International Journal of Modern Agriculture
ISSN: 2305-7246
Volume 10 Issue 2, Month 2021

Artificial Neural Network - Based Greenhouse Monitoring

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Abstract— This paper evaluates the applications of ANN's which are abbreviated as Artificial Neural Networks in greenhouse technology, which explains the development in upcoming years by adjusting new technologies like Machine Learning(ML) and the Internet of Things (IoT). This paperwork is analyzed using feed-forward architecture, while hybrid networks and recurrent are tiny make use of various greenhouse tasks. In this research, we presented many training techniques for different networks; practicality using different optimization models for the learning process is exhibited. Different applications of Neural Networks' many advantages and disadvantages were observed. Based on energy expenditure, the prediction of a microclimate to many specific tasks like control of carbon dioxide. The most supreme in this work might be used as some of the suggestions for developers who utilize smart protected agriculture technology, in which system demand technologies 4.0.

Keywords- Greenhouse; artificial neural network; deep learning; hybrid neural networks; microclimate; optimization algorithms.

I. INTRODUCTION

A greenhouse is a system that preserves crops from all the elements that can cause damage. This is comprised of a closed structure that comprises a cover of translucent material. This approach aims to maintain an independent climate and improve the growth conditions for an increase in both the quality and quantity of the products. Greenhouse systems can fabricate without any restriction in a certain place of agro-climatic conditions. These systems are designed in such a way that they can suit any environmental conditions and installed accordingly. In optimal development, Microclimate control is necessary for the plant as it constitutes 90% of the crop production, shape, equipment, and elements of the greenhouse system will depend on different outdoor climate based on the plant's requirement [1]–[4].

Greenhouse climate is based upon the environmental conditions of what plants require for good condition. The microclimate of a greenhouse is very complex, non-linear, multi-parametric that depends on a set of internal and external factors, including meteorological factors like humidity and ambient temperature, solar intensity radiation, speed, and wind direction, among others. Greenhouse dimensions are Internal factors, crops, greenhouse components, and elements like fogging, heating and ventilation systems, soil types, etc. Different, describing greenhouse climate is explained in two approaches: one is based on mass flow equations and energy, which describes the process. The other uses the system identification approach consists of investigating both input and output data of the process. Using these details, it is hard to fully account for all the key factors. In this sight, it is related to resolving all the microclimate problems based on modern methods of an adaptive and non-linear system. It is very important to relate greenhouse system climate to plan a good control system as it is a process of handling the variables that may affect its behavior.

To achieve predetermined and optimal results, greenhouse climate control produces a favorable environment for cultivation. Several strategies and control techniques like adaptive control, predictive control, fuzzy logic, robust control, non-linear feedback control, and optimal control have been proposed for controlling the greenhouse environment. For greenhouse environment control, conventional proportional derivative controllers(P.I.D.) and integral are mainly evolved due to their architecture, flexibility, and good performance.

Another interesting topic acquired from the fabrication of greenhouse crops is energetic utilization. Solar energy is presented as a feasible replacement for traditional sources like electricity, fuel. As fuels are not renewable and also high cost, solar energy is better compared with traditional sources. Traditional energy sources can be put back with sustainable energies like wind energy, solar energy, geothermal energy, biomass, and cogeneration systems. Solar thermal energy or solar photovoltaic cells are largely used and merged with other sustainable energy systems.

Solar greenhouses provide controlled system cultivation. The main pivot is to bring down heating energy requirements, i.e., this heating requirement is hugely obtained from the sun. Solar energy will represent a chief element in the heating of greenhouses, and that happens it possible to cut back on production costs. They are many studies that have been brought out in which energy savings are sought, where methods are applied to optimize energy collection, physical models, and computational fluid dynamics (C.F.D.) techniques to forecast the microclimate of solar greenhouses[5], [6].

These prediction methods are divided into two groups:1. The physical method, 2. Black box method. This physical method is based on mathematical theory, which is essential for a huge number of parameters to be regulated, and there is difficulty in calculating those parameters. The black box method is based on modern computational technology that will not always ensure convergence to an optimal solution and even easily go through partial optimization. On the other hand, alternatively of programmed, neural networks learn to realize all the patterns. These greenhouse systems are highly pertinent to reflect the knowledge that cannot be programmed to represent non-linear phenomena [7]–[9].

Several studies have been developed in greenhouse crop production for different applications. As greenhouses are invariant over time, non-linear, and strong coupling, many investigations are done to opt for Artificial Neural Networks (ANN) for simulation, optimization, prediction, and control of all these processes. For the optimization of ANN's database, mathematical analysis methods have been developed. These models represent a variable relationship that makes the variable less trivial and simplifies the network structure. In this way, it improves the total yield of the greenhouse. This review explores all the different applications and ANN's investigations in greenhouse technology. The development of this type of model in the future will enhance its application and unite with 4.0

technologies that are appealed in smart agriculture (S.A.), these are utilized in the production of greenhouse-like Machine Learning(ML), Internet of things (IoT), big data, image analysis[10]–[14]. Fig.1. shows the greenhouse and model classification.

