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ARTIFICIAL INTELLIGENCE

The Next Evolution

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CONTENT

THE VISION

The Power Of AI For Indian Agriculture

M C Dominic
Founder & Editor-in-Chief

Artificial Intelligence (AI) holds immense potential to transform Indian agriculture by optimizing resource utilization, enhancing productivity, and fostering sustainability. By harnessing the power of AI-driven solutions, India can address the challenges of food security, rural livelihoods, and environmental conservation, paving the way for a more prosperous and resilient agricultural sector.

AI is revolutionizing Indian agriculture by offering innovative solutions to age-old challenges, optimizing processes, and enhancing productivity across the agricultural value chain. With its potential to analyse vast amounts of data and provide actionable insights, AI is empowering farmers, agribusinesses, and policymakers to make informed decisions, ultimately leading to sustainable growth and food security.

One significant application of AI in Indian agriculture is predictive analytics for crop management. By harnessing historical and real-time data on weather patterns, soil quality, and crop health, AI-powered systems can forecast crop yields, detect diseases, and recommend precise interventions. This enables farmers to optimize resource allocation, minimize input costs, and maximize yields.

AI-driven precision farming techniques are gaining traction in India. Through the integration of technologies such as sensors, drones, and IoT devices, farmers can monitor field conditions with unprecedented accuracy. AI algorithms process this data to generate heat maps, identify areas requiring attention, and automate tasks like irrigation and fertilization. These precision farming methods not only improve crop quality and yield but also conserve resources and mitigate environmental impact, crucial considerations in India's agriculture-dependent economy.

AI is also revolutionizing supply chain management in Indian agriculture. By optimizing logistics, predicting market demand, and facilitating traceability, AI enhances transparency and efficiency throughout the distribution network.

Additionally, AI-powered technologies are driving innovation in agricultural research and development. From crop breeding and genetic engineering to disease detection and pest management, AI accelerates the pace of innovation, enabling scientists to develop resilient, high-yielding crop varieties suited to India's diverse agro-climatic conditions.

Millionaire Farmers of India Awards – Glamourizing Indian Agriculture

The Millionaire Farmers of India Awards stand as a beacon of recognition and celebration, illuminating the transformative potential and prosperity within Indian agriculture. In a landscape often overshadowed by urban-centric glamour, these awards bring much-deserved attention to the remarkable achievements and contributions of farmers who have not only excelled in their field but have also significantly impacted the agricultural sector.

By showcasing the success stories of millionaire farmers, these awards highlight the immense potential for prosperity and wealth creation within the agricultural domain. This recognition not only uplifts the morale of farmers across the country but also inspires the younger generation to perceive farming as a viable and lucrative career option.

The Millionaire Farmers of India Awards play a crucial role in reshaping societal perceptions about agriculture. They portray farming not merely as a subsistence activity but as a dynamic and profitable business venture capable of generating substantial wealth and driving economic growth. This shift in perception is essential for attracting investment, fostering innovation, and revitalizing rural economies.

These awards serve as a platform for knowledge sharing and exchange of best practices. Millionaire farmers, recognized for their exemplary performance, often become role models within their communities, sharing their expertise and insights to uplift fellow farmers. This dissemination of knowledge promotes adoption of modern agricultural practices, technology integration, and sustainable farming methods, thereby contributing to the overall development and modernization of Indian agriculture.

The Millionaire Farmers of India Awards not only celebrate individual success but also serve as a catalyst for transforming the agricultural landscape of the nation. By glamourizing Indian agriculture, these awards inspire a new generation of farmers, attract investment, and foster innovation, ultimately driving the sector towards greater prosperity, sustainability, and global competitiveness.

Shiny Dominic
Managing Director

AI in Agriculture - A Smart Tomorrow

The growing population and effect of climate change have put a huge responsibility on the agriculture sector to increase food-grain production and productivity. In most of the countries where expansion of cropland is next to impossible, agriculture automation has become the only option and is the need of the hour.

Internet of things and Artificial intelligence has already started capitalizing across all the industries including agriculture. Advancement in these digital technologies has made revolutionary changes in agriculture by providing smart systems that can monitor, control, and visualize various farm operations in real-time and with comparable intelligence of human experts.

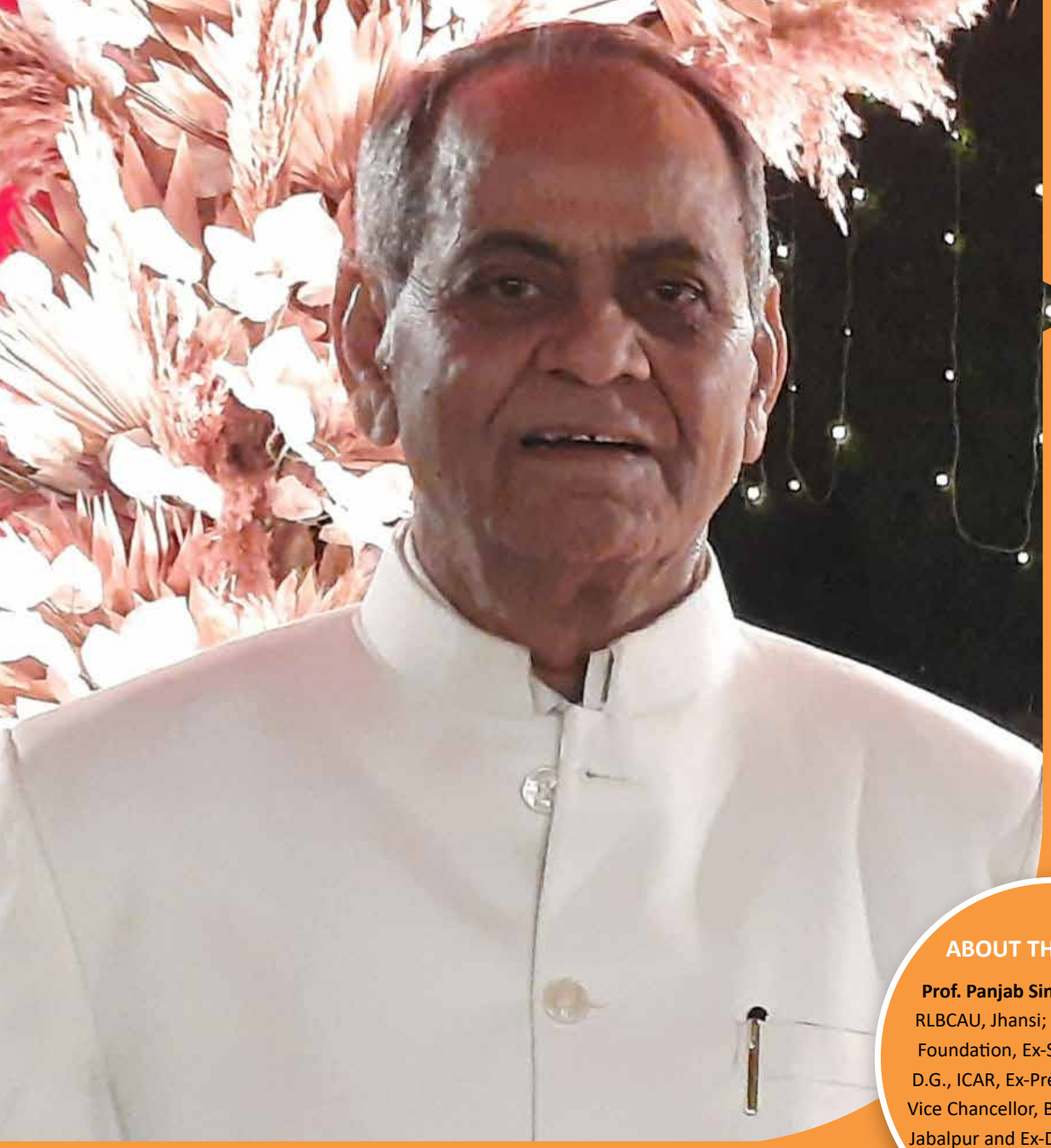
It has been observed that the digitization of agriculture using AI and IoT has matured from their nascent conceptual stage and reached the execution phase. The technical details of artificial intelligence, IoT, and challenges related to the adoption of these digital technologies are also discussed. This will help in understanding how digital technologies can be integrated into agricultural practices and pave the way for the implementation of AI and IoT based solutions in the farms for an Aatmnirbhar Krishi.

Artificial intelligence is revolutionizing agriculture by offering innovative solutions to various challenges faced by the industry. AI is making an impact in Precision Farming, Crop Monitoring and Management, Predictive Analytics, Weed and Pest Control, Labor Optimization, Supply Chain Management, Market Forecasting and Pricing.

Overall, AI holds great promise for the agriculture industry, offering solutions to enhance productivity, sustainability, and profitability while addressing the challenges of feeding a growing global population amidst climate change and resource constraints.

This edition of Agricultural World focuses on the potential applications of Internet of Things (IoT) and Artificial Intelligence (AI) in the development of smart farm machinery, irrigation systems, weed and pest control, fertilizer application, greenhouse cultivation, storage structures, drones for plant protection, crop health monitoring and several others. The main objective of this edition is to provide an overview of recent research in the area of digital technology-driven agriculture and identification of the most prominent applications.

Mamta Jain
Group Editor & CEO



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AI
The Immense Possibilities

> Our farmers need to be educated and trained in how to use AI powered solutions

With the global population projected to reach 9.7 billion by 2050, the pressure is mounting on the agricultural industry to produce more food while using fewer resources and reducing its environmental impact.

All this warrants for the use of innovative technology like AI in future agriculture to overcome the limitations of traditional farming.

AI-Powered Farming Solutions

AI is a set of technologies that is automated through programming. In essence an AI algorithm mimics the way people think. It learns first, and then solves problems based on data. AI defines human intelligence in such a way that a machine can easily capture it and can execute tasks which are simplest, as well as those that are even more complex. AI powered farming solutions enables a farmer to do more with less, enhancing the quality, also ensuring a quick go-to-market strategy for produce.

The modern world is all about data. AI powered predictive analytics can gather and process more data in less time and analyse and predict market demand, forecast prices as well as determine optimum time of sowing and harvesting. It can explore soil health to collect insight, monitor weather conditions and recommend the application of fertilizer and pesticides.

AI use can scanned images to find mold, rot, insects or other threats to crop health and alert farmers to act quickly in order to exterminate pests or isolate crops to prevent spread of diseases and can also identify or even predict crop diseases.

AI algorithms can analyze the chemical composition of soil samples to determine which nutrients may be lacking. In irrigation, AI can identify optimal nutrient application times, while predicting the optimal mix of agronomic products. It can be used in sorting harvested produce, risk management, plant breeding, soil and crop health analysis, crop feeding and many others.

The Power Of Data Utilization

By collecting data on plant growth, AI can help produce crops that are less prone to disease and better adapted to weather conditions. For farmers, more accessible and reliable data gives them an advantage.

As more data is entered into systems enabling machines to learn more, they become increasingly accurate, helping growers to assess how healthy crops are, how to save and retarget water, and pinpoint nutrient levels.

Artificial intelligence including robotics, drone technology and sensor networks can do a really good job collecting large amounts of complex data within the field. Farm management software boosts production together with profitability enabling farmer to make better decisions at every stage of crop cultivation process. These technologies can even automatically do a plant-by-plant assessment, thereby creating the possibility of a big revolution.

The Challenges

While AI could help farmers grow more crops with fewer resources, and make smarter decisions resulting in higher profitability and sustainable growth, like any other technology, it comes with its share of caveats and disadvantages.

The first challenge, especially in the Indian context, is the high cost of investment for small scale farmers who have limited resources. Alongside, the lack of technical expertise for operating and maintenance of these systems, resistance to change due to their educational levels, underexposure and lack of familiarity to such techniques and systems is another potential impediment.

The fear of potential job displacement cannot be dismissed aside easily either. Further, challenges of AI integration with farming practices, data privacy and security risks, and over reliance on AI predictions could be limitations in the use of AI technology.

Policy Directions

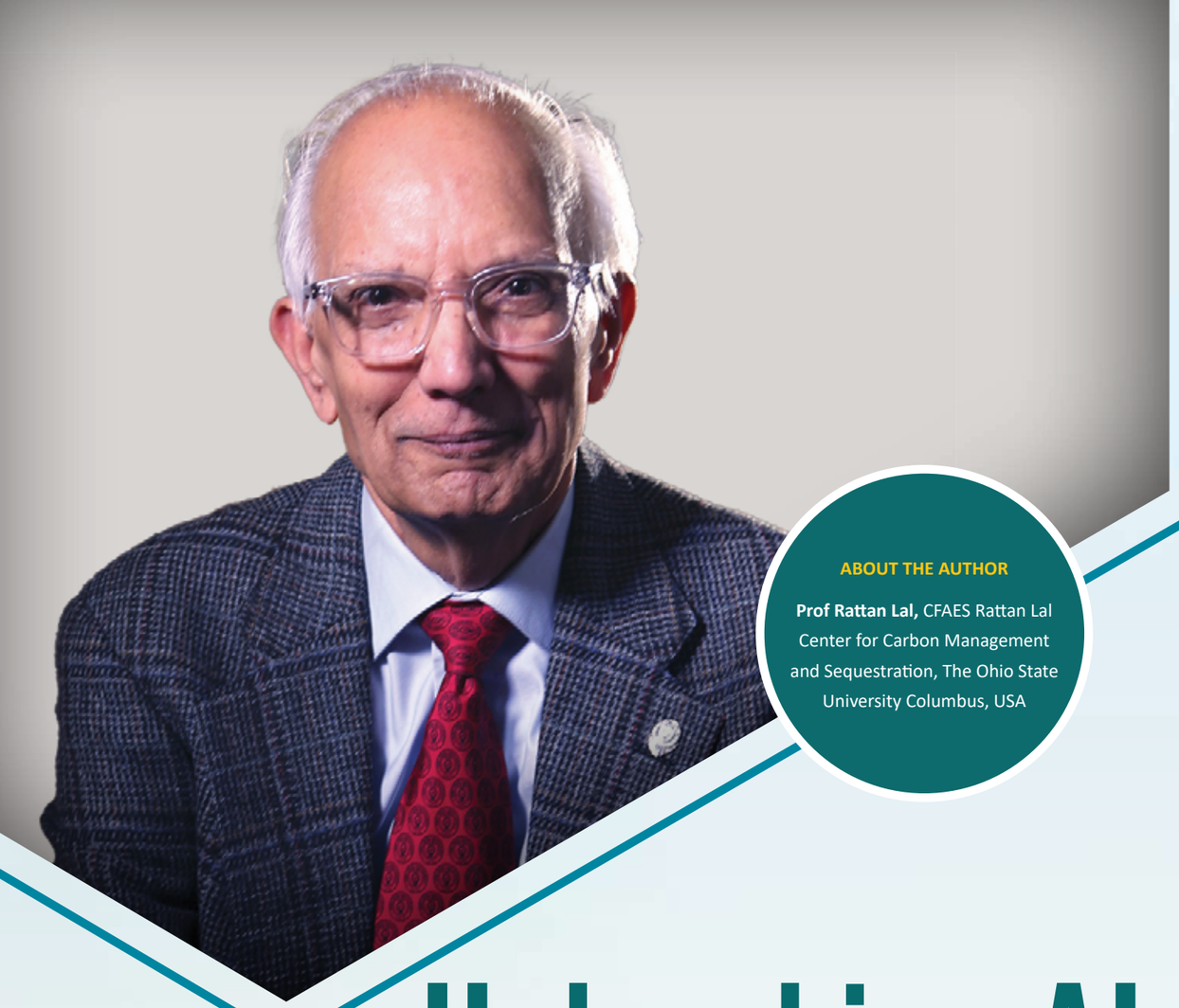
Whatever the challenges, the AI genie is upon us. AI in Agriculture will be part of our future. It would not only be difficult, but perhaps undesirable to stay away from it. The challenge however is to address concerns about AI and the issue of trust. We need to develop and adopt a framework, that is suitable for our context and our specificities, and not blindly follow solutions designed and sold by the West, that are often designed for their context. It is paramount to create transparency and trust. The framework would need an implementation strategy to put it into action.

This implies spending time to truly understand our user base, their context and their openness to using AI. To educate them about the approach and the value it delivers, to prioritize human-centered design to make complex systems usable. We need to build trust with the target audience for data piracy and protection, and design the digital system in such a way as to ensure its usability and accessibility by those who are technologists and also those who are not.

The government would need to pro-actively develop regulations to ensure only those technologies that are adopted that are not a threat. Interdisciplinary centres that have expertise in both AI and agriculture, and how they would interact would need to be established. Such bodies would need to advise the government.

At the brass tacks, our farmers would need to be educated and trained in how to use AI powered solutions. Public and private system and NGOs would need to step into this role – to not just provide resource and training, but first to inform, educate and motivate.

The fear that AI would reduce jobs, could create misinformation and bias, blur boundaries between reality and virtual reality, would need to be carefully understood and addressed. While some jobs are likely to be lost in agriculture, AI use would create the need for a fair number of engineers and code writers, data interpreters, machine operators and maintainers.



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Unleashing AI

Revolutionizing 21st Century Agriculture

> **Emerging challenges in agriculture will require innovative approaches in management of soil health to advance food, nutrition, and climate security**

The 20th century should be named "The Agricultural Century". Innovative technologies in agriculture broke the yield barrier, and increased the rate of global food production which exceeded that of the population growth. The greatest success story of agriculture in human history proved the Malthusian theory wrong. However , even bigger challenges lie ahead during the 21st century; especially those in protection, restoration and sustainable management of finite and precious natural resources of soil and water; and these must be effectively addressed. Thus, the focus of this article is to describe the historic evolution of seed-centric Green Revolution (GR) 1.0 and soil-centric Green Revolution 2.0, and enumerate the importance of artificial intelligence (AI) in up-scaling the soil-centric GR-2.0. The AI, considered the 4th Industrial Revolution (4IR), can be used to revolutionize agriculture of the 21st century while increasing productivity, improving ecoefficiency and reducing its environmental footprint.

The Seed-Centric Green Revolution 1.0

The term GR, drastic increase in agronomic yield of food crops by growing input-responsive dwarf varieties, was first used by W.S. Gaud (1968, en.wikipedia.org/wiki/green_revolution) because of notable developments in improving yield of wheat and corn since 1940s in Mexico (Cottier, 2003). Geographically and historically, GR occurred in several sequential or chronological stages. The first stage of GR1.0 occurred in Mexico, and it was brought about by development of dwarf varieties of wheat by an Iowa agronomist named Norman Borlaug who was appointed to conduct research in Mexico on food security by Henry Wallace, the then U.S. Secretary of Agriculture (Andrews, 2009). Norman Borlaug worked at The International Maize and Wheat Improvement Center (CIMMYT), which was established at El Batán, Mexico in 1943. Secretary Wallace was also the founder of the Pioneer Hi-Bred International seed company. Increase in agronomic yield of wheat and corn made Mexico food self-sufficient (Wellhausen, 1977). The second stage of the GR occurred through development of dwarf rice variety (IR-8) in the Philippines in 1966 at The International Rice Research Institute (IRRI). Increased grain yield of IR-8 was obtained through heavy inputs of fertilizers and pesticides in flooded rice paddies of the input-responsive dwarf ricer variety. The third stage of GR occurred in India when Dr. M.S. Swaminathan, working at The Indian Council of Agricultural Research (ICAR), invited Norman Borlaug to India and the visit led to importation of wheat seed from CIMMYT. The new variety of wheat from CIMMYT was grown on irrigated alluvial soils of Punjab, along with IR-8 from IRRI in the Philippines. A new high-yielding variety of rice developed from IR-8 in India was named IR-36 (De Datta et al., 1968). The third stage of GR occurred in China by development of hybrid rice by Yuan Longping who was considered the father of hybrid rice (Bradsher and Buckley, 2021). These three stages of seed-centric GR led to the 1970 Nobel Peace Prize awarded to Norman Borlaug.

The Soil-Centric Green Revolution 2.0

The Seed-Centric GR 1.0, which enhanced agronomic yield and saved hundreds of millions of people from starvation, was effective on alluvial and fertile soils of South, Southeastern and Northern Asia, and Central America because of the critical inputs of supplemental irrigation and energy-based inputs of fertilizers and pesticides. However, not only did the GR 1.0 bypass sub-Saharan Africa (SSA)

where irrigation was not available and resource-poor small land-holder farmers could not afford the use of agro-chemicals, but it was also not effective where the soils were prone to degradation by a range of processes (i.e., erosion by water and wind, drought and heat wave, nutrient depletion and elemental imbalance). Soil degradation was also aggravated by critically low level of soil organic matter (SOM) content because of the widespread use of extractive farming practices (i.e., removal of crop residues for other uses) based on mechanical soil disturbance and in-field burning of biomass for new land development and seedbed preparations. Research done at The International Institute of Tropical Agriculture (IITA), established in 1970 in Ibadan, Nigeria, documented that the severe problems of soil erosion by water could be addressed by no-till farming along with retention of crop residue mulch (Greenland, 1975; Lal, 1976), and integration of crops with perennial shrubs planted on the contour as alley cropping systems (Kang, et al., 1981; Lal, 1987). The long-term experiments also showed that restoration of SOM content was essential to protecting, restoring, and sustaining soil health (Lal, 2004).

Since the early 2000s, there has been a strong interest in adoption of no-till farming in soils of Latin America (Sá et al., 2001; Lal et al., 2006). Adoption of a system-based conservation agriculture (CA)and integration of crops with trees and livestock (Lal,2020a)are effective in restoring SOM content in soil, conserving soil and water (Lal, 2020b) while also improving and sustaining crop yield (Lal, 2020c). These developments led to the concept of carbon farming, or growing carbon in land (soil and vegetation) to specifically create another income stream for farmers (Lal, 2023a). These approaches of restoring soil health led identification/ development of farming systems which can also spare some land and water to nature (Lal, 2023b). Producing more from less is an important facet of the soil-centric GR 2.0.

