International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Optimization of Irrigation and Herbicides Using Artificial Intelligence in Agriculture

Atluri Vani Vathsala [1], Lakshmi H N[2], Gangolu Yedukondalu[3], Channapragada Rama Seshagiri Rao[4] ,Dr. Mahesh Kotha[5] ,Ravindra Changala[6]

Submitted: 26/04/2023 **Revised**: 28/06/2023 **Accepted**: 08/07/2023

Abstract: Technological aspects play a key role in the economy of country. The usage of technologies in various fields makes automation strong. The integration of new technologies for agriculture era gives a great yield. Demand for food with respect to the population is a great deal. Huge population required tremendous food requirement which cannot be possible with the conventional agriculture methods. In this paper we introduced a new method for agriculture with Artificial Intelligence became a new trend set. Our approach saved crop yield from various geological factors. The primary objective of our work was how various AI applications used in the domain of agriculture sector and increases the fertility of the soil. The vase survey we conducted for this paper was helped us for current set ups for the agriculture through weeding, robots and drones. We focused mainly on automated weeding techniques and sensing issues of water of soil. 94% of the pesticides produced are to protect he crop and to increase the production of crop. But this leads many hazardous issues of environments and humans. By using KNN (K-nearest neighborhood) and LRC (Logical Regression Classification) algorithms we got the predicted value of 88.5%.

Keywords: *Herbicides, pesticides, AI, irrigation, agriculture, soil management, disease management, crop management*.

1.Introduction

As per the EPA (Environmental Protection Agency) nominal usage of pesticides was good for crop production and health yields but when used them in un permissible limit causes dangerous harm to the human generations which had already we experienced. Since pesticide is a biologically active agent impacts on global health issues and resulted 3,20,000 lacs of deaths in a year over the globe, but few researcher had already altered this number becomes 5 million soon if we do not take proper measures against it. Our objective is how to give solutions for these issues by using advanced AI techniques.

Recently, artificial intelligence (AI) has being employed in agriculture. The industry must overcome a variety of challenges to increase output, such as inadequate soil treatment, disease and insect infestation, high data needs, poor yield, and a knowledge gap between farmers and technology. The main ideas behind artificial intelligence in agriculture are its adaptability, excellence, precision, and economy. This article talks about how artificial intelligence (AI) is being used to manage diseases, weeds, crops, soil, and crops.. The benefits and limits of the programme, as well as the strategy for using expert systems to enhance productivity, are prominently underlined[1].

The majority of technologically sophisticated nations banned or outlawed the use of organochlorine insecticides after the 1960s, despite the fact that they were effective against a number of illnesses including malaria and typhus. The most well-known pesticides that supported the expansion of agricultural productivity and pest control in the 1960s and 1970s, respectively, were synthetic insecticides, organophosphate (OP) insecticides, carbamates [2] in the 1970s, and pyrethroids in the 1980s. In India, pesticides are extremely expensive. Every year, it spends roughly $600 million. Despite the fact that pesticide use in India remains low, the country controls 1.6% of the worldwide pesticide market.Pesticide residue contamination of food is caused by indiscriminate and careless pesticide application. Regardless, the World Health Organisation (WHO) has banned the use of some organochlorine syntheses. Many poor countries, particularly India, make widespread use of these chemicals in small quantities. In India, these chemicals are utilised in trace amounts for agricultural, animal, and public health programmes [3].

1Professor, Department of Computer Science and Engineering, CVR College of Engineering, Hyderabad, India.
E-mail: vani_vathsala@cvr.ac.in.
2Professor, Computer Science and Engineering (AIML, CS and DS), CVR College of Engineering, Hyderabad, India.
E-mail: hn.lakshmi@cvr.ac.in
Associate Professor, Department of CSE, Anurag University, Hyderabad, India.
E-mail: gyedukondalu@gmail.com
4Department of CSE, Professor & Principal, Vignana Bharathi Engineering College Hyderabad, India.
E-mail: crsgrao@gmail.com
5Associate professor, Department of CSE (AI&ML), CMR Technical Campus Hyderabad, India.
E-mail: kotha.mahesh528@Gmail.com.
6Assistant Professor, IT Department, Guru Nanak Institutions Technical Campus, Hyderabad, India.
E-mail: changalaravindra@gmail.com.

The population of world's is predicted to exceed 10 billion by 2050, with agricultural production increasing by roughly 50% over 2013 (FAO, 2017). Crop production accounts for approximately 37.7% of total land surface (World Bank, 2015). Agriculture is important in numerous ways, including job creation and the generation of national wealth. It contributes significantly to the economic success of industrialized countries while also actively participating in the economies of emerging countries [4].

Agriculture augmentation has significantly increased rural per capita income. As a result, growing the agriculture industry makes sense and is acceptable. Agriculture contributes for 18% of GDP [5] in India and employs 50% of the workers. Agriculture expansion will spur rural development, ultimately leading to rural transformation and structural change. As a result of the advancement of technology, some places around the world have undergone substantial changes. Surprisingly, despite being the least digital, agricultural technology research and commercialization has increased. AI is becoming increasingly pervasive in our daily lives, broadening our perspectives and boosting our power to manage our surroundings. Plesson (2019) presented a crop assignment and truck route harvest planning system. Work that was once limited to a few industrial areas is now contributing to a wide range of industries as technology advances.

AI is based on a variety of disciplines, including biology, languages, computer science, mathematics, psychology, and engineering.A summary of current agricultural automation applications is given by Jha et al. (2019). Artificial intelligence's main objective is to develop technology that works as the human brain does (Parekh et al., 2020; Jani et al., 2019). This technology is used by comprehending how the human brain functions, how people learn, make decisions, and behave while solving an issue, and then designing intelligent software and systems based on this notion [7].

These clever robots get training data, much like the human brain, which they then utilise to produce the correct response for each valid input. Machine learning and deep learning are subfields of artificial intelligence (Patel et al., 2020; Pandya et al., 2020; Sukhadiya et al., 2020). A subset of both ML—the ability to learn things without explicitly programming them—and AI—the study of creating intelligent machines and programs—is deep neural network learning. The basic goal of AI is to assist humans in finding solutions to issues, which may include employing ANN (Shah et al., 2020).

2. Problem Statement

In this section we defined the problem statement with respect to our approach. Implementation of artificial intelligence in agriculture for optimization of irrigation and herbicides by using ANN and LRC techniques and also addressed various applications of AI in the field of agriculture and scope of usage of various pesticides. Given brief about irrigation, weeding and herbicides.

In this section we defined the problem statement with respect to our approach. Implementation of artificial intelligence in agriculture for optimization of irrigation and herbicides by using ANN and LRC techniques and also addressed various applications of AI in the field of agriculture and scope of usage of various pesticides. Given brief about irrigation, weeding and herbicides.

Artificial intelligence (AI) is a game-changing farming strategy. Machines and technology fueled by artificial intelligence have catapulted today's agriculture system to unparalleled heights. This technology has increased agricultural yields by improving real-time monitoring, harvesting, processing, and selling. Recent automated system technologies, such as agricultural robots and drones, have assisted the agro based economy tremendously. Various high-tech computer-based methodologies are being developed for determining critical factors such as weed identification, yield detection, crop quality, and many others.

