSIFICATION OF PLANT DISEASES

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***Abstract*:**
*In this survey, a comprehensive review of image based different plant disease detection, segmentation and classification techniques are presented. It describes various method used for identify and classify diseases from a plant. In the concern, the detection of disease refers to the pre-processing of image for enhancement and color conversion. Further, the image is analyzed with segmentation process to identify the plant leaf portion which is affected with disease (i.e. identify diseased leaf and non-diseased leaf). The present study describe brief about different stage of image processing, before segmentation of plant images. Firstly pre-processing is performed. After that segmentation is introduced for identify the diseased and non diseased portion of leaf. For the final results the diseased image is classified with different techniques. The review is basically focusing on the different approaches followed for disease identification, segmentation and classification.*

***Keywords:*** *Plant Disease, detection, segmentation, classification, agriculture.*

## INTRODUCTION

### Background

Plant diseases are the biggest challenge in the field of agriculture. These diseases are the main cause of continuous increment of harmful presides in weather which leads to originate different kind of diseases in living thing. Moreover, plant diseases leave impact on crop yield which is one of the main reasons for low production scale and high toxic environment. The low production level directly impacts on the economy of the nation. For the solution of this problem numerous researchers have proposed different methods for betterment of agriculture field. According to the study [1] rice production in Australia for 2016-17 was forecast on a paddy basis at 0.625 million metric tons, inclined 0.069 from previous month and gain 60 percent from past season. But yield was calculated in the last month declined by 6.3 percent. In spite of year it was down by 4.1 percent. Continuously decrement in the production of paddy did not meet the forecasted number per hectare which was 10.42 metric tons. On the other hand, based on the study [2] in mid 2015 population of the world was reached 7.3 billion, depicted that one billion had increased in last 12 years. The data represented that in Asia 60 percent of the global population live, in Europe 10 percent, Africa had 16 percent, The Caribbean and Latin America 9 percent, and 5 per cent in

Oceania and Northern America. In the population index china and India hold the first two positions in the world respectively. Both counties placed on top in list because these counties have more than one billion which is near about 18-19 percent of the total population of the world. Continuously increment in the population rate leads to increase the food supply. For that, to fulfill needs the countries are increasing the use of pesticide for gain the higher production. With respect to report [3] usage of pesticides has risen in developing countries and the continuous growing business in Africa, South and Central America, Asia etc. To export in large amount they use pesticides in excess. Although developing countries use only 25 percent of the pesticides produced worldwide, they face 99 percent of the deaths. This is reason behind poor health conditions and less effective education system in developing counties. In nature, pesticide has both positive and negative impact. To meet the human needs according to population we need more and more yield from agriculture this is the main reason behind increment of pesticides usage. For example, in rice crop diseases increases lose percentage near about 40 percent of the total harvest area. The most prominent disease in the rice crop is sheath blight which one affects in all the reasons. Other disease like leaf blast, bacterial blight and neck blast are less prominent [4]. The plants diseases are needed to be identifying before applying pesticides. Blindly spraying pesticide may damage whole crop. It should be apply on the basis of disease symptoms. There is numerous of detection methods are available for identification of diseases. Detection and identification of diseases in crops could be realized via both direct and indirect methods. Direct detection of diseases includes molecular and serological methods that can be used for high-throughput analysis when large numbers of samples need to be analyzed. In these methods, the disease causing pathogens such as bacteria, fungi and viruses are directly detected to provide accurate identification of the disease/pathogen. Using indirect methods identify the plant diseases through various parameters such as morphological change, temperature change, transpiration rate change and volatile organic compounds released by infected plants [5]. There are different ways to detect plant pathologies. Some diseases do not have any detectable symptoms associated. In those cases, normally microscopes are used for analysis of diseases. In other cases, the electromagnetic spectrum used to identify signs which are not visible with naked eye. Remote sensing method is widely in this case that to helps to explore different type of images like hyper spectral and multi Images. To reach at their goal these methods use digital image processing [6]. After the identification of disease plant image is segmented for find the actual affected leaf of the plant. Once the image is segmented the image is classified to identify affected plant pixels as a result. Diseases identification with image processing can be a second opinion for the pathologist.

**Image processing challenges**

In the recent study have tried to focus on need of disease diagnosis and method those are useful for identify the disease. For the detection and discrimination of soil and plant leaves have to be segmented. But sometimes according to field conditions segmentation may provide the faulty results. They also described that some of the machine vision techniques are not good enough for provide the favorable result as per need [7].

In this study we emphasis on different techniques of detection, segmentation and classification those are used under various conditions. Figure 1 Depicts the block diagram of various steps followed while performing image processing for detect diseases from a plant image. This is basically starts with image pre-processing and then followed by segmentation and classification. There is number of methods are available to perform individual task. The detail of each step is given in the following section of the paper.

## IMAGE PROCESSING OVERVIEW

### Image pre-processing

Pre-processing is the basic step while going to process a digital image. Both input and output operations are based on captured images. Basic operation are performed for image enhancement and remove noise from the original image. The input and output images are same type as an original image which is captured by camera or a sensor. The images are having high intensity and these are represented by matrix. Aim of pre-processing of image to enhance intensity of image that can be used for further processing [8].

### Image Segmentation and Classification

After removing distortion from an image, the output image is ready for segmentation process. Image segmentation is the one of the most important tasks. The primary goal of image segmentation is to extract useful information form an image. It is a processing by which an image is divided into small parts and identify those parts are more important and having useful information. The output of segmentation phase need s to be handle carefully because it directly affects result of next phases [9]. After that image classification refers to the task of extracting information classes from a multiband raster image.

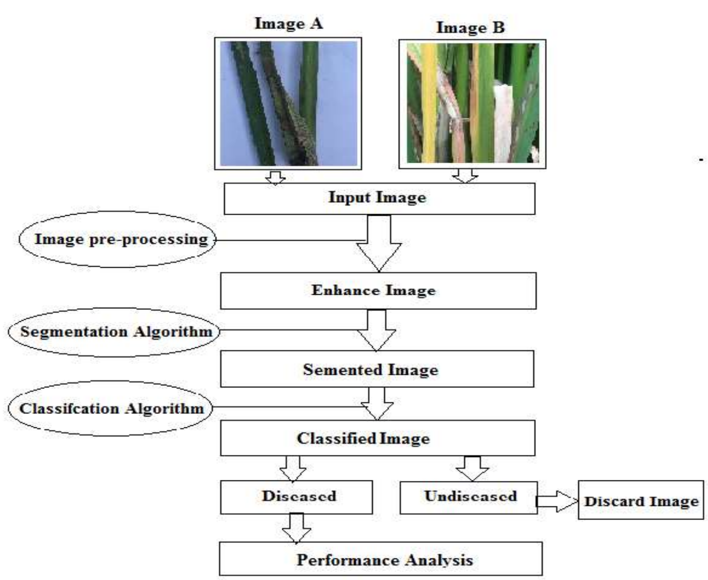


Figure. 1 General Method for disease identification and performance evaluation

## IMAGE PROCESSING IN AGRICULTURE

In [10], digital image processing was incorporated to eliminate the subjectiveness of manual inspection of diseases in rice plant and accurately identify the three common diseases to Philippine's farmlands: (1) Bacterial leaf blight, (2) Brown spot, and (3) Rice blast using back propagation neutral network. [11] Described a software prototype system for rice disease detection based on the infected images of various rice plants. It has also worked on brown spot and rice blast.

In [12], analysis is performed on basmati rice granules; to evaluate the performance using image processing and Neural Network is implemented based on the features extracted from rice granules for classification grades of granules.[13] A relatively faster computer vision system has been discussed to analyze and sort rice kernels. A series of measurements were done using image processing techniques on three varieties of Indian rice namely Markfed Supreme, Markfed Golden (export quality), Hafed Basmati. [14] focused on development of an image recognition system that can recognize paddy diseases. Images were acquired under laboratory condition using digital camera. Three major diseases mostly found in Sri Lanka, Rice blast (Magnaporthe grisea), Rice sheath blight (Rhizoctonia solani) and Brown spot (Cochiobolus miyabeanus] were selected. In [15], similar object shape detection and its description methods were studied firstly. Then shape description method was applied on grain and boundary was proposed based on 8 features. The aim of that study was to detect seed and image size. A calibration method was used which one based on black white grid. At the end an algorithm was proposed for 8 feature point. In the field of pomegranate [16] designed a grading system using fuzzy logic and machine vision for grading the level of disease. It was the helping hand for a pathologist for disease diagnoses. This system helped to manage the flaws of manual system which was more complex and consumes more time. [17] has worked on rice panicle blast grading. On the basis of k-means method a system was proposed for better clustering. The proposed method had many advantages while applied to panicle blast grading. The procedure of clustering, quantization, and histogram statistics changed each hyper-spectral image with millions of dimensions into a model that provided with only 1350 dimensions. While system was tested 312 samples were selected, that included two batches picked in two different seasons. Firstly, two cultivars were selected for first batch. For the second batch the number was more than 50. The system generated favorable results for combined batch and binary grading. In [18] focused on the use of different type of optical sensors for identification and quantification of stressors. The experiment was conducted with different techniques like chlorophyll fluorescence measurement, thermography and hyper-spectral. In the initial phase these techniques we individual tested after that, these were tested with the combination of sensors. As a result it was identified that interaction of host-pathogen can highlighted at an early stage. It could be helpful for manage the complexity during identification of different stressors. In [19] experiment was performed on bean plant. The NPLAD method was applied and it was noticed that method was helpful to identify leave damage level. Mainly in this study T. urticae feeding was focused that can damage bean plant leaves. That method is more reliable instrument for evaluation of damage leaves. [20] proposed a method based on Multivariate image analysis for detection of problems in during quality testing of citrus during post harvest period. With that method reference eigen space can be extracted that can models a good color texture with the help of spatial data that was collected from defect free samples. The spatial data was generated by unfolding color. Those eigen space was used to test images for generate T2 map based on the score matrix. The experiment was conducted on 120 samples those were collected from different cultivars. That method achieved better classification of damaged and sound citrus fruit. In [21] presented a method for estimation of mango crop yield. That system worked images those were captured daytime. It counted the mangoes of individual tree using machine vision. During that experiment images were collected 3 week before harvesting. That approach was tested on 15 mango trees. Images of trees were taken from both sides. Images were segmented based on adjacent pixel variability using color segmentation and texture segmentation. Output of these techniques was helpful in the counting of mangoes. But problem with that system was it was not good enough in lighting conditions. [22] proposed a method cotton detection based on supervised semantic labeling and unsupervised region generation in the image of specific region. The region was generated with the help of different clustering methods like density-based spatial clustering of applications with noise and simple linear iterative clustering. After that featured were extracted with color and texture methods. These features were passed to random forest for semantic labeling of cotton images. For the experiment purpose 46 images were taken from year 2012 to 2015. The system was tested based on certain parameters. It was identified that system was able to detect properly cotton form images. [23] focused on the fast and effective method for disease detection in citrus fruit. That method was developed to reduce the losses of citrus fruit. In this approach images infected with citrus canker were used. Images were collected from the fields not from any experimental lab. Improved AdaBoost algorithm was used for feature extraction of citrus lesions. Then there lesions were used for segmentation purpose. The canker lesion descriptor was proposed for texture and color distribution in which pant phytopathologists suggested different canker lesions. Then the proposed system was tested and experimental results depicted that the system workes like a human expert. In [24] anticipated an algorithm for identifying damaged maize plants by the fall armyworm (Spodoptera frugiperda) using digital color images was developed and tested. The algorithm was tested using damaged and non-damaged maize plant images that were taken under different lighting conditions and stages of maturity. The proposed algorithm performed well, correctly classifying 94 72% of the images. [25] reviewed the different type of segmentation techniques and indentified the better one technique. While segmentation was performed on the original image and the grayscale image both gives the different result. It has been observed that the LTSRG segmentation method works better with multi-channel grayscale information for find disease spot. Not only grayscale experiment was performed with spatial information the results was consistent. The comparison of LTSRG was performed with other segmentation methods. It was noticed that results of LTSRG algorithm were more consistent. In [26] applied support vector machine method for identification of cucumber diseases. Two sets of test images were taken and different kernel functions were applied. It was observed that RBF kernel function that is based on support vector machine method gave better results while tried to perform classification of cucumber diseases. That method was helpful for automatic disease identification from cucumber. [27] proposal a novel method for early detection of rice plant diseases. That method worked with color texture analysis approach. The experiment was performed with 400 sample images of normal rice plant and affected with diseases. It was noticed that diseases were correctly identified. That technique was helpful for detecting rice disease and can help in the boost up of rice production. [28] prepared a intelligent model system for disease detection from a rubber leaf. The images were collected from industry. The RGB color model was used for identification of diseases from rubber leaf. That model basically worked on color indices those were extracted with the help of RGB color model. After the classification of disease ANN models were designed based on RGB and PCA data of RGB components. [29] analyzed the color model for rice images segmentation. The proposed method was compared with other eight methods. For that comparison 56 test images were collected. Test was conducted into two segments one contained six crop segmentation method and another one contained two skin segmentation methods. It was observed that the proposed method was more accurate and consistent then the other eight methods. Segmentation was carried out with different image those were taken under different sky conditions.

## FUTURE SCOPE

In the field of agriculture different method and algorithms has been proposed for disease identification, segmentation and classification using image processing. For disease observation different methods method are used like neutral network, k-means clustering, iterative method, Multilayer perception, Radial Basis Function (RBF), kernel functions, color threshold function, etc. These methods were tested on the images of different fruits and crops. But these methods are applicable in the software system. There should be device for famer and pathologist to identify and classify the diseases. Moreover there is no isolated system available for identify multiple disease crop from a single image.

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# CHALLENGES WITH ARTIFICIAL INTELLIGENCE IN AGRICULTURE

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## *Abstract:*

*Agriculture as well as similar activities play a huge part in a country's economy. Increasing growth in population, decreasing farmland, depletion of resources, irregular climate change, shifting market needs are all pushing agriculture into a new paradigm. Agriculture must handle the task of feeding a growing population while limiting environmental impacts around the world. There is still the difficulty of making farming lucrative for minor landholders in India. Low-input, high-output agriculture would necessitate limiting over-exploitation of groundwater resources, soil analysis-based fertilizers use, conservation agriculture, crop variability, and maximizing crop and livestock yield, according to input-output analysis. The purpose of this study is to identify the most significant concerns and challenges affecting Indian agriculture, as well as possible solutions.*

***Keywords:*** *Agriculture, AI, Smart farming.*

## 1. INTRODUCTION

Artificial Intelligence is having a major effect across all industries. It has been progressing at a breakneck pace recently. Through limiting environment pollution, AI was able to solve several issues while also protecting a valuable resource. AI is revolutionizing agriculture by combining inefficient traditional ways with more effective approaches that help to become a desirable location [1]. The populations is rapidly growing, with it comes an increase in interest in food & business. AI intervention in agriculture is assisting farmers in regaining their farming planning and reducing harmful atmospheric impacts [2]. Agriculture's primary disadvantage is disease infestation. As a result of this flaw, Agriculture production quality and variety suffer The AI technology is used to discover & diagnose disease on agricultural products.

## II. ARTIFICIAL INTELLIGENCE IN AGRICULTURE

The core idea of AI in agriculture is its elasticity, rapidity, correctness, expensive. AI-based software assists to enhance productivity in all parts & handles the issues that many industries face, such, irrigation, crop observing, weed, crop harvesting, harvest, foundation in the agricultural sector. On farms, AI sensors could monitor and classify weeds, as well as diagnose plant diseases, pests, and malnutrition. Illness detection beliefs, segmentation of the diseased part, & disease categorization mythologies [4]. ML and DL are two types of artificial intelligence which provide an efficient and practical solution to the issue. Using ML to train enormous data sets made publically available gives us a definite method to identify disease in plants on a massive range. ML-based algorithms would be utilized to detect and categories diseases on agricultural items such as plants, fruits, vegetables [5]. A robot is introduced that uses image processing and ML to identify leaf illness. The survey of CNN-based agricultural recent studies [6]. Using CNN (convolutional neural networks) to identify illnesses and pests in plant photos.

## III. LITERATURE SURVEY

Despite a lot of work and money put into fixing the situation, Indian agriculture seems to be in a slump. Climate change is one of the most major difficulties. Farmers must meet people's increasing demands in less time. They must increase their output in a shorter period of time. People in rural India are ignorant, conservative, and superstitious, and they are wary of adopting new techniques and technologies that could boost their output. Also, because India is a heavily populated country, there is an excessive amount of pressure on land, resulting in increased fragmentation of uneconomic holdings.

Adhiwibawa et al., (2015) proposed an autonomous system for providing forecasts on drought-tolerant soybean varieties. This research evaluated FL & ANN as AI techniques for processing raw information in way to forecast the drought resistance soybean variety. The prototype implementation for drought tolerant prediction was finally developed using the C# programming script, and the values calculated measurement of leaf region distinction through 18.04 percent, FL & NN approaches for drought tolerant prediction were effectively implemented. The success rate of ANN is higher than fuzzy logic in the 41 DAP and 51 DAP datasets, with 80 percent versus 40 percent for the 41 DAP database and 53 percent versus 46 percent for the 51 DAP dataset [9]. Michele et al., (2020) Precision Agriculture (PA) as well as Agriculture 4.0 (A4.0) have been hugely described as potential solutions to agricultural output difficulties. Authors offer a Systematic Literature Review (SLR) on the A4.0 innovations & Precision Agriculture (PA) approaches in the sector of coffee, accompanied by a BPNA. To conduct the SLR, 87 articles from the Web of Science & Scopus datasets were removed using the PRISMA method. Findings show twenty- three clusters at distinct phases of growth & maturity. Conceptual entire network of the most widely used A4.0 systems in the coffee industry was also uncovered and displayed. As per results, the IoT, ML, Geostatistics are the most commonly employed approaches in the coffee industry. Authors also discuss the primary difficulties & modes in technology assumption in coffee operations. Researchers may use demonstrated findings in future research & decision-making in the field of study [10]. Diego et al.,(2018) presented 25 studies from the last five years, each with a creative approach to disease recognition, grain standard, phenotyping. The comprehensive study's findings reveal significant prospects, such as the use of GPUs & advanced AI techniques like DBNs in the development of strong computer vision approaches for accurate agriculture [11]. Anandharajan et al., (2016) ML techniques are used to make an educated prediction based on the given information. ML, an AI branch, has been shown to be a reliable way for anticipating and interpreting data sets. A complete publication was done with the MATLAB tool and the Vectorization approach. The analysis and forecast are based on linear regression, which estimates the weather for the next day. An accuracy rate higher than 90% is achieved Based on the database. ML algorithms outperformed traditional statistical methods in recent studies [12].

Dyrmann et al., (2016) using a CNN, the authors offered a method for recognizing plant species in color photos. The system was instructed & evaluated the average of 10,413 pictures featuring 22 weed & crop species at various phases of development. These photos were created using six separate data sets with variable lighting, resolution, soil types. This covers photographs shot using hand-held mobile phones in areas with varying lighting restrictions and soil kinds, as well as images shot under monitored restrictions for evaluate to camera stabilization & brightness. The system has an accuracy of 86.2 percent in categorization [13]. Dela Cruz et al., (2017) integrated it into the suggested SFAIS through developing an intelligent device, use NN in optimizing water utilization in the smart farm. The MATLAB NN toolbox was used to run simulations, and the findings suggested that neural networks are a helpful tool [14]. Murugan et al., (2017) method is designed and used to separate sparse & dense zones within a sugar plantation. It makes use of the merging of drone and satellite photos to provide an adaptive technique for reducing drone usage repetition. The strategy is developed adaptive by employing picture statistics and a multiobjective optimization technique to establish a threshold that maximizes the OA while minimizing the FAR. The findings indicated that the suggested approach is suitable for classifying sparse & dense classes, with a correctness of roughly 87 percent for testing & 73 percent for validation data, respectively [15]. Jha et al. (2019) additionally, using Arduino innovation, an automated process was designed to reduce manpower & time usage in the watering process [16].

## IV. CHALLENGES IN THE FIELD OF AGRICULTURE

- **Possible uneven future distribution of mechanization**

As per projections for robot shipments from 2011 to 2013, the United States will see an average annual increase of 9%, Asia-Australia countries will see a 12 percent higher, and Europe will see an 8% rise. According to current trends, robot penetration will be 15% in 2030 and 75% in 2045. However, the distribution of mechanization may be uneven, with certain locations lacking access to services as well as situations that are unlikely to alter despite scientific advances and technical advancements [17]. For instance, while most AI devices are depend on the Internet, their use in remote or rural locations might well be limited because of the lack of a web service & knowledge with AI procedures [8]. As an outcome, anticipate a slow & high distributed unequally assumption of AI in agriculture, so it's still unclear whether this acceptance will improve food construction beyond certain natural land constraints.

- **Discrepancies among control experiments & actual implementation**

Since of elements like lighting fluctuation, background complexities, capture angle, and so on, photos obtained in applied environments differ to pictures produced in control atmosphere. Furthermore, even at the same site, grains planted in the fields are physically diverse mainly as a result of other components such as insects, soil, inert materials. In such situation, unique physiological traits increase the difficulty of factors to consider while processing images, necessitating a larger & high diversified set of control information to enhance the present classification accuracy. Nonetheless, despite the modest variety of research, methods like DBN & CNN suggest intriguing uses in the future for processing massive volumes of difficult information [18]. Furthermore, in way to reduce a service's response time, the information processed should be the most relevant. The capacity of a technology to execute activities correctly in a less duration of time is crucial in determining its economic worth, and it also has a significant impact on user selection, what customers value most is the least amount of work needed and the highest level of accuracy.

- **Security & Privacy**

Because they could be left unattended for long durations, certain physical models, including the IoT are exposed to hardware assaults initially. Location-dependent applications are also susceptible to a machine capture assault, seizing a machine, an attacker could remove cryptographic algorithms and so have unlimited access to anything kept on it The cloud servers are vulnerable to information tampering, which might lead the farm's automatic processes to be disrupted without permission. Ethical hacking, login misuse, and denial of service (DoS) are all methods that could disrupt cloud infrastructures. Cryptographic methods, data flow control policies, recognize authentication methods, and other security regulations are included. As a result, security concerns are producing major problems that must be handled at many levels [19-20].

## V. CONCLUSION

The population is imagining exceeding nine billion users by 2050, requiring a 70% increase in agricultural products to satisfy demands. Only around 10% of the additional production might come from undeveloped area, with the majority coming from existing manufacturing improvements. Here environment, employing cutting-edge technical solutions to improve farming efficiency is a must. Despite a lot of work and money put into fixing the situation, Indian agriculture seems to be in a slump. Climate change is one of the most major difficulties. Farmers must meet people's increasing demands in less time. They must increase their output in a shorter period of time. People in rural India are ignorant, conservative, and superstitious, and they are wary of adopting new techniques and technologies that could boost their output. Also, because India is a heavily populated country, there is an excessive amount of pressure on land, resulting in increased fragmentation of uneconomic holdings. In agriculture, farmers may simply reduce labour, farming tools and equipment, as well as investments, by implementing the AI farming industry. In comparison to traditional ways, the automated system will require fewer farmers and less time. Because AI optimizes the usage and power of resources, it could be accepted and useful in agriculture. The paper also discusses several literatures that represent how agriculture improve by using different techniques. According to the literature, AI technologies are an excellent tool for a country's agronomics. As a result, future researchers should compile a comprehensive database spanning all aspects of agriculture as well as improve present technology to boost primary sector production.

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# IoT BASED MODEL FOR SMART FARMING

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## *Abstract:*

*Now in these days of technology, everyone is trying to work with the help of machines, because machines may reduce the cost of working and also work with efficiency as compared to humans. So, researchers are trying from a decade to make the farming profession upgrade by using smart farming techniques. In this paper, we have proposed a SWAPS model for smart farming based on IoT. This is a layered model used for smart farming, and it will cover the five factors and then output of these factors will be analyzed to produce commands for the automated devices to work with the crops. This model will help the farmers to work with the large farms using automated IoT and unmanned vehicles, and it will also provide the high production.*

***Keywords***: *Smart farming, IoT, UAV, UGV, smart agriculture.*

## 1. INTRODUCTION:

Smart Farming is the new innovation which is followed in the field of agriculture. It makes agriculture more profitable for the farmers with usage of IOT (Internet of things) devices like UAV'S (Unmanned Aerial vehicle Devices) e.g. drones etc., UGV'S (Unmanned ground vehicles) [8]. It helps in reducing resource inputs, which will save farmer money, labour, risk, and also increased the reliability of space. With the help of remote storage devices, smart farming can analysis the farm productivity and can take possible measures to improve it more. This concept is in trend these days because a lot of problems are faced by farmers like population is shifting from rural to urban areas and due to scarcity of the labour, many innovators, growers have to consider this factor and apart from this other factors are also in consideration like PH level of soil, the rate of Nitrogen depletion) affecting growth, properusage of fertilizers/additives to crop etc. So, smart farming helps to reduce the cost and also improves the crop performance and increases the productivity of farm. As technology is growing day by day in every field and making agriculture is also digitalized like other industry. In these days we can closely examine our crop with the help of remote sensing techniques utilizing UAV'S like drones utilization in farming, with the help of these drones it's easy to detect driest field and proper irrigation is being done by using this technology, and water resources are also used economically. Moreover, it's also beneficial for to spray correct amount of chemical substance to crops because soil fertility is really important in order to grow fruits and vegetables. Phosphorous, potassium and magnesium are the composition of soil, salinity, and moisture levels are the signals for measuring quality and conditions of the soil [21].

### 1.1 IoT with Agriculture

IoT is the field which deals with the devices having some identifiable address and works with internet, it may be a sensor or other device. The output from these sensors is collected and analysed for the purpose of decisions. So in this time, IoT is used with agriculture. IoT devices are planted in field and data is collected from those to produce some decision. It may be about the growth of plant, information about the nature of soil, ph value of water and other various factors. Researcher used these things for various purposes [15].

Fig. 1: IoT with Agriculture

### 1.2 Use of UAV's and UGV's in agriculture:

These are the devices which can be used with the direct human operation, human can run these types of devices remotely by giving instructions.

UAV's – Unmanned Aerial Vehicles: these are the devices in the form of drones which can carry some payload without the human help. These drones has capability to work remotely without humans and can be used in agricultural farms for spaying and to capture photographs etc.

Fig. 2: Unmanned Ariel vehicles

UGV's – Unmanned Ground Vehicles: These are the vehicles which work on ground without the presence of human operator, these vehicles work according to the sensors embedded on it and makes their decisions according to the input from the sensors[ 17].

Fig. 3 Unmanned Ground vehicles

## 2. RELATED WORK:

Jithin Das V. et al. [14] has surveyed and interviewed about the Smart Farming Technology acceptance among Irish farmers. They also find the problems of acceptance and non-acceptance of new farming technology among farmers. The study shows that cloud computing technology (CCT) is highly accepted by youngsters rather than Ireland old farmers. The reason of old farmers for not acquiring this technology is due to the lack of awareness, age, high expenditure and lack of allowance. This study did not cover the size of the farm but this could also be the main barrier of not accepting the CCT and they also mentioned that this is not enough research to get the exact results of adoption but farmer's response can be considered, and more research is needed in future.

Manlio Bacco, et al. [2] has presented an overview of IOT (cameras, sensors etc.) devices and autonomous vehicles in farming and also examine the enabling wireless technologies. In this paper they have surveyed that IOT (Internet of things) devices are working great in farming field like drones, with the help of these drones it's easy to detect driest field and proper irrigation is being done by using this technology, and water resources are also used economically. Moreover, it's also beneficial for to spray correct amount of chemical substance to crops. They also considered Unmanned Arial vehicles (UAV'S) and unmanned ground vehicles (UGV'S) uses and requirements in smart farming. At the end they have also purposed that integration of UAV'S and UGV'S are missing. So, they recommended that deep learning architectures and CNN techniques can be key enablers for their joint use for more understanding. Prem Prakash Jayaraman et al. [3] has presented the design of SmartFarmNet, an IOT (Internet of things) based platform for improving farm productivity and also analysis the performance of crop.

Amilaris Feng et al. [5] has proposed an Agri-IOT based smart farming applications, which supports reasoning over various heterogeneous sensor data streams in real-time. It basically involves the crop studies, fertilizers/additives, plant growing, environment conditions and taking these parameters in account for more productivity and quality from farms. Kernecker et al. [6] has described the comparison between adopters and non-adopters. According to surveyed in Europe, authors experienced that adopters are more interested into exploration of the status of Smart Farming Technology (SFT) in the various cropping system. On the other hand non-adopters have high expectations from SFT and not convinced that these technologies are accessible and available. They have also suggested that for betterment of SFT, there would be face- to-face communication among experts and farmers. Dieisson Pivoto et al. [21] has reviewed about smart farming technology in various countries and described the various difficulties for adopting this like education of farmers, poor telecommunication infrastructure in rural areas, etc.

Achim Waltera et al. [19] has discussed about the profits to farmers with the help of this smart farming. It helps in reducing resource inputs, which will save farmer money, labour, risk, and also increased the reliability of spatially explicit data.

Leanne Wisemana et al. [23] has discussed the legal and regulatory challenges related to agricultural data. They have discussed about the data license and fear of farmers related to this rules and regulations.

## 3. PROPOSED MODEL

There are number of models are developed for smart farming, but in this paper we are presenting a model which is fully automated and will works with the help of IoT devices, cloud services, unmanned aerial vehicles and unmanned grounded vehicles. First of all farm is divided into virtual cells and that cells will be arranged in the form of rows and columns to form a grid. Then five parameters are taken for the observation purpose: Soil, water, air, plants and space (aerial view) of the crop. The data for all these factors will be collected from the sensors used in the farm. Then this data will be sent to the central point where it collects data from all the layers and then this information will be sent to cloud, which will work as a storage place. Then comes analysis process. In this process all the data will be analyze and report will be generated and then this report will in the form of commands and these commands will be given to the UAV's and UGV's and these devices will perform according to the input and perform their activates on the farm to produces the best results. Then again the system will check all the sensor data and command the UAV's and UGV's. This will lead to reduce the interference of humans and also perform the activates timely as per the requirement of the crop.

## Process:

1. Farm Division and implementation of sensors.
2. Data collection at all the layers
   a. Soil
   b. Water
   c. Air
   d. Plants
   e. Space (Arial view)
3. Data consolidation (all layers)
4. Storage of data at cloud
5. Data Analysis and reporting
6. Commands to UAV's and UGV's.

This model will reduce the interaction of humans with the farms can leads towards automatic farming which will be very helpful in future for large farms.

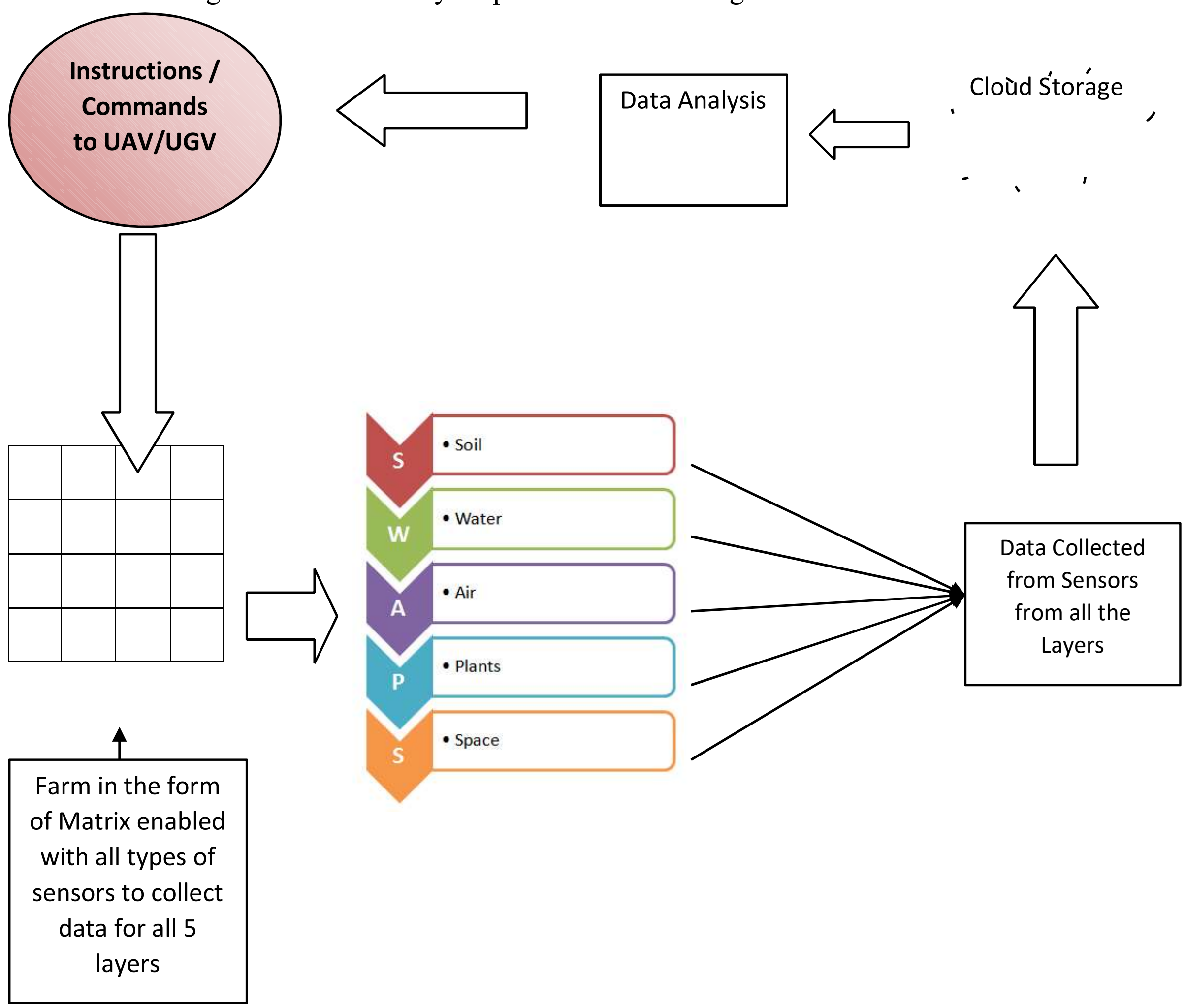


Fig. 4 SWAPS - IoT based Model for Smart Farming

## 4. CONCLUSION AND FUTURE WORK

Smart farming is booming in this time, because the invention on new tools and technologies is increasing day by day. In this paper we have proposed a SWPAS smart farming model, this models based on layering system and works with IoT, cloud and UAV's and UGA's. IoT will help to collect data, cloud will store the data provided by the IoT sensors and UAV's and UGA's will work physically for the betterment of the corp. It will cover all the five factors: Soil, water, air, plant and aerial system. Data from all the factors will be analyzed and this data can be used for the running of vehicles on the crops and as well as it will provide data for the analysis of farming parameters of the region, which will lead towards the type of crop is beneficial according to the environment of the particular location. In the future, big data can be used with the smart farming, because large number of data will be collected from the sensors and this data can be processed through the dada analytics tools to reach on a result.

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# EMBEDDED SYSTEMS IN AGRICULTURE

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## *Abstract:*

*This article discusses key points regarding the development in the field of agriculture by embedded systems. Agriculture provides as one of the economic solid Foundation to the majority of the rural India. Majority of the people in rural places rely on agriculture for there livelihood, So it is very crucial to understand the roots of agricultural development. The conventional methods that they use require a lot of human labour and consume energy. General Idea behind helping farmers is by using smart device that can not only impact there lives but also help save environment. A agricultural land can be a huge data generating hub i.e. it generates lots n lots of data, this can be used in a positivie way to impact our lives.*

*Agriculture in India is livelihood for a majority of the population and can never be underestimated. With the help of technology advancement and more concrete research journals agriculture sector can be improved. Every day farms generate lot of data points on temperature, soil, usage of water, weather condition, etc. With the help of artificial intelligence, this data can be used in realtime for obtaining useful insights like, an embedded system based agricultural field monitoring design that develop and implement the use of different sensors embedded to an AVR microcontroller [2]*


***Keywords:*** *Embedded Systems, Microcontroller, Sensors.*

## 1 INTRODUCTION

The technique consists of an AVR Microcontroller which is the main part of the system. Different sensors such as LM35 temperature, YL-69 Soil moisture, and raindrop detector sensors are used. A pump is connected to a relay which is then linked to the controller that pumps water depending on the water requirement by the soil and LCD for displaying the condition of the field. The program for the system is developed using embedded C in AVR studio programming software.

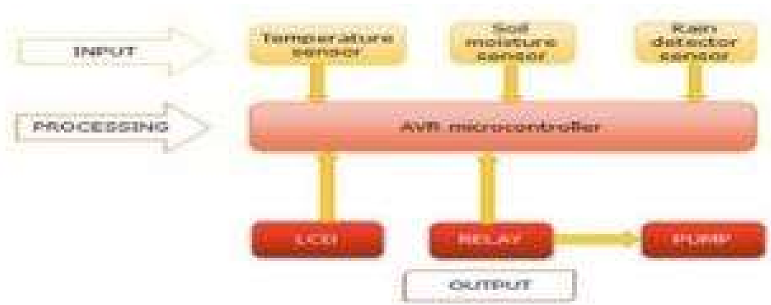


**Fig. 1.** A figure elaborating the usage of a microcontroller with various sensors connected to it.

### 1.1 AVR Microcontroller

Microcontroller AVR is a family of 8-bit microprocessors. Features may vary across models, but mostly, the following ones are present: 4–256 kB Flash memory, from 28 to 100 pins (SMD or DIP packaging), up to 20 MHz clock speed (depending on an external clock) [3]. In addition, the family of microprocessors offers on-chip Flash, SRAM, and internal EEPROM memories. Analog capabilities like a built-in temperature sensor and internal voltage reference and a programmable Analog gain amplifier. All the necessary circuits are built-in, leaving the end-user just with the task of connecting the board to the power supply and connecting any desired peripheries. The dedicated Arduino Integrated Development Environment (IDE) is used for programming purposes. The IDE is based on the C/C++ programming language. Microcontroller Mainly consists of central processing unit (CPU), random access memory (RAM), input/output units. AVR Microcontroller is used for High Speed signal processing operations inside an embedded system. It processes the data from various sensors in the whole unit. AVR microcontroller comes in different configuration, some designed using surface mounting and some designed using hole mounting. It is available with 8-pins to 100-pins, any microcontroller with 64-pin or over is surface mount only.

### 1.2 LM-35 Sensor

The microcontroller-based system will automatically detect the temperature of a particular atmosphere. Considering the temperature of the Room or atmosphere. Temperature measurement varies in a particular agricultural land judging by the temperature that needs to be met at that location. Temperature changes can be monitored and the data can be used. Much more common are the temperatures of fluids in processes or process support applications, LM35 is a temperature sensor that outputs an Analog signal which is proportional to the instantaneous temperature. The output voltage can easily be interpreted to obtain a temperature reading in Celsius. LM35 can measure from -55 degrees centigrade to 150-degree centigrade. The accuracy level is very high if operated at optimal temperature and humidity levels. The conversion of the output voltage to centigrade is also easy and straight forward.[4]


**Fig. 1.2** A LM-35 Sensor

The temperature rises whenever the voltage increases. The sensor records any voltage drop between the transistor base and emitter. thus the output voltage varies linearly with temperature.

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Temperature. [5]. If the air temperature around is much higher or lower than the surface temperature, The Temperature of the LM35 would be between the surface temperature and the air temperature.

### 1.3 YL-69 Sensor

YL 69 Sensor or soil moisture sensor is usually used to detect the humidity of the soil. The output voltage decreases when the soil is wet, when the soil is dry the voltage would increase ideally. The output can be a digital signal LOW or HIGH, depending on the water content. If the soil humidity exceeds a certain predefined threshold value, the modules outputs LOW, otherwise it outputs HIGH. The threshold value for the digital signal can be adjusted using the potentiometer.[6] As current is passed across the electrodes through the soil; the resistance to the current in the soil determines the soil moisture. If the soil has more water, resistance will be low and thus more current will pass through. On the other hand when the soil moisture is low, the sensor module outputs a high level of resistance.

The accuracy of the sensor is very influential on the performance of the control system, so that sensor calibration is done before it is applied to smart irrigation. If the soil moisture is not sufficient then the plants will dry and vice versa if the soil moisture is excessive then its will be damaged and rot.

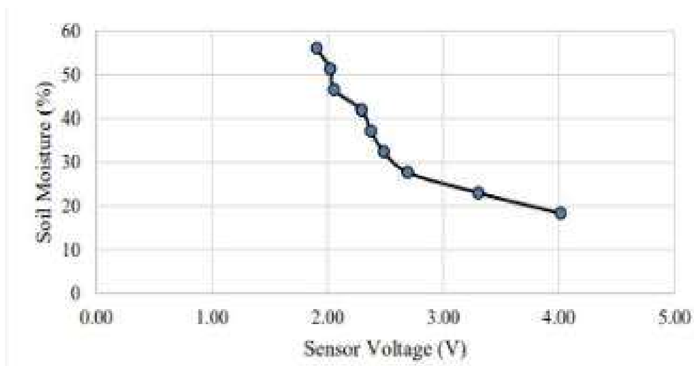


**Fig. 1.3** The correlation between soil moisture and sensor voltage create the curve. Humidity of soil is high then sensor voltage is low and vice versa

### 1.3 Raindrop Detector Sensor

A sensor that is used to detect the water drops or rainfall is known as a rain sensor. It mainly consists of two main components sensing module and sensing pad. The Rainwater drops on the main sensing pad the sensor module connected reads the data to process it further and convert it to digital output. The output can also be Analog, Hence final result can be both digital or Analog from this sensor.[7]

**Fig. 1.4** Following Figure shows a Raindrop Sensor Module

The rain sensor module includes a sensing pad which includes two series copper tracks coated with nickel. This pad includes two header pins which are connected internally to the copper tracks of the pad. The main function of these two header pins is for connecting the Sensing Pad with the rain sensor module with the help of two jumper wires. Here, the rain sensor module's one pin provides a +5v power supply toward the one path of the sensing pad, whereas the other pin gets the return power from another path of the pad. As the intensity of water increases the voltage decreases, while we have connected it to a 5V supply.

## 2. Setup and Flow

The main flow of working starts from the initialization of the LCD display that monitors the whole process, After the setup of the display the Sensors are calibrated for reduced error reading. Once LM 35 Sensor is calibrated the temperature readings are observed and recorded. Similarly After calibrating YL- 69 Sensor for recording the soil moisture, the readings are observed. Similarly raindrop sensor records the readings.

## 3. Monitoring

When the device is fired up, various sensor data are recorded one of them is the soil moisture. Now if this soil Moisture is less than 51% the soil moisture sensors voltage will be amplified which is then supplied to the controller. Depending on the condition of the rain from the raindrop sensor board, the voltage received is enough to drive and turn on the relay. Relay is connected with a PUMP that controls the flow of water incoming in the fields. This relay is nothing but a switch powered when voltage changes. The LCD displays the following three results depending upon the condition of the voltage "PUMP ON" or "PUMP OFF" and "RAINING" or "NO RAIN".

| Soil Condition | Raindrop Sensor Board Condition | Pump Condition |
|---|---|---|
| >51% | "RAINING" | "PUMP OFF" |
| >51% | "NO RAIN" | "PUMP OFF" |
| <51% | "RAINING" | "PUMP OFF" |
| <51% | "NO RAIN" | "PUMP ON" |

**Fig. 1.5** Following Figure shows the observations of sensors

Similarly, when the soil moisture is greater than 51%, the voltage obtained is not enough to drive and turn on the relay. Thus, during this condition the relay is turned off. Considering whether it rains or not, the pump will not work in this condition as the soil moisture level is high. prevents from wastage of water thus reducing the manual labour which is very useful for the farmers and increasing yield of crops. Furthermore, more sensors can be added up for proper monitoring of the field and installation of communication systems to the user for providing the real time condition of the field in the form of SMS as well as MMS facility for video capturing of the field.

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# ARTIFICIAL INTELLIGENCE ASSISTED CROP YIELD IMPROVEMENT TECHNIQUES – A REVIEW

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## *Abstract:*

*The advent of Artificial Intelligence (AI) has opened a wide range of possibilities of technological advancements in almost every sector of the modern economies. Since past decade, in the agricultural economies, the researchers have focussed to improve the economic gains in agriculture through valuable assistant of AI. The main research attention is to increase the production of different crops in a demographic area. In this paper a review is made of various techniques and algorithms which are being used to increase the crop yield. There are various machine learning algorithms which are used to learn and then predict the yield of any crop. These algorithms minimize the losses faced by the farmers by providing deep insights and rich recommendations about the crops. The paper concludes by comparing various AI techniques under different set of conditions.*

***Keywords:*** *Artificial Intelligence, Machine Learning, Detection and Estimation, Image Processing, Precision Agriculture*

The yield of any crop not only benefits the farmer but the economy of that country also depends heavily on it. From time to time, researchers from different countries have tried to increase the production and decrease losses. With the advancement in technology, agriculture field has also received great interest from the researchers of Artificial intelligence to automate the things where manual work does not produce much results. Several papers have been published so far. The main areas of focus are crop management, water management, soil management, classification of crops, ripening of crops, challenges and methodologies in the field of ML and Image Processing in agriculture, crop yield prediction. Disease detection in plants and Weed detection and management are another significant problem in agriculture. Keeping track of information about the crops, environment, and market, may help farmers to take better decisions and alleviate problems related to agriculture. Technologies like Artificial Intelligence, IoT, machine learning, deep learning, cloud computing, edge computing can be used to get information and process it.

In this paper, a review is made on the techniques and algorithms which are being used to increase the crop yield. There are various machine learning algorithms which are used to learn and then predict the yield of any crop. These algorithms provide deep insights about the crops and minimize the losses faced by the farmers.

### 1.1 Various problems which lead to losses in farming

Lack of knowledge of soil types, yields, crops, weather, and improper use of pesticides, problems in irrigation, erroneous harvesting and lack of information about market trend led to the loss of farmers or adds to additional cost. Lack of knowledge in each stage of agriculture leads to new problems or increases the old problems and add the cost to farming.

### 1.2 Advancement of Artificial Intelligence and the field of agriculture

Artificial Intelligence (AI) is composed of two words Artificial and Intelligence, where Artificial defines "man-made," and intelligence defines "thinking power", hence AI means "a man-made thinking power." AI is a discipline of computer science that studies algorithms to develop computer solutions. It copies the cognitive, physiological, or evolutionary phenomena of nature and human beings. Unlike the traditional model, it does not require knowledge of specific paths to the resolution of problems. Rather, it is the data, examples of solutions, or relationships between these that facilitate the resolution of diverse problems. AI exhibits, in certain aspects, “an intelligent behaviour” that can be confused with that of a human expert in the development of certain tasks [1]. Artificial Intelligence, one of the relevant areas of technology, is transforming the agriculture sector by reducing the consumption and use of resources [2]. Machine Learning (ML) uses various algorithms for building mathematical models and making predictions using historical data or information (see **Fig. 1**). Machine learning makes machines capable to learn on its own without being strictly programmed [3]. ML has emerged together along with big data technologies. This has created an opportunity to understand data intensive processes in the operational environments of agriculture. There is a range of scientific fields where ML algorithms are being applied, for example, medicine, bioinformatics, biochemistry, meteorology, robotics, aquaculture and food security and climatology.