Role of Artificial Intelligence in Promoting Soil-Centric Green Revolution 2.0

The soil-centric GR 2.0 is based on the premise of achieving high eco-efficiency of inputs, restoring soil health, sparing some land and water for nature, and yet producing high agronomic and livestock yield along with a high nutritional value (mico-nutrients, vitamins, etc.) of the farm produce. It is in this context that artificial intelligence (AI) can play a critical role in upscaling the innovations. The AI, with a wide range of applications in modern agriculture, includes practices such as application of Artificial Neural Networks (Kujawa and Niedbala, 2021), Machine Learning (Araújo et al., 2023), Digitalization or use of precision agriculture (Masram and Patkar, 2021), Internet of Things (IoT) and Wireless Sensor Networks or WSNs (Mowla et al., 2023) among other applications in sustainable agriculture (Sood et al., 2022), forestry (Nie et al., 2022), and crop management (Attri et al., 2023). IoT and modern

sensors have numerous applications including those in robotics and remote sensing used for characterization of weather conditions, soil health, crop monitoring etc. The use of robots for harvesting and weeding and employment of drones for monitoring soil and crops are among numerous applications of AI in agriculture (Ullo and Sinha, 2021). Satellite imageries are also used for efficient use of water resources in agriculture (da Cunha et al., 2023). Thus, AI is becoming a key element in addressing issues of food and climate security in China, U.S.A., India, and Australia (Vaquez et al., 2021) and elsewhere. In addition, Artificial Neural Networks are being used for projecting production in agriculture on the basis of parameters such as incidence of disease and pests, judicious weed control, and assessment of the quality of produce (Kujawa and Niedbala, 2021). Mowla and colleagues (2023) used IoT and WSNs for production agriculture by monitoring irrigation and soil moisture regime, optimizing fertilizer use, pest and managing diseases and pests, and conserving energy.

Modernization of agriculture in SSA is also being envisaged through the application of smart technologies (Jellason et al., 2021). Agriculture in SSA, where agronomic productivity can be easily tripled over a short period, is in an urgent need of applications of emerging AI technologies such as IoT, Machine Learning, Big Data, Cloud Computing, sensors, robotics, etc. Araújo et al. (2023) proposed the use of Preferred Reporting Items for Systematic Reviews and Meta Analysis (PRISMA) methodology to harness the benefits of Machine Learning in agriculture, in conjunction with digital twins of sustainable agriculture and forestry (Nie et al. ,2022). Machine Learning has specific applications to destection of weeds and pest, plant diseases, stress in crops, smart farms or automation in farms, and estimation/prediction of crop yield (Attri et al., 2023). There is an enthusiastic response to convergence of AI and IoT (AIoT) to addressing numerous challenges in agriculture including pest management and post-harvest management as the driving force for smart agriculture (Adli et al. ,2023;Tripodi et al., 2023; de Oliveira et al., 2023; de Abreu and Van Deventer et al., 2022).Above all, digital transformation of agriculture can also reduce carbon emission from farm operations, and advance adoption of green technologies. Indeed, using AI is an innovative option for achieving the green sustainability in agriculture.

Conclusion

The Soil-Centric GR-2.0 can be accelerated and upscaled to India, South and Southeastern Asia, Central America along with The Caribbeans, SSA and other developing regions of the world through the use of AI and IoT which are the innovative developments of the 21st Century. The emerging challenges in agriculture (i.e., producing more from less by enhancing eco-efficiency and sparing some land and water for nature, and improving nutritional quality of food while making agriculture a part of the solution to enhancing the environment) will require innovative approaches in management of soil health to advance food, nutrition, and climate security. In this regard, emerging technologies in AIoT, Machine Learning, Big Data, etc. are critical to translating science into action and upscaling of innovative options such as conservation agriculture and soil carbon sequestration for the long-term goal of sustaining soil health and making agriculture a part of the solution to addressing environmental issues. It is apparent that more changes will occur in agriculture between 2025 and 2050 than have occurred throughout the 10 millennia since the onset of agriculture. These changes will be ushered through the use of AI and robotics for revolutionizing agriculture of the 21st century, reducing carbon emission from farm operations, addressing anthropogenic climate change, and putting Sustainable Development Goals of the Agenda 2030 of the United Nations on track.

> Just as technology is fast changing the world, so can it revolutionise the livestock sector

Artificial Intelligence and Native Wisdom

Key to Livestock Management

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"Artificial intelligence is not a substitute for human intelligence; it is a tool to amplify human creativity and ingenuity," Fei-Fei Li, Artificial Intelligence and IT Professor at Stanford.

A dairy farm of 1500 odd cattle in the Netherlands, each of the animals yielding an upward of thirty litres milk per day managed by its sole owner, a middle aged lady with a part time support staff numbering a mere three, amazed me no end. Alongside the dairy was hundreds of acres of farmland growing fodder for these cattle as also a cow dung fed captive power plant to supply energy to the farm and the house.

All this was handled by the lone lady and her three part-time gentlemen employees. What made this possible was the complex web computers, machines and robots. Robots would guide the animals in batches to the milking booth, but not before checking their basic health and hygiene parameters such as body temperature, skin condition etc.

A set of machines would wash and sanitise their teats before another set begins milching. Both the quantity and quality of milk of each animal, including the composition of nutrients would be captured and displayed in real time; the monitor would keep ticking till the last drop was milked. And in a blink of an eye, the booth was cleaned and readied for the next batch of cows, by these very machines.

It is the tool of Artificial Intelligence (AI) that made it possible, that too in quick time. I was a witness to it in the year 2019. Wouldn't it have appeared to be an unbelievable miracle a few years back?

AI Influences Action And Behaviour

Today, a few gentle taps on the screen of our smart phone gets us milk, a host of other items too, delivered home in a jiffy. Thanks to AI powered apps. AI, thus, influences action and behaviour both at the production and consumption ends, of course during the supply chain too.

John McCarthy, the renowned computer and cognitive scientist who is regarded as one of the original creators of the discipline of AI gave it a rather simple and broad definition, “the science and engineering of making intelligent machines.”

Artificial intelligence (AI), in its all encompassing explanation, refers to computer systems capable of performing complex tasks that historically only a human could do, such as reasoning, making decisions, or solving problems. Today, the term “AI” describes a wide range of technologies that power many of the services and goods we use every day, in real time too.

At the most basic level, AI functions by taking in data and using an iterative processing system and different algorithms to learn from patterns found in the data, and then react to it in a specific way. AI uses a system, quite appropriately, named propensity model to make predictions based on the data it processes, and then uses those predictions to respond to or initiate actions.

Different types of AI lean on different baseline algorithms, which make them react and learn in different ways. Some do simple tasks of categorising data or making predictions. Some do much more complex tasks, such as driving a car without a human at the wheel or herding and milking the cows or even monitoring the feed of the fish in a pond.

How AI Works

However, even the artificial intelligence designs, big or small, complex or simple, need basic instructions in order to function. And these instructions are provided by algorithms, the foundation as also the building blocks of AI.

In the simplest of terms, algorithms are step-by-step instructions that guide a computer till the completion of the task. Algorithm is akin to an instruction manual that lets the machine know exactly what to do and when to do it. Without this information and instruction, the computer would be at a loss as to when and where to start or how to proceed. Without algorithms, there would neither be a start nor the end to the programming process. It is the algorithm driven machines and processes that enabled the Dutch lady to professionally and scientifically manage her big dairy farm.

Feeding nearly 10 billion people by the year 2050 is a formidable challenge, more so in the light of the developments

where agriculture driven growth is at risk thus contributing to food insecurity, particularly so in the developing economies. Climate change compounds the risk in food insecure regions by adversely affecting crop yields. It indeed is a tragic irony against this background that one third of the food is wasted or lost.

The Value Of Livestock

Livestock sector, in such a scenario, could play a much wider and more significant role. Livestock contribute substantially to global food systems, providing valuable nutritional benefits, supporting livelihoods, and strengthening the resilience of families and communities to environmental and other shocks. Animal products provide more than 60 percent of dietary protein in developed countries, compared to only about 23 percent in developing countries. There is, therefore, substantial room for expansion of livestock production in the emerging economies.

The livestock sector in India could be well characterised by borrowing Dickensian idiom of the opening lines of his famous novel A Tale of Two Cities. Our livestock is the biggest, yet it is the smallest: we are way ahead of others in sheer numbers yet way behind in the output of those numbers.

We are the richest, yet we are the poorest: biggest and most diverse resource base, highest production but poor productivity levels; it is production by mass rather than mass production. The livestock sector offers the spring of hope, but alongside also lurks the winter of despair: the sector and all its sub-sectors have been registering an impressive and consistent growth over the years, even in the midst of a general stagnancy in the agriculture sector yet the levels of productivity and the quality of produce remain matters of serious concern.

> “Absence of traceability is the single most powerful impediment to the export of our livestock products

The Role Of Technology

Just as technology is fast changing the world, so can it revolutionise the livestock sector. In fact, the opportunities of harnessing modern technology of AI for the advancement of livestock are several times over other activities because this sector has a very sound base of indigenous and traditional knowledge.

The most critical aspects in livestock management, to put it very simply, are the seed and the feed. Interventions of AI could centre around these two critical parameters. Our entire artificial insemination (ai) programme is based on selection of the parents on phenotype models; Dam’s milk yield and in case of the Sire, it is again the female progeny’s milk yield that forms the primary criterion. Sound only if you are a thorough bred experienced livestock farmer as our entire selection of animals is merely on observation of physical attributes and anecdotal evidence; the chubby baby syndrome: fat means healthy.

Move to genotype, wherein the data of the ancestry, several generations in the past, from health to disease, breed to feed, milk to meat, and several other algorithms, is digitally available. It is quite akin to a horoscope generated by a learned pundit, and now AI of computers, giving intimate details of the ancestors. The mantra being that genetic makeup is more important than visible physical traits.

Here the traditional wisdom gets support of Artificial Intelligence (AI) to select the candidates for artificial insemination

(ai). But how does a small livestock farmer who predominates the livestock canvas, and typically owns between one to five animals, afford genomic selection through AI for ai?

It is the government who has to play a big, proactive and hand holding role here. Steps are already underway to create this vast database. These need to be accelerated, caring along the process to ensure correct and reliable data, and most importantly its easy and affordable access to farmers across the spectrum.

The success rate of the ai programme, which is at an abysmally low rate of a suspicious figure of 30%, would dramatically improve, both in numbers as also the health and productivity of the progeny. The game changing technology of sex sorted semen, once demonstrably successful, has the potential of revolutionising the dairy sector on the one hand, and addressing the serious and sensitive problem of stray cattle on the other.

A genotype selection of the parent stock for the technologies of embryo transfer and in vitro fertilisation would lend further health and value to the progeny, besides making the existing stock more productive. Our livestock is both vast and diverse; AI could simplify the database and the solutions.

A genotypically selected or bred animal may begin healthy, but would require the feed or diet to remain healthy and become healthier. What should be the ideal mix of green fodder and dry feed? Must we feed what we have been doing over the years or assess each animal's requirements. The AI generated health and nutrition information, of every individual animal, could assist in micro planning the balanced feed and fodder requirement of the livestock. The ration balancing programme of the government seeks to achieve precisely this objective, but again the effort requires more weight since the challenge is huge and the intervention too little.

AI For ai

The government support for introduction of appropriate technologies for the most important activities of breeding and feeding is sine qua non as the smallholder livestock farmer can ill afford to access or afford the cost of technology on his own.

A robust database, such as the one being created through the Information Network for Animal Productivity and Health (INAPH), in the public domain could create a multitude of livestock trading platforms to offer informed choice to both the buyer and the seller. But technology when offered to the farmer must be simple and understandable, especially when it involves complex data sets. INAPH should have a farmer friendly interface, imbibing from native wisdom too when it comes to using the data for decision making.

What about water; the biggest of the components of our livestock products? Milk, not only here but all over the world, is the most consumed livestock product. Between 85 to 90 percent milk is water, the remaining 10 to 15 percent being the other solids, fats and proteins.

We have no data either on the consumption of water by the livestock or its requirement in the present and the future; the quality of water available; the incidence of water borne diseases in livestock and their further transmission to humans etc.

In fact, the policies, planning and programmes of the water sector have largely ignored the livestock sector. This is primarily on account of a complete absence of reliable data and information on availability of water for the livestock sector. The quantity and quality of water both seriously impact livestock productivity and the quality of the product. Data analytics power of AI in mapping the perennial and seasonal water bodies, making a comparative assessment of competing requirements of water, could support an inclusive water management regime taking into account the livestock's demand both in quantity and quality.

Challenges And Opportunities

Digitalisation has been efficiently transforming the milk retail market in the metropolitan cities. It is further making inroads into the processing activities. A strategic infusion of AI technology for value addition could diversify our milk from a raw material to scores of products, from the elementary curd, paneer, khoya etc. to a variety of cheese, chocolates etc. Most importantly, technology should lead us to product traceability. Absence of traceability is the single most powerful impediment to the export of our livestock products. Isn't it ironic that while we sit at the top of the production cliff in almost all products, our share in global trade, except for shrimp, is negligible. The discerning consumer, both overseas and domestic, demands to know the actual source of the product and its integrity; and in the unorganised spread of our livestock, it is only the technology of digitalisation which could trace the source.

Possibilities are unending; the narration above is a small illustration. The moot question is how does the farmer access and reap the benefits of the AI technology. He is small and unorganised, barely able to stay afloat. After all, a sophisticated technology such as AI costs money; and this causes concern of inequities in the sector. The role of the government is critical here. It must be reiterated that a proactive approach by the central and state governments to make technology affordable, accessible and above all meaningful for the smallholder livestock farmer would be of critical importance. The technology, in a nutshell, should lead the farmer to greater value of his efforts making livestock an attractive proposition; and further add similar value across the production and supply chains.

The boundless possibilities offered by technology and our innate ability to harness it should make the future of livestock decidedly brighter than the past and the present.

Decoding AI and Robotics *in* Indian Agriculture

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> Robots are most suitable for dull, dirty, dangerous, disinterested, labour intensive job; and agriculture has all these adjectives

Artificial Intelligence is probably one of the biggest buzz words being used in technological development and automation in al walk of life. It is nowadays presented in a way that AI is poised to drive a transformative shift in agriculture fostering innovation for sustainable development and Indian Agriculture is expected to be the major segment for this by 2025. NITI Aayog is also nurturing the AI ecosystem in India with the theme, 'AI for all'.

Splatter dash are such that AI is going to address all challenges of precision agriculture, resource optimization, efficient supply chain management, and empowering smallholder farmers, that have been persisted for generations. There is no doubt as the world's population continues to grow, harnessing the power of technologies and tools in agriculture becomes more imperative than ever before.

What is AI?

Artificial intelligence is the science of making machines that can think like humans. It can do things that are considered "smart." AI technology can process large amounts of data in ways, unlike humans (Fig. 1). The goal for AI is to be able to do things such as recognize patterns, make decisions, and judge like humans. (Pattam A, (03/03/2024 at www.hcltech.com/blogs/artificial-intelligence-defined-simple-terms). The way however the term AI mostly is being used is nothing but a prediction software.

The Indian agricultural fields are flooded with Apps that claims AI based tools, but in majority of cases it is only a prediction software developed based on limited data. It gives only information, in line of data on which it was trained, and then farmers have to take decision and action. Most of so called AI based Apps here does not physically perform based on decision, but gives only suggestions. Above all, prediction of all these Apps are mostly not validated in varied cases and so accuracies are in questions. One should be careful for such AI Apps' claims and applications.

The Uses Of AI

There is no doubt that AI is important, if developed and employed in a machine or tool as defined above to take decision and act/perform the operations. AI may be used as a driving solutions (say brain) in lieu of human labours (say robots) in Agriculture, labour situations in Indian Agriculture is likely to be grim in near future. Dynamics of labour force in India is changing at faster rate. Rapid growth in service and industry sectors and increase in income from other sources are affecting the migration of labours from one sector to other. In 2011 the agriculture labour force was about 49.26 %, while it is decreasing year-by-year and in 2021 was only about 43.96 % (Fig. 2). Some other estimates further indicate that agricultural labour force in 2021 was only about 39.4 %, amongst which 45 % is women. The Fig. 3 indicates the ratio of men and women workforce dynamics in India. As targets of India to become the developed country by 2047, the labour dynamics shall change at faster rate. By 2047 total agricultural workforce may not be more than 30 % of which about 60 % will be women workers (Jha SN, 2024, Women in Agricultural Engineering, Agricultural Engineering Today 48,1, 2024.)

The Demographics Of Agriculture

Indian Agriculture as far as labour is concerned shall be further facing a peculiar condition. Farmers are ageing. Majority of them are aged above 40. In 2016, the average age of Indian farmer was 50.1 years and the next generations of these farmers is not taking up this profession. It means we are approaching a situation where one of the biggest consumers of food will be left with only a few farmers. So importance of AI led robots in agriculture shall be of paramount importance.

Where do we stand in these fields? Numerous research and development works are being carried out throughout world. Government of India has also special plans and is boosting research, but in AI research alone, forget deployment, India is much behind than USA, Japan and China (Fig. 4). Total researches reported by China, USA, Japan and UK in a year are 63344, 39820, 17257 and 14864, respectively while during the same period for India it was only 13948. China seems to be far ahead than any other countries in the world.

The agricultural AI marketing at world level is growing with CIGR of 25.5 % while that of agricultural robotics is 24.3 % (Fig. 5). Growth of application of robots in medical and health care is -4 % with number of instances were about 9.3 thousand. Its growth rate in case of hospitality, professional cleaning, transportations & logistics, and agriculture are 125 %, 8 %, 44 % and 18%, respectively (Fig. 6).

This shows, the activities which are difficult and labour intensive, having higher rate of growth. In fact, robots are most suitable and desirable for dull, dirty, dangerous, disinterested, labour intensive job; and agriculture has all these adjectives. In addition, Indian agriculture is dominant by small and marginal farm holdings (about 86 % of total farm), where robots driven agricultural operations may be easier and profitable. By embracing AI-driven robotic solutions for our farming fraternity may therefore pave the way for a future where food security is assured, resources are conserved, and rural economies thrive.

How To Empower Women Farmers To Unlock Agri Economy

> Progress and growth of women in farming must be closely linked to overall development goals of the country

In Zaheerabad, Telangana, Misbah's story is nothing short of inspiring. Misbah is a farmer by profession and a tractor-driving instructor. After getting married, she convinced her husband to move to Zaheerabad, where she joined a tractor-driving programme. Among 80 men in the programme, she was the only woman.

Reflecting on her experience, Misbah said, «**My classmates were curious and teased me about my plans after the training. But with my husband›s support I persisted, moving from student to trainer over time.»**

Her journey encouraged 40 other women to join the programme. Misbah found fulfilment in knowing that her courage not only allowed her to learn a skill typically associated with men but also inspired others. She realised the immense influence women like her could have in rural communities. **"This realisation fuelled my belief that women can achieve anything they set their minds to."**

Women's Role Is Often Overlooked

In India's rural villages, many women are often overlooked when it comes to securing a plausible income from their family's farmlands, despite being actively involved in farming. They are the unsung heroes of India's agri economy, carrying a great part of that burden of their families' farmlands, as their spouses are compelled to move to urban centres in the quest to improve their family's economic situation.

Despite their pivotal role, prevalence of gender stereotypes, social restrictions and traditional role expectations, hamper women's access to knowledge and technology in farming, resulting in low productivity. According to the PLFS 2021-2022, the literacy rate of rural women of age 7 years and above is at 68.9% compared to rural men at 83.5% and urban women at 84%. According to the Agricultural Wages in India (AWI) report of May 2020, it is also alarming that despite increasing participation of women in farming, the wage gap between men and women is not on par.

Source Of Inspiration

Regardless of these challenges, women farmers are a source of immense inspiration as they serve the nation with a spark in their spirit.

Given this, what actions can policymakers take to greatly encourage women in farming, while establishing the country as the global hub for food? Especially in the context of the government support for agriculture as well as emerging agricultural technologies. What could the next set of reforms be, to take forward the already established momentum of feminisation of agriculture?

Evolving Women Self-Help Groups (SHGs) Into Farmer Producer Organisations (FPOs)

'Sabka saath sabka vikas' through women SHGs can attain various objectives, including empowerment women by nurturing their knowledge and skills. SHGs can help strengthen their physical and emotional resilience, including that of their families, through education, nutrition and inculcating birth control measures. The government's 'Sabka Saath' initiative is laudable. 84 lakh SHGs with 9 crore women have been integrated into the transformation of the socio-economic fabric of our country.

From there on, transforming these women-led SHGs, into women-led FPOs (Farmers Producer Organisation), could go a long way in further creating 'lakhpati didis'. They can collectively guide participants on crop choice, access to microfinance and effective product marketing, gradually morphing into micro-enterprises producing packaged foods, for better earnings, while driving positive change in the lives of rural women. The government's emphasis on agriculture, commitment to modernising storage, supply chains, and branding in the farm sector aligns with this approach, driving value addition and income enhancement through farming, benefiting both farmers and consumers.

Programmes Providing Access To Critical Farm Equipment

A lot more women are interested in operating their equipment. Government initiatives like SMAM signify a step in the right direction. Under this central governments scheme, farmers are provided with the benefit of subsidies ranging from 50-80% for buying agricultural machinery, with priority given to women farmers. With implementation in all states, it is important for the government to ensures greater access to affordable finance to acquire this farm equipment while establishing custom hiring centres to sample them.

India also needs to look at farm mechanisation beyond tractors, for affordable solutions catering to varied types of crops, across the lifecycle of the crop. Eg: Better penetration of Rice Transplanting technology can drastically reduce drudgery, over backbreaking manual transplanting, often seen in paddy states like Orissa, Telangana and Tamil Nadu.

Develop And Drive Solutions For Women, By Women

More needs to be done to ensure that GOI centres work towards enrolling more women and fast-track the development of women-friendly farming solutions, with a tailored approach, to impart the required education and sensitivities related to women in farming. Integration of new-age technologies like AI, ML, IoT and app-based solutions too, can help mark a transformative shift for women in farming.

The private sector can play a major role in delivering affordable and accessible farm solutions developed for women farmers. Innovations are needed among rural women, to feel inclusive, contributing further to agriculture and the Prime Minister's vision of a 'Viksit Bharat'.