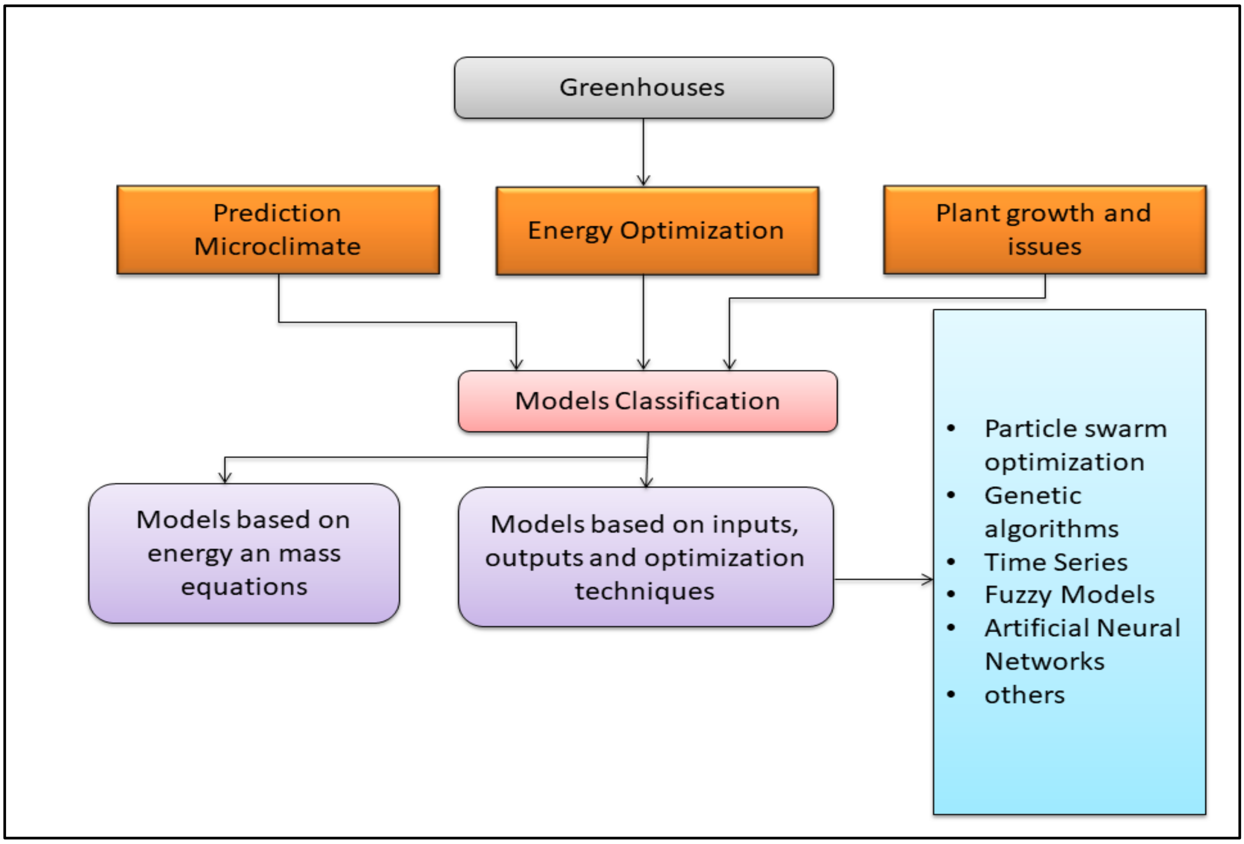

Fig 1. Greenhouse and model classification

II. Artificial Neural Networks

An ANN is an ML algorithm that is based upon the notion of a human neuron. This is a biologically influenced computational model that consists of processing elements (neurons) and relationships between them with coefficients generally called weights in our concept affixed to the connections[15]. Generally, ANN's got inspired by the human brain structure, so the main thing is to define neurons, dendrites, cell body, and axon works. In this network, dendrites carry electrical signals to the cell body. The cell body receives electric signals. Using a long fiber, axons carry the signal from one cell body to other neurons. When an axon and dendrite come in contact, that is called a synapse. Purposes of neural networks are entrenched through the organization of individual synaptic forces and neurons. Neural structures evolve through learning, and this may constantly change, weakening or strengthening. These neural networks are not complex as the human brain. The greatest similarities are primarily both the networks are linked, and the connection between neurons regulates the networks' purpose.