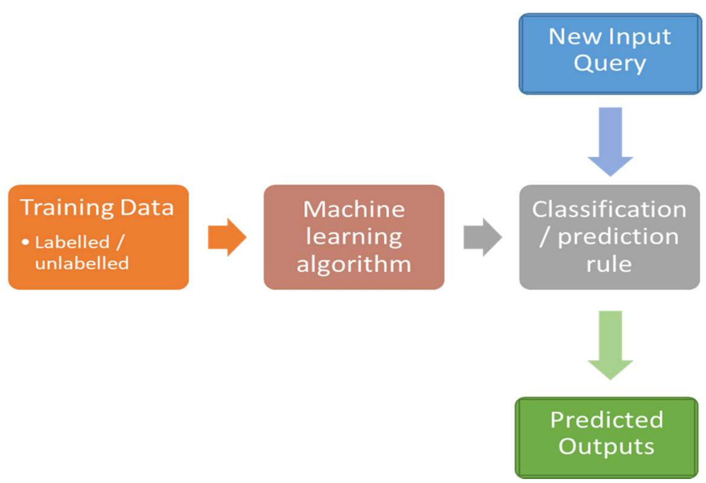


**Fig. 1.** A typical machine learning algorithm

In [4] the authors have shown how farm management systems areapplying machine learning to sensor data which evolve into real artificial intelligence systems by. The recommendations and insights provided by these algorithms helps for the subsequent decisions and actions which ultimately improve the production.

Deep Learning (DL) is basically a sub-part of the broader family of Machine Learning (**Fig. 2**) which makes use of Neural Networks (similar to the neurons working in our brain) to mimic human brain-like behaviour. DL algorithms focus on information processing patterns mechanism to possibly identify the patterns just like our human brain does and classifies the information accordingly. DL works on larger sets of data when compared to ML and prediction mechanism is self-administered by machines.

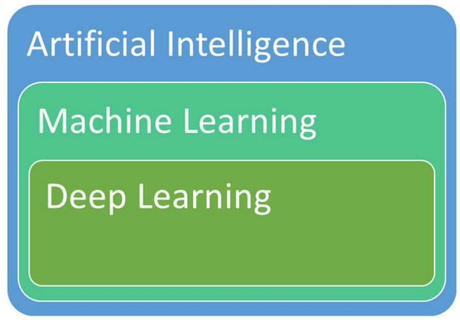


**Fig. 2.** Inter-relation of AI, ML and DL

There are many algorithms that comes under ML [5] and DL [6]. Studies shows that applications of computer vision, machine learning, IoT will help to raise the production, improves the quality, and ultimately increase the profitability of the farmers and associated domains.

N. N. Misra et al. [7] have discussed the role of IoT and big data analysis in agriculture. It includes greenhouse monitoring, intelligent farm machines, and drone-based crop imaging. In food industry, they discussed supply chain modernization, social media (for open innovation and sentiment analysis). For assessing food quality using spectral methods and sensor fusion. Finally for food safety using gene sequencing and blockchain-based digital traceability.

K Dokic et al. [8] have shown the growth of artificial intelligence in the field of agriculture staring from the use of simple machine learning algorithms to neural network and deep learning. They have concluded that for constructing neural networks TensorFlow is a dominant framework, but most of the researchers use Keras because of its simplifying nature. For giving input to the neural networks the dominant input device is the camera and images are the most common input medium. Wheat, corn and grape are mostly the focus of research and crop analysis is the most common area of the deep learning application. Finally, the use of convolutional neural networks has become commonplace in solving problems in agriculture.

In [9], the authors have categorized the tasks of agriculture into three main categories: pre-harvesting, harvesting and post-harvesting. There are various factors upon which machine learning and deep learning techniques can be applied to increase the overall production. Some of these factors during harvesting stage are soil, application of fertilizer or pesticide, seeds quality, cultivar selection, genetic and environmental conditions, irrigation, crop load, weed detection, disease detection. During Harvesting the factors which can be considered are Fruit/crop size, skin color, firmness, taste, quality, maturity stage, market window, fruit detection and classification. Then the Post-harvesting factors affecting the fruit shelf-life such as temperature, humidity, gasses used in fruit containers, usage of chemicals in postharvest and fruit handling processes to retain the quality, fruit grading as per quality.

Barbedo et al. [10] reviewed on the automatic classification of crop areas in remotely sensed images. They have highlighted that manual classification is a labour intensive, expensive and error prone process which makes the search for alternative options a priority. Automating partially the classification process using image processing and machine learning seems to be a more viable choice if more high-quality satellite images become available. However, there are many challenges yet to be overcome which prevents this kind of strategy to be used in practice.

## 2 MACHINE LEARNING AND CROP YIELD

To increase productivity many researchers are working in the field of management of crop, mapping its yield, estimating the crop yield, to match demand with supply. To automate and speed up the process, the researchers are gaining interest in implementing machine learning algorithms.

In the works of [11] examples of ML applications were included. The main motive of this work is to help the farmers of coffee by providing such information which increases the economic benefits and also help them to plan out their agricultural activities. This paper aims at counting coffee fruits on a branch automatically. They developed a low-cost method which is efficient and non-destructive. They have made three categories of counting the coffee fruit: ready to harvest, not ready for harvest, and fruits with disregarded maturation stage. It also calculated the weight of the coffee fruit along with their maturation percentage.

Another study for yield prediction is given by the authors of [12]. They have automated the process of shaking and catching the cherries at the time of harvest by developing a machine vision system. This system aims at reducing the labour requirements which are otherwise required for harvesting and handling manually. Their system is capable of segmenting and detecting those branches which are hidden but have full foliage.

In another paper [13], an early yield mapping system is developed by the authors which identifies immature green citrus in a citrus grove. It provides information specific to yield which helps the growers to increase profit and yield.

The authors of [14] developed a model in their study based on Artificial Neural Networks and multitemporal remote sensing data for estimating the biomass of grassland.

In [15], the authors worked upon wheat yield prediction and developed method which uses satellite imagery. Then they fused crop growth characteristics with multi-layer soil data for predicting more accurately.

Another study dedicated to wheat yield prediction was presented in [15]. The developed method used satellite imagery and received crop growth characteristics fused with on-line multi-layer soil data for a more accurate prediction. Then they compared the performance of counter-propagation artificial neural networks (CP-ANNs), XY-fused Networks (XY-Fs) and Supervised Kohonen Networks (SKNs) for predicting wheat yield in a 22-ha field in Bedfordshire, UK.

Another study [16] is dedicated to develop a method for detection of tomatoes. They used unmanned aerial vehicle to capture images.

In [17, the authors developed a method for predicting the development stage of rice. They have used basic geographic information and SVM algorithm. They have obtained geographic information from weather stations in China.

Then a generalized method was presented in [18] for predicting agricultural yield. Their method mainly focuses on supporting farmers to avoid any imbalance in market supply and demand. In this method Ensemble Neural Network is applied on the agronomical data generated over a long period (1997-2014).

Klompenburg et al. in his paper [19] have reviewed the prediction of crop yield. Based on 50 machine learning based and 30 deep learning based papers, they have extracted important algorithms that have been used by the researchers to predict crop yield. The most used ML algorithms are neural network, linear regression, random forest, Support Vector Machine and gradient boosting tree. In contrast to this, various DL algorithms which are used mostly are Convolutional Neural Network (CNN) [20], Long-Short Term Memory (LSTM) and Deep Neural Network (DNN) [21] (**Fig. 3**).

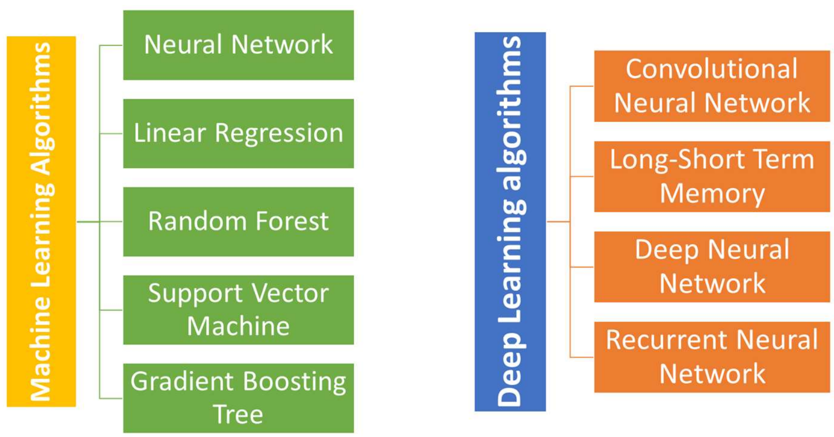


**Fig. 3.** Most widely used algorithms for crop yield estimation

The authors of [22] have shown the problems faced by deep learning-based models. Firstly, these models are unable to find any linear or non-linearmapping between the raw data and crop yield values. Secondly, the quality of the extracted features highly effects the performance of deep learning models. The author purposed a method to solve the above issues. They came up with an idea to combine the intelligence of reinforcement learning and deep learning. They suggested to construct a Deep Recurrent Q-Network model. The deep learning algorithm which is used in this model is Recurrent Neural Network and the Q-Learning is used for reinforcement learning algorithm. They finally constructed a complete crop yield prediction framework that can map the raw data to the crop prediction values.

**Table 1** summarizes the above-mentioned research papers for crop yield.

**Table 1.** Summary of Crop Yield Research Papers

| Sr. No. | Article | Aim | Algorithm of AItechnology used |
|---|---|---|---|
| 1 | [11] | fruit count on coffee branches | Machine vision system based on image processing algorithm and linear estimation model |
| 2 | [12] | automating shaking and catching cherries | Machine vision system using Bayesian classifier |
| 3 | [13] | To develop an early yield mapping system to find out immature green citrus in a citrus grove | SVM, connected component algorithm and scale invariant feature transform (SIFT) algorithm |
| 4 | [14] | for the estimation of grassland biomass | ANNs and multitemporal remote sensing data |
| 5 | [15] | to predict wheat yield | (CP-ANNs), XY-fused Networks (XY-Fs) and Supervised Kohonen Networks (SKNs) |
| 6 | [16] | detection of tomatoes | EM and remotely sensed red green blue (RGB) images |
| 7 | [17] | rice development stage prediction | Support vector machine |
| 8 | [18] | accuracy analysis mechanism for agriculture data | Ensemble Neural Network Method |
| 9 | [22] | crop yield prediction | Recurrent Neural Network deep learning algorithm over the Q-Learning reinforcement learning algorithm |

# 3 CONCLUSION & FUTURE SCOPE

In this paper, a review is made on the advances in technology and how it impacted the agriculture sector specifically crop yield. Every paper investigates yield prediction but differs from one another in terms of features used, crop investigated and algorithm implemented. A number of applications were also developed specific to the crops in study which increases the overall productivity. There is a large scope to enhance the quality of images used for prediction. Most of the models are relying heavily on the features used. So, there is a need to improve the feature set.

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# PLANT DISEASE DETECTION THROUGH IMAGE PROCESSING

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***Abstract:***
*All emerging economies are based on the agriculture sector. It is tremendously significant to the Indian economy. Farmers need to be given the finest practices in order to get the largest crop yields. A wide range of industries employ AI extensively. One of the most crucial aspects of averting significant outbreaks is the early diagnosis of plant diseases. Plant disease detection must be automated. The publication gives a summary of image processing techniques for plant diseases. In many cases, the word "disease" refers exclusively to the death of live plants. Fungi, bacteria, and microorganisms are the main causes of many plant illnesses. One of the main causes of plant extinction is bacteria. Pesticides are used by farmers to get rid of these microorganisms. A diagnostic method for diagnostic detection is the answer to this issue. Photo analysis is performed to quantify the disease's afflicted area and identify any color changes in that region. Imaging techniques for dissecting are employed.*

***Keyword:*** *Disease detection, Featuresextraction, Classification.*

## 1. INTRODUCTION

Due to its rapid technological development and broad range of applications, artificial intelligence is one of the most significant fields in computer science. Agriculture is one of the primary sectors where artificial intelligence is most required. The projected growth in world population to over nine billion people by 2050 will necessitate a 70% increase in agricultural production to keep up with demand. The availability of undeveloped land may account for just around 10% of this expanding production, with the other 90% being fulfilled by boosting existing output. In this context, the use of the latest technology solutions to make farming more efficient is still one of the biggest demands [1]. A labor-intensive, patient, low-paying, and uncertain way of life, farming. Farmers are compelled to accept agriculture as their primary source of income since they have to put in a lot of effort to cultivate the correct crops for a very long period. However, due to poor revenue and occasionally no gain in land due to weather, farmers frequently experience losses. Declining financial conditions eventually leads to suicide due to pressure [2]. The application of artificial intelligence (AI) solutions in the agricultural sector is referred to as precision agriculture or AI in agriculture. The technique is utilized for weed and insect management, nutritional deficits in the soil, field harvesting, health monitoring, and other purposes.

## 2. IMPORTANCE OF AIIN AGRICULTURE

In the modern world, abundant agricultural land provides more than just food. A large portion of India's economy is based on agriculture. Any agricultural production system will benefit from the collection of data relating to data from various sources. To increase agricultural productivity, numerous stakeholders frequently rely on the advice of agricultural experts and incomplete information. It's not always possible to get professional agricultural aid when you need it. All sectors of agriculture, from science to farmer aid, have recently seen improvements thanks to tools, technologies, and the usage of information technology. The expert program's integration as a potent tool for participants in agricultural production is very effective [3]. AI tools including machine learning, predicting statistics, and computer vision are used by the agribusiness industry. However, they result in some advantageous advantages, such as:

- Remove weeds automatically.
- Harvesting automatically.
- Identifying plant diseases.
- Track the state of your soil's health.
- Irrigated land for agriculture.
- Herbicides and insecticides are used.

## 3. DISCOVERY OF PLANT DISEASES

Plant and insect diseases cause between 20 and 40 percent of the world's food production to be lost. Therefore, the identification of plant diseases is crucial in the agricultural industry. It is advantageous to use an automated diagnostic tool for early disease detection in plants. For instance, the United States' pine trees are susceptible to the devastating illness known as tiny leaf disease. Within 6 years, the affected tree grows and perishes. In the southern regions of the US, Alabama and Georgia are affected. Early detection in these situations would be beneficial. [4] To accomplish this, a sizable team of specialists and ongoing crop monitoring are needed, both of which are quite expensive. Farmers in certain nations lack the necessary tools or even the knowledge that they can seek professional advice. The suggested method appears to be helpful in such situations for keeping an eye on vast plantings. It is simpler and less expensive when symptoms are automatically detected on plant leaves. Additionally, this supports machine vision, which offers automatic process control based on image, scan, and robot direction.

## 4. KEY STEPS IN DISCOVERY OF DISEASES

The diagnostic procedure involves a number of stages, with the following four being the most important ones: The colour change structure of the RGB input image is initially obtained, and after applying a particular limit, the green pixels are hidden and eliminated, which advances the process. Following the separation procedure, texture counts are computed to identify segments that are valuable. Finally, the extracted characteristics are applied to the separator for diagnosing a sickness[5].

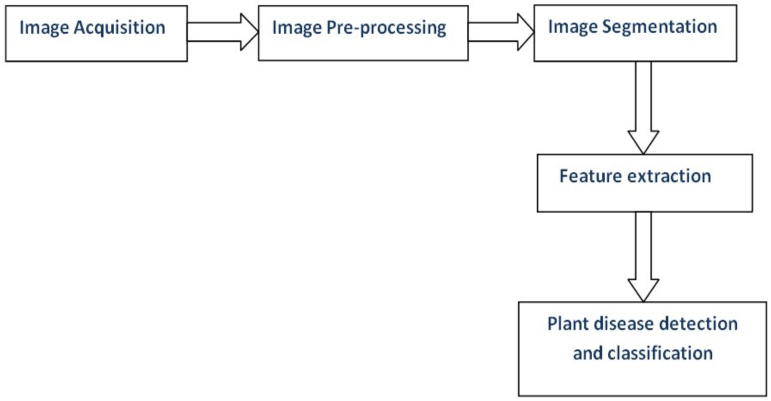


**Fig. 1.** Basic steps for plant disease detection and classification.

4.1 **Acquiring Image:** Photographs of a plant leaf are taken with a camera. This image is in RGB form (Red, Green, and Blue).

**Fig.2.** Input image

RGB leaf color converter is created, and then, the device color rendering on the device is applied to the image. This is the first stage [6].

**4.2 Pre-Image Processing:** To remove sound from an image or other object removal, consider different pre-processing techniques [7]. Cropping a photo, for example, to determine where an intriguing image is located. A smooth filter is used to smooth out images. Brightness improvement is the goal of image enhancement. RGB images in gray images use color conversion using the function(1).

$$f(x) = 0.2989 * R + 0.5870 * G + 0.114. * B \text{ - - - - - - - - - - - } (1)$$

Then, to improve the photographs of plant illnesses, a histogram measurement that distributes image stabilization is applied to the image. The values of the solids are distributed using an increasing distribution function. A lot of picture data enhancement techniques employ pre-image processing. It is applied to eliminate undesirable distortions.

**4.3 Image Separation:** This is a process used to make image representation easier and more difficult to analyze [8]. It is the division of an image into several pieces. Image categorization is another crucial step in the processing of digital images since it serves as the foundation for feature rendering and patternidentification.

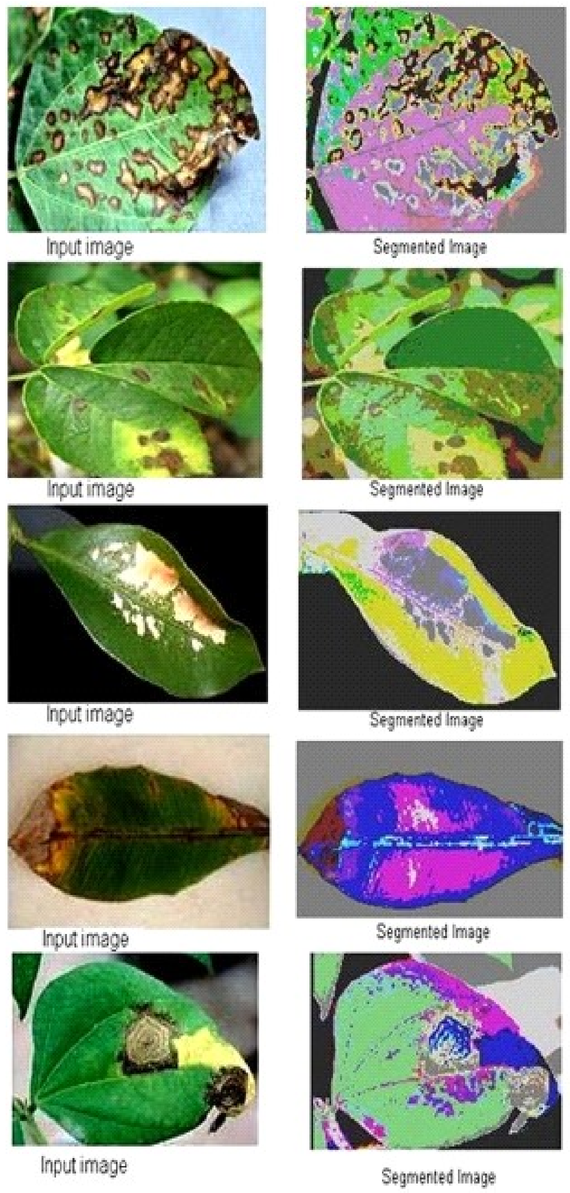


**Fig.3.** Image Segmentation[9]

Many image separation techniques can be used with a single process.

**4.3.1. Region based**: This tactic combines pixels that are associated to objects. The test site ought to be shut down. There won't be a gap because the edge has no pixels. To divide, boundaries are drawn. At each phase, the region is related to and taken into consideration by at least one pixel. The edge flow is converted into a vector after a change in color and texture has been detected. These edges are then obtained for a more thorough separation.

**4.3.2. Edge Base:** Separation can be done using edge retrieval techniques. There are various strategies namely. gradient, canny, sobel, laplacian, robert. In this process the boundary is categorized. The edges are obtained to detect discoloration in the image.

**4.3.3. Threshold based**: It is an easy way to divide. In this segmentation are done using threshold values found in the histogram of those real image edges. This method of classification is not suitable for complex images.

**4.3.4. Feature-based integration:**Merging is another method of separation. The image is histogrammed before merging is applied. This is applied to common photos. When it's a sound image, it causes splitting. The stitched photos are categorized using the fundamental clustering k-means algorithm. Brings together related pixels to divide the image. Combining characteristics creates separation, which is then altered in accordance with the color components. Separation is also fully dependent on the characteristics of the image. Factors are taken into account to distinguish. The discrepancy between classification values for color and intensity.

**4.4 Feature Extraction:** After dividing an area of interest i.e. the diseased part is removed. In the next step, the key features are removed and those features can be used to determine the given sample description [10]. In actuality, color, texture, and texture are frequently present in an image's constituent parts. Plant diseases are divided into various categories with the aid of texturing components. A feature can be extracted in many different methods.

**4.4.1. Methods of analysis of texture**

Structure is a pattern of distinctive pixel-level spatial distribution of varying picture intensities. Certain structures, such as familiarity, congestion, concentration, roughness, firmness, and periodicity, are crucial in replicating the texture.

**4.4.2. Ways to remove the texture element**

From the input image, interesting and significant features are extracted using extraction algorithms. The stitching element is the one that was used to remove it in the images. In the realm of weaving, the most widely used extraction techniques are:

*4.4.2.1 Color scheme combination*: The mathematical distribution of the detected energy compounds in the designated areas is used to compute the textural features in mathematical analysis. Gray Level Co-occurrence Matrices (GLCM) is a mathematical method. Text features can be calculated in the generated GLCMs, e.g. difference, strength and homogeneity. However, in recent years, instead of using each GLCM, it has been integrated with other alternatives.

*4.4.2.2 Gabor Filters*: The form, standard deviation, and radial centre frequency of gabor filters are among the parameters. It can be used to define a collection of stops and radial centre frequencies. Gabor filters must be limited to avoid size issues because the signal processing technique generates a big feature size. Principal Component Analysis (PCA) would be a good decision to reduce the feature Although Gabor filters are popular for separating textures they are sometimes combined with alternatives.

*4.4.2.3* Wave conversion: Several popular wave transformers are used today such as

Discrete Wavelet Transforms (DWT), Haar wavelet and Daubechies. Among these, DWT is widely used for wave conversion. Information in the frequency domain is typically more reliable than information in the local domain. Therefore, wavelet modification tends to provide better features with higher accuracy even if it is exceedingly complex and slow-moving.

*4.4.2.4 Key component analysis:*Using orthogonal conversion, the mathematical procedure PCA transforms a set of observations into variables that could be linked to a set of unrelated variable values known as key components. More genuine variables exist than or on par with the number of crucial elements. It is sensitive to the original variable's relative dimensions. A straightforward eigenvector-based multivariate analysis is PCA.

### 4.5 Diagnosis and stages of plant diseases

Based on acquired traits, category dividers are used to recognise and categorise various diseases that manifest on plant leaves. Digital image classification uses spectral information to identify each pixel by using visual information encoded as digital integers in one or more visual bands. There are numerous methods to differentiate.

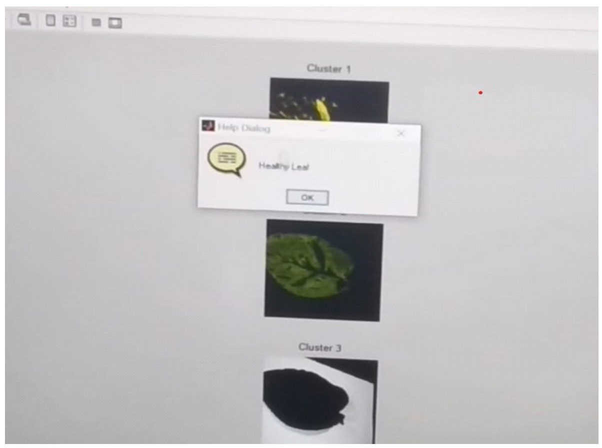


**Fig. 4.** A healthy leaf

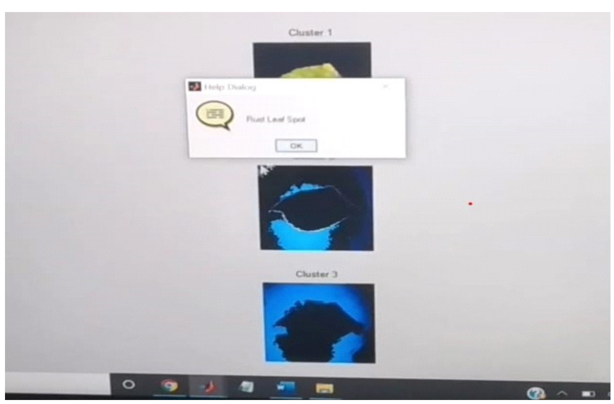


**Fig. 5.** Sick leaf

**4.5.1. K-nearest neighbor:** The minimal distance between a given point and other points is calculated using the neighbor measurement near K to categories a given point. The objective is to determine the distance between the sample question and each training sample, then choose the neighbor with the shortest distance.

**4.5.2. Radial foundation function:** The true value of a radial basis function (RBF) is based only on the distance to the source. The Euclidean range is the most widely used measurement system. RBF networks where the distance between the input vector and the prototype vector determines whether the hidden units are activated. In recent years, neural networks created using well-liked machine learning methods have been deployed extensively. A fundamental ANN type called Multilayer Perception (MLP) reviews weight by broadcasting backwards during training. There are other neural network versions that have lately been effective at segmentation.

**4.5.3. Probabilistic Neural Network (PNN),** It has a compactly distributed processor with a built-in inclination to store experience data and is based on the Radial Basis Function (RBF) network. PNN uses the kernel discriminate analysis algorithm, in which jobs are arranged into an input layer, pattern layer, integration layer, and output layer of a multi-layer server network.

**4.5.4. Back Propagation network:** Three parts make up a typical BP network: the input layer, concealed layer, and outflow layer. With the weight of the collecting weight between the nodes, three sections in a row connect. The key characteristic of the BP network is that it continuously modifies the weight of the network structure until the predicted value of the square of the error between the output of the network and the output of the sample is met.

**4.5.5. Support Vector machine:** A recent development in machine learning algorithms is the supporting vector mechanism (SVM), which cannot be categorized. SVM is only intended to function with two classes. Increasing the margin from the higher plane achieves this. In order to determine the top plane, also known as the supporting vectors, samples are very close to the chosen genes. Multi-category is useful, and two-phase SVMs are essentially created to use one against all or one in order to solve an issue. [11]

**Table 1.** Dividing strategies Comparisons

| **Technique** | **Advantages** |
|---|---|
| K-Nearest Neighbor | Simpler classifier applicable in case of a small not trained dataset. |
| Radial Basis Function | Provides faster training & hidden layer is easier to interpret. |
| Probabilistic Neural Networks | Tolerates noisy inputs. |
| Back propagation Network | Applicable to variety of problems. |
| Support Vector Machine | Robust, when input data has some bias. |

## 5. CONCLUSION

The methods for image processing to find plant diseases are compiled in the current paper. The most widely utilized techniques are K means Integration, BPNN, SGDM, and SVM.

Any of these techniques can be used to automatically detect plant leaf disease. The impact of background information on the resulting image, the development of a specific leaf-specific disease pathology, and the automation of an automatic leaf disease monitoring strategy under real-field circumstances are some of the issues associated with this approach. According to the article, this diagnostic technique shows both unique limitations and a significant ability to identify plant leaf illnesses. As a result, there are numerous advancements in current research. With the most cutting-edge techniques, more research is being conducted to help conventional agriculture transition to a more cost-effective, efficient kind of agriculture.

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# AGRICULTURE AUTOMATION: A REVIEW

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## *Abstract:*

*Monitoring the agricultural environment has become a major challenge in recent years as a result of a number of variables such as population expansion, the demand for increased food supply, and the apparent beginning of global warming. The rise in population has caused environmental challenges, as a result, the demand has increased for food production from a largely stagnant and gradually decreasing food production land area [1]. Modern agriculture is gradually leaning toward the use of automation in production to combat these issues. Agricultural automation is the use of technology to automate the agricultural production process. This includes everything from planting and harvesting to packaging and distribution. Agricultural automation can help farmers increase yields, reduce labour costs, and improve the quality of their products.*

*One area of agricultural automation that is seeing increasing adoption is irrigation automation. Farmers are using irrigation controllers to automate the watering of their crops. Irrigation controllers can be programmed to turn on and off the irrigation system based on weather conditions, soil moisture levels, and other factors. This can help farmers save water and energy, and reduce the risk of crop damage from over-or under-watering.*

*Another area of agricultural automation that is growing in popularity is greenhouse automation. Greenhouse automation systems can control the environment inside a greenhouse, including temperature, humidity, ventilation, and lighting. This can help farmers optimize conditions for plant growth and yield. Greenhouse automation systems can also automate the process of watering, fertilizing, and pest control.*

## 1. INTRODUCTION

With the rise of automation in different fields, it’s clear that the future of production in any industry will depend on automation for better and fast results. The farming transformation from manual ploughing to the use of tractors and different automated tools for numerals purposes to enhance production demonstrated the clear adoption of automation in agriculture back in the 90s. Now IoT is scaling its range of devices that can be used in agriculture and it is being accepted with open arms.

IoT solutions are aimed at assisting farmers in closing the supply-demand gap by assuring high yields, profitability, and environmental preservation. Smart farming refers to the use of the Internet of things (IoT) to assure optimal resource use to produce high agricultural yields while lowering operating expenses.

Farmers can benefit from IoT devices in a variety of ways, including:

- Agricultural automation can assist farmers cut labour expenses. Farmers may use automation technologies to automate processes such as irrigation, planting, and harvesting. Automation can also assist farmers in more effective livestock management.

- The use of IoT devices in agriculture can also assist farmers in increasing agricultural production: Farmers can more precisely monitor their crops and ensure that they receive the proper quantity of water and nutrients with the aid of automation.
- Agricultural Automation can also assist farmers in reducing their environmental effects. Farmers may use less water and pesticides with the aid of automation. Farmers can also benefit from automation in terms of lowering their greenhouse gas emissions.

Rice plantations occupy 10% of the country's land area in India [2]. Furthermore, 20% of the Indian population lives below the poverty line, and 15% is food insecure. As a result, poor food production has an impact on both the people and the economy. The monsoon season of the decade 2010-2020 provided the least quantity of precipitation in the previous 130 years. As a result of the scarcity of freshwater, rice output declined. The Standardized Precipitation Evapotranspiration Index (SPEI) was used to evaluate the drought induced by anomalies in surface water. These indices, along with data from sensors that monitor the environment, soil, and water, may be used to estimate the present status of the water and the potential of covering all the freshwater needs.

## 2 IRRIGATION AUTOMATION

Irrigation, being one of the most significant aspects of farming, requires automated technologies to expand growth and harvests. Farmers throughout the world are concerned about the growing speed of climate change. Farmers in India, where agriculture is the basis of the economy, are already feeling the effects of climate change in the shape of increasingly irregular weather patterns. Farmers are attempting to offset the effects of climate change by implementing irrigation automation. Farmers can remotely monitor and regulate the watering of their crops by employing smart irrigation systems that are connected through the internet [5,11]. This not only saves time and labour but also helps to reduce the wastage of water. IoT-enabled irrigation automation is therefore becoming an increasingly popular choice for farmers in India. The irrigation industry is one of the most exciting sectors in terms of automation and the potential for IoT. There are a few different types of devices that can be used for irrigation automation, including weather stations, soil moisture sensors, and irrigation controllers [8,9,10]. Weather stations are used to collect data about local weather conditions, which can be used to optimize irrigation schedules. Soil moisture sensors are used to measure the moisture content of the soil, which can be used to determine when and how much to water. Irrigation controllers are used to automatically turn on and off the irrigation system based on the data collected by the weather station and soil moisture sensor. IoT in agriculture is transforming the way farmers manage their crops and irrigation systems.

By using sensors and automation, farmers can optimize their irrigation schedules to save time, water, and money.

In 2017, an experiment was carried out to evaluate the effectiveness of an indigenously built automated system on vegetable crops under various irrigation systems, and it was discovered that water production rose under the automated drip irrigation system. In the result, the water savings ranged from 39.6 to 48.6 percent when automated drip irrigation was used instead of manual control check basin irrigation [4].

### 2.1 Irrigation automation devices

Based on the primary pattern of variation, the smart irrigation devices can be divided into the following categories:

**Climate-Controlled Devices**

Climate controllers, also known as Evapotranspiration (ET) controllers, alter irrigation schedules based on local meteorological data, then this data is utilized by ET controllers to predict evapotranspiration rates, which are subsequently used to plan irrigation. The soil moisture sensor is the most popular form of ET controller, and it employs sensors to detect the moisture content of the soil[6]. These climate-based controllers collect local weather data from subsequent sources.

ET controllers are classified into three types:

- Signal-based controllers employ weather station signals and publicly available weather parameters to calculate the ET value at the location. These controllers are often utilized in places where there are no weather stations.
- Using a pre-programmed water consumption curve, Historic ET controllers estimate evapotranspiration rates based on past data. These controllers are also used in areas where weather stations are not available.
- On-site weather measurement controllers determine evapotranspiration rates based on on-site weather data. These controllers are generally utilized in places where the weather is unpredictable.

**Controllers for Soil Moisture Sensors**

The soil moisture sensor controllers are used to measure the moisture content in the soil. The controllers are used to turn on the irrigation system when the soil moisture content falls below the present value. The controllers are also used to turn off the irrigation system when the soil moisture content rises above the present value [7].

The advantages of soil moisture sensor controllers are that they eliminate the need for weather data and automatically calibrate the irrigation schedule to the specific site conditions. The disadvantages of these controllers are that they are expensive, require regular maintenance, and may be less reliable than weather-based controllers.

**Sensors for Soil Moisture**

Soil moisture sensors can be linked to the controller of an existing irrigation system. Before a planned watering event, the sensor checks the soil moisture content in the root zone and skips the cycle if the soil moisture is over a certain threshold [7].

**Rain and Freeze Sensors**

Rain and Freeze Sensors detect the moisture and temperature changes in the mounted position. If moisture or temperature changes are detected, the device will automatically turn on or off. When there is a rain or frost occurrence, rain and freeze sensors stop the irrigation cycle. Watering during the rain is wasteful of both water and money because it produces unneeded runoff.

Several IoT technologies, primarily cloud-based IoT architecture for agriculture, have recently been created to regulate water use in irrigation [3].

## 3 IOT IN GREENHOUSE AND ITS FUTURE

The Internet of Things (IoT) is a network of physical devices, automobiles, household appliances, and other items that are integrated with electronics, software, sensors, and connections, allowing them to communicate and share data. The future of IoT in greenhouses is bright, with the potential to transform the way we produce crops and manage farms.

Farmers will be able to remotely monitor and operate their greenhouses using IoT, guaranteeing that the circumstances for plant development are ideal [12,14]. They will be able to get real-time data on the temperature, humidity, soil moisture, and other factors within the greenhouse and make necessary adjustments. The Internet of Things will also enable farmers to automate many of the chores associated with greenhouse care, such as watering, fertilizing, and venting.

The advantages of IoT in greenhouses do not just help farmers. The enhanced efficiency and production of IoT-enabled greenhouses will also benefit consumers. IoT-connected greenhouses will be able to deliver real-time data about the status of the plants, allowing buyers to make educated decisions about when to purchase them. Furthermore, better greenhouse efficiency will result in decreased pricing for fruits and vegetables.

### 3.1 Greenhouse automation devices

Many greenhouse owners are seeking to automate their greenhouse output. This review sheds insight on the systems utilized to automate the procedure in a greenhouse. There are two main types of greenhouse automation systems: climate control systems and irrigation systems. Climate control systems regulate temperature, humidity, and ventilation to create the ideal conditions for your plants. Irrigation systems automate the watering process so you can set it and forget it. Climate control systems can be further divided into two categories: passive and active. Passive systems use natural airflow and insulation to regulate the greenhouse environment. Active systems use mechanical devices like fans and vents to control the climate.

Irrigation systems can also be divided into two categories: drip and overhead. Drip systems deliver water directly to the roots of your plants. Overhead systems spray water over the entire plant. The cost of a greenhouse automation system depends on the size of your greenhouse and the type of system you choose. Climate control systems can range in price from a few hundred dollars to several thousand. Irrigation systems are typically less expensive, but the cost will also depend on the size

## CONCLUSION

The deployment of IoT devices is expected to continue to grow in the coming years as more farmers adopt these technologies to improve their operations.

The agricultural industry is under pressure to increase efficiency and productivity in the face of dwindling resources and labour shortages. Agricultural automation is one solution that is being explored to address these challenges. This research paper reviews the current state of agricultural automation, its potential benefits and challenges, and the key issues that need to be addressed for successful implementation.

Currently, agricultural automation is being used primarily for tasks such as crop monitoring, irrigation, and machine guidance. However, the potential exists for further automation of tasks such as planting, harvesting, and post-harvest processing. Benefits of agricultural automation include increased efficiency, productivity, and quality, as well as reduced labour costs. Challenges include the high initial investment cost, lack of standardization, and potential impact on employment. To realize the full potential of agricultural automation, the authors suggest that key issues such as these need to be addressed. In particular, they call for more research to be conducted on the economic and social impacts of automation, as well as on the development of standards and regulations.

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# LEVERAGING ARTIFICIAL INTELLIGENCE (AI) FOR EARLY DETECTION OF PLANT DISEASES: A SURVEY

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***Abstract:***

*Agricultural sector shares about 14% of GDP and about 42% of employment in Indian economy. Crop yield in terms of both quality and quantity, is heavily affected by the plant diseases and the condition becomes even severe if the famers fail to detect the plant diseases early. The conventional method of identification of a plant disease is based on the visual detection of the symptoms of plant diseases. The plant diseases have contributed to a considerable degree of yield losses, affecting the country's economy. Therefore, the early and precise identification of plant diseases is very important. Manual detection of plant diseases is practically time consuming, error-prone, requires thorough experience and varies in-person. Early detection of the diseases can save time and effort through artificial intelligence (AI)-assisted automated methods to a large extent. Image processing through machine learning, AI-based hyperspectral image analysis, internet of things (IoT)-based soft computing techniques that have largely contributed in automated the plant disease detection. These technical advancements are compiled in this survey paper with their summarization of their (dis)advantages. Further, the present survey will delve into different challenges encountered and possible solutions. Conclusively, this work summarized different AI-based automated techniques in the research landscape of plant disease detection useful for the researchers working in this area.*

***Keywords:*** *Image sensors, image segmentation, plant pathogen, precision farming, internet of things, plant disease detection, image classification*

## 1 INTRODUCTION

The plant diseases caused by a different classes of plant pathogens (viz., phytoplasma, spiroplasma, viroids, virus, bacteria, fungi, nematodes etc.) are considered as a serious threat to global food security [1]. Traditionally, the plant disease monitoring was performed by experienced farmers and plant pathologists based on the visual symptoms of plant diseases. These symptoms of the plant diseases appear late, when the bio-chemical and physiological changes within a plant affect the external morphology or alteration in normal physiology of the plant. At the bio-chemical level, accumulation of reactive oxygen species (ROS) [2], accumulation of PR proteins [3], accumulation of some defence related molecules like phytoalexins [4] etc., and at the physiological level several changes like alteration in the patterns of photosynthesis and stomatal conductance [5] etc., takes place.

However, the visual assessment of plant disease symptoms may not be very precise, could be time consuming and expensive too. Further, the recent advances in molecular biology techniques such as PCR and DNA sequencing supported the bio-informatic tools are generally used by plant pathologists are also expensive and needs a person with technical knowledge. However, the above molecular biology-based methods need tissue processing, however the image-based method, now being used have made it possible to detect plant diseases in a non-destructive manner [1]. Further, the ability to diagnose a plant disease in a traditional method have certain limitations as the human eye can work only in the visible range of the electromagnetic spectrum. Recently various optical sensors (like RGB imaging, 3D-imaging, chlorophyll-fluorescence imaging, thermography, and multispectral (MSI) and hyperspectral imaging (HSI) have been successfully used for the early and precise detection of plant diseases [6]. The optical properties of a crop are measured within various regions of the electromagnetic spectrum, using different kinds of image sensors (discussed in subsequent heading in detail). However, the processing of the data from various image sensors requires its computational analysis, that involves various steps like image acquisition, image pre-processing, image-segmentation, feature extraction and image classification using various machine learning methods. The present paper therefore discusses are above major steps in the AI-based early detection of plant diseases through image processing (Figure 3).

## 2 PLANT DISEASE SENSORS

Imaging involves the capturing and storing of visual information for any down-stream analysis. However, the most important step in imaging techniques is the selection of an appropriate image sensor. We have previously discussed, various types of image sensors used in the detection of plant diseases, elsewhere [1]. The RGB sensors are based on the recording of colour characteristics, whereas the IR sensors are based on thermographic (temperature related) differences in the imaging landscape. Further, the multispectral image sensors (MSI) capture multiple images over multiple bands of the electromagnetic spectrum, whereas in a hyperspectral image sensor (HIS) has a wider and large number of spectral wavebands (i.e., hyperspectral image data is usually organized as huge matrices with spatial x- and y- axes and spectral waveband information in the z-axis) [1,7-8]. Due to this, HSI needs to processes a higher amount of information than MSI and therefore requires a higher computing configuration to process the data [9]. The example of successful utilization of different image sensors in detection of plant diseases is presented in **Table 1**.

**Table 1.** Examples of different types of image sensors employed in detection of plant

diseases

| S. No. | Disease | Pathogen | Host | Reference |
|---|---|---|---|---|
| **RGB Sensors** | | | | |
| 1. | Cercospora leaf spot | *Cercosporabeticola* | Beta vulgaris | [10] |
| 2. | Stripe rust | *Puccinia striiformis* f. sp. *tritici* | Triticum aestivum | [11] |
| 3. | Late blight | *Phytophthora infestans* | Solanum tuberosum | [12] |
| 4. | Phymatotrichopsis root rot | *Phymatotrichopsisomnivora* | Medicago sativa | [13] |
| 5. | Verticillium wilt | *Verticillium dahliae* | Olea europaea | [14] |
| **Thermal (IR) Sensor** | | | | |
| 1. | Downy mildew | *Pseudoperonosporacubensis* | Cucumis sativus | [15] |
| 2. | Powdery mildew | *Erysiphe graminis* f. sp. *tritici* | Triticum aestivum | [16] |
| 3. | Scab | *Venturia inaequalis* | Malus domestica | [17] |
| 4. | Leaf spot Peanut | *Mycosphaerellaarachidis* and *Mycosphaerellaberkeleyi* | Arachis hypogaea | [18] |
| 5. | Stripe rust | *Puccinia striiformis* | Triticum aestivum | [19] |
| **Hyperspectral Sensors** | | | | |
| 1. | Powdery mildew | *Erysiphe necator* | Vitis vinifera | [20] |
| 2. | Charcoal rot | *Macrophominaphaseolina* | Glycine max | [21] |
| 3. | Sheath blight | *Rhizoctonia solani* | Oryza sativa | [22] |
| 4. | Black spot | *Alternaria alternata* | Pyrus communis | [23] |
| 5. | Bull's eye rot | *Peziculamalicorticis* | Malus domestica | [24] |
| **Multi-spectral Sensors** | | | | |
| 1. | Powdery mildew | *Blumeriagraminis*f.sp. *hordei* | Hordeum vulgare cv. Ingrid | [25] |
| 2. | Rust Soybean | *Phakopsorapachyrhizi* | Glycine max | [26] |
| 3. | Citrus greening Citrus fruits | *Candidatusliberibacter* | Citrus Sp. | [27] |
| 4. | Leaf spot | *Pyrenopezizabrassicae* | Brassica napus | [28] |
| 5. | Spotted wilt Peanut | *Tomato spotted wilt virus (TSWV)* | Arachis hypogaea | [29] |

## 3 SYSTEM ARCHITECTURE FOR PLANT DISEASE DETECTION

Conventional image processing techniques assume the input data to be linear in form, which is very rare under the real-world situations [30]. If the data is piece-wise linear, we can still use the conventional methods. The present paper summarizes the existing AI-based techniques along with image processing. The complete process of plant disease detection using has the following stages viz., image acquisition, image pre-processing, image segmentation and identification / classification, have been presented in Figure 1.

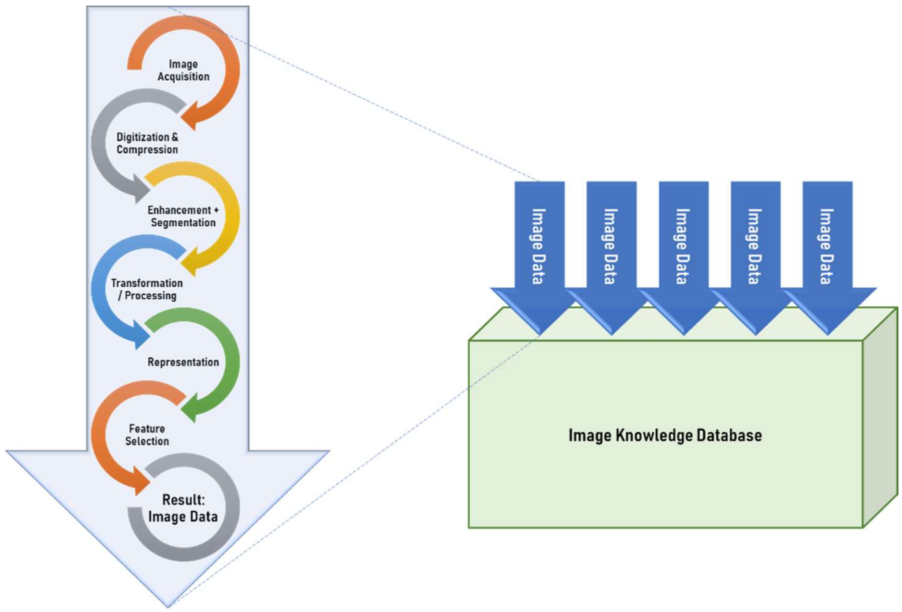


**Fig. 1.** Creation of Image Database for learning

### 3.1 Image Acquisition

For every AI-classifier based system, the data acquisition (images in this case) is the initial and very important step. This is the common step for (i) creating a pool of benchmark images i.e., knowledge database; and (ii) fresh input images directly from field under test i.e., test dataset. The precision of any plant disease detection system is based on quality of images in database, for the purpose of training. The quality of images captured depends on several factors like camera used, daylight conditions, noise, background and shadows etc. For the purpose of plant disease detection, not only capturing the disease symptoms (like leaf with spots), but also a similar type of background noise for image pre-processing. Moreover, different capturing devices are required to capture fluorescent, thermal, hyper-spectral images (discusses in the preceding section). Several researchers utilize public datasets like APS image dataset, PlantVillage, COFI (Computers and Optics in Food Inspection), and Digipathos images [31]–[33]. There are many researchers who used self-made image dataset collected from real-time fields or controlled lab conditions using their own devices like smartphones and digicams etc [34]–[37]. However, many others use the datasets generated by the others like a dataset generated by the plant pathology department of a university [38]–[40].