India ought to focus on developing core competencies around gender issues in agriculture and more so rural India, with inclusion of the women perspective as an integrated component in policy and research. Progress and growth of women in farming must be closely linked to overall development goals of the country.

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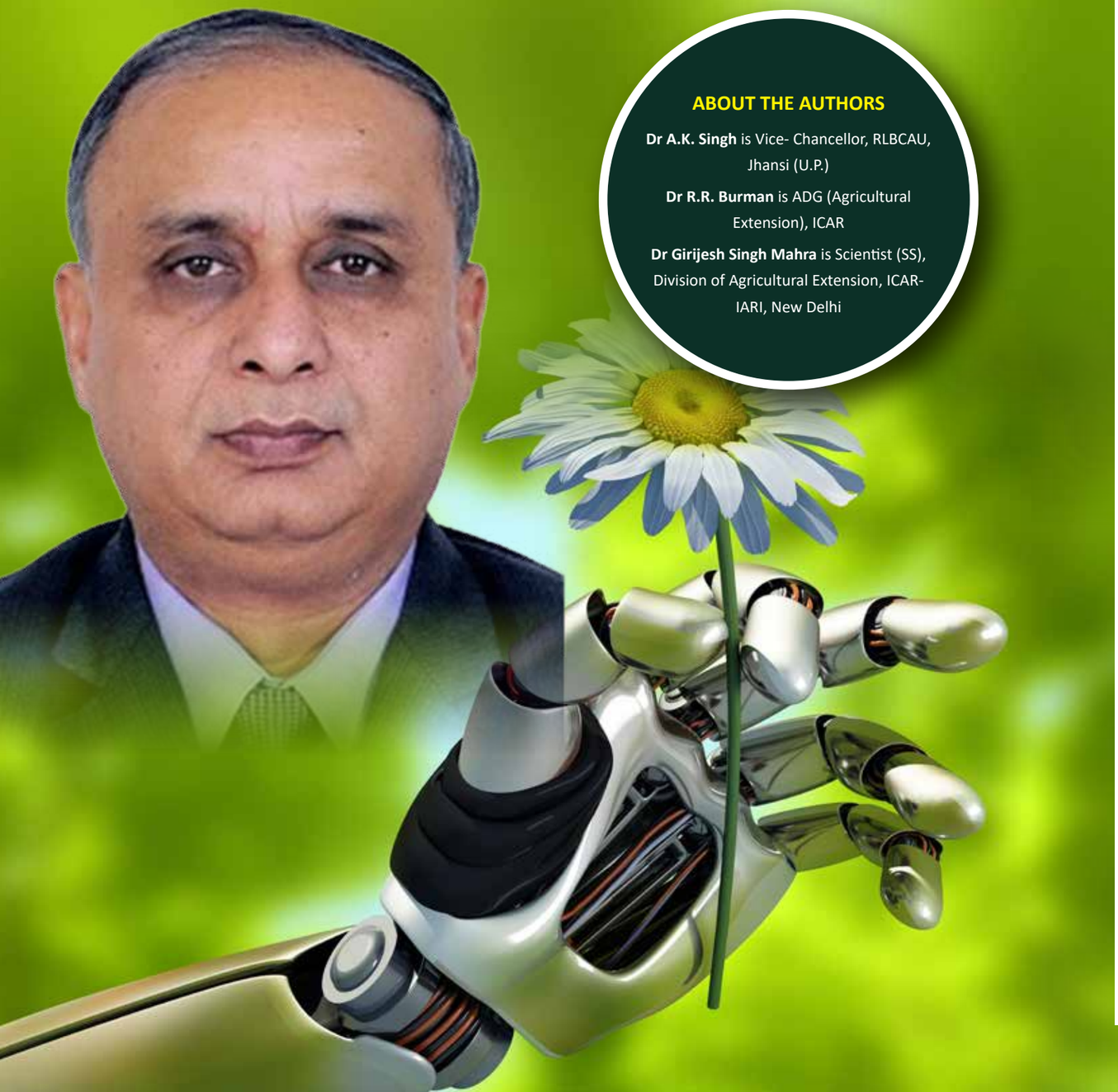
AI The Powerful Transformation



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Agriculture stands as the cornerstone of the Indian economy, with over 37.7% of the nation's land dedicated to crop production.

Despite this significant commitment to agriculture, India's traditional farming practices face challenges in meeting the demands of a rapidly growing population, which has already surpassed 1.4 billion.

As the need for increased food production and employment intensifies, the conversation around agricultural automation becomes paramount. The schemes being run by the Government of India in agriculture have played an important role in this growth, but in 2050, to meet the agricultural challenges related to food security, India will have to implement smart farming techniques on a large scale.

The integration of cutting-edge technologies such as robotics, artificial intelligence (AI), and the Internet of Things (IoT) into farming practices offer promising solutions. These automated systems empower farmers to streamline operations, enhance productivity, and mitigate labor costs. Recognizing the transformative potential of AI in agriculture.

AI FOR ALL

NITI Aayog is fostering an inclusive AI ecosystem in India under the banner of 'AI for all'. With Indian agriculture poised to become the second-largest segment by 2025, the imperative for embracing automation becomes increasingly clear. AI has the potential to address several real-time challenges in Indian agriculture such as contributing to its growth and sustainability.

Artificial Intelligence (AI) is based on the principle that human intelligence can be defined in a way that a machine can easily mimic it and execute tasks, from the simplest to those that are even more complex. The goals of artificial intelligence include learning, reasoning, and perception. offers analytical and decision-making capability to machine like a human being.

Transformative Role

Here are some ways in which AI can play a transformative role:

Precision Farming: The advent of data-driven decision-making through AI algorithms marks a transformative leap for agriculture. Drawing insights from a myriad of sources, including sensors and satellites, these algorithms empower farmers with a comprehensive understanding of soil health, weather conditions, and crop performance. This newfound knowledge becomes a potent tool in rectifying the historically inefficient utilization of resources, such as water, fertilizers, and pesticides. The result is the implementation of precise irrigation schedules, targeted nutrient applications, and heightened efficacy in pest control strategies. 'FASAL Agritech' is such an innovative agri-tech startup which leverages the smart farming agriculture for the access of real-time data and solutions.

Crop Monitoring and Disease Prediction: The integration of AI-powered drones in agriculture promises extensive advantages for the farming community. By harnessing drone-based imaging coupled with advanced AI algorithms, the precise detection of crop diseases becomes possible, enabling timely interventions. This not only curtails the spread of diseases but also minimizes crop losses, resulting in enhanced yields, heightened incomes, and improved economic stability for farmers.

Moreover, the targeted interventions facilitated by AI lead to a reduction in chemical usage, promoting sustainable farming practices and ensuring environmental preservation for generations to come.

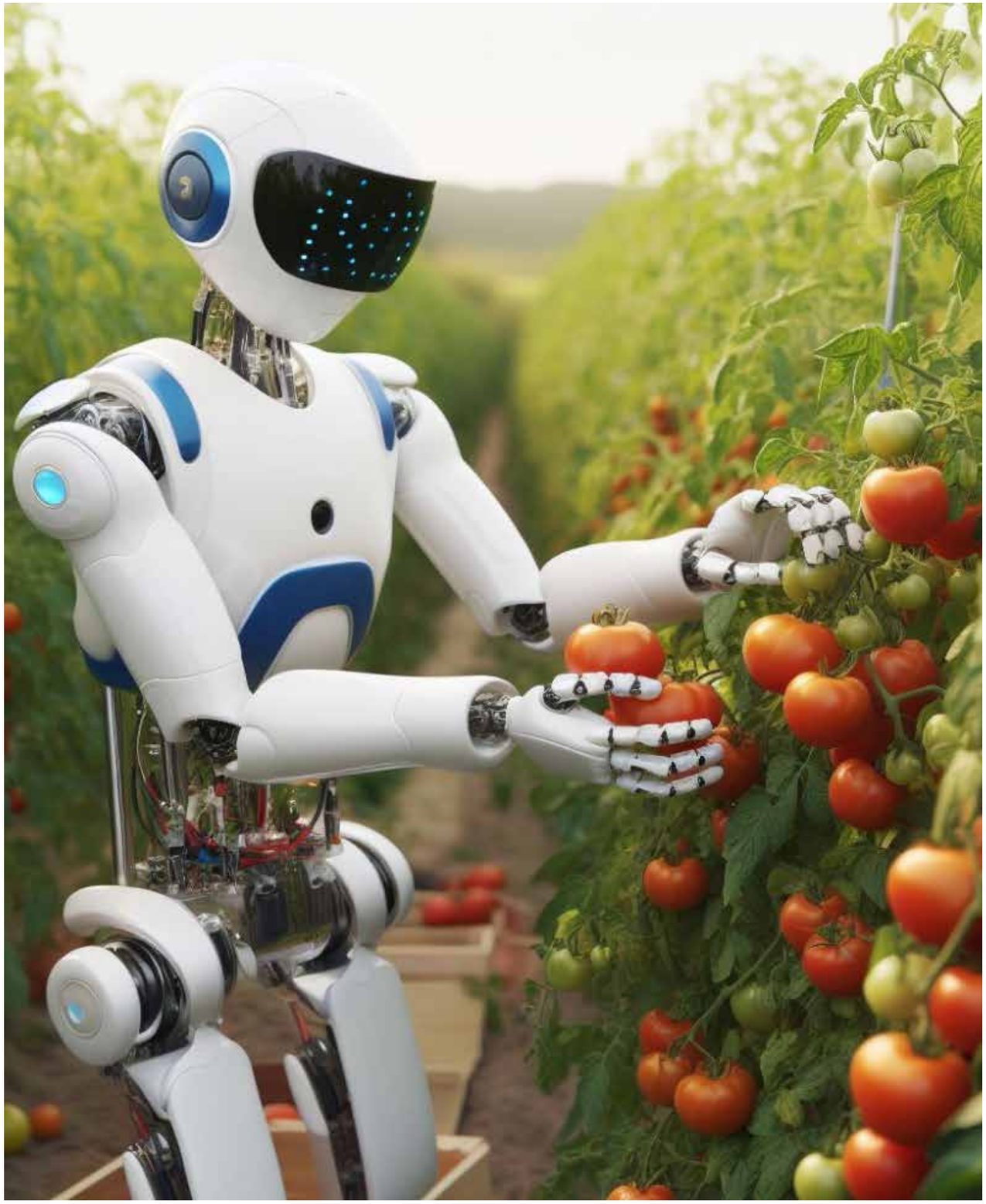
Weather Forecasting and Risk Management: AI and predictive analytics play a pivotal role in delivering comprehensive weather and soil moisture insights to farmers, facilitating informed decisions on water usage and crop management. Through AI-based tools and platforms, farmers gain access to productivity assessments, decision guidance, and detailed analyses of sub-seasonal and seasonal forecasts.

Precision agriculture solutions, merging AI and weather data, provide valuable farm-level insights for enhanced decision-making and productivity optimization.

Increasing the share of price realisation to producers: Improving the share of profits for farmers is a major challenge, particularly in sectors like fruits and vegetables where they often only get very less of the final price. This issue arises due to pricing systems, inefficiencies in the supply chain, and local regulations.

AGRICULTURE WORLD

NITI Aayog and IBM have joined forces to pioneer a groundbreaking crop yield prediction model utilizing AI technology, delivering real-time advisory services to farmers



Using AI-powered predictive analytics can help tackle this problem by providing farmers with better insights into supply and demand trends. This bridges the gap between farmers and middlemen, making pricing more transparent.

Considering how interconnected global commodity prices are, analyzing large datasets from sources like e-NAM and Soil Health Samples is crucial for accurate predictions.

Predictive Analytics: AI-enabled technologies predict weather conditions, analyse crop sustainability, and evaluate farms for the presence of diseases or pests and poor plant nutrition on farms with data like temperature, precipitation, wind speed, and solar radiation.

Precision farming is all about "Right place, Right Time, and Right products". The AI based precision farming technique which uses predictive analytics, is a much accurate and controlled way that can replace the labor-intensive part of farming to perform repetitive tasks.

Livestock Management: Livestock management in India is witnessing a transformative shift with the advent of AI technology. From real-time health monitoring through sensor analysis to predictive analytics forecasting disease outbreaks and market trends, AI optimizes productivity.

Nutritional management ensures balanced diets for livestock, while reproductive management aids precise breeding decisions. Chitale Dairy in Maharashtra exemplifies this shift, employing RFID tags and cloud-based applications to optimize operations and enhance real-time monitoring of animal health and milk processing.

G20 Perspective on AI:

The 2019 G20 Osaka summit guidelines call for users and developers of AI to be fair and accountable, with transparent decision-making processes and to respect the rule of law and values including privacy, equality, diversity, and internationally recognized labor rights.

The 18th G20 Summit, 2023 at New Delhi has sought to take the lead on addressing the opportunities and risks associated with Artificial Intelligence (AI). Under the New Delhi Declaration, the G20 countries have decided to pursue "pro innovation" regulatory approach with the aim of maximising benefits while accounting for the risks associated with AI.

The New Delhi Declaration cites commitment to the G20 AI Principles of 2019. The G20 has also resolved to share information on approaches to using AI to support solutions in the digital economy and to promote the use of responsible AI for achieving SDGs. The G20 declaration notes that for deployment of AI – "protection of human rights, transparency and explainability, fairness, accountability, regulation, safety, appropriate human oversight, ethics, biases, privacy, and data protection must be addressed". The G20 countries have resolved to ensure international cooperation and discussion on international governance of AI.

AI In Agriculture

The Government of India is actively championing the infusion of Artificial Intelligence (AI) in agriculture, collaborating with state governments to modernize farming practices nationwide. Initiatives such as the Sub-Mission on Agricultural Mechanization encourage the adoption of AI-driven technologies, including farmer-centric drones.

The NeGPA program allocates funds for digital agriculture projects, leveraging emerging technologies like AI, ML, IoT, and blockchain. The Rashtriya Krishi Vikas Yojana introduces "Innovation and Agri-Entrepreneurship Development" under RKVY-RAFTAAR to support AI-driven startups addressing agricultural challenges. Additionally, the 'Per Drop More Crop' scheme emphasizes micro irrigation with AI applications, reducing costs and enhancing water-use efficiency.

The government's budget announcement for 2023-24 has the commitment of building digital public infrastructure for widespread access to AI-driven agricultural technology and information. These strategic initiatives signify a pivotal shift toward leveraging AI to revolutionize farming, enhance productivity, and empower farmers across the nation.

NITI Aayog and IBM have joined forces to pioneer a groundbreaking crop yield prediction model utilizing AI technology, delivering real-time advisory services to farmers. Leveraging data from diverse sources including remote sensing (ISRO), soil health cards, IMD's weather predictions, and crop phenology, the model delivers precise prescriptions to farmers.

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AI for Addressing Agriculture Challenges

> As AI continues to evolve, its role in Indian agriculture becomes increasingly pronounced

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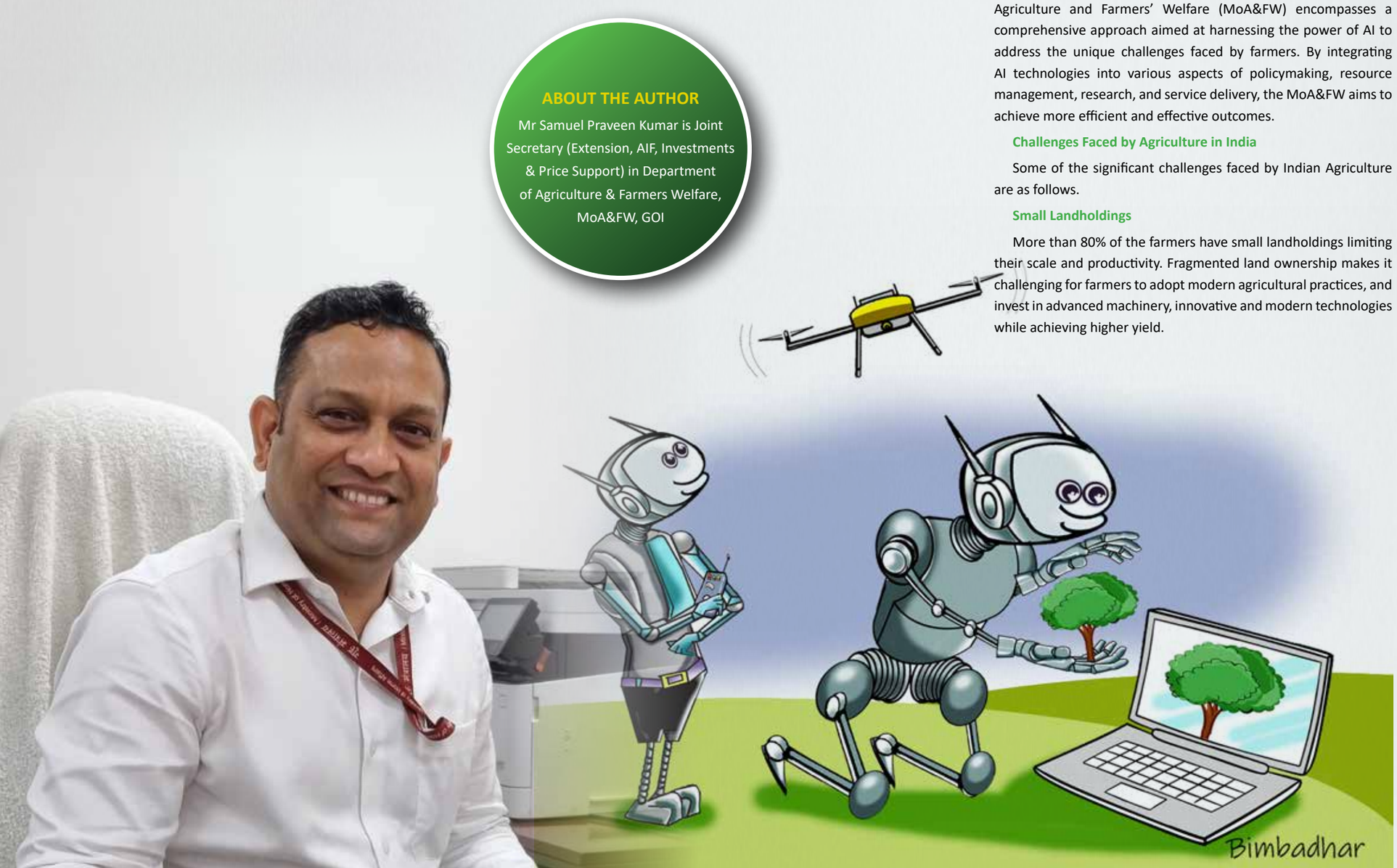

Agriculture stands as the backbone of India's economy and is facing enormous, ever-evolving challenges due to the impact of climate change. This is leading to increased uncertainty and inability of farming to realize its true potential. Contributing to approximately 16-17% of the Gross Domestic Product (GDP), this sector not only fuels economic growth but also sustains over 50% of the country's workforce, playing a pivotal role in sustaining rural livelihoods. Beyond its economic impact, Agriculture is the cornerstone of India's food and nutrition security needs, being a global powerhouse in food grain production. From staples like rice, wheat and pulses to an array of exportable commodities like fruits, flowers and spices , Indian agriculture commands a crucial position on the world stage, bolstering the nation's foreign exchange earnings.

The AI implementation strategy adopted by the Ministry of Agriculture and Farmers' Welfare (MoA&FW) encompasses a comprehensive approach aimed at harnessing the power of AI to address the unique challenges faced by farmers. By integrating AI technologies into various aspects of policymaking, resource management, research, and service delivery, the MoA&FW aims to achieve more efficient and effective outcomes.

Challenges Faced by Agriculture in India

Some of the significant challenges faced by Indian Agriculture are as follows.

Small Landholdings

More than 80% of the farmers have small landholdings limiting their scale and productivity. Fragmented land ownership makes it challenging for farmers to adopt modern agricultural practices, and invest in advanced machinery, innovative and modern technologies while achieving higher yield.

Outdated/Unscientific Farming Practices

Farmers in India still rely on traditional and outdated farming practices. Limited access to modern/ improved and innovative farming technologies, and education hinders productivity and growth.

Climate Change Impact

Changing climate conditions affect crop yields, leading to increased risks for farmers. Adaptation strategies and resilient crop varieties and practices are crucial to address and mitigate climate-related challenges.

Post-Harvest Losses

Lack of proper scientific storage, transportation and processing facilities leads to spoilage and wastage of agricultural produce, impacting farmers' income and food security. More importantly it's a loss to the nation.

Market Access and Price Volatility

Farmers often face challenges in accessing markets, and unpredictable price fluctuations make it difficult for them to plan and invest in their agricultural activities. This in turn leads to inefficiency in the overall supply chain.

Limited Technology Adoption

Limited awareness, access, and training hinder the widespread adoption of modern technologies and practices, hindering the sector's overall efficiency and competitiveness.

Lack of Credit and Financial Support

Insufficient financial resources prevent farmers from investing in quality seeds, fertilizers, and machinery, impeding their ability to enhance productivity. Lack of access to institutional finances, forces them into debt trap of money lenders, ultimately making farming even costlier, un-remunerative and unsustainable.

Can AI Help Address Challenges in Agriculture?

The potential of AI in revolutionizing various aspects of human life is unprecedented. AI technologies possess the capability to analyze vast amounts of data, identify patterns, and make predictions with a level of accuracy that surpasses human capabilities. From enhancing efficiency in industries to improving healthcare diagnostics, AI holds promise in transforming societies globally. Its ability to automate tasks, optimize processes, and facilitate decision-making has already started reshaping the way we live and work. As AI continues to evolve and mature, its potential to drive innovation and solve complex problems across diverse sectors remains immense. In short, Ai helps to magnify and amplify manifolds the human capabilities for impact at population scale.

AI presents an enormous scope for addressing national challenges across different domains. Additionally, in governance, AI can facilitate data-driven decision-making, enhance public service delivery, and optimize resource allocation, thereby fostering efficiency and transparency in governance processes.

By leveraging AI's capabilities, nations can effectively tackle socio economic issues, strengthen infrastructure, and foster inclusive growth, ultimately leading to a more prosperous and equitable society.