Neurons obtain inputs in the form of impulse. Some of the measures used to describe a neuron activity are the peak rate created over time and the average peak generation in several runs. A neuron is recognized by the speed at which it produces the peaks. By adaptive synaptic weights, neurons are connected to other neurons in the previous layer. In a set of connection weights, knowledge is generally stored. A training process is bringing out a suitable learning method when these connection weights are modified accordingly. These learning methods contain the input to the network and generate the desired output by altering the weights to generate a perfect output. As the method gets trained so that the weights will have pertinent information compared to prior training as it contains all the redundant and meaningless information. Figure 3 represents the simple neuron structure. To process the details in a neuron which begins with input Xn, they are weighted and added up before going through some activity generally called training to produce its output. The above process is represented as $\xi = \Sigma X_i \bullet W_i$. For each connection, this activation value is multiplied by the specific weight Wn, which is transferred to the next node. If this is considered as a linear activation, the output would be given as $y=\alpha(wx+b)$ [16]–[19]. Fig.2. shows feed-forward neural network structure.

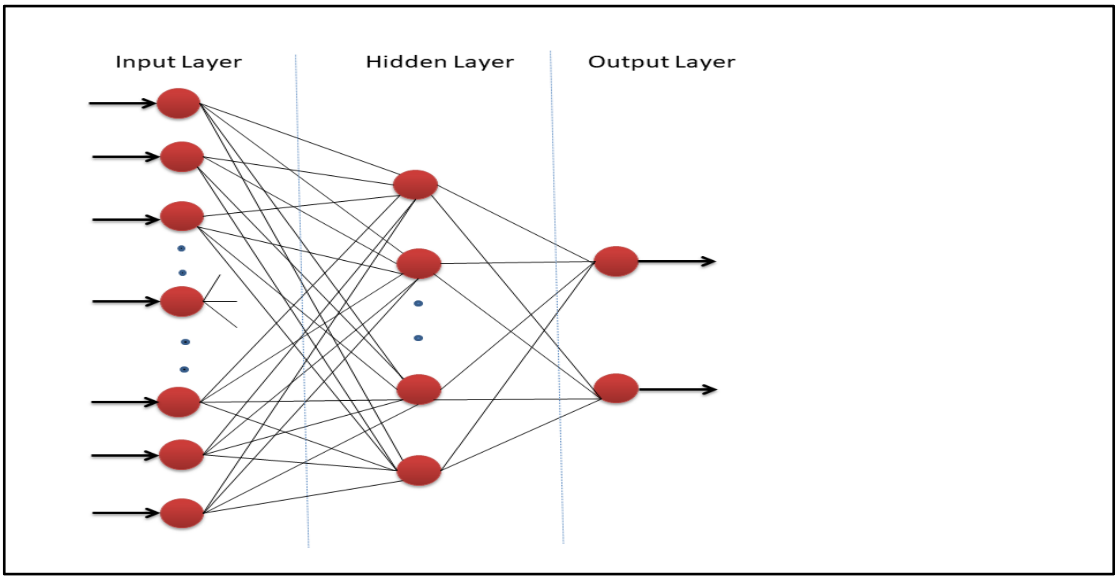

Fig 2. Feedforward neural network structure.

A. *Learning of Artificial Neural Networks*

In Neural networks, learning is a crucial part. This process will define the input and output association as this requires the most precise predictive calculation. This learning process is classified into two categories:1. Supervised and 2. Unsupervised. Supervised learning perceives the anticipated results and labels data. In unsupervised learning, it is not that requisite to perceive the data, as the learning is done through the locating of data representation and internal structures.

The supervised learning technique comprises cutting back a cost function that assembles the errors between the desired outputs and actual outputs for the given inputs. To reduce this cost function, several methods are ben used. B.P. algorithm is one of the most used for acquired results in one and multilayer networks. In unsupervised learning is based on input data. Updating the weights is brought out internally in the network; the algorithm is designed for ANN's self-organization and derived by Hebbian law. Learning techniques that got exposed allowed in the evolvement of advanced algorithms like S.O.M. (Self-Organizing Maps) and SOTA (Self-Organizing Tree Algorithm). Based on unsupervised N.N.'s, these are time series clustering algorithms. For data visualization and clustering data analysis tool is S.O.M. The main disadvantage of this tool is that the user needs to choose the map size, which leads to numerous experiments with different size maps, which is trying to obtain the optimal result. This process may be quite slow as we used training and using these large maps. To classify the patterns in the final layer in a more precise way, SOTA will permit the classification at the initial stages of the group of patterns separated from one another. These techniques help us in the learning of connection weights from the example and in learning a neural network structure from the examples. By using SOTA methods, neural networks can be put up automatically from the available training data.

III. Application of ANNs for the Prediction of the Greenhouse Microclimate

According to these application methods and tools treatment, variables related to climate for the greenhouse are crucial. Some parameters like speed calculation, prediction behavior of the precision, and different elements variable control remain a tremendous challenge. By using some of the non-linear methods, Artificial Neural Networks attend these tasks hugely. In the main study of modeling the N.N.'s of a greenhouse, the climate is mainly focused on both input and output relationship, in the process of selecting best input among them and training the network was not important to this study an Artificial Neural Network's proved that these could attain best results than a physical model method of mass and transfer of energy[20], [21].