1. ***Organophosphate Pesticides:*** Organophosphate is a man-made substance. It contains a pesticide. It is sprayed on crops and plants in agriculture. Organophosphate [1, 8] is a pesticide that causes neurological damage.

It blocks the enzyme that regulates acetylcholine, a neurotransmitter.

2. ***Carbamate Pesticides***: Organophosphate (OP) is linked to carbamate insecticides. Carbamate chemicals are insecticides that are carbamic acid esters. Carbamate insecticides [8, 9] have also been shown to have an effect on the neurological system. (ey block the enzyme that controls the neurotransmitter acetylcholine. Reversible reactions are catalyzed by enzymes. Carbamates are divided into several subgroups, including aldicarb, carbofuran, and carbaryl.

S.No	Insecticides	Persistence	Penetration	Rain fastness rating
1	Organophosphate pesticides	Medium-long	Surface	Low
2	Carbamate pesticides	Short	Cuticle	Moderate
3	Organochlorine insecticides	Long	Surface	High
4	Pyrethroid pesticides	Short	Cuticle	Moderate-high

Table 1. Explanation of insecticides persistence, plant penetration and rain fastness rating.

3. ***Organochlorine Insecticides:*** Organochlorine is a broad category of compounds that contain carbon, chlorine, and other elements. Organochlorine is dichlorodiphenyltrichloroethane. It was formerly used. Because of their effects, some organochlorines have been taken off the market. The health of the populace is harmed. It thrives in its surroundings. Examples of generic OC compounds include DDT, chlordane, aldrin, dieldrin, and heptachlor.

4. ***Pyrethroid Pesticides:*** Pyrethroids are pesticides used to kill insects like mosquitos. They are a spoof of the natural pesticides pyrethrin [10,11] scilicet, which may be found in chrysanthemums.

They've been improved to be more environmentally stable. To the umpteenth pyrethroid mimic, the neurological system is poisonous. Deltamethrin, cypermethrin, and permethrin are examples of common pyrethroids.

S. No	Name	Pesticide types	Compounds	Area	Mixed	Toxic
1	Carbamate	Mostly insecticides	Esters of carbamic acid	Kill insects by affecting their brains and nervous systems	Water highly significant ($P < 0.05$)	Toxicological action alters neuromuscular synapses in a reversible way
2	Organophosphate	Organic compounds	Household	Commercial insecticides	Water & oil	Toxicological action alters neuromuscular synapses
3	Pyrethroid	Insecticides	Chrysanthemum flowers	Household insecticides, pet sprays, and shampoos	Water & oil	Permethrin, resmethrin, and sumithrin
4	Organochlorine	Insecticides	Hydrocarbons with more than one chlorine atom	Agriculture and mosquito	Water	DDT, methoxychlor, dieldrin, chlordane, toxaphene, mirex, kepone, lindane, and benzene hexachloride

Table 2: Chemical pesticide types.

Fig 1: People, pets, and animals are all affected by repeated pesticide use.

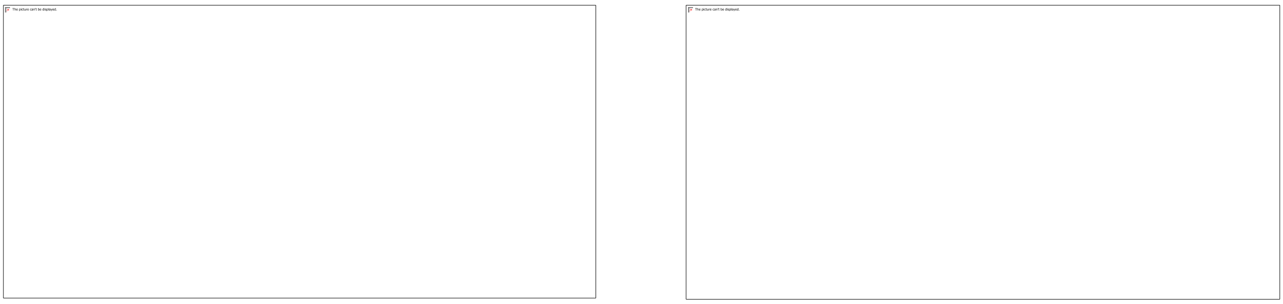

Fig 2. Pesticides' negative impacts on people, animals, and the environment.

3. Related Work

Agriculture and the agricultural industry's future rely largely on creative concepts and technical breakthroughs to increase yields and enhance resource utilization through the use of unconventional computer tools.

Agriculture is increasingly using crop models and decision-making tools to boost productivity and resource efficiency.. Artificial intelligence has the ability to improve agriculture by using contemporary technology to estimate agricultural productivity [12]. Agriculture was first used in agriculture in

1983 [13]. To address current agricultural challenges, many solutions have been offered, ranging from databases to decision support systems [14]. AI-powered solutions outperform all of these variables in terms of resilience and accuracy.

Climate change, increased production costs, limited irrigation water supplies, and agricultural manpower shortages have all had a devastating impact on agriculture production systems in recent decades [15].Furthermore, the COVID-19 pandemic is endangering supply chains and food production [16]. Such factors have an impact on the ecosystem's sustainability as well as the existing and future food supply chain [7]. Significant inventions are continually required to keep up with the rate of climate change [8]. The apparent problem here is acquiring enough food for the ever-increasing populace. The researchers are constantly incorporating cutting-edge expertise and experimenting with new ways into the agricultural system [15].

Farming is riddled with difficult decisions and unknowns.

Seasonal weather changes, agricultural input costs shift, soil deteriorates, crops falter, weeds stifle growth, pests damage crops, and the environment shifts. Farmers must manage these uncertainties. This research focuses on soil, crop, disease, and weeds as significant components of agricultural output despite the diversity of agricultural practises. The application of artificial intelligence (AI) in agriculture for pest, disease, and crop management must be thoroughly studied. The major supply of nutrients needed for crop development is in the soil, making it a crucial element of successful agriculture. Soil is essential to all

agricultural, forestry, and fishery production systems. Soil holds water, minerals, and proteins in order to support crop growth and development.

- Crop production is critical to the Nigerian economy. It does give food, raw materials, and work opportunities. Marketing, processing, distribution, and after-sales support are all becoming increasingly important components of agricultural production. In low-income areas, crop agriculture and other primary industries are being prioritized.
- Higher agricultural production output and productivity have been proved to contribute considerably to a country's overall economic development. As a result, greater focus will be placed on agricultural output development.
- Plant diseases reduce agricultural productivity and quality as agriculture attempts to feed the world's rapidly growing population. Post-harvest infections can cause severe agricultural losses.
- One of the biggest dangers to all agricultural activity is weeds. Weeds take over crops, suffocate pastures, deplete agricultural and forestry production, and in some circumstances even kill livestock. They fiercely compete with crops for water, nutrients, and sunshine, which lowers agricultural output and lowers crop quality.