In line with the National Strategy on AI released by NITI Aayog, the Ministry of Agriculture & Farmer Welfare, Government of India has launched several digital initiatives using AI capabilities through the collaborative efforts of public and private agencies. The initiatives aim to create a comprehensive AI ecosystem, based on the principle of inclusivity and transparency, to ensure the efficient delivery of farmer welfare programs, enhance the farmers' capability to access relevant scheme data and address their issues in real-time, facilitate farmers in informed decision-making and capture & share best practices of farmers. The Ministry is integrating AI into its initiatives for providing accessible solutions with advanced technology. The Ministry has already created an AI cell and an Advisory Committee of experts for adopting the best practices. This article outlines key programs and systems, inspiring states to adopt and further develop these forward-thinking approaches.

Customized Advisories and Real-Time Query Resolution

AI can use Large language models (LLM) to understand the intent of the query asked by the farmers/beneficiaries and generate a contextualized and customized advisory based on their location.

Kisan e-MITRA

With scheme related grievance redressal being a core problem, the Ministry of Agriculture has developed an AI-powered scheme chatbot for farmers designed to promptly assist farmers with issues and complaints pertaining to payment, registration, eligibility, eKYC updation etc. The chatbot operates in the farmer's local language, facilitating instant support and streamlined grievance resolution for the central and state governments by automating scheme-related processes, thereby reducing manual workload. The Kisan e-Mitra chatbot is powered by AI and leverages speech to text technology and models that identify query intent (based on farmer input) which then connects to the backend to either provide information or retrieve status and communicate response. While this currently supports PMKisan related queries, the vision is to make Kisan E-Mitra a one-stop solution for queries related to all of the schemes implemented by the Ministry of Agriculture and Farmers Welfare, Govt. of India in the coming days.

Krishi Saathi (Chatbot for Kisan Knowledge Management System)

Kisan Call Centers (KCCs), established by the MoA&FW, assist with various types of crop related queries ranging from pest control to market price support. These KCCs receive around 15,000 calls a day, attended by 476 Farm Tele Advisors (FTA's) from 17 locations across the country. However, response rates and farmer-wait times are long-standing issues which can be optimized through the integration of FTA support mechanisms that leverage AI. Krishi Saathi is an AI/ML conversational chatbot that uses Large Language Models (LLM) and web crawlers to provide access to summarized, verified and accurate responses to farmer queries. Not only will this increase the capacity of the KCC to respond to more calls by ~15%, but also reduce farmer-query turnaround time.

Crop Monitoring and Disease Detection

AI-powered image recognition can identify crop diseases, nutrient deficiencies, and pest infestations by analyzing images of plants. Early detection allows farmers to take prompt preventive and corrective action and minimize crop losses.

National Pest Surveillance System (NPSS)

India is set to feed 1.7 billion people by 2050, requiring a 35% increase in food production. With an increase in the population of India, producing food sustainably is of prime concern. However, there are several challenges which inhibit India from achieving food security, in a sustainable manner. One major challenge is that of pest attacks and diseases and by 2050, India could face up to 15-20% of crop loss due to pest attacks and diseases. The MoA&FW has built the NPSS as a warning mechanism to identify such pest attacks and diseases, provide accurate advisory and avoid crop loss to boost agricultural productivity. This pest-surveillance system (portal and mobile application) is being built in collaboration with ICAR's National Research Centre for Integrated Pest Management, an organization responsible for collecting and capturing data regarding focus crops and their associated pests, symptoms and disease images at field level. This data is then used to build AI/ML models to detect crop defects and provide pre-harvest advisories at the national level to stakeholders.

Crop Classification: Strengthening the Krishi Decision Support System

The digital crop survey has been introduced to provide accurate and correct information on the crops grown by farmers to State and Central Governments to enable seamless benefit delivery. The Digital Crop Survey currently relies on farmer-captured photographs that are then tagged and cross-referenced to crops. However, the margin for error with respect to crop identification is high given the extent of manual intervention this requires. The MoA&FW is exploring ways in which pictorial analyses can be used to correctly infer crop photographs to eliminate errors that could feed into crop estimation and modeling.

Digitization and Information Dissemination

VISTAAR

The Virtually Integrated System for Accessing Agricultural Resources or VISTAAR, is a flagship initiative by the MoA&FW to revolutionize advisory dissemination to farmers. By creating a network grid containing vast agricultural data, this initiative provides customized advisories and real-time query resolution by leveraging AI's prowess to deliver personalized and contextual advice to farmers. AI is able to not only retrieve data based on input/query but also analyze vast agricultural data to understand nuances like weather patterns and soil conditions.

By integrating advisory retrieval solutions into the digital public infrastructure, farmers gain equitable access to agricultural information and technology, fostering innovation and continuous learning in the sector. Through user-friendly platforms, farmers can access real-time updates and expert advice, empowering them to make informed decisions and improve their livelihoods, promising a sustainable future for Indian agriculture.

VISTAAR is being developed as Digital Public Infrastructure (DPI) for agriculture, the first such initiative across the globe, which enables an ecosystem level convergence among Government, academic & research Institutions, private players, Agri-startups and social enterprises coming together with a "farmer first" approach. This farmer-centric initiative has the potential to transform agricultural extension services in India and beyond.

Farmer Innovation & Best Practices

The Farmer Innovation Repository is the first of its kind platform, aiming to build a knowledge base by farmers regarding innovative farm practices followed across India. The first prototype of this repository brought in the knowledge, insights, challenges, practices of over 1700 diverse farmers as audio recordings from every district of Tamil Nadu. Using the power of AI, this knowledge can be accessed through voice or through text interface and in any Indian language. This will not only build an environment of peer-to-peer learning but will also help the larger ecosystem respond more effectively to the needs of the farming community. Given the success of the TN prototype the plan is to expand this beyond TN to other states and eventually create a pan-India repository which encourages and facilitates knowledge exchanges transcending state boundaries.

Scheme Impact Assessment

The conventional approach of conducting assessments is often based on measured observations using various experimental designs that are mostly expensive, time-consuming and require highly skilled evaluators. These are often associated with human bias involved. In the age of exponential technology like AI, assessments can be readily conducted in a way which is much more convenient, low cost, bias-free and at speed and scale.

MoA&FW has created a farmer feedback mechanism which can act as an Impact Assessment Tool. Such assessments captured in the form of voices/audio responses coming from the targeted farmers/beneficiaries are more reliable and trustworthy as they can be traced back to the network of farmers who are the beneficiaries of various schemes and projects. AI-powered assessments give a complete 360-degree view of the impact that can be synthesized based on the input provided by the targeted beneficiaries. This innovation was initially tested for assessing the impact made by Agriculture Infrastructure Fund (AIF) scheme- with a sample of over 200 beneficiaries from across India and it provided comprehensive insights on the impact. Given the success, the assessment is being carried out for other schemes including PM Kisan, Kisan Credit Card, Soil Health Card, Natural Farming etc.

> GOI initiatives such as Kisan eMitra, VISTAAR, KKMS and AI chatbots are some of the pioneering efforts towards building a more sustainable and tech-driven agricultural sector

Krishi 24/7

Krishi 24/7, an innovative AI-driven Agriculture News Monitoring platform, is dedicated to tracking media content and promptly issuing alerts concerning plant diseases, damages, and natural calamities. Drawing from a vast array of sources including web articles and Google Alerts, the application efficiently sifts through approximately 2.4 million articles per month, selecting relevant pieces across more than 10 categories and scanning through 150+ keywords. These curated articles serve as input to the system, where pertinent updates are extracted and presented. Designed to meet the needs of all the Divisions in the Ministry of Agriculture and Farmers Welfare, the platform operates seamlessly in 12 languages, ensuring widespread accessibility and utility.

Conclusion

As AI continues to evolve, its role in Indian agriculture becomes increasingly pronounced. Government initiatives such as Kisan eMitra , VISTAAR, KKMS and AI chatbots are some of the pioneering efforts towards building a more sustainable and tech-driven agricultural sector. These initiatives aim to empower farmers with instantaneous grievance redressal, real-time and contextual advisory and knowledge of crop management practices, thereby enabling them to make informed decisions and optimize their agricultural practices. Such initiatives set into motion a virtuous cycle of knowledge and benefits from harnessing new-age technologies, thus pushing India and its agricultural sector into an era of prosperity.

The integration of AI not only addresses existing challenges such as lack of information accessibility, pest infestation and climate uncertainties but also lays the foundation for a future where Indian farmers can harness the power of technology for improved yields, reduced production costs, and enhanced farm income, leading to better livelihoods and eventually increased agricultural resilience. The synergy between emerging exponential technologies like AI and Agriculture is a promising trajectory that holds the potential to transform India's agrarian landscape, ensuring food security, sustainability, and prosperity for millions of farmers across the country.

ROLE OF MACHINE LEARNING IN AGRICULTURE

Agriculture is regarded as a key pillar of the global economy. To establish a sustainable equilibrium, agricultural production needs to be increased. The crop's ability to produce sustainably is mostly dependent on a number of variables, including the soil, water, climate, and surroundings. Artificial intelligence gives a way to monitor the crop and to predict the yield in an automatized outcome. With today's cutting-edge technology, precision agriculture is crucial to creating an agricultural system that is optimised.

There are many applications of ML in agriculture. According to the recent study, three standard categories were identified which refer to crop, water, and soil management.

As far as crop management is concerned, it includes yield prediction; disease detection; weed detection; crop recognition; and crop quality. Crop diseases deteriorate yield, hence, sensing, diagnosing, and alerting the farmer to problems is a huge help using ML techniques. Machine learning algorithms coupled with imaging processing technologies allow for real-time identification and mapping of target weeds. This helps with applying herbicides to specific zones instead of over-spraying fields. The defects can be identified and the produce be sorted by weight, color, size, and ripeness of crop.

Sustainable agriculture revolves around organic carbon (OC), which is essential for numerous soil functions and ecological attributes. To enhance soil health and yield, farmers are interested in maintaining and adding more soil organic carbon to specific fields. My research predicts the Organic Carbon in Soil using Machine Learning Techniques and Geospatial Data for Sustainable Agriculture. To forecast OC of soil at a 30 m resolution, four machine learning models—Random Forest, Support Vector Machine, Adaptive Boosting and K-Nearest Neighbour were used which gave considerably good results.

The objective of the research was to create a model based on topography and properties of soil for the fore-cast of Organic Carbon (OC) present in soil, which will assist farmers in making proper improving crop yield. Numerous environmental and biological factors, as well as their interactions, regulate the amount of nutrients in the soil. A group of covariates that represent topography, climate, and remote sensing will be chosen as potential predictor factors to forecast soil organic carbon. By altering the support size, this data must be integrated with various spatial, spectral, and radiometric resolutions. As shown in Fig 1, proposed methodology mainly consists of data processing and model building steps to determine an estimate of OC which can be used for decision making suitable for sustainable agriculture.

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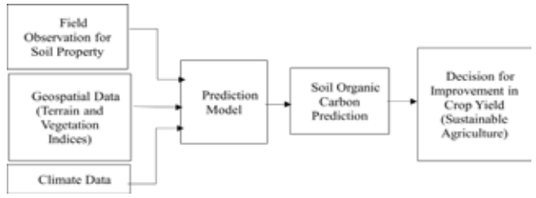

Fig. 1 Schematic Representation of Proposed Methodology for Organic Carbon Prediction Modelling

Gathering input data for machine learning model-ling required basic steps as depicted in Fig 2. Pre-processing entails actions that are typically necessary before the primary data analysis and soil information extraction. Data Extraction mainly consists of two steps one is Raster Stacking where raster get combined to retrieve predictor values and second one is Sampling raster values in which Raster values been extracted from stacked raster and stored in temporary file in format suitable for modelling.

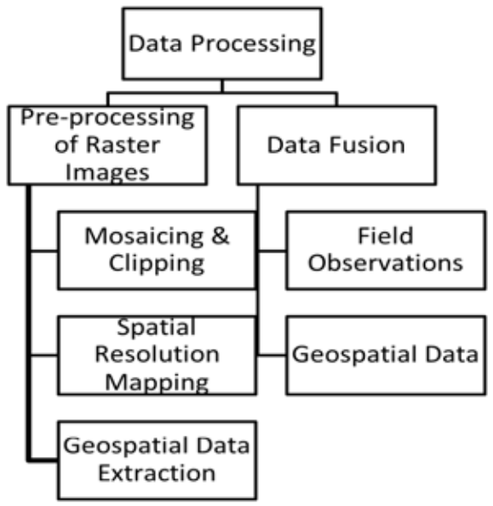

Fig. 2 Data Processing Steps

After gathering the data from different sources, that data to be used as model input was resampled. For data sampling and model analysis, we have used various Python packages.

The performance of the four models for the forecasting of the OC in the Dhamtari District of Chattisgarh, state of India was evaluated and Random Forest algorithm showed the best results as depicted in the Table 1 with and without Cross Validation (CV).

Table 4 Model Performance for Testing Dataset

ML model	With CV		Without CV	
	R^2	RMSE	R^2	RMSE
RF	0.1526	0.2175	0.1281	0.2207
SVM	0.0031	0.2359	0.0030	0.2360
KNN	0.2141	0.2604	0.2145	0.2604
Adaboost	0.0633	0.2287	0.0724	0.2447

The performance of the models in forecasting the Organic Carbon was validated by using train-test split methodology. Dataset split into two halves: 20% for testing and 80% for training. To make sure the model was stable, cross validation with 10 folds, was operated to train the dataset. To evaluate the model, two error metrics have been used, namely R2 and RMSE. R2 is the statistical measure used to assess the regression model's quality of fit. The coefficient of determination, R2 interpreted as the proportion of the variance in the dependent variable that is predictable from the independent variables. RMSE is statistical measure which implies an estimate of deviation of error.

The study's findings demonstrate how effective digital soil-mapping methods are at producing accurate soil-related data. Farmers can receive the knowledge via digital platforms and mobile applications, among other Information and Communication Technology (ICT) technologies.

Unlocking the Future of *Animal Husbandry*

How AI Is Revolutionizing Animal Health

> **AI/ML is addressing long-standing challenges in animal health and welfare, driving efficiency, sustainability, and transparency across the agricultural industry**

In the bustling world of agriculture, where every advancement counts towards efficiency and sustainability, a silent yet powerful revolution is taking place. Welcome to the age of Artificial Intelligence/Machine Learning (AI/ML) in animal husbandry—a domain where data meets innovation to tackle age-old challenges and drive unprecedented progress in animal rearing and health management.

From dairy farms nestled in rural landscapes to sprawling poultry facilities, AI/ML is making its mark, offering solutions that were once the stuff of science fiction. Let's delve into how AI/ML is transforming the landscape of animal husbandry and revolutionizing the way we care for our livestock.

Precision Livestock Farming

Imagine a farm where every animal's needs are meticulously monitored and met in real-time. This is the promise of precision livestock farming (PLF), a concept powered by AI/ML. Sensors and wearable devices equipped with AI algorithms track vital parameters such as feed intake, activity levels, and health indicators. This data is then analyzed to detect anomalies and patterns, allowing farmers to intervene early in case of health issues or optimize feeding strategies to maximize production efficiency.

Automated Monitoring and Management

Gone are the days of manual labour-intensive tasks on the farm. With AI-powered automation technologies, tasks such as milking, feeding, and monitoring can now be seamlessly automated, reducing labor costs and improving operational efficiency. Robotic milkers, automated feeding systems, and smart sensors are just a few examples of how AI/ML is transforming the way farms are managed, allowing farmers to focus on strategic decision-making rather than mundane chores.

Data-Driven Decision Making

In the age of big data, information is power, and AI/ML is the key to unlocking its potential in animal husbandry. By harnessing vast amounts of data generated from sensors, satellites, and IoT devices, AI/ML algorithms can provide valuable insights into animal behavior, productivity trends, and environmental conditions. Armed with this knowledge, farmers can make informed decisions about resource allocation, breeding programs, and health management strategies, leading to better outcomes for both animals and farmers.

Personalized Nutrition and Care

Just as humans have unique dietary needs, so do animals. AI-powered nutrition management systems analyze individual animal data to formulate personalized feeding plans tailored to their specific requirements. Whether it's optimizing protein levels for poultry or balancing mineral supplements for dairy cows, AI/ML ensures that each animal receives the nutrients it needs to thrive, leading to improved health and productivity.

Disease Detection and Prevention

One of the greatest challenges in animal husbandry is the timely detection and prevention of diseases. AI/ML is changing the game by offering predictive analytics models that can forecast disease outbreaks based on environmental factors, animal behavior, and historical data. By identifying potential hotspots and risk factors, farmers can implement targeted interventions such as vaccination campaigns or biosecurity measures to mitigate the spread of diseases and protect livestock health.

Remote Monitoring and Telemedicine

With AI-powered remote monitoring and telemedicine solutions, veterinarians can provide virtual consultations and diagnostic services to farmers, even in remote areas. This not only improves access to healthcare for livestock but also reduces the need for physical visits, saving time and resources for both farmers and veterinarians.

Environmental Monitoring and Sustainability

In an era of growing environmental concerns, sustainable farming practices are more important than ever. AI/ML technologies enable farms to monitor and manage environmental factors such as water usage, air quality, and waste management more efficiently. By optimizing resource utilization and reducing environmental impact, AI/ML helps farms operate more sustainably while ensuring the well-being of both animals and the planet.

Supply Chain Transparency and Traceability

Consumers today are more conscious than ever about the origins and production methods of the food they consume. AI/ML technologies enable farms to maintain detailed records of animal health, welfare, and production metrics, ensuring transparency and traceability throughout the supply chain. From farm to fork, consumers can have confidence knowing that the food they're consuming is produced responsibly and ethically.

By monitoring and managing individual animal behavior and health status, smart animal husbandry systems also contribute to the improvement of animal welfare standards. Farmers can identify and address potential stressors, injuries, or health issues promptly, ensuring that animals are provided with optimal care and living conditions.

The integration of AI/ML into animal husbandry represents a transformative shift in the way we care for and manage livestock for assuring food and nutritional security, conservation of resources and uplifting the rural economy. By harnessing the power of data and innovation, AI/ML is addressing long-standing challenges in animal health and welfare, driving efficiency, sustainability, and transparency across the agricultural industry. As we continue to unlock the full potential of AI/ML in animal husbandry, the future looks brighter than ever for farmers, consumers, and the animals they care for.

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New Vistas of AI

At Dr YSR Horticultural University, AP



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> **Future horticulture will become smart with novel technologies such as AI, big data, new-generation biotechnology, and IOT**

Horticultural operations are arduous and expensive, and it is challenging to get and retain the labor force in this sector. The use of robots, drones, and automated systems is the future when it comes to enhancing efficiency and productivity within the horticulture industry. To make these tasks more efficient, Dr. Y.S.R. Horticultural University, which is the second Horticultural University in the country has unleashed AI in different fields of horticulture in support of farming community.

Technologies developed at Dr. YSRHU Using AI

Smart robotic pesticide sprayer

Globally more than half of the pesticides are utilized in Asia. India stands 12th in pesticide use globally and 3rd in Asia after China and Turkey. In the last decade from 2012-13 to 2021-22, India's consumption of chemical pesticides has been an average of 58,429.7 MT. Per hectare application rate of pesticide in India is 0.31 kg. While consumption in China, Japan and America was around 13.07, 11.76 and 3.57 kg ha-1 of pesticides respectively. India applies less pesticides in per hectare of crop land area. But uncontrolled and haphazard pesticide usage is responsible for the presence of high pesticide residues in both natural and physical environment.

Automated spraying practices are inevitable for modern polyhouse management to attain a broader objective of minimizing human exposure to agrochemicals. Manual spraying struggles with the lack of human resources in polyhouses. Inspired by this problem, Scientists have developed smart robotic sprayer, which can operate autonomously on rugged conditions of the seed beds in in polyhouse environment.

This system uses sensors to determine variations in the speed and pressure of spray fluid to implement variable-rate application. Application of spray fluid was achieved through nozzles mounted at different heights based on the height of the crop in polyhouses. This robot is equipped with receiver and transmitter that ranges around 1 km radius with self-navigation using remote operated channel. The battery capacity of this sprayer can be operated for about 10-18 hours.

Soil Moisture Sensor-Based Automatic Irrigation System

Irrigation in Andhra Pradesh plays a vital role in the state's agrarian economy, given its semi-arid to sub-humid climate. The state's economy largely relies on agriculture, with about 62% of the population dependent on farming. The predominant types of irrigation in Andhra Pradesh include canal irrigation, bore-well and tube-well irrigation, tank irrigation, and minor irrigation which includes drip and sprinkler systems.

Bore-well and tube-well irrigation, often used in areas with groundwater availability, have seen substantial growth, while tank irrigation is traditional and widespread in the Rayalaseema region.

In Andhra Pradesh, agricultural sector is the largest consumer of water comprising about 70% of the total demand. Of that 70% used by farmers, 40% is lost to the environment due to poor irrigation systems, evaporation, and overall poor water management. To optimize water usage and provide uniform and required level of water for the agricultural farm, a wireless sensor-based irrigation system has been developed.

This system operates when the moisture level drops below a certain threshold (Field capacity 70%), the system sends a wireless message to the receiver unit. Once the microcontroller receives the message, the power supply to the water pump is altered to activate the pump, causing water to flow through the system and irrigate that region. When the moisture level rises above a certain level, the system sends a wireless message to the receiver unit that alters the power supply to the water pump causing water to stop flowing through the system and the pump to stop allowing water from the water source into the irrigation pipelines. The automated irrigation system can be applied to a single land section requiring irrigation or multiple land sections with differing irrigation requirements by using number of sensors.

Similarly, the pump can be operated by using temperature mode at a threshold value of 32°C. The pump can be operated either in sensor or manual modes. The real time data of soil moisture, temperature and humidity values can be monitored on mobile screen through blink application.

Automatic Hydroponic System

Globally, soil quality is decreasing, putting additional pressure on our food system. As soil degradation continues and freshwater supplies become scarce, development of farming approaches that use both land and water more efficiently and productively to grow food is essential. This need has created a niche for scientists and farmers to develop techniques to improve either land productivity or to use alternative agricultural techniques. Hydroponic farming offers a solution to many of the detriments of our world's current agricultural problems.

