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Future of Precision Agriculture in India using Machine learning and Artificial Intelligence

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Abstract- The changes in weather and climate conditions have always affected crop cultivation, farming and animal breeding. Measures put in place sometimes fail. Information and cognitive technologies are innovative techniques that can be leveraged to combat these changes by applying precision agriculture. In this paper discussion is on future of precision agriculture which has been proven to work in other countries using machine learning & artificial intelligence. The scope of utilization is focused on medium and large scale farmers with an aim to point out the advantages and disadvantages of the techniques. Previously there has been a slow growth in this sector but from the year 2016 onwards many start ups have been emerging which are yielding high investments. These cognitive technologies have been applied in advanced countries and have resulted in increased yield, growth in GDP, low mortality rates and improved living standards. The same can be applied locally to boost production in the agricultural sector.

Keywords*:* precision agriculture, Artificial intelligence, Machine learning, promising solutions.

I. INTRODUCTION

Agriculture in India is the major source of livelihood for two-thirds of the entire population India, Service and private sector account for the rest. Agricultural land occupies approximately 43% of India's geographical land cover. In the earlier days, India was largely dependent upon food imports but over the years through research, the country has achieved self-sufficiency in grain and seed production. Concerted efforts have been made to be self-sufficient in the food production and this endeavor has lead to the formation of the Green Revolution [1]. Through the green revolution the following achievements have been obtained:

- Acquiring more land for cultivation.
- Expansion of irrigation schemes.
- Adoption of advanced high-yielding seeds.
- Application of better water management techniques.
- Plant protection activities through prudent use of fertilizers, pesticides and crop applications.

The above achievements in turn have led to an impressive rise in wheat and rice production. Considering the quantum rise, a national Pulse Development Programme that covered almost 13 states was set up in 1986 with the aim to introduce the improved technologies for farmers. A nationwide Technology task force was unveiled in 1986 after the success of National pulse Development Programme to improve the oil and seeds sector in India's thrift. Pulses too came under this programme. This trend has continued till date and improvements have been witnessed continually. According to [2] Precision farming or precision agriculture refers to performing the right thing, in the right way, in the right place and at the right time. Precision farming is meant to match agricultural practices as per agro-climatic conditions in order to increase the accuracy of application**.** In the last 40 years farming land has shrunk a little but the number of farmers had just doubled. As per Agricultural Census of 2010–11[3], the total number of operational holdings (individual farmers) was estimated as 138.35 million and the total operated area was 159.59 million hectare. The average size of holding had been estimated to be 1.15 hectare. It simply meant that one farmer was having 1.15 hectare of land to grow the crops. Out of these statistics Rajasthan was estimated as having 6888 million hectare number of operational holding and 21136 million hectare of total operated area. The average size of holding was estimated to be 3.07 hectare. This means that there is a huge scope to create a balance between the available lands versus the land under cultivation. To make this viable, precision agriculture offers an opportunity venture into this type of farming for its sustainability.

II METHODOLOGY

The methodology of research focuses on the recent technologies that can be leveraged in order to provide a suitable alternative for current methods in agriculture. The study is divided into 3 sections. Section 1 deals with machine learning and precision agriculture, section 2 deals with results and conclusion, section 3 deals with conclusion and future scope.

i. Machine learning cognitive technology

According to [4] Machine Learning is the branch of artificial intelligence and computer science which deals with the creation of algorithms that exhibit self-learning property. With the aid of machine learning accurate and efficient systems capable of evaluating a much wider set of tasks are developed to solve the day to day tasks. Scientists can use computer simulations to conduct early crop tests to evaluate how a certain variety may perform when faced with different sub climates, soil types, weather patterns and other factors. This digital testing does not replace physical field trials, but allows plant breeders more accurately predict the performance of crops.

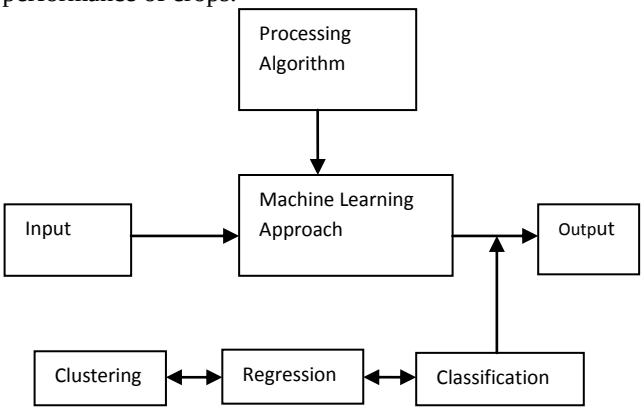

Fig1. *Machine learning data processing diagram*

Information about the crop variety to be tested is used as input and passed through a machine learning approach that supervised or unsupervised such as convolution neural network CNN, Bayesian network, support vector machine etc. The approach analyses the input to extract the relevant features and information related to the problem subject. Based on the variables and functions set, the processing algorithm performing the data analysis and provides a feasible output that is classified, or regressed.

