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Artificial Intelligence use in Agriculture Sector for Sustainable Development.

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Abstract:

Agriculture sector plays a significant role in the economic sector. The automation in agriculture sector is the main concern and the emerging subject across the whole world. The population is continues increasing tremendously and with this increase the demand of food and employment is also increasing. The traditional methods which were used by the farmers in Agriculture sector, were not sufficient enough to fulfill these requirements. Thus, new automated methods were introduced. These new methods satisfied the food requirements and also provided employment opportunities to billions of people in society.

Artificial Intelligence (AI)in agriculture sector has brought an agriculture revolution. This technology has protected the crop yield from various factors like the climate changes, population growth, educational, employment issues and the food security problems. This main concern of this research paper is to audit the various applications of Artificial intelligence (AI) in agriculture sector such as for irrigation, weeding, spraying with the help of sensors and other means embedded in robots and drones. These technologies save the excess use of water, pesticides, herbicides, maintains the fertility of the soil, also helps in the efficient use of man power and elevate the productivity, profitability and improve the quality. This research paper surveys the work of many researchers to get a brief overview about the current implementation of automation in agriculture sector.

Keyword: Artificial Intelligence (AI) , Machine Learning (M.L), Natural Language Processing (NLP), Information and Communications Technology (ICT).

Introduction:

The young generation of rural India is mostly school or college dropouts and educationally backward because of different issues which lead highest unemployment ratio in rural India. Different factors like unemployability, unsatisfactory income, drought, and fewer educational or medical facilities lead to urban migration in India. This urbanization can be reduced by providing employability, and uplifting the socio-economics of the farmer by providing different money-generating sources apart from traditional farming. There are different challenges to the agricultural sector industry such as service quality, hurdles in providing the service, infrastructural scarcity, multilevel medium at regional levels, educational background of the farmers and, Government subsidies (Singh, 2016).

As Agriculture sector is a demanding sector in the future, there is a severe need to promote various practices among farmers to save agricultural land, increase the socio-economic status of farmers and reduce the urbanization among the rural youth.

Sustainability is one of the challenges of agriculture sector and specially of rural areas. To run the farming practices, it is necessary to identify the latest trends among Agriculture sector. Trends can be a development or change in the behavior of a customer. Social media is

having a gigantic impact on such trends. Emerging technology like machine learning and NLP can be used to find these farming practices trends by finding patterns in the data as well as extracting real- time data using scrapping techniques and providing an opportunity for farmers to explore and improve their experiences.

If an integrated decision support system is developed using advanced technologies like Artificial Intelligence (AI)**,** Machine Learning, and NLP will help in the overall planning and development of farmers. The motive of this study is to explore this area in detail and provide an integrated frame work for all the stakeholders.

Artificial Intelligence (AI) is a growing technology that enables computers to learn automatically from past data. With different mathematical algorithms, Machine Learning develops prediction models which predict output with the help of historical data. We can apply various Machine learning techniques for development and sustainability of the all farmers in agriculture sector.

Literature Review:

The literature review is essential for gaining an understanding of the existing research and explore a particular topic or area of study, and to present that knowledge. The databases such as Science Direct, IEEE Xplore, Springer, Google Scholar, and Research Gate were referred using Machine learning, predicting farming practices in agriculture produce, framework as keywords.

The integration of AI in agriculture has revolutionized farming practices, enabling more efficient and precise resource management that leads to increased crop yields while minimizing environmental impact. By utilizing data analytics and machine learning algorithms, farmers can make informed decisions on irrigation, pest control, and nutrient management, significantly reducing waste and promoting sustainable land use. Moreover, AI-driven solutions facilitate the development of innovative business models, such as vertical farming and precision agriculture, which not only enhance productivity but also foster resilience in food supply chains by adapting to climate change and fluctuating market demands (Rathod et al., 2024).

The use of AI in agriculture is revolutionizing the way farmers manage crops and livestock, leading to increased efficiency and sustainability. By employing advanced algorithms and machine learning techniques, AI can analyze large datasets from sensors and satellite imagery to provide insights on soil health, crop conditions, and weather patterns, enabling farmers to make data-driven decisions that optimize yields while minimizing environmental impact. Furthermore, AI-driven precision agriculture practices, such as automated irrigation systems and targeted pest control, help conserve resources and reduce chemical use, promoting more sustainable agricultural practices that are vital for addressing the challenges of food security and environmental sustainability in the face of a changing climate (Wavare et al., 2024).