A. *Greenhouse Microclimate*

To attain a controlled agricultural production, these greenhouses are non-linear systems and complex. These systems have internal factors and a composite dynamic impulse by external factors and control mechanisms. Based on the microclimate and control of greenhouse crops, it acts as a central element and a crucial part of the system. This system generally considers some of the common issues which are more relevant responses of the microclimate as it is a complex and diversity of crops in the greenhouse. The greenhouse system mainly focuses on the set of an environment which affects crop development and growth. Due to its sizeable benefaction towards a refinement of crop yield greenhouse microclimate system has received contemplate attention in recent years. To predict different elements like the amount of CO_2, temperature, and relative humidity system has implemented statistics and engineering, artificial intelligence.

The greenhouse system uses a conventional control to guarantee the desired performance, but this control may not be satisfactory. Many control techniques and strategies have been suggested in this scenario, like optimal control, model predictive control, fuzzy control, predictive control, Neural Network control, robust control, and linear-quadratic adaptive control. The bulk of these suggested proposals are based upon the behavior of variables and control in opposition to these changes, focusing on a particular crop. The topic that recently gained interest is the application of Neural Networks in the control of microclimate. To reflect non-linear characteristics, N.N.'s provide all the reliable models to the greenhouse as there is a difficult to solve by using traditional techniques as reliable models doesn't require any prior knowledge of the system, in real-time, the model is very satisfactory for dynamic systems [4], [7].

The most relevant attributes in the greenhouse microclimate system are humidity and temperature. There may be some complex exchange of gas in the environment, and there might be interactions between both mass, heat, and inner air, and some of the greenhouse elements from the outer side. Building a reliable model is a very difficult task as it needs to fulfill all the parameters, mathematical functions, and transformation functions. When we build a model with ANN's, we can see a great capability for mapping all the non – linear functions to generate numerous production process systems. To build a model, we have to design the system's network like humidity and air temperature of the greenhouses that are contemplated as outputs; this is caused due to some facts. To a model, the toughest thing is to set an input to better understand the system. To avoid wild extrapolations, it is not appropriate to contemplate numerous inputs to the system to avoid all the problems; instead, we can increase the estimation power. To consider an input variable to the system following contemplation needs to be followed: 1. Input and output physical dependence nature, 2. Correlation between both inputs and outputs, 3. Variable range of input.

B. *Other Models of ANNs for Prediction of Microclimate in Greenhouses*

Lagged values are used for a measurable signal as an input vector in Neural Networks. The network consists of long-range predicted values, which doesn't guarantee optimal results. The structure of the network comprises M.L.P. Still, due to these lagged values, we suggest having more non-regressive entries compared to autoregressive entries. Intelligent control schemes are based on NNARX to control all the humidity and temperature of a greenhouse system. Here they suggested control schemes as follows: Non-linear Autoregressive Mobile Average Controller, in short, it is called as NARMA-L2 and Neural Predictive Controller, in short, it is called as N.P.C. By using intelligent control schemes result produces good monitoring of the setpoint and rejection capabilities of both humidity and temperature simulation.

IV. ANNs in Energy Optimization of Greenhouses

Energy optimization is one of the greenhouse system problems, mainly in a ventilation system, control elements, and heating. In this optimal control strategy, the main part is based upon calculating and mathematical models of energy consumption, and there are several methods to reduce total energy consumptions. Consider an example of a state energy balance model. This method is not new to this greenhouse system, and it doesn't use any real-time energy optimization. This technique is implemented with all the satisfactory technologies like Photovoltaic. To predict the performance of the system and establish a better system to microclimate collectors are used. Moreover, other greenhouse systems that optimize energy consumptions must evaluate whether the heating is needed or not before the implementation. This process can be done through energy transfer models and mass flow. Currently, to predict heating requirements, these models are developed and made successful in resolving different issues like energy requirements based upon the parameters of the system inside the greenhouse, such as the thermal properties of the crop, construction materials, and physical. In addition to this, energy-saving models and system performance models are proposed. Some other types of models like particle swarm optimization, G.A. also generated good outputs like Neural Networks. Energy consumption is largely derived from temperature, humidity control elements of the system. One advanced forecasted method for greenhouses' energy consumption from M.L.P. is also differentiated between the ANN and non-linear regression models. The conventional model results imply forecasted power of a network is better compared to the regression model with appropriate accuracy of 95%. Architecture is being cascaded for the structure of this model's network inputs: time, humidity, temperature, and electrical consumption are considered the output variable. Many M.L.P. models are tested among those hidden layers was the only one with many neurons.