Model	Functionality	Scope	Ref
CALEX	Explained about crop management techniques	More time consuming.	[1]
PROLOG	Given efficient Farming tools	Vary location to location	[2]
ANN	Estimation of Crop yields.	Focusing only on weather regarding crop.	[3]
ROBOTICS Demeter	Can produce up to 43 hectares crop	Cost effective since more fuel usage.	[4]
ROBOTICS	Produces 83% crop yield	Accurate model but slow.	[5]
ANN	Succeeded in achieving 93% disorder in crop nutrition.	Few symptoms were considered for the nutrition.	[6]
FUZZY Cognitive Map	Both suitable for cotton output and beneficial for crop decision-making.	Comparatively slow in performance.	[7]
FUZZY Cognitive Map	Suitable for cotton yield and good for decision management for crops.	Comparatively slow in performance.	[8]

ANN	Explained more about soil moisture for better crop.	Focused on only texture and temperature as main factors.	[9]
ANN and Fuzzy Logic	Given more about harmful insects' reduction for crops.	Lagging in explain crop and weed gaps of crop.	[10]
ANN	Suitable for rice crop and performs accurate prediction	More time taken and suitable for a specific climate.	[11]

Table 3. AI in crop management summary

4. Pest Management

The most frustrating issue in agriculture is insect infestation, which results in significant financial loss. By creating computer systems that can identify aggressive bugs and suggest treatment procedures, scientists have been working to lessen this danger for decades. The rule-based expert system may be prone to indecision since agricultural management information is usually inaccurate, partial, and unfocused [17]. Numerous logic-based expert systems were suggested by Saini and Kamal [18] and Siraj and Arbaiy [19] to deal with this issue.In order to develop TEAPEST, Ghosh and Samanta employed an object-oriented paradigm to establish a rule-based expert system [20]. An organised dialogue and identification process helped to achieve this. In order to obtain high sorting rates, Samanta and Ghosh rebuilt the system using a multidimensional back proliferation neural network [21], which Banerjee subsequently reorganised with a radial basis function prototype [22].Artificial intelligence is used by pest treatment organisations to programme and build anything from pest route planning to pest prediction.

Pest control businesses and farmers may remotely monitor all crops using drone technology in order to find pests, illnesses, dead soil, or unexpected crop degeneration. Based on this knowledge, the farmer may gather information from any agricultural zone, halting the disease's spread.

5. Disease Management

Plant diseases have the potential to be exceedingly hazardous to the world economy, environment, consumers, and farmers. Pests and diseases damage 35% of crops in India alone, causing farmers to suffer tremendous losses. Unselective pesticide use endangers human health since certain pesticides are biomagnified and poisonous. These consequences can be prevented by closely monitoring the crop, detecting sickness, and providing appropriate treatment. Recognising an indisposed plant and then carrying out the essential treatments to recover it necessitates extensive knowledge and experience. All across the world, computerised systems are used to research the condition and subsequently offer ways to control it. To make sure that pictures of the leaves are divided into exterior sections like the non-infected area, background, and sick area of the leaf, image sensing and analysis is employed. The contaminated leaf is then removed and taken to the lab for additional examination. This helps identify pests and identify nutritional inadequacies.

6. Irrigation and Soil Management

Irrigation is a labor-intensive and time-consuming farming technique. Irrigation and soil concerns are critical to cultural development. Poor soil management and irrigation result in agricultural losses and contaminated environments. Automation of irrigation can increase overall production thanks to AI systems that have been trained to comprehend previous weather patterns, crop kinds, and soil conditions. More than 70% of the fresh water available on Earth is used for irrigation, therefore automating this process may both save water and help farmers overcome their water shortages.

Companies like Intello Labs and CropIn are creating AI-based tools and sensors to monitor soil health. CropIn employs artificial intelligence to increase per-acre value, and Intello Labs uses deep learning to evaluate photos.

This section focuses on individual irrigation and soil management research projects that have benefited from artificial intelligence technologies. Sicat and John [26] used the experience of agriculturalists to create a fuzzy technique for awarding harvests based on the adequacy of the system's generated land maps. Arif [27] developed a neural network technique to calculate topsoil moisture in rice fields. Manek and Singh explored the topologies of neural networks for rainfall forecasting with four distinct inputs [28]. According to the findings, the neural network's radial basis function beats previous models.

7. Weed Management

One of the most burdensome problems for a farmer is weed management, which is also the most challenging aspect of pest control. Herbicides are used more frequently than any other pesticide, including insecticides. No farmer likes to use pesticides, but no farmer wants the water and nutrients intended for crops to be completely consumed by weeds. Herbicide use is hazardous to both human health and the environment. Several companies and organisations are interested in using computer visualisation, robotics, and machine learning. Through precise and effective weed management, cutting-edge artificial intelligence systems have been developed. Pasqual [29] created a skilled method for weed detection and removal in crops including wheat, barley, and oats. Additionally, Burks [30] examined three other neural networks, including backpropagation, counter dissemination, and radial based function models, using the identical set of contributions as the previous research and found that the backpropagation design had the highest accuracy (97%).

Ref	Algorithm/Method	Disease/pest	Crop	Application
[12]	Machine vision	Bakanae	Rice	Bakane detection
[13]	KNN, SVM, CV	Foliar	Soyabean	Leaf disease detection
[14]	SVM, HOG (Histogram of Oriented Gradients), and MSER (Maximally Stable Extremal Regions).	Aphids	Wheat	Detection of Aphids in wheat fields
[15]	CV, SVM	Septoria, Yellow rust	Wheat	Leaf spot Severity
[16]	Deep convolution neural network	Pest	-	Pest detection
[17]	Deep learning, CNN, BPNN	Mould	Rice	Detection of Fungal colonies
[18]	Raspberry PI	Insects	-	Flying insect counting and identification

Table 4. Applications of AI for disease and pest management and weeding operations.

8. Yield Prediction and Management

Crop production forecasting is extremely helpful in estimating crop costs and marketing tactics. Furthermore, in this day and age of precision agriculture, predictive models can be used to explore critical factors that have a consistent impact on production. An ecosystem for efficient, effective, and smart farming is developing as a result of the introduction of cutting-edge

technologies including artificial intelligence (AI), satellite images, cloud machine learning, and advanced analytics. The combination of these new technologies is helping farmers achieve the highest possible average productivity while also giving them more control over the quantity of food grains they gather, assuring their financial success. Liu and Minzan [31] employed an AI neural network model with backpropagation knowledge to anticipate production from topsoil constraints.. Climate information, ideal planting seasons, and real-time tracking Absorption of Moisture Artificial intelligence algorithms can extract data from frequent raindrop data and soil moisture to produce estimates and advise farmers on the ideal time to sow.

9. Pre-Requisites

Data Set

The data collection approach relates to how the programme acquires and measures information depending on investigation factors. The information used came from a variety of sources, including the Rajasthan Government's official website. Wheat, rapeseed and mustard, barley, bajra, jowar onion, and maize are among the state's most harvested crops, with data collected and documented from all 33 districts (Table 1). The data from 1997 to 2019 was gathered from the Rajasthan Government's official website.