The integration of artificial intelligence (AI) in agriculture is revolutionizing farming practices by enhancing productivity and sustainability. AI-driven technologies, such as precision farming tools and predictive analytics, allow farmers to optimize their crop yields by analyzing soil conditions, weather patterns, and pest infestations in real time. This not only helps in minimizing resource wastage but also boosts profitability. Additionally, the marketing opportunities arising from AI in agriculture are substantial; the ability to gather and analyze consumer data enables companies to tailor their products and services to meet the specific needs and preferences of their customers. By leveraging AI-driven marketing strategies, agribusinesses can improve supply chain efficiencies, enhance customer engagement, and create targeted advertising campaigns that resonate with health-conscious consumers seeking sustainable and

locally sourced food options. Ultimately, the synergy between AI technologies and agricultural practices presents a promising avenue for innovation and growth in the sector (Mengal & Pawar, 2024).

The integration of artificial intelligence (AI) in agriculture has revolutionized farming practices by enhancing productivity and sustainability through precision agriculture techniques. AI-driven technologies, such as predictive analytics and machine learning algorithms, enable farmers to make informed decisions regarding crop management, soil health, and pest control, ultimately leading to optimized resource usage and reduced environmental impact. Extension agencies play a crucial role in this transformation by disseminating information, providing training, and facilitating access to AI tools and resources, ensuring that farmers, especially smallholders, can leverage these innovations to improve their yields and livelihoods effectively. Through their efforts, extension agencies not only bridge the gap between technology and farmers but also promote best practices and foster community engagement, ultimately contributing to a more resilient agricultural sector (Pawar, 2023).

Objective:

1. To understand the different machine learning techniques used for growth of farmers.
2. To compare different machine learning techniques used in agriculture sector forecasting.
3. To identify influential attributes which are important for growth of in agriculture sector.

Research Methodology:

The data needs for research will be broadly classified into three categories. For the primary and secondary data is needed. Secondary data will be collected directly from the farmers. Primary data will be collected from social media, farmers as well as visitors of using different techniques like survey techniques, questionnaire and etc.

Potential of Artificial Intelligence (AI) in Indian Agriculture Sector:

Farm Crop Health Monitoring Systems: Artificial Intelligence (AI) can be access Remote sensing techniques, hyperspectral imaging and Artificial Intelligence (AI) build crop health monitoring systems that can monitor crop health from both time and effort perspectives. Artificial Intelligence (AI) facilitates identification of pests, diseases, and weeds problems and automates the management of these problems. Artificial Intelligence (AI) enabled agricultural production systems also predict future situations and issue advisories for sowing, pest control and commodity rate of pricing

Image-based Insight Generation Farming: Artificial Intelligence (AI) using the satellite and drone imagery real-time alerts can be generated in precision farming. These artificial intelligence systems not only save time but also increase safety and reduce potential human error while improving efficiency and effectiveness.

Agricultural Sector Growth driven by IoT: Artificial Intelligence (AI) and IoT can be used to create intelligent systems that can be embedded in machines to make it work with higher efficiency and with accuracy. These new technologies can be help in the spatial and temporal evaluation of individual plots or plants

Identification of Optimal Agronomic Product Mix: Artificial Intelligence (AI) helps to generate farm specific recommendations analyzing different parameters like soil health, weather forecast, type of seeds, water management and pest infestation in the area. Though the recommendation includes best choice of crops and technologies for a specific farm, it can be

further personalized based on the farm's requirements, local term and conditions, and past data on successful use in farming.

Smart Water Management Irrigation Systems: Artificial Intelligence (AI) use for Smart irrigation involves providing the right quantity of water at the right place at the right time for the right crop so as to improve crop yield. Using sensor based automated irrigation system issues associated with the low irrigation efficiency of Indian agriculture sector can be resolved to a greater extent. Also, automated irrigation system scheduling is possible using machines trained on historical weather patterns and soil quality of the locality along with the kind of crops to be grown.

Agriculture Sector Risk Management: Climate change issues such as increased temperature, erratic rainfall pattern and other associated problems have increased the importance of the Artificial Intelligence (AI) system in agriculture in recent years. Artificial Intelligence (AI) based technologies support to farmers in the management of risk and uncertainty in agriculture by facilitating the preparedness of farmers to handle the crisis efficiently.