Hydroponic systems can be automated using Internet of Things technology is very beneficial in this regard. The hydroponics market is estimated to be valued at USD 8.1 billion in 2019 and is projected to grow at a CAGR of 12.1% through 2025.

Two of the most important aspects of hydroponic water are pH and EC levels. If they become unbalanced, the whole system goes off the rails. To avoid this hectic task of monitoring, sensor-controlled pH, EC and water system has been developed at our university in different models (rectangular, vertical, pyramid shaped) which reduce manpower to a great extent during cropping season. The sensors are linked to mobile device through Blink app for necessary adjustments as per the crop nutrient requirement. To maintain water flow, timer schedule has been assigned to submersible motor with on/off commands that can be operated hours/day/weekly basis.

Insect Pest Detection

Currently, Insect detection process is carried out by manually or by means of different trapping tools. One of the most used approaches is bare eye inspection, but for this method needs the specialist entomologist which is expensive. Deep Convolutional Neural Network (CNN) is become extensive and alternate tool for better execution and outperforms than other mainstream computer vision techniques for object detection and identification. Keeping this in view, our university NIT- Andhra Pradesh, has carried out and research on detection and monitoring of pests through Artificial intelligence (AI) were conducted using the Python software through Keras and Tensor flow frame works and for this purpose CNN VGG-16 model was used.

A total of 645 insect images were loaded and included in ten different datasets and were resized to 227_227 pixels. In the context of pest classification, the model has achieved remarkable accuracy rates ranging between 95-98% for four key stages of two important insect pests of Brinjal viz.,shoot and fruit borer (Leucinodes orbonalis (Guenee)) larvae and adults and Epilachna beetle (Epilachna vigintioctopunctata) grub and adults. In the pursuit of detecting insect classification an accuracy of 95 per cent (for 9 insect classes) and 92 per cent (for 10 insect class datasets) was predicted with F1 score of 0.89 which shows that the CNN (VGG) model is consistent in detecting the type of insect.

AI As A Subject In Horticulture

AI based learning modules have been included at under graduated level, in order to equip the young generation with up-to-date information on machine learning, drones and robotics in horticulture along with farm power, machinery and processing.

Way Forward

We expect that the horticulture industry would benefit from integration with smart technologies. This requires the use of novel solutions to build a new advanced system encompassing smart breeding, smart cultivation, smart transportation, and smart sales. As the use of technology continues to evolve, it is likely that we will see even more exciting developments in the horticulture sector in India.

Progress has been achieved in the research of certain horticultural plants, such as citrus, but the industrial applications are insufficient. Smart horticulture is still in its infancy and is divided among various companies, academic institutions, and universities. The quality and yield of horticultural crops can be increased by the combination of knowledge from industry, education, and scientific research.

Future horticulture will become smart with novel technologies such as AI, big data, new-generation biotechnology, and IOT. Horticulture industry should aim to achieve a systematic mechanistic, automated, and informational production process within the next 30 years which needs solid long-term planning in days to come.

Unleashing AI *For* Agriculture

> The future of AI in agriculture is optimistic, with ongoing research and development aimed at making these technologies more accessible and effective

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Agriculture, the bedrock of India's economy, provides livelihoods to millions and acts as the foundation of the country's food production. However, India's smallholder farmers encounter formidable challenges such as unpredictable weather patterns, pest outbreaks, diminishing yields, and post-harvest dilemmas like crop wastage, logistical hurdles, and market volatility. The traditional farming techniques, which have been the lifeline for countless generations, now face the critical challenge of balancing the escalating food demand with the imperative of environmental conservation. Amidst a burgeoning population and increasing urbanization, the agricultural sector is under pressure to innovate. This urgency paves the way for Agriculture 5.0 in India, embracing state-of-the-art technologies like sensors, big data, the IoT, robotics, and AI.

The advent of AI in Indian agriculture heralds a transformative shift towards data-driven, efficient, and sustainable farming practices. By integrating AI, we anticipate enhanced crop health, optimized resource utilization, and improved food supply chain management, directly addressing the acute challenges confronting Indian farmers. Delving into the realm of smart agriculture, here are a few key applications of AI across the globe that are pioneering a new wave of innovation in the fields:

Crop Health Monitoring and Disease Management

AI-powered health monitoring systems provide farmers with real-time information on crop health, enabling early detection of diseases or nutrient deficiencies. Technologies like hyperspectral imaging and 3D laser scanning offer precise data on plant health, facilitating timely interventions to address issues before they escalate. This proactive approach not only saves crops but also reduces the reliance on chemical treatments, promoting a healthier environment. The companies like VineView and Farmers Edge from Canada, and Taranis from Israel are leveraging AI and high-resolution imagery for efficient crop monitoring and management.

Water Resource Management

Water scarcity is a pressing issue in many agricultural regions. AI can significantly improve water use efficiency through intelligent irrigation systems. These systems analyze weather forecasts, soil moisture levels, and plant water requirements to optimize irrigation schedules and quantities. Applying water only when and where needed allows AI-powered irrigation to substantially reduce water consumption and prevent wastage. CSIRO's WaterWise technology in Australia exemplifies how AI can predict crop water needs with next-day accuracy, optimizing irrigation and showcasing AI's role in advancing sustainable agriculture practices.

Harvest Optimisation

By analysing historical yield data, weather patterns, and current crop health indicators, AI can forecast the expected harvest with a high degree of accuracy, allowing farmers to make informed decisions about harvest timing and logistics, optimising the yield and reducing post-harvest losses.

Some technologies, like Farmwave's Harvest Vision in Australia, enhance this process by using AI to monitor harvest loss in real-time, capturing images to analyze and report on-the-fly adjustments to minimize loss, demonstrating a practical application of AI in improving harvest outcomes.

Soil Monitoring

Understanding and managing soil health is crucial for sustainable agriculture. AI technologies assist in analyzing soil properties, including moisture levels, nutrient content and pH balance. Some AI models can analyse the soil sample to give an idea of the types of microbes present in the soil (for example, Trace Genomics from USA). Based on that data, recommendations can be made on what kind of fertilizers can be used to improve the quality of the soil and whether the soil contains any type of defects that need to be treated.

Real-time Weather Forecasting

Crop losses often stem from weather-related events, many of which can be mitigated with predictive weather modeling. Factors like temperature, rainfall, humidity, and solar radiation critically influence crop yields. Utilizing AI to amalgamate data from satellites, ground sensors, and weather stations enables more accurate weather forecasts (for example, Benchmark Labs from USA). This enhanced modeling provides farmers with vital information on optimal times for sowing and harvesting, helping to prevent potential losses and optimize agricultural productivity.

Weed Eradication

Advanced image recognition and deep learning algorithms empower AI systems to differentiate crops and weeds accurately. When integrated into farm machinery like tractors, these systems precisely target weeds for herbicide application, significantly reducing herbicide volumes (for example, WeedScan from CSIRO, Australia). This precise method lowers both costs and environmental impact, highlighting the importance of precision agriculture technologies in promoting crop health and yield and supporting sustainable farming methods.

AI-driven Market Insights

AI extends its benefits beyond agriculture by offering critical market insights to farmers, aiding in strategic decisions regarding crop selection and optimal selling times. Such AI tools utilize market trends, weather conditions, and agri-statistics data to predict crop prices and demand, enabling farmers to enhance profit margins and mitigate the risks of market fluctuations. This empowerment through AI-driven insights facilitates more efficient resource management and promotes environmentally sustainable farming practices, advancing smarter, future-oriented agriculture.

The AI Market In Indian Agriculture

In India, the AI market in agriculture currently valued at >50 million USD is witnessing a considerable growth. Farmers in India are increasingly adopting AI technologies for tasks like predicting weather, monitoring crops, and enhancing supply chain management. Innovators such as CropIn, AgNext, and Fasal are at the forefront, introducing solutions that boost both productivity and profits. With the Indian government's support for digital farming initiatives, the AI sector in agriculture is expected to see significant growth. At the forefront of this revolution is the Artificial Intelligence for Agriculture Innovation (AI4AI) initiative, which is a collaborative effort between the World Economic Forum India's Centre for the Fourth Industrial Revolution, India's Union Ministry of Agriculture and the state of Telangana.

One of the success stories of this initiative is Saagu Baagu, which is implemented in the Khammam district of Telangana with the support of the Bill and Melinda Gates Foundation. The project leveraged AI, drones, and blockchain to improve the chilli value chain for more than 7,000 farmers. The success of Saagu Baagu is manifold: farmers saw their net incomes double, chilli yields increase by 21%, and a reduction in pesticide and fertilizer usage. This not only improved the sustainability of their practices but also the quality of their produce, which in turn increased market prices. The initiative's scale-up to include 500,000 farmers across multiple districts is a testament to AI's enormous potential and scalable nature in agriculture.

The future of AI in agriculture is optimistic, with ongoing research and development aimed at making these technologies more accessible and effective. As AI tools become more sophisticated and farmers become more adept at using them, we can anticipate even more significant improvements in food security, environmental sustainability, and the economic viability of farming.

However, the adoption of AI in agriculture faces hurdles such as the high cost of technology, the need for substantial digital infrastructure, and the imperative for farmer education on AI usage. Moreover, data privacy issues and the risk of widening the digital divide between large and small-scale farmers present significant concerns that must be addressed.

Looking forward, the path to fully unleashing AI's potential in agriculture will involve concerted efforts between state governments, academic institutions, local communities, and industries to overcome these barriers, innovative research to tailor AI solutions to diverse farming needs, and policies that ensure equitable access to technology. As we navigate these challenges, the promise of AI in revolutionizing agriculture remains a beacon of hope for a sustainable, productive, and food-secure future in India.

Tech for Growth

Samunnati's Vision for AI-Powered Agriculture in India

> AI offers hope, harmonizing traditional wisdom with modern farming practices

ABOUT THE AUTHOR

Mr Anil Kumar SG is the Founder & CEO of Samunnati, India's largest agri enterprise aiming to unlock the trillion dollar potential of Indian agriculture, with smallholder farmers as the focus.

At first glance, the marriage of agriculture and AI may seem incongruous, like the meeting of tradition and modernity. However, delve deeper, and one finds a harmonious synergy, where the wisdom of generations meets the precision of algorithms.

India's agriculture sector is undergoing a significant transformation, driven by the fusion of smart farming practices and emerging trends, along with traditional farming knowledge. The rise of artificial intelligence presents a unique opportunity to revolutionise agriculture and empower Indian farmers facing numerous challenges, from mausam (unpredictable weather) to mandi (market fluctuations).

At Samunnati, we are dedicatedly advancing along this transformative journey, positioning ourselves as early adopters and proponents of AI to drive growth, sustainability, and inclusivity in agriculture.

Some Use Cases For AI

The integration of AI into both global and Indian agriculture encompasses a wide range of applications, including pest and weed detection, agricultural robotics, crop health assessment using drones, precision farming through predictive analytics, and AI-driven crop price forecasting. These advancements are not only transforming farming practices, but also setting new standards for efficiency and sustainability.

One notable example is technology for predictive maintenance (PdM), which automatically initiates maintenance based on signals from equipment using sensors and measuring devices. In precision agriculture, PdM yields invaluable real-time insights into crop health, nutrient levels, disease spread, and climate conditions.

The integration of AI is poised to revolutionise supply chain management, both in the procurement of inputs (fertilizers, seeds, pesticides) and output (harvest, processing, marketing). By analysing historical data and market trends, AI algorithms accurately predict agricultural product demand, ensuring transparency and traceability throughout the supply chain.

The adoption of AI in agriculture involves two stages: product development and commercialization, requiring collaboration between startups, industry, academia, and policymakers. The Indian government has shown interest in this area, with initiatives such as establishing Centers of Excellence (CoEs) for AI in top educational institutions.

Initiatives like Tamil Nadu's 'Uzhavan' app and Telangana's digital authentication systems demonstrate AI's potential to address rural challenges, offering solutions tailored to local languages and contexts. Other initiatives such as Agristack, digital soil-health cards, and the eNAM platform signify a move towards a data-driven, transparent, and efficient agricultural ecosystem.

For organisations like Samunnati, AI presents an invaluable possibility for assessing risk and identifying opportunities to offer value-added services to Farmer Producer Organisations (FPOs) and farmer collectives.

However, it's essential to view AI as a tool rather than a solution to all problems. Contextual data, farming practices, and local conditions must accompany technologies like satellite imagery to ensure their effectiveness. Therefore, a phased and community-involved adoption strategy is crucial to maximize AI's benefits.

Reality Check

Currently, Indian farmers shoulder all risks associated with their endeavours. The uncertainty surrounding income from produce, exacerbated by perishable goods and inadequate storage facilities, adds complexity. Affordability, therefore, emerges as a paramount concern for farmers considering breakthrough technologies like AI.

Sustainability is another critical concern. Rampant pollution resulting from fertiliser and pesticide use underscores the need for eco-friendly methods. Technological solutions aim to optimise input usage, but achieving broader sustainability goals remains elusive.

Additionally, bridging the credit gap with AI presents a significant challenge. Underserved farmers face a credit gap, as traditional scoring models may fail to capture the complexities of rural farming. AI, with its ability to analyse vast datasets and uncover patterns, offers a promising solution. Integrating AI into underwriting processes can promote financial inclusion in critical sectors, ensuring that agriculture remains a priority and farmers receive the support they need.

Is AI a solution?

Despite the strides made in fostering an AI-enabled ecosystem, several challenges hinder a seamless transition from legacy systems to advanced technologies that can enhance human capabilities. Some of these challenges are outlined below.

Lack of digital literacy: Addressing information asymmetry and upskilling small and marginal farmers is essential to overcoming scepticism and promoting the adoption of AI-enabled technologies in agriculture.

Existing gaps in public AI research: India primarily concentrates its AI research initiatives in a few institutions as the Indian Institutes of Technology (IITs). However, only a handful of researchers are engaged in agriculture-related AI innovations. While India ranks third globally in AI research publications, practical application is unable to catch up due to resource and administrative constraints, siloed research approaches, and inadequate computing infrastructure.

Low data quality and limited access: AI relies heavily on quality data, which poses a challenge as many datasets are disaggregated and inaccessible. Much of the agriculture data is only held by government bodies, necessitating startups to actively compile data for their systems. This diverts resources from R&D efforts.

Limitations to upscaling: Most players and startups in the agricultural value chain focus on downstream or midstream segments, leaving the market highly fragmented. Large corporations, with their brand value, have an edge over startups, creating a dependent relationship with farmers and hindering domestic innovation.

Looking Ahead: A Sustainable Future

In India, agriculture isn't just an economic pillar; it's a lifeline, sustaining 58% of the population and making a substantial global contribution to agricultural value. Despite challenges such as unpredictable weather and fragmented land holdings, the sector remains indispensable.

However, Artificial Intelligence offers a glimmer of hope, harmonizing traditional wisdom with modern farming practices. At Samunnati, investment transcends technology, nurturing farmers' aspirations for sustainable futures. With AI, we're not just observers of a revolution; we're actively shaping it to ensure that Indian agriculture flourishes as vibrantly as our cherished soil.

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Empowering Smallholder Farmers

In recent years, AI has been applied across various fields, including farming. This has led to a revolution in traditional farming practices, resulting in a new era of 'precision agriculture.' Advanced technologies like drones, sensors, and satellite imagery are being used to accurately monitor crop health, soil conditions, and weather patterns. This has helped farmers to optimize inputs like water, fertilizers, and pesticides while minimizing waste, ultimately increasing efficiency and yields. The use of AI-powered predictive analytics has also empowered farmers with valuable insights into crop diseases, pest infestations, and market trends. This enables them to anticipate challenges and make informed decisions to mitigate risks, leading to a more sustainable and prosperous future for farmers and their communities.

AI has also facilitated the development of smart farming systems, integrating Internet of Things (IoT) devices and AI algorithms to create interconnected networks that automate various farming tasks and optimize operational efficiency. AI-powered robotic systems autonomously plant seeds, weed fields, and harvest crops, reducing labour costs and increasing productivity. These systems also monitor livestock health and behaviour, enabling early detection of diseases and improving overall animal welfare. Overall, the integration of AI technologies in agriculture holds the promise of transforming traditional farming practices, making them more efficient, sustainable, and resilient in the face of evolving environmental and economic challenges.

Vital Role Of AI

However, while AI's applications in agriculture are vast and diverse, its role in advisory services, particularly in the context of Digital Public Information (DPI) systems, stands out as a cornerstone of empowering smallholder farmers. These AI-powered platforms, driven by Large Language Models (LLMs) like GPT-4, have revolutionized the way farmers access information and make decisions.

By delivering contextual, gender-responsive, and climate-smart advisories in local languages, these platforms ensure that farmers receive tailored advice that addresses their unique challenges and circumstances. By leveraging advanced technologies such as speech-to-text transcription, language translation, and content retrieval processes, these platforms enable seamless interactions with farmers, regardless of their digital literacy levels.

> AI is democratizing access to knowledge, optimizing resource utilization, and promoting sustainable practices

Additionally, AI-powered advisory networks facilitate the dissemination of site-specific recommendations for crop management, irrigation, and livestock rearing, thereby optimizing resource utilization and promoting sustainable farming practices. Through these innovative solutions, AI is democratizing access to knowledge, optimizing resource utilization, and promoting sustainable practices, empowering millions of smallholder farmers and ensuring food security and economic prosperity for generations to come.

AI-Driven Solutions

One of the most significant advantages of AI-powered DPIs is their ability to drastically enhance the cost-effectiveness of advisory services. Unlike traditional extension methods, which incurred substantial costs per adoption of new practices, AI-driven solutions have the potential to significantly reduce the cost per adoption, making valuable agricultural insights accessible even to the most resource-constrained farmers.

As global concerns about environmental sustainability escalate, the role of AI in promoting sustainable farming practices becomes increasingly vital. By optimizing resource use, reducing chemical inputs, and advocating for regenerative agriculture, AI contributes to the preservation of natural resources and ecosystems. This is particularly crucial for smallholder farmers who rely heavily on the land for their livelihoods, as embracing sustainable practices not only ensures long-term productivity but also fosters environmental stewardship for future generations.

Moreover, AI-powered DPIs prioritize quality and customization, ensuring that farmers receive tailored advice in their local languages. Unlike rigid, pre-scripted responses, AI assistants draw upon vast databases of scientifically vetted advisory data to provide immediate and relevant recommendations, addressing the unique challenges faced by farmers across different regions and crop value chains.

These AI-driven networks leverage advanced technologies such as speech-to-text transcription, language translation, and content retrieval processes to enable seamless interactions with farmers. By incorporating various input formats including text, voice, photo, or video, these platforms ensure that farmers can effectively communicate their queries, regardless of their digital literacy levels.

Furthermore, AI-powered advisory networks facilitate the dissemination of site-specific recommendations for crop management, irrigation, and livestock rearing, thereby optimizing resource utilization and promoting sustainable farming practices. By harnessing the power of growing agricultural data ecosystems, these networks enable the publication and sharing of relevant content while ensuring adherence to governance standards set by state and national-level authorities.

In a landscape where agricultural practices must adapt to climate variability and change, AI plays a pivotal role in building climate resilience. Through predictive analytics, AI processes vast amounts of data, from historical weather patterns to market trends, offering insights that help farmers anticipate challenges and implement mitigation strategies. By empowering farmers to proactively address risks associated with climate change, AI ensures a steady harvest and safeguards livelihoods against the uncertainties of nature and market fluctuations.

VISTAAR

In India, the introduction of VISTAAR (Virtually Integrated System to Access Agricultural Resources) reflects the country's commitment to inclusive and sustainable farming practices. This open-source platform, spearheaded by the Department of Agriculture and Farmer Welfare, Government of India, aims to democratize access to vital agricultural information, inputs, financial services, and market intelligence. By leveraging AI-driven technologies, VISTAAR seeks to bridge the gap between research institutions, extension agencies, and smallholder farmers, thereby fostering agricultural productivity and resilience in the face of climate change.

As India continues its journey towards agricultural transformation, the integration of AI-powered advisory services holds immense potential to revolutionize the sector. By democratizing access to knowledge, optimizing resource utilization, and promoting sustainable practices, these innovative solutions are poised to empower millions of smallholder farmers, ensuring food security and economic prosperity for generations to come.

Future Beholds for AI in Agriculture

> For AI in agriculture to succeed, it is imperative to make local level data, local level solutions and local level contexts for AI to learn and train from

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Mr Krishnan Pallassana is the Chief Executive of Grameen Foundation in India. He is a sustainable development strategist, thinker and practitioner with over two decades experience in India, Nepal, Bangladesh and Afghanistan. He has helped organisations design disruptive innovations and deliver impactful solutions at scale.

According to the United Nations' prediction data on population and hunger, the world's population will increase by 2 billion people by 2050, requiring a 60% increase in food productivity to feed them. An estimated 80 percent of all farmers are small scale producers, having less than 5 acres of land and accounting for one-third of the global food production. Small scale producers keep the rural economic engine running, by ensuring grassroots food security, productivity, and employment.

Farming Is Complex, Dynamic And Data Driven

Farming is a complex process that depends on a variety of indefinite but factors and interdependent variables including land, soil, water and weather. Farmers must have accurate and timely insights around weather, seasonal changes, migratory patterns of animals, birds and insets, fertilizer composition, availability of water, irrigation and drainage, knowledge on pesticides – crop by crop, season by season, location by location.

Agriculture is such a localised subject and vocation that what works in one village or location may not work on the neighbouring village. While they must deal with so much uncertainty in production, similar challenges await them in post-harvest market outreach too. With increasing impact of climate change, farmers are becoming more vulnerable to increased risks and threats.

Farm level data, that traditionally farmers carried in their head and took decisions are becoming more complex and dynamic. With data dictating decisions and outcomes, success in agriculture has become more dependent on farmers ability to organise, understand and use data. That is where Artificial Intelligence can play a significant role for farmers to enhance their productivity, income and ability manage risks.