3664 rows and 7 columns make up the dataset's final structure after all invalid and null data have been eliminated. Now, yield is a variable that may vary independently. A few more independent elements, such the soil type found there and the quantity of rainfall that has fallen in these regions throughout time, are included in the dataset to help draw a more scientific conclusion. The decision to focus on these particular variables was made because soil, which is one of the most crucial elements of crop yield because it supplies the crop with the necessary nutrients, water, and oxygen, and rainfall patterns, which help to predict how much natural water will be available for crop growth, replenishment, and production.

It was discovered that each area has its own distinct type of soil. There are around 27 different types of soil in Rajasthan, and each of the state's 32 present districts has soil that is a blend of one or more of these 27 types. It is evident that each district has a unique soil composition, which is shown as categorical data.

CROP	Dataset Data
Onion	723
Jowar	739
Maize	710
Wheat	752
Barley	748
Bajra	748
Mustard	752

Table 5. Crop dataset details

As a result, the soil data must be encoded in order to forecast throughout the dataset, resulting in the creation of dummy variables. The "Soil Type" column of the original data frame was deleted after the data frames were consolidated. The way the district names are displayed must also be changed.

Techniques used	Purpose	Gaps	Title References
ANN	Can predict soil enzyme activity. Accurately predicts and classifies soil structure.	Only measures a few soil enzymes. It considers more classification than improving the performance of the soil.	[19]
MOM	Minimizes nitrate leaching, maximizes production.	Takes time. Limited only to nitrogen.	[20]
ANN	Can predict monthly mean soil temperature	Considers only temperature as a factor for soil performance.	[21]
Fuzzy Logic: SRC-DSS	Can classify soil according to associated risks.	Needs big data. Only a few cases were studied.	[22]
ANN	It predicts soil texture	Requires big data for training. Has restriction in areas of implementation.	[23]
ANN	Able to predict soil moisture.	The prediction will fail with time as weather conditions are hardly predictable.	[24]
ANN	Successfully reports soil texture.	It does not improve soil texture or proffers solution to bad soil texture.	[25]
ANN	Cost-effective, saves time, has 92% accuracy	Requires big data.	[26]
ANN	Can estimate soil nutrients after erosion.	Its estimate is restricted to only NH-4.	[27]

Table 6. Comparative survey of various methods

Then, data on rainfall was included to the dataset. Data on rainfall in Rajasthan was available for each district from 1901 to 2002 and again from 2004 to 2010.While the data for 2011 to 2017 was gathered from official records maintained by the Rajasthan Government, the rainfall data for 2003 was calculated by averaging the data that was available. In order to incorporate rainfall data for 2018 and 2019, data from 1901 to 2017 were averaged. The final dataset comprises monthly rainfall data for each district for the same time period as the core dataset, which contains data on agricultural productivity from 1997 to 2019. The primary dataset is then combined with the dataset related to rainfall.

S. No	Algorithms	Method of evapotranspiration/ desired calculation	Other Technologies	Advantages/Results	References
1	PLSR and other regression Algorithms	Evapotranspiration model	Sensors for data collection, IOT Hardware Implementation	Increased efficiency and economic feasibility	Choudhary et al. (2019)
2	Artificial Neural Network based control system	Evapotranspiration model	Sensors for measurement of soil, temperature, wind speed, etc.	Automation	Umair and Usman (2010)
3	Fuzzy Logic	FAO Penman-Monteith method		Optimization	Kia et al. (2009)
4	ANN (multilayer neural model), Levenberg Marquardt, Backpropagation	Penman–Monteith method	-	Evaporation decreased due to schedule and savings observed in water and electrical energy	Karasekreter et al. (2013)
5	Fuzzy Logic	-	WSN, Zigbee	Experimental results verification. Can be applied to home gardens and grass	Al-Ali et al. (2015)
6	ANN Feed Forward, Backpropagation	-	-	Optimization of water resources in a smart farm.	Dela Cruz et al. (2017)
7	Fuzzy Logic Controller	Penman–Monteith method	Wireless sensors	Drip irrigation prevents wastage of water and evaporation	Anand et al. (2015)
8	Machine Learning algorithm	-	Sensors, Zigbee, Arduino microcontroller	Prediction and tackles drought situations	Arvind et al. (2017)

Table 7. Summary of various methods used for crop yields improvement

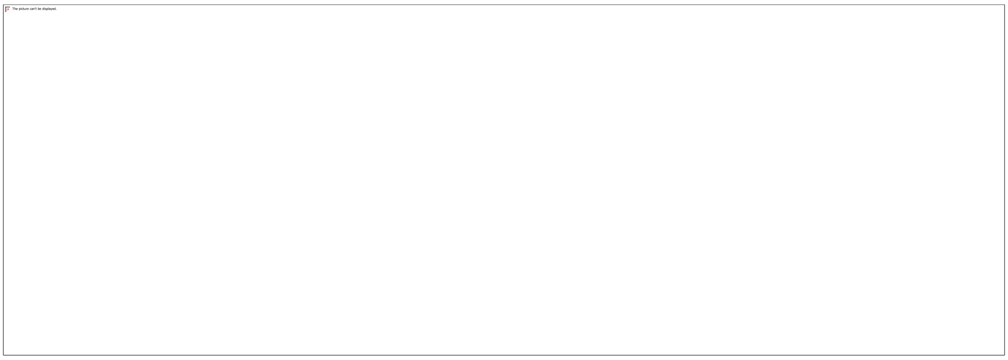

Fig. 3. Sinusoidal prediction.

Fig. 4. Daily water tension prediction.

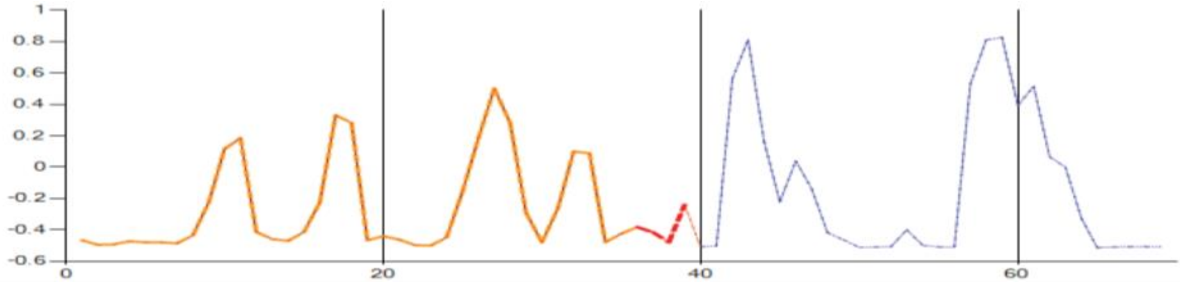

Fig. 5. Monthly water tension prediction

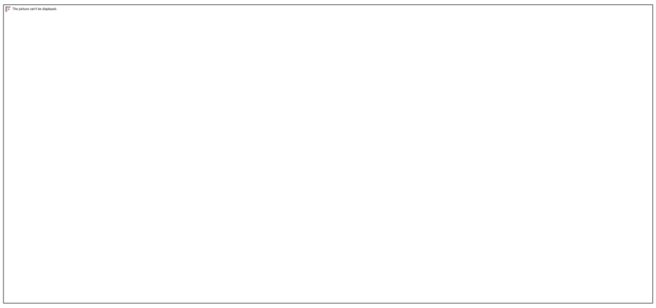

Fig. 6. Model performance of Random Forest.