Attract the Youth to Agriculture Sector: Decreasing agriculture sector labor force due to migration of youth to other jobs can be well addressed using Artificial Intelligence (AI) based agriculture. Artificial Intelligence (AI) based technologies will attract the tech-savvy youth, reduce drudgery and save natural resources and agriculture

Natural Language Processing (NLP) for Agri Consultancy: India is a multi-lingual society and majority of farmers are illiterate. A lot of content failed to reach the desired people due to lack of human-resource to convert it to the end-user's language. This gap can be effectively filled through natural language processing.

Challenges in the adoption of Artificial Intelligence (AI) in Indian Agriculture Sector:

Education and Technical Skill: All factors identified as inhibitors of Artificial Intelligence (AI) adoption include language barrier, high illiteracy rates, and the digital divide, lack of formal education, non-formal education, and informal education in data engineering, data analysis, data science and insufficient proficiency.

Detecting Pests and Diseases: Advanced computer and internet vision models can recognise specific patterns or symptoms of pests or diseases, helping farmers in agricultural produce take preventive and controlling measures to avoid damage.

Precision Farming: Artificial Intelligence (AI) can assist farmers in optimising resource usage, such as water, seeds, fertilisers, and pesticides, by analysing data on soil moisture levels, weather conditions, and plant health. This can lead to the implementation of precise irrigation schedules, targeted nutrient applications, and more effective pest control strategies.

Finance and Investment Management: Problems related to finance and investing are insufficient capital to invest in ICT devices and data infrastructures, fund deficiency for the maintenance of existing infrastructures, lack of public investments to bridge gaps in data engineering, data analysis, and data science education, low awareness and clarity regarding return on investment in Artificial Intelligence (AI) systems, and no financial assistance schemes for small farms to adopt and deploy ICT devices and embedded systems.

Predicting Crop Yield: Artificial intelligence (AI) has become an increasingly helpful tool for the farmers to improve crop yields and reduce waste. By analysing factors such as weather data, soil conditions, and crop types, Artificial Intelligence (AI) can aggregate and analyse vast information related to crop yields. With this data, Artificial Intelligence (AI) can develop predictive models that provide real-time information to farmers. This information can help them make informed decisions about plant timing, crop quantities, and care. Overall, Artificial

Intelligence (AI) has the potential to significantly improve the efficiency and productivity of farming while also reducing costs and environmental impact.

Information and Communications Technology and Data Infrastructure: Inhibiting factors related to ICT and data infrastructure include lack of supporting ICT and data infrastructure, data collection, transmission, storage, processing, cleaning, and analysis devices, missing historical data and insufficient digitization and labeling of data, deficient telecommunication networks and poor internet connectivity, low bandwidth and slow network performance, limited access to cloud-hosted data, irregular and erratic electricity supply, fragmentation of data and lack of data standards.

Culture and Society: Challenges were recognized and prioritized i.e., Risk-aversion and resistance to change, lack of Knowledge, lack of trust in technology, and insufficient support of universities in data digitization and digital agriculture sector.

Risk Management: By partnership with top financial institutions, aggrotech private companies can leverage Artificial Intelligence (AI) technology to suggest personalised crop insurance policies to farmers, protecting them against financial losses in crop failure.

Harvest Optimisation: Artificial Intelligence (AI) can predict the farmers a farm yields, helping farmers optimise harvest by planning labour, time, storage, and transportation

Policy: In comprehensive data governance and data rights regime, and lack of enforcement of data regulations, privacy, and transparency.

Conclusion:

The agricultural sector face various challenges such as lack of effective irrigation systems, weeds, issues with plant monitoring due to crop height and extreme weather conditions. But the performance can be increased with the aid of technology and thus these problems can be solved. It can be improved with different Artificial Intelligence (AI) driven techniques like remote sensors for soil moisture content detection and automated irrigation with the help of Artificial Intelligence (AI) and GPS.

In this research paper, the socio – economic knowledge about farmers agricultural sector relationship with the environment was studied, and environmental sustainability guidelines and indicators were adhered to. The study by present an indicator system to evaluate sustainable agricultural sector at the cultural destination. Measuring the sustainability of agricultural sector requires in-depth knowledge of existing systems, which is different for each location. The are main dimensions of sustainability political, social, economic, environmental and technological studied in the research paper.

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