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Harvesting Innovation: The AI Revolution in agriculture

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The United Nations data project a population of 9.8 billion by 2050 placing increasing pressure on existing agriculture 4.8 billion hectares land. According to the World Bank, 46% of the world's population and 70% of the world's poor live in rural areas, with agriculture as their main source of income and employment.

The agriculture sector is facing complex challenges to sustainably produce food but recent research conducted by NASSCOM and McKinsey in India's Agritech startup hub highlights the significant potential of AI technologies by analyzing 15 crucial agriculture datasets, ranging from soil health records to pest imagery, India stands to unlock a staggering $ 65 billion potential in its agricultural economy. This emphasizes the transformative role of AI in agriculture, providing actionable insights and driving innovation to revolutionize traditional farming practices.

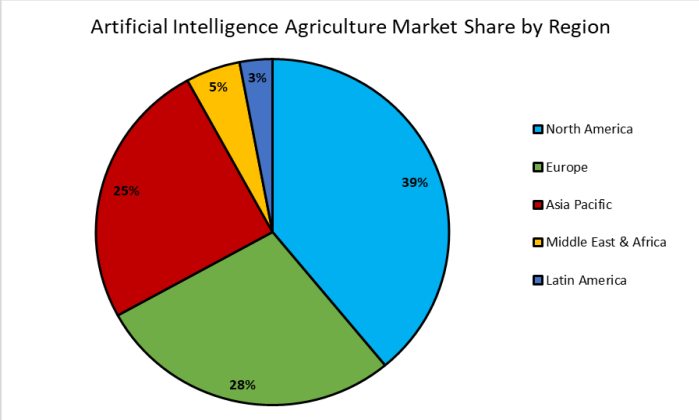

Fig. 1: Artificial Intelligence in Agriculture Market share by region in 2022.

(Source: Artificial Intelligence in agriculture market size, Report By 2032: Precedence Research)

Transforming Farming practices with AI

AI encourages farmers to make data-driven decisions, efficient resource usage, and adopting environmental friendly methods.

1. **Predicting crop yields:** AI make considerable analysis of vast amounts of historical data related to crop yields, with factors such as weather data, soil conditions, and crop types. This data holds potential for crafting predictive algorithms that furnish farmers with up-to-the-minute insights, enabling them to optimize planting schedules, crop quantities, and agricultural maintenance practices.
2. **Detecting pests and diseases:** The Food and Agriculture Organization of the United Nations (FAO) reported that up to 20to 40% of yearly global crop production is lost due to pests. Plant diseases cost the world economy over $220 billion and pests approximately $70 billion. AI technologies can be deployed as a promising solution to identify pests and diseases harmful crops. Advanced computer vision models, for instance, can recognize specific patterns or symptoms associated with different diseases or pests. Such insights can help farmers take preventive or control measures before significant damage occurs. The World Economic Forum has reported that AI integration in agriculture could bring about a 60% decrease in pesticides usage.
3. **Precision farming:** Site specific crop management can be achieved by analyzing data on soil moisture levels, weather conditions, and plant health, AI empowers farmers to optimize resource usage, including water, fertilizers, and pesticides. AI-generated algorithms can recommend precise irrigation schedules, targeted nutrient application, and pest control strategies.
4. **Harvest optimization:** AI algorithms that predict farm yields can assist farmers in optimizing their harvesting operations by effectively planning labor, storage, and transportation resources.
5. **Risk management:** Agritech companies in collaboration with leading financial

institutions can leverage AI to recommend crop insurance policies to farmers, safeguarding them from financial losses in the event of crop failure.

6. **Blockchain in Agriculture:** Block chain technology in agriculture involves using a digital record book that can't be changed and is spread across many computers. It keeps track of transactions, like when food is grown or sold, in a way that's open and hard to tamper with. This helps make sure the farming and food system is clear and can be traced easily. Blockchain technology is revolutionizing agriculture by enabling traceability initiatives like Walmart's Food Traceability Initiative and ensuring transparency in the coffee supply chain. Additionally, it's facilitating secure crop insurance and tracking seafood from boat to supermarket, all while providing consumers with confidence in the origin and quality of their food.