Fig. 7. Model performance of Lasso Regression.

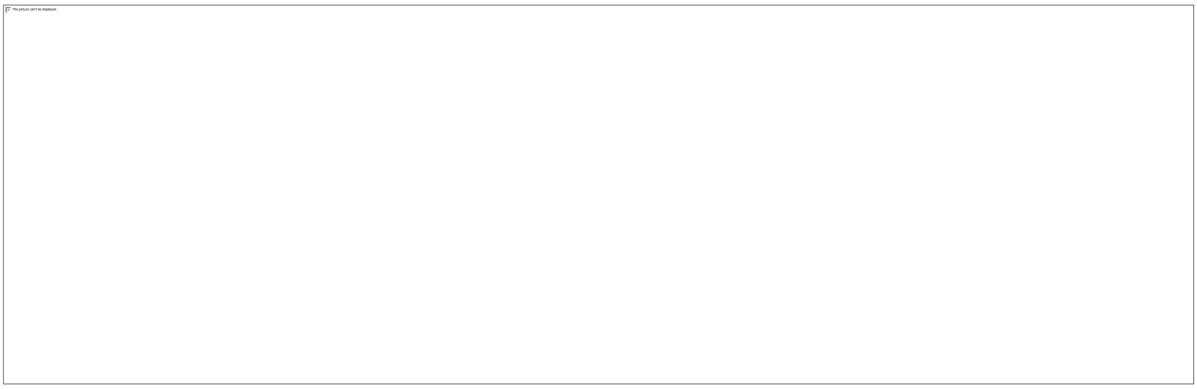

Fig. 8. Model performance of LSTM.

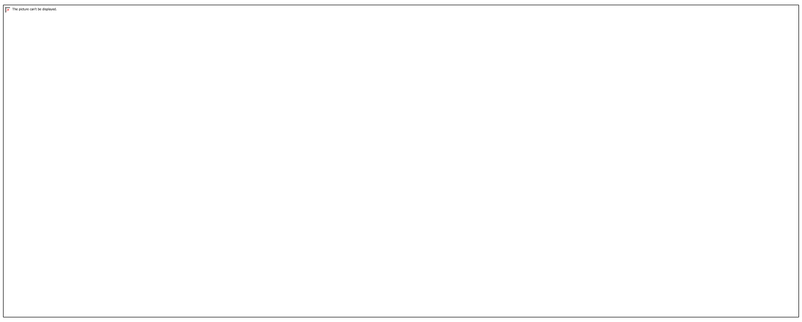

Table 8. Model output using only area and productivity as inputs.

Algorithms	**R2 Score**	**RMSE**	**MAE**
RANDOM FOREST	0.950140	0.040291	0.035122
SVM	0.812040	0.069791	0.037852
LASSO REGRESSION	0.900130	0.089840	0.058009
GRADIENT DESCENT	0.75067	0.098468	0.070069
LSTM	0.70109	0.601882	0.406492
KNN	0.96891	0.041203	0.320348

Table 9. Model performance using all parameters

H-High rain fastness (- 30% residue wash=off), M-Moderate rain fastness (- 50% residue wash=off), L-Low rain fastness (- 70% residue wash=off), Systemic residues remain in plants.

Table 10. general properties of chemical classes used in pesticides.

Table 11. An explanation of the pesticides used in the nation together with the domain name, code, region, and the number of units utilised along with the values attained.

Table 12. Based on item code, value, and the flag, pesticides and insecticides differ from one other.

Fig 6: Using a graph showing the total amount of pesticides used in India from 2011 to 2022.

Table 13. Explanation of insecticides persistence, plant penetration, and rainfastness rating.

Algorithm	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
Naïve Bayes	0.987	0.017	0.996	0.987	0.992	0.958	0.984	0.991	norm
	0.983	0.013	0.950	0.983	0.966	0.958	0.982	0.954	abnormal
	0.986	0.016	0.987	0.986	0.987	0.958	0.984	0.982	*Weighted Average*
Random Forest	0.922	0.530	0.628	0.922	0.747	0.437	0.847	0.823	norm
	0.470	0.078	0.861	0.470	0.608	0.437	0.800	0.809	abnormal
	0.692	0.301	0.746	0.692	0.676	0.437	0.823	0.816	*Weighted Average*
J48	0.927	0.457	0.710	0.927	0.804	0.517	0.897	0.897	norm
	0.543	0.073	0.859	0.543	0.665	0.517	0.865	0.834	abnormal
	0.753	0.283	0.778	0.753	0.741	0.517	0.883	0.868	*Weighted Average*
LRC	0.543	0.073	0.922	0.747	0.437	0.437	0.865	0.834	norm
	0.470	0.078	0.861	0.470	0.608	0.437	0.800	0.809	abnormal

	0.692	0.301	0.746	0.692	0.676	0.437	0.823	0.816	*Weighted Average*
KNN	0.987	0.017	0.996	0.987	0.992	0.916	0.984	0.991	norm
	0.983	0.013	0.950	0.983	0.966	0.916	0.982	0.954	abnormal
	0.986	0.016	0.987	0.986	0.987	0.916	0.984	0.982	*Weighted Average*

Table 14. Summary of accuracy of algorithms.

The photos can alternatively be divided into 16 x 40 blocks, with each block in this case covering an area of about 8768 sq mm. This means that instead of 8, we actually need 16 nozzles.

The subsequent processing, or the work of spraying, was carried out in accordance with the aforementioned requirements.

The circumstances are:

1. A block is classified as a weed block if the percentage of weed pixels in the block under examination is greater than 10% of the block's overall area.

2. Herbicides have been applied on every block under inspection.

3. Following these two requirements, it is intended to eliminate all weeds sprayed in an area equal to or more than 30% of their total area.

4.The herbicide used in this procedure is selective, meaning it only kills weeds and leaves the other plants alone.