One more important topic of interest is energy production in the greenhouse. The same as energy production optimization and energy management are also topics. P.V. is one of the practical options in the task. P.V.s are developed for a greenhouse where ANN's utilization is mainly focused on the greenhouse system. The networks are trained through feed-forward L.M. algorithms. Input variables that are contemplated were humidity, wind speed, radiation, wind direction, ambient temperature. Only PV energy production was contemplated as output variables. One hundred forty neurons were contemplated in the network of the hidden layer, and these neurons were tested 1 sec predict error for the primary production of electricity beneath 20W.

Utilizing the amount of energy as a basic parameter and used ANN's to predict greenhouse production. One who has gone through the M.L.P. network and forecasted greenhouse tomato production. Inputs used for this suggested system are human energy, machinery, chemical fertilizers, electricity, energy equivalence of chemical products, and irrigation water. This architecture is comprised of 10 neurons and seven inputs for two hidden layers and one output. The hyperbolic tangent transfer function is utilized for the hidden layer. A linear transfer function is utilized for the output layer. For the input layer, a transfer function is not utilized. From the results, it is disclosed that diesel fuel, chemical fertilizers, electricity, and human energy consumed most of the energy in 40%, 30%, 12%, and 10%, respectively. The differentiation between M.L.R., abbreviated as Multi Linear Regression Model and Artificial Neural Networks, shows that ANN's output is best compared to the M.L.R. model. By reducing the energy consumption of greenhouses development of new strategies control which influence cost is developed. Control of the system seems to be overestimated for the potential energy-saving control. Strategies that control climate have been developed for energy saving from the analysis of roofing materials of greenhouse and evaluated the effect of energy consumption by using thermal screens. In the same way, an investigation has been done on the crop when applying all these techniques for energy saving [22]–[25]

V. ANNs OTHER APPLICATIONS IN GREENHOUSE

In greenhouses, there will be many applications to perform different tasks. They can model both non-linear and complex Artificial Neural Networks, where greenhouses are utilized to predict the microclimate of the environment where most of the study is focused. The behavior of the system is predicted by considering variables like humidity and internal temperature. The proper functioning of greenhouses is considered by other elements like CO2, which enriches the hot climate. Neural Networks develop the concentration of CO2, and the prediction of temperature is concentrated separately using the B.P. algorithm. The linear and activation functions are performed accordingly by choosing a hidden layer for the activation function, and the output layer linear function was used. As the Neural Network becomes complex for the greenhouse system, Neural networks' size reduction can be made using Multiple Input and Multiple Output (MIMO). Data is well fitted for the opted model and also generated reliable optimization results. The effect of evaporation is demonstrated by cooling the period of CO2 enrichment. Photosynthetic efficiency and crop growth are also related to the concentration of CO2 by considering all the environmental factors. These all are performed on Artificial Neural Network. The system's architecture is designed to consist of a feed-forward network with both ten input layers and two hidden layers, respectively. Input variables of the system are internal relative humidity, internal temperature, internal atmospheric pressure, external temperature, photosynthetic photon flow density, external atmospheric pressure, external temperature, wind speed, external atmospheric pressure, and wind direction output variable of the system is CO2. Throughout the layers, a transfer function is used. 0.97 of the coefficient was resulted by using prediction of CO2 concentration. Artificial Neural Network needs to be trained accordingly to all possible situations and measurable sites to obtain a unique output with limited data.

VI. PERSPECTIVE: APPLICATIONS OF ARTIFICIAL NEURAL NETWORKS

A. ANN's and Agriculture 4.0

As there is much advancement in technology, so in this modern technology, there is advancement in farming. Hence, farmers need to update modern technology and adapt to those new technologies and try those in farming. As of now, farming has gone through 4 stages, starting with the use of animal force farming is used to be done this is agriculture 1.0, in agriculture 2.0 engines are used to do farming, in agriculture 3.0 used precision agriculture and G.P.S. systems to do farming, in agriculture 4.0 they have come across through connecting to the cloud. Agriculture 4.0 is an encapsulation of technologies where A.I., IoT, cloud computing P.A., and many others here the system is connected directly to the cloud and automate the system based upon the environment crop production done. The system is driven by using P.A. and IoT for data management. P.A. is used to manage both temporal and spatial variations in fields concerning plants, soil, and atmosphere, and communication technologies. Some fields will be poor in crop production. To overcome that problem, this system is invented for good crop production based on different management, allowing auto-tuning of the crop based on the climatic changes and crop management system. This agriculture 4.0 uses devices like sensors to transmute element action, which has been involved in agriculture. Valuable information can be generated by using this agriculture 4.0 as this is based upon IoT technologies. Agriculture 4.0 has come across different names like digital agriculture, which plays an important role in agriculture 4.0. the main of this 4.0 is to concentrate on agriculture's main objectives like saving water, increasing crop production, and limiting the emission of carbon into the air, soil conversion [7]–[9].

IoT and PA: P.A. encapsulates all the new technologies, consisting of crop management that tries to optimize the type based on the crop and input quantity in real needs for a small area within the agriculture field. These crop inputs will be more effective as this is based upon the real needs encompassing tillage, fertilizers, pesticides, and irrigation water.