Different case studies of AI in farming

1. Smallholder farmers in Africa, particularly in Nigeria, face challenges related to over fertilization, soil degradation, and limited access to soil testing services. Traditional guesswork methods for assessing soil fertility lead to incorrect fertilizer application, contributing to environmental pollution, biodiversity loss, and decreased crop production. Limited access to affordable and timely soil testing services exacerbates these issues, as conventional laboratories are often located far from rural farming communities, expensive, time-consuming, and require professional expertise.

Implementing blockchain-integrated soil analysis solutions can address these challenges by providing smallholder farmers with accessible, affordable, and accurate soil testing services. Blockchain technology can facilitate the creation of a decentralized network of soil testing laboratories, allowing farmers to access testing services closer to their communities. Automated soil analysis systems powered by blockchain can provide rapid and cost-effective results, enabling farmers to make informed decisions about fertilizer application based on their soil's nutrient levels, pH, organic matter content, and moisture levels. By empowering farmers with actionable soil data, blockchain-integrated solutions promote sustainable farming practices, improve crop yields, protect soil and water quality, and contribute to environmental conservation efforts.

2. The World Economic Forum's Artificial Intelligence for Agriculture Innovation (AI4AI) initiative is revolutionizing India's agricultural transformation by driving the use of artificial intelligence (AI) and related technologies for agricultural advancements led by the Centre for the Fourth Industrial Revolution (C4IR) India. The 'Saagu Baagu' pilot, developed in partnership with Telangana state government, in its Khammam district, supported by the Bill and Melinda Gates Foundation and implemented by Digital Green has substantially improved the chili value chain for more than 7,000 farmers and increased 21% chili yields per acre which now aims to impact 5 lakh farmers encompassing five different crops.

3. The Government of India launched the Pradhan Mantri Fasal Bima Yojana (PMFBY) in 2016, aiming to provide comprehensive crop insurance cover nationwide to stabilize farmers' incomes. To improve the assessment of crop yields and streamline the process, the government adopted artificial intelligence (AI) and machine learning technologies, along with remote sensing imagery and modeling tools. Partnering with CropIn Technology Solutions, an AI company based in Bangalore, the government implemented SmartFarm, which captures farm details, crop information, and geo-tags for accountability and transparency. SmartRisk, another component, utilizes ground-level data and satellite imagery to identify suitable farm plots for experiments, ensuring accuracy and removing ambiguity from the selection process. This approach also helps estimate crop health, yield, and acreage at a district level.

Challenges and consideration

1. **Data availability: -** The basic data needed for machine learning application are sensor reading, weather reports and farm activity history and accumulation of these outdated data limits the

creation of predictive models with machine learning algorithms. The location of collected data also presents the challenge of global adoption of machine learning in agriculture. This problem can be overcome by using existing datasets collected by government agencies or universities.

2. **Infrastructure requirement**s: - Modern tech companies should account factors like power supply, internet connectivity and equipment availability for successful implementation of machine learning even in rural areas and developing countries.

3. **Cultural barriers**: - Majority of farming community includes small marginal farmers with old traditional practices, beliefs. This cultural lag creates challenge to sustain social balance between old beliefs and modern technology. ML based solutions should carefully consider their need for sustainable bio diversity and land productivity.

4. **Regulations**: - The current agriculture regulations or labor laws restricts the machine learning application use on the farm. There is need of proper legal framework for creating safe workplaces for employees.

Future outlook and opportunities

Looking ahead, the integration of technology into farming practices will continue to be a significant trend in India. The COVID-19 pandemic highlighted the importance of technological solutions in sustaining agricultural activities. Therefore, in the future, we can expect an increased adoption of online platforms and digital tools by farmers to enhance operational efficiency and expand market reach. This means that farmers will be able to sell their produce in new markets and directly connect with buyers, thereby improving their business prospects. Furthermore, small-scale farmers will benefit from these technological advancements, enabling them to compete more effectively in the agricultural sector. To facilitate this transition, policymakers need to ensure equitable access to technology and invest in the development of digital infrastructure. Additionally, farmers will increasingly rely on data-driven decision-making processes to optimize their farming strategies. To unlock the long-term potential of AI in agriculture, it is essential for the government to regulate more subsidies with insured payouts that fulfill farmers' needs, especially during drought-like conditions. This can be supported by education, trust, and fair pricing mechanisms. All these factors are crucial for leveraging AI in agriculture effectively and sustainably.

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