### 3.2 Image Pre-processing

In this section, we have tried to discuss the need, method and role of pre-processing step. Image pre-processing phase is a fundamental step of image processing. The images captured by any device may have some inherent background noise, shadows, complex distortions present in them. The pre-processing is therefore, the first step to improve it and make it suitable for subsequent image processing stages [41]. The image pre-processing includes several operations like denoising, smoothing, cropping, rotation, base-line shift, wander alignment etc. These operations are applied to a varied extent, depending upon the quality and the nature of the images. Generally, colour correction is succeeded by enhancement, filtering, background reduction steps [42]. Different researchers have made use of HSV, HSI, RGB, L*a*b, gray-scale, and YIQ colour spaces in their analysis [43]–[50]. Some of the researchers have also utilized mean and median filters for denoising [51], [52] and the other transformations like brightness and colour enhancement for augmentation [53], [54], in the dataset captured in real-time.

### 3.3 Image Segmentation

The next step of the image analysis is segmentation. In this step, the image is partitioned to find the interested regions (). During this step, the abnormal regions in the image are separated out, to make the representation simplified, easy to analyse and more meaningful [55]–[57]. Image segmentation is carried out by using either (i) traditional edge/region/threshold -detection based algorithms[58]–[61] or (ii) fuzzy logic[62], [63] / neural network / AI-segmenter based algorithms [64]–[66]. Depending upon the nature of the plant diseases and the input image quality, one of the said approaches is chosen by a researcher. Generally, it is considered that the AI based techniques perform better, than the traditional approaches for image segmentation.

### 3.4 Feature Extrction and Learning

Features are analogous to the distinguishing marks that help discriminate attributes/ information associated with different objects and also assigning the parent class associated with them. Once extracted, features of the different objects are used to build characterization and recognition models for each class [67]. Mostly, the features used in plant diseases detection are leaf shape, colour, size, corners, edges, *etc*. These features of diseased image section are used for plant disease detection and the subsequent classification. Therefore, depending on these attributes, various feature extraction techniques exist, which are are utilized differently by different researches. The colour information is characterized by hue, saturation, luminance, histogram, moments *etc*.; texture information is described as variance, contrast and entropy *etc*.; whereas, the area, eccentricity and roundness are considered as other shape related features. Some of the various techniques used for this purpose are like Wavelet transform, Gray-level co-occurrence matrix (GLCM), Haralick texture & Gabor Transform, Histogram of oriented gradients (HOG), and some local binary computation techniques [68]–[71].

### 3.5 Disease Classification

This is the last and the most important stage to make use of complete system architecture for plant disease detection, referred to as disease classification stage. Though of much importance, the effectiveness of this step largely depends on the efficiency of previous steps: Image acquisition, pre-processing, segmentation and feature extraction. Plant disease detection systems categorize images of plant leaves based on the infections and classify them on the basis of their symptoms. Importantly, the image data set is used to train the AI classifier model to classify/recognize the image(s) under test. The AI classifier is solely responsible to classify/categorize healthy and infected leaves along with the type of infections associated [68], [72], [73].

Machine Learning (ML) is a subset of AI which gives an ecosystem of artificial neural network models that is capable of learning, improving with experiences and making decisions (e.g., classification / categorization) [74]. Generally, supervised learning and un-supervised learning are two forms of machine learning techniques. The supervised-learning uses labelled datasets and the unsupervised learning uses non-labelled datasets for the training [75]. Additionally, a hybrid technique also exists, that is known as semi-supervised learning that makes use of both labelled and unlabelled datasets for training the artificial neural network (ANN). The known classification methods are support vector machine (SVN), artificial neural networks (ANN), k-nearest neighbour (k-NN). Further various models of the respective methods like multilayer perceptron (MLP), error back-propagation, feed forward neural network, fully connected layer (Figure 2) and probabilistic neural network (PNN) are in exploration for plant disease detection use cases [74]–[81]. The complete processing architecture is depicted in Figure 4.

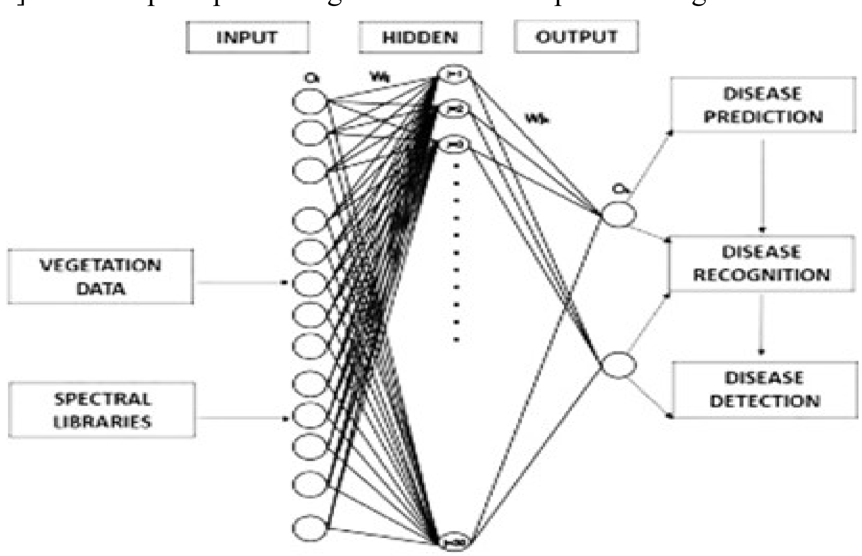


**Fig. 2.** Completely connected neural layer for image processing

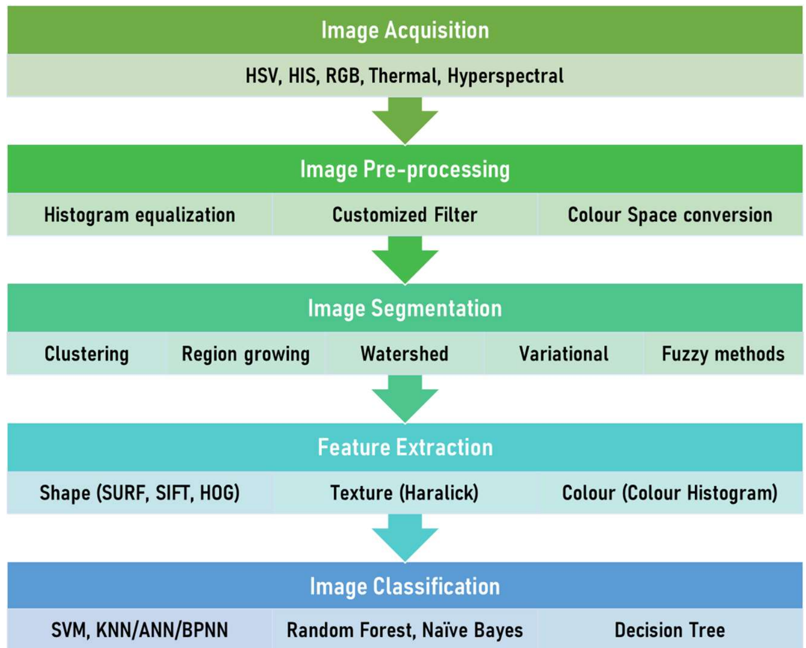


**Fig. 3.** Flowchart for image processing and classification

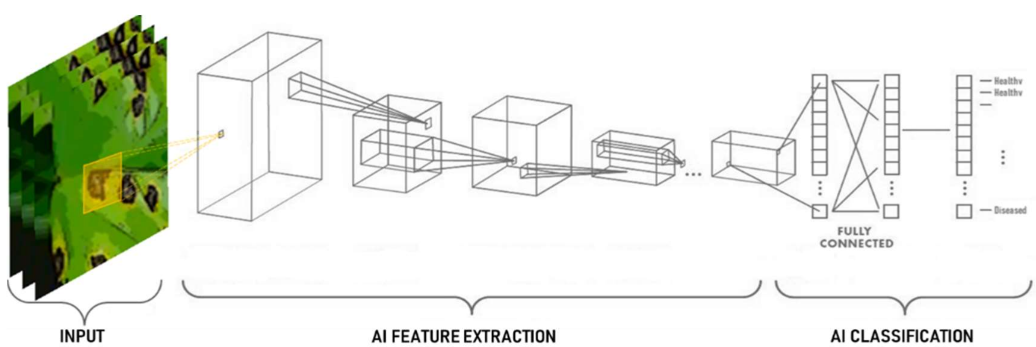


**Fig. 4.** Overview of feature extraction and image classification architecture

## 4 CONCLUSION AND FUTURE PROSPECTS

The classical methods of plant disease detection were based on the careful observation of any alteration in plant's morphology also referred to as symptoms. However, this needs the skill and also the human eye has a limitation to observe in the visible range of the electromagnetic spectrum only. The use of various image acquisition sensors and the combinations thereof, the enhanced computing abilities (using computers) have opened the possibility to analyse the even other regions of the electromagnetic spectrum and can anise complicated data of generated by multispectral and hyperspectral sensors in a non-destructive manner. However, this required the pre-processing of images, their segmentation, feature extraction and classification. AI based methods have a great potential in early detection of plant diseases in a non-destructive way, that can be optimised to field level images at a later stage to a smartphone-based disease detection and recommendations support for the farmers. In near future, the AI based plant disease detection technology may enable us to monitor plant diseases in the agriculture fields in a real-time manner and may also make early recommend the remedies like spraying of an agro-chemical. a fungicide in a mobile app based or somewhat platforms.

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# CHALLENGES IN THE FIELD OF AGRICULTURE AUTOMATION

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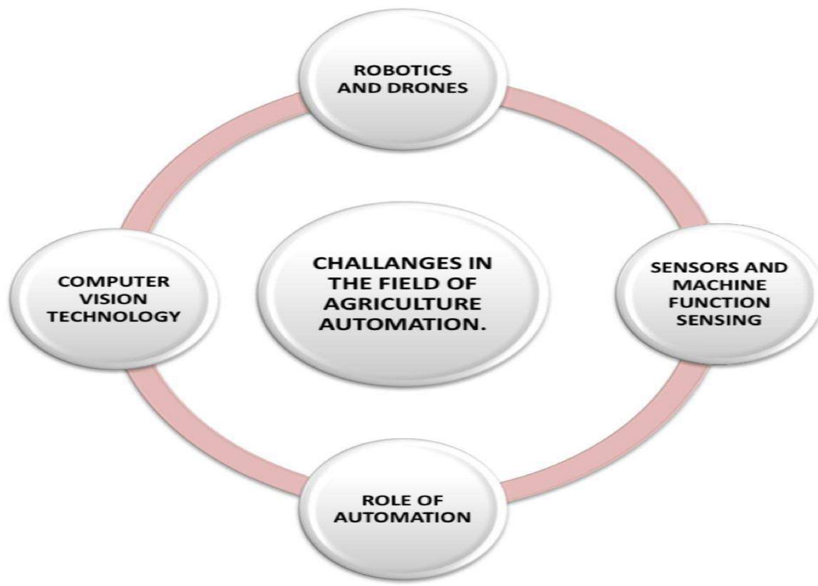
***Abstract:***

*Agriculture plays an important role in the economic sector. The automation in agriculture is the main concern and the major issue across the world wide. The population is increasing continuously and with this the demand of food and employment is also increasing. The traditional methods which were used by the farmers were not sufficient to fulfill these requirements and also these methods of farming include using of pesticides, fertilizers etc. conclusively lead to soil in-fertility. Thus, new automated systems were introduced. The automation in this field can lead to revolution and fulfillment of increasing demand. These automated systems consist of using of new technologies such as Internet of things, Artificial intelligence, machine learning etc. This paper systematically summarizes and analyzes the challenges and technologies in the past years and explores future opportunities for the enhancement of agricultural automation. Through the analyses, it is found that the existing technology can help the development of agricultural automation for small field farming to achieve the advantages of low cost, high efficiency and high precision in agricultural practices. Hereby, the work of many researches is given to get a brief overview about the current implementation of automation in agriculture.*

## INTRODUCTION:

Agriculture in an important part of our livelihood In India, agriculture is our primary economic activity and about two thirds of our population is engaged in the same. As science is growing day by day new technologies are developed, in the field of agriculture many new technologies and ideas were being introduced for the better production of crops. The main basic reason for the enhancement of technology is to help the farmers to produce sufficient foods, feeds, fibers, bio-fuels etc. Automation offers a potential means by which improved productivity, resource optimization, worker health and safety. As the population is increasing day by day the demand for agricultural products is also increasing and the area under cultivation land is continuously decreasing which leads a pressure on agricultural system [1,2]. With these things there is a big ask for the safe agricultural food production methods. Now days the performance of precision agriculture is not limited for the particular land area but it is main focusing into several areas as skills, productivity, technologies etc. [3]. For the performance of agriculture functions which are cultivation, spraying etc automation agriculture becomes the major mode. The word automated is used to explain the parts of machine which are developed to remote manual intervention in agriculture. In the current span the precision agriculture plays an important role in order to maintain the crop production also the environment management at a same width. But today, the precision agriculture is not limited for a specific landscape type. It is focusing on the area of technology, digitalization impacts on society, skills, environment and productivity. Day by day the automation become the trend of new era in which many agricultural operations takes participate like pruning, spraying and harvesting[4]. Agricultural automation largely works on autonomous vehicle such as robot or tractor where it is being used to risky, deadly and long working experienced by the farmers. This paper reviews the challenges which have been faced by the farmers with the development of technologies.




## ROLE OF AUTOMATION

Managing the environment of agriculture becomes a major issue due to increasing population growth day by day as a result the food production decreases. With increase in population the pressure to produce more food is highly affecting the management of agriculture. To reduce this pressure and reset the management the engineers developed the new technologies in the field of agriculture which is known as automation. Now days, the modern agriculture is mainly depending upon the engineering technology, biological and physical science. With the development of new technologies the production of food increase and the time period decrease. Europe and USA subordinate the agricultural mechanization revolution which has been followed by Japan and rest of the world is also adopting it. Present mechanization level of India is between 40-45 percent [5]. The primary goal of farm automation technology is to cover easier tasks. There are some other technologies that are most commonly being utilized by farms. In the start of 20$^{th}$ century the first development of automation step in, automation refers to a procedure conducted with minimum human assistance. As the machines can replace human activity successfully at a low cost and also increasing the speed and success of process such as seeding, monitoring and harvesting looking forward, the contribution of automated agricultural practices to food security is expected to increase. The combination of other technologies with automation advances such as machine learning also boosts crop productivity as highlighted in 2019 review in the journal of artificial intelligence in agriculture. Ultimately enhancing automated machines and processes as well as refining existing technique will provide many solutions to emerging issue. Such progress will improve the outlook of agriculture systems in the face of mounting environmental whilst also contributing to the management of crop health [6].

## COMPUTER VISION TECHNOLOGY IN AGRICULTURE AUTOMATION

- Modern farms management with automation.
- The constant development application field.
- The realization of automatic crop harvesting.
- Need to improve the growth in demand of professional talent.

Computer vision is a technological application that can detect, locate or track objects. It is an important technology in the terms of production automation. These technologies can facilitate object detection and localization but requires a large amount of storage, which poses a significant challenge in their implementation. Automatic working robots in the agricultural sector have been researched for several decades, but there is still ni such accurate product available. Now days due to a lot of advancement, computer vision technology will be widely used in the field of the agriculture automation. The various technologies in the field are machine learning and artificial intelligence etc. The enhancement of these technologies results in the development of agriculture automation. The practices of computer vision technology are not fully developed till the date. If we make a vision at large scale public database in the agricultural sector, there is no such production. In order to control crop pests and diseases we have to enhance the existing computer vision techniques including this there are a lot of area where we need to explore the computer vision technology. Graphics processing unit have played an important role in development of computer vision. In agricultural application the computer vision based statistical machine learning algorithms are widely used some of them are using the high density data parallel computing functionality highlighted in the GPUs [7]. The main existing problem in the computer vision technology is lack of generality and high demand of the professional skill. There is high requirement of experienced persons and the professionals in order to use the computer vision at a large scale, except all this all there is a lot of work done in the field of agriculture automation to overcome the many difficulties and various complementary gaps among computer vision technology, computer vision technology and artificial intelligence algorithms can enhance economical efficiency, general performance, co-ordination and robust agricultural automation systems performance[8].

## DEVELOPMENT IN AUTOMATED SYSTEM

Although we know that technology can revolutionize the agricultural practices but the farmers having lack of technical knowledge regarding machinery equipments can lead to a major challenge. To get rid of this difficulty the developers should keep the farmers in mind at the time of system development including this, developers should also provide the solutions in local languages in order to overcome this challenge. The quality and high cost of the sensors and other devices are experienced as another main problem among the farmers to adopt the advanced technology. On comparison of health care and military application with agricultural solutions they deal with very less personal data. Still, when the information regarding the farm and crop is passed through a channel there are a lot of challenges in the delay reception. Therefore, another major area need to be focused is communication delay. Internet of things and artificial intelligence are expected to contribute in agricultural practices in order to make agriculture automated and smart. The evolution of 5G technologies also played another important role in promoting the internet of things in upcoming years. 5G technology is much better than 4G and also provides a high internet speed. As the main tackling problem of IOT is communication delay this can be solved by 5G technology [9]. The continuous growth of internet of things and artificial intelligence will open a door of opportunities for development of automated systems also besides this sensor and other devices will be available widely at a cheaper cost. The impact of developed agricultural technologies is directly seen at the rate of production practices [10]. For complete enhancement the researchers, designers, producers and the users all need to be actively involved in the complete process.

## ROBOTICS AND DRONES IN THE FIELD OF AGRICULTURE

Crucial technologies developments take place for several processes during last decades. These developments are come into force in order to enhance the production of crop and introducing the new ideas. Food and Agriculture Organization [FAO] of the United Nations shows that there has been undisputed advancement in reducing nourishment amount and upgrade nutrition and health levels in 2017. But if we see in the next 20years there will be a practicing to different agriculture ways. Precision Agriculture [PA] and Agro-ecosystem management introducing technique to upgrade the food production. As the meaning of Precision Agriculture is that to increase the yield production of food with reducing the use of fuel, insecticides, herbicide & nutrients [11]. And Agro-ecosystem says that make more interaction with nature so that they will grow more. But these two approaches are difficult to understand as we cannot measure the crops from inch to inch. To overcome these problems Robots & Drones are come in the field. The development of Robots & Drones helps to enhance the production of crops and to reduce the work of the farmers. But there are some challenges to work with these technologies which are as follows:

## BUDGET

The main existing problem which has been seen in past years is that the farmers have to invest a bunch of money to buy sensors which is used for autonomous navigation and are commercial agricultural robots. The cost of robots like BoniRob, GRAPE and AgRob, Robotanist, Ladybird and strathclyde is in the range of 7,000 USD to 38,825 USD and the hardware component which are used for navigation are approximately exist in the range upto 8,000 USD[12]. The estimated price of robotics is classified on the basis of light weight and heavy weight. It seems very difficult to work with these expensive technologies because the small scale farmers cannot afford this for more productivity. Therefore, the price of sensors and robotics should be diminished by companies as low cost new technologies step in market.

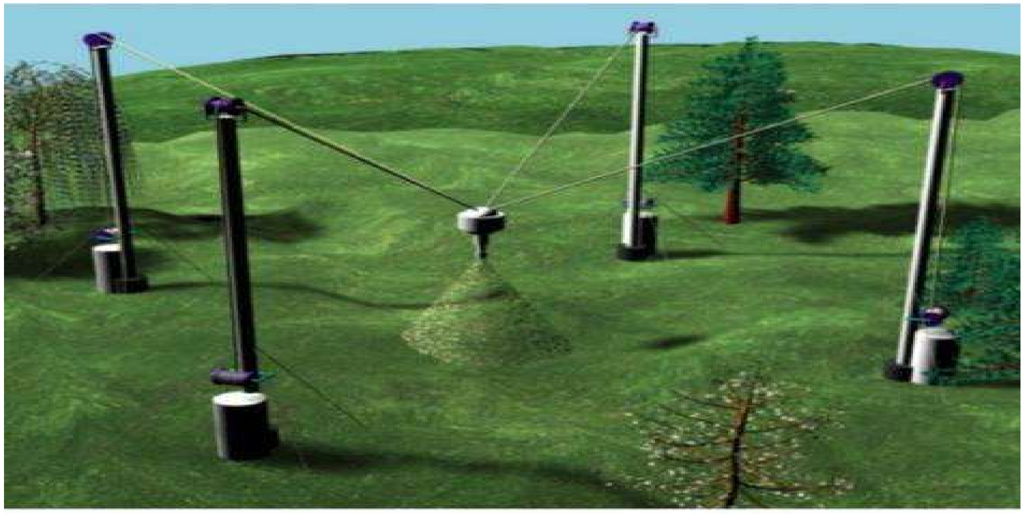
## REPLACEMET OF NATIVE WORKERS

Many ethical issues which are coming in force due to arise of robotics and drone technologies in agriculture over the years are that the migrant workers are replacing the native workers across the developed countries. There are around 65000 migrant laborers in UK farms occur due to lack of knowledge [13]. Native workers often low skill, preferring to stay unemployed mostly in those countries which have strong welfare state system. The highly skilled migrant workers with their unique skills take place of native workers and the enumeration of an ageing population stops the supply of the manual labor. In UK the average age of farmers is 58 years [14]. In result we can say that the robotic automation is a creator of desirable and rewarding employment enabling human jobs and captivating skilled workers and graduates to agrifood.

## REQUIREMENT OF LARGE AREA FOR LARGE SCALE WIRE ROBOTICS

Fundamental challenges of these technologies include large working area as the development of wire robots need large region to be placed. Wire robots pointing the benefits of evaluating large spans, fast moving, light weight and heavy duty active spatial mechanisms.

Robacane NIST represents first large wire robot having the 6m span, which is used to perform various applications [15]. One of the best cable-array robots are the sky cam and spider cam which provide computer controlled, stabilized, cable suspended camera transporters. The systems have three dimensional spaces with a set of four computer controlled winches. It is a broadcast quality, robotic camera, suspend from a cable driven, computerized transport system. The operations such as fertilization and spraying, plant inspection and disease detection, optional irrigation, spraying and selective harvesting etc. can be done with the help of robots. Some wire robots like five hundred meter aperture spherical radio telescope (FAST) need large area to be placed. It is based on the structure of cable drive Stewart platform which take in large space coarse motion. The rigid Stewart manipulator attached to the suspended trolley which is responsible for fine manipulation. LOFAM (large area overhead manipulator for access of fields) representing the first effort for introducing the wire robot in agricultural sector. LOFAM performance for large area applications without stabilizing downhaul cables [16]. In short these wire robots need a large area to be developed.

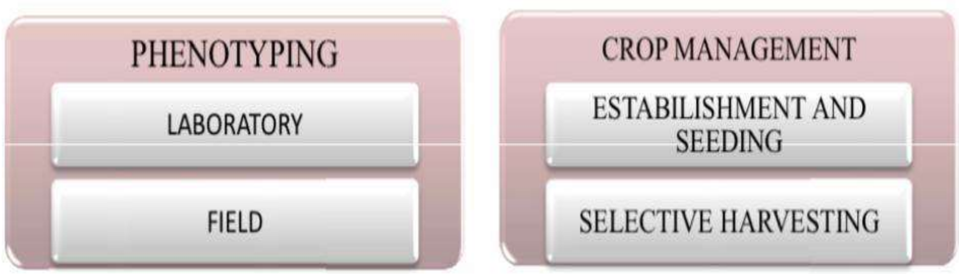


**A SCHEMATIC VIEW OF WIRE ROBOTICS IN FARMS**

**BREEDING AND FARMING:**

Breeding and farming are two main challenging areas for agro-robotics. The second name of breeding and farming is phenotyping and primary production [17].

- Phenotyping and crop management.




Plant phenotyping: offers data on the anatomical, historical, biological and physiological properties of the plant. Plant phenotyping is a leading factor in the intensity of selection, precision in selection, and new genetic variation detection. Within a plant breeding system, genetic benefit (the amount of increase in output over time) can be accelerated in a variety of ways, including by increasing the size of breeding program to allow for higher selection intensity [robotic issues] recognizing and selecting the heritable with advantages of biotic or a biotic input and output traits of biomass conversion. In recent years the breeding action have been seen the percentage of robotic systems to decrease the dependence on manual intervention, but the price and difficulties to develop, result in limiting their uptake [18]. The uncontrolled 'non-laboratory' systems raise appropriate challenges across the specific traits to make a beneficial phenotyping response.

Crop management: In crop management the seeding, crop care and harvesting are involved. The ploughing is an important cultivation process which involves the mixing of topsoil and 80-90 percent energy of traditional cultivation is used to fixing up the damage done by the tractors. Robots also play an important role in the inputs to primary production including the monitoring and interventions mainly for soil and water. The main operation in the crop management is to make a survey of the crop. The autonomous robots, range of sensors are used to check the health of crop. Robots work on different parameters like robotic weeding is a dynamic area of ongoing research, finding alternative technique to kill, remove or retard unwanted plants without giving any damage to crop [19]. The inter-low weeding is more difficult as it requires precise positioning of the crop plants as compared to intra-low weeding.

## CONCLUSION

In the whole review on automation challenges in agriculture the main idea which came out is that with increasing the newly discovered technologies the new challenges step in the field of agriculture. The challenges which we discussed above are quite difficult to resolve but farmers have to cope up with these newly developed technologies in order to produce good quality of food in a short period of time. But with these new technologies like robotics, drones, computer vision the work of the labor is extremely reduced which can lead to a factor such as unemployment and also with enhancement of these innovative technologies the cultural way of farming is disappearing day by day. In last, the meaning of automation is not just development of technologies, new ideas etc. but also the decrement of wastage produced in farming practices.

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# ROLE OF EXPERT SYSTEM IN AGRICULTURE

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## *Abstract:*

*Expert system is a computer system that solve the problems in the particular area. It provides the information about that area that we need. It provides training tool. In this draft we study about the expert system in agriculture. It plays main role in the agriculture for better cropping and it gives knowledge all about cropping. It makes a channel between scientists and farmers. When farmers face any difficulty in the area of agriculture it gives the particular solution for that difficulty and they use this piece of information to take idea. We explain the need of expert system in agriculture that how it helps for betterment of the crops and growth of system. It includes the procedure how expert system in getting input from user call user interface and then it reaches to rule engine that find the problem and it share to expert, he/she find solution and research on it and then share solution about it that helps the farmers. There are many applications of the expert system in which fields expert system is working and how it helps in cropping. There are existing of limitations in the expert system like if user get wrong information about there problem then it makes big problem to expert system and then researchers are work on it and correct this mistake. We also explain emerging technology in this draft. A production table shows the growth of agriculture in previous years.*

## INTRODUCTION:

It indicates by name that expert system means a expert in a particular system or domain. Expert system is a computer program that solve the problems of people in a particular area and also called problem solving domain. Expert system provides effective ways to solve any problem easily. Expert system works in many branches like food, clothing, agriculture, water treatments, building works, related environment and animals. In this chapter we discuss about the role of expert system in agriculture, it means how expert system works in field of agriculture for better results. Expert system has a lot of knowledge and information. It gives advice to less experience person in agriculture how to select material for a crop and everything that a crop needs for better growth. It tell us about proper seeds, soil, season that required for proper growth of crop. People take information from expert system for better understanding in a special area which they work. Expert system has solution of every problem because it spread in all over the world. Whole world scientists and professors are connected with expert system and share knowledge in which they research.

## Striking question:

Que: Why am reading this paper?

Ans: THIS paper explores the probabilities of development and implementation of an expert for different activities of agriculture in integrated approach. Also in this, the first commercial products of artificial intelligence and is now available in the large number of areas. The potency, scope and appropreateness of expert system in the area of agriculture have been well realized two decades back in development countries. [5][6]

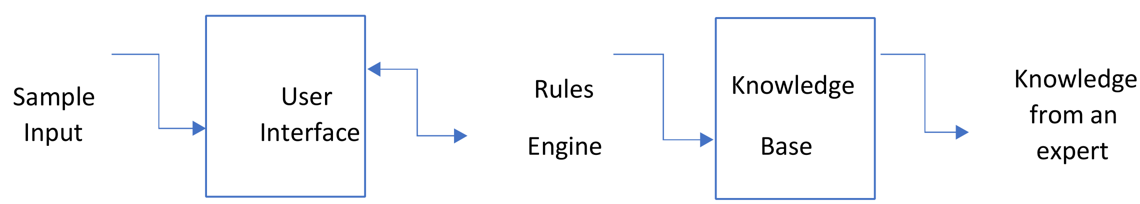
They involved human experts and very scare, inconsistent in their day-today decisions unable to comprehend large amount of data quickly. [Expertsystem in artificial intelligence is a prominent domain for research in [AI] It was initially introduced by research at STANDARD UNIVERSITY and was developed to solve complex problems in a particular domain]

## NEED OF EXPERT SYSTEM IN AGRICULTURE

In previous year people are not aware about better agriculture system and this is main problem of less growth of agriculture. There are no arrangements of workshop to give information and knowledge to farmers about crops. For this, expert system plays an important role in agriculture. It provides a channel between scientists and farmers. That channel is only possible by expert system. Many scientists of higher knowledge and education in particular area are connected with farmers by expert by system directly. If a farmer or any person faces difficulties in agriculture then he/ she use that knowledge or piece of information for their ideas and it makes easy for them. Expert system gives the training tool in agriculture. [7]

## PROCEDURE

Expert systems are compound of several basic components as a lower interface, a database, a knowledge base, an interface mechanism and learning module.



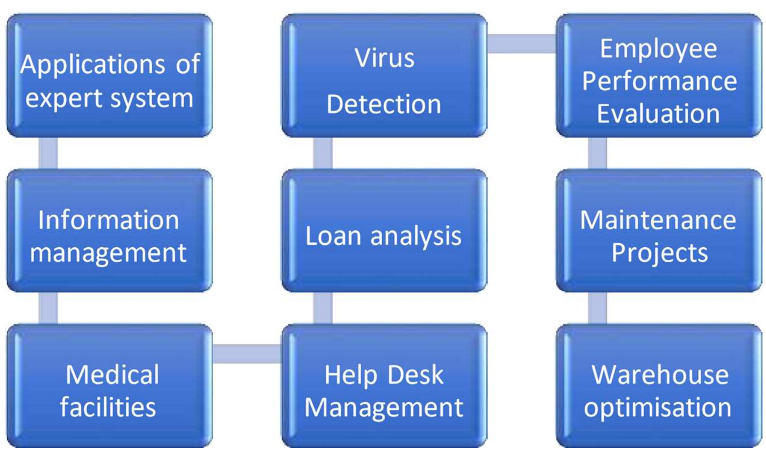

Above expression shows that how the expert system stimulates dynamically. By knowing the skew fragments of particular expert system the normal man in field of agro works can access easily whole the peaks of betterments. In the procedure of expert system user or farmer gives input to the expert system and then it works on it and export this information to rule engine and scientists and researchers are modify this problem and then working on it. And find appropriate solution for that problem and share with other experts and then they export this knowledge to farmers and they use this information for better cropping.[7]

### DEVELOPMENT OF EXPERT SYSTEM IN AGRICULTURE

An expert system is that system which captures the human knowledge in computer to solve the human problems that are required by human expertise. In agriculture, expert system provides the information about pathology, methodology, agriculture meteorology, entomology, horticulture and animal science that bases on the requirements of farmers. Expert system transfer knowledge and guide to growers to take different decisions for increasing the productivity of crops. Expert system grows due to change in time. It gives best results, that satisfy to a farmer. It shares same knowledge and information to different locations at same time. It is the big achievement of the expert system. Expertise try to give their best of knowledge to growers and give different ideas about same topic. Development of expert system is possible because of scientist that are connected with this system. It provides fast way of communication between scientists and growers. In today's world the importance of expert system increases day by day in every field. Farmers who use the expert system and gain knowledge from this are successful in their field. Expert system works according a module that first it take input then it shares to the rule engine. Many of the scientist are connected with expert system and they they work in that area. Then it shares collected information to expert and then it shares with farmers as output. It gives all information collected about that particular area. Expert system provides solution of every problem. Many types of languages are used in this system that provides easier and faster way of sharing knowledge. In agriculture, scientists give knowledge about cropping – which type of soil is used? In which season crop have better growth? Which type of fertilization method is required by that crop? What type of seeds are best? How much water is it required? How much sun light is essential for it for better growth? etc.

## APPLICATIONS OF EXPERT SYSTEM

In this paper we represent the framework of expert system in the area of agriculture and describe rules of expert system. It is a knowledge base system that transfer knowledge from one place to another place. The scope of expert system is increasing with time. Expert system works in every field effectively. The purpose of expert system is collect information from different places and give it a sequence and then share it to others. This information is collect from higher scientists and researchers who works in particular domain.



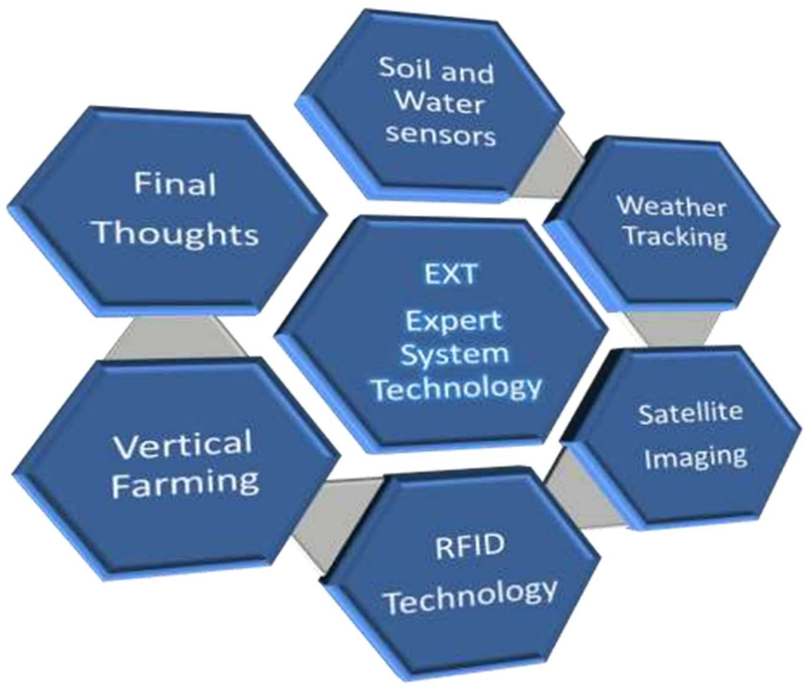

## LIMITATIONS OF EXPERT SYSTEM

- Sometimes the expert system gives wrong information because it gets wrong input.

- The development cost of expert system is very high.
- Like as a human expert system doesn't produce creative output for different systems.
- It's very difficult for scientists to upload same type of data in different forms.
- We cannot learn expert system itself because it requires the manual updates.
- For every domain we use different types of expert system in specific area.
- It also includes income instability.
- Farmers want affective way for production but if Expert system fails for it there is no more interest of farmers.

## 5 EMERGING TECHNOLOGY IN AGRO WORKS

Soil and Water sensers Weather Tracking Satellite Imaging Pervasive Automation Minichromosomal Technology RFID Technology Vertical Farming Final thoughts

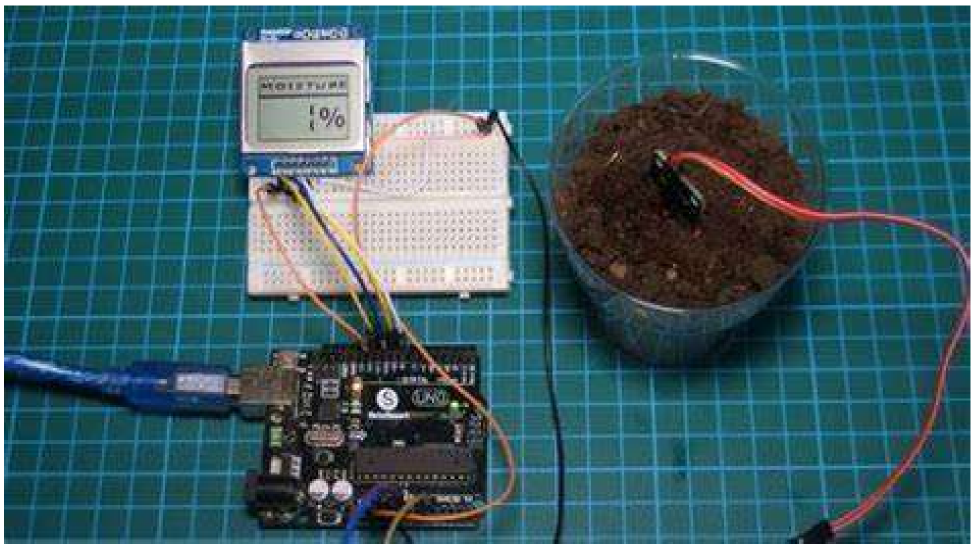



Certainly, the tools having the most quick effect are soil and water sensors. These sensors are durable and somewhat expensive.

Although the family farmers are seeping it affordable to spread them throughout their grasslands and they provide quality outputs. It provides knowledge in every field. In cropping it gives idea about soil, water sensers and weather and fertilization method used in this crop and provide satellite imaging, about the type of farming and gives knowledge about RFID technology etc. For instance, these sensors can be detect moisture and nitrogen levels, and the particular farm can be use this information to analyse when to water and fertilize rather than rely on a pre solved flowchart. And that given results in a more durable use of sources and evenly lesser costs. But it also helps the needy Farm to be more greenhood friendly by saving water, lesser erosion and reducing fertilizer or particular levels in local canals and water bodies.[8]

Weather Tracking:- Now we are still making beat about bushes of our local metereologists, the real thing is that the computerized forecast modelling is becoming increasingly conjusted. There are online weather services that focus exclusively on agriculture and farmers can reach their services on dedicated onboard and handled farm technology but also through phone apps that run just about any consumer smartphone [8]

Soil and Water sensors:- The soil moisture sensor is a device that measures the strength of current soil moisture. The most common types of soil moisture sensors include tensiometer, capacitance, dielectric method, gypsum blocks and neutron probes. These meters help to reduce or enhance irrigation to achieve optimal path growth.




Soil senser

Overirrigation can also:

- Increase water and energy costs
- Leach fertilizers below the root zone
- Erode soil
- Move soil particles and chemicals to drainage ditches

By understanding basic soil water concepts the strength and weakness of different types of soil water sensors, methods of installing them.

Satellite Imaging: - As remote satellite imaging has become more crowded. It's make it for real-time crop imagery. This isn't just a bird's eye-view snapshots but images in resolution of 5meter panels and even greater.[8] Additionally, this technology can be co-relate with crops, soil and water sensors so the farmers can collapse the updates along with appropriate satellite pictures when there emergency danger thresholds are met.

Minichromosomal Technology: - Recently one of the exciting realistic agrotechnology is coming in a quite tiny package.

- A minichromosomal is a small structure within a cell that consists very tiny genetic material but can, in layman's terms.
- It carrying a lot of information.
- By stepping in minichromosomal, agro- genetics can add dozens and may even

hundreds of trait to a plant. These traits can be conveniently complex.

Thus, the results are faster regulatory approved and vast, quick acceptance from consumer. [8]

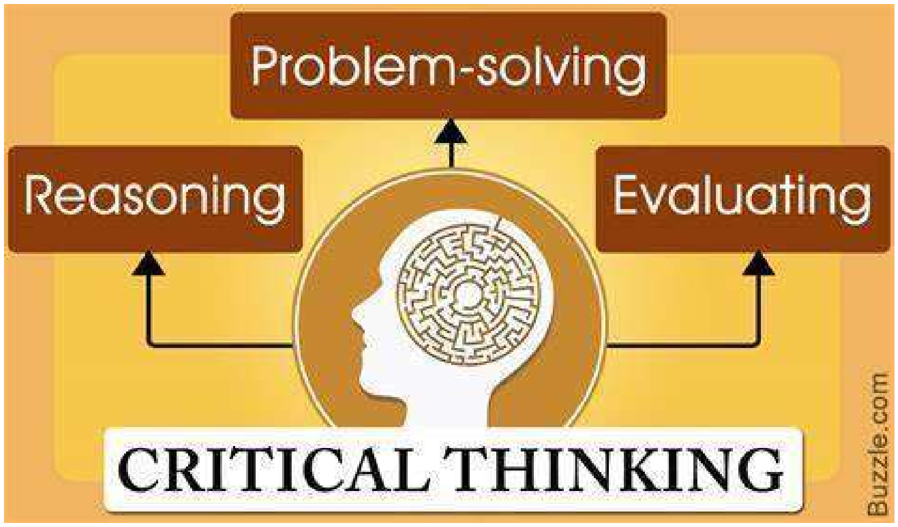
Pervasive Automation: The kind of automation is like a burr term in the agriculture technology industry. It can reduce operator workload, example- like autonomous vehicles handed by robotics or remotely through the terminals and hyper precision, which then rename as RKT navigation system.

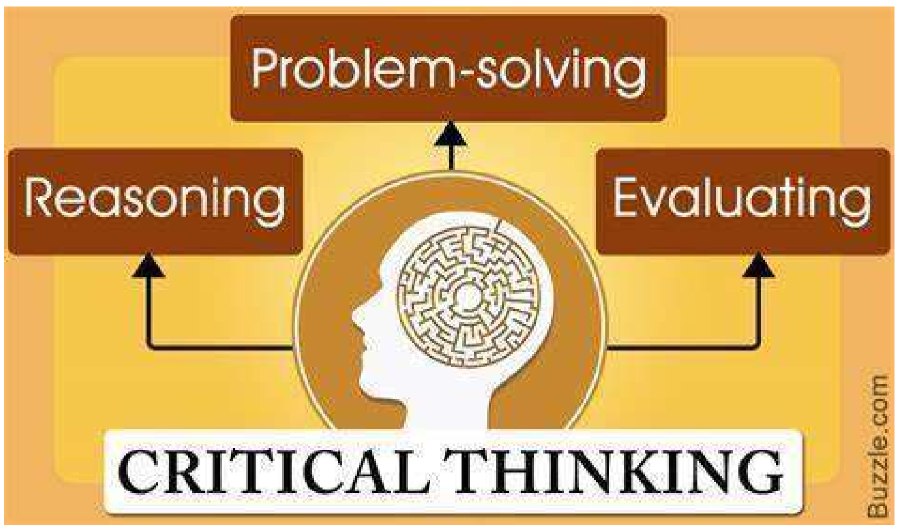
Which can make dropping of seeds and fertilizations system as possible as they can. There are variety of farming tools already adopts the ISOBUS standards and then they adds on the precipice of a forming. Actually where the balers, combines and tractors and rest of tools to interacts and even operate in a plug and plug manner.

RFID Technology: The term refers as “Radio Frequency Identification”. In this, the land water sensors refers earlier have set a foundation for traceability. The base workshops has only began to realize this infrastructure, but its taking the fast molding. There tech gadgets gives updates then can be associate with farming yields. It likely as science fiction, but we’re existing in real world where a bag of tomatoes can have a bar scan that we can scan with your smartphones in wish to access data about the soil. A coming future where the farmers can marketed by own and have loyal and not baised purchasing.[8]

## CONCLUSION

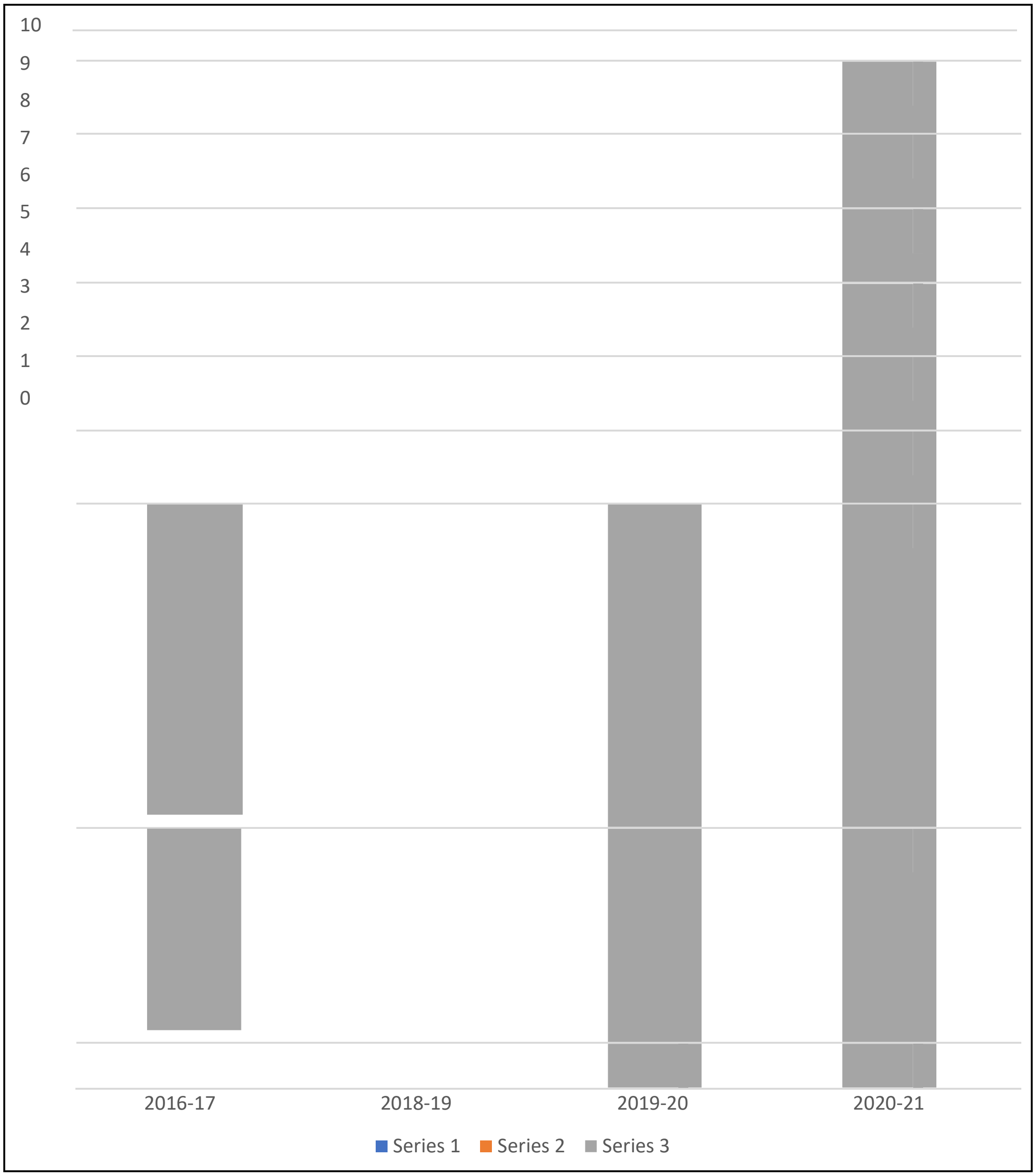
In this paper we discuss about the expert system in agriculture field that how expert system help in agriculture for better result. Expert system is a domain in which we find effective solution of our problem related to agriculture in any type of crop production. In today’s generation expert system become very popular in people. Many of the scientists are connected with expert system and they provides farmers best of their knowledge and information. It works as a channel between farmers and scientists to share solution of problems. It helps to growers to take decisions for crop management, fertilization methods, nutrition management, soil preparation, weather casting. Most of the expert system are in English language so its difficult for Indians farmers to understand because most of Indians farmers are uneducated or less educated. So, expert system are provided in mother tongue also and use audio visual aids for share knowledge to farmers. There are few application and limitation of expert system in which we discuss about the working of expert system in agriculture and sometimes it gets wrong information etc. are solved by the research in this area. In development of expert system, its performance is increase day by day. Most of the people are used it in their work and take ideas from it. Expert system provides a proper domain for problem of a solution. It has many domains in different areas so we can use it in every field we want to take information. Sometimes system gives wrong information related to our search then it produce some problems for scientists. To reduce this farmers write in complaint box to research and they take strict action related their information. In the agriculture expert system plays main role for problem solving system. This draft is helped for contribute to an easy development of other expert system.