AI for Agriculture

AI is the technology that enables computing machines to simulate human intelligence and problems solving capabilities. Advent of OpenAI's ChatGPT has further enabled abstractness of human thinking into machine learning, and along with conversational AI using Large Language Models (LLM), is expected to transform the way business and society works in the coming days.

What does it mean for agriculture sector? Will AI be as effective in agriculture as it is in other sectors? Can farmers find value in it by enabling higher productivity, higher income and reduced exposure to risks? These are some of the questions and considerations around discourses around use and application of AI for decision support in agriculture.

Intelligence in AI comes from data. More the data and interactions, better does the AI engine gets trained and better the results will be. Yield mapping, crop prediction, real/near time weather forecast, pest management, traceability and market price predictions are some of the immediate applications of AI in agriculture that combines other technologies including satellite imaging and drones. However, these are useful for large scale applications and institutions than for an average individual small scale producer farmer.

Organisations like Digital Green, KissanAI, Wadhwani AI, EkStep and Sygenta are already investing in finding AI enabled solutions based on both generative and conversational models. Targeting farmers, grassroots agents, farmers collectives and the farming community at large, such solutions are at early stages of maturity but is poised to grow by leap and bounds in the days to come.

Challenges for AI in Agriculture

The biggest problem in agriculture is that due to its highly localised nature, there is not enough data in the larger ecosystem for AI to consume and comprehend. Unless the highly scattered information bases are opened up and made available in the internet space, advancement of AI in agriculture space will be slow. Till then, farmers may not get contextualised solutions for their localised problems as the answers through AI engine may not be relevant or tailor made to meet their specific needs.

For AI in agriculture to succeed, it is imperative to make local level data, local level solutions and local level contexts for AI to learn and train from. This calls for larger investments to create, catalogue and store contents for a variety of crops, geographies, situations and contexts. Additionally, the scientists and researchers have to be trained help AI help farmers. Unless that happens, farmers will be better off to depend on local resources that are nearer to them to seek opinion and advice.

For Indian agriculture system with hundreds of universities, 730 odd Krishi Vigyan Kendras and thousands of scientists on ground, AI can be a huge assistance for the scientific and research community. AI can help arrive at faster solutions, avoid duplication and usher higher efficiencies.

AI can perhaps never replace the knowledge and wisdom farmers have accumulated. However, AI can surely help farmers to take much better data-based decisions that will help them utilise resources and opportunities in a much better way. It does augur well for both farmers and the world at large. For AI in agriculture, a great future beholds!

Haryana

Fears Of Water Scarcity And Proposed Solutions

Haryana is facing the twin problem of water shortage-depletion of groundwater on one hand and flooding-water logging on the other. Let's discuss the expectations, specifically for water conservation and environmental protection.

Haryana's Water Resources

Surface water is limited and groundwater is declining sharply in most parts of the state. The state is leading to water scarcity.

According to the Integrated Water Resources Plan (IWRP)-2023-26 of Haryana prepared by Haryana Water Resources Authority (HWRA), the total water demand of the state is estimated to be 35 BCM (Billion Cubic Meters) whereas total water availability from all sources including surface water, groundwater and treated wastewater is only 21 BCM. That means the annual water shortage in the state is 14 BCM. Water conservation is a critical need of the day.

One, groundwater level in Haryana is depleting fast due to the over extraction exceeding the annual recharge. Second, water logging conditions have created salinity problems and this has made the water unfit both for drinking and agriculture.

HWRA data reveals that out of 7,287 villages, 3,041 villages (42%) are groundwater stressed and 421 villages (6%) are affected by water logging. Both these situations require urgent attention so that the sustainability of water is achieved without adversely impacting food grain production. Out of the 141 blocks, 85 have been categorized as 'Over-exploited', 12 as 'Critical', 14 as 'Semi-Critical', and 30 as 'Safe'.

The agricultural sector consumes 85% of water. Water-intensive crops like paddy, sugarcane and wheat are responsible for groundwater shortage in the state. There is a great need to adopt technological advancements in agriculture sector and crop diversification. The state government is taking steps for water conservation by expanding the area under micro irrigation, emphasis on direct sowing of rice (DSR), effective implementation of natural farming, re-use of treated waste water, groundwater recharge and modernization of channels. But a lot more needs to be done.

Concerns Regarding Water Scarcity

Let us study water availability vis-a-vis water demand of four districts of Haryana in NCR - Faridabad, Palwal, Gurgaon and Mewat. The main sources of water are rainfall, canal water and groundwater. The rainfall is scanty and uneven. Agra canal and Gurgaon canal offtaking from Okhla barrage Delhi irrigates 1.57 Mha (Million Hectare) area in these districts. But these districts are facing acute water issues both quantity-wise and quality-wise.

Yamuna at Okhla barrage has on average 3000-5000 Cs (Cubic feet per second) flow during non-monsoon season. Out of which Haryana gets only 400-450 Cs water through Agra canal and Gurgaon canal against the allocated water share of 600-700 Cs. W

These areas are also not getting their allocated share from Ravi-Beas River due to non-construction of SYL canal. Thousands of Cs of excess flood water pass out during monsoon season devasting their crops and habitation. Farmers extract groundwater to meet water demands for crops, due to which the water level is going down by 1 to 2 feet every year. Out of the 20 blocks of these four districts, 10 have been categorized as 'Over-exploited', 4 as 'Critical', 2 as 'Semi-Critical', and 4 as 'Safe'. Thus, these districts are facing acute water scarcity.

Due to wrong practices over decades, Yamuna water is highly polluted, toxic and poisonous. Quality parameters such as Biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), total coli-forms, sulphates, nitrates, total dissolved solids TDS and electrical conductivity etc exceed permissible limits. The presence of high traces of toxic and heavy metals such as cadmium, chromium, copper, nickel, ferric, lead and zinc have adversely affected the aquatic species of the river and also lead to increase in health risks such as cancer, skin and other waterborne diseases. This poisonous water has become part of our food chain. Many deaths have been reported in the recent years due to cancer in many villages located near Agra canal.

ABOUT THE AUTHOR

Dr Shiv Singh Rawat is a former Superintending Engineer of Haryana Irrigation and Water Resources Department. He organized "Walk For Yamuna" (#WFY) program. He walked on foot along the Yamuna from Delhi-Faridabad border to Haryana-UP border during December 2023 to create mass awareness to save Yamuna

> Gurgaon has lost highest forest cover in recent years followed by Faridabad, Mewat and Palwal. It is a matter of grave concern

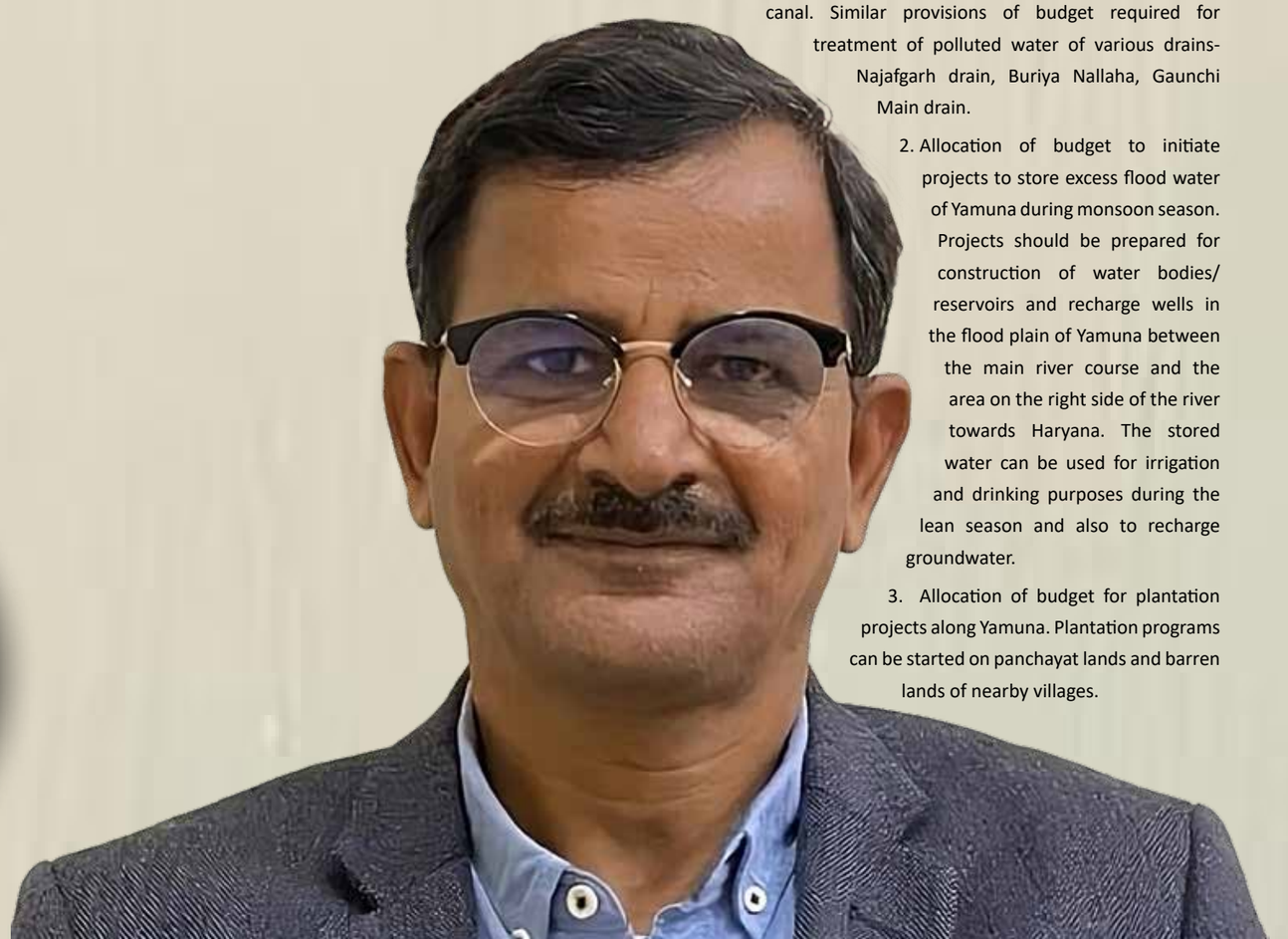
Environmental Concerns

According to the National Forest Policy of India, the ideal percentage of total geographical area under forest should be at least 33% to maintain ecological stability. However, currently the forest cover is just 24.62% and is shrinking rapidly. The forest cover in Haryana is 1603 square km which is only 3.63 percent of the total geographical area of the state.

Gurgaon has lost highest forest cover in recent years followed by Faridabad, Mewat and Palwal. It is a matter of grave concern. Increasing population, urbanization and shrinking forest areas are the alarming signs of climate change and global warming for the society and the government. There is an urgent need to increase forest area through massive plantation drives.

The state should incorporate the following projects for water conservation and environment protection:

1. Allocation of budget for treating and cleaning the highly polluted water of Yamuna River; Agra Canal and Gurgaon canal. Similar provisions of budget required for treatment of polluted water of various drains-Najafgarh drain, Buriya Nallaha, Gaunchi Main drain.
2. Allocation of budget to initiate projects to store excess flood water of Yamuna during monsoon season. Projects should be prepared for construction of water bodies/ reservoirs and recharge wells in the flood plain of Yamuna between the main river course and the area on the right side of the river towards Haryana. The stored water can be used for irrigation and drinking purposes during the lean season and also to recharge groundwater.
3. Allocation of budget for plantation projects along Yamuna. Plantation programs can be started on panchayat lands and barren lands of nearby villages.



AI In Indian Agriculture

Vital For Grassroots

It is essential to ensure that AI solutions are accessible, affordable, and tailored to the diverse needs of smallholder farmers across different regions of the country

ABOUT THE AUTHOR

Ms. Priyanka Jha is an Environmental Specialist, working with National Mission for Clean Ganga (Namami Gange) at the Ministry of Jal Shakti, Department of Water Resources, GOI. She is largely responsible for implementation of interventions under Arth Ganga, one of the key pillars of Namami Gange

The AI revolution in India represents a transformative shift across various sectors, driving innovation, economic growth, and societal development. AI technologies are transforming industries such as healthcare, finance, retail, manufacturing, and agriculture. AI-powered solutions enable automation, optimization, and data-driven decision-making, leading to improved efficiency, productivity, and competitiveness. India has emerged as a hub for AI innovation, with a growing ecosystem of startups, research institutions, and technology companies.

These entities are developing cutting-edge AI solutions tailored to the Indian context, addressing local challenges and driving global impact. The AI revolution is fostering entrepreneurship and creating new job opportunities across various sectors. Startups are leveraging AI to disrupt traditional business models, while established companies are investing in AI-driven initiatives to stay competitive in the digital economy.

The Indian government has recognized the strategic importance of AI and has launched initiatives to promote its adoption and development. Programs such as the National AI Mission, Startup India, and Digital India are aimed at fostering AI innovation, research, and entrepreneurship. AI technologies are being used to enhance governance, public service delivery, and citizen engagement. Applications such as predictive analytics, smart cities, and e-governance platforms improve the efficiency and effectiveness of government operations, leading to better outcomes for citizens. India's academic institutions are at the forefront of AI research and education. Universities and research labs are conducting cutting-edge research in areas such as machine learning, natural language processing, computer vision, and robotics, nurturing the next generation of AI talent.

Potential To Address Diverse Challenges

AI has the potential to address pressing social challenges in India, such as healthcare access, education quality, agriculture productivity, and environmental sustainability. AI-driven solutions can empower marginalized communities, improve service delivery, and drive inclusive growth. As AI adoption grows, there is increasing emphasis on ethical considerations, privacy protection, and regulatory frameworks.

India is developing guidelines and policies to ensure responsible AI development and deployment, balancing innovation with ethical considerations. Overall, the revolution of AI in India represents a significant opportunity to drive inclusive and sustainable growth, foster innovation and entrepreneurship, and address complex societal challenges. By harnessing the power of AI in a responsible and ethical manner, India can position itself as a global leader in the AI revolution and unlock new opportunities for prosperity and well-being.

Unleashing the power of AI for Indian agriculture has the potential to revolutionize the sector, addressing challenges such as food security, climate change resilience, and sustainable farming practices.

Helping Small And Marginal Farmers

Small and marginal farmers in India constitute a significant portion of the agricultural workforce and play a crucial role in the country's food security and rural economy. They typically own or cultivate less than 2 hectares of land. Their landholding size is often insufficient to sustain their families, leading to low agricultural productivity and limited economies of scale. They face challenges in accessing essential resources such as credit, irrigation, quality seeds, fertilizers, and technology. They often rely on rain-fed agriculture and traditional farming methods, which are susceptible to climate variability and yield fluctuations. Due to factors like unpredictable weather patterns, market fluctuations, and rising input costs, they experience income instability. They may struggle to cover their production costs and are vulnerable to debt traps and financial distress.

Many small and marginal farmers lack access to basic infrastructure such as roads, markets, storage facilities, and extension services. This hampers their ability to transport and sell their produce efficiently and access timely agricultural information and support.

They often belong to socially marginalized communities, including Scheduled Castes, Scheduled Tribes, and Other Backward Classes. They face discrimination, landlessness, and limited access to education, healthcare, and other social services. They may engage in unsustainable agricultural practices, leading to soil degradation, deforestation, water scarcity, and loss of biodiversity. They often lack awareness and incentives to adopt conservation measures and climate-smart agriculture practices.

They typically lack bargaining power and market linkages, making them vulnerable to exploitation by middlemen and traders. They may receive low prices for their produce and face challenges in accessing formal markets and value chains. Government policies and institutional frameworks may not adequately address the needs and priorities of small and marginal farmers. There is a lack of targeted support programs, land reforms, extension services, and risk mitigation measures tailored to their specific circumstances.

Despite these challenges, small and marginal farmers demonstrate resilience, innovation, and resourcefulness in coping with adversity. Efforts to empower and support them through targeted interventions such as credit facilities, agricultural extension services, market linkages, land tenure reforms, and climate-smart technologies can enhance their livelihoods, improve food security, and promote inclusive rural development in India. Additionally, initiatives to strengthen farmer producer organizations, promote collective marketing, and ensure social protection can help address the vulnerabilities faced by small and marginal farmers and enable them to thrive in a rapidly changing agricultural landscape.

Leveraging AI For Smallholder Farmers

The utilization of Artificial Intelligence (AI) for small and marginal farmers in India holds immense potential to address various challenges and enhance agricultural productivity. Here's how AI can be leveraged for the benefit of smallholder farmers:

Precision Farming: AI-powered technologies such as satellite imagery, drones, and sensors can provide small and marginal farmers with precise information about soil health, crop growth, and pest infestations. By analyzing this data, farmers can optimize the use of inputs like water, fertilizers, and pesticides, resulting in increased yields and reduced costs.

Crop Monitoring and Management: AI algorithms can analyze data from sensors and IoT devices deployed in the field to monitor crop health, detect diseases, and predict yield outcomes. This enables farmers to take timely corrective actions, such as adjusting irrigation schedules or applying targeted treatments, to improve crop productivity.

Weather Forecasting and Climate Resilience: AI models trained on historical weather data can improve the accuracy of weather forecasting, helping farmers anticipate and prepare for climate-related risks such as droughts, floods, and extreme temperatures. This enables farmers to adopt adaptive strategies and mitigate the impact of adverse weather conditions on their crops and livelihoods.

Crop Selection and Planning: AI-driven decision support systems can analyze factors such as soil type, climate conditions, market demand, and input costs to recommend suitable crop varieties and planting schedules for smallholder farmers. This helps optimize resource allocation and diversify income streams, thereby increasing resilience to market fluctuations and climate variability.

Market Access and Price Optimization: AI technologies can provide small and marginal farmers with market intelligence and price forecasting, enabling them to make informed decisions about when and where to sell their produce for the best prices. Additionally, AI-powered platforms can facilitate direct linkages between farmers and buyers, reducing reliance on intermediaries and improving market access.

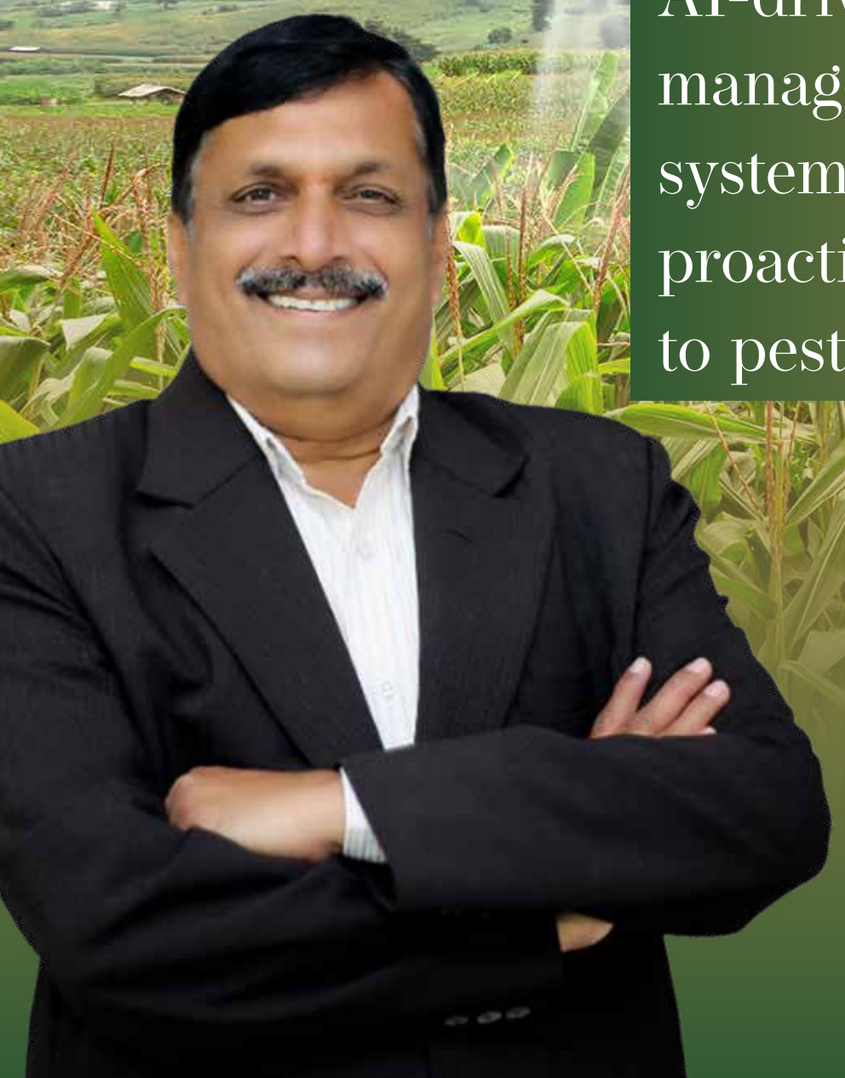
Financial Inclusion: AI-based credit scoring models can assess the creditworthiness of smallholder farmers based on alternative data sources such as crop yields and transaction histories. This enables financial institutions to offer tailored loan products and insurance services to farmers, promoting financial inclusion and risk management.

Capacity Building and Extension Services: AI-driven mobile applications and chatbots can deliver personalized agronomic advice, training materials, and extension services to smallholder farmers, even in remote areas with limited access to agricultural extension offices. This empowers farmers with knowledge and resources to adopt best practices and improve their farming techniques.

Collaborative Platforms and Knowledge Sharing: AI-enabled platforms can facilitate peer-to-peer knowledge sharing, collaboration, and collective action among smallholder farmers, agricultural experts, and other stakeholders. By connecting farmers with each other and with relevant information and resources, AI promotes learning, innovation, and community empowerment.

By harnessing the power of AI, Indian agriculture can become more resilient, sustainable, and productive, contributing to food security and rural development while minimizing environmental impact. However, it's essential to ensure that AI solutions are accessible, affordable, and tailored to the diverse needs of smallholder farmers across different regions of the country. Collaboration between government agencies, research institutions, technology providers, and farmers' organizations is key to realizing the full potential of AI in Indian agriculture.