P.A. comprises five elements: decision support, variable rate treatment, G.P.S., information gathering, and performance mapping. To monitor the results for all the different inputs provided, this mapping is used by comparing the previous crops' outputs. We need to consider large data to compare all the values to generate an accurate output. A huge amount of data will be produced by different mapping factors of crops, soils. The farmer will be overloaded will this huge data, so they need a support system to monitor all the data and their model according to the climate. As we need to monitor huge data, they require a depth analysis to control the environment. S.A. widens the concept of P.A. as we need to make perfect decision management of the situation. Real-time resource assistance is required to monitor what can be done using IoT devices. IoT devices are encapsulated with many sensors to address many schemes as it is connected over the internet and generates an alert like pests, detection of weeds, warnings, monitoring of soil, etc., [19], [22].

Smart Farming: In the agriculture world, Both PA and S.A. play a vital role in current advancement. To enlarge both quality and quantity of production S.A. is used as it utilizes the concept of modern technology, accessing G.P.S., data management, soil scanning, and many IoT technologies. Manual farming is cost-effective compared to smart farming, so smart farming is utilized to control and monitor the crop-based upon the weather condition. Various sensors are utilized for effective crop production, and evaluation is done based upon the cloud. There are many advantages to smart farming as the data can be obtained from sensors. These sensors can be controlled, and network management can be done via LAN. In manual or traditional agriculture, the farming is done by farmers, and there is no assurance for the accuracy of parameters like humidity, lighting, and temperature. In a smart greenhouse, we can have many sensors based upon the system model and requirement so that data that is collected via sensors can be communicated to the operator. By using this smart greenhouse system, we can get the accurate output. Generated information can be utilized to design a model based on the greenhouse behavior and parameters, and this can be redesigned based upon the capacity. Fig.3. shows greenhouse agriculture 4.0.

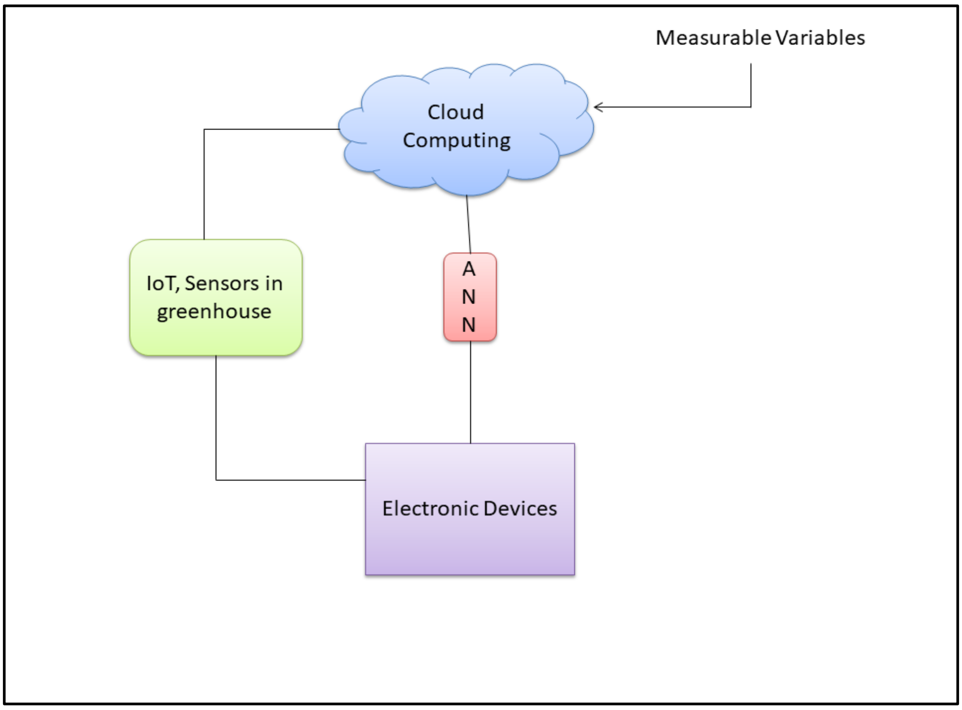

Fig 3. Greenhouse agriculture 4.0

B. *ANN's Learning Algorithm*

Depending on various factors, algorithms are trained to gain more influence on the efficiency of Neural Networks. Network to Network nodes and hidden layers will be varied according to the model, so efficiency varies for each node in each network. Parameters for BFGS and G.D.M. are as follows: Performance of BFGS is better than G.D.M. network 0.0022 internal temperature, 0.0034 internal humidity and 0.1877 internal temperature, and 0.1143 humidity for G.D.M. network. L.M. algorithm has an advantage in testing both online or offline methods like Resource Allocating Networks, orthogonal Least Square, and many others. Accurate results are obtained both online or offline via L.M. methods contrasted to adaptive and hybrid methods. The mean square value for the offline method was 0.0108 with a hidden layer composed of 8 neurons, and the online method was 0.0072 with the same architecture model.