Expert system increase the production of crops by taking one or more decision about one problem, scientist and researchers are work on it and provides many ways to solve a problem so it gives more option of farming. Its very useful in today's generation because it gives every problems solution no matter is it a big problem or small problem. It also gives the knowledge about meterology, entomology, pathology, horticulture in agriculture. It tells us all about the particular area that we required.

**PRODUCTION TABLE:**




This growth is related to agro- sector in past 5 years of India. This indicates the impact in the reuse of natural and handmade resources. In last 10 years of agriculture farmers used to circulate to their form by their traditional practices. It has been continued till years between 2010-15. But due to need for satisfying the over population. There was huge rise up in agriculture sector. Modern equipments and vaster. But after the 2018 covid-19 virus again falls down the rate of growth. But modern technology like expert system again shook it up.

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# A SURVEY: SMART FARMING USING CLOUD COMPUTING

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***Abstract:***
*The availability and consumption of food are rising together with the global population. For most people in India, farming is their main source of income and survival. One of the emerging agricultural technologies, known as "smart farming," aims to increase food output by utilizing a variety of cutting-edge farming technologies. With the use of sensors and actuators, cloud-based smart farming enables farmers to continuously monitor their fields, crops, water, fertilizer as needed, and livestock conditions. In order to produce the number and quality of crops they need, farmers use an autonomous irrigation system. The success of agriculture for the development of farmers, which in turn is for the successful development of the country, depends on a number of apps, technologies, and cloud services. This study describes the cloud computing technologies, services, and advantages for farmers to raise their productivity and efficiency for improved agricultural cultivation.*

***Keyword:*** *Cloud Computing, Smart Farming, Agriculture Monitoring*

## 1. INTRODUCTION

Cloud computing is a collection of shared pools of resources, software, applications, and services delivered over the internet in response to customer demand. India is referred to as a land of agriculture since it produces more foods, cereals, and other goods than any other country. The farmers continue to engage in archaic, conventional farming practices. Weather, water use, and deteriorating soil have all prevented the improvement. of farmer's economic circumstances. By improperly controlling the controlled environment of crop development, such as a greenhouse, cloud technology can solve the challenges in agriculture. It helps farmers by providing timely agricultural guidance on topics including pesticide use, seasonal plant diseases, as well as natural disasters and recovery strategies. It is possible to store information about soil, weather, crops, and farmers in a number of separate databases in one place or in the cloud. Farmers, experts, consultants, academics, and other end users can access the data at any time from any location using smart devices that are linked to the cloud system. The following is a list of the various types of sensors like moisture, air humidity, temperate that are used to mange the crops.

**1.1 Crop Data:** This database keeps track of all the crops that have been grown in the past and the present and advises farmers on what crops to plant next. The cloud can be used to store weather data, including present conditions and forecasts of data relevant to region-specific problems and their effects.

**1.2 Soil Data-** The decision-making process for crops uses just soil data for calculating soil air moisture. Without the profile, it can show past pattern in the soil, making it simpler to predict an upcoming trend.

**1.3 Crop Growth**- Crop growth is regularly observed in a number of sites. This makes it possible to compare recent growth trends to earlier growth patterns.

**1.4 Farmers' Data-** Regional-level farmer information can be gathered, followed, and examined with the aid of local farmers who are assessing their own performance. Manually maintaining both field and financial data separately leads to errors. Insecticides and fertilizer are sprayed all over the field. Smart farming helps in early detection and practical application only to the damaged area reduce costs.

Satellite and aerial imagery are crucial in modern agriculture because the elements of temperature and soil moisture influence the growth of agricultural, including productivity, illnesses, and yield generation. New methods s designed using Raspberry Pi and Arduino as the main micro-controllers to control the various sensors, relay-switch, and motor are required if agriculture is to grow and reach its full potential. Physical objects with sensing and actuation, which are essential for connectivity with the internet, supply the user with accurate information. The report discusses the benefits and challenges of cloud computing in smart agriculture.

The following are some of the technologies that are available to farmers today:

**1.4.1 Sensors:** Soil, water, light, humidity, moisture and temperature control.

**1.4.2 Software:** Specific software solutions for different types of farms or IoT platforms that are not case-specific.

**1.4.3 Connectivity:** Cellular, Long Range Radio ( LoRa), LoRa WAN etc.

**1.4.4 Location:** satellite, GPS, etc.

**1.4.5 Robotics:** self-driving tractors, manufacturing plants, etc.

**1.4.6 Data analytics:** this includes standalone analytics information and data pipelines for later-stage solutions.

## 2. LITERATURE REVIEW

Markovic et al., [1] When using cloud computing, users can access applications through a browser while the software is installed and maintained on a server. Numerous farmers may now access information without having to download or install anything on their computers or mobile devices thanks to a brand-new style of computing. Agriculturists and average farmers can now gather and share agricultural data in real-time from any location due to sensor technologies, personal mobile devices, wireless internet connections, and cloud computing. Personal mobile devices, such as smartphones and Personal Digital Assistants (PDAs), are advancing in terms of processing and information management, and they are becoming a more significant part of people's daily life. This designed a scalable, affordable real-time agricultural monitoring and analysis system as a result of this technological advancement for individuals who need to frequently monitor their crops.

Muhammad Junaid et al. [2] built a real-time, cloud-based agricultural monitoring and analysis system that can help farmers manage their farms more effectively by reducing or eliminating on-site consultations. The majority of the aforementioned problems that currently plague agriculture are to be resolved by an AGRICLOUD. The major objective of researches is to suggest a creative method for structuring methods in the cloud, which will allow for initial pre-processing of large number data availability and various resources utilization. When resources are allocated to the virtual machines as a result of this pre-processing, execution time and energy consumption will be drastically decreased. As the solution is evaluated with progressively more resources, it becomes feasible, resilient, and scalable.

Meenakshi Rathod et al. [3]. proposed use of cloud computing and IoT for Smart Farm Agri Tech. Given that the world's population is currently increasing daily, feeding the entire population is a difficult undertaking.. Therefore, the agricultural industry should adopt cloud computing, IOT, networking, and many other technologies for crop maintenance, weather, water monitoring, and fertilizer application as needed. To control the many sensors, relay-switch, and motor in this Smart Farm AgriTech System, Raspberry Pi and Arduino were used as the primary micro-controllers. The server and APIs used to gather and store the data through the Internet or a Local Area Network are made by AWS and Thing Speak (LAN). The data coming from the Raspberry Pi and Arduino board is also controlled and monitored by a GUI (Graphical User Interface) application.

Sutanni Bhowmick et al. [4] have detailed about Vertical farming concept in his paper. Vertical farming is a modern tool for measuring the ambient factors of the soil that improve the crop cultivation. He developed sensor arrays for collecting data and sent those data to the cloud system module and analyzed the ambient factors. He also made use the app, to intimate the farmers about the threshold falls.

K.A. Patil et al. [5] has proposed a model in a combined approach with internet and wireless communications. He named the system as Remote Monitoring System (RMS). The system gathers real-time data from the production environment and sends the farmer notifications via SMS. It also offers some basic recommendations on weather patterns, crops that should be planted in the soil, and other topics. Thus, this approach was successful in giving farmers convenient access to agricultural facilities. Thin Film Dual Probe Heat Pulse (DPHP) Micro Heater Network for Soil Moisture Content Estimation in Smart Agriculture was introduced by Almaw Ayele Aniley. By tying together sensors and actuators throughout the farming area, he put forth the network concept. To increase soil humidity, the suggested technique measured soil nutrients and PH.

Mahammad Shareef Mekala et al. [6] A small number of common technologies are using cloud computing. The development of sustainable smart agriculture benefits from a thorough grasp of the various technologies. With a wireless network, a IoT-enabled devices might be thought of as more precise and effective in agriculture. The business of agriculture can be improved through the effective use of various resources, such as energy and water. The efficient use of fertilizers and pesticides is made possible by IOT, which also contributes to the development of an hi- tech Agriculture farming. IOT architecture that is encapsulated with low costs, low device power consumption, better decision-making processes, quality services, optimal performance, and is simple to grasp by farmers without technical expertise.

## 3. CLOUD COMPUTING TECHNOLOGIES

The most fundamental function of cloud computing technology is to provide users with online access to certain software, data, and applications. Data is saved on remote servers, independent of the user, rather than on the local network or the device's actual hard drive when cloud computing technologies are employed. Therefore, customers only need to enter into a website or portal with legitimate credentials to access their data, their subscribed applications, and cloud storage over the internet. Cloud-based technologies work across their different types and forms are listed below.

### 3.1 VIRTUALIZATION

Virtualization is a physical instance of an application or resource can be shared by a number of clients or businesses. For consumers of their cloud services, it offers the applications in standard editions.

### 3.2 Service Oriented Architecture (SOA)

A paradigm for application development called SOA separates common business applications into discrete services, or business activities and procedures. SOA support both user front end applications and enterprise back-end servers to be integrated into cloud services.

### 3.3 GRID COMPUTING

Grid systems are created for resource sharing using widely dispersed large-scale cluster computing. By breaking enormous problems down into smaller ones, servers are broadcast to and placed inside the grid through the use of grid computing.

### 3.4 CLOUD COMPUTING(CC)

On-demand computing is the technique of distributing system resources and data among users on demand. It can be portrayed in a variety of ways, including IaaS, PaaS, and SaaS. It has four deployment model such as Public, Private, Community, Hybrid.

### 3.5 EMBEDDED SYSTEMS (ES)

Utility computing is based on Pay-per-Use model. It provides computational resources on demand as a metered service. An embedded system may not have any user interface tools built into the devices to perform the task.

## 4. CLOUD COMPUTING SERVICE MODEL

Raj Kumar Buya [7] The term "cloud computing" refers to a parallel and distributed system made up of a number of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources in accordance with service-level agreements that have been negotiated between the service provider and customers. This definition of "cloud computing" states that it is the act of providing software and infrastructure as a service that is paid-as-you-go.

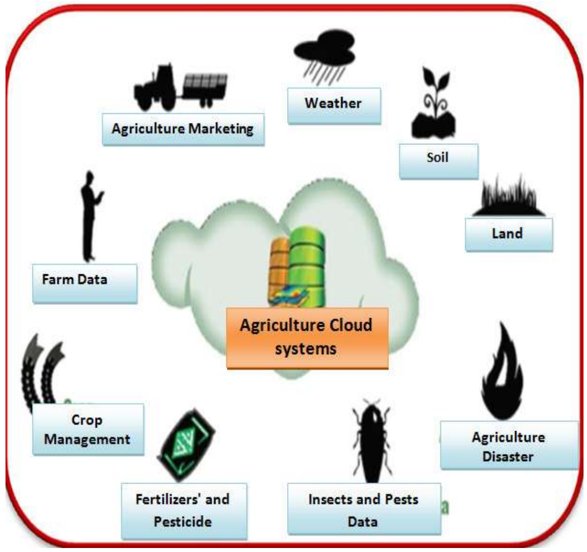


**Fig. 1.** Agriculture cloud System

The concept of cloud computing was first used for business in 2007 by tech giants like Google and Amazon. Cloud computing technology and resources are centred in centralized data centers, dynamically changed and calibrated to reach maximum efficiency, giving an unmatched economy of scale. The cloud concept is made available to customers as focused pay-per-use services with guarantees provided by the providers through personalized Service Level Agreements (SLAs). Web browsers, mobile apps, thin clients, terminals, emulators, etc. are examples of cloud clients. Cloud computing services for agriculture assist in centrally organizing and storing all of the data. It may contain several, independent databases. Data availability can be achieved by storing soil-related, weather-related, research, crop, and farmer-related data in one place. End users, such as farmers, specialists, consultants, researchers, etc., can easily access this data at any time from any location using devices connected to the cloud system. A cloud client is any computer hardware or software that uses cloud computing to deliver applications or use cloud services. The following three cloud services are described in further detail:

### 4.1 SOFTWARE AS A SERVICE (SAAS)

A cloud application eliminates the need to install and operate the application on the user's computer by delivering "Software as a Service (SaaS)" through the internet. Commercially available software that is accessible through a network and maintained from a single place, allowing users to access these programmes remotely over the internet. CRM, email, virtual desktops, gaming, and communication are all examples of communication tools. SalesForce.com (SFDC), NetSuite, Oracle, IBM, and Microsoft are a few examples of significant vendors. The SaaS that is used the most is Google Apps.

### 4.2 PLATFORM AS A SERVICE (PAAS)

On Paas are all the applications that the client generally needs deployed. Thus, the client does not have to deal with the inconveniences of purchasing and setting up the necessary hardware and software. Through this service, software developers can access all the environments and systems needed for the development, testing, deployment, and hosting of web applications, including a database, web server, execution runtime, and development tool. Two prime examples are GAE and Azure.

### 4.3 INFRASTRUCTURE AS A SERVICE (IAAS)

Iaas has its own servers, load balancers, storage, virtual machines, and network. Clients are not required to buy the necessary servers, data centres, or network infrastructure. The fact that clients only need to pay for the time they use the service is another major benefit. Customers can benefit from considerably faster service delivery at a lower cost as a result. Some examples: GoGrid, Flexiscale, Layered Technologies, Joyent, and Mosso/Rackspace

## 5. APPLICATIONS OF IOT IN SMART FARMING

M.Sowmiya, S.Prabavathi [8] The concept of "Smart Farming" is not widely used in India, although it has dynamic qualities for assisting agriculture. It helps the plant grow and develop in a variety of ways. The following list includes the applications for enhancing plant growth.

### 5.1 MONITORING OF CLIMATE CONDITIONS

The main elements to consider in agriculture are the climate and weather. Several sensors are used in IoT-enabled smart agriculture to keep track of the local climate. The sensor's job is to gather data from all around the field and send it to the cloud. The cloud contains certain fundamental measures that will be compared to the sensed data. We can map the climatic conditions and select the necessary crop for cultivation based on the comparison. These IoT devices for agriculture include METEO, Smart Elements, and Pycno, to name a few.

### 5.2 AGRICULTURE DRONES

Drones are among the greatest IoT uses in agriculture. Drones give aerial and graphical maps of the plants, enabling farmers to identify which crops require immediate attention. Additionally, drones assess each crop's health, irrigation, progress tracking, spraying, and planting. Drones are useful for reducing work and saving time. There are two different kinds of drones: aerial drones and ground-based drones. Both are utilised for soil & field analysis, irrigation, planting, and crop health assessment. Farmers must select the field's height or ground resolution before using drones on it. The farmer can therefore provide quick assistance for thenecessary crops thanks to the drones, which capture images of the crops.

### 5.3 LIVESTOCK MONITORING

Monitoring the health of the herds is done through livestock. The IoT device tracks the animals' health and keeps an eye out for any sickness symptoms. The sensors attached to the animals will gather information about their whereabouts and health. Even cattle pregnancies may be tracked by the sensors, which can also signal when a cow is about to give birth.

### 5.4 SMART GREENHOUSES

A method for increasing crop, vegetable, and fruit yields is greenhouse farming. Greenhouses can regulate environmental factors in two different ways: manually or with a proportional control system. These techniques are less efficient, though, because manual intervention has drawbacks such production loss, energy waste, and personnel cost. A smart greenhouse uses embedded IoT systems to intelligently monitor and manage the environment. removing the need for human intervention in the process. In a smart greenhouse, various sensors that measure environmental parameters in accordance with plant requirements are employed to regulate the environment. When it connects utilizing IoT, a cloud server is then created for remote access to the machine.

### 5.5 CROP WATER MANAGEMENT

Agriculture requires a lot of water as a resource. The availability of sufficient water is a prerequisite for all agricultural activities. Therefore, it is essential for the farmer to guarantee that the crops receive an adequate supply of water. In order to guarantee a enough water supply for the irrigation of the crops, this method makes use of the Web Map Service (WMS) and Sensor Observation Service (SOS). So, this IoT helps to prevent water waste.

## 6. SENSOR-BASED AGRICULTURE MONITORING

With the aid of the technology employed in "smart agriculture," farmers now have access to GPS, soil scanning, and improved crop monitoring. Three GPS satellites are used by the location sensors to determine the precise location.

**6.1 Optical Sensors-**To measure the characteristics of the soil, optical sensors are employed. Near-infrared, mid-infrared, and filtered light spectrum reflectance

frequencies are measured by the detectors. On vehicles, aerial platforms like drones, or even satellites, sensors can be mounted.

**6.2 Electrochemical Sensors-** Important farming information on pH and soil nutrient levels is provided by electrochemical sensors.

**6.3 Mechanical sensors-** The mechanical resistance or resistive forces of the soil are measured by mechanical sensors. By using airflow sensors, soil air permeability can be calculated.

**6.4 Dielectric soil moisture sensor-** Using the dielectric constant, a dielectric soil moisture sensor gauges the amount of moisture in the soil.

**6.5 Parrot sensors-** Temperature, moisture, and soil salinity are all detected by parrot sensors in plants. The farmers' cell phones are shown the information.

## 7. ANALYSIS OF WIRELESS SENSORS

A single IOT device may have many wired and wireless interfaces for connecting to other IOT devices. Some of the wireless sensors are listed below, along with brief descriptions of each.

### 7.1 Wi-Fi -802.11

A group of Wireless Local Area Network (WLAN) communication protocols is known as

IEEE 802.11. For instance, 802.11a uses the 5 GHz spectrum, 802.11b and 802.11g the 2.4 GHz band, 802.11n the 2.4/5 GHz band, 802.11ac the 5 GHz band, and 802.11ad the 60 GHz range. These specifications offer data speeds ranging from 1 Mb/s to 6.75 GB/s. Wi-communication Fi's range ranges from 20 metres (indoors) to 100 metres (outdoor).

### 7.2 WiMax -802.16

A set of wireless broadband standards known as IEEE 802.16. The WiMAX (Worldwide Interoperability for Microwave Access) standards offer data rates of 1.5 Mb/s to 1 GB/s. Mobile stations receive data at a rate of 100 Mb/s, and stationary stations receive data at a rate of 1 GB/s (802.16 m). Specifications can be found on the IEEE 802.16 working group website (IEEE 802.16, 2014).

### 7.3. LR-WPAN -802.15.4

Low-Rate Wireless Personal Area Networks (LR-WPAN) specifications are part of IEEE 802.15.4. 802.15.4 creates high-level communication protocols like ZigBee., LR-WPAN offers data rates of 40 Kb/s to 250 Kb/s. LR-WPAN offers low-cost, slow connectivity to power-restricted devices. The LR-WPAN has a high data rate frequency of 2.4 GHz and a low frequency data rate of 868/915 MHz.

### 7.4 Bluetooth- 802.15.1

Bluetooth uses the IEEE 802.15.1 standard. Bluetooth enables data transmission between mobile devices over a short distance (8–10 m). A low-cost, low-power wireless communication technique is Bluetooth. Communication via a personal area network (PAN) is defined by the Bluetooth standard. It makes use of the 2.4 GHz spectrum. The 1 Mb/s to 24 Mb/s Bluetooth data rate range is available. The extremely low power and inexpensive form of Bluetooth is called Bluetooth Low Energy (BLE or Bluetooth Smart). In 2010, BLE and Bluetooth v4.0 were combined.

### 7.5 Lora WAN R1.0

In order to support the Internet of Things (IoT), the open and nonprofit LoraTM Alliance recently created the Low Power Wide Area Networks (LPWAN) standard protocol. Interoperability across diverse operators under a single open, international standard is the primary goal of this protocol. Data rates for LoRaWAN range from 0.3 kbps to 50 kbps. ISM bands at 868 MHz and 900 MHz are used by LoRa. According to post capes, LoRa can communicate between linked nodes up to a distance of 20 miles in no-obstacle situations. The linked node's battery typically has a very long lifespan of up to 10 years.

## 8. SMART FARMING OPERATING MODEL

One of the operations of a smart farm is the daily monitoring and control of crops with regard to their environmental conditions and data-driven crop planning. Other Smart Farm operations include marketing, inbound/outbound logistics, crop finance, and insurance, among other farming-related tasks. An ecosystem for a smart farm consists of two buckets together.

In order to gather information about the environment and crop health, sensors and IoT devices are positioned across the field. This information is then communicated to the data cloud via a gateway. The data cloud is largely in charge of data processing, analytics, and storage. Farmers and decision-makers can access the data and important insights through reporting dashboards. On a more immediate level, a user interface or an app to activate smart devices like temperature controllers or actuators/motors on the ground. Analytics are used to plan for the future at a macro level by combining data on demand, production, and the environment.

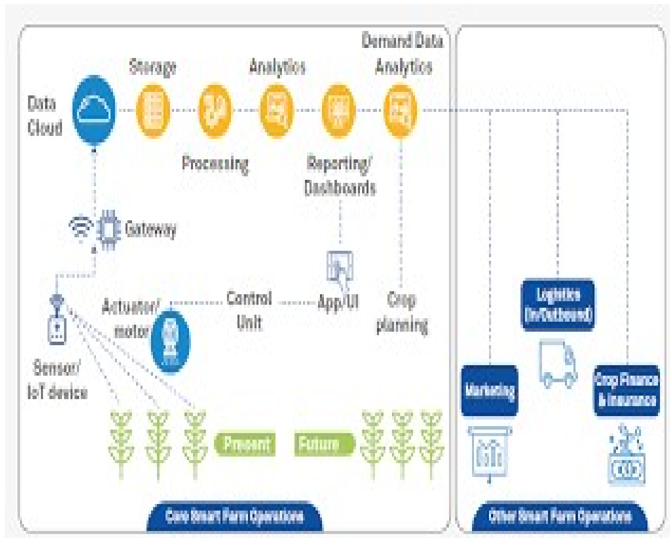


**Fig. 2.** Smart Farming Operation Model

Clay, organic matter, and moisture levels in the soil are all measured using optical sensors. Usually, the drones have these sensors mounted to them.

This information is important for marketing activities, incoming logistics (supply, procurement, and storage of seeds, fertilizer, manure, etc.), and outbound logistics (distribution to the market).

## 9. BENEFITS OF CLOUD COMPUTING IN AGRICULTURE

With the aid of sensors and actuators, the user is able to get a significant amount of agricultural data from any location at any time in order to control internal processes and outcomes with a reduced risk. With the aid of sensors and actuators, the user is able to get a significant amount of agricultural data from any location at any time in order to control internal processes and outcomes with a reduced risk.

- Cloud-based smart farming helps farmers obtain environmental data, such as temperature, humidity, soil moisture, and electrical conductivity, in order to increase their total output and the calibre of their trade items in both rural and urban settings.
- Real-time cloud computing services enable farmers to remotely monitor smart agricultural equipment to keep an eye on their farms from numerous locations.
- Cloud computing in the agricultural sector is expected to have a minimal cost with improved output, which is advantageous to farmers and the general state of the

economy in the country.

- Cloud computing guaranteed increased yield output by precisely controlling temperature, irrigation, and energy use to cultivate healthy crops.

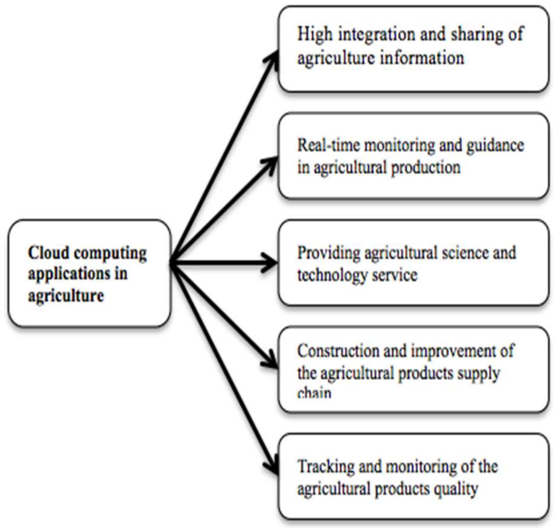


**Fig. 3.** Cloud Computing Applications in Agriculture

## 10. CHALLENGE FOR CLOUD COMPUTING IN AGRICULTURE

- Maintenance & supervision is handled by a third party, which reduces data security.
- Implied administrative responsibility.
- Cloud computing technology is unknown to farmers.
- Farmer's familiarity with cloud computing technology is unknown.
- The allure of hackers.
- The necessity of network connectivity.
- Necessitates an ongoing Internet connection.
- Farmers do not easily have access to platforms.
- This technology requires training for farmers.
- Does not function well with slow connections.
- There is a security risk.

## 11. CONCLUSION

The future of smart farming will be shaped by the innovative technology known as cloud computing. The majority of people on all continents depend on agriculture. Therefore, for a modern farm automation system, old agricultural methods are being replaced by cloud computing. In addition to other things, cloud computing technology is helpful for improving agriculture growth, food, grain, product, economic condition, assuring food safety, nation's GDP, and spreading information about agriculture. By installing sensors and image-capture equipment in crop fields that are connected to the internet, an appropriate judgement can be made utilizing fertilizer and pesticide efficiently by cloud computing. The idea of cloud computing's uses, as well as its benefits and challenges in smart agriculture. With the aid of this study, farmers will be better able to utilize current agricultural technologies to increase food production, thereby promoting the nation's overall health.

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# AUTOMATION OF HORTICULTURE SYSTEMS WITH DATA MINING

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## *Abstract:*

*Data mining is a method for finding a feasible solution that will help improve growth in a coordinated manner. Farmers in the agriculture sector encounter several obstacles and difficulties as a result of a lack of awareness and implementation of actions designed to boost their development and output. Although there is a huge number of data accessible for analysis and examination, those pertaining to the agriculture industry are in little supply. As a result, correct methods must be used to separate and process the data from the sources. It's difficult to get a precise estimate of a crop's output, both in number and quality, in places with various grain growth and diverse soil structure. Creating a strong relationship between customer expectations and the agricultural sector's producing capabilities may be a win-win scenario for both parties, and this can be accomplished by recording data segment by segment and in an organised manner. As a result, rather than being pleased with what is supplied to him, the client will be able to fulfil his demand according to his wishes. The use of such methodologies allows us to forecast and analyse a variety of issues, as well as assist farmers in making tough agricultural decisions depending on circumstances, soil fertility, crop length, disease, and other significant elements that might lead to low yield output. Using data mining techniques, the agrarian economy may be boosted and their financials improved, allowing them to become self-sufficient in their demands.*

***Keywords:*** *Information mining, clustering, classification, agriculture, horticulture.*

## I. INTRODUCTION

Horticulture is the review of developing area, remembering the steady improvement of soil quality for request to create crops for food, fleece, and different items. How much land under development has diminished emphatically over the long run because of growing urbanization and industrialisation; likewise, the farming business has been seriously affected by populace control and environmental change[1,2,3]. Just a little level of ranchers are utilizing imaginative cycles, hardware, and developing strategies to further develop efficiency. In the agrarian business, data is critical. To do this, asset usage ought to be finished so that most extreme creation and efficiency are reached.

Rural organizations might assemble and make immense measures of information, which can then be robotized to separate the data required. Information mining might be utilized to recover helpful information examples and data. Here's where information mining comes in, which might be used to research and gauge agrarian characteristics later on. Information mining is the method involved with removing significant and important data from enormous information assortments. We give an outline of information mining applications in the farming business in our review[4,5,6]. Horticulture is dependent on an assortment of components, including farming, water system, water reaping, composts, environment, soil, pesticides, weeds, and others. Information mining is utilized by agrarian organizations to assess creation so that store network procedures might be arranged and executed[7]. Agribusiness depends vigorously on yield forecast. The tremendous volume of information got because of these tasks has undiscovered capacity for expanding the proficiency of associated businesses. Information mining additionally uncovers stowed away data that ranch chiefs could use to improve decisions. Information mining, otherwise called Knowledge Discovery in Data (KDD)[9.10], is isolated into two sorts: distinct information mining and prescient information mining.

Clear mining exercises make sense of the elements of the information in an objective information assortment, though prescient information mining position use values to estimate what's in store. Prescient investigation, then again, offers a more extensive scope of utilizations than elucidating examination.

*Data mining techniques*

- *Classification*
- *Clustering*
- *Association Rule Mining*
- *Regression*
- *Prediction*

## II. INTRODUCTION TO DATA MINING AND AUTOMATION IN HOTICULTURE

Information digging is the most common way of perceiving and showing designs in monstrous data sets. The goal is to remove conceptual data from a major informational collection, investigate it, and transform it into a comprehensible organization for additional use[11,12,13]. Consider numerous perspectives in various ways while concentrating on the informational collection, and don't restrict yourself to one kind of information examination. Illustrative and prescient information mining are two kinds of information mining that are utilized to order information. Prescient information mining expects future qualities in view of authentic results. Illustrative information mining sorts out information as per general characteristics. Extraction of examples and models from enormous informational collections requires applications that incorporate calculations and a progression of stages like information planning, choice, cleaning, and understanding. Information digging is a strategy for recognizing and showing measurable data in view of soil, environment conditions, crop creation history, and government horticultural drives. The key information mining approaches used to deal with the horticultural issue incorporate bunching, relapse, and affiliation rules.

Affiliation rules are generally utilized in conditional data sets to track down connections. Additionally, search for components that show up every now and again. Parcel, Pruning (DHP), and Apriori Algorithm (AA) [14,15] are instances of information digging calculations for affiliation rules. Affiliation rules are utilized in the rural region to distinguish ailments conveyed by bugs. Bunching is an information mining process that includes moving things across a bunch of information to extricate valuable data for independent direction. Grouping is a strategy utilized by ranchers to get the best information for crop improvement and the board. Relapse is an information digging approach for assessing and foreseeing the likelihood of an information thing. It is utilized to estimate item interest. Additionally, analysts in the field of farming were encouraged to utilize information mining to reveal new data.

## III. LEADING INFORMATION MINING RESEARCHES IN AUTOMATION HOTICULTURE

A ton of studies have been led in the horticultural region utilizing information mining and information mining techniques. The sub classes that are combined with information mining incorporate weather conditions guaging, soil portrayal, crop forecast, and illness discovery. As per A. Mucherino et al. [3] the k-implies approach is utilized to expect climate, research soil properties, and examine apples before they are delivered to the market. It was likewise cleared up how for utilize a brain organization to recognize pig hacks and how to utilize a vector machine to distinguish bone supper and tissue. What's more, a few future improvements were featured, for example, the utilization of convoluted ways to deal with accomplish elite execution in the area of farming. A.K. Tripathy, J. Adinarayana, D. Sudharsan, S. N. Shipper, U. B. Desai, K. Vijayalakshmi, D. Raji Reddy, G. Sreenivas, S. Ninomiya, M Hirafuji, T. Kiura, and K. Tanaka conveyed a paper on A.K. Tripathy, J. Adinarayana, D. Sudhars a promising methodology for diminishing the nuisance by finding stowed away bugs relationship. The eventual fate of the task was likewise viewed as M Model of relapse V. Ramesh and K. Ramar featured the few classifications that might be utilized to foresee soil elements and ways of behaving[16,17,18,19]. Different arrangement strategies were examined, including the USDA soil scientific categorization, the UNESCO framework, and the French framework. Soils of Kanchipuram region are arranged into eight gatherings, as indicated by the locale's dirt characterization.

Class 1 is suggested for line trimming, while class 8 isn't suggested for-column editing. There are two kinds of information mining characterizations. The main classification of approaches comprises of bearings for accomplishing the work in a specific succession. The guidelines in the subsequent class tell the best way to achieve or finish the responsibility[20,21]. The Nave Bayes arrangement utilizes Bayesian insights to make ends in light of likelihood. Surabhi Chouhan, Divakar Singh, and Anju Singh led a study to examine all current information digging approaches for farming harvest classification, their advantages, limits, and the most proficient methods among those strategies.

This article talks about grouping, straight discriminant examination, Bayesian organizations, P-Tree calculations, and the FP-Growth calculation. This study proposes an order framework light of Fuzzy Conclusion Trees[22]. With regards to Knowledge Discovery in Precision Agriculture (KDPL), a blend of Bayesian grouping and inductive standards was utilized by S.W Lee and L. Kerschberg. These frameworks are both unaided and directed. The mix of information mining and information disclosure in huge (KDL) to convey the KDD method is a significant component of this methodology. They found ten classes from an example informational index in this trial. This technique is superb for learning connections, ideas, and portraying data in a particular informational collection[23]. Bauckhage and K. Kersting offered answers for settling troubles brought about by bothers or an absence of water. Man-made consciousness and information mining are utilized related in these ways. The use of versatile and remote innovation, as well as new computational insight and sensors, settled the system [9,24].

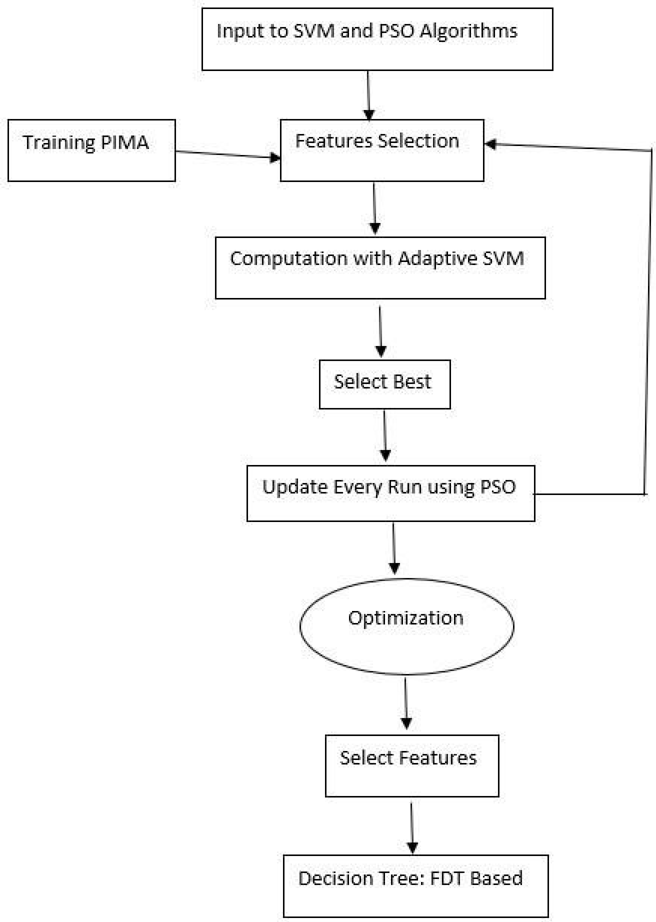


**Figure 1:** Control flow for classification techniques

Rajeswari and K. Arunesh led examination to decide the best arrangement framework for breaking down soil types. For anticipating the ideal technique, they utilized three calculations: J48, and Navie Bayes [25]. JRip is the most dependable and prevalent of these characterization frameworks. Subsequently, JRip is the best instrument for anticipating soil types.

## IV. CHALLENGES OF INFORMATION MINING IN AUTOMATION HOTICULTURE

Still a many challenges of horticulture automation are un-addressed even after availability of various data mining techniques are available [26,27,28,29,30,31].

i. Hybrid and speculation information mining procedures isn't indicated in the specific area or information. Its relevant for the any kind of information in any domain.
ii. Require extraordinary Knowledge to tackle unique information, volume of information, current methodologies and aftereffects of expectation is very intricate.
iii. est against the little size of data Most of the ongoing systems considered only a piece of the dataset or little size of the dataset to determine the end result.
iv. Very high computation cost for example, grouping and characterization, k-NN, k-Means.
v. Most of the ranchers have small area of land.

## V. USES OF INFORMATION MINING

Information mining strategies and frameworks have been utilized in farming field by resolving the different issues in different fields, for example, soil describing, sicknesses ID, distinguish request in a market. Brain network has been utilized to weather conditions estimating [32]. The framework is created to record the boundaries which are applicable to climate circumstance, for example, speed and bearing of the breeze, temperature and dampness of region, precipitation size and time range. In the event that there were any adjustment of those boundaries, can be foresee the impending climate circumstance by utilizing Neural organization. Expectation should be possible for the huge region by expanding the consequence of little region. Likewise, a framework to distinguish the rotten ones from great apples and a framework to characterize the eggs have been created by utilizing brain organization. Another Artificial brain organization's application is a framework to track down the connection between yield estimations and restricting elements. A mechanized framework to work on the course of soil arrangement was created. Fruitfulness of the dirt example is the central issue of that framework [33,34,35]. As indicated by fruitfulness, soil tests named as exceptionally Low, Moderate and High. The framework assists with marking the dirt examples. For additional near review, use arrangement calculations.

## VI. CONCLUSION AND FUTURE SCOPE

As of now, because of immense advancement of the innovation and related region non mechanical region becoming more straightforward. Mining with the help of existing data and farming is a very fascinating examination region among research individuals. Accordingly, impediments in the information mining application concerning agrarian field are additionally chosen. Because of those impediments high advancements recognized in a quick improvement to field.

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# EXPLORATION OF HYDROPONICS

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***Abstract:***
*Hydroponics is an approach of soil less agriculture which means growing plants in water and nutrient solution with out the use of soil. Hydroponics is the sub set of hydroculture, in Greek words hydroponics is known as water and labor. In this paper we have illustrate the requirements in hydroponics and the types of crops and their techniques to be grown in hydroponics system. The term hydroponics originally meant nutrient solution culture with no supporting medium.*

***Keywords–****NFT, DFT, Hydroponics, Real time information, deep water culture.*

## 1. INTRODUCTION

Soil is the natural sourcefor growing plants but as the knowledge of plant nutrients increased, growing plants without soil is not new, so people learned to grow plants in artificial media.in some places like metropolitan city or areas there is scarcity of soil for growing crops and in some places there is less fertile cultivable land due to their unfavorable geographical conditions, so the soil less cultivation is normally referred to the techniques of "Hydroponics and Aeroponics". Plants that are not traditionally grown in a climate condition would be possible to grow using control environment system like hydroponics. In Greek words "hydroponics" is known as water and labor, it is the technique of growing plants in nutrients solution without soil. This system helps to face the challenges of climate changes and in production system management for efficient utilization of natural resources and controlling malnutrition. Hydroponic system farming can beuse to grow crops/plants in compact spaces such as terrace, backward, or in the offices which don't have their space for farming.

## 2. LITERATURE SURVEY

A review of research works conducted in India and abroad with different hydroponics management system are being presented below. In this paperadhau et al.[12] proposed work shows, how hydroponic farming can be efficiently automated using minimum resources and cost, they have use the techniques of smooth stability and smooth controller action for PID controller. The author Srivani P. et al. [13] describe many intelligent algorithms and technologies like fuzzy logic, linear regression, machine learning, artificial intelligence, image processing how this can be implemented. Geetalisaha[7] gives an analysis of various applications, microprocessor program – based monitoring and technological advances in the automation industry. directing qualitive research that gives exact evaluations of the ecological environmental and social benefitsVedivel et al. [14] species in their paper all security issues, vulnerabilities and focus on challenges and open research issues and their future scopes

Falmatamodu et al. [4] in this paper the author investigated the smart hydroponic system in the literature. It is also noted that research have done a lot of work in the monitoring of hydroponic system and the automation of nutrient supply. few AI base research carried out and have shown that AI isa goodtechniques for controlling the hydroponics.

P.K Naik et al.[11] says that hydroponics technology can also be adopted by progressive modern dairy farmers with elite dairy herd and produce hydroponic fodder for feeding their dairy animals and also proposed that further research is needed to developed low cost devices.

Nilanjan bhatta charya [9]describe about the land rapid lost, so scientist develop hydroponics farming techniques to developed another which is without utilizing land which is fast depleting resource and hydroponics is the main alternative way to associated with that problem.

Walter esfrain Pereira et al. [15] the author discuss about the plant growth rate in the presence of aluminium in the present of nutrient solution. The result obtain is that agreement in those reported in other researches carried out with different species.

Philomena George et al. [3] they says that hydroponic farming has high cost. And hydroponic farming sum up promising area with vast potential to improve the quality and quantity of agriculture with the help of technological tools.

## 3. REQUIREMENTS OF HYDROPONICS SYSTEM

In the hydroponics system plants require basics key elements to survive and flourish which you all need to be supply for the growth of the plants are given below

**3.1 Temperature–** Since most hydroponic systems are in greenhouses or confined areas, specific temperatures can be set.

Each type of plant has an optimal temperature range for maximum growth.

**3.2 Light–** All vegetables and most flowering plants need large amounts of light.

Hydroponically grown vegetables require 8 to 10 hours of direct sunlight daily for healthy growth.

Commercial operations sometimes use high-powered lamps to increase light intensity and duration.

**3.3 Nutrients–** In hydroponics total 17 essential nutrients are required and processplant growth and development occurred.

Since hydroponic systems do not use soil, essential nutrients must be provided with a water solution.

The solution requires careful calculations to ensure that the optimal amounts of macronutrients and micronutrients are provided.

# 4. CROPS TO BE GROWN IN HYDROPONICS

Starting from medicinal plants, fruits, vegetables and flowers which can be grown in hydroponic system using soil less culture. list of crops are listed in table 1.

**Table 1.** List of crops grown on commercial level using hydroponic system

| Types of Crop | Name of the Crops |
|---|---|
| Fruits | Strawberry<br>Raspberry |
| Vegetables | Tomato<br>Cabbage<br>Cucumber<br>Brinjal<br>Green bean<br>Chilli<br>Onion |
| Cereals | Rice<br>Maize |
| Flowers | Rose<br>Lily<br>Anthurium<br>Marigold |
| Leafy Vegetables | Lettuce<br>Kangkong |
| Condiments | Parsley<br>Oregano<br>Mint |
| Medicinal Crops | Aloe vera<br>Coleus |

# 5. EXAMPLES OF HYDROPONIC FARMING

## 5.1 Loktak lake Manipur

Loktak lake is the main livelihood purpose of the people of Manipur because the lake provida economical and financial growth to the people living around the lake, they practice hydroponic farming upon the lake for their main livelihood purpose.

## 5.2 Dal Lake Srignagar

The floating garden of dal lake srignagar mainly formed from the weeds, which are available in the lake itself, the boat man collect the weeds and pressed them one up on another and their muddy sticky weeds attached and they formed mats which float in the lake water and people perform hydrophonic farming system up on the floating mats knows as floating gaden.

### 5.3 Bus rooftop Garden Spain

Main purpose of this bus rooftop garden is that, if a gardenwere planted on the roof of every one of the 4500 buses in the city's bus feet, the buses could add 35 acres of new rolling green space in the city.

### 5.4 Bangladesh Floating Garden

This is the floating vegetable garden mostly common in the district of Gopalganj, Barisal and Pirojpur, mainly in the monsoon season the farmer cultivate their crops in small balls locally called tema, which are made of peat soil with the mixed of cow dung slit and wrapped in coconut fibre.

## 6 TECHNIQUES OF HYDROPONICS

Hydroponics mainly depended on the nutrients solution for the effective growth which are divided into three types as given below

### 6.1 Circulating Methods (closed system)/ Continuous Flow Solution Culture

Flowing solution culture systems can provide a consistent nutrient environment for roots. They are highly amenable to automatic control but are subject to rapid plant desiccation if the flow of solution stops for any reason. Thus frequent attention is required.

This are further divided into two parts

- Nutrient film technique (NFT)
- Deep flow technique (DFT)

### 6.2 Non-Circulating method (open systems)/ Static solution culture

It has following techniques used under non-circulating method

- Root dipping technique
- Floating technique
- Capillary action

### 6.3 Media culture

The media culture method has a solid medium for the roots and is named for the type of inert medium, e.g. sand culture, gravel culture or rock wool culture.

There are two main variations for each medium, sub-irrigation and top-irrigation. However, it is classified as follows–

- Hanging bag technique
- Grow bag technique
- Trench or trough technique
- Pot technique

## 7 CONCLUSION AND FUTURE SCOPE

Various researchers have contributed in the hydroponics farming in crop cultivation with the integration of technology. Hydroponic is the fastest growing sector in the agriculture and well dominated food production in the future. In this paper we are just referring and analyzing the contribution done on hydroponics system by the researchers. Now a day's people want easy and sustainable method by using hydroponic system of farming.

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# CROP RECOMMENDATION USING MACHINE LEARNING TECHNIQUES- KNN AND DECISION TREES

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## *Abstract:*

*Continuous eating of the same grain and constant growing of the same crop leads to stagnancy; be it in the growth of a person or the growth of the crop in the field. States like Punjab, Haryana, and Western Uttar Pradesh have been continuously focusing on Paddy, a water-guzzling crop. There may be several reasons for that but the crop is not the best-suited one for sure as these areas have seen a dip in the groundwater levels; this happens because a large fraction of farmers has not been exposed to the various advancements in the field, resulting in lower productivity.*

*Crop recommendation systems focus on finding the best-suited crop according to the soil requirements and availabilities so that the farmer need not exploit other resources for the growth of some crop that is not the best-suited one. Growing crops less suitable for the soil, the area, and the then climate can lead to economical and social burdens on the farmers. Here is when Machine Learning comes into play. The advancements empower agricultural management systems to handle farm data in a presentable manner and increase agribusiness by devising effective machine learning models.*

***Keywords:*** *Agriculture, Farmers, Machine Learning, Techniques, Productivity, Crop Recommendation, Artificial Intelligence, Decision Trees, K-NN*

## INTRODUCTION

Agriculture being a very important part of the country's economy provides income to over 70% of the rural households. Also contributing around 25% to the nation's GDP, it still has to depend on natural rainfalls and weather conditions. Agriculture nationwide faces a lot of problems including small landholdings, lesser irrigation, manures, pesticides, biochemicals, soil erosion, and a logger list of such problems including shortage of capital but why does this happen?