The initial two circumstances referenced above characterizes the where the herbicides are to be showered, or at least, characterizes the regions which requires splashing. The main condition referenced decreases the regions which contains tiny measure of weeds and which doesn't need showering. This is a significant piece of weeding. To obliterate weeds, every one of the pieces of the weeds doesn't need showering, yet possibly splashing an adequate number of regions is significant as while showering is finished on one piece of weeds it is consumed by various pieces of the weeds eventually obliterating the weeds. Yet, one requirements to take care that enough regions in a weed are splashed since, supposing that the showered regions are too little then, at that point, all things considered the weeds may not obliterate. In this manner we characterize a base splashing region in the condition 3.The characterized condition 4 is there to work out the decrease in how much herbicides utilized as contrasted and the showering in the general region. Estimating the annihilation weed rate, the correct splash rate, the misleading shower rate, and the herbicide reduction rate is necessary for the evaluation of this weeding strategy. Calculate the following information as follows:

Destroyed weed rate = (N_K / N_W)

Correct spray rate = $(N_{CSR} / N_{SNWB)}$ X 100

False spray = $(N_{FSB} / N_{SB)}$ X 100

Herbicides reduction rate = $(1-N_{SB} / N_{B)}$ X 100

Here, NK stands for "number of weeds killed," NW for "total number of weeds in the block," NCSB for "number of weed blocks sprayed," NFSB for "number of non-weed blocks sprayed," NSB for "total number of blocks sprayed," and NB for "total number of blocks examined."

Here the framework is intended to apply spark just on the areas where weeds are identified. When the locales having weeds are recognized, the determination of weed focuses is finished by the framework for spark release, these weed focuses address the weed regions. Like the above talked about compound strategy, in this technique additionally a few circumstances are characterized. The circumstances are as per the following:

1. The normal of the multitude of directions of the pixels in the pictures is determined and it is characterized as the focal point of that district.

2. At this halfway point, the spark release used for weeding is administered.

3. In the event that a weed gets the spark release, that specific weed is viewed as obliterated.

The initial two circumstances are laid out to choose the fight releasing focuses in the fields and the third condition is for setting the capability of weed annihilation. In this strategy a few additional variables are assessed alongside the three elements determined in the past technique, the right spark rate and the misleading spark rate.

Correct spark rate = (N_{CSK} / N_{SK}) X 100

False spark rate = (N_{FSK} / N_{SK}) X 100

Here N_{CSK} is the number of sparked weed pixels, N_{FSK} is the number of sparked non-weed pixels and NSK is the total number of sparked points.

10. Drones in Agriculture

Automated aeroplanes that can be operated to some extent in a mechanical environment are known as automated aeronautical vehicles (UAVs) or automated ethereal structures (UAS) (Mogli and Deepak, 2018). Together, they operate the GPS and other sensors that are attached on them. Drones are used in horticulture for a variety of tasks, including crop health inspection, water system hardware observation, weed identification proof, crowd and wild life inspection, and disaster management (Veroustraete,

2015; Ahirwar et al., 2019; Natu and Kulkarni, 2016). Far away Horticulture is being significantly impacted by the use of UAVs for image capturing, handling, and research. (2015) Abdullahi et al. Using these driven tools to alter conventional agricultural practises, the provincial business appears to have a hold on meander aimlessly development with amazing eagerness (Pederi and Cheporniuk, 2015).

According to a continual PwC analysis, the total addressable evaluation of computerization-filled courses of action in every relevant industry is fundamentally more than USD 127 billion.

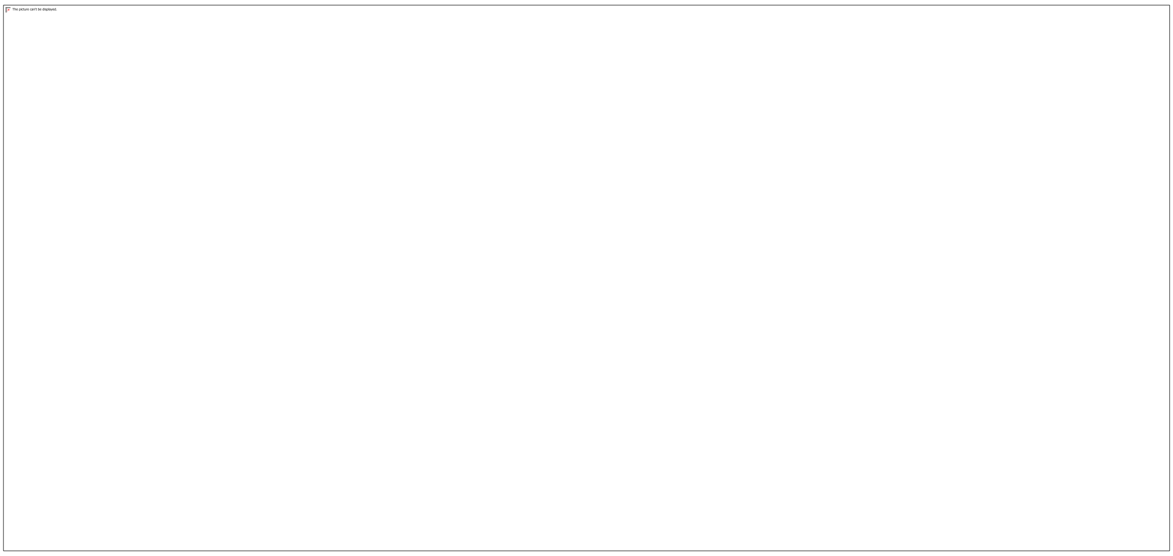

Fig 9. Various drone duties in agriculture monitoring.

They can be distinguished from a typical, simple-to-use camera for unmistakable images, but while a standard camera can give some information about plant development, consideration, and other things, a multispectral sensor broadens the utility of the strategy and empowers farmers to see things that can't be tracked down in the recognisable reach, such as moisture content in the dirt, plant wellbeing checking. These could help in getting through the different obstacles that prevent agricultural production. Remote sensor organisations (WSN) are merged with the evolution of UAS. The WSN's information retrieval capabilities enable the UAS to advance their use, such as restricting the spraying of prepared combinations to meticulously designated locations. Since natural conditions often and unexpectedly change, the control circle should most likely respond as soon as it is logically predicted. That is something that the agreement with WSN may contribute to (Costa et al., 2012). UAVs are mainly suitable for agribusiness tasks in accuracy farming, such as soil and field examination (Primicerio et al., 2012), crop observing (Bendig et al., 2012), crop level assessments (Anthony et al., 2014), and pesticide showering (Faiçal et al., 2017; Faiçal et al., 2014a, b, c; Huang et al. In Table 4, However, their equipment performance (Maurya, 2015) is just based on fundamental factors like weight, range of flight, payload, design, and their costs. According to Huang et al. (2013), an investigation of UAV innovations, methods, frameworks, and limitations is looked at. To select the ideal UAV for horticulture, more than 250 models are broken down and totaled up (S.R. (See Table 3.) Kurkute et al., 2018). Soon, the market for agricultural robots is expected to grow by more than 38%. It is acknowledged that the need for knowledgeable agriculture will only increase substantial as a result of rising population densities and evolving environmental patterns (Puri et al., 2017).

Agriculture needs to deal with serious issues such a lack of water system infrastructure, temperature changes, depth of groundwater, food shortages and waste, and much more. The future of development often depends on the fusion of various mental configurations. The industry is currently severely underfunded, despite the fact that much research is continuously being conducted and a few apps are already available online (Shobila and Mind-set, 2014). Cultivating is now in its infancy with regard to addressing practical issues faced by ranchers and utilising independent navigation and imaginative solutions to solve them. Applications need to be stronger in order to examine the enormous scope of artificial intelligence in farming (Butcher et al., 2008).