C. *GreenHouse Microclimate prediction and ANN's database*

Neural Network proper functioning requires a hugely applicable database. This paper describes many models where these artificial neural networks are appealed to predict the greenhouse system's microclimate, and optimization of the network is connected to its structure and type. As training data is required for a model, data collection is one of the key points that takes equal importance for a system for the effective output. In every database, there will be three common phases like testing, training, and validation. These phases are needed to be considered in every neural network. The Balck box model requires a huge amount of data in ANN's. Optional amount in a black-box model is a trial and error method that choose hidden layer and neurons. As we consider a huge amount of data to generate an accurate output but this leads to an affected process by less efficiency. Some techniques are applied to the model with huge data that can be simplified and optimize N.N.'s training process. The period of 12 months database is an ideal one for ANN to predict the greenhouse neural network, which has a huge amount of data. A model within 29 days, 22 days of a training phase, and seven days of the test phase have been chosen. A model with three days has been considered phases divided as 15% for validation, 15% for testing, and 70% for training the network. Based upon the model and requirements, the period is considered to produce an accurate output [4]. Fig.4. shows Greenhouse microclimate prediction in Artificial Neural Network

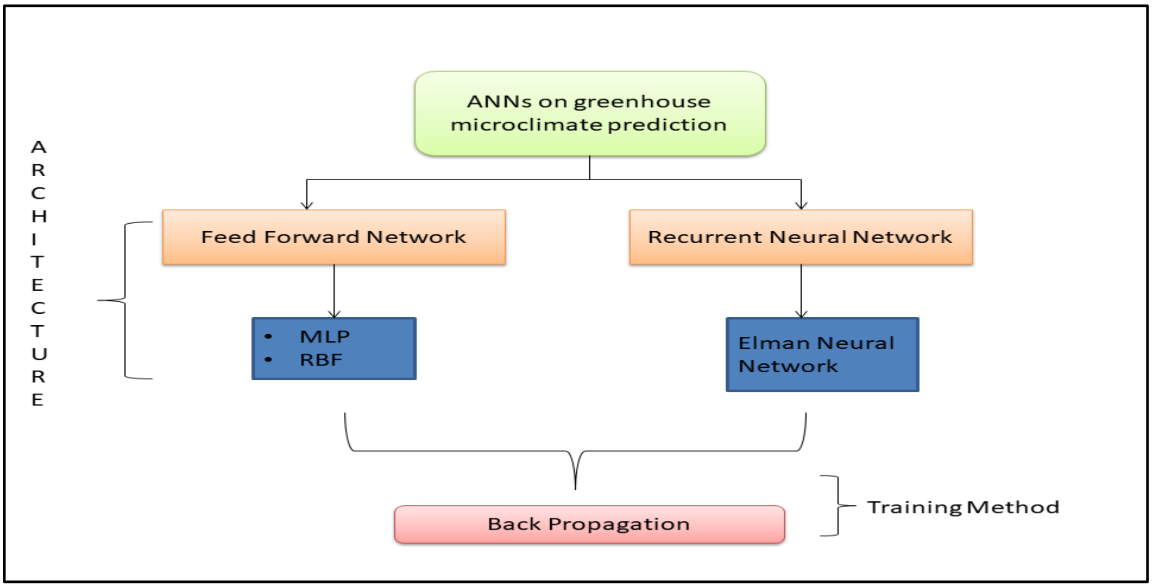

Fig 4. Greenhouse microclimate prediction in Artificial Neural Network

D. *Artificial Intelligence*

A.I. provides a specific solution for all the complex problem methods built up with branches like particle swarm optimization, genetic algorithms ANN's hybrid model, and simulation. This contains the mapping between both input and outputs for a process in a non-linear behavior. To solve all the difficult tasks, A.I. contains many tools that require human intelligence, with functions like recognition, perception, decision making, and a combination of brain science and related fields like psychology and cognitive science. To control greenhouse microclimate, A.I. permits the prediction of thermal properties of biomass tools which have proven ANN's to develop biomass energy prediction. N.N.'s are used flexibly to accommodate all the non-physical and non-linear data to reduce the risk of extrapolation. A.I. employs different algorithm and mathematical approaches from ML, operational research restricted programming, and DL. For more depth in modeling, DL widens on ML. Feature learning is one of A.I.'s advantages, where it extracts features automatically from the available raw data and quick resolution of complex problems. DL is composed of various components like grouping layers, convolutions, gates, memory cells, encoding or decoding schemes, and connected layers, dependent on the network's architecture [12], [13].