A very simple answer to most of the problems, leading one to another, is systemized agriculture or it can be said agriculture according to what the soil demands not what gives the most expensive crop. Due to no systemized planning and lesser diversification in the crop patterns, the greenhouse states have seen the problem of stagnancy in the crop yield and over-exploitation of groundwater resources that call for immediate working on and implementation of technological innovations using machine learning models embedded with artificial intelligence. Machine learning has played an important role in various aspects of artificial intelligence and predictions based on the learning and feedback. Machine learning sensors capture different parameters or take input from the trainer. It has played a significant role in the agricultural sector. The sophisticated data and analysis tools are increasingly being accessed using both ML and AI. These instruments enable better decisions and improved efficiency. The population has defined increased efficiency as increased saving and efficient usage of the previously extracted resources that includes lesser wastage of food and producing biofuel, minimizing the negative environmental consequences. Machine learning has been proved useful in several aspects of agriculture itself including factors like digital farming, which brings increased precision to crop production using data-driven insights supporting key farm management decisions; Assessment of the quality of the particular crop and the environment including the soil has proven to be of great help. Knowing what disease can infect the plants and what amount of weed might grow in a particular area are also dealt with using machine learning and artificial intelligence. ML helps in finding the quality of a specific breed so that the farmers know which ones would make the best combinations according to the results required. Also one of the most discussed use is crop recommendation, under which the machine learning tools monitor various parameters and predict the crop that is best suited according to the results.

Agricultural crop recommendation being the new generation bubble aims to extract the maximum possible yield out of the natural conditions knowing exactly what the soil needs and with what crop will it give the maximum output. Crop recommendation models collect data based on the environments where the particular crops best grow and then according to the current environment tell the farmer what crop would be the best-suited one. This paper has been based on the dataset extracted from “kaggle.com” on crop recommendation. The dataset includes some selective and important features including the meters of nitrogen, phosphorus, and potassium, temperature, ph, humidity, and rainfall of the crop growing environment based on which the specific crop (that is most suitable) is predicted.

## LITERATURE REVIEW

Machine Learning is the topic with hype and agriculture being the most important topic of concern, together make up a hot topic for discussion. The two being discussed on a considerably large scale have brought up a lot of research and thesis work importance.

Many pieces of research and studies have been conducted on both the topics of agriculture and advanced machine learning. Some of the work is reviewed:

[1] In this model, Nasreen Taj, M.B., et al aims on attaining an efficient and accurate model for model prediction. This paper proposes a system that uses the k-nearest neighbor algorithm to build an efficient and accurate model to reduce the errors to the maximum as

errors may lead to heavy material and capital loss. The methodology of the paper includes clustering and classification techniques including k-NN, logistic regression, and artificial neural networks to predict the right crop for the given land and environment to increase the yield and productivity for the farmers.

[2] This paper is consists of a theoretical and conceptual platform for the crop Recommendation system. Bandara and Pradeepa et al have included integrated models of collecting environmental factors using various devices such as Arduino microcontrollers and using Machine learning techniques both Supervised- Support Vector Machine (SVM) and Unsupervised machine learning algorithms such as K-means Clustering and also Natural Language Processing with machine learning techniques (Sentiment Analysis) concerned with the Artificial Intelligence to recommend a crop for the selected land with site-specific parameters keeping in account parameters like accuracy and efficiency. The discussed model works on the feedback system. The farmer grows the crop for a month and the feedback is fed to the machine for results with better accuracies in the future. The experiments conducted over the 4-6 months proved the reliability and accuracy of the system.

[3] This research for the Journal of Applied Technology and Innovation" starts with data mining and digs into precision agriculture discussing the topics of crop health, and productivity rates. It also explains how machine learning is a solution to the basic and the most important issue of crop health and productivity- the choice of the crop to be cultivated. It aims at providing a model that proposes not only crops but also the fertilizers required and even the best-suited farming techniques, for each case, with increasing accuracy each day. It also keeps in consideration the accuracy of results as it discusses the importance of the same.

This model is based on a self-analyzed dataset at a soil testing lab in Madurai, Tamil Nadu, and focuses on various crops like millet, groundnut, pulses, cotton, paddy, sugarcane, coriander, and vegetables including banana. It focuses more on, particularly the soil itself than other environmental factors. Factors like soil permeability are taken into account. With 88% of efficiency, the model aims at extending itself to predict the yield and productivity of the crop starting from deciding as to which crop has to be planted.

[4] This research aims at breaking the standards of practicing the local plantation methods 'cause growing according to what other people are growing is not the right one. This system provides "farming assistance" by helping farmers choose the most profitable crop. The farmer can take the, then possible, best decision for storage and business side. This proposed system uses some widely used techniques such as random forest, svm, logistic regression, etc. With the highest accuracy of 99.3%. Along with crop recommendations, the system also provides weather forecasts for the next five days so that the crops can be watered accordingly. The paper presents a method for selecting crops, also known crop selection method (csm). It also helps in improving the rate of net yield of the crop.

## METHODOLOGY

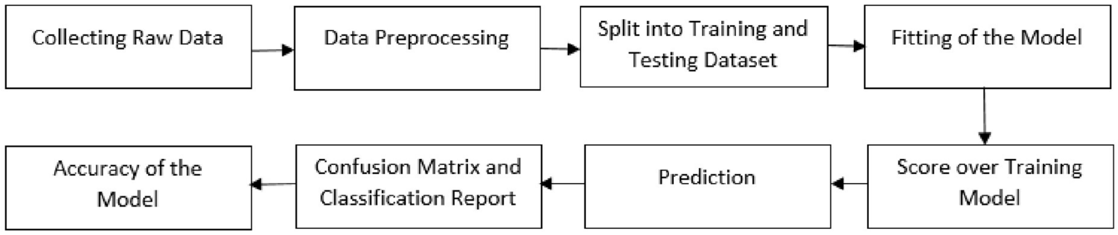



**Figure 1: Steps involved in Methodology**

***Collecting the Raw Data***

The practice of cumulating and scrutinizing data from different sources is known as data collection. Data collection is a way to keep track of past occurrences so that one can utilize data analysis to collect repetitive patterns. The 'Crop Recommendation' dataset is collected from the Kaggle website. The dataset takes into account 22 different crops as class labels and 7 features- (i) Nitrogen content ratio(N) (ii) Phosphorus content ratio (P) (iii) Potassium content ratio (K) in the soil, (iv) Temperature expressed in degree Celsius (v) Percentage of Relative Humidity(vi) ph value and(vii) Rainfall measured in millimeters.

**Table 1: Dataset sample**

| N | P | K | temperatu | humidity | ph | rainfall | label |
|---|---|---|---|---|---|---|---|
| 90 | 42 | 43 | 20.87974 | 82.00274 | 6.502985 | 202.9355 | rice |
| 85 | 58 | 41 | 21.77046 | 80.31964 | 7.038096 | 226.6555 | rice |
| 60 | 55 | 44 | 23.00446 | 82.32076 | 7.840207 | 263.9642 | rice |
| 74 | 35 | 40 | 26.4911 | 80.15836 | 6.980401 | 242.864 | rice |
| 67 | 60 | 25 | 24.92162 | 66.78627 | 5.750255 | 109.2162 | maize |
| 70 | 44 | 19 | 23.31689 | 73.45415 | 5.852607 | 94.29713 | maize |
| 90 | 49 | 21 | 24.84017 | 68.35846 | 6.472523 | 74.05475 | maize |
| 62 | 52 | 16 | 22.27527 | 58.84016 | 6.967058 | 63.87021 | maize |
| 92 | 44 | 16 | 18.87751 | 65.76816 | 6.082974 | 94.76189 | maize |
| 66 | 54 | 21 | 25.19009 | 60.20017 | 5.919046 | 72.12376 | maize |
| 63 | 58 | 22 | 18.25405 | 55.2822 | 6.204748 | 63.72358 | maize |
| 70 | 47 | 17 | 24.61291 | 70.41624 | 6.600827 | 104.1626 | maize |
| 61 | 41 | 17 | 25.14206 | 65.26185 | 6.021902 | 76.68456 | maize |
| 66 | 53 | 19 | 23.09348 | 60.11594 | 6.03355 | 65.49731 | maize |

***Data Preprocessing***

After collecting datasets from various resources, dataset must be preprocessing before training to the model. The data preprocessing can be done by various stages, begins with reading the collected dataset the process continues to data cleaning. In data cleaning the datasets contain some redundant attributes, those attributes are not considering for crop prediction. So, we have to drop unwanted attributes and datasets containing some missing values we need to drop these missing values or fill with unwanted values in order to get better accuracy. Then define the target for a model. After data cleaning the dataset will be split into training and test set by using sklearn library.

***Train and Test Split***

It is a process of splitting the dataset into a training dataset and testing dataset using train_test_split() method of scikit learn module. 2200 data in the dataset has been divided as 80% of a dataset into training dataset-1760 and 20% of a dataset into testing dataset-440 data.

*Fitting the model*

Modifying the model's parameters to increase accuracy is referred to as fitting. To construct a machine learning model, an algorithm is performed on data for which the target variable is known. The model's accuracy is determined by comparing the model's outputs to the target variable's actual, observed values. Model fitting is the ability of a machine learning model to generalize data comparable to that with which it was trained. When given unknown inputs, a good model fit refers to a model that properly approximates the output.

*Checking the score over a training dataset*

Scoring, often known as prediction, is the act of creating values from new input data using a trained machine learning model. Using model.score() method calculating the score of each model over a training dataset shows how well the model has learned.

*Predicting the model*

When forecasting the likelihood of a specific result, "prediction" refers to the outcome of an algorithm after it has been trained on a previous dataset and applied to new data. Predicting the model using predict() method using test feature dataset. It has given the output as an array of predicted values.

*Confusion Matrix and Classification Report*

Confusion Matrix and Classification Report are the methods imported from the metrics module in the scikit learn library are calculated using the actual labels of test datasets and predicted values.

**Confusion Matrix** gives the matrix of frequency of true negatives, false negatives, true positives and false positives.

**Classification Report** is a metric used for evaluating the performance of a classification algorithm's predictions. It gives three things: Precision, Recall and f1-score of the model.

**Precision** refers to a classifier's ability to identify the number of positive predictions which are relatively correct. It is calculated as the ratio of true positives to the sum of true and false positives for each class.

**Recall** is the capability of a classifier to discover all positive cases from the confusion matrix. It is calculated as the ratio of true positives to the sum of true positives and false negatives for each class.

**F1 score** is a weighted harmonic mean of precision and recall, with 0.0 being the worst and 1.0 being the best. Since precision and recall are used in the computation, F1 scores are often lower than accuracy measurements

**Accuracy of model**

The number of correct predictions divided by the total number of predictions is known as accuracy. The accuracy of model is calculated using accuracy score() method of scikit learn matrices module

## K-NN Algorithm

The K-Nearest Neighbor algorithm is based on the supervised learning technique and is a simple machine learning algorithm. The K-NN technique saves all possible and classifies the incoming data depending on how similar they are to the actual data. The k-nearest neighbor (k-NN) method is a data mining technique considered to be among the top five techniques for data mining. In this, we consider each of the characteristics in our training set as a different dimension in some space, and take the value an observation has for this characteristic to be its coordinate in that dimension, so getting a set of points in space. We can then consider the similarity of two points to be the distance between them in this space under some appropriate metric. The way in which the algorithm decides which of the points from the training set are similar enough to be considered when choosing the class to predict for a new observation is to pick the k closest data points to the new observation, and to take the most common class among these.

This means that the K-NN technique can swiftly classify new instances into a precisely defined category. The KNN technique can be used in both regression and classification problems but, it is most likely to be used in classification.

KNN technique has two properties. First, the model is based on the dataset or, it is not required to identify parameters for the distribution. Hence it is referred to as non-parametric. Second, there is no learning taking place; instead, it just stores the training data. The classification of the dataset happens during the testing phase, due to which the testing phase becomes time-consuming and takes a lot of memory. This property is known as lazy-learner.

***Working of KNN Algorithm***

**Step 1** − For implementing any algorithm, we need dataset. So during the first step of KNN, we must load the training as well as test data.

**Step 2** − Next, we need to choose the value of K i.e. the nearest data points. K can be any integer.

**Step 3** − For each point in the test data do the following −

**3.1** − Calculate the distance between test data and each row of training data with the help of any of the method namely: Euclidean, Manhattan or Hamming distance. The most commonly used method to calculate distance is Euclidean.

**3.2** − Now, based on the distance value, sort them in ascending order.

**3.3** − Next, it will choose the top K rows from the sorted array.

**3.4** − Now, it will assign a class to the test point based on most frequent class of these rows.

## DECISION TREE ALGORITHM

Decision Tree algorithm belongs to the family of supervised learning algorithms. Unlike other supervised learning algorithms, the decision tree algorithm can be used for solving regression and classification problems too. The goal of using a Decision Tree is to create a training model that can use to predict the class or value of the target variable by learning simple decision rules inferred from prior data(training data).

In Decision Trees, for predicting a class label for a record we start from the **root** of the tree. We compare the values of the root attribute with the record's attribute. On the basis of comparison, we follow the branch corresponding to that value and jump to the next node.

This splitting continues, generating sub-tree until its reach a leaf node which determines class labels for that instance. It divides the tree recursively, which is known as recursive partitioning. With high accuracy, decision trees are capable of handling high-dimensional data. It's a flowchart diagram-style representation that closely parallels human-level thinking. As a result, decision trees are simple to explain and apprehend.

We have applied Decision tree approach in our model as:

(i) Importing library Decision Tree Classifier from sklearn.tree Class

(ii) Now we create Decision Tree Classifier object

(iii) In the last we fit our data from sklearn.tree import Decision Tree Classifier

DT = DecisionTreeClassifier(criterion="entropy", random_state=2, max_depth=5)

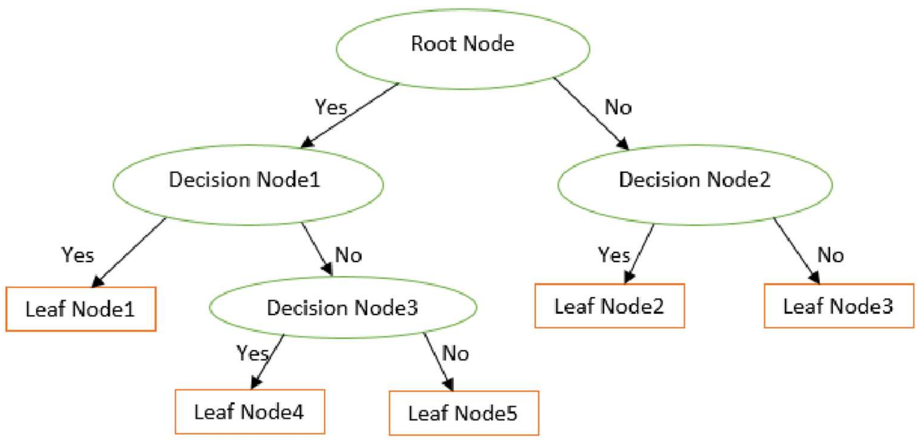



**Figure 2: Decision Tree Classifier**

***Working of Decision Tree Algorithm:***

**Step 1-** It begins with the original set S as the root node.

**Step 2-** On each iteration of the algorithm, it iterates through the very unused attribute of the set S and calculates **Entropy(H)** and **Information gain(IG)** of this attribute.

**Step 3-** It then selects the attribute which has the smallest Entropy or Largest Information gain.

**Step 4-**The set S is then split by the selected attribute to produce a subset of the data.

**Step 5-**The algorithm continues to recur on each subset, considering only attributes never selected before

## RESULTS

**KNN Algorithm-**

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| apple | 1.00 | 1.00 | 1.00 | 13 |
| banana | 1.00 | 1.00 | 1.00 | 17 |
| blackgram | 0.94 | 1.00 | 0.97 | 16 |
| chickpea | 1.00 | 1.00 | 1.00 | 21 |
| coconut | 1.00 | 1.00 | 1.00 | 21 |
| coffee | 1.00 | 1.00 | 1.00 | 22 |
| cotton | 0.95 | 1.00 | 0.98 | 20 |
| grapes | 1.00 | 1.00 | 1.00 | 18 |
| jute | 0.89 | 0.86 | 0.87 | 28 |
| kidneybeans | 0.93 | 1.00 | 0.97 | 14 |
| lentil | 0.96 | 1.00 | 0.98 | 23 |
| maize | 1.00 | 0.95 | 0.98 | 21 |
| mango | 1.00 | 1.00 | 1.00 | 26 |
| mothbeans | 1.00 | 0.89 | 0.94 | 19 |
| mungbean | 1.00 | 1.00 | 1.00 | 24 |
| muskmelon | 1.00 | 1.00 | 1.00 | 23 |
| orange | 1.00 | 1.00 | 1.00 | 29 |
| papaya | 1.00 | 1.00 | 1.00 | 19 |
| pigeonpeas | 1.00 | 0.94 | 0.97 | 18 |
| pomegranate | 1.00 | 1.00 | 1.00 | 17 |
| rice | 0.76 | 0.81 | 0.79 | 16 |
| watermelon | 1.00 | 1.00 | 1.00 | 15 |
| accuracy | | | 0.97 | 440 |
| macro avg | 0.97 | 0.98 | 0.97 | 440 |
| weighted avg | 0.98 | 0.97 | 0.98 | 440 |

**Table 2: Classification Report for K-NN**

Precision=0.974

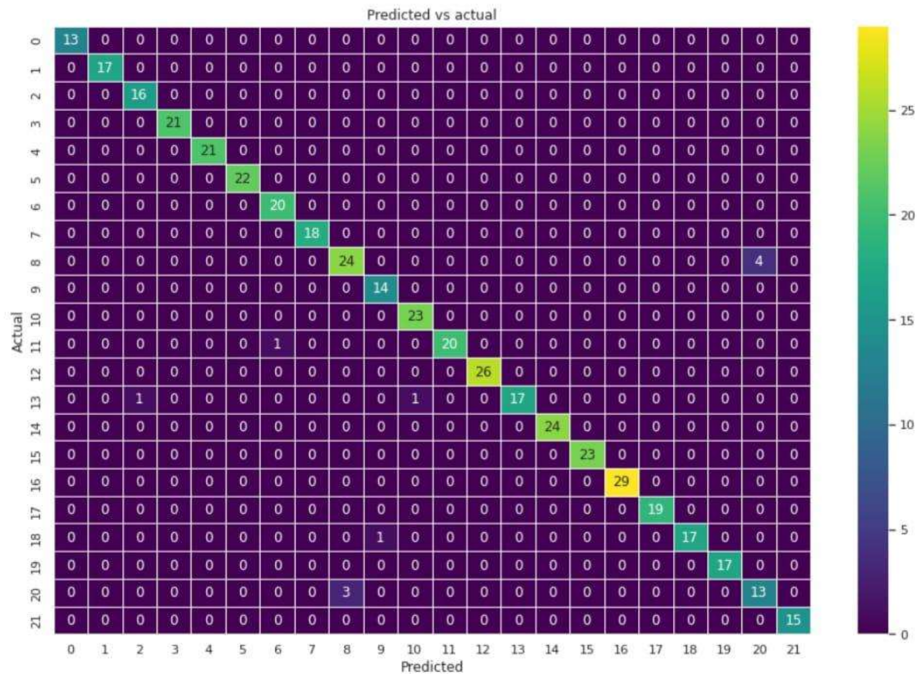
Recall=0.975

F1-score=0.975

knn_train_accuracy = 0.9886363636363636

knn_test_accuracy = 0.975

K-NN accuracy is 0.975




**Matrix 1: Confusion Matrix for K-NN**

## Decision Tree Algorithm-

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| apple | 1.00 | 1.00 | 1.00 | 13 |
| banana | 1.00 | 1.00 | 1.00 | 17 |
| blackgram | 0.59 | 1.00 | 0.74 | 16 |
| chickpea | 1.00 | 1.00 | 1.00 | 21 |
| coconut | 0.91 | 1.00 | 0.95 | 21 |
| coffee | 1.00 | 1.00 | 1.00 | 22 |
| cotton | 1.00 | 1.00 | 1.00 | 20 |
| grapes | 1.00 | 1.00 | 1.00 | 18 |
| jute | 0.74 | 0.93 | 0.83 | 28 |
| kidneybeans | 0.00 | 0.00 | 0.00 | 14 |
| lentil | 0.68 | 1.00 | 0.81 | 23 |
| maize | 1.00 | 1.00 | 1.00 | 21 |
| mango | 1.00 | 1.00 | 1.00 | 26 |
| mothbeans | 0.00 | 0.00 | 0.00 | 19 |
| mungbean | 1.00 | 1.00 | 1.00 | 24 |
| muskmelon | 1.00 | 1.00 | 1.00 | 23 |
| orange | 1.00 | 1.00 | 1.00 | 29 |
| papaya | 1.00 | 0.84 | 0.91 | 19 |
| pigeonpeas | 0.62 | 1.00 | 0.77 | 18 |
| pomegranate | 1.00 | 1.00 | 1.00 | 17 |
| rice | 1.00 | 0.62 | 0.77 | 16 |
| watermelon | 1.00 | 1.00 | 1.00 | 15 |
| accuracy | | | 0.90 | 440 |
| macro avg | 0.84 | 0.88 | 0.85 | 440 |
| weighted avg | 0.86 | 0.90 | 0.87 | 440 |

**Table 3: Classification Report For Decision Tree**

Precision=0.928

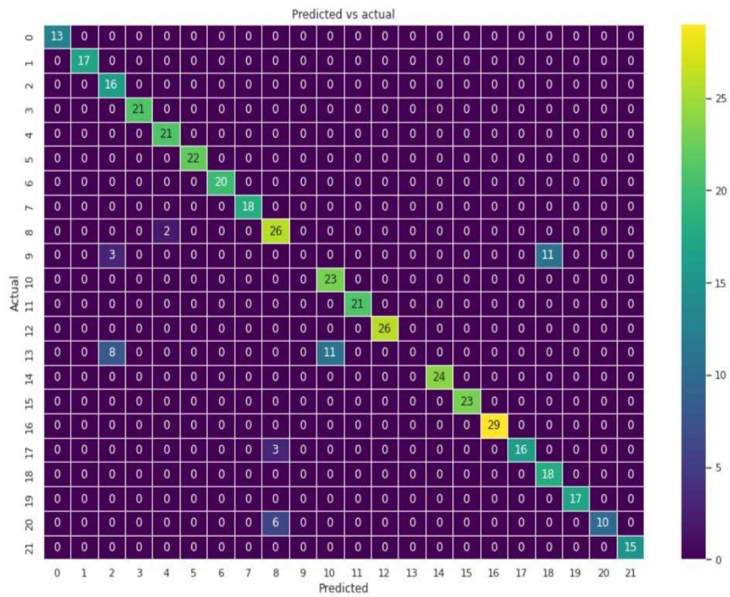
Recall=0.929

F1-score-0.929

Decision Tree's Accuracy is: 90.0

Training accuracy = 0.8818181818181818

Testing accuracy = 0.9




**Matrix 2: Confusion Matrix for Decision Tree**

## CONCLUSION

Several farmers plant crops according to what their fathers or other elderly men tell them or what the neighbors are growing or the ones that are trending; without knowing what is required by the soil and what crops could bring out the best results from the soil. Due to the lack of the most crucial news, farmers get deprived of detailed information about the nutrients in the soil and work on estimations. The nutrients if well informed can be extracted to great extents.

This paper focuses on recommending the right crop for the right soil using machine learning methods like K-NN and Decision trees.

Sometimes soil with a lot of nutrients gets exploited by soil erosion and supplying the crop with unnecessary pesticides and extra water; which can have great negative effects on the long-term health of the soil. Growing crops not meant for the soil needs extra care and resources. To prervent such wastage of the nutrients crop recommendation systems are of great importance.

Selecting a crop recommendation model with bare eye is not possible. This requires different machine learning tools. Recommending more than one crop is essential because there may be other factors that hinder the possibility of the growth of the crop in the specific area; there can be various other reasons for that including economical factors.

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# GREEN REVOLUTION AND ITS IMPACT ON ENVIRONMENT

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## *Abstract:*

*The paper focuses on the study of the ecological impact of Green Revolution, in Punjab. It analyses how the use of HYV (high yielding variety) seeds, chemical fertilizers, better irrigation facilities, improved farm implements and crop protection measures which have on the one hand increased food self sufficiency and on the other hand have deteriorated the ecological health of the region. The advancements in farming techniques have resulted in a serious ground water depletion and contamination, air and soil pollution due to stubble burning and the deathly indebtedness of farmers. The paper also suggests certain preventive measures to curtail the adverse effects of the Green Revolution. It is suggested that Crop Diversification, Water Harvesting, Organic Farming, and Residue Management may help immensely in controlling the ecological damage done by Green Revolution.*

***Keywords:*** *Green Revolution, Multiple Cropping, Soil Health, Ground Water Depletion, Stubble Burning.*

## 1. INTRODUCTION

Prior to the mid-1960s, increased crop production in India was largely achieved by expansion of cultivated area. To gain self-sufficiency in food grain production, a new agricultural strategy popularly known as the Green Revolution was implemented in the mid-1960s (Nelson, 2019). The Strategy involved the use of modern technology, including HYV (high yielding variety) seeds, chemical fertilizers, irrigation facilities, improved farm implements and crop protection measures. The success of this Strategy has led to apparent food self-sufficiency.

The Mexican Agricultural Programme established by the Rockefeller Foundation in 1943 initiated the process of the Green Revolution in which American and Mexican scientists worked to develop synthetic and hybrid corn and wheat varieties which were high-yielding in comparison to local varieties. Due to the success of the Green Revolution in Mexico, its technologies spread worldwide in the 1950s and 1960s (Rahman, 2015).

In 1960s, due to its favorable agricultural conditions, Punjab was chosen to be the state where the Green Revolution would begin in the country. By 1983-85, 95% of land in Punjab under food grain cultivation was under high-yield variety (HYV) seeds, as compared to 54% of the land in the rest of India. From the initiation of the Green Revolution till the early 1990s, the area of degraded, barren, uncultivable, saline and waterlogged land in

Punjab reduced significantly, due to the installation of tube wells as well as the economic incentive that the new, profitable crops provided to reclaim degraded land. As a result of the benefits of the Green Revolution, Punjab became one of the most prosperous states of India. However, the significant achievement in agriculture which was celebrated throughout the country for more than fifty years brought various adverse results too, specifically the deterioration of environment (Pingali et al., 2012). Before discussing these adverse results, it is essential to understand what the factors that account for Green Revolution are and how this success is achieved at the cost of environment. Thus, the current study is divided into two parts. The first part deliberates on the factors that account for the Green Revolution and the second part explores its adverse effects.

## 2. STEPS TAKEN BY THE GOVERNMENT TO BRING ABOUT THE GREEN REVOLUTION

The major steps taken by the Government that help in achieving the Green Revolution are as discussed below:

### 2.1 High Yielding Varieties of Seed

The seeds evolved by Dr. Norman E. Borlaun, the Nobel Prize winner of 1970 were introduced and used under Intensive Agricultural Database Programme in the selected states. The seeds of wheat – Sona, PB 18 and Kalyan, of rice – IR, of Bajra – HV1, of maize – Ganga 101 and Ranjit, and of jowar – CSH 2 gave spectacular high yield in 1966-67. The Yield of wheat increased from 8.5 to 26 quintal per hectare, similarly the yield of bajra increased to 8 quintals per hectare and that of maize to 17 quintals per hectare.

### 2.2 Fertilisers

The use of fertilisers was another important factor that helped in achieving high yield of the crops. In 1967-68, 11 lakh tons of fertilisers were used which increased to 143 lakh tons in the very next year. The per hectare consumption of fertilisers which was 19 kg earlier increased to 74 kg in 1967-68.

### 2.3 Irrigation

The State gave special attention to irrigation facilities to the agriculturalist and launched various development plans to take water to the fields. Within thirty years, the land under irrigation was extended to 893 lakh hectares from 320 lakh hectares. Of this, 104 lakh hectares was earlier under minor irrigation such as tube wells and wells. This was done by developing canal system and by electrification of villages. In 1950-51 only 3000 villages were getting electricity supply which is extended to 5.32 lakh villages out of 5.76 villages within forty years. Rural electrification made the minor irrigation through tubewells and pumping sets feasible.

### 2.4 Multiple Cropping

Owing to HYV seeds and better irrigation, the farmers started getting more than one crop per farm in a year. After the harvest of wheat, the crop of moong is sown, followed by rice or sugarcane. This resulted in enhanced production of food grains. Within thirty years, 408 lakh hectares of land was under multiple cropping systems.

### 2.5 Advent of Agricultural Machinery

The machinery like tractor, pumping sets and harvester has made the use of HYV seeds and multiple cropping easier. Seventeen Agro Corporations were established to help the farmers by providing machinery at low cost and high quality.

### 2.6 Credit Facilities

Co-operative Credit societies were set up in 1967-68 to provide loans at lower interest rate to the farmers. This saved them from the exploitation at the hands of the local money lenders. In 1967-68, the loans of Rs. 400 crore amounts were given to the farmers which enabled them to buy HYV seeds, new machinery and fertilizers, besides arranging for minor irrigation at their own.

### 2.7 Price Incentives

The Government established the Agricultural Costs and Price Commission; this commission determines the minimum prices of the important agricultural commodities. Based on this minimum support price, the price of a particular crop is determined. Government started buying crops on this price through Food Corporation of India and other such corporations.

## 3. EFFECTS OF GREEN REVOLUTION

As a result of the Green Revolution, production of many crops particularly the food grains such as wheat and rice increased rapidly and India became self-sufficient in the terms of food grain production (John and Babu, 2021). The income of the farmers, particularly in Punjab increased and as a result Punjab became one of the most prosperous states of India. Tushar Seth in his article "Green Revolution: Effects and Limitations of the Green Revolution" gives a comparative view of change in annual crop yield over a period of fifty years. The following table given by Seth shows average annual yield per hectare of rice, wheat and pulses from 1950 to 2000.

Average yield per hectare of crops during 1950-2000 (in Kgs) is shown in the following table.

| *Year* | *Rice* | *Wheat* | *Pulses* |
|---|---|---|---|
| **1950-51** | **668** | **663** | **441** |
| **1960-61** | **1.013** | **851** | **539** |
| **1970-71** | **1.123** | **1.307** | **524** |
| **1980-81** | **1.336** | **1.630** | **433** |
| **1990-91** | **1.740** | **2.281** | **578** |
| **1991-93** | **1.744** | **2.327** | **573** |
| **1995-96** | **1.855** | **2.493** | **552** |
| **2000-2001** | **1.986** | **2.778** | **635** |

# 4. EFFECT OF GREEN REVOLUTION ON ENVIRONMENT

## 4.1 GROUND WATER DEPLETION

The percentage of land under paddy in Punjab increased from 6.9% in 1970-71 to 33.8% in 2005-06, while the area under traditional crops now stands at 2-3%. Besides implications for biodiversity and ecosystems (Sannigrahi et al., 2021), for some parts of the state, the new system has led to a rapid decrease in the water table, as paddy cultivation is water-intensive. Irrigation from ground water accounts for 60–65% of the total irrigation requirement and the remaining 35–40% is met through canals. This intensive exploitation has caused the ground water problems (Dangar, 2021). The groundwater table has alarmingly decreased from 15 feet to 100-115 feet or more in Punjab state of India. The water table is depleting at an annual average rate of 55 cm across whole of the state of Punjab. More than half of development blocks of Punjab and Haryana state of India, where intensive irrigation is practiced, cannot sustain any further increase in the number of tube wells. In Punjab state, out of 137 blocks, 103 blocks were over-exploited, five blocks are critical, four blocks were semi critical and only 25 blocks were in safe category. The total requirement of water for agriculture activities based on cropping pattern and practices stands at 4.38 mham against the total availability of 3.13 mham. The deficit of 1.25 mham is met through over-exploitation of groundwater reserves through tube wells, resulting in rapid decline of water table in the entire state.

## 4.2 GROUND WATER CONTAMINATION

One component of modern agriculture in Punjab is the intensive use of chemical fertilizers, or urea, and chemical pesticides. Apart from the chemical inputs' contributions to yields and farmer debt, chemical-intensive agriculture has also been linked to public health in Punjab, especially in the Malwa region of southern Punjab. Fertiliser consumption has increased from 3 kg $ha^{-1}$ in 1960's to 130 kg $ha^{-1}$ in 1990's. Presently fertiliser use for rice and wheat is 160 and 170 kg $ha^{-1}$, respectively. There is an imbalance in the N, P and K consumption ratio in rice–wheat crops. According to the Indian Journal of Fertilizers, in Haryana and Punjab, farmers used 32 times and 24 times more nitrogen than potassium in the fiscal year 2008-2009, respectively, much more than the recommended 4-to-1 ratio (Rahman, 2015). There is a definite trend in accumulation of nitrates to toxic levels in the ground water the Malwa region heavily uses pesticides. Pesticides being used in agriculture tracts are released into the environment and come into human contact directly or indirectly affecting human life. A number of studies reported pesticides and heavy metals in drinking and groundwater in different parts of India. Organochlorine and organophosphorous pesticide residues were detected in groundwater samples from irrigation and drinking purposes.

The Malwa region of Punjab has been described as India's 'cancer capital' due to abnormally high number of cancer cases, which have increased 3-fold in the last 10 years. Studies show strong correlation between pesticide use and cancer, via contamination of groundwater and above-acceptable levels seeping inside vegetables. Also associated with excessive pesticide use are mental retardation and reproductive disorders, which have also increased in the Malwa region. Government health care is scarce in rural areas, and the cost of cancer-treatment drugs are often beyond people's means, creating another source of debt. Although the high incidence of cancer in Punjab has multiple causes, including industrial pollution, pesticide use is one prominent cause over which farmers should have direct control.

### 4.3 IMPACT ON LIVESTOCK

Indiscriminate and disproportionate use of chemicals pollutes the soil, air and water and is primarily responsible for various adverse livestock health conditions. The livestock fodder crops and feeds produced on this salt affected, toxic and micronutrient deficient soil contain nitrates and pesticide residues and deficient in micronutrients. This may be one of the important etiologies of increased productive and reproductive health problems of livestock, especially bovine. Higher contents of organochlorine pesticide residues had been reported in milk samples collected at different locations of the country and meat samples. An analysis of randomly selected samples of ready to eat chicken products collected from different areas of Punjab revealed that 74.00 per cent of samples showed the presence of pesticide residues. HCH, DDT and Endosulfan were detected above minimum detectable levels in 52.63, 42.11 and 15.79 per cent samples, respectively. Pesticide contamination poses significant risks to the livestock and human health.

### 4.4 WHEAT-PADDY MONOCULTURE AND DEPLETION OF SOIL HEALTH

Another aspect of agriculture to emerge in Punjab after the Green Revolution is the wheat-paddy monoculture system, in which farmers grow paddy during the kharif season and wheat during rabi season. Punjab traditionally grew a variety of crops, including maize, pearl millet, pulses and oilseeds; however, the Green Revolution introduced high-yielding hybrid seeds for wheat and rice and in 1966-67, the government began to offer farmers Minimum Support Prices (MSP) for wheat and rice in the interest of food security. Hence, as wheat and paddy cultivation became both lucrative and low-risk, wheat-paddy monoculture rose as the dominant system. The percentage of land under paddy in Punjab increased from 6.9% in 1970-71to 33.8% in 2005-06, while the area under traditional crops now stands at 2-3%.

3% of soil in 1980 had a low P content and by 1995 a low P content was found in 73% of soil, whilst the area of soil with a low N content only increased from 89 to 91%. Soils with a high K content have decreased from 91% in 1980 to 61% in 1995. The wheat–rice rotation is disturbing the balance of available nutrients in the soil and also causing a deficiency of micronutrients, particularly zinc and copper

### 4.5 STUBBLE BURNING

Another consequence of the wheat-paddy system is stubble burning, which has caught national and international attention in recent years. Since wheat and paddy are harvested by cutting the crop, after harvest, the bottoms of crops remain in the fields. This straw stubble can be sown back into the soil with benefits to the soil, but this requires time and great effort. In order to save resources and have the fields ready in time for sowing the next crop, many farmers burn their fields to eliminate the stubble. The government of Punjab enacted a law to restrict paddy sowing times such that cultivation takes greater advantage of monsoon rains and relies less on drawing groundwater. Although the law has decreased the rate of water depletion but it results in very less time between harvesting of paddy and sowing of wheat.

The practice of stubble burning, especially when done by Punjab and Haryana farmers en masse, causes massive air pollution that affects not only local areas, but as far as Delhi. The heat from the burning also kills beneficial organisms in the soil. Stubble burning has been banned in India since 1981 (Mukerjee, 2016); however, only recently has enforcement been vigilant enough to be potentially compelling to farmers. Although technologies exist to make alternatives to stubble burning possible, such technologies are too expensive for many farmers. The roots of the stubble burning problem lie in the wheat-paddy system.

### 4.6 INDEBTEDNESS OF FARMERS

High cost of farm input which includes fertilizers, pesticides, weedicides and modern farm equipment along with easy availability of loans which are given based on the value of land owned by the farmer rather than income generated from that land has put a majority of farmers in Punjab and Haryana especially small and marginal ones in a debt trap.

## 5. REMEDIES

The adverse effects of the Green Revolution can be curtailed and the ecological damage can be amended by following the strategies discussed below:

1) Crop Diversification: Crop Diversification can be adopted to enhance the soil health. It will help soil to regain the lost ingredients and to gain its fertility.
2) Water Harvesting: Water harvesting is the dire need of the hour to the depleting water table. Water Harvesting is the collection, diversion and storage of the freshwater sources, such as rain. Through water harvesting in fields as well as in residential areas, the rain water can be used instead of ground water, for irrigation and other domestic and industrial uses.
3) Organic Farming: Returning to basics is the call of the environmentalists today. The adoption of organic system of farming will help in lessen the use of fertilizers, pesticides, insecticides and other chemicals which harm the soul health terribly.
4) Residue Management: Residue Management is the only solution to the problem of stubble burning. Hence, Government should encourage farmers through awareness campaigns and incentives to adopt residue management system.

These are just a few measures for the preservation of ecological against the adverse effects of the Green Revolution. Many more innovative ecocentric measures can be taken to save the environment as well as grain pool of the country.

## 6. CONCLUSION

In this paper, ecological impact of Green Revolution in Punjab is discussed. It includes, how better quality seeds, better irrigation facilities, chemical fertilizers, multiple cropping, advent of agriculture machinery and crop protection measures have improved farm yields in Punjab. Also the adverse effect of Green Revolution on ecological health of region is studied. As the advancements in farming techniques also resulted in ground water depletion and contamination of water and air, so certain preventive measures to curtail the adverse effects of Green Revolution are also suggested. It has been argued that crop diversification, water harvesting, organic farming, and residue management could all be very helpful in reducing the environmental harm caused by the Green Revolution.

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# ROLE OF ARTIFICIAL INTELLIGENCE IN CHECKING PADDY STRAW BURNING

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***Abstract:***

*Every year in the month of October – November, pollution level in northern part of India increases at a drastic level and this region becomes one of the most polluted regions of the world. This is mainly due to the agricultural farm fires in Punjab and Haryana. Most of farmers burn the paddy straw to prepare their fields for next crop sowing which produces many types of health hazards, pollution and will also result in loss of the fertility of soil. There is a dire need of controlling and managing the stubble burning of paddy crop. One of the methods is to collect the straw with the help of bailer and the other way is the incorporation of rice straw into the soil. This helps in maintaining and enhancing the soil fertility. However, ineffective management of straw incorporation can result in a decrease in production efficiency and increased greenhouse gas emissions. The artificial intelligence based remote sensing techniques can be used to forecast, check and detect the stubble burning. Based upon this, proper enforcement and correctives measures can be taken to substantially reduce or completely diminish the crop burning through an effective residue management system.*

## 1. INTRODUCTION

Punjab is the major contributor of rice and wheat to the central pool of India. Rice and wheat are the major crops of Punjab. The rice and wheat are harvested with the help of combine harvesters. These harvesters separate the grain from the crop residue. This crop residue also known as stubble. With the introduction of high yielding varieties of rice and wheat, not only the production of grains has increased, but also the stubble increased by many folds. Wheat crop residue does not create much problem, as it can be collected by straw combine also known by reaper and can be used as animal feed. But paddy crop harvesting leaves huge amount of stubble or crop residue in the fields which is a very difficult task to manage and it should be cleared from the fields before sowing next crop. Stubble burning [1]is the intentional burning of the crop residue in the fields to prepare the fields for the sowing of the next crop. The crop residue interferes and create problem with tillage and seeding operation. So, crop residue burning is the easiest method of stubble management.

As per the Punjab government reports[2], in the last paddy harvest season of 2021, 72466 farm fires were recorded down from 76590 in 2020. But is higher than 5299 incidents recorded in 2019. The data shows that farm fires particularly during the paddy season are not stopping. Despite the centre government providing funds to the state to the tune of Rs 1145 crores for supplying the subsidized machines for the stubble management.

## 2. REASONS FOR STUBBLE BURNING

Farmers are following this practice of stubble burning in north India because they have to prepare their fields for wheat crop in month of October and November because

- Main reason for stubble burning is to control weeds that are herbicide resistant.
- Time saving-short time span or window between rice harvesting and wheat sowing.
- Labour saving- Burning paddy straw does not need any labour.
- Money saving- Paddy straw burning does not need any machinery.
- Also, rice straw is not considered suitable as fodder for animals because of its high silica content (this is true for the non-basmati variety of rice).

As per Section 188 of the Indian Penal Code (IPC), stubble burning is a crime. Under the Air (Prevention and Control of Pollution) Act, 1981, it was notified as on offense. Despite being banned, the practice continues in India, where farmers cite a lack of viable alternatives to clear their fields of stubble.

## 3. ADVERSE EFFECTS OF STUBBLE BURNING

Paddy straw burning generates lots of smoke that results in reduced air quality, human respiratory problems and less visibility on roads which may results in accidents. It also results in loss of natural biodiversity and soil health. Paddy stubble of one ton on burning releases 1515 kg $CO_2$, 3.83 kg NO, 92 kg CO, 0.4 kg $SO_2$, 2.7 kg $CH_4$, and 15.7 kg non-methane volatile organic compounds. As per Punjab Agriculture University [3], the monitory Loss of Nutrient Per acre is given below.

- Average 3 Tonne paddy straw burn in One Acre
- If we calculate this loss in Rupees

| | | |
|---|---|---|
| Nitrogen | 21 Kg/acre | Rs. 250/- |
| Phosphors | 3.6 Kg/acre | Rs 150/- |
| Potassium | 35 Kg/acre | Rs 1000/- |
| Sulphur | 30 Kg/acre | Rs. 900/- |
| Zinc | 300 gm/acre | Rs. 50/- |
| Iron | 2.1 Kg/acre | Rs. 100/- |
| Manganese | 2.25 Kg/acre | Rs 150/- |
| **Total** | **Rs 2600/-** | |

So if we incorporate the paddy straw into the soil, it will have benefits upto Rs 2600 to the farmer per acre. Paddy straw burning pollution produces health problems like.

- Lungs ailments
- Chronic heart problems

- Respiratory problem
- Eyes Problems

Paddy straw burning also causes the depletion of Natural resources & Biodiversity which includes: Micro Flora & Fauna, Organic Carbone, Friendly Organism i.e. Earthworm, Insects and birds.

## 4. SUSTAINABLE PRACTICES TO STOP STRAW BURNING

Some of the techniques that are used for stubble management [4] [5] are given below.

**PADDY STRAW CHOPPER PLUS ROTAVATOR**

Tractor operated straw chopper can be used to chop or break the paddy straw into small pieces. This chopped straw is spreads in the field by straw spreader. Then this chopped stubble can be easily mixed in the soil with the help of rotavator. After tillage is done by rotavator, irrigation is applied to the soil which decays the stubble and subsequently wheat sowing is done with no-till drill or traditional drill. Normally, it takes about15-20 days to come in to proper moisture content for sowing the wheat crop. This time period also depends upon the type of soil.

**Figure 1**: View of paddy straw chopper in operation [3]

**STRAW BAILER**

This method is widely used in many countries. The straw bailer [6][7] collects the crop residue from the fields and makes bales of it. Bales are made up of various sizes with varying height and width depending upon need and convenience of handling. These bales can be easily be transported to power houses and their place of use.

**Figure 2:** Bailer [3]

**SMS (SUPER STRAW MANAGEMENT SYSTEM)**

The combine harvester comes with the extension of SMS system. SMS system has two parts. First part is straw chopper which cut down the crop residue into small pieces. Second part shreds these chopped parts into the fields. Then reverse plough can be used to mix it in the soil or wheat can be sown with the help of happy seeder or super seeder. With this technique, wheat sowing is possible without crop residue burning. But its cost and lack of demonstration is major reason for its adoption.

**Figure 3**: Combine fitted with SMS system in operation [3].

**Figure 4**: Happy Seeder and super seeder [3].

But farmers are reluctant to use these machines due to following reasons.

- Costly
- Time Consuming (very short interval)
- Difficult to adopt Politics. Crop residue burning is an offense under Air Act 1981 and code of criminal procedure 1973. But due to fear of losing goodwill, the government is not acting against the farmers who burn paddy straw.
- Farm unions are in the favour of paddy straw burning. They are saving there is no alternative to stubble burning.

But some farmers are using these techniques to counter the burning of straw. One of them is S. Birdalvinder Singh Khattra ofVillage Kallar Majri, Tehsil Nabha Distt Patiala who is role model for many farmers. As per its efforts, his villageKallar Majri was projected as a model village at National Green Tribunal (NGT) by the punjab where the state government recorded zero stubble burning. He was also appreciated By Prime Ministers Modi in Mann kiBaatprogramme.

The administration has taken several measures to curb the practice of stubble burning by farmers.

- In 2019, the Supreme Court directed the governments of Haryana, Punjab and Uttar Pradesh to pay farmers a financial incentive to curb the practice.
- In 2020, the Government of Punjab appointed 8000 nodal officers in villages that grow paddy in order to put a check on stubble burning.
- Already, penalties for stubble burning are imposed on farmers who break the law and resort to burning crop residue.

By adopting these techniques, government gets some success and area under farm fires had decreased on some extent [8].

## 5. ARTIFICIAL INTELLIGENCE (AI) SOLUTION FOR CHECKING STUBBLE BURNING

Farm fires degrade the air quality [10] to unlivable level. It should be monitored regularly for the pollution control. With the help of satellite images which uses remote sensing technique [11], farm fires can be checked. NASA's which is a USA space agency, satellite images shows and recorded lots of farm red dots in India especially across Punjab and Haryana. These red dots indicate theannual stubble burning practice adopted by the farmers after paddy harvesting and before sowing of wheat crop.

**Figure 5**: NASA image indicates stubble burning[ 9].

Punjab Pollution Control Board with the help of satellite imageries from the Punjab Remote Sensing Centre, were also able to locate the crop burning areas and charged fine from the farmers. Government also awarded farmers with incentives, rewards and subsidies for practicing the control measures for stubble management [12 ].

Latest machine learning techniques like Artificial Neural Network (ANN)[13], Internet of things (IoT) and many more are used to efficiently analyze large amount of collected data by satellite images[14] to forecast and predict farm fires.