It can really manage continuing changes in the environment at that point, follow ongoing instructions, and make use of an appropriate structure or stage for efficiently capturing logical data. The high cost of the numerous mental setups available for cultivation is a further important aspect to consider. To make sure that the innovation reaches the majority, the agreements must become more fair. The arrangements would be more affordable using an open source stage, which would result in quick acceptance and larger admission among the ranchers. Ranchers will benefit from the invention since it will let them produce big yields and excellent sporadic harvests at standard span. Ranchers in several countries, including India, are dependent on storms for their development. They mostly rely on expectations from various offices rather than the climatic circumstances, especially when it comes to downpour-affected development. The development of artificial intelligence will be useful to predict the weather and other conditions related to horticulture, such as land quality, groundwater, crop cycle, nuisance attack, etc. The bulk of the ranchers' concerns will be reduced by the accurate prediction or forecast made possible by the simulated intelligence innovation. Simulated intelligence-driven sensors are quite useful for removing important data related to agriculture. The knowledge will aid in improving creativity. There is a tremendous application for these sensors in horticulture. Agribusiness researchers can deduce information on the kind of soil, the temperature, the level of the groundwater, and other factors that are important for advancing the growth cycle. In order to obtain the information, artificial intelligence-enabled sensors can also be added to the mechanical reaping equipment. Artificial intelligence-based warnings are thought to be useful for increasing invention by 30%. The biggest challenge in farming is the yield damage caused by mishaps of any kind, especially irritation attacks. Most often, ranchers lose their yields as a result of a lack of reliable data. Ranchers would benefit from the innovation in this digital era if they wanted to protect their progress from any attacks. Picture recognition driven by computer-based intelligence will be beneficial on this road. Robotic creation screening and vermin attack detection have been implemented by several organisations. Such efforts have frequently proven beneficial, which motivates the need for a system to monitor and protect crops.

A yellow tomato seedling flower is the subject of a mechanical focal point. A man-made consciousness calculation that incorporates images of the plant makes a clear prediction about how long it will take for the tomato to mature into a ripe tomato that is suitable for picking, pressing, and the produce section of a store. The 20-year-old organisation Nature New Homesteads, which cultivates vegetables on 185 acres of land between Ohio and Ontario, is where the idea is being developed and studied. According to Keith Bradley, IT Manager at NatureFresh Ranches, knowing precisely the quantity of tomatoes that will be available for sale later simplifies the job of the outreach group and directly benefits reality. It's just one example of artificial intelligence influencing agriculture; it's an emerging pattern that will help prompt a revolution in the sector. Computerised reasoning can assist humanity in meeting what may be its greatest challenge: caring for an additional 2 billion people by 2050, despite environmental change disrupting the seasons, turning arable land into deserts, and inundating once-productive deltas with seawater. Computerised reasoning can do this by identifying nuisances and predicting which harvests will yield the best returns. By the middle of the next century, according to the Assembled Nations, we should double the amount of food produced. Between 1960 and 2015, rural creation drastically rose as the global population grew from 3 billion to 7 billion people. A substantial portion of the growth may be attributed to simply furrowing additional land, chopping down trees, and diverting fresh water to fields, plantations, and rice paddies. Innovation had a part in this as well with insecticides, manures, and machinery. This time, we should be more shrewd. In the coming few years, simulated intelligence will likely transform horticulture and the market. The development has helped ranchers better understand the many types of half-and-half improvements that might increase their income in a short amount of time. Artificial intelligence used legally in the agricultural sector will help with development management and market environment creation. According to data from shipping companies, there is a significant amount of food wasted worldwide. By using the proper calculations, this problem may also be resolved, saving time and money while also opening the door to potential outcomes. With the aid of technological advancements like artificial intelligence, farming has higher chances for progressive transformation. However, everything depends on a vast amount of data that is very difficult to compile because the creation cycle occurs more than once a year. In any case, ranchers adjust to the changing environment by implementing artificial intelligence to develop the agribusiness. It's just one example of how artificial intelligence is altering farming, a pattern that will help spur a rural uprising. This time, we should be more creative.

11. Conclusion

The agriculture industry has a variety of challenges, such as the lack of functional water system frameworks, weeds, difficulty with plant observation due to yield level, and extreme weather conditions. Nevertheless, the presentation may be enhanced using the innovation model, and these problems can then be solved. It might very well be enhanced with various computer-based intelligence-driven techniques, such as GPS-enabled automated water systems and remote sensors for recognising soil moisture content. Ranchers looked at the fact that precise weeding techniques outweighed the significant amount of yields lost throughout the weeding system. In addition to increasing proficiency, these autonomous robots also reduce the need for unnecessary pesticides and herbicides. In addition, ranchers may use robots to spray pesticides and herbicides directly on their land, and plant inspection is now not a burden. First off, in terms of agriculture difficulties, inadequacies of resources and professions may be seen via the lens of man-made mental capacity. In traditional methods, a great deal of labour was required to get agricultural qualities such as plant level, soil surface, and content, necessitating tedious manual testing. Fast and non-harmful high throughput phenotyping with the possibility for adaptable and profitable action, on-demand access to data, and geographical aims would be possible with the aid of the several frameworks examined.

References

[1] R. E. Plant, "An artificial intelligence based method for scheduling crop management actions", Agricultural Systems, Vol. 31, No. 1, pp. 127-155, 1989.

[2] H. Lal, J. W. Jones, R. M. Peart, W. D. Shoup, "FARMSYS-A wholefarm machinery management decision support system", Agricultural Systems, Vol. 38, No. 3, pp. 257-273, 1992.

[3] S. S. Snehal, S. V. Sandeep, "Agricultural crop yield prediction using artificial neural network approach", International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, Vol. 2, No. 1, pp. 683-686, 2014.

[4] T. Pilarski, M. Happold, H. Pangels, M. Ollis, K. Fitzpatrick, A. Stentz, The Demeter System for Automated Harvesting, Springer, 2002.

[5] E. J. V. Henten, J. Hemming, B. A. J. V. Tuijl, J. G. Kornet, J.Meuleman, J. Bontsema, E. A. V. Os, An Autonomous Robot for Harvesting Cucumbers in Greenhouses, Springer, 2002 [34] H. Song, Y. He, "Crop Nutrition Diagnosis Expert System Based on Artificial Neural Networks", 3rd International Conference on Information Technology and Applications, Sydney, Australia, July 4–7, 2005.

[6] E. I. Papageorgiou, A. T. Markinos, T. A. Gemtos, "Fuzzy cognitive map based approach for predicting crop production as a basis for decision support system in precision agriculture application", Applied Soft Computing, Vol. 11, No. 4, pp. 3643-3657, 2011.

[7] X. Dai, Z. Huo, H. Wang, "Simulation of response of crop yield to soil moisture and salinity with artificial neural network", Field Crops Research, Vol. 121, No. 3, pp. 441-449, 2011.