ii. Impact of Precision Agriculture

Applying cognitive technologies in agriculture could help in determining the best crop choice for different climatic conditions and better suited to farmers' needs [7]. This can be achieved by analyzing and comparing information about seeds types, weather, types of soil, infestations in a certain area, probability of diseases and data about what worked best, year by year outcomes, current market trends, prices and consumer needs. Farmers can then make decisions on how to maximize return on crops. The pace at which the machine learning technology is developing it would appear that the farming industry is on the cusp of a technological revolution under Artificial intelligence as its driving force.

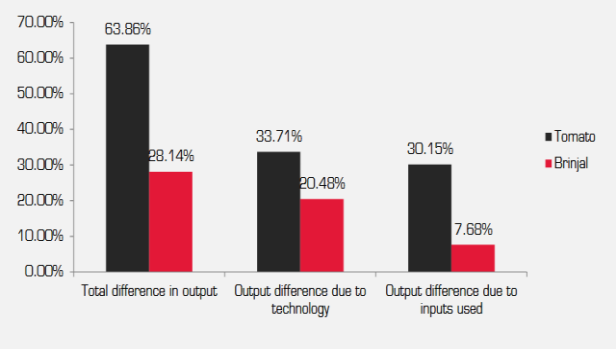

Fig:2 *Tomato and Brinjal productivity comparison using precision and imprecision farming*.

iii. Machine learning technologies for precision farming

a. Chat bots for farmers

Chat bots are conversational virtual assistant which automate interactions with end users. In agriculture chat bots are used for communication between farmers, government stakeholders, manufacturers and markets. While still in its early days chat bots were used mostly by retail, travel, media or insurance agencies. Agriculture could also leverage this emerging technology by assisting farmers with answers to their questions, giving advice and recommendations on specific farm problems [4]. The innovative mode will provide timely and interactive monitoring of the crops remotely.

b. Drones and unmanned aerial vehicles

Unmanned aerial vehicles UAV capture images and collect data about a particular scene. The use of UAV leads to low cost of operation and wide environmental monitoring. Providing new ways of increasing crop yields through in-depth analysis, long-distance crop spraying and high-efficiency will enhance the level of productivity. Technologies in drones are quickly gaining trust among farmers. Practical applications for drone technology are constantly advancing therefore it is likely that drone-powered solutions will be on the notch over the next few years.

c. Driverless Tractors

Robotic agriculture is an anticipated future yet to be fully implemented in the next 10-15 years. Driverless tractors perform all the farm practices autonomously. They are fixed with sensors that are able to perform the required practices, monitor obstacles and understand where to apply the farm inputs [6]. Driverless vehicle technology has been the adaptation across a wide array of technological firms. Agriculture is now combining off- shelf technologies such as GPS systems, radars and sensors. This sophistication in software and machinery are creating new avenues of enterprising farming and farmers will reduce pressures on an already strained workforce and allow for more acreage to be worked on for longer time periods.

d. Automated irrigation systems

As farmers know, traditional irrigation management is an arduous task. Applying automated irrigation systems coupled with a heavy reliance on historical weather conditions will predict required resources. Thankfully automated irrigation systems are designed to utilize real time machine learning to constantly maintain desired soil conditions in order to increase average yields. Not only does this reduce the labor significantly but also provide the potential to drive down productions costs. Given that agriculture utilizes about 70% of the worlds freshwater, the ability to be conscious on how it's managed would be a big impact on saving water towers and reservoirs

e. Crop health monitoring

Traditional crop health monitoring techniques are extremely time consuming and mostly categorical. Companies in the race hyper spectral imaging and 3D laser scanning are predominantly increasing their precision and accuracy with the volume of data that gets collected. According to [5] crop protection can be improved by providing an alert based system that utilizes the deep learning technique of machine learning.