Some Mobile Applications are developed based upon these techniques. An Indian start-up blue sky Analytics, is working on an AI-based platform called Zuri [15] that it claims will be able to monitor and predict the adverse effects of stubble burning. According to them, improved monitoring will help to reduce the pollution level to half directly benefitting the people and reducing the disease burden. Zuri utilizes historical data on fire counts to understand the history of farm fires in every district and state, and can predict high-risk zones as well as expected volume and calorific value of crop waste. It also includes information on marketplace to enable farmers to sell stubble rather than burn it.

It is very difficult for farmers to reach to factories for the disposing of the stubble. Some AI enabled website can be developed which acts as platform for the sale and purchase of stubble.

Punjab government is planning to use drones to check the farm fires. Government submitted the proposal to the Union agriculture and farmer welfare demanded Rs 53 crores funds for the purchase of drones to keep eye on farm fires.

## 6. CONCLUSION

Stubble is the leftover after grain segregation. The collection of stubble is not fetching much money for the farmer. The best is to incorporate the paddy straw directly into the soil with the help of harvester fitted with SMS system and sow wheat with happy or super seeder. So to tackle the problem of stubble burning and pollution, corrective measures should be taken like–

- State Governments may be given full assistance for promotion through awareness by way of demonstration, training and capacity building.
- Higher slabs of subsidy may be given to farmers for procurement of machinery
- More Custom hiring centers may be promoted for easy reach of costly equipment for small and marginal farmers at village level.
- Incentivize farmers for adoption of various residue management operations.
- Support for funding R&D/ technological up-gradation to States
- Crop diversification.

Artificial Intelligence and IoT technologies can be used to check the stubble burning and control pollution levels. Sensors can be used to collect data and forecasting system can be developed with the artificial intelligence and machine learning techniques to predict the farm fires and suitable corrective measures should be taken. With the help of AI technique, early estimation of harvesting dates or period can be done district wise, this residue burning period helps the decision makers to reduce the rice stubble burning. Monitoring through satellite data using Remote Sensing and GIS helps the policy makers to access and implement techniques to weed out the problem of stubble burning and control pollution.

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# A COMPREHENSIVE STUDY ON MODERN FARMING USING IOT

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***Abstract:***
*The globe gets around 200 thousand individuals every day, and the total world population is predicted to reach 9.6 billion by 2050. This will result in increased food demand, which can only be supplied by increasing agricultural productivity. As a result, agricultural modernization has become an urgent necessity. Several limits contribute to crop yields that can be solved by utilizing drone technology in agriculture. This report examines drone technology and its evolution in the agricultural industry over the previous decade. The use of drones in crop monitoring and pesticide spraying for Precision Agriculture (PA) has been discussed. The work done on drone structure, multiple sensor development, and spot area spraying innovation has been presented. Furthermore, the application of Artificial Intelligence (AI) and deep learning for agricultural remote monitoring has been addressed.*

***Keywords:*** *Remote Sensors, Agriculture drone, IoT, Crop monitoring, Smart Farming, UAV's*

## INTRODUCTION

Food production is a difficult challenge because of the continuously growing population. The Food and Agriculture Organization (FAO) of the United Nations estimates that 815 million people worldwide suffer from chronic hunger, with Asia accounting for 64% of this population. By 2050, the world's food output must rise by almost 50% in order to feed its nine billion people[1]. Contrarily, the fundamental resources needed for crop cultivation, such as rivers and lakes, are getting rarer by the day. A 2018 survey found that 9.2% of the world's population experienced serious difficulties with access to food[2]. A very pitiful situation will emerge from any additional reductions in the food supply. Additionally, there was an issue with severe undernourishment (i.e., up to 17.2 percent of the population), which meant that they did not often have availability to wholesome and sufficient food[3]. An estimated 26.4 percent of the population is affected by the moderate - to - severe levels of the food access issue.

The COVID-19 outbreak had a significant negative impact on agricultural output and the food distribution channel. Many producers were unable to meet their fundamental needs for agriculture, such as labor, seeds, fertilizer, and pesticides, in a timely manner, which reduced output [3]. Many emerging Asian countries are struggling with issues including a large population and considerably poorer agricultural productivity when contrasted to more advanced economies of technology. India also has a similar problem[4]. This is a result of its subpar farming techniques, insufficient electricity supply, and untrained farmers, among other factors. Indian cultivation is still performed in the traditional way, with over 73 percent of people becoming explicitly or implicitly reliant on the agricultural industry[5].

Airborne remotely sensed data is among the most crucial technologies for Precision Farming (PF) and vertical agriculture. Drones are used in airborne satellite imaging, which uses photos captured at various frequencies and analyzes plant indicators to identify the various crop situations[2]. In the past, required photographs used for precision farming were captured by either aeroplanes or spacecraft. Using fixed-wing aircraft to capture photos is quite expensive, and the issue with aerial photographs is that the sensitivity and specificity are typically not as excellent as required[6]. Additionally, the clarity and accessibility of photos are influenced by the weather[7].

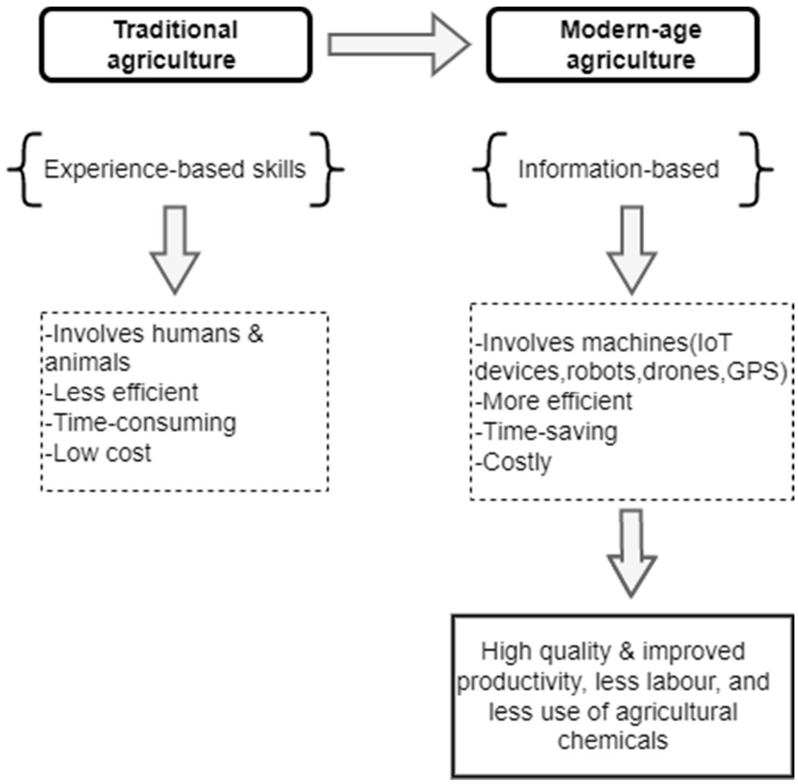


**Fig. 1.** Traditional Vs Modern-Age Agriculture [2]

The use of UAV surveillance devices by farmers allows them to observe overhead shots of the crop. This provides details on the water supply, soil types, insects, and fungus infections. Drone-collected crop photos provide details in the infrared and visual wavelength ranges. It is possible to extract various elements from these photos, which provide information about the condition of plants in a way that is invisible to the human eye[8]. Some other crucial aspect of this innovation is its capacity to routinely evaluate the yield, such as every week or every hour[9]. Crop knowledge is often available, enabling farmers to improve necessary adjustments for improved crop administration.

## IOT-BASED TECHNOLOGIES IN AGRICULTURE

We are experiencing unprecedented levels of technological adoption in agriculture. Many upcoming agricultural technologies appear to be highly promising for the future of farming.

IoT was originally considered an emergent agro-technology, but it has already entered the mainstream due to widespread usage. The IoT-based feature enables the use of several sensing devices to collect agricultural data, which is then evaluated using a simulation model[10]. IoT is the internet controlling things. IoT smart agriculture solutions are intended to assist in agricultural field monitoring by employing sensors and automating irrigation systems. This device utilizes resources more effectively, improves data collecting, requires less time, and reduces the need for human work[11]. Robots, drones, remote sensors, and computerized image systems, along with ever-improving machine learning and analytical tools, are used in agriculture to monitor crop health, height, weed detection, automatic and scaled water supply to crops, survey and map fields, and provide data to farmers for sensible farm management plans, saving both time and money[3]. There are some limitations to this technology, including sophistication, protection, and transparency.

**Agricultural robots**

With rising labour needs and a global labour crisis, agriculture robots, also known as Agribots, are gaining popularity among farmers[8]. Farmers may focus more on boosting overall output yields by automating sluggish, repetitive, and boring operations with agricultural robots. Commonly these robots are used for weed controlling, harvesting, picking, sorting and packing different products.

**Remote sensing in agriculture**

Remote sensing in agriculture works by collecting information from various sensors throughout time. The information acquired may then be utilized to examine various elements of the crop and production[11]. This study is used to make crop adjustments to achieve maximum yield. The main advantages of remote sensing are precise analysis and assessment of crop sown region, crop disease identification and soil properties.

**Drones in agriculture**

Agriculture is one of the primary industries incorporating drones. Drones with sensors and cameras are used to photograph, map, and survey farms. Drones can assist farmers in optimising input consumption like quantity of seed, fertiliser, and water and responding more swiftly to threats like weeds, pests, and fungus in the crops. In further sections, we have discussed agricultural drone types and applications in detail[11].

## LITERATURE REVIEW

There are four distinct drone diverse applications, including agricultural spraying, crop monitoring, mapping and soil analysis, agriculture of livestock[1]. Table 1 lists the many techniques and tools that previous researchers have utilized to complete the intended goals.

**Crop Spraying**

In the agricultural industry, the usage of drone spraying is particularly beneficial since it can be used to effectively spray water, fertilizer, and pesticides. Producers may access areas that could be too damp or somehow unavailable to them by using this approach[11].

Another advantage of this use is that no people are involved in the pesticide spraying process, significantly lowering the danger of chemical contamination. Additionally, the spraying heights achieved by this method are often higher than those achieved by traditional ground sprayers, which may cause some harm to delicate crops if the spraying height is too low[6]. The primary drawbacks of this strategy are the drone's low carrying capacity for liquid (spraying substance) and its short flight time. A spray tank to hold the liquid and nozzle for spraying are the usual components of a drone spraying system. Pesticide spraying frequently uses a pressure pump, whereas fertilizer spraying does not.

**Crop Monitoring**

Farmers must constantly review the status of their crops, particularly throughout the growing season. The knowledge gained will guide farmers' decisions on comprehensive measures to achieve maximum output at the close of the regular season[5]. The computerized, infrared, and hyperspectral types of cameras are the most often utilized lenses, and they play a major role in giving the necessary statistics on harvest status. A thermal imaging camcorder with an infrared sensor may create a thermal map that shows the crop's warmth readings[12]. While hyperspectral cameras can take observable and unobservable photographs of the crop by using specific colours of light to establish a collection of pictures for that wavenumber, which are then mixed to obtain a precise mosaic, captured cameras from digital photography can be processed to extract red-green-blue (RGB) colour information.

**Mapping and Soil Analysis**

In so far as the findings of aerial photography may be utilized to even further examine the soil's health and calculate the crop yield, mapping and soil analysis are closely connected. As per our pre-planned path, either manual or automatic drone mapping can be done[13]. The internal camera will collect and transmit photographs of the terrain along this trip, which will then be analyzed using special tools. Several studies have been done for this purpose, yet if the goal is to examine the soil, image the area, or do both at once.

**Livestock Monitoring**

The use of drones to inspect livestock has attracted a lot of interest from farmers. The quantity and behaviour of the livestock may be ascertained from the drone's livestock photographs, which are then relayed in genuine to the surveillance equipment so that producers can take appropriate action. This strategy is quite effective, particularly when it comes to keeping an eye on the cattle on a sizable agricultural property and locating human intruders[10]. Due to the similarities in some species' physical characteristics, this programme sometimes misclassifies animals, which results in inaccurate information being given to farmers. False information may also be effectively conveyed through the use of light and surrounding effects.

**Table 1.** Types of Drones with different methodologies.

| S.No. | Applications | Research objectives | Methodologies |
|---|---|---|---|
| 1. | Crop spraying | Determine the deposition and mobility of droplets | Use TTA M8A drone with integrated spraying system |

| | | | |
|---|---|---|---|
| | | with various rotor spinning rates | and PIV method for analysis[14] |
| 2. | Crop spraying | Determine the impact of rotor rotating speed on spray deposition on crop surfaces | Design spraying mechanism with using flat fan nozzle and equip it to DJI S 900 drone[13] |
| 3. | Crop Monitoring | Crop productivity is estimated by evaluating canopy closure from drone pictures. | Use DJI Phantom 3 Pro (RGB camera)[8] |
| 4. | Crop Monitoring | Classify vegetation into various classes based on the satellite data and drone images | Use Landsat 8 satellite data and DJI Phantom drone (RGB camera) |
| 5. | Crop Monitoring | Calculate the quantity of corn plants. | Use 3DR SOLO drone with RGB camera and DJI Phantom 4 drone equipped with 4 multispectral cameras[15] |
| 6. | Mapping and Soil Analysis | Determine soil pH of pineapple crop | Use DJI Phantom 4 drone (RGB camera) |
| 7. | Mapping and Soil Analysis | Develop automated classification technique to automatically create weed maps in oat fields | Use SenseFly eBee drone (RGB camera) for images and by using digital image processing, compare object and pixel-based classification algorithms |
| 8. | Livestock Farming | Automatically tracks the cattle's activity based on images from the drone | Use DJI Phantom 3 drone (RGB camera)[10] |

## AGRICULTURAL DRONES

Drones were initially developed as a defense tool and were known under several names, including Unmanned Aerial Vehicles (UAV), Miniature Pilotless Aircraft, and Airborne Micro Machines. These days, it is used in a variety of industries, including commerce, engineering, agriculture, defense, compensation claims, geology, recreation, telecommunications, and transportation[4]. The facts in Table 2 show that the drone has significant commercial potential. UAV innovation has progressed extremely quickly as a consequence of such widespread drone use, becoming more user-friendly every day[13]. These days, the use of tiny unmanned aerial vehicles (UAVs) in aquaculture is expanding extremely quickly.

**Table 2.** Drone Application

| S.No | Industry | Drone applications |
|---|---|---|
| **1.** | Infrastructure | Investment monitoring, Maintenance, Asset tracking and monitoring performance |

| | | |
|---|---|---|
| **2.** | Agriculture | Analysis of soils and drainage, Crop health tracking, Yield forecasting, Pesticides and fertilizer spot spraying |
| **3.** | Security | Monitoring lines and sites, Prompt response |
| **4.** | Mining | Planning, Exploration, Environmental impact assessment |
| **5.** | Telecommunication | Tower maintenance, Signal broadcasting |
| **6.** | Oil & gas utilities | Inspecting power lines, solar panels, and wind turbines |

Drones are semi-automated gadgets that are moving steadily in the direction of being self-explanatory. These tools offer great promise for agricultural planning and gathering associated geographical data. Despite its inherent limitations, this technique may be used for user data processing[2]. While current aircraft are GPS-based autonomous aerial vehicles, UAVs were the first broadcast devices flown by a controller from the bottom. Depending on the use of a quadcopter, the type of cameras, sensors, and activities on-site will vary[3]. Helicopter, fixed-wing, and multi-copter systems make up the three primary categories of UAVs.

Fixed-wing UAV*:* UAVs with fixed wings provide the lift required when they reach a particular speed thanks to their aerofoil-shaped, stationary wings[10].

Helicopters: They provide lift and thrust by using a single pair of horizontally revolving blades that are mounted to a technological standpoint. A helicopter has the ability to take off and land vertically, fly forward as well as reverse, and hover in one spot[4]. Due to these characteristics, helicopters may be used in crowded and inaccessible regions wherein fixed-wing aircraft cannot fly.

Multi-copters: Rotorcraft having several rows of horizontally revolving blades, generally four to eight, may lift and steer unmanned aerial vehicles (UAVs)[8].

**Table 3.** Various Agricultural Drones and Their Applications

| Types of Aerial Platforms | Commercial agriculture drone | Price range | Applications in Agriculture |
|---|---|---|---|
| **Piloted agricultural aircraft** | M-18 Dromader<br>PZL-106AR KRUK<br>Grumman Ag Cat<br>PAC Fletcher<br>Air tractor | Very High | Crop scouting<br>Fertilizer and pesticide spraying for larger areas<br>Drought monitoring Security and surveillance |
| **Single Rotor Helicopter (UAV)** | Yamaha RMAXR22-UVR66 spray system Align Demeter<br>E1SR20 and SR200 of rotomotion | High | Large area pesticide spraying In remote area where high payload capability is needed<br>Crop height estimations Soil<br>Field analysis Crop classification |
| **Fixed Wing** | Trimble UX5<br>AgEagle RX60<br>Sensefly eBee Ag<br>Precision Hawk | Medium-High | Large area monitoring<br>Carry more weight<br>Crop health status monitoring<br>Fertilizer and pesticide |

| | | | |
|---|---|---|---|
| | Lancaster 5<br>Parrot Disco-Pro Ag<br>Sentera Phoenix 2Trimble UX5 | | spraying |
| **Multi-copter** | Parrot bluegrass fields<br>A410<br>DJI Phantom 4 PRO<br>AGCO Solo<br>Sentera Omni Ag<br>SenseFly eXom<br>AgBot | Low -Medium | Small field monitoring<br>crop height Estimations<br>Soil and field analysis<br>Water stress calculation<br>Operationally efficient and take less time for inspection<br>Visual inspection |

## CROP HEALTH SURVEILLANCE

Farmers check their crops on a daily basis for possible dangers including illnesses, pests, and sluggish development[16]. Visual examination and manually taking ground measurements from a selection of areas were the conventional techniques for crop monitoring. For almost 50 years, crop development has been monitored using colour and infrared photographs taken from various platforms[4]. By applying sophisticated image data processing techniques, a drone with a camera on it may identify crops that have illnesses or other problems[6]. Figure 3 illustrates how field mapping and crop monitoring are the two major uses of drones in agriculture. In this area, research and data on the use of UAVs for agricultural monitoring have been done.

Images taken by unmanned aerial vehicles ( UAVs ) cameras may be used to produce a chart of the vegetation types[3]. On the basis of these indicators, crop parameters such as plant diseases, fertilizer needs, and drip irrigation may be determined. Using statistical parameters, one may distinguish between weeds, ill plants, and good plants[10]. Drones are used extensively in the agricultural sector to evaluate crop health, support corrective measures, and ultimately avoid crop spoilage. a few ways to use drones for agricultural monitoring systems.

The choice of sensors to utilize in conjunction with drones is crucial for efficient crop management. The choice of sensor is largely influenced by the uses for that sensor, such as illness diagnosis, nutrition detection, freshwater status recognition, etc[11]. Drones have been progressively improved, and undertaking drones for environmental monitoring have been created by scientists. However, it wasn't until approximately 2011—probably—that the UAV system achieved success in the agriculture industry because payload gadgets and drone advanced electronics have both become more accessible and inexpensive.

Data gathering has been carried out using a spatial and spectral camera. The RGB, additional RedEdge, and NIR spectral bands were all collected[4]. The suggested platform's semantic segmentation was based on U-Net. The use of additional bands improved the performance of image classification. The categorization of the picture data was done using deep learning methods predicated on the Random Forest algorithm[13]. Deep learning is a machine learning (ML) approach based on Convolutional Neural Networks (CNN). ML is a well-liked method for analyzing and predicting outcomes from visual data[17].

**Fig. 2.** Crop Health Monitoring Using Agricultural Drone[3]

## DISCUSSIONS & CONCLUSION

In this study article, the most recent advancements in unmanned drones for smart agriculture are discussed. Crop surveillance and insecticide spraying are the two fundamental drone technologies in smart farming that are covered in this paper. Changes in drone constructions, the creation of sensors for data collecting, innovations in drones that spray pesticides, the use of machine learning, and the use of Intelligence for remote agricultural monitoring have all been addressed. It has already been determined that drone applications for smart farming will increase after 2017. This is brought on by the decrease in weight, increase in UAV cost, and expansion of cargo capacity. Quadcopter and fixed-wing drones are the most common varieties employed in agricultural health monitoring and livestock identification. Each day, these drones' size and price continue to decrease. Due to their large cargo capacity, drone helicopters are mostly utilized for spraying fertilizer or pesticides. Nevertheless, the use of multi-copters for pesticide application is constantly growing. Due to their increased flying stability, multi-copters are a superior choice for target spraying. The mass, dimensions, and quality of drone cameras have significantly changed throughout time. Smart devices and IoT services are used in so many agricultural activities like spraying, analysis of the crop using Image segmentation & automatic water irrigation. These services are based on networks like MANET, WSN, and VANET. These networks render some useful services to the farmer which helps them to handle and maintain their work easily using AI and IoT services and devices. This ad-hoc network allowed IoT devices in the agricultural area for developing intelligent fields can converse and share their much-important statistics.

## FUTURE SCOPE

In this paper as author reviewed some areas i.e. agricultural drones, Crop monitoring, Drip Irrigation, Crop Health Surveillance, Soil Analysis and Management. After the analysis of all the related terms, every technology, method and algorithm is working on the devices or machines either on IoT Devices or AI devices or they use any MANET services for their functioning of drones, water management, and soil analysis projects. So, the author advises that if someone wants to proceed with the same work then they will proceed with the privacy or security concerns of the devices which are used in farming, the more devices connected to the server the more risk is there for security attacks to happen because of vulnerabilities of the network and IoT devices.

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# ROLE OF ARTIFICIAL INTELLIGENCE IN SMART AGRICULTURE: A SURVEY

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***Abstract**:*

*We all know that in this modern age, technology plays a very important role in every job. In all fields, the technology is used to improve job efficiency, less time-consuming, and more complete and better outcomes. The global population is expected to reach more than nine billion by 2050 which will require a 70% increase in agricultural production to meet demand. Farming assumes a significant part in the financial area. Mechanization in agriculture artificial-intelligenceis the most ridiculously stressing and arising point on the planet. The traditional methods used by farmers were not sufficient to meet these needs. Therefore, new automated methods are introduced. These new methods have met the needs of the diet and employed billions of people. Artificial Intelligence in agriculture has brought about a change in agriculture. These technologies have protected crop yields from a variety of factors such as climate change, population growth, employment problems, and food security issues. This paper discusses the use of smart artificial intelligence techniques in the major agricultural sector so that students can capture various agro-intelligent development. his paper analyzes the utilization of Artificial knowledge in agribusiness like water system, developing, and splashing with the assistance of sensors and different techniques introduced on robots and robots. Also, to get a short outline of the ongoing execution of farming automation, robotic growth programs, and drones.*

***Keywords**: Agriculture, Artificial Intelligence, Robotics, Smart Farming. Automation.*

## INTRODUCTION

Farming is a significant type of revenue for Indians. It contributes around 17% to 18% of absolute GDP and 10% of total exports in India. Either straight forwarding or in a discursive way around 60% of individuals in India depend on agribusiness for vocation. It takes under the essential area of Indians economy more than the 60% of India region is arable making it the second biggest country as far as absolute arable land. But due to the different crop diseases, the amount of quality and quality of the crops is reducing day by day. More than half of the area is cultivatedthe whole earth. Artificial intelligence means imitating human intelligence on machines that are designed to think like human beings and replicate their behavior such as learning and solving problems. Machine learning is a subset of artificial intelligence as shown in Fig. 1.0 Machine learning is a tool used to identify, understand and analyze patterns in data. One of the most important research areas in the world for advanced computer technology is Artificial Intelligence. in the agricultural sector, various agricultural producers are struggling to cope with the risks and dangers posed by the use of pesticides in their crops to combat pests and other diseases. A professional program can be defined as a tool for generating information. Information is available in a variety of ways or is generated by data and information. Text, images, video, and audio are the types of media from which information can be obtained, and the role of information technology is to establish, design, and store archives and process this information. Mathematical knowledge is a good example of information generated from data while the advice produced by a professional program is a good example of information generated from knowledge.

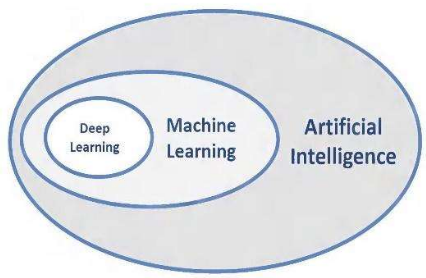


Figure 1.0: Subset of AI.
Source: https://human-centered.ai/2017/11/11/difference-ai-ml/

**A. The Need for Agricultural Specialist Programs:** The need for specialist technology transfer systems in agriculture can be identified by identifying problems in implementing the traditional technology transfer system, and by proving that specialist systems can help to overcome solved problems, and are likely to improve.

**B. Solid Information**: The technical knowledge of the pulse production stored and available at the problem site indicates that the information is static and may not change according to the needs of the farmers. Therefore, the information is usually incomplete.

**C. Compilation of specialized items:** Most extension documents address issues related to specific specialties: plant diseases, entomology, nutrition, production, etc. In real cases, the problem may be for more than one reason, and it may require a combination of information. In addition to the information included in the extension documents and various publications.

**D. Update:** Over time the extension texts expire that need to be updated from time to time. Changes in chemicals, their dosages, and their impact on the environment should be considered when adopting manufacturing and protection technologies. Updating this information in the same documents and distribution takes longer.

**E. Availability of information:** Certain information may not be available in any type of media. It is only available to human professionals, extensions, and/or experienced growers. In addition, the transfer of information from experts and scientists to extension consultants and growers represents a challenge to the development of crop production technology at the national level.

**1.1 Features of the Agricultural Specialist Program:**

- It mimics human thinking about the problem-solving environment, rather than imitating the domain itself.
- Consults by displaying personal information
- Solves problems with heuristic or limited methods.

**1.2 Lifecycle of Agriculture:**

The agriculture lifecycle can be described as:

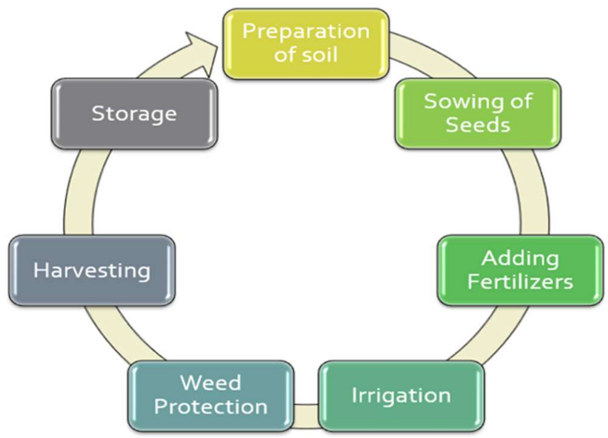


**Figure 1.1 Lifecycle of Agriculture**

Source: https://www.analyticsvidhya.com/blog/2020/11/artificial-intelligence-agriculture.such as rain

**1.3 The challenges that farmers face through traditional farming methods:**

In harm, the weather patterns like downpour, temperature, and humidity assume a significant part in the cultivating cycle. Increased deforestation and pollution are causing climate change, so it is challenging for ranchers to settle on choices to set up the dirt, plant seeds, and collect.

All plants need some nutrients in the soil. And there are three essential nutrients and potassium (K) nitrogen (N) and phosphorus (P), needed to be in the soil. Malnutrition can lead to low crop yields. As we see in the agricultural cycle that weed control plays an important role. If left unchecked, it can lead to increased production costs and depletion of nutrients in the soil which can lead to nutrient deficiencies in the soil.

**1.4 Applications of Artificial Intelligence in Agriculture:**

The business is going to Artificial Intelligence innovation to assist with delivering solid plants, control bothers, screen soil, and developing circumstances, sort out rancher information, help with functional burden, and foster different agrarian related exercises all through the food inventory network.

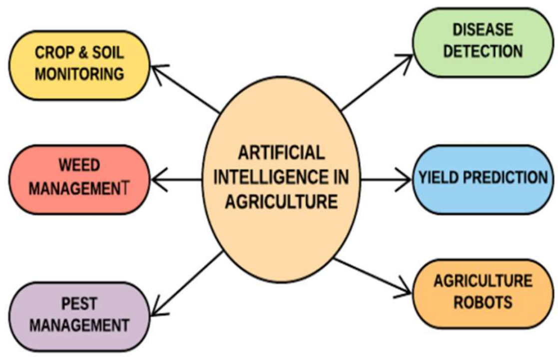


Figure 1.2 Agricultural AI Implementation.

**A. Weather forecasts:**With environmental change and expanded contamination it is challenging for ranchers to set aside the perfect time to sow seeds, with the help of Artificial Intelligence farmers can analyze the weather using weather forecasts which help them plan the crop to grow and when the seeds should be sown.

**B. Soil and Plant Health Monitoring System:** Soil type and nutrient uptake are important factors in crop type and crop quality. Due to the increase, deforestation is declining and it is difficult to detect the quality of the soil.

**C. Analyzing plant life with drones:** SkySqurrel Technologies has introduced Ariel drone-based thinking solutions for plant health monitoring. In this process, the drone captures data from the fields and the information is moved through a USB drive from the robot tothe computer and analysed professionally.

**D. Predictive Analytics in Farming:** Horticultural AI applications have created applications and apparatuses that help ranchersto be efficient also, oversee cultivating by giving fitting direction to ranchers on water management, crop pivot, ideal gathering, crop type, proper planting, and pesticides. attacks, nutrition management.

**E. Agrarian Robots:** AI organizations are creating robots that can without much of a stretch for every structure many undertakings in the horticultural area. This sort of robot is prepared to control weeds and collect harvests quicker than hu-monitors.

These sorts of robots are prepared to screen the nature of plants and identify weeds by picking and pressing plants simultaneously. These robotscan withstand the challenges that agricultural workers face.

**F. Open AI insect detection system:**Bugs are one of the most exceedingly awful foes of ranchers to harm crops.

Computer-based intelligence frameworks utilize satellite symbolism and contrast it and verifiable information utilizing AI calculations and see whether a bug has lived and what sort of bug has endured like beetles, grasshoppers, and so forth. Additionally, send notices to ranchers on their cell phones so ranchers can take them. Essential wellbeing measures and execution bug control are expected subsequently AI assists ranchers with controlling vermin.

## LITERATURE SERVEY

Artificial Intelligence reasoning has been demonstrated to be horrendously useful inside the field of data recognition in the timeframe. The machines act with each other to sort out which yield is best for advancing and accumulating. Significant methodologies will guarantee ranchers of the phenomenal field the board and sound harvests. The paper is intended to supply the most extreme sum data achievable, concerning the different AI ways utilized in horticulture. the use of AI can benefit ranchers to understand their objective of a sound gathering by making further developed determinations inside the field [1].

Agriculture has suffered major setbacks such as lack of irrigation systems, temperature changes, groundwater congestion, food shortages and pollution, and much more. The conclusion of the development depends to a large extent on the acquisition of various cognitive solutions. When it comes to addressing the real challenges that farmers face and implementing independent decisions and solutions, farming is still in its infancy. To test the scope of AI in agriculture, applications need robustness. It tends to be created with different AI-controlled strategies, for example, distant sensors for acquiring soil dampness and programmed water system with the assistance of GPS [2].

This research presents a thought for the utilization of AI innovation in agribusiness. In accordance with the ongoing social environment of declining work, the restricted usable rural world, and the immense hole between absolute food creation and the total populace, AI has been viewed as the most feasible answer for those issues and has been created and worked on throughout the long term. by researchers everywhere. In this audit, AI definitions are presented, where the feature is Turing trying. Then, at that point, featured the two fields wherein AI assumed a key part, in soil the executives, weed control, the Internet of Things (IoT), valuable information examination, and support of broadly utilized rural innovation, were presented. This survey additionally features three significant down to earth AI challenges in agribusiness. Artificial intelligence-based gear and calculations from control tests to truly rural conditions require further examinations and exploration, as well as being capacity to oversee huge informational indexes and decipher them precisely and rapidly are two significant provokes that should be addressed for the application to be powerful; at long last, the security of gadgets utilized in open areas of farming climate and the secrecy of information gathered are additionally issues to be tended [3].

Today, these Artificial Intelligence-enabled solutions are being used to address the objectives of a few industries, such as transportation, banking, medicine, and agriculture. The use of this Artificial Intelligence technology has transformed the entire food process with enormous benefits. In addition to supporting producers in organic farming and culture, Artificial In intelligence in agriculture also leads to more accurate crop production with better crop yields and better-quality resources while using limited resources. In addition, remote sensors use advanced methods, which help farmers to look after their crops without actually looking at the farm. To several companies are looking forward to agricultural development enhanced by Artificial Intelligence. Artificial Intelligence, combined with remote sensing, redefines common agricultural patterns and thus redefines the traditional farming model. In agriculture, the future of Artificial Intelligence is progressively evolving with more complex strategies for complete transformation. [4]

Considering the future of agriculture, we must be careful to avoid technological terminism. Apart from denying that technology is powerful and that economic requirements can greatly encourage certain uses of technology, it is important to recognize the agency citizens, communities, engineers, and governments have when it comes to shaping technological approaches. Some of the risks outlined above may be mitigated by good design and therefore should be a concern between designers and AI producers in agriculture. Many of the risks associated with the use of AI in agriculture are associated with AI factors - being at risk of bias, the "black box" environment, and being at risk of theft - which are is really problematic, if not, in some cases where AI is detected. To a large extent, AI designers and developers in the agricultural sector should be able to use strategies to reduce these risks that are being developed elsewhere. The dangers of bias, and ways to overcome them, are becoming increasingly well-known and the subject of extensive discussion and research. Issues affecting privacy, surveillance, data ownership and, possible use of data, as well as the appropriate role of intellectual property in farming practices, will need to be discussed in more detail among the stakeholders. We believe that it is very important that as much community as possible be included in this process, it from the diversity of ideas and because what happens in the agricultural sector ultimately affects the whole community. Those who are concerned about the dangers of using AI in agriculture should seize the opportunity to draw them to the general public. Those who are convinced that AI is full of shared benefits should not be afraid of such controversy [5].

This paper will analyze the social and moral ramifications of utilizing fake intel-ligence (AI) in the farming area. It will distinguish probably the most well-known difficulties and suggestions recognized in the writing, how these connect with those talked about in the AI set of principles, and yet again utilized as AI moral rules. This will be accomplished by looking at distributed articles and meeting processes that emphasis on friendly or moral ramifications for AI in the horticultural food area, through the setting examination of the writing. This study will compare what impacts can be examined in rural AI and what issues can be talked about in AI moral rules, however which can be examined comparable to agrarian AI. The reason for this is to recognize holes between rural writing, as well as the gaps in AI code of conduct, which may need to be tended to. The reason for this paper guidance on how horticultural AI Literature has created, contrasting the extent of AI rules, and regions appropriate for future exploration[6].

In a rapidly changing world, in anticipation of declining arable land due to urban and industrial growth, agricultural production requires a 70% increase in productivity and effective growth in harvesting, distribution and utilization of resources, in order to meet demand. There are new technologies in Information and Communication Technology that can be applied to the agricultural sector in the fields of precision farming, the use of farm management software, wireless sensors, and the use of agricultural machinery. Remote technology plays a major role in agricultural accuracy. This paper highlights ways in which agricultural accuracy can affect agriculture through the use of unmanned aerial vehicles for photography, processing and analysis. UAV technology for precision farming is a robust, timely, and cost-effective way of obtaining effective data on a farm to improve yields and overall profitability from sustainable farming systems. Save time, increase yields and provide investment benefits. The future of agricultural production with low human activity increased productivity, and reduced losses in harvesting and planting, all depend heavily on this technology and should be properly considered in all development [7].

The current paper has identified critical disruptive technologies that are changing the current agricultural food systems. However, the results may not reflect the real-world situation because the research was based solely on literature searches that limited published information. However, the study provides a detailed understanding of how disruptive technologies are adopted in agricultural food systems. In fact, a single disruptive technology does not define Agriculture 4.0 but the interaction or integration of several agri-food technologies provides the definition of Agriculture 4.0. The study revealed the need for more in-depth research to increase the areas of use of disruptive technologies in Agri diet systems [8].

AI provides a sweeping transformation in advanced ways that will redefine common patterns and limitations of agriculture. AI will drive agricultural transformation at a time when the world has to produce more food using fewer resources. ARS scientists have used AI technology in various laboratories to advance agricultural research and speed up scientific discovery. Unfortunately, many AI-based agricultural research projects in ARS could not be addressed in this limited space. This Special Section is designed to make it as informative as possible about the details of the various AI strategies used in ARS [9].

The remote sensor has an unused value in assessing the spatial and temporal variability of agricultural systems. In this study, we combined hot images and visualization in the form of normalization difference vegetative index (NDVI) to assess field spatial variability over time. Combining thermal imaging to test water availability and NDVI to assess plant viability and efficiency of light photography has led to the identification of three areas within each field: a more stable, less productive, and a more unstable area. Each of these areas needs to be managed differently in order to achieve maximum performance for each field and using AI and ML can guide producers in identifying, implementing, and evaluating dynamic strategies. Progress in this area develops a platform for efforts to expand these tools to measure the impact of management decisions on food security. [10].

## ADOPTING CHALLENGES IN AGRICULTURE

Artificial Intelligence in the rural area, yet, there isn't sufficient data with regards to answers for learning super-advanced horticultural apparatus. Recognizing natural cultivation, for example, soil conditions, weather patterns, and the gamble of irritation flare-up is high. While reaping starts, an arranged yield development program toward the start of the time might appear to be awkward due to outer impacts. More information is required on the AI framework to prepare gear, to make exact expectations. On account of the enormous scope of cultivating, it is not difficult to gather region information while accomplishing transitory information is a test. Since it requires investment for a site to develop, it integrates a lot of adaptabilities to fabricate a strong AI ML model. This is the primary reason for involving AI in farming-related items like pesticides, manures, and seeds. One more significant component is the significant expense of numerous farming perception arrangements that are promptly accessible on the lookout. Man-made intelligence enlivened arrangements ought to be profoundly doable to guarantee that innovation affects the agrarian local area.

### 3.1 HOW AI CAN BE HELPFUL IN HORTICULTURE

Farming includes many cycles and stages; AI can perform mind-boggling and complex errands. It can gather and handle a lot of information in a computerized field, think of the best arrangement, and execute that activity when joined with different advances. The role of AI in the agricultural knowledge management cycle:

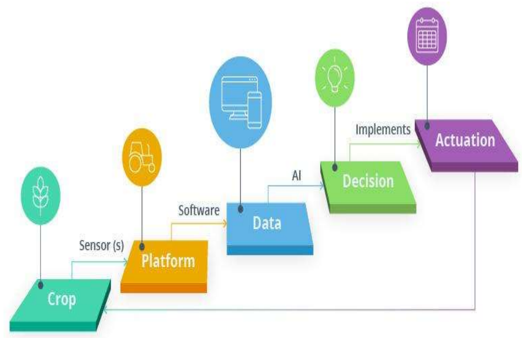


Figure 1.3 Agriculture information management cycle.

*Source: MDPI – [From Smart Farming towards Agriculture.]*

Combining practical and agricultural skills can benefit from the Different processes which are described below:

**1. Analyses market demand:**

AI can analyze crop selection and can help growers to see which product is going to be most profitable.

**2. Risk management:**

Farmer can use the different forecasts and forecasting statistics to decrease the errors in business work and reduce the risk of crop failure.

**3. Soil monitoring and checking:**

Artificial intelligence frameworks can perform compound soil examination and give exact evaluations of inadequate supplements.

**4. Plant security:**

Simulated intelligence can screen plant conditions to identify and foresee illness, recognize and eliminate weeds, and suggest powerful irritation control.

**5. Plant nourishment:**

Artificial intelligence is helpful in recognizing the right water system examples and supplement use times and foreseeing the right blend of rural items.

**6. Collect:**

With the assistance of AI, it is feasible to collect and try and foresee your best time consequently.

### 3.2 ARTIFICIAL INTELLIGENCE TO SOLVE FARMING CHALLENGES:

**A. AI enables you to make better decisions:**

Speculating measurements can change the genuine game. Ranchers can gather and handle a ton of information and interact it quicker with AI than they would somehow. Dissecting market interest, valuing evaluations, and carving out the ideal open door to plant and collect are significant difficulties that ranchers can tackle with AI.

That being said, AI can similarly total soil prosperity data, give manure recommendations, screen the environment, and screen thing accessibility. All of this empowers ranchers to pursue better choices at all phases of the interaction.

**B. AI brings cost savings:**

A certain approach to farm management - more efficient agriculture - can help farmers to grow fewer crop resources. Precise cultivating fueled by AI could be the following enormous thing in agribusiness. Accu-rate cultivating consolidates best soil the executives rehearses, adaptable innovations, and successful information the board frameworks to assist ranchers with expanding yields and re-duce costs.

**C. AI addresses staff shortages:**

Agricultural activity is difficult, and the shortage of workers in the industry is nothing new. Farmers can solve this problem with the help of automation techniques. Non-driving work vehicles, shrewd water systems and fertilizing the soil frameworks, cunning splashing, direct cultivating programming, and AI-based gathering robots are a few instances of how ranchers can accomplish the work without employing an excessive number of individuals. Contrasted with any human ranch specialist, AI-fueled apparatuses are quicker, more vigorous, and more precise.

**D. Problems which farms faced while using AI:**

the benefits of practical farming techniques, using this technology might seem like a daunting task for every farmer. However, serious problems remain.

**E. Adoption of Long process in technology:**

Ranchers need to comprehend that AI is just a high-level part of straightforward innovation for handling, gathering, and checking field information. Artificial intelligence requires the right specialized framework to work. For that reason, even those ranches that have some innovation can't push ahead.

**F. Lack of knowledge in emerging technologies:**

The farming area in non-industrial nations is not the same as the rural area in Western Europe and the US. A few districts might profit from brilliant arti-ficial knowledge, yet it could be hard to sell such innovation in regions where rural innovation is uncommon. Ranchers will presumably require help to embrace it.

**G. Protection and security issues:**

As there are no unmistakable approaches and guidelines in regards to the utilization of AI in agribusiness as well as a general rule, exact cultivating and brilliant cultivating raise different lawful issues that stay unanswered. Dangers to protection and security, for example, digital assaults and information holes could cause ranchers difficult issues. Sadly, many ranches are in danger of these dangers.

**Table 1.** Conclusion of expert systems in agriculture

| SYSTEM NAME | CROP NAME | CONCLUSION |
|---|---|---|
| TEAPEST | TEA | It is an item situated, decide-based master framework that can recognize serious bug vermin of tea and in this way recommend a reasonable control system. |
| AGREX | Fruits, Vegetables, Paddy | In Kerala, The Center for Informatics Research and Advancement (CIRA) has constructed a specialist framework program named AGREX which can uphold the ranchers to get a very coordinated and reliable direction. This master program tracks down expanded use in paddy, vegetables, postharvest innovation, and natural products in the field of harvest assurance, compost application, sickness diagnostics, and water system planning. |
| JAFexpert | Jute | Focal Research Institute for Jute and Allied Fibers (ICAR-CRIJAF) fostered an electronic master framework called JAFexpert. It is equipped for giving information to the board and precise ID of harmful creatures and abiotic harms for jute and partnered fiber crops. |
| AGPEST | Wheat, Rice | This master framework is intended for the detection of illnesses set off by wheat plants and rice bothers individually. It likewise helps the choice help module with a cooperative control center base UI for investigation made close by the inquiries connecting with some particular sickness side effect. |
| AMPRAPALIKA | **Mango** | This master framework program is used for making a determination of a particular sickness of mango. The framework's information base incorporates data about the pointers and treatments of 14 mango tree ailments that exist during the non-endlessly fruiting seasons. |

## CONCLUSION

Automation in agriculture is consciousness in agribusiness assists ranchers with computerizing their cultivating as well as movements to more proficient cultivating to accomplish higher harvest yields and better quality while utilizing less assets. Companies that participate in the development of machine learning or products based on Artificial Intelligence or services such as agricultural training data, drones, and automation will receive technological advances in the future that will provide the most useful applications in this field to help the world cope with food production problems.

Computer based intelligence frameworks assist with further developing harvest quality and precision - known as horticultural exactness. Simulated intelligence innovation analyze illnesses on plants, bugs, and supplements on ranches. Simulated intelligence sensors can identify and guide weeds and figure out which treatment to locally utilize. The advantages of AI in horticulture are certain. Shrewd cultivating instruments and exact cultivating frameworks can make little, tedious, and tedious undertakings so that ranch laborers can utilize their opportunity to do vital assignments that require human ingenuity. In any case, it is vital to take note that dissimilar to a farm truck, one can't just pursue AI and begin it. Man-made intelligence is definitely not a genuine article. A bunch of innovations is automatically created by the framework.

The commonsense insight of acting is to emulate thinking; is to learn and address problems in light of information. Computer-based intelligence is only the following stage in the improvement of smart cultivation, and it needs innovation to work, as a matter of fact. At the end of the day, to procure all the bene-attacks of AI, ranchers need an innovative foundation first. It will require investment, perhaps years, to update that foundation. In any case, thusly, ranchers will actually want to construct areas of strength for a biological system that will endure everyday hardship.

Meanwhile, innovation suppliers need to contemplate a couple of things: how to work on their instruments, how to assist ranchers with adapting to their difficulties, and how to effectively and consistently pass that AI helps on to take care of genuine issues, like diminishing difficult work. The fate of AI in farming makes certain to be organic and product full.

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# A ROLE OF URSHASSU EXPERT SYSTEM IN A AGRICULTURE: A REVIEW

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## *ABSTRACT:*

*Food quality play an important role in today's challenging times which is accomplished by the help of a expert system including experimental practical experience by different researcher and farmers who face lot of invisible issues and problems in field of food processing and food Engineering using technological approaches in agriculture.*

*In this research paper urshassu algorithm is proposed to quantities quality analysis and detect defect of edible fruit and vegetables', further very useful to grading and sorting by automated system to identify and verified to a product examination by its color, size shape, defects and texture using image processing. Actual color appearance play key role to determine the quality, where intensity value of a pixel form digital image is recognized using MATLAB.*

***Keywords:*** *Brinjal vegetable, farmer, researcher, computer vision system, graphic, digital image, Color*

## I. INTRODUCTION

In the modern world an expert system is wonderful tool to provide best service for good health of the peoples, So Food Engineering, food Processing and agriculture food products are major requirement for disease free healthy food products. But now these days so many organization used harmful pesticide spray on food products in natural processing which really harmful human health. In another side numbers number of farmers use old organic technique for farming/agriculture.

Image analysis consists of invisible contents and objects as image data for quantitative information. Digital images are common and easiest way to represent digitized information. A image is worth a hindered or more words in digital form. Inter- relationships between objects can verified by positions, color and sizes.  Computer science and engineering settle an example for multi-disciplinary research which play a vital role for new finding in the field of Food Engineering, food Processing and Agriculture.