AI
The Future Is Here And Now



> AI-driven pest management systems offer a proactive approach to pest control

ABOUT THE AUTHOR

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As India marches towards a future powered by innovation and technology, the agricultural sector stands at the cusp of transformation. With the population burgeoning and climate change casting uncertainties on traditional farming practices, there's an urgent need to unlock the potential of Artificial Intelligence (AI) to bolster productivity, sustainability, and resilience in Indian agriculture.

In this narrative, we delve into the myriad ways AI is poised to revolutionize the sector, with a spotlight on soil health management, optimized irrigation strategies, drone technology utilization, and the customization of fertilization practices.

AI for Soil Health Management

The health of soil underpins the success of agricultural endeavors. Here, AI emerges as a potent ally, offering sophisticated tools to monitor, analyze, and enhance soil health. Utilizing a plethora of data points ranging from soil composition and moisture levels to microbial activity, AI algorithms provide farmers with actionable insights into soil fertility and structure.

By leveraging machine learning, these algorithms predict soil nutrient deficiencies, salinity issues, and erosion risks, enabling preemptive measures to be taken.

Moreover, AI-powered soil sensors deployed across farmlands continuously monitor soil conditions, transmitting real-time data to farmers' devices, thereby facilitating timely interventions and optimizing resource utilization.

Optimized Irrigation Strategies with AI

Water scarcity poses a significant challenge to Indian agriculture, necessitating the adoption of precision irrigation techniques. AI-driven irrigation management systems offer a solution by enabling farmers to optimize water usage while maximizing crop yields. Through the integration of weather forecasts, soil moisture sensors, and crop water requirements, AI algorithms generate tailored irrigation schedules that account for factors such as evapotranspiration rates and rainfall patterns.

Moreover, AI-powered predictive analytics anticipate water stress in crops, allowing for proactive irrigation adjustments. This not only conserves water but also minimizes nutrient leaching and soil erosion, thereby promoting sustainable agricultural practices.

Drone Technology Revolutionizing Agriculture

The proliferation of drone technology heralds a new era in agriculture, where aerial intelligence transforms farming practices. Equipped with high-resolution cameras, multispectral sensors, and AI-powered image analysis algorithms, drones offer a bird's-eye view of farmlands, enabling farmers to monitor crop health, detect pests and diseases, and assess field conditions with unparalleled precision. AI algorithms process drone-captured imagery to generate detailed vegetation maps, identifying areas of stress or infestation.

Furthermore, drones equipped with precision spraying systems deliver targeted interventions, reducing chemical usage and minimizing environmental impact. By augmenting human capabilities and enhancing operational efficiency, drones powered by AI are revolutionizing crop management practices in Indian agriculture.

Tailored Fertilization Practices with AI

Fertilization plays a pivotal role in ensuring optimal crop growth and yield. AI-driven fertilizer management systems leverage data analytics and machine learning to customize nutrient application based on soil characteristics, crop requirements, and environmental conditions. Soil and plant tissue analysis, coupled with historical yield data, inform AI algorithms to generate personalized fertilization recommendations for each field.

Moreover, real-time monitoring of nutrient levels enables dynamic adjustments to fertilizer application rates, ensuring precise dosing and minimizing waste. By tailoring fertilization practices to specific agronomic contexts, AI optimizes nutrient utilization efficiency, reduces input costs, and mitigates environmental pollution associated with excessive fertilizer use.

Integrated Pest Management with AI

Pest and disease outbreaks pose formidable challenges to Indian farmers, threatening crop yields and livelihoods. AI-driven pest management systems offer a proactive approach to pest control, leveraging predictive analytics and decision support tools to mitigate risks.

By analyzing vast datasets on pest life cycles, environmental factors, and crop susceptibility, AI algorithms forecast pest outbreaks and recommend targeted interventions. Drones equipped with thermal imaging cameras detect pest infestations at an early stage, enabling precise localized treatment. Furthermore, AI-powered pest identification apps empower farmers to identify and monitor pest species accurately, facilitating timely response measures. By integrating AI into pest management strategies, Indian farmers can reduce reliance on chemical pesticides, minimize crop losses, and promote ecosystem balance.

Block chain for Transparent Supply Chains

In an era marked by heightened consumer awareness and demand for transparency, blockchain technology emerges as a powerful tool to trace the journey of agricultural products from farm to fork.

By recording every transaction and movement along the supply chain in an immutable ledger, blockchain ensures transparency, authenticity, and accountability. AI algorithms analyze blockchain data to provide consumers with real-time information on the origin, quality, and sustainability credentials of agricultural products.

Moreover, smart contracts embedded in blockchain facilitate secure and automated transactions, streamlining payments and reducing transaction costs for farmers. By fostering trust and accountability in the agricultural value chain, blockchain powered by AI promotes fair trade practices and enhances market access for Indian farmers.

Organic Farming

Crucial Role of AI and AgTech

> The future of agriculture will be closely integrated with AI to ensure the effective implementation of sustainable practices

ABOUT THE AUTHOR

Mr. Satyajit Hange is Co-founder Farmer of Two Brothers Organic Farms

Organic farming, characterized by its emphasis on sustainability, natural practices, and minimal use of synthetic inputs, will emerge as one of the major sources of feeding the global population which is projected to reach 9 billion by 2050.

The role of sustainable farming practices which are increasingly gaining popularity among consumers and farmers due to their health and environment-linked benefits will play a key role in satiating the global food demand. India, with its rich tradition of organic farming, is well-positioned to lead the world to sustainable food production.

Integrating AI With Farming Practices

Integrating Artificial Intelligence with farming practices is emerging as a game-changer in organic farming. Typically, AI-backed farming solutions are increasingly helping address issues related to crop yield and quality while promoting sustainable agricultural practices. Such developments have further prompted several AgTech startups based in India to integrate the best of AI with organic farming to transform the Indian agricultural landscape that is touted as the second-largest in the world and generates employment for half of India's current population.

Even a recent report by Nasscom-Ernst & Young stated that artificial intelligence is anticipated to transform the landscape of Indian agriculture. The sector can significantly reduce waste, improve produce quality, and support faster market access if it embraces data-driven organic farming practices and resorts to AI-backed agri solutions.

Far-Reaching Impact

Technological advancement's implementation in agriculture could be far-reaching. Here's how the same is currently transforming different aspects of modern-day organic farming.

Precision Farming

As per a report shared by the European Space Agency, the practice of precision farming can help farmers lower their input costs by a sharp 20% and help increase their crop yields by 10%. AI-powered precision farming methods are known to aid organic farmers in optimizing the use of agri inputs. Essentially, farmers use sensors and drones equipped with AI to monitor things such as soil moisture, crop health, nutrient levels, and even weather patterns in real-time. For instance, AI algorithm factors in soil data to offer tailored solutions to improve soil fertility and nutrient levels.

Similarly, with the help of the retrieved data, farmers optimize the use of manure and existing irrigation methods or schedules, improve pest control strategies, and reduce wastage.

Pest and Disease Management Using Predictive Analytics

With advancements in image recognition algorithms, AI systems have become adept at predictive analysis. The systems process and analyze copious data related to weather patterns, previous crop data, and overall soil conditions to predict potential pest and disease outbreaks. To elaborate, computer vision and Machine Learning algorithms actively analyze video footage and images from drones and satellites to predict and monitor crop conditions.

The AI-backed systems also allow farmers to access real-time alerts to identify early signs of diseases and employ timely organic remedies to tackle the challenges of pest infestations. It also helps farmers accurately differentiate weeds from crops, which enables targeted weed removal. This further helps them to prevent massive crop losses and ensure healthy produce.

Sustainable Water Management

AI-powered systems are known to be effective in optimizing irrigation. The technology typically factors in weather forecasts, crop needs, and level of soil moisture to offer suitable water management solutions. After a deep analysis, the AI-backed systems provide valuable insights to the farmers, which help them to lower water wastage and optimize its use to ensure efficient and eco-friendly farming.

Besides these, more AgTech startups and organic farmers are utilizing AI to analyze data on weather trends, consumer demand, and even crop prices. Additionally, they are leveraging the technology to gain insights into supply chain data to help make more effective decisions regarding crop selection, ideal planting time, pricing, and distribution strategies. Such an approach not only helps meet the rising demand for organic products but also enables farmers to align their methods to generate maximum returns.

Food Safety and Environmental Sustainability

This rising emphasis on organic farming has emerged as a means for today's consumers to ensure food safety and environmental sustainability, and in this aspect, the assistance of AI is becoming crucial. In fact, more AgTechs and farmers are using AI to streamline their record-keeping methods and for effective data management to ensure that when the time comes, the process of availing organic certification is smooth and hassle-free.

How AgTech Startups Are Amplifying AI Adoption in Organic Farming

The Indian AgTech industry is anticipated to grow significantly in the upcoming years, with the segment's revenue projected to touch the $204 billion mark by 2025. This projection can be attributed to the rising popularity of the industry in India. For instance, between January 2020 and June 2022, nearly a hundred Indian AgTech startups raised approximately $1.33 billion, underscoring interest in this space.

In fact, both the supply chain technology and output market make up the biggest growing areas in this industry and have the potential to become a $12.1 billion market.

Today, AI, IoT, and Machine Learning are being used by over a thousand agriculture startups in India, which are working with the aim of boosting the nation's agricultural productivity and efficiency.

They are using analytics, precision farming, and advisory segments while actively providing data and insights to farmers. Many are also active in segments including IoT-powered agriculture and drones, e-distributors, precision farming, marketplaces and e-distributors, and crop quality measurements.

AI Defining The Future

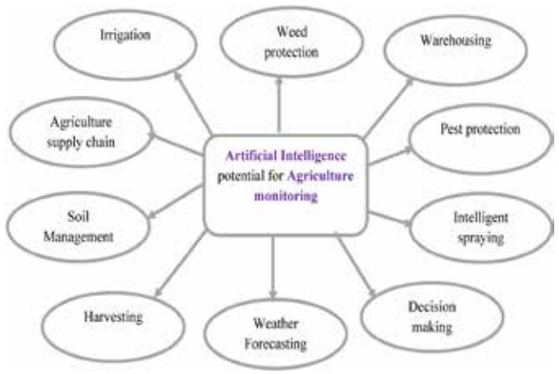
AI is revolutionizing agriculture by offering innovative solutions to improve efficiency, productivity, and sustainability. AI-powered technologies enable precision farming techniques by analyzing data from various sources such as satellites, drones, and sensors to provide real-time insights into soil health, crop growth, and pest infestation. This enables farmers to make data-driven decisions regarding irrigation, fertilization, and pest control, leading to optimized resource usage and higher yields. Additionally, AI facilitates predictive analytics, helping farmers anticipate market trends, weather patterns, and crop yields.

Automation of tasks such as seeding, spraying, and harvesting using AI-driven machinery enhances efficiency and reduces labor costs. In recent years, Artificial Intelligence (AI) has been extensively applied in farming. AI helps farmers choose the optimum seed for a given weather scenario. AI-powered solutions will help farmers produce more with lesser resources and improve crop quality.

Furthermore, AI-based platforms connect farmers directly to markets, enabling fair pricing and efficient supply chain management. Overall, AI applications in agriculture are transforming the sector by making farming more precise, productive, and sustainable.

Significant Applications of AI in Agriculture

The role of AI in Indian agriculture is increasingly significant, as it offers solutions to various challenges faced by farmers and the agricultural sector as a whole. Here are some key points that could be covered in a discussion on this topic:



Precision Agriculture: AI enables precision agriculture techniques by analyzing data from satellites, drones, and sensors to provide insights into soil health, moisture levels, crop growth, and pest infestation. This helps farmers make informed decisions about irrigation, fertilization, and pest control, leading to optimized resource usage and higher yields.

Crop Monitoring and Management: AI-powered systems can monitor crops throughout their growth cycle, detecting diseases, nutrient deficiencies, and other issues early on. This allows farmers to take timely actions to prevent crop loss and improve productivity.

Predictive Analytics: AI algorithms can analyze historical data on weather patterns, soil types, crop varieties, and market trends to make predictions about future yields, prices, and potential risks. This helps farmers plan their planting schedules, manage inventory, and optimize marketing strategies.

ABOUT THE AUTHOR

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> AI maximizes resource utilization and efficiency and, to a significant part, resolves the resource and labour shortage

Smart Farming Equipment: AI is being integrated into farm machinery and equipment to automate tasks such as seeding, spraying, and harvesting. Autonomous tractors and drones equipped with AI technology can perform these tasks with higher precision and efficiency than manual labor, reducing costs and labor requirements.

Market Linkages: AI-powered platforms connect farmers directly to buyers, processors, and retailers, eliminating intermediaries and ensuring fair prices for agricultural produce. These platforms use AI algorithms to match supply with demand, optimize logistics, and facilitate transactions, benefiting both farmers and consumers.

Extension Services: AI-based mobile apps and chatbots provide farmers with real-time access to expert advice, weather forecasts, market prices, and agricultural best practices. These digital extension services complement traditional extension efforts, reaching remote areas and empowering farmers with knowledge and information.

Climate Resilience: AI can help farmers adapt to climate change by providing early warnings of extreme weather events, recommending drought-resistant crops, and optimizing water management strategies. By harnessing AI technologies, Indian agriculture can become more resilient to the challenges posed by climate variability.

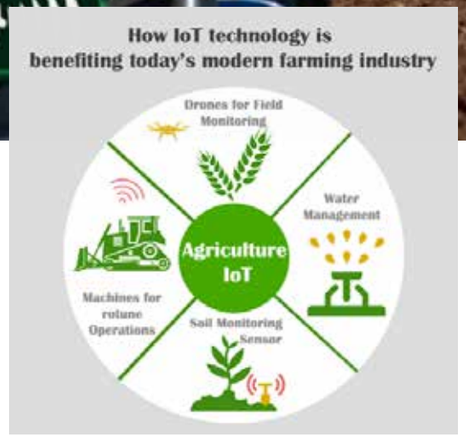
Data Privacy and Security: As AI systems rely on vast amounts of data, ensuring the privacy and security of farmers' data is crucial. Regulations and standards need to be established to govern the collection, storage, and usage of agricultural data, protecting farmers' interests and preventing misuse.

By leveraging AI technologies effectively, Indian agriculture can become more sustainable, productive, and resilient, contributing to food security and rural development. However, it's essential to address challenges such as access to technology, digital literacy, and infrastructure constraints to ensure that the benefits of AI are accessible to all farmers, regardless of their location or socio-economic status.

Conclusion

AI technologies are delivering innovative and precise solutions to major agricultural issues confronting farmers worldwide. This technology will also play an essential role in research and development in the field of horticulture. More exciting discoveries in AI directly related to farming will be made in the coming years.

AI will assist farmers in becoming agricultural scientists using data to optimize yields to individual rows of plants. AI companies are developing robots that can readily do various duties in farm settings. This robot is engineered to pick crops more quickly and thoroughly than humans can. These robots are taught to harvest and pack crops while checking crop quality and weeds. AI algorithms use satellite photos and historical data to detect whether an insect has landed and what kind of insect has landed. AI helps farmers



with pest management by sending notifications to their cellphones to take the required measures and apply the appropriate insect control. AI is helping farmers automate their farming and is also moving toward precision cultivation for improved crop output and quality while utilizing fewer resources. F

uture technical development will help businesses interested in enhancing AI-based goods or services, such as training data for agriculture, drones, and automated machine manufacturing, allowing the globe to address challenges with food supply for a growing population. The future of ML-automated agricultural goods and data science in farming will be secured by extending reach and connection to small farms in distant regions worldwide. Because AI maximizes resource utilization and efficiency and, to a significant part, resolves the resource and labour shortage, it will be helpful and effective in the agriculture industry. Farmers' problems, such as climate change and insect and weed infestations that lower yields, may be resolved through AI solutions. AI will be used in agriculture to improve the entire agriculture process.

AI and The Future of **Animal Sector**

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AI revolutionizes animal sciences by offering new solutions for traditional challenges in animal husbandry and agriculture

In the face of a rapidly increasing global population, shrinking agricultural lands, and the various challenges posed by climate change, the agricultural sector, particularly animal husbandry, stands at a critical juncture. Over 58% of rural households depend on agriculture, which is now at a crossroads due to the myriad challenges. Modernization, especially through technological innovation, has become imperative to address these multifaceted challenges.

AI, a transformative force with the potential to revolutionize the animal sector, is a dynamic branch of computer science, that empowers machines to learn from data, make decisions, and perform tasks autonomously, thus offering new horizons in agricultural practices and animal management. This article explores the multifaceted applications of AI in the animal sector, highlighting how this technology is reshaping practices ranging from precision livestock farming to individual animal monitoring, behavioral analysis, health surveillance, nutritional optimization, and beyond, promising a new era of efficiency, sustainability, and animal welfare.

Precision Livestock Farming

Precision livestock farming is used to measure the physiological, behavioral and production indicators of the individual animals to improve management strategies, profitability and farm performance. Computer vision systems in animal farming allow for precise management by monitoring behavior and health, differentiating individual animals, and detecting signs of disease or stress. They utilize AI, 2D and 3D sensors for analyses like body condition scoring and morphometric assessments. This technology facilitates automated, real-time monitoring and aids in breeding and health assurance. GPS collars and AI algorithms optimize farm processes by analyzing the extensive data generated.

Individual Animal Identification

In animal farming, monitoring individual animals is vital. AI-equipped computer vision systems, using cameras, offer non-intrusive, cost-effective monitoring by analyzing video feeds in real-time. They identify animals like cows or chickens by unique features, such as muzzle prints or feather patterns, enabling precise tracking of health and performance.

Behavioural Monitoring

Computer vision systems continuously monitor animal behaviour. They capture and analyse data on activities like feeding patterns, movement, and social interactions. Any deviations from typical behaviour can signal potential issues. This analysis helps in identifying stress, discomfort, or illnesses early, ensuring timely intervention. Additionally, AI can predict future behaviors based on historical data, aiding in personalized treatment plans.

Health Monitoring and Disease Control

AI-powered systems, with wearable sensors and cameras, are transforming animal health monitoring by tracking indicators like temperature and heart rate in real-time, enabling early illness detection and reducing mortality. Non-invasive techniques include wearable devices, camera and microphone systems, environmental sensors, and drones to monitor health and environmental conditions without causing stress.

Early detection of diseases is a primary goal in animal farming. AI-powered computer vision systems can analyse various indicators of illness, such as changes in gait, body posture, or abnormal

feeding behavior. AI algorithms detect animal diseases by analyzing specific data such as Bag of Words (BoW) and Gradient Boosted Tree (GBT) for detection of mastitis through somatic cell counts and conductivity; Fog Computing and Classification and Regression Tree (CART) for lameness via leg and neck movements; and Random Forest Algorithm (RFA) for postpartum diseases through lactose, protein, and milk yield metrics.

Nutrition Optimization

The role of AI in nutrition composition in animals involves monitoring feed intake and production by observing activity at the feeder. AI notes that healthy animals spend more time at the feeder and are more likely to visit immediately after feed delivery compared to sick animals.

Rumen pH and Temperature Determination

AI plays a pivotal role in livestock health management by employing sensors to continuously measure and transmit real-time data on rumen pH and temperature. This data is analyzed to detect and diagnose conditions such as Ruminal Acidosis. By leveraging wireless telemetry, AI allows for early detection of digestive disorders, enabling timely intervention and promoting the well-being of ruminants.

Oestrus (Heat) Detection

To determine the ideal time for insemination, sows must have accurate estrus detection. These days, a technological advancement is available that uses linked sensors and cameras to identify a sow's oestrus, Such as 3D Accelerometer that are placed on the leg and neck of the animal. They are a highly efficient and accurate method of oestrous detection.

Walking Activity Monitoring

Pedometer allows both walking and milking activity in dairy farms. These are used to observe daily movements, including milking, eating, standing, lying and can detect changes in this measurement activity. Pedometer predicts lameness earlier than the appearance of the clinical signs by correlating pedometric activity (PA) with clinical cases of lameness.

Challenges and Solutions

AI in animal sciences faces challenges like invasive data collection, high computational demands, and ethical concerns regarding animal welfare. Addressing these issues requires collaboration between technologists, scientists, and ethicists, employing non-invasive monitoring and establishing ethical AI guidelines.

Future of AI in Animal Sciences

Future of AI in animal sciences is bright, with potential for more tailored and precise animal management, enhancing health, nutrition, and welfare. This progress promises a more sustainable and ethical approach to animal husbandry, leading to healthier and more satisfied animals.

AI revolutionizes animal sciences by offering new solutions for traditional challenges in animal husbandry and agriculture. AI enables more individualized, accurate, and efficient management of animal health, nutrition, and welfare. Despite ethical issues and the need for high computational resources, AI's future in this field is very promising. Collaborative work between technologists, scientists, and ethicists is crucial for developing ethical, non-invasive monitoring methods. AI promises to enhance animal production sustainability and improve animals' quality of life, leading to a more sustainable, productive, and ethical future in animal husbandry, thus ensuring better animal well-being and securing the food supply for the future.

AI

The Paradigm Shift

> India's smallholding farmers struggle with erratic weather and the impacts of climate change, pest infestations, and declining yields

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The growth of the global population, which is projected to reach 10 billion by 2050, is placing significant pressure on the agricultural sector to increase crop production and maximize yields. Each season brings new technologies designed to improve efficiency and capitalize on the harvest. However, both individual farmers and global agribusinesses often miss out on the opportunities that artificial intelligence in agriculture can offer to their farming methods.

Until recently, using the words AI and agriculture in the same sentence may have sounded strange. After all, agriculture has been the backbone of human civilization for millennia, providing sustenance as well as contributing to economic development, while even the most primitive AI only emerged several decades ago.

Nevertheless, innovative ideas are being introduced in every industry, and agriculture is no exception. In recent years, the world has witnessed rapid advancements in agricultural technology, revolutionizing farming practices. These innovations are becoming increasingly essential as global challenges such as climate change, population growth together with resource scarcity threaten the sustainability of our food system. Introducing AI solves many challenges and helps to diminish many disadvantages of traditional farming.

AI In Context Of Indian Agriculture

India's smallholding farmers face significant challenges. They struggle with erratic weather and the impacts of climate change, pest infestations, and declining yields. Financially constrained, many are trapped by high-interest loans from local lenders. Post-harvest, issues such as crop wastage, logistics, and market access can add to their troubles, with up to 40% of produce lost. Market fluctuations and the inability to meet quality standards further exacerbate their struggles.