VII. RESULTS AND CONCLUSION

In this research, many ANN applications are represented for the prediction of microclimate in greenhouse and optimization. ANN's potential will be discussed can be in future research. Physical models designed for predicting microclimate are good plans to feed Neural Networks as the model will tune accordingly to generate accurate output by using the agriculture 4.0 method by solving all the problems. Seigner and linker proposed two configurations, one in parallel and the other in series. Here we haven't used serial configuration as it utilizes the conjunction with tools like P.C.A. that optimizes the selection process of data for a neural network. Hybrid networks are enlarged, and parallel and serial configurations are utilized for the conjunctions by optimizing algorithms like PSO, GA, and many others. W.S.N. utilization is a part of S.A. in the greenhouse that has an advantage of climate control of greenhouse and data collection and device type energy utilization. ANN in W.S.N. of the greenhouse is one of the attentive topics to flourish. On the other hand, there are automatic reprogramming and forecast variables collected using a sensor network.

Disease identification and pests in a greenhouse can be made through image analysis where R.N.N.'s are compared with FFNN's. CNN and DL tools are used, which ease all the tasks. By using the analysis of thermographic images and CNN forecast of microclimate were very attentive to apply. CNN's study of growth and transpiration of crops theme would be worth developing the models. In traditional methods, the process is done through manual farming and mathematical challenges, but CNN's would simplify all the problems with thermal analysis and morphology. Integration and exchange of information will be done in agriculture 4.0 as the system will be encapsulated with many sensors to perform the work based upon the requirement. Based upon the requirement, and crop greenhouse system will be developed. For different crops, different greenhouses need to be designed. As the system will function continuously, then data can be accessed at any time from the sensors. For every greenhouses system, reliable data is required as the system will be trained based on reliable data. Suppose there are many crops in a specific area. In that case, different greenhouse systems need to designed though every crop has a similar greenhouse system due to outside climate there may be some changes. Hence, we need to use synthetic data to overcome these variations. To detect plagues and diseases in crops, W.S.N. will be trained so that the trained data greenhouse can predict those and take necessary measures.

In this paper, we have represented different studies of Artificial Neural Networks in the greenhouse system. The architecture of a greenhouse system mainly focuses on microclimate prediction and variations, so it uses a feed-forward network. To design a greenhouse system, we need to explore and research architecture and many training methods. After the research, we need to compare all the advantages and disadvantages and compare those with the feed-forward network. Greenhouse systems need to use the latest technologies like ML, DL, and many more, to ease production under the greenhouse system. To reduce the calculation time and data management, we need optimization techniques for training the greenhouse system.

The utilization of statistical tools like Principal Component Analysis is feasible. Some of the application methods which have complex architecture like R.N.N. should be considered in the same manner. There will be some physical methods that cannot be studied where ANN will spend few minutes analyzing and concluding an indoor climate forecast. A hybrid network that combines physical methods and ANNwill also allows for better prediction of microclimate, but the network needs to be studied prior. Like CNN's other applicational methods of Neural Networks in the greenhouse also evaluate and predict diseases and plague in crops by using trending technologies like image analysis. Compared to traditional methods, the prediction of microclimate is very easy with these technologies as a huge amount of information can be handled by these methods. ANN methods used to predict the P.H., nitrogen, depth, and temperature from crops like cotton, sugarcane, soybean, corn, groundnut, rice, wheat. The significant results are plotted and shown in Fig.5.

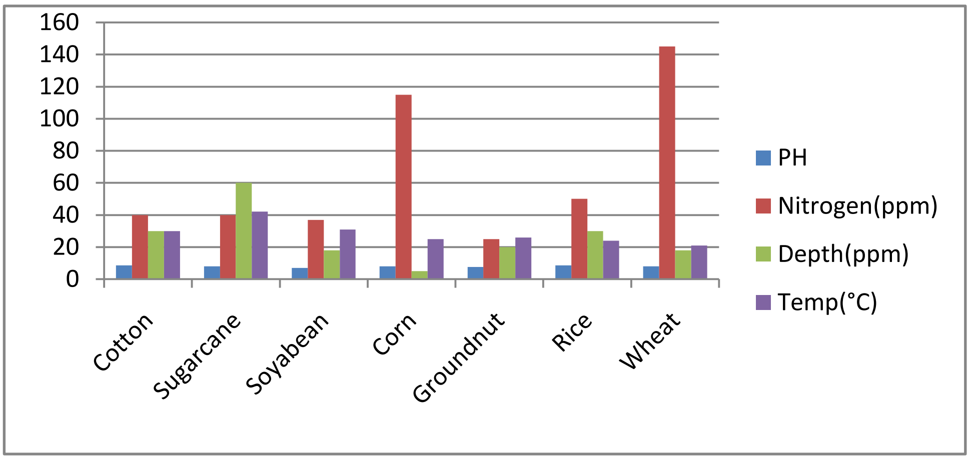

Fig 5. Crop based analysis

In the future, a major guideline for work is the exchange and integration of particulars using 4.0 technologies, Artificial Neural Network's role is to develop models that are used to predict an advantage of a particular generated and managing that information.

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