Expert system have main components includes knowledge base, inference engine and user interface are Major factor. The knowledge base is that consist of experience share by researcher and farmer further information is represent by set of rules and regulation. The inference engine workout for final outcome basis of Knowledgebase which conclude based on the available evidence and reasoning.

The user interface is the component that allows the user to query according to his/her expectation from the system and receive the results accordingly.

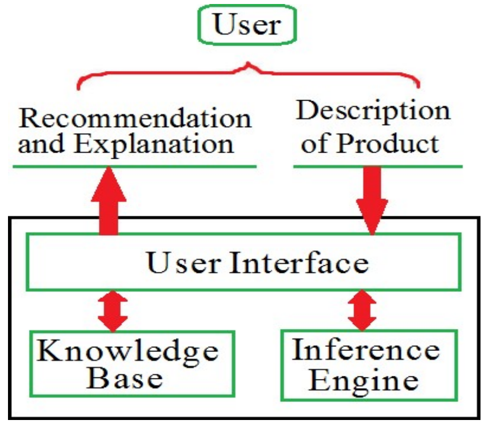



**Figure 1.** Show the component of Expert System

The agriculture sector makes up a sizeable portion of the global economy, and in more the ten countries, agronomy is the leading industry[1] due to continues to grow world's population, So does the demand for food, both in term of quantity and quality. Many expert system also contain an explanation feature that explains the purpose of a question/query or how a result was reached.

The proposed algorithm is a well defined list of steps for solving a particular problem. There so may application areas in computer science and engineering. One major purpose of this research paper to design a new updated algorithm to implemented in the MATLAB software in the application of food engineering, food science and food marketing so that enhance agriculture field with help of computer technology.

## IMAGE PROCESSING AND MACHINE LEARNING

Image processing and Machine Learning is helpful to developer/researcher to achieve objective of proposed research.

Digital image processing and Machine learning focuses on following [3, 4,9]:

1. Filter invisible pictorial information for more better interpretation.
2. Processing of image data for storage and transmission.
3. Autonomous machine perception based system.
4. Identify unidentified features and structures from images for measurement.

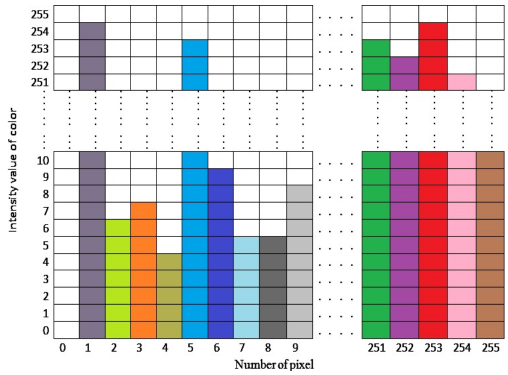



**Figure 2.** Show chart of color intensity of pixels.

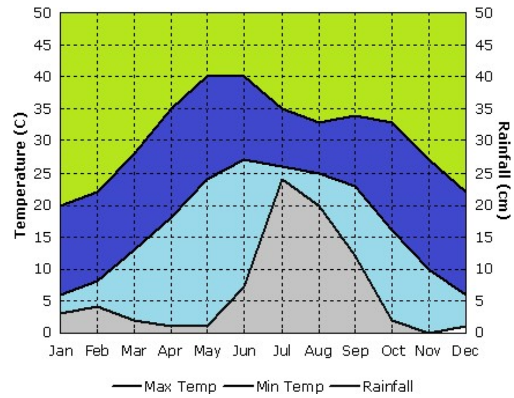



**Figure 3.** Represent temperature and rainfall in a year.

The proper working and implementation of machine learning measure its successful rate on the basis its performance as figure 2 represents number pixels separate intensity value from 0 to 255 RGB color based collections of a digital image of a edible vegetable product figure 3 show represent impact on vegetable unripe to ripening process due to temperature and rainfall in a year. The proposed algorithm really helpful to farmer in agriculture sector in the sense as machine learning to identify its quality and marketing of crop during the season as in figure 4 by hierarchy to represents data flow for helpful alternative decision and action.

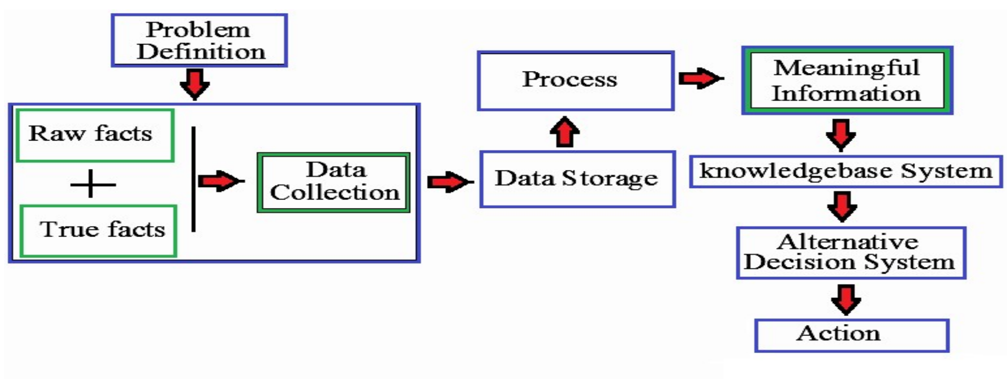
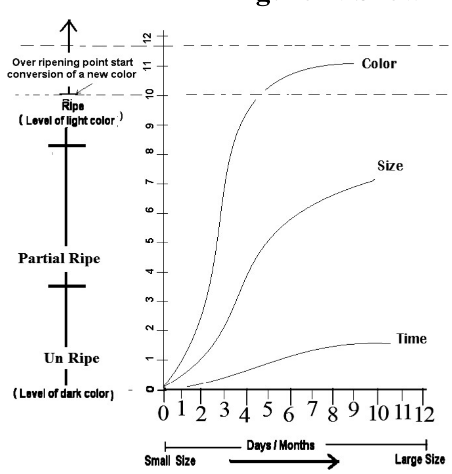
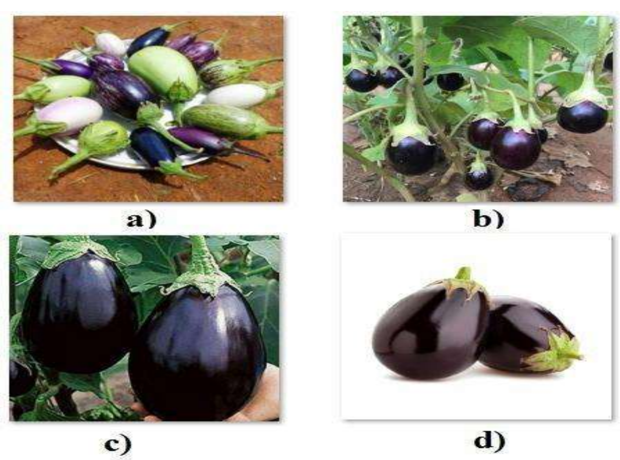



**Figure 4:** Show Hierarchy to represents data flow.



## OBJECTIVES

Main aim of the research is to develop a new and efficient algorithm for Quality analysis without intervention human. The goal will be achieved through the attainment of following objectives.

1. To develop an expert System for particular brinjal agriculture product.
2. To develop a new updated algorithm for invisible quantities quality analysis.
3. Comparative analysis for speed of identification, verification, sorting and grading.
4. Develop a system to undergo color detection for sorting and grading with new technology system.

## LITERATURE REVIEW

In agriculture sector several researchers and Industry of today's machine learning devices are rushed to market basic security and privacy protections using different recognition techniques are developed based upon color and size attributes in the literature survey. Different images may have similar or identical color, size and shape values.[4,5]

Quality is also born from experience so that reviews mean know old research and then go forward for a new one research.

Even new born baby start image processing with his/her eyes to identify real mother for feed as input.

## PROPOSED ALGORITHM TO DETECT AND ANALYSIS QUALITY OF BRINJAL VEGETABLE

Prerequisite: [40 Reference Images], [camera], [computer system] Step1:-

i) Load 40 reference images of brinjal vegetable.

ii) Pass all 40 reference images through color array to calculate image value by intensity value in the continuous series with help of step deviation method.

[In this purposed method system will check the color intensity values of the image pixels of brinjal vegetable because 0-255 intensity may be possible of a pixel in color array as in reference image value]

Step 2:- i) Take new image of brinjal vegetable.

ii) Pass it through color array to calculate image value by intensity value in the continuous series with help of step deviation method.

[In this purposed method system will check the color intensity values of the image pixels of brinjal vegetable because 0-255 intensity may be possible of a pixel in color array]

The following formula is used.

Image Value =

$$\frac{f_1 * d_1 + f_2 * d_2 + f_3 * d_3 + \dots\dots\dots + f_{16} * d_{16} * c}{f_1 + f_2 + f_3 + \dots\dots + f_{16}}$$

Where

$f_i$= no. of pixels that belong to color intensity of pixels Class interval (16 spells)

$d_i$= step deviation of range between color intensity of pixels Class interval

$c$ = length of Class interval in color intensity of pixels.

If image value match lie between 1 to 15 image.

Then

Result is brinjal un-ripe Else if

brinjal Image value match lie between 16 to 24 images.

Then

Result is brinjal partially ripe

Else if

brinjal Image value match lie between 25 to 34 images.

Then

Result brinjal is ripe

Else if

brinjal Image value matches with 35 and 40 image.

Then

Result brinjal is over ripe

Step3:- Repeat the Step 2 for next new image.

Step4:- Exit.

## RESULT DISCUSSION

The proposed work is deals to (0 to 255) RGB color quantities which is analysis a digital images to quality analysis in any reason include environment. Further by these, farmer get support for productive farming due to proper information regarding brinjal vegetable production in smart environment via internet network, a farmer can easily more care about his yield crop with various modern equipments and tools.

## CONCLUSION

Proposed review work based on comparative analysis between existing system as in database and new finding for final outcomes, to confirm more accuracy, real time in which MATLAB/image processing play very important role to quality analysis from digital image to identify unidentified invisible elements for food product by its color quality and quantities brinjal vegetable where natural environment also impact in natural ripening process of a vegetable product.

## FUTURE SCOPE

The proposed work can be upgratded for mobile app as Sensing and machine learning in wide resitricted area to more secure, smart environment using image processing in multidisciplnary research area by using computer science and engineering.

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# CLASSIFICATION OF PEST IN TOMATO PLANTS USING CNN MODELS

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## *Abstract:*

*Plant diseases and pests are a major challenge in the agriculture sector. An accurate and a faster detection of plant diseases and pests can help in making an early treatment technique which can further help in reducing economic losses. Recent developments in deep neural networks have allowed the researchers to improve the accuracy of object detection and image recognition. In this paper, there is a use of transfer learning based framework for the classification of pests in tomato plants. The data was collected from online resources containing 859 images of tomato pests categorized in 10 classes. There is a full performance comparison of the 15 pre-trained CNN models and results show that the highest accuracy was shown by DenseNet169 Model. Further, the results demonstrate how effective it is for detecting pest in tomato plants.*


## INTRODUCTION

The country's economy can be assessed by the role of agriculture. When it comes to crops the biggest issues is the affect to crops caused by variety of diseases and pest, mainly in tropical, subtropical and temperate regions around the globe. Climate changes also affect the crop production. Change in climate variable such as humidity, temperature and precipitation leads to the growth of pathogens, virus and plagues that can destroy the crop and impacts on population [**4**]. A pest in agriculture is defined as a population of animals that feed from crop plant tissue that produces economic losses. Most pests are insects. The development of a pest depends mostly on the local weather, external insect’s pressure, greenhouses design, and crop management practices [**5**]. This problem of pest and plant diseases is a worldwide issue that is also related to food security and effects of diseases in plants cause significant damage to farmers. There are traditional methods from which we can control pest like blacklight traps and sticky traps. Spraying pesticides is also a method to remove pest but excessive use of it can cause damage to the crops [**6**].

This approach is focused on the identification and recognition of diseases and pests that affect tomato plants. As tomato has become most important vegetable crop worldwide and its production has significantly increased in recent years. The major tomato producers are China, the European Union, India, the USA, and Turkey. India ranks second in the area of tomato farming and tomato production [**8**]. In this paper, a transfer learning-based approach has been has been introduced for differentiating tomato pests to reduce the aforementioned restrictions. In a deep neural network, a fundamental problem is the need for a large database for effective model training. Here, 15 pre-trained CNN models are reviewed and presented a comprehensive comparison of the performance of these models in classifying tomato pests. Tests were performed on 859 tomato pest images categorized in 10 classes.

## METHODOLOG DATASET DESCRIPTION

The dataset used is downloaded from online sources (Flickr 2018; Pest Pictures 2018; IPM Pictures 2018; National Office of Pesticide Resources (NBAIR) 2013; Tamil Nadu Agricultural University [TNAU] 2019). The dataset has images of 859 tomato pest categorized in 10 classes. The first class is Bactrocera Latifrons is a quite threatening pest for tomato plants and also for other plants like brinjal and bell pepper but the damage is least due to this pest. Bemisia Tabaci is an insect which is hard to predict as it covers a large area. Chrysodeixis Chalcites is a polyphagous insect which feeds on lot of fruits and vegetables. Epilachna Vigintiopunctata is a pest that feeds on tomatoes and potatoes. Helicoverpa Armigera is a fruit fish that bears fruit leading to the rotting of that fruit. Icerya Aegyptiaca is a insect pest with larger affected area. It damages the leaves by absorbing the milk from the leaf cells and the soft upper part of the plant. Liriomyza Trifolii is another harmful pest whichreduces the production rate of the plants. Tuta Absoluta is damaging pest, it affects all stages in tomato growth like eggs, larvae, caterpillars and the adult. In comparison to insects such as Nesidiocoris Tenuis are useful for inducing the immunity of the plants due to its phytophagous behaviour.

## TRANSFER LEARNING

Collecting a large amount of data during a new task can be challenging, especially in agriculture due to climate change, insect resistance, etc. For obtaining good model performance using a small amount of data for training is also difficult. The solution for this problem is using Transfer learning. Transfer learning is a machine learning method in which we reuse a pre-trained model as a starting point for a model on a new task. After applying transfer learning to a new task, one can achieve higher performance than training with only a small amount of data. Deep learning experts introduced transfer learning to overcome the limitation of traditional machine learning models. Transfer leaning models achieve good best performance faster than traditional machine learning models because the models that leverage km=knowledge from previously trained models already understand the features which makes it faster than training the neural networks from scratch[**3**]. The use of transfer learning can be seen in the figure 1.

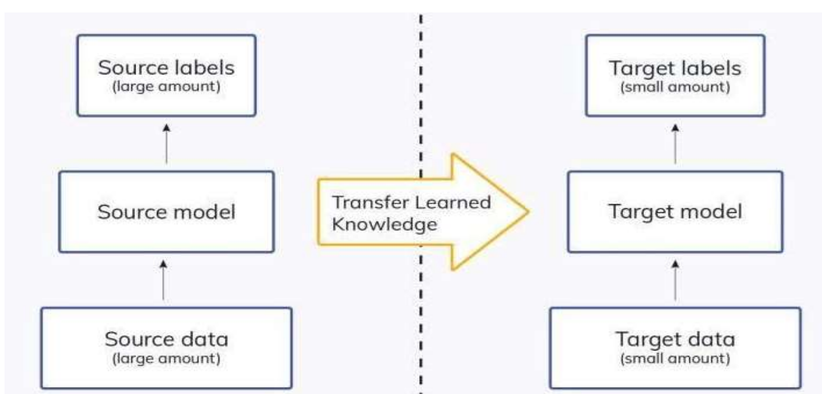


Figure 1; Transfer Learning [**3**]

**Table 1:** Details of Pest Dataset [**1**]

| Class Label | Class Name | # Images | Sample Images |
|---|---|---|---|
| Pest 1 | Bactrocera Latifrons | 80 |    |
| Pest 2 | Bemisia Tabacii | 80 |    |
| Pest 3 | Chrysodeixis Chalcites | 94 |    |
| Pest 4 | Epilachna Vigintioctopunctata | 94 |    |
| Pest 5 | Helicoverpa Armigera | 92 |    |
| Pest 6 | Icerya Aegyptiaca | 80 |    |
| Pest 7 | Liriomyza Trifolii | 88 |    |
| Pest 8 | Nesidiocoris Tenuis | 91 |    |
| Pest 9 | Spodoptera Litura | 80 |    |
| Pest 10 | Tuta Absoluta | 80 |    |
| Total Number of Images | | 859 | |

## PRE-TRAINED DEEP CNN MODEL

Here, 15 pre-trained CNN models are taken and these models are VGG16 (Simonyan and Zisserman 2014), VGG19 (Simonyan and Zisserman 2014), ResNet50V2 (He et al. 2016), ResNet101V2 (He et al. 20152), Res (Net1V2), Res He and others 2016), InceptionV3 (Szegedy et al. 2016), Xception (Chollet 2017), InceptionResNetV2 (Szegedy et al. 2017), MobileNet (Howard et al. 2017), DenseNet121 (Huang et al. 2019). ), (Huang et al. 2017), DenseNet201 (Huang et al. 2017), NASNetMobile (Zoph et al. 2018), NASNetLarge (Zoph et al. 2018), and MobileNetV2 (Sandler et al. 2018). All of the above models has been trained in the ImageNet database (Krizhevsky, Sutskever, and Hinton 2012) with 1.2 million images of 1,000 parts. In this each model has some unique features. VGG16 and VGG19 are a consecutive neural convolutional network that uses 3 × 3 filters. Max-pooling is done in a 2 × 2 pixel window with 2 rows. After each maxpool layer, the number of convolution filters doubles in VGG16 and VGG19. As the name implies, VGG16 has 16 layers and VGG19 has 19 layers. The ResNet model (ResNet50V2, ResNet101V2, and ResNet152V2) has an escape link from the previous layer and a direct link from the previous layer. The InceptionV3 works with blocks. And each block contains the same presence of convolution filters in before one and integration layer. This is very helpful as it manages computer resources in a better way.

The InceptionResNetV2 is a combination of Inception architecture and residual communication. This model has three remainder ensembles and one InceptionV3 connection. The Xception model is the result of a deep divisive variable that means it is a complete separation of the local variables and the transverse channel variability. The MobileNet is built from deep fragmentation integration and that is followed by start-up models to reduce the problems of the first few layers. There is another model, MobileNetV2 that is based on the residual architecture response where the shortcut connections are between the smaller layers of the bottle. In case of DenseNet, each layer is connected to the rest of the layer with a dynamic communication pattern. Here introduce a direct L (L + 1) / 2 connection instead of the L layers in other networks. NASNet has introduced a new setup called a schedule drop path that is very useful as it improves performance.[**1**]

## RESULTS EXPERIMENTAL SETUP

Here all the experimental setup for training 15 pre-trained tomato pests models has been provided. It can be noted that the input status varies for each model. Therefore, it was needed to reshape the images of tomato insects into the shape that is needed according to the requirements of each model. For example, images of tomato insects have been resized to 224× 224 × 3 in the VGG16 model and 299 × 299 × 3 in the First model. Then the second test setup replaces the last fully connected layer containing 1,000 neurons to a fully connected layer with 10 neurons. This is happening because all 15 pre-trained models considered here are trained in the 1,000-class ImageNet database and that is the reason why the final layercontains 1,000 neurons. However, in the data set of tomato pests used in this study has 10 classes so for the final fully integrated layer should contain 10 neurons. In addition to all this, all layers were frozen because of the training other than the final layer based on the concept of transfer reading i.e., the weights obtained from ImageNet database training remained thesame during training of the tomato pests data set and final weights only. Now the layer will be updated. Which leads the number of training parameters was significantly reduced. Then, the tomato insect database is taken and randomly divided into 70% training set, 10% verification set, and 20% test set. In this way each model is trained for 100 epochs with 8 mini-batch size and a reading rate of 0.01. This test was performed with a Adam (Adaptive Moment Estimation) test. In addition to this, five trial (T) models have been used to reduce variability found in segment accuracy due to random train segmentation, validation, and test data. Finally, total accuracy (OA) was calculated with an accuracy of five tests. In addition, a standard deviation (STD) of accuracy in five tests indicating the strength of the model is showed in it.

## EXPERIMENTAL RESULTS

The highest accuracy was obtained by the DenseNet169 model compared to the 15 pre-trained models used for the classification of tomato pests. The performance comparison of the 15 pre-trained CNN models can be seen in the Figure 2. The classification accuracy for each test is obtained for five trials. The DenseNet169 model has shown the accuracy of 88.83%.

[**1**] Hence, it can be said that the DenseNet169 model is best for the classification of tomato pests. This model can help in detecting the tomato pests easily and can help in saving tomato plants from pests.


Figure 2: Performance comparison of 15 pre-trained deep CNN models on tomato pest dataset. [**1**]

## CONCLUSION

For the classification of tomato pests, a large dataset was used which contains 859 different images of tomato pests categorized into 10 classes. The dataset was obtained from online sources. In this paper, 15 pre-trained models were used and the highest accuracy for the classification of tomato pests was obtained by the Densenet169 model. The accuracy obtained using this model was 88.83%. The use of transfer learning framework had shown quite good results.

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# DIAGNOSIS OF PLANT DISEASES AND PESTS BASED ON DEEP LEARNING: A REVIEW

**Sarabjeet Singh, Sangeeta**

## *Abstract:*

*Plant diseases and pests are important factors that determine crop yield and crop quality. Plant and insect diseases identification can be done using digital image processing. In recent years, DP study has made progress in the field of digital imaging, far beyond traditional methods. How to use in Deep learning technology to study plant diseases and insect identification has become a research topic that is of great concern to researchers.*

*This review provides an overview of plant diseases and pest infestation problems, prioritizing comparisons with traditional plant diseases and pest control methods. In terms of network structure variability, this study presents research on plant diseases and pest acquisitions based on in-depth study in recent years from three aspects of network differentiation, network acquisition and network fragmentation, and the advantages and disadvantages of each method being summarized. Regular data sets were presented, and the performance of existing studies was compared. On this basis, this study discusses the potential challenges to the practical application of plant diseases and insecticides based on deep learning study. In addition, potential solutions and research ideas are proposed for the challenges, and a few suggestions are offered. Finally, this study provides an analysis and prospects for future trends in plant diseases and pest-based findings based on deep learning.[1][2][7]*

## BACKGROUND

Plant conditions and pests ’discovery is a veritably important exploration content in the field of machine vision. It's a technology that uses machine vision outfit to acquire images to judge whether there are conditions and pests in the collected factory images. At present, machine vision- grounded factory conditions and pests ’discovery outfit has been originally applied in husbandry and has replaced the traditional naked eye identification to some extent. For traditional machine vision- grounded factoryconditions and pests ’discovery system, conventional image processing algorithms or homemade design of features plus classifiers are frequently used. This kind of system generally makes use of the different parcels of factory conditions and pests to design the imaging scheme and chooses applicable light source and firing angle, which is helpful to gain images with invariant illumination. Although care- completely constructed imaging schemes can greatly reduce the difficulty of classical algorithm design, but also increase the operation cost. At the same time, under natural terrain, it's frequently unrealistic to anticipate the classical algorithms designed to fully exclude the impact of scene changes on the recognition results. In real complex natural terrain, factory conditions and pests’ discovery are faced with numerous challenges, similar as small difference between thelesion area and the background, area.

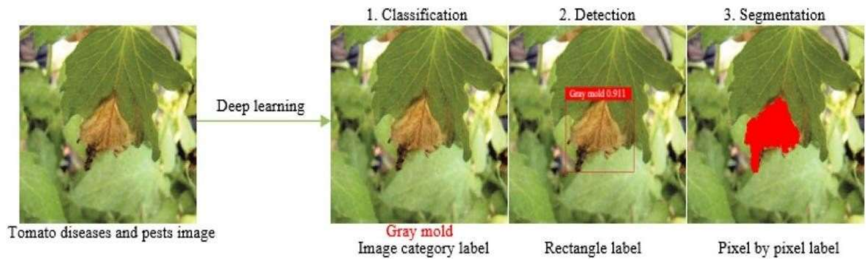
Also, there are a lot of disturbances when collecting factory conditions and pests' images under natural light conditions. At this time, the traditional classical methods often appear helpless, and it is difficult to achieve better detection results.

## DEFINITION OF PLANT DISEASES AND PESTS' DETECTION PROBLEM DEFINITION OF PLANT DISEASES AND PESTS

Plant diseases and pests is one kind of natural disasters that affect the normal growth of plants and even cause plant death during the whole growth process of plants from seed development to seedling and to seedling growth. In machine vision tasks, plant diseases and pests tend to be the concepts of human experience rather than a purely mathematical definition.

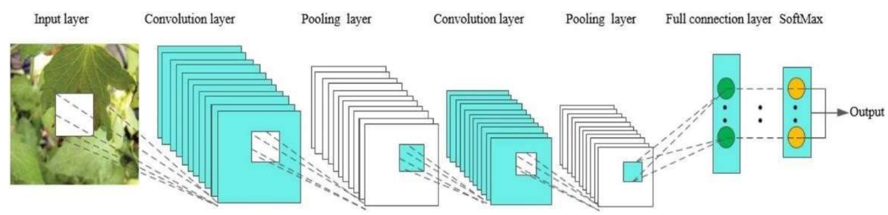
## DEFINITION OF PLANT DISEASES AND PESTS' DETECTION

Compared with the definite classification, detection and segmentation tasks in computer vision the requirements of plant diseases and pests' detection is very general. In fact, its requirements can be divided into three different levels: what, where and how. In the first stage, "what" corresponds to the classification task in computer vision. The label of the category to which it belongs is given. The task in this stage can be called classification and only gives the category information of the image. In the second stage, "where"corresponds to the location task in computer vision, and the positioning of this stage is the rigorous sense of detection. This stage not only acquires what types of diseases and pests exist in the image, but also gives their specific locations. The plaque area of gray mold is marked with a rectangular box. In the third stage, "how" corresponds to the segmentation task in computer vision. The lesions of gray mold are separated from the background pixel by pixel, and a series of information such as the length, area, location of the lesions of gray mold can be further obtained, which can assist the higher-level severity level evaluation of plant diseases and pests. Classification describes the image globally through feature expression, and then determines whether there is a certain kind of object in the image by means of classification operation; while object detection focuses on local description, that is, answering what object exists in what position in an image, so in addition to feature expression, object structure is the most obvious feature that object detection differs from object classification. That is, feature expression is the main research line of object classification, while structure learning is the research focus of object detection. Although the function requirements and objectives of the three stages of plant diseases and pests' detection are different, yet in fact, the three stages are mutually inclusive and can be converted. For example, the "where" in the second stage contains the process of "what" in the first stage, and the "how" in the third stage can finish the task of "where" in the second stage. Also, the "what" in the first stage can achieve the goal of the second and the third stages through some methods. Therefore, the problem in this study is collectively referred to as plant dis- eases and pests' detection as conventions in the following text, and the terminology differentiates only when different network structures and functions areadopted.



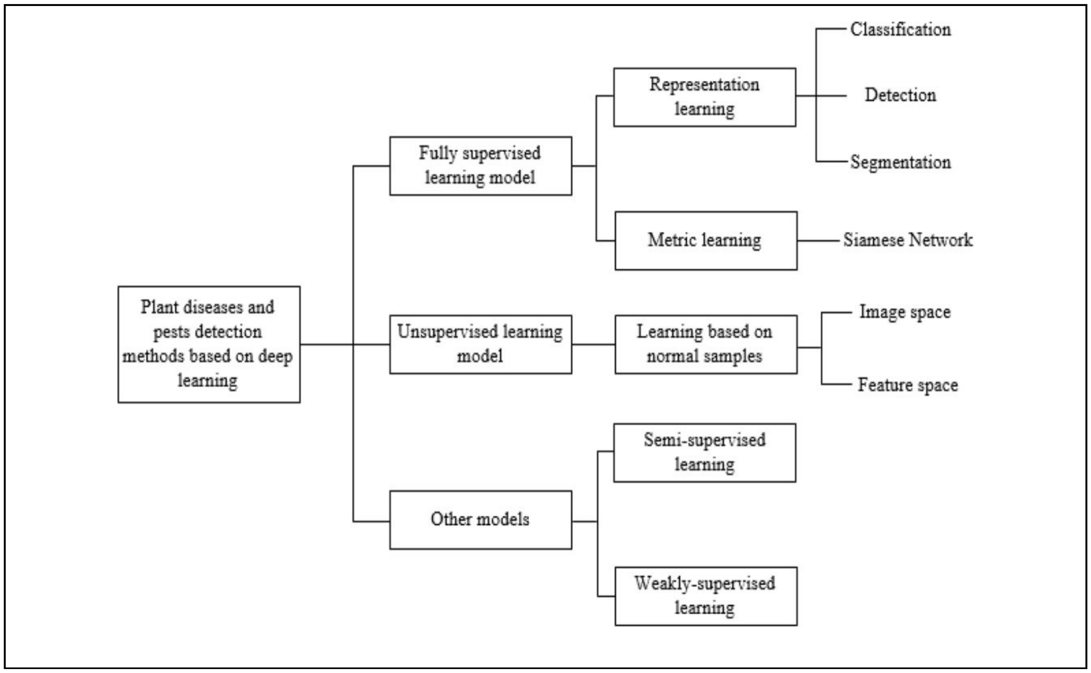

## PLANT DISEASES AND PESTS' DETECTION METHODS BASED ON DEEP LEARNING

This section gives a summary overview of plant diseases and pests detection methods based on deep learning. Since the goal achieved is completely consistent with the computer vision task, plant diseases and pests' detection methods based on deep learning can be seen as an application of relevant classical networks in the field of agriculture. the network can be further subdivided into classification network, detection network and segmentation network according to the different network structures. As can be seen from this paper is subdivided into several different sub-methods according to the processing characteristics of each type of methods.




### Comparison of open-source tools for deep learning

| Tools | Publisher | Supporting hardware | Applicable interface | Usability |
|---|---|---|---|---|
| TensorFlow | Google | CPU, GPU, Mobile | C, Python | Flexible development, portability, powerful performance, support for distributed applications |
| Torch/PyTorch | Facebook | CPU, GPU, FPGA | C, Python, Lua | Easy to debug and develop, support dynamic neural network, easy to expand, modularization and low learning cost |
| Caffe | BAIR | CPU, GPU | Python, MATLAB | High readability, easy to expand, fast speed, large number of users and wide community |
| Theano | MILA | CPU, GPU | Python | Flexible and high performance |
| | | | | |




## CLASSIFICATION NETWORK

In real natural environment, the great differences in shape, size, texture, color, background, layout and imaging illumination of plant diseases and pests make the recognition a difficult task. Due to the strong feature extraction capability of CNN, the adoption of CNN- based classification network has become the most commonly used pattern in plant diseases and pests' classification. Generally, the feature extraction part of CNN classification network consists of cascaded convolution layer + pooling layer, followed by full connection layer (or average pooling layer) + SoftMax structure for classification. Existing plant diseases and pests classification network mostly use the muture network structures in computer vision, including AlexNetGoogleLeNet, VGGNet, ResNet, Inception V4, DenseNets, MobileNet and SqueezeNet. There are also some studies which have designed net- work structures based on practical problems. By inputting a test image into the classification network, the network analyses the input image and returns a label that classifies the image. According to the difference of tasks achieved by the classification network method, it can be subdivided into three subcategories: using the network as a feature extractor, using the network for classification directly and using the network for lesions location.

## USING NETWORK AS FEATURE EXTRACTOR

In the early studies on plant diseases and pests classification methods based on deep learning, many researchers took advantage of the powerful feature extraction capability of CNN, and the methods were combined with traditional classifiers. First, the images are input into a pretrained CNN network to obtain image characterization features, and the acquired features are then input into a conventional machine learning classifier (e.g., SVM) for classification. Yalcin et al. proposed a convolutional neural network architecture to extract the features of images while performing experiments using SVM classifiers with different kernels and feature descriptors such as LBP and GIST, the experimental results confirmed the effectiveness of the approach. Fuentes et al. put forward the idea of CNN based meta-architecture with different feature extractors, and the input images included healthy and infected plants, which were identified as their respective classes after going through themeta-architecture. Hasan et identified and classified nine different types of rice dis- eases by using the features extracted from DCNN model and input into SVM, and the accuracy achieved 97.5%.

## CONCLUSIONS AND FUTURE DIRECTIONS

Compared with traditional image processing methods, which deal with plant diseases and pests detection tasksin several steps and links, plant diseases and pests detetion methods based on deep learning unify them into end-to- end feature extraction, which has a broad development prospects and great potential. Although plant diseases and pests' detection technology is developing rapidly, it has been moving from academic research to agricultural application, there is still a certain distance from the mature application in the real natural environment, and there are still some problems to be solved.

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# MACHINE LEARNING IN MODERN AGRICULTURE

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## *Abstract:*

*With the development of big data systems and advanced computers, machine learning has opened up new possibilities for data-intensive research in the multidisciplinary field of agriculture technology. In this study, we give a thorough overview of the literature on machine learning applications in agricultural production systems. The evaluated studies were divided into four categories: crop administration (a), livestock breeding (b), watershed management (c), and soil maintenance (d). Crop management included applications for yield prediction, disease detection, weed detection, and crop quality, and features are available. The categorization and screening of the papers shown here show how machine learning management systems will help agriculture. Agricultural production systems are becoming genuine ai technology-enabled programmes that offer comprehensive suggestions and analyses for farmer strategic planning and execution by using machine learning to sensor information.*

***Keywords:*** *Intelligent systems, scheduling, precision farming, agronomic practices, conservation measures, soil protection.*

## INTRODUCTION

The global economy is heavily reliant on the agricultural sector. As the human population keeps growing, the strain on the agroecosystem will rise. Smart farming and agro-based, also referred to as digital agriculture, are emerging as new scientific disciplines that employ data-intensive methods to increase agricultural output while reducing its ecological effect[1]. Modern farming procedures generate data from a wide range of sensors, allowing for improved comprehension of both the execution on its own (machinery data) and the context of the project (an communication of vibrant harvest, ground, and wind patterns)[2]. This enables a more effective and precise outcome. Along with big data innovations and advanced computers, machine learning (ML) has arisen to open up new possibilities for unravelling, quantifying, and comprehending data-intensive workflows in agricultural design and operation. Amongst other things, machine learning (ML) is described as the branch of science that allows machines to understand without even being explicitly programmed[3]. Every year, machine learning (ML) is used in an increasing number of scientific domains, such as genomics, pharmacology, healthcare, forecasting, macroeconomic sciences, automation, fish farming, and nutrition security, as well as meteorological. We give a thorough analysis of machine learning's use in agriculture in this study.

Several pertinent publications highlight important and distinctive characteristics of well-known Machine learning techniques given. The current work is arranged as shown below:

The most well-known learning methods and procedures are together with the ML nomenclature, description, training tasks, and assessment[2]. The established approach for the gathering and classification of the works. The benefits of applying ML to agri-technology along with predictions for the future of the field.

## BRIEF INTRODUCTION TO MACHINE LEARNING

2.1 Nomenclature and Concepts of Machine Learning

ML approaches often entail a retraining procedure with the goal of understanding from "expertise" (training data) in order to carry out a task[4]. In ML, the input is a collection of instances. Typically, a collection of properties, often referred to as characteristics or factors, are used to characterize a specific example. A characteristic can be numerical, boolean, sequential, or conventional (ordered list, such as A+ or B) (integer, real number, etc.). A performance indicator that gets better with practice throughout time is used to assess how well the ML model performs in a particular activity. Several computational and numerical methods are used to determine how well Machine learning and strategies function. After the training procedure is complete, the learned model may be used to categorize, forecast, or aggregate[2] fresh instances[3][5]s (testing data) based on the knowledge gained. Figure 1 depicts a standard ML strategy.

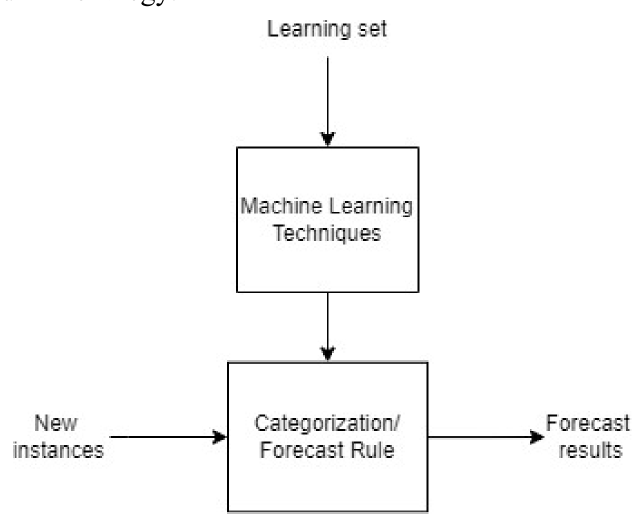


**Figure 1. A common machine learning strategy[6].**

According to the training type (supervised/unsupervised), training models (identification, modelling correlation, segmentation, and size reduction), or the learning models used to accomplish the task, ML activities are often divided into many broad groups[7].

### 2.1 The Learning Task

Relying on the training signal provided by the training system, supervised and unsupervised learning activities are divided into two primary types. In reinforcement methods, examples of inputs and results are supplied together with information, and the goal is to make a global rule that maps inputs to outputs[3]. Certain inputs may only be fairly limited, and some of the desired outcomes may not be present or may only be provided as the response to the measures undertaken in a changing situation (deep reinforcement). In the supervised context, the training set and gained knowledge are utilized to forecast the test information's missing outputs (labels)[8]. Nevertheless, with unsupervised learning, there is no separation among learning and testing sets concerning unlabeled data.

### 2.2 Learning Analysis

The objective of dimensionality reduction (DR), which is used in both families of supervised and unsupervised learning types, is to give a more compact, lower-dimensional representation of a dataset while retaining as much knowledge from the source data as possible[9]. To counteract the impacts of dimensionality, it is frequently done before using a classification or regression model. Principal component analysis, partial least squares regression, and linear discriminant analysis are a few of the most popular DR techniques[4].

### 2.3 Algorithms of Learning

Only those learning models used in machine learning (ML) works that are described in this review are presented.

**Table 1: Learning models with description**

| ML Algorithm | Description |
|---|---|
| **Supervised Learning** | Supervised learning is a strategy for constructing artificial intelligence (AI) in which a computer technique is trained on labelled input data for a particular output[10]. |
| **Decision Tree** | Decision trees are created using a computational strategy that recognizes various ways to divides a data se based on various situations[11]. |
| **Support Vector Machine (SVM)** | A boundary recognition technique that finds/defines multi - dimensional boundaries that separate data points from various classes[7]. |
| **Artificial Neural Networks (ANN)** | Artificial neural networks (ANNs) are computational designs influenced by biological neural networks. It is capable of machine learning and pattern recognition respectively. These are represented as interconnected "neurons" that can calculate values from inputs[12]. |
| **Ensemble learning** | This technique employs several independent models to make a prediction and aggregates the final prediction, utilizing the knowledge of the crowd. |
| | Random forests, gradient boosting machines (GBM), bootstrapped aggregation (bagging), AdaBoost, stacked generalization (blending), and gradient boosted regression trees (GBRT) are among the popular ensemble learning methods[7]. |
| **Regression** | Regression is a method for establishing how independent features or variables connect to a dependent feature or result. It is a methodology for machine learning forecasting simulation, where a method is used to forecast continuous results[13]. |
| **Clustering** | Clustering algorithms are methods to categorize similar data points into different clusters according to their values or attributes. Clusters are collections of data points with similar values or attributes[14]. |

## MACHINE LEARNING IN DIFFERENT FIELDS OF AGRICULTURE

In this section it is described that how machine learning algorthims is used in agriculture.

## 3.1 Crop Management

The collection of farming techniques used to boost the establishment, production, and production of crops is known as crop management[15]. Preparing the seedbed, planting the seeds, and crop upkeep are the first steps. Crop harvesting, storage, and commercialization are the last. The timing and order of agricultural processes depend on a number of variables, including the harvesting of winter or spring commodities, wheat, forage, and fodder, spread and row-crop planting techniques, growth conditions, terrain, geography, and wind patterns[16].

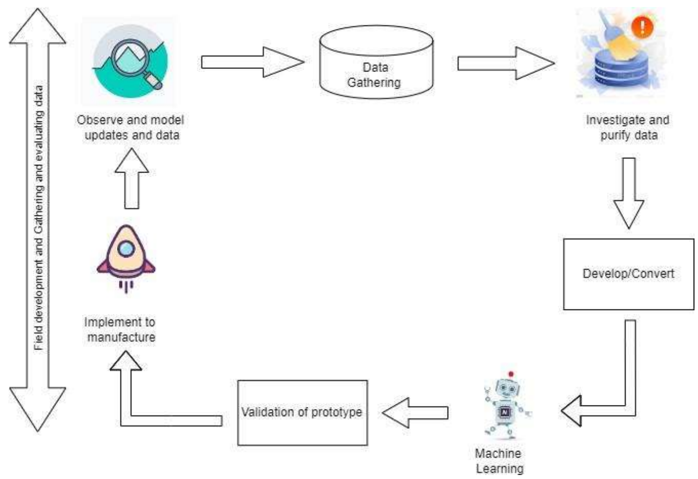


Figure 2. Crop Management

### 3.1.1 Disease Detection

The subcategories with some of the most publications included in this review are disease detection and yield forecasting. Pest and infection control in open-air (arable farming) and greenhouse settings is one of the biggest issues in agriculture[17]. Spraying pesticides evenly all over the crop area is the method of pest and disease control that is most frequently used. Despite being useful, this practice has a high cost to the environment and the economy. Remains in crop products, consequences of groundwater contamination, effects on local native animals and ecosystems, and other things can have an impact on the environment[18]. Agro-chemical input is aimed in terms of location and time with the help of ML, which is a component of precision agriculture management. A method for identifying healthy Silybum marianum plants and those that are infected with the smut fungus Microbotyum Silybum during vegetative growth is presented in the literature[19]. In their research, the authors created a brand-new technique relying on image processing for the classification of parasites and the automatic detection of thrips in a strawberry greenhouse environment, for real-time control. An approach for identifying and screening for Bakanae disease in rice seedlings was presented by the authors. The study's main objective was to precisely identify the pathogen Fusarium fujikuroi in two rice cultivars. When compared to a visual inspection, the automated detection of infected plants increased grain yield and took less time.

### 3.1.2 Crop Quality

Studies created for the evaluation of characteristics related to agricultural yields make up the penultimate subsection for crop classification[17]. Accurately identifying and categorizing agricultural quality traits may raise product prices and decrease waste. The researchers of the first research described and created a novel technique for the identification and categorization of foreign materials, both botanical and non-botanical, that are embedded in cotton after harvest[20]. The study's goal was to maximize quality while limiting fibre damage. A technique was developed for the identification and differentiation of Korla fragrance in a distinct study that specializes in the manufacture of pears. This approach may predict and categorize the provenance of fruits into groups of deciduous-calyx or continuous[21].

### 3.1.3 Species Recognition

The species recognition subcategory of the crop category is the final one. The automatic identification and classification of species of plants are the main objective in order to prevent the need for human experts and to speed up the classification process[1][22]. White beans, red beans, and soybeans are three species of legumes, and a method for identifying and classifying them using leaf vein patterns has been introduced accurate information about the characteristics of the leaf is contained in vein morphology. Compared to colour and shape, it is the perfect tool for identifying plants.

## 3.2 Livestock Management

Animal welfare and livestock farming are the two subtypes that make up the livestock division. Animal safety and comfort are related, and machine learning is mostly used to track living things in order to identify illnesses early[21]. On the other hand, livestock farming addresses problems with the manufacturing systems, and the major application area for ML in this field is the precise calculation of farmers' economical balances based on production line monitoring.

## 3.3 Water Management

Wastewater reuse is a labour-intensive process that is crucial to the hydrological, climatological, and agronomic equilibrium of crop yields. Several analyses that were primarily created for the estimation of daily, weekly, or annual evaporation and transpiration make up this part[1][23]. A complicated process, precise pan evaporation estimate is crucial for irrigational design and operations as well as resource management in agricultural production.

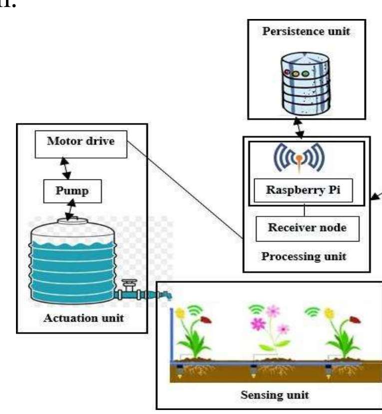


Figure 2. Water Management[24]

## 3.4 Soil Management

The natural resource soil is diverse and has difficult-to-understand complicated processes and systems[7]. Scholars may use soil parameters to comprehend how agriculture affects environmental dynamics. A precise assessment of the state of the soil can result in better soil quality. For an appropriate examination of a region's sustainable and environmental parameters and the impacts of climate change, soil moisture alone is crucial. It is a crucial climatic variable that regulates the interactions between weather and the earth. In contrast, crop production fluctuation is significantly influenced by soil precipitation[15]. This work provided a way for assessing soil dryness for precision agriculture, to be more precise. Using data on evapotranspiration and rainfall, the approach provides a precise assessment of soil dryness in an area near Urbana, Illinois, in the United States[1][15]. For the purpose of predicting soil organic carbon (OC), moisture content (MC), and total nitrogen, the study specifically offered the comparability of four linear regressions (TN). More particular, 140 wet, untreated samples of the top layer of Luvisol soil types were utilized to obtain soil spectra using a visible-near infrared (VIS-NIR) spectrometer. Near August 2013, following the harvest of wheat harvests, samples were taken from an agricultural area in Premslin, Germany[15].

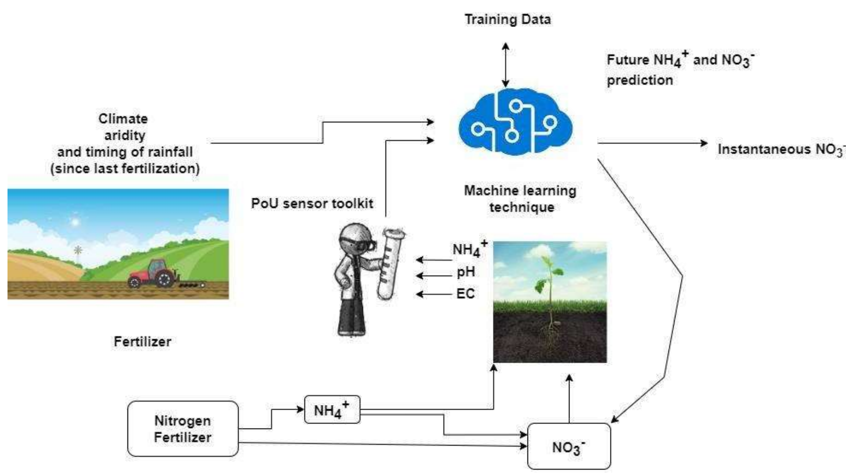


Figure 4: Soil Management

## 4. DISCUSSIONS AND CONCLUSIONS

The current comprehensive literature study focuses on ML in agriculture, a subject that is getting more and more attention globally. In order to do this, a thorough investigation of the current situation with regard to the four broad categories that Liakos et al. had defined in their earlier evaluation was undertaken. These subcategories deal with managing land, water, crops, and livestock. As a result, numerous elements were examined using an using the by analyzing the relevant articles from the last three years (2018–2020).