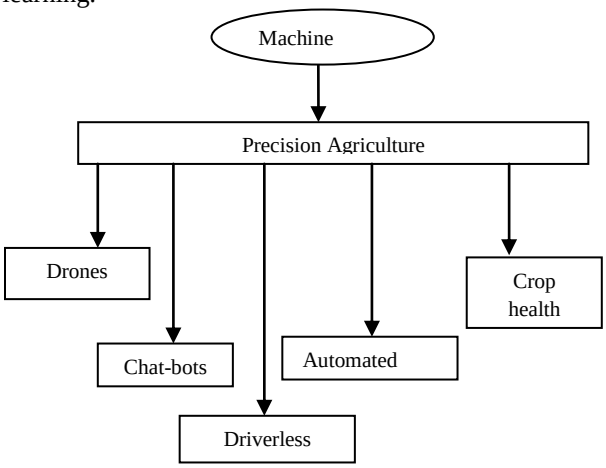

Fig 3: *Solutions to Precision agriculture*

iv. Indian Agriculture and scope for Artificial intelligence

The sole driver and promotion of AI and its cognitive implications across industries, has not been just to reduce manual activities significantly, but progressively and accurately predict for future outcomes. Agriculture in the last decade has been limited by penetration of technology driven business, the onset of AI has allowed an opportunity to solve challenges like climate change and global warming. This milestone has helped to cope up with the increasing amount of complexity in modern farming. Farm Analytics driven by the cognitive ability of neural networks to run through large datasets, has become one of the high drive for efficiency and research driven applications.. While the development of AI algorithms can be a challenging task in an agricultural setting, the advent of big data and sector specific machine learning tools related to the sector can increase agriculture yields

The future of AI in farming is more important for a country like India, where more than 64% of the general population is still using direct agriculture while close to 75% still depends on the sector for their livelihood. Unlike the west, India's agricultural problems cannot be dealt with just advanced agritech solutions like plant breeding and yield multiplication as farming still remains largely scattered and unorganized.

v. Challenges of AI in Agricultural Sector in India

Although the use of AI is promising when it comes to farming, the development of AI algorithms can be challenging in agricultural setting. The initial and fundamental block requires large chunks of data, clean data to efficiently train the algorithms with significant amount of spatial data in agriculture. A greater amount of sufficient data is mostly available during the growing season which is once, making research cycles limited.

For India in particular, non-availability of data from remote areas and farmlands that don't meet minimum hectare criteria during surveys are often left out, given the majority of our farmlands still remain fragmented, a mass dissertation or holistic data collection may be quite ambitious.

With the ever changing climatic conditions, there are unpredictable weather conditions in the soil texture. The unprecedented arrival of pests and diseases remains unknown even with enough protection measures in place. Farmers and growers may feel secured from all harvest and prepare for a bumper harvest but the uncertainties of nature are always in waiting

What may occur with the same seed and fertilizer in the United States may not be applicable in India. A few factors that could affect the variance would typically include the measurement of rain per unit of a crop planted, soil types, patterns of oil degradation, daylight hours, temperature and so forth. To address the problem of growers' concerns; the problem is no two environments will be exactly alike, which makes the testing, validation and successful rollout of such technologies much more laborious than most other industries.

III. RESULTS AND DISCUSSION

The above study was conducted and satisfactory results obtained. The statistical report obtained from the state of Rajasthan ministry of agriculture. It was observed than more than 50% of the total landscape is still unstructured. Use of human effort and mechanical tools to support agriculture are widely used. The comparison in growth rate of tomatoes and brinjals which are highly cultivated in this region showed the following margins.

Table1: Comparison table for farming with precision agriculture

Precision agriculture comparison table	Difference in output	Difference in ouput due to technology	Difference in output due to inputs
With P.A	63.86%	33.71%	30.15%
Without P.A	28.14%	20.48%	7.69%
Margin Difference	35.72%	13.23%	22.46%

Thus the above results obtained show that there is a big scope when precision agriculture can be applied to other vegetables and different crops.

IV. CONCLUSION AND FUTURE SCOPE

Precision agriculture still remains a wishful concept in many developing countries [7]. It is possible to achieve the above vision in India in order to improve the food security and per capita income of the farmers. The above mentioned challenges and promising solutions are prediction of future landscape of the Indian agriculture. Technological advancements and government initiatives to foster and promote precision agriculture through aids, reliefs, tax holidays and other incentives to farmers will greatly attract investment. This move will thus help deliberate efforts to protect the growth and sustainability of future generations yet to come.

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