[8] C. C. Yang, S. O. Prasher, J. A. Landry, H. S. Ramaswamy, "Development of herbicide application map using artificial neural network and fuzzy logic", Agricultural Systems, Vol. 76, No. 2, pp. 561-574, 2003.

[9] B. Ji, Y. Sun, S. Yang, J. Wan, "Artificial neural networks for rice yield prediction in mountainous regions", Journal of Agricultural Science, Vol. 145, No. 3, pp. 249-261, 2007.

[10] Patrício, D. I., & Rieder, R. (2018). Computer vision and artificial intelligence in precision agriculture for grain crops: A systematic review. Computers and electronics in agriculture, 153,69-81.

[11] Shrivastava, S., Singh, S. K., & Hooda, D. S. (2017). Soybean plant foliar disease detection using image retrieval approaches. Multimedia Tools and Applications, 76, 26647-26674.

[12] Liu, T., Chen, W., Wu, W., Sun, C., Guo, W., & Zhu, X. (2016). Detection of aphids in wheat fields using a computer vision technique. Biosystems Engineering, 141, 82-93.

[13] Han, L., Haleem, M. S., & Taylor, M. (2015, July). A novel computer vision-based approach to automatic detection and severity assessment of crop diseases. In 2015 Science and Information Conference (SAI) (pp. 638-644). IEEE.

[14] Nam, N. T., & Hung, P. D. (2018, June). Pest detection on traps using deep convolutional neural networks. In Proceedings of the 1st International Conference on Control and Computer Vision (pp. 33-38).

[15] Sun, K., Wang, Z., Tu, K., Wang, S., & Pan, L. (2016). Recognition of mould colony on unhulled paddy based on computer vision using conventional machine-learning and deep learning techniques. Scientific reports, 6(1), 1-14.

[16] Zhong, Y., Gao, J., Lei, Q., & Zhou, Y. (2018). A vision-based counting and recognition system for flying insects in intelligent agriculture. Sensors, 18(5), 1489.

[17] S. Tajik, S. Ayoubi, F. Nourbakhsh, "Prediction of soil enzymes activity by digital terrain analysis: Comparing artificial neural network and multiple linear regression models", Environmental Engineering Science, Vol. 29, No. 8, pp. 798-806, 2012.

[18] E. R. Levine, D. S. Kimes, V. G. Sigillito, "Classifying soil structure using neural networks",

Ecological Modelling, Vol. 92, No. 1, pp. 101-108, 1996.

[19] M. Bilgili, “The use of artificial neural network for forecasting the monthly mean soil temperature in Adana, Turkey”, Turkish Journal of Agriculture and Forestry, Vol. 35, No. 1, pp. 83-93, 2011.

[20] Z. Zhao, T. L. Chow, H. W. Rees, Q. Yang, Z. Xing, F. R. Meng, “Predict soil texture distributions using an artificial neural network model”, Computers and Electronics in Agriculture, Vol. 65, No. 1, pp. 36-48, 2009.

[21] Elshorbagy, K. Parasuraman, “On the relevance of using artificial neural networks for estimating soil moisture content”, Journal of Hydrology, Vol. 362, No. 1-2, pp. 1-18, 2008.

[22] D. H. Chang, S. Islam, “Estimation of soil physical properties using remote sensing and artificial neural network”, Remote Sensing of Enviroment, Vol. 74, No. 3, pp. 534-544, 2000.

[23] T. Behrens, H. Forster, T. Scholten, U. Steinrucken, E. D. Spies, M.Goldschmitt, “Digital soil mapping using artificial neural networks”,Journal of Plant Nutrition and Soil Science, Vol. 168, No. 1, pp. 21-33,2005.

[24] T. Behrens, H. Forster, T. Scholten, U. Steinrucken, E. D. Spies, M.Goldschmitt, “Digital soil mapping using artificial neural networks”,Journal of Plant Nutrition and Soil Science, Vol. 168, No. 1, pp. 21-33,2005.

[25] M. Kim, J. E. Gilley, “Artificial neural network estimation of soil erosion and nutrient concentrations in runoff from land applicationareas”, Computers and Electronics in Agriculture, Vol. 64, No. 2, pp.268-275, 2008.

[26] M. S. Moran, Y. Inoue, E. M. Barnes, “Opportunities and limitations for image-based remote sensing in precision crop management”, Remote Sensing of Enviroment, Vol. 61, No. 3, pp. 319-346, 1997.

[27] P. Debaeke, A. Aboudrare, “Adaptation of crop management to waterlimited environments”, European Journal of Agronomy, Vol. 21, No. 4, pp. 433-446, 2004.

[28] Ahir, K., Govani, K., Gajera, R., Shah, M., 2020. Application on virtual reality for enhanced

[29] education learning,military training and sports. Augmented Human Research (2020),5:7.

[30] Ahirwar, S., Swarnkar, R., Bhukya, S., Namwade, G., 2019. Application of drone in agriculture.Int. J. Curr. Microbiol. App. Sci. 8 (1), 2500–2505.

[31] Arvind, G., Athira, V.G., Haripriya, H., Rani, R.A., Aravind, S., 2017. Automated irrigation

[32] with advanced seed germination and pest control. 2017 IEEE Technological Innovations in ICT for Agriculture and Rural Development (TIAR). https://doi.org/10.1109/tiar.2017.8273687.

[33] Choudhary, S., Gaurav, V., Singh, A., Agarwal, S., 2019. Autonomous crop irrigation system

[34] using artificial intelligence. International Journal of Engineering and Advanced Technology.

[35] 8 (5S), 46–51.

[36] Chung, S., Choi, M., Lee, K., Kim, Y., Hong, S., Li, M., 2016. Sensing Technologies for Grain Crop Yield Monitoring Systems: a review. Journal of Biosystems Engineering 2016 41 (4), 408–417.

[37] Cillis, D., Pezzuolo, A., Marinello, F., Sartori, L., 2018. Field-scale electrical resistivity profilingmapping for delineating soil condition in a nitrate vulnerable zone. Appl. Soil Ecol. 123, 780–786.

[38] Prof. Nikhil Surkar. (2015). Design and Analysis of Optimized Fin-FETs. International Journal of New Practices in Management and Engineering, 4(04), 01 - 06. Retrieved from http://ijnpme.org/index.php/IJNPME/article/view/39

[39] Chaudhury, S., Dhabliya, D., Madan, S., & Chakrabarti, S. (2023). Blockchain Technology: A Global Provider of Digital Technology and Services. In Building Secure Business Models Through Blockchain Technology: Tactics, Methods, Limitations, and Performance (pp. 168–193). IGI Global.

[40] Vaideghy, A. ., & Thiyagarajan, C. . (2023). An Ensemble Classification and Hybrid Feature Selection Approach for Fake News Stance Detection . International Journal on Recent and Innovation Trends in Computing and Communication, 11(4s), 28–39. https://doi.org/10.17762/ijritcc.v11i4s.6304