It was discovered through the examination of these papers that a total of eight ML models had been used. Five ML models were explicitly used in crop management techniques, with ANNs being the most preferred model (because wheat is the most common crop in question). Four ML methods were used in the livestock management area, with SVMs being one of the most prevalent models (because cattle are the most common type of livestock at the moment). Two ML algorithms were used for water management, namely evapotranspiration estimate. ANNs were used more regularly. In the field of soil quality, four ML models were ANNs.

## FUTURE SCOPE

In this study, the author discussed the Machine Learning algorithms which are used in precise farming for the development of agricultural areas i.e. Crop management, Livestock management, Water management, and Soil management. In this study total of eight models were reviewed which are used in agricultural areas like spraying drones, analyses of diseases in crops, Species Recognition, and many more. If someone wants to proceed in this work in

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# CLOUD COMPUTING IN SMART AGRICULTURE: A REVIEW

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## Abstract:

In today's world, the Internet of Things (IoT) is one of the most rapidly developing technologies. Cloud Computing serves as the Internet of Things' backbone in its implementation. The notion enables physical devices with sensing, actuation, processing power, and other capabilities to be connected. The concept of Smart Objects is achieved with the help of sensors, actuators, and microcontrollers. It sparked interest in modern scientific research among engineers, academics, and analysts, among others. It has become a popular topic of scientific investigation. Its significance and applications are hotly debated, while in agricultureand forestry, it is far less so. After analyzing some of the most critical agricultural and forest demands, a brief research has been conducted in this research report on modern demand.

**Keywords:** Internet-of-Things (IOT), Cloud Computing, WSN Architecture. Smart Agriculture, Forests, Artificial Intelligence, Big- Data and Big Data Analytics, Embedded Systems, MachineLearning, First Section

## 1. INTRODUCTION:

Internet of Things (IOT), artificial intelligence (AI), cloud computing, mobile computing, and bigdata analysis are all hot topics these days. It would be embarrassing if we did not mention sensors when discussing developing technologies, because they are the primary components accountable for the actions to be taken throughout the process. It conceptualizes the use of these technologies to modernize agriculture for healthy growth and improved results. This sector would improve as a result of it.

**IoT (Internet of Things):** RFID (Radio Frequency Identification) is a type of wireless communication that employs electromagnetic and electrostatic coupling of the radio frequency portion of the electromagnetic spectrum to uniquely identify an object, animal, or person in theInternet of Things. They refer to physical items equipped with sensors, dependable software, and other technologies that are linked via the Internet, Cloud Computers, or other Communication Networks[9]. IoTs are a misnomer because they are not immediately connected to the public internet; instead, they must be connected to a network and have their own unique address.

**Cloud Computing:** Cloud computing is the pooling of resources to create coherence anda pay-as-you-go approachthat helps reduce the capital value of predicted actual expenses without the user having to handle them directly. It was the first company to use server virtualization to supply IaaS (Infrastructure as a Service) at a lower cost and on a demand basis. It allows consumers to profit from all of the most up-to-date technology equipment, gear, and software without requiring extensive knowledge and skill in each of them. Virtualization is the major enabling technology. This property of cloud computing has aided the IT industry's huge and broad growth. It has reduced user engagement, speed up the process, lowered lab or costs, and reduced the time it takes to complete the task.

**WSN Architecture:** WSN (Wireless Sensor Network) Architecture is a physically distributed dedicated sensor network that performs a specified activity. Any change in the status of operation indicates that action should be taken over the network. It adheres to the OSI architecture model. It's a sensor network design that may be used in places like schools, hospitals, roads, and buildings. It's employed in a variety of situations, including crisis management, catastrophe management, and security management. These can be used to detect and analyze numerous agricultural characteristics during the development period. In order to maintain and improve crop productivity, WSN Architectures are suggested, tested, and implemented.

**BigData and BigData Analytics:** Bigdata refers to a vast amount of data gathered over time from a variety of sources, such as sensor data, social networking data, and commercial data. capturing, storing, and analyzing. Capture, storage, analysis, and search are the primary challenges [1]. It's used in business dataprocessing and To search for hidden patterns in data, big data analytics is used. Big data is used for agroproduct supplychain management in the agriculture domain [2]. Big data analytics is the use of advanced analytic techniques to very large, heterogeneous big data sets, which can contain structured, semi-structured, and unstructured data, as well as data from many sources and sizes ranging from terabytes to zettabytes.

**Mobil Computing:** Mobile computing is a technology that allows users to send data from one device toanother without using aphysical link or cords. The term "mobile computing" refers to a technology that allowsdata, speech, and video to be transmitted wirelessly from a computer orother device. It does not rely on afixed physical link for connectivity. It allows users to transition from one physicallocation to another while communicating.


Figure 1.5(a) Mobile Computing [1]

**Data Mining, Analysis and Knowledge Building:** In the process of Data Mining, hidden patterns in the data were discovered. For years, implementing Data Mining in the sector of agriculture has been a difficult task. Data mininghas been used to compare the nature of soil from historical records for the same field with current soil and nutrient information to determine the soil type and various treatments necessaryfor greater crop yields.

## RELATED WORK

Different models for the agriculture industry have been presented by researchers, using oneor more of the technologies indicated above. The use of IoT in agriculture has been advocated in [a, b and c]. The authors of [a] described an FMS architecture that takes advantage of Future Internet properties. This design will provide farmers with easy access to information and advice. IoT was applied in the product supply chain business process in [b, c]. In the agriculture industry, IoT and cloud computing have been used [2, 3]. The authors of [2] looked at this from the perspective of service providers and supply chains for farmers looking for low-cost services.

The authors of [3] describe a regulated smart agriculture architecture based on IoT and Cloud Computing. [37] explain show cloud computing can be used in the agriculture sector to store specifics of agricultural data. Work history information, fertilizer distribution, cultivation photographs captured with a camera, and environmental data collected with sensors, as well as collection and recording information, a real stored in the cloud. For the design of a standard work model, the authors investigated the obtained data for correlations between environment, work, and yield. Detection of faults and monitoring for negative signs. The authors of [8] employed image processing on crop photos to detect crop disease, and the image data was saved in the cloud. In [9], a strategy basedon artificial neural networks for predicting agricultural production by sensing soil quality and meteorological conditions is proposed. The impact of bigdata technology in agriculture on cost reductions and productivity.[2] addresses the impact of big-data technologies in agriculture on cost savings and benefits. Agricultural difficulties and remote sensing applications, such as crop estimation and farmland mapping, are discussed in[13]. The authors of [15] devised and executed a WSN for agriculture based on soil temperature and humidity monitoring utilizing Zig Bee and GPS technology. The authors of [24] argued for the construction of a real-time rice cropping monitoring system in order to increase rice yield. External sensors for leaf moisture, soil moisture, and soil pH are available. The farmer receives PH values by SMS from the base station via GSM modem. The amount of fertilizer to be used can be determined using the pH values. [32] discusses IoT with data mining, including the data createdby IoT and the application of various data mining algorithms to this data. The authorsalso examined the adjustments that are required for data mining in the context of the Internet of Things, as well as concerns and future trends.[35] describes a WSN-based greenhouse environment monitoring system thatuses temperature, humidity, $CO_2$, and light detection modules. This hybrid of WSN and greenhouse management technologies allows for automatic greenhouse modification.

[36] discusses bigdata applications in datamining. The authors of [38] conducted a study to find the most successful data mining approaches for obtaining new knowledge and information from current soil profile data contained inside a soil data set. They've described data-mining techniques that can be applied in agriculture to produce varied forecasts.[39] Proposes utilizing data mining to estimate crop yields using existing data. They used four variables to do so: the year, rainfall, sowing area, and production. The authors of [41] looked at data mining methods to improve the accuracy and generality of crop yield predictions using existing data.

[43] Proposes an e-agriculture information system for farmers to give information on current agribusiness plans as well as information on plantation. The technology and uses of WSN in agriculture have been evaluated by the authors in[44]. The authors also discussed existing agricultural regimes.

[45] Discusses the use of a WEKA-based datamining and analysis methodology. The authors used a case study inthe agricultural domain to discuss the usage of machine learning algorithms in the mushroom grading process. Theuse of spatial data mining in the agricultural domain is discussed in [47]. For spatial association analysis, they employed the K-means algorithm and the optimization method progressive refinement. Temperature and rainfall are provided as initial spatial data, which is analyzed for the purpose of increasing crop productivity and reducing crop losses. After crop harvesting, an IoT device enquires about crop production details from farmers and stores these details in a central location as cloud storage, which can be utilized by numerous users to monitor various soil properties from each farmland and environmental conditions on aregular basis in a central location as cloud storage. As a result, Big-data will be collected over time and analyzed for fertilizer needs for the present crop, as well as mapping agricultural yield to soil. This will aid in the increase of manufacturing.

**2.** All agricultural entities, including farmers, agro marketing agencies, agro product sellers, the Ministry of Agriculture, and Agro Banks, should be connected. This will make it easier for farmers to sell their products to customers and for agro vendors to sell to farmers. Farmers will be able to get notices about new government programmes for the agriculture industry through the Ministry of Agriculture.

## 3. PROPOSED SMART AGRICULTURE INTER DISCIPLINARY MODEL

Figure 2.1 depicts the suggested architecture of a multidisciplinary model, which is made up of five modules:

1) Sensor Kit Module is the first module in the Sensor Kit series.
2) Module for mobile apps.
3) Module for Agro Clouds.
4) Engine Module for Big-Data Mining, Analysis, and Knowledge Creation.
5) User Interface for Government and Agro Banks

Sensor Kit is a small IoT gadget that includes soil and environmental sensors. The Mobile App module provides a user interface. Storage, Big-Data mining, analysis, and knowledge building engines, as well as an application module to interface with users, makeup the Agro Cloud Module.

A web portal providing information about agricultural projects and loans provided by the government and AgroBanks.

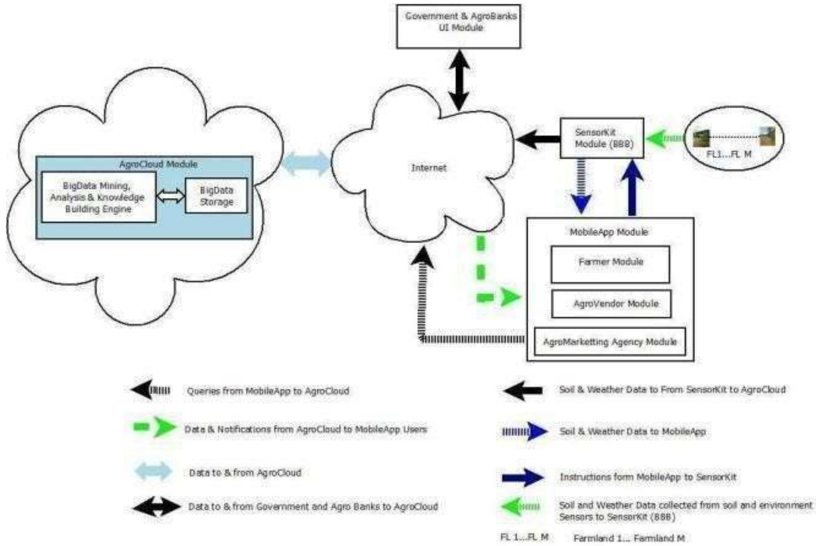


Figure 2.1: ProposedArchitecture forMultidisciplinarymodelforSmartAgriculture[a]

***Sensor Kit Module:*** This module is an important aspect of the architecture because it is in charge of taking soilsamples at regular intervals in order to obtain soil property data. The *Sensor Kit* module is shown in Figure 3.1. Sensor Kit is a low-cost, portable kit that makes use of the Beagle Black Bone, an IoT-enabled device having memory and computing capabilities, as well as a GPS sensor to detect positional data.

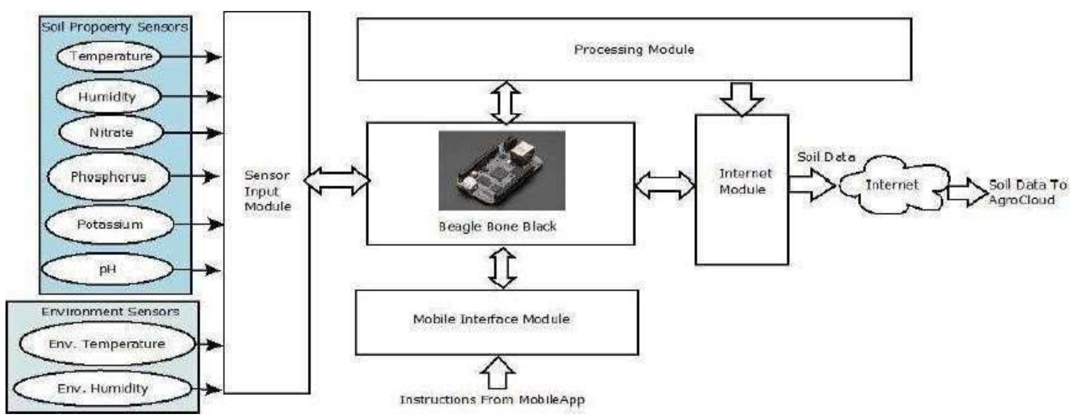


Figure 3.1: Sensor Kit Module [b]

The soil nutrient sensor devices that are attached to it are the main components of thiskit. [8] Soil pH sensor, soil moisture sensor, Phosphorus (P), Potassium (K), and Nitrate (N) sensors that are interfaced to the IoT device have all been explored for this concept.

**3.** ***Mobile App Module:*** The enduser's phone must be downloaded and installed with mobile applications. It's broken down into three pieces.

a. User interface for farmers;

b. User interface for agro marketing agencies;

c. User interface for agro vendors, such as fertilizer companies, pesticide companies, and seed companies.

The end user must first register for the mobile app by providing information such as their identity, user type, address, geographic location, and other relevant details.

[12] SensorKit is used to collect soil data for each farms. *SensorKit* receives the necessary commands from MobileApp. The data will be transmitted to AgroCloud Big-Data storage and stored there. When crop cultivation is in operation, SensorKit captures and sends soil information to cloud storage. Farmers can get recommendations for the fertilisers they need and how much they need using these apps, resulting in greater crop results and cost savings. This application is also used to send notifications to users. When the crop is harvested, the entire production data for each crop, as well as current soil characteristics after cultivation, will be transferred to the cloud storage by the farmer. This information, along with the time-stamp details, is saved in the cloud storage. Farmers' harvested commodities must be purchased by agro marketing agencies, which must submit periodic reports on price changes and their buying requirements. [**M] Fertilizer, seed, insecticide, and agricultural equipment are sold by agricultural goods sellers. Agro vendors are required to give product and cost modifications reports on a regular basis. Figure 3.2 depicts the mobile application module.

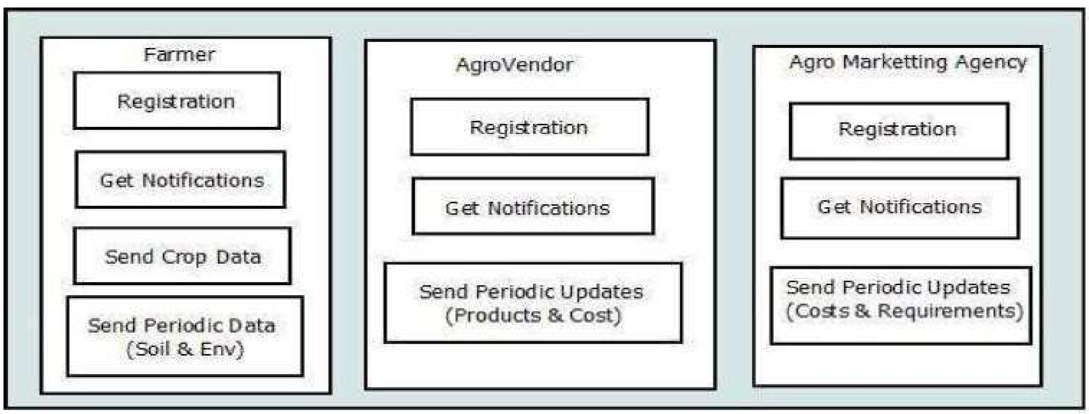


**Figure 3.2:** Mobile App Module [c]

***AgroCloud Module:*** All users in the agriculture sector must register for AgroCloud via the MobileApp. AgroCloud storage, which consists of Big-Data storage, will store all of the information about farmers, agromarketing agents, as well as agro vendors and service providers (fertilizer/pesticide/seed, and agro equipment), as well as government agriculture schemes such as bank loans for farmers and seed and fertilizer concessions. This module also maintains data collected on a regular basis from soil and environmental samples. The data amount expands rapidly over time as a larger and increasing number of end users join to this service, resulting in Big-Data.

The *AgroCloud* module, which contains Big-Data storage, Big-Data mining, analysis, and knowledge-building engines, is depicted in Figure 3.3.

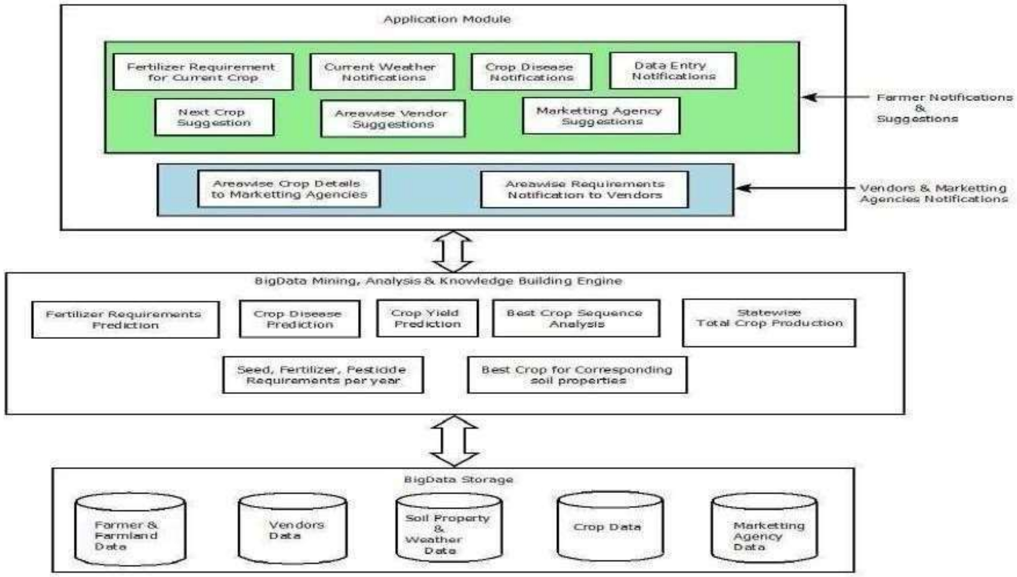


**Figure 3.3:** ***AgroCloud Module*** **[d]**

**Big-Data Mining, Analysis and Knowledge Building Engine**

Engine for Big-Data Mining, Analysis, and Knowledge Creation: This module is hosted at AgroCloud and isused to make decisions regarding fertiliser requirements for current crops based on current soil parameters inorder to improve yields, as shown in Figure 3.3. [7] crop disease prediction based on current soil parameters and weather conditions, crop yield prediction, optimal crop sequence analysis from time-series data, [10] [11] the ideal crop for the relevant soil qualities, as well as the amount of watering required based on soil moisture This database also contains information on agricultural production characteristics for each crop by region, as well as total crop output by state. Consumer demands, will aid in cost control for each agro product [5].

Data mining inference findings can be produced for improved crop sequences to be carried out for maximum productivity and soil health because this database collects data for soil characteristics and crop information details with production quantities for each farm land over time. In addition, based on prior stock of agro goods and current market requirements, [12] this database can make recommendations to farmers for crops to plant on acreage with unusual soil features. On the basis of existing knowledge, bigdata analysis can be used to anticipate future output of each product. The cloud storage application module is used to deliver notifications to users, [13] make recommendations based on analysis, and provide crop disease notifications based on current weather conditions and past knowledge base.

**4. Conclusion and Future Work:** In this paper, we propose a multidisciplinary approach to smart agriculture based on five key technologies: the Internet of Things (IoT), sensors, cloud computing, mobile computing, andbig-data analysis. Farmers will be able to obtain the crop's current fertilizer requirements. This is a critical demand for India's agriculture sector in order to boost crop productivity while lowering fertilizer costs and maintaining soil health. This model provides Big-Data analysis for the best crop sequence, the next cropto farm for greater yields, total crop production in the region of interest, total fertiliser requirements, and other relevant data. Because all agricultural-related entities are linked, it will be easier to distribute produced goods to agro marketing agencies, and farmers will be able to obtain necessary agriculture items and services from agrovendors. This model also makes it easier to calculate overall production per crop by region and state, as well astotal fertiliser requirements.[6] This will aid in keeping agricultural commodity costs under control. Farmers willbe updated about current agricultural schemes via notifications. Interfacing numerous soil nutrient sensors with a beagle black bone and analyzing the findings to obtain accurate and improved results, adopting this model and collecting data from various farmlands, analyzing data mining techniques suitable for agricultural Big-Data analysis.

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# CHALLENGES IN THE FIELD OF AGRICULTURE AUTOMATION

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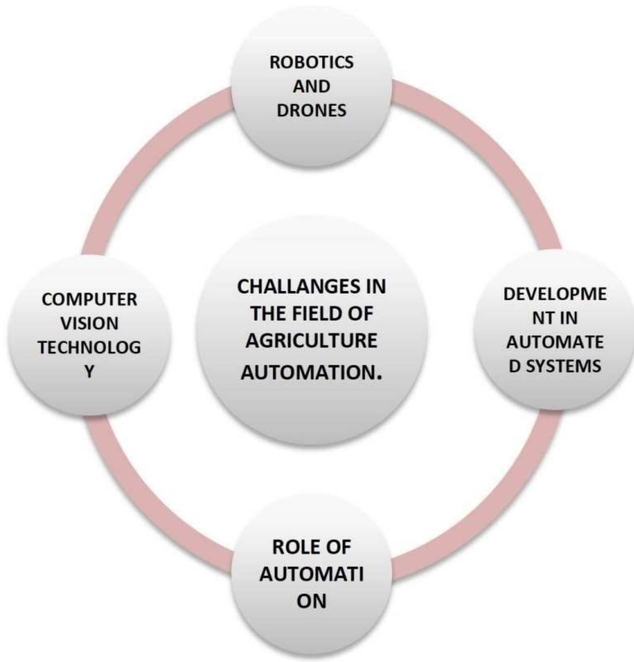
## *ABSTRACT:*

*Agriculture plays an important role in the economic sector. The automation in agriculture is the main concern and the major issue across the world wide. The population is increasing continuously and with this the demand of food and employment is also increasing. The traditional methods which were used by the farmers were not sufficient to fulfill these requirements and also these methods of farming include using of pesticides, fertilizers etc. conclusively lead to soil in-fertility. Thus, new automated systems were introduced. The automation in this field can lead to revolution and fulfillment of increasing demand. These automated systems consist of using of new technologies such as Internet of things, Artificial intelligence, machine learning etc. This paper systematically summarizes and analyzes the challenges and technologies in the past years and explores future opportunities for the enhancement of agricultural automation. Through the analyses, it is found that the existing technology can help the development of agricultural automation for small field farming to achieve the advantages of low cost, high efficiency and high precision in agricultural practices. Hereby, the work of many researches is given to get a brief overview about the current implementation of automation in agriculture.*

## INTRODUCTION:

Agriculture is an important part of our livelihood in India, agriculture is our primary economic activity and about two thirds of our population is engaged in the same. As scienceis growing day by day new technologies are developed, in the field of agriculture many new technologies and ideas were being introduced for the better production of crops. The main basic reason for the enhancement of technology is to help the farmers to produce sufficientfoods, feeds, fibers, bio-fuels etc. Automation offers a potential means by which improved productivity, resource optimization, worker health and safety. As the population is increasing day by day the demand for agricultural products is also increasing and the area under cultivation land is continuously decreasing which leads a pressure on agricultural system[1,2]. With these things there is a big ask for the safe agricultural food production methods. Now days the performance of precision agriculture is not limited for the particular land area but it is main focusing into several areas as skills, productivity, technologies etc. [3]. For the performance of agriculture functions which are cultivation, spraying etc., automation agriculture becomes the major mode. The word automated is used to explain the parts ofmachine which are developed to remote manual intervention in agriculture. In the current span the precision agriculture plays an important role in order to maintain the crop production also the environment management at a same width. But today, the precision agriculture is not limited for a specific landscape type. It is focusing on the area of technology, digitalization impacts on society, skills, environment and productivity. Day byday the automation become the trend of new era in which many agricultural operations takes participate like pruning, spraying and harvesting[4]. Agricultural automation largely works on autonomous vehicle such as robot or tractor where it is being used to risky, deadly and long working experienced by the farmers. This paper reviews the challenges which have been faced by the farmers with the development of technologies.




## ROLE OF AUTOMATION

Managing the environment of agriculture becomes a major issue due to increasing population growth day by day as a result the food production decreases. With increase in population the pressure to produce more food is highly affecting the management of agriculture. To reduce this pressure and reset the management the engineers developed the new technologies in the field of agriculture which is known as automation. Nowdays, the modern agriculture is mainly depending upon the engineering technology, biological and physical science. With the development of new technologies the production of food increase and the time period decrease. Europe and USA subordinate the agricultural mechanization revolution which has been followedby Japan and rest of the world is also adopting it. Present mechanization level of India is between 40-45 percent [5]. The primary goal of farm automation technology is to cover easier tasks. There are some other technologies that are most commonly being utilized by farms. In the start of $20^{th}$ century the first development of automation step in, automation refers to a procedure conducted with minimum human assistance. As the machines can replace human activity successfully at a low cost and also increasing the speed and success of process such as seeding, the journal of artificial intelligence in agriculture. Ultimately enhancing automated machines and processes as well as refining existing technique will provide many solutions to emerging issue. Such progress will improve the outlook of agriculture systems in the face of mounting environmental whilst also contributing to the management of crop health [6].

## COMPUTER VISION TECHNOLOGY IN AGRICULTURE AUTOMATION

- Modern farms management with automation.
- The constant development application field.
- The realization of automatic crop harvesting.
- Need to improve the growth in demand of professional talent.

Computer vision is a technological application that can detect, locate or track objects. It is an important technology in the terms of production automation. These technologies can facilitate object detection and localization but requiresa large amount of storage, which posesa significant challenge in their implementation. Automatic working robots in the agricultural sector have been researched for several decades, but there is still in such accurate product available. Nowdays, due to a lot of advancement, computer vision technology will bewidely used in the field of the agriculture automation. The various technologies in the fieldare machine learning and artificial intelligence etc. The enhancement of these technologies results in the development of agriculture automation. The practices of computer vision technology are not fully developed till the date. If we make a vision at large scale public database in the agricultural sector, there is no such production. In order to control crop pestsand diseases we have to enhance the existing computer vision techniques including this there are a lot of area where we need to explore the computer vision technology. Graphics processing unit have played an important role in development of computer vision. In agricultural application the computer vision based statistical machine learning algorithms are widely used some of them are using the high density data parallel computing functionality highlighted in the GPUs [7]. The main existing problem in the computer vision technology is lack of generality and high demand of the professional skill. There is high requirement of experienced persons and the professionals in order to use the computer vision at a large scale, except all this all there is a lot of work done in the field of agriculture automation to overcome the many difficulties and various complementary gaps among computer vision technology, computer vision technology and artificial intelligence algorithms can enhance economical efficiency, general performance, co-ordination and robust agricultural automation systems performance[8].

## DEVELOPMENT IN AUTOMATED SYSTEM

Althoughweknowthattechnologycanrevolutionizetheagriculturalpracticesbutthefarmers having lack of technical knowledge regarding machinery equipments can lead to amajor challenge. To get rid of this difficulty the developers should keep the farmers in mind at the time of system development including this, developers should also provide the solutions in local languages in order to overcome this challenge. The quality and high cost of the sensors and other devices are experienced as another main problem among the farmers to adopt the advanced technology. On comparison of health care and military application with agricultural solutions they deal with very less personal data. Still, when the information regarding the farm and crop is passed through a channel there are a lot of challenges in the delay reception. Therefore, another major area need to be focused is communication delay. Internet of things and artificial intelligence are expected to contribute in agricultural practicesin order to make agriculture automated and smart. The evolution of 5G technologies also played another important role in promoting the internet of things in upcoming years. 5G technology is much better than 4G and also provides a high internet speed. As the maintackling problem of IOT is communication delay this can be solved by 5G technology [9]. The continuous growth of internet of things and artificial intelligence will open a door of opportunities for development of automated systems also besides this sensor and other devices will be available widely at a cheaper cost. The impact of developed agricultural technologies is directly seen at the rate of production practices[10]. For complete enhancement the researchers, designers, producers and the users all need to be actively involved in the complete process.

## ROBOTICS AND DRONES IN THE FIELD OF AGRICULTURE

Crucial technologies developments take place for several processes during last decades. These developments are come into force in order to enhance the production of crop and introducing the new ideas. Food and Agriculture Organization [FAO] of the United Nations shows that there has been undisputed advancement in reducing nourishment amount and upgrade nutrition and health levels in 2017. But if we see in the next 20years there will be a practicing to different agriculture ways. Precision Agriculture [PA] and Agro-eco system management introducing technique to upgrade the food production. As the meaning of Precision Agriculture is that to increase the yield production of food with reducing the use of fuel, insecticides, herbicide & nutrients [11]. And Agro-ecosystem says that make more interaction with nature so that they will grow more. But these two approaches are difficult to understand as we cannot measure the crops from inch to inch. To overcome these problems Robots & Drones are come in the field. The development of Robots & Drones helps to enhance the production of crops and to reduce the work of the farmers. But there are some challenges to work with these technologies which are as follows:

## BUDGET

The main existing problem which has been seen in past years is that the farmers have to invest a bunch of money to buy sensors which is used for autonomous navigation and are commercial agricultural robots. The cost of robots like Boni Rob, GRAPE and AgRob, Robotanist, Ladybird and strathclyde is in the range of 7,000 USD to 38,825 USD and the hardware component which are used for navigation are approximately exist in the range upto 8,000 USD[12]. The estimated price of robotics is classified on the basis of light weight andheavy weight. It seems very difficult to work with these expensive technologies because thesm all scale farmers cannot afford this for more productivity. Therefore, the price of sensors and robotics should be diminished by companies as low cost new technologies step in market.

## REPLACEMENT OF NATIVE WORKERS

Many ethical issues which are coming in force due to a rise of robotics and drone technologies in agriculture over the years are that the migrant workers are replacing the native workers across the developed countries. There are around 65000 migrant laborers in UK farms occur due to lack of knowledge [13]. Native workers often low skill, preferring tostay unemployed mostly in those countries which have strong welfare state system. The highly skilled migrant workers with their unique skills take place of native workers and the renumeration of an ageing population stops the supply of the manual labor. In UK the average age of farmers is 58 years [14]. In result we can say that the robotic automation is a creator ofdesirable and rewarding employment enabling human jobs and captivating skilled workers and graduates to agrifood.

### REQUIREMENT OF LARGE AREA FOR LARGE SCALE WIRE ROBOTICS

Fundamental challenges of these technologies include large working area as the development of wire robots need large region to be placed. Wire robots pointing the benefits of evaluating large spans, fast moving, light weight and heavy duty active spatial mechanisms.

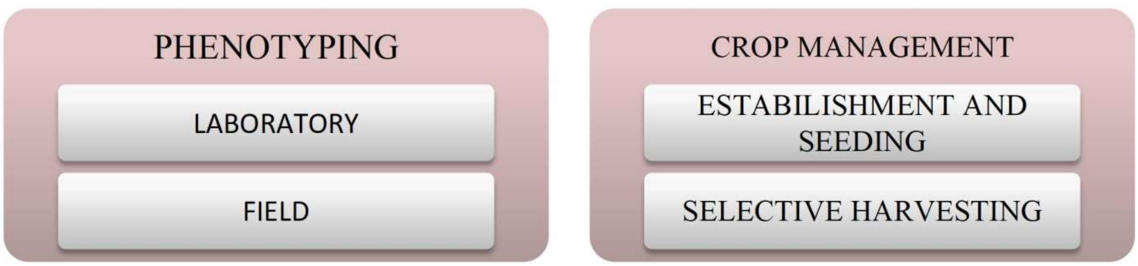
Robacane NIST represents first large wire robot having the 6m span, which is used to perform various applications [15]. One of the best cable-array robots are the sky cam and spidercam which provide computer controlled, stabilized, cable suspended camera transporters. The systems have three dimensional spaces with a set of four computer controlled winches. It is a broadcast quality, robotic camera, suspend from a cable driven, computerized transport system. The operations such as fertilization and spraying, plant inspection and disease detection, optional irrigation, spraying and selective harvesting etc. can be done with the help of robots. Some wire robots like five hundred meter aperture spherical radio telescope (FAST) need large area to be placed. It is based on the structure of cable drive Stewart platform which take in large space coarse motion. The rigid Stewart manipulator attached to the suspended trolley which is responsible for fine manipulation. LOFAM (large area overhead manipulator for access of fields) representing the first effortfor introducing the wire robot in agricultural sector. LOFAM performance for large are aapplications without stabilizing downhaul cables [16]. In short these wire robots need alarge area to be developed.

**Figure: A schematic view of wire robotics in farms**

## BREEDING AND FARMING

Breeding and farming are two main challenging areas for agro-robotics. The second name of breeding and farming is phenotyping and primary production [17].

**Phenotyping and crop management.**




Plant phenotyping: Offers data on the anatomical, historical, biological and physiological properties of the plant. Plant phenotyping is a leading factor in the intensity of selection, precision in selection, and new genetic variation detection. Within a plant breeding system, genetic benefit (the amount of increase in output over time) can be accelerated in a variety of ways, including by increasing the size of breeding program to allow for higher selection intensity [robotic issues] recognizing and selecting the heritable with advantages of biotic or abiotic input and output traits of biomass conversion. In recent years the breeding actions have been seen the percentage of robotic systems to decrease the dependence on manual intervention, but the price and difficulties to develop, result in limiting their uptake [18]. The uncontrolled 'non-laboratory' systems raise appropriate challenges across the specific traits to make a beneficialphenotypingresponse.

Crop management: In crop management the seeding, crop care and harvesting are involved. The ploughing is an important cultivation process which involves the mixing of topsoil and 80-90 percent energy of traditional cultivation is used to fixing up the damage done by the tractors. Robots also play an important role in the inputs to primary production including the monitoring and interventions mainly for soil and water. The main operation in the crop management is tomake a survey of the crop. The autonomous robots, range of sensors are used to check the health of crop. Robots work on different parameters like robotic weeding is a dynamic area of ongoing research, finding alternative technique to kill, remove or retard unwanted plants without giving any damage to crop[19]. The inter-low weeding is more difficult as it requires precise positioning of the crop plants as compared to intra-low weeding.

## CONCLUSION

In the whole review on automation challenges in agriculture the main idea which came out is that with increasing the newly discovered technologies the new challenges step in the field of agriculture. The challenges which we discussed above are quite difficult to resolve but farmers have to cope up with these newly developed technologies in order to produce good quality offood in a short period of time. But with these new technologies like robotics, drones, computer vision the work of the labor is extremely reduced which can lead to a factor such as unemployment and also with enhancement of these innovative technologies the cultural way offarming is disappearing day by day. In last, the meaning of automation is not just development of technologies, new ideas etc. but also the decrement of wastage produced in farming practices.

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# REVIEW ON APPLICATION AREAS OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE

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## *Abstract*

*In recent years, the use of artificial intelligence (AI) in agriculture has becomeapparent. Improper soil treatment, disease and pest infestation, massive data requirements, low productivity, and aknowledge gap between farmers and technology are just a few of the issues the industry faces in order to maximize its produce. The flexibility, high performance, accuracy, and cost-effectiveness of AI in agriculture are the main concepts. The applications of AI in soil management, crop management, weed control, and disease management are discussed in this study. A significant emphasis is placed on the application's strengths and limitations, as well as how to use expert systems to increase productivity.*

## INTRODUCTION

Agriculture is the foundation of any economy's long-term viability[1]. It is important for long-term economic growth and structural change[2-3], however, it varies by country[4]. Agricultural operations used to be restricted to food and crop production [5]. However, in the recent two decades, it has expanded to include crop and livestock processing, production, marketing, and distribution. Agricultural operations are currently used as a primary source of income, increasing GDP[6], serving as a source of national commerce, lowering unemployment, providing raw materials for other sectors, and helping to improve the economy overall [7-8]. With the world's geometric population growing, it's more important than ever tostudy agricultural techniques in order to come up with new ways to sustain and improve agricultural activities. Other technological advancements, such as big data analytics, robotics, the internet of things, the availability of inexpensive sensors and cameras, drone technology, and even wide-scale internet connectivity on geographically separated fields, will enable the introduction of AI to agriculture. AI systems will be able to predict which crop to plant in a given year and when the best dates to sow and harvest are in a specific area by analysing soil management data sources such as temperature, weather, soil analysis, moisture, and historic crop performance. This will improve crop yields and reduce the use of water, fertilisers, and pesticides. The impact on natural ecosystems can be decreased, and worker safety can be improved, which will keep food prices low and ensure that food production keeps up with the growing population.

## CONSIDERATION OVERVIEW

Farming includes a considerable lot of uncertainty and decision-making. The weather fluctuates from season to season, as do the prices of farming materials, soil degradation, crop failure, weed suffocation, pest damage, and climate change. Farmers must deal with these unknowns. Although agricultural practise is vast, soil, crop, disease, and weeds are all key contributions to agricultural production in this study. Reviewing the application of AI to agriculture in terms of soil, crop, disease, and pest management is critical.

- Soil is an essential component of successful agriculture since it is the original source ofnutrients for crop growth. Soil is the foundation of all agricultural, forestry, and fishing production systems. Water, minerals, and proteins are stored in the soil until they are needed for crop growth and development.
- Crop production is critical to Nigeria's economic growth. Food, raw resources, and jobs are all provided by it. Marketing, processing, distribution, and after-sales service are now recognised as integral components of crop production in modern times. Crop cultivation and other core industries are being prioritised in locations where the real income per capita is low. Increased crop production output and productivity have been shown to significantly contribute to a country's overall economic development. As a result, a stronger focus on crop development will be appropriate.
- As agriculture tries to meet the demands of an ever-increasing population, plant diseases diminish crop quantity and quality. Post-harvest disease losses in agriculture can be devastating.
- Weeds are a significant menace to all agricultural activity. Weeds diminish farm and forest productivity, invading crops, suffocating pastures, and even harming cattle in some circumstances. They fiercely compete for water, nutrients, and sunlight with the crops, resulting in lower agricultural output and poor crop quality.

## SOIL MANAGEMENT

Soil management is a crucial aspectof agricultural operations. Crop production will be improved and soil resources will be conserved with a thorough understanding of diverse soil types and conditions. It is the application of operations, techniques, and treatments to improve the performance of soils. Pollutants may be present in urban soils, which can be studied using a typical soil survey method [9]. Compost and manure help to promote soil porosity and aggregation. Better aggregation implies the inclusion of organic elements, which are vital in preventing the formation of soil crusts. Alternative till age strategies can be used to prevent soil physical degradation. Organic materials must be applied in order to increase soil quality [10]. Several soil-borne diseases that must be controlled by soil management have a substantial impact on the production of vegetables and other food crops [11]. With acknowledgement of the fact that soils differ in their ability to resistchange and recover, sensitivity to soil degradation is implicit in the assessment of the sustainability of land management techniques [12]. Because it consists of a set of created plausible management options, a simulator that assesses each alternative, and anevaluator that determines which alternative matches the user-weighted multiple criteria, management-oriented modelling (MOM) decreases nitrate leaching. MOM employs "hill-climbing" as a strategic search approach and "best-first" as a tactical search method to identify the shortest path between nodes[13]. The Soil Risk Characterization Decision Support System (SRC-DSS) is built using three stages of engineering knowledge: knowledge gathering, conceptual design, and system implementation [14]. Based on features gathered from current coarse resolution soil maps paired with hydrographic parameters produced from a digital elevation model (DEM), an artificial neural network (ANN) model predicts soil texture (sand, clay, and silt concentrations)[15]. A remote sensing device incorporated in a higher-order neural network (HONN) [16] is used to describe and estimate the dynamics of soil moisture.

## CROP MANAGEMENT

Crop management begins with the sowing of seeds and continues with growth monitoring, harvesting, and crop storage and distribution. It can be characterised as practises that promote agricultural product growth and yield. Crop production will undoubtedly grow as a result of a thorough understanding of the many crop classes and their timing in relation to the thriving soil type. Precision crop management (PCM) is an agricultural management technique that optimizes profitability and protects the environment by targeting crop and soil inputs according to field requirements. Lack of timely, widely disseminated information on crop and soilconditions has impeded PCM [17]. To deal with water deficits caused by soil, weather, or in adequate irrigation, farmers must combine diverse crop management practises. Crop management systems that are flexible and based on decision rules should be favoured. Drought timing, intensity, and predictability are all essential factors to consider when deciding between cropping options [18]. Understanding weather patterns aids in the decision-making process, resulting in a high and high-quality agricultural output [19]. PROLOG evaluates a farm system's operational behaviour using meteorological data, machinery capacity, labour availability, and information on permissible and prioritised operators, tractors, and tools. Crop yield, gross revenue, and net profit are also estimated for individual fields and the entire farm[20]. Crop prediction approach is used to anticipate the best crop by detecting a variety of soil factors as well as atmospheric parameters. Soil type, PH, nitrogen, phosphate, potassium, organic carbon, calcium, magnesium, sulphur, manganese, copper, iron, depth, temperature, rainfall, and humidity are all variables to consider [21]. Demeter is a computer-controlled speed-rowing machine featuring two video cameras and a navigational global positioning sensor. It can plan harvesting activities for a full field and then carry them out by cutting crop rows, pivoting to cut subsequent rows, repositioning itself in the field, and recognizing unexpected obstructions [22]. The individual hardware and software components of the robot, including the autonomous vehicle, the manipulator, the end-effector, the two computer vision systems for detection and 3D imaging of the fruit and the environment, and finally, a control scheme that generates data, are all used in the use of AI in cucumber harvesting. During harvesting, the manipulator should move in a collision-free manner [23]. For each site, field-specific rain fall data and weather variables can be employed. The accuracy of rice yield projections is affected by adjusting ANN parameters. In model optimization, smaller data sets necessitated fewer hidden nodes and lower learning rates[24].

## DISEASE MANAGEMENT

Disease control is required for an optimal yield in agricultural harvest. Plant and animal illnesses are a key stumbling block to increasing productivity. Genetics, soil type, rain, dry weather, wind, temperature, and other elements all have a role in the incubation of these illnesses that target plants and animals. Managing the consequences of these factors, as well as the unpredictability of some illnesses' causal influences, is a major issue, especially in large-scale farming in model optimization [25]. A farmer should use an integrated disease control and management approach that combines physical, chemical, and biological measures to successfully control illnesses and minimise losses [26]. To attain these goals, it takes time and money [27], necessitating the use of an AI-based approach to disease control and management. The explanation block (EB) depicts the reasoning followed by the expert system's kernel [28]. In order to draw intelligent inferences for agricultural disease control, the system employs a novel approach of rule promotion based on fuzzy logic. For the text-to-speech (TTS) user interface, a text-to-speech (TTS) converter is employed. Provides a web-based interactive user interface for live interactions that is highly effective [29]. The system that aids indiagnosing disorders and providing treatment suggestions in [30] was developed using a rule-based and forward chaining inference engine.

## WEED MANAGEMENT

Weed regularly lowers predicted profit and output for farmers[31]. If weed infestations are not controlled, a survey confirms a 50% drop in output for dry beans and maize harvests [31]. Weed competition causes a 48 percent reduction in wheat yield[32,33]. These losses might sometimes be as hig has 60%[34]. A research on the influence of weed on soy be an yields found that yields were reduced by from 8% to 55% [35]. A research on the influence of weed on soybean yields found that yields were reduced by from 8% to 55% [35]. According to a study on sesame crop production losses, they range from 50 to 75 percent [36]. The length of exposure of the crops to the weeds[37,38] and the spatial heterogeneity of weeds [39] may be responsible for the variation in yield losses. Weed has both beneficial and harmful effects on the ecology in addition to these. Weed effects include flooding during hurricanes, some species of weeds can pave their way during wildfires, some cause irreversible liver damage if consumed, and they muscle out plants or crops by competing for water, nutrients, and sunlight, according to the Weed Science Society of America (WSSA) report. Some weeds are harmful, causing allergic reactions or possibly posing a health risk. Over the last few decades, rigorous herbicide control has been used to decrease the impact on crops. Even with this management pattern, crop losses due to weed in western Canada field crops are expected to surpass $500 million per year [40], necessitating the development to famore sophisticated weed control approach to compensate for this loss[31]. An unmanned aerial vehicle(UAV)-imagery can be used by a system to divide, compute, and analyse an image. Vegetation indexes are converted to binary, crop rows are detected, parameters are optimised, and a classification model is learned. Because crops are frequently arranged in rows, using a crop row recognition technique can help distinguish between weed and crop pixels, which is a common problem due to their spectral similarity [41]. Weed control in sugar-beet, maize, winter wheat, and winter barley, can be done by applying online weed detection using digital image analysis taken by an UAV (drone), computer-based decision making and global positioning system (GPS)-controlled patch spraying[42]. The drone in [43] travelled at a speed of 1.2km/h, with execution times of 58.10ms and 37.44ms, respectively, to find the tomato and weed locations to the spray controller.

## CONCLUSION

In future, the global population is predicted to reach more than ninebillion people, necessitating a 70% increase in agricultural production to meet demand. Only around 10% of the extra production might come from vacant land, with the balance coming from present production intensification. In this environment, employing cutting-edge technical solutions to improve farming efficiency is a must. Current agricultural intensification tactics necessitate significant energy inputs, while the market demands high-quality food. Global industries are poised to be transformed by robotics and autonomous systems (RAS). Large sectors of the economy with poor productivity, such as agro-food, will be greatlyimpacted by these technologies (food production from the farm to the retail shelf).

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As population is increasing day by day and our food requirement is also increasing, so to fulfil the food requirements with existing resources we have to think about other alternatives to increase the production of crops. This problem requires a smart solution and the role of artificial intelligence will be critical to solving this problem. The role of artificial intelligence in agriculture steps up in other supplemental areas of agriculture also to lift the entire agriculture industry. The major focus of the seminar is to share the contribution of Artificial Intelligence and Automation in Agriculture sector so that researchers/students from Academia and industry can get benefit of the knowledge shared by resource persons and they can try to implement at ground level to help the end users (farmers) afterwards.


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