Complexities In AI Implementation in India

- In the context of applying technology, most farmers in India have a small landholdings, and they are unable to sustain the cost of buying the seeds and other essentials. In such a situation, can we expect them to invest in such a technology which is expensive, not completely proven.
- Technology can enable education and training to enable a large skilled workforce, which is lacking currently. And while doing this, the sustainability aspects can be considered as the core of the course. This skill enablement can lead to job creation for at least 10 lakh people, and while doing this, it can also bring down the people concentration in urban areas thereby making urban and rural areas more sustainable.
- This is a huge challenge to get the relevant data at a farmer's level. Not only is easy data collection a challenge, but people are also not happy to share their data as privacy concerns are prevalent. Hence there needs to be a technological answer to data collection as well. We need to devise ways to collect data without encroaching on the privacy of the farmers, in an automated manner.

There have been continuous efforts from governments and society to bridge these gaps. There are a lot of initiatives in the field of AI worldwide and in India. Like WEF's Artificial Intelligence for Agricultural Innovation (AI4AI) to support Indian agriculture transformation. It is led by Center for 4th industrial revolution (C4IR) INDIA bringing together academia, government, and business houses to develop innovative solutions for agriculture.

Chili Value Chain

For example, '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. The project has substantially improved the chili value chain for more than 7,000 farmers. The state government of Telangana has played a key role in this transformation by creating enabling infrastructure and policies including India's first agriculture data exchange and agri data management framework. Farmers participating in the program saw a 21% increase in chili yields per acre, a 9% reduction in pesticide use, a 5% decrease in fertilizer usage, and an 8% improvement in unit prices due to quality enhancements. Because of these improvements, farmers have seen their incomes soar by more than INR 66,000 (around 800 USD) per acre per crop cycle, effectively doubling their earnings.

AI for agriculture can support everything from planning to selling crops. Intelligent crop planning, Smart farming, farmgate to fork (MOTTO OF F2DF), data driven agriculture.

AI has both non-biological and human aspects embedded in it. Needless to say, diffusion of AI in all application arenas will also bring a paradigm shift in the way we do research and development in agriculture now. AI systems require continuous feeding of new information and increasing the amount of information in the backend databases used for performing tasks with almost accuracy, including mapping the history of and guiding the predictions from such systems. The AI systems will get evolved over time akin to human perfection in addition to adaptability.

Collaborating efforts between governments, industry, philanthropists, innovators and farmers can create national frameworks for implementing digital agriculture programs to ensure food security, sustainability, and policies in line with sustainable development goals. Sharing lessons learned through these digital platforms gives farmers valuable insights and evidence-based strategies for using AI for agriculture. It helps accelerate innovation and guide global and Indian efforts in digital farming, promoting sustainability, efficiency and improved nutrition and food security worldwide.

Aqua Glory

> Carp hatcheries have been established across the country through private-public participation

Aquaculture, predominantly a rural activity, has a long tradition in India. Farming fish in homestead ponds and community tanks accompanied by human resource with a rich traditional knowledge-base used to be practiced mainly in eastern India since time immemorial.

Being home of more than 10% of global fish biodiversity, the country ranks third in the world in total fish production in which freshwater aquaculture continues to be its principal contributor. In the Sanskrit encyclopaedia 'Manasollasa', we find vivid description of freshwater aquaculture during those days.

It has information on how and when to feed the fish in culture ponds as well as about emergency care required. Aquaculture indeed evolved from a modest beginning to that of a highly impressive farming enterprise in recent years and is providing value addition and diversification thereby placing aquaculture on the faster track of development.

The Contribution Of Aquaculture

Multiple carp breeding, cryopreservation (-196 degree Celsius) of milt for fertilization of viable matured eggs to ensure quality seed production, design of portable hatcheries, development of improved carps through selection protocols, composite fish culture system to make full use of the ecosystem space and available natural food organisms spread out in different zones of it, balanced feed development using locally available plant derived feedstuffs have shown visible impacts on productivity levels, Again, in view of shrinking clean freshwater availability and increased wastewater generation, necessary amelioration measures are also being emphasized.

In this context, aquaculture as a tool in bioremediation/ treatment of wastewater has been successfully demonstrated at ICAR-CIFA. thereby proving that aquaculture also contributes to a cleaner environment.

The annual growth rate of over 6% also indicates potential of this segment in contributing towards domestic nutritional security, Today the sector has been recognized as a powerful income and employment generator to over 15 million fishers and fish farmers, besides promoting India's export basket.

Given the wide spectrum of cultivable species biodiversity backed up with several need-based technologies starting from breeding and seed production of potential fish and shrimps, grow-out culture methods to the allied aspects of nutrition including right kind of feeding strategy (feed sources, preparation, and schedule). and health care of major fish and crustaceans species generated over the years by the Indian Council of Agricultural Research (ICAR) have been widely accepted by the farmers and entrepreneurs of the country to promote sustainable aquaculture and efficient natural resource management.

Wider Adoption of Technologies

Wider adoptions of these technologies accompanied by traditional wisdom and skills of our farming community will not only provide enormous scope and cater to the needs of our society in general but also for the other countries in the region and ensure satisfactory and creative livelihoods.

It is felt that there is ample scope for improving the product quality through large scale adoption of better management practices, application of scientific principles and optimization of supply of critical nutrients through supplementary feeding whenever needed.

We are blessed with plenty of natural freshwater resources in the form of ponds, tanks, reservoirs, lakes, irrigation canals, river-check dams ,various wetlands in the form of beels, jheels, swamps and even-man-made water bodies. We also have adequate solar energy, rich aquatic bio-resources year-long availability of bio -organic inputs ideal for conducting ecological farming practices and access to global standard laboratory facilities. for strategic and applied research.

Release of inorganic nutrients from pond soil in presence of bright sunshine enhances phytoplankton growth on which again the growth of zooplankton depends. Maintaining a balance of both these kinds of plankton population throughout the culture period, will therefore be of help in enhancing the survival and growth of various fish species Water temperature also affects the dissolved oxygen content which, in turn, is responsible for nutrient absorption, bioenergetics and growth as well as aerobic decomposition of organic matter.

Earlier in the absence of our understanding on captive breeding of Cyprinid fish species, a novel method used to be known as "bundh breeding" where a sudden gush of rainwater is forced into spawning ponds were and are even today used to induce natural spawning. The advent of induced spawning techniques to breed these fishes in captivity in a consistent manner and simple improvements in hatchery technologies for mass breeding has accelerated the development of the culture of Indian major carps eliminating dependence on collection of seeds from the rivers. Now that carp hatcheries have been established all over the country through private-public participation, technology of multiple breeding of carps has now been standardized well.

Innovative Ideas Of Farmers

Use of simple tools and implements accompanied by continuous farmers' creative ideas in fish husbandry process and the skill of problem solving proved to be quite useful and stood the test of time. Some of the areas wherein farmers' innovative ideas proved to be beneficial in aquaculture include the following.

1. keeping the pond clean of aquatic macrophytes using straw made rope and not resorting to any undesirable chemical application,
2. fabrication and installation of bamboo cages in ponds for diversification of fish culture including small local fish species and using split bamboo pole stuffed with organic manure for raising plankton
3. control of predator birds without virtually any additional expense and not harming the birds including the migratory ones.
4. providing aeration facility to enhance the dissolved oxygen content in pond water
5. simple methods of fish feed preparations and application in culture ponds-for example using perforated bags tied with bamboo poles in the pond, feeding the fishes grazing in the various zones of the culture pond- surface, column and bottom feeding fish and simple enclosure for feeding with floating/flake-type feed to the fishes
6. breeding, seed production and transport under oxygen packing in captivity without any hatchery infrastructure
7. Creating shade on the pond with the help of palm leaves during summer months when heat become unbearable
8. measurement of water quality parameter -like turbidity using fabricated secchi disc
9. application at fortnightly intervals of medicated feed containing herbal extracts like combination of neem leaf , turmeric, basil leaves, garlic extracted together and mixed with pinch of common salt to prevent disease infestations
10. periodic removal of generated gases from the pond bottom using rakers followed by lime application in ponds to maintain water quality paremeters within recommended levels to mention a few.

Our Institutes are working in different eco-regions of the country with participation of farming communities and entrepreneurs to promote sustainable farming systems. While there is no denying that application of scientific principles is important in the scaling up of the production performance of cultured fishes, ingenuity of large spectrum of knowhow and skills, farmers' innovations and improvements successfully tested over time continue to be crucial for Atmanirbhar Bharat in letter and spirit.

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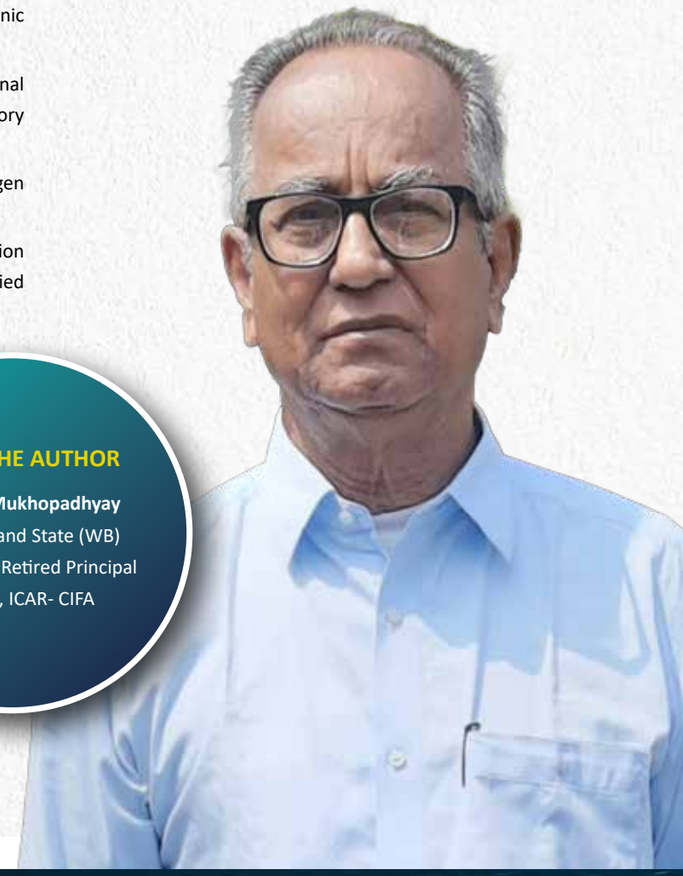

AI in Agriculture

Cultivating A Sustainable Future

ABOUT THE AUTHOR

Mr Ravindra Savant is an author and experienced professional in vegetable seed industry for 18 years. He has experimented with 'future vegetables' and holds numerous awards for his outstanding work in high-tech agriculture

> AI is not just a buzzword—it's a critical tool for sustainable agriculture

AI is reshaping the landscape of agriculture, promising increased efficiency, sustainability, and food security. From precision farming to disease detection, AI technologies are revolutionizing how we cultivate crops and raise livestock. In this article, we delve into the transformative potential of AI in agriculture and explore the challenges and opportunities it presents.

The world's population is projected to reach 9.7 billion by 2050, placing immense pressure on global food production. Traditional farming methods struggle to meet this demand while grappling with climate change, resource scarcity, and environmental degradation. Enter AI—a powerful ally that can help address these challenges.

Precision Agriculture: Nurturing Crops with Data-Driven Insights

Precision agriculture leverages AI to optimize resource allocation. Sensors, drones, and satellite imagery collect real-time data on soil moisture, temperature, and crop health. AI algorithms process this information, enabling farmers to make informed decisions about irrigation, fertilization, and pest control. The result? Increased yields and reduced environmental impact.

Urban Farming: AI in Cityscapes

Urbanization is on the rise, and cities need sustainable food sources. AI enables vertical farming, rooftop gardens, and hydroponics. Algorithms regulate light, water, and nutrients, maximizing crop growth in limited spaces. Urban farmers can produce fresh vegetables year-round, reducing transportation costs and food miles.

Disease Detection and Prevention

AI-powered cameras and sensors monitor plant health. Early disease detection allows targeted interventions, minimizing crop losses. Machine learning models analyze patterns in leaf discoloration, pest infestations, and fungal infections. Farmers receive alerts, enabling timely action.

Smart Irrigation Systems

Water scarcity is a global concern. AI-driven irrigation systems adapt to weather conditions, soil moisture, and crop requirements. By delivering precise amounts of water where needed, farmers conserve resources and enhance crop resilience.

Livestock Management

AI tracks animal behavior, health, and nutrition. Wearable devices collect data on activity levels, feeding habits, and disease symptoms. Predictive models help prevent outbreaks and optimize feed efficiency.

Crop Monitoring

Satellites and drones capture high-resolution images of fields. AI algorithms analyze vegetation indices, identifying stressed areas. Farmers receive maps highlighting irrigation needs, nutrient deficiencies, and pest hotspots.

Supply Chain Optimization

AI streamlines logistics, reducing food waste. Predictive analytics optimize transportation routes, storage conditions, and distribution schedules. Fresh produce reaches consumers faster, minimizing spoilage.

Challenges Ahead: Balancing Innovation and Responsibility

While AI offers immense potential, challenges persist:

Data Privacy: Protecting farmers' data and ensuring transparency.

Ethical Use: Avoiding biases and unintended consequences.

Affordability: Making AI accessible to small-scale farmers.

Education: Training farmers to harness AI effectively.

In conclusion, AI is not just a buzzword—it's a critical tool for sustainable agriculture. As we cultivate a greener future, let's embrace AI responsibly and reap its harvest of progress.

Digital Intelligence For Optimum Application Of Crop Inputs

> The lack of technical knowledge and reluctance to change among the farmers is still a big hurdle



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World population is expected to reach 9.8 billion by 2050 and, 11.2 billion by 2100, according to United Nations report. This has increased pressure on agricultural sector for enhancing crop productivity and yield per hectare. For last few years, farmers are continuously facing challenges like climate change, labor shortage, resource inefficiency, and reduction in soil fertility etc. which has made agriculture less profitable.

Increasing land usage and practicing farming in large areas is a possible solution to tackle food security, but in developing countries like India with highly populated areas, it becomes merely impossible to increase land under agriculture. The other possible solution is to adopt cutting edge technologies like Artificial Intelligence (AI), Internet of Things (IOT), Digital Twinning etc. and make farming smarter. The incorporation of these technologies will help farmers gather information about crops, soil, and weather conditions for better insights of the agricultural field and plan further farming practices systematically with optimum use of resources and minimum risk. The scope of recent advancements in these technologies is endless in agriculture practices as it can automate complex tasks with minimal manual intervention.

AI and IOT in Agriculture

IOT is referred to as a network of physical objects called 'things' with network connectivity that can interact with the environment and can collect data. IOT driven intelligent systems have the capability to even surpass humans in terms of accuracy. Already this technology has seen a lot of use cases in various fields, but it can be a game changer in agricultural automation. The main goal of the IOT devices is to generate and record real time data which is mostly unstructured. During the early stage of this technology, simpler tasks were being performed using the data collected without the need for data analyzing.

But as the systems got complex and sophisticated, the big data collected from fields gave rise to the need of complex analysis through AI algorithms. AI algorithms have the capability to handle big data and derive meaningful insights which can lead to intelligent decision making. Most of the data driven automation in agriculture has been possible through pattern recognition, complex classification, digital image processing, analyzing vast datasets with the use of algorithms based on Machine Learning (ML), Deep Learning (DL), Machine Vision (MV), Artificial Neural Network (ANN), Convolutional Neural Network (CNN), Natural Language Processing (NLP) etc.

Autonomous Vehicles

Advancements in Global Navigation Satellite System (GNSS), sensors like radar, LIDAR have led to the development of autonomous vehicles. But in agriculture, satellite positioning may not be accurate at all positions due to obstacles in field and in closed environment like greenhouses. So, recent autonomous vehicles in agriculture are dependent on stereo cameras, sensors, RGB cameras, infrared cameras for collecting real time information in the field and making decisions using deep learning algorithms with the help of microprocessors. Auto-steering technology is also getting popular nowadays for straight line navigation of machines.

UAV/Drone

The introduction of UAV/drones in agriculture has also become another breakthrough leading to the automation of various tasks like seeding, soil monitoring, pesticide spraying, crop monitoring etc. Punjab Agricultural University, Ludhiana is working on need based spraying (Variable Rate Spraying) through monitoring various crop and soil parameters using sensors like N sensor, greenseeker for reducing the usage of chemicals in field. Although in countries like India, the opportunities for drone-based solutions is high due to the ground based surveys being expensive and time consuming, but the regulations still need to be clearer for drone usage.

Smart Irrigation Systems

To meet the future food requirements, there is a need to efficiently utilize water resources. Although technological interventions for efficient water management has started for years, but the recent advances have led to the development of intelligent decision support systems that collect real time data on temperature, humidity, rainfall, soil moisture using sensors, stores them on cloud where AI algorithms analyze the data and provide farmers with automated irrigation scheduling.

Pest and Weed Control

Conventionally farmers apply uniform herbicides in field without assessing the location of weeds in field resulting in increased herbicide cost and methane & nitrous oxide emissions. AI enabled systems have led to the development of site specific weed removal robots which use RGB and stereo cameras to capture real time data in field.

The data collected is analyzed using object detection algorithms like YOLO which help to identify weeds in field during on the go operation and apply interventions like targeted spraying, lasers etc. Many companies have developed apps like Plantix, Pestoscope, AgroDoc, Xarvio Scouting etc. that use machine/deep learning algorithms to obtain crop and soil diagnosis for farmers.

Automatic Livestock Management

The precision monitoring systems help in ensuring the health and well-being of the livestock. IOT enabled systems collect real time data on temperature, humidity, CO_2 emissions, ammonia which can affect the health of livestock and control outputs like sprinklers, fans and ventilation systems for their effective management. With the help of cameras, early disease detection, heat events, feed intake, estrus events can also be recorded to provide farmers better insights into the health of the cattle.

Challenges and Opportunities

Despite the fact that these technologies have the potential to revolutionize agriculture, the lack of technical knowledge and reluctance to change among the farmers is still a big hurdle. Another challenge for the farmers is the initial high cost of the system with security concerns with the data being generated. Although the challenges are still big, the advancements in these technologies are expected to contribute towards Smart and Automated Agriculture.

Bringing AI *To Farmers*

Agriculture is one of the most prominent areas where artificial intelligence (AI) is making a profound impact. AI-powered systems can analyze vast amounts of data to provide real-time insights into soil PH, soil NPK, soil micro nutrients, soil EC, soil moisture and crop health. This allows farmers to apply fertilizers, pesticides, and water precisely where and when they are needed, thereby reducing waste and minimizing environmental impact.

We are ready to introduce Robotic technology throughout India in the upcoming year to assist micro and small-scale farmers in the country. The advent of this technology is expected to be a boon for the farming community, providing them with the support they need to enhance their agricultural output and profitability.

Addressing Critical Challenges

This initiative underscores the importance of adopting advanced technologies in agriculture to address critical challenges such as labor scarcity and sustainability. By leveraging AI and robotic systems, farmers can enhance their decision-making capabilities and streamline their operations, leading to improved productivity and increased profits.

Agriculture continues to constitute the backbone of the Indian economy, with a considerable proportion of the total land mass, specifically 38%, devoted to crop production while 46% of the land is used in agricultural activities. However, there is a disparity between traditional agricultural practices and recent population trends. With the population growing at an alarming rate of 1.4 billion people, there is a need to increase food production and employment, which has brought forward the imperative question of agricultural automation.

Indo Agritech is a startup working in the field of artificial intelligence, under the initiatives of Startup India and Vocal for Local. In the future, we aim to provide affordable AI technology for soil, crop protection, and robotics to farmers. Our goal is to offer these products at the lowest possible price to help farmers increase their yield and productivity.

> By leveraging AI and robotic systems, farmers can enhance their decision-making capabilities and streamline their operations, leading to improved productivity and increased profits

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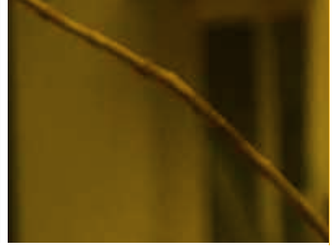
The Transformative Force



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> AI-driven predictive analytics is revolutionizing decision-making in agriculture

In recent years, Artificial Intelligence (AI) has emerged as a transformative force across various industries, and agriculture is no exception.

AI in agricultural sector is use to enhance productivity, sustainability, and efficiency. From precision farming to crop monitoring and predictive analytics, AI-powered solutions are reshaping the way we cultivate crops and manage agricultural resources.

One of the most significant contributions of AI to agriculture is in the realm of precision farming. Traditional farming methods often rely on uniform application of resources such as water, fertilizers, and pesticides across entire fields, leading to inefficiencies and wastage. AI-enabled precision farming techniques leverage data from various sources, including satellite imagery, drones, and sensors, to provide farmers with detailed insights into soil health, moisture levels, and crop conditions. By precisely targeting inputs based on real-time data analytics, farmers can optimize resource usage, minimize environmental impact, and maximize yields.

Crop Monitoring

Crop monitoring is another area where AI is making significant strides. Remote sensing technologies combined with machine learning algorithms enable farmers to monitor crop growth, detect pests and diseases, and assess overall plant health with accuracy.

Advanced image recognition algorithms can analyze aerial imagery to identify subtle variations in crop color, texture, and density, providing early warnings of potential threats. By detecting issues at an early stage, farmers can take proactive measures to reduce risks and protect their crops.

AI-Driven Predictive Analytics

These are revolutionizing decision-making in agriculture. By analyzing vast amounts of historical and real-time data, AI algorithms can forecast weather patterns, market trends, and crop yields with remarkable precision. Moreover, AI-powered predictive models can help farmers anticipate and manage risks such as extreme weather events, market fluctuations, and supply chain disruptions, enabling them to adapt quickly to changing circumstances.

AI is also playing a crucial role in sustainable agriculture practices. By optimizing resource utilization and minimizing environmental impact, AI-powered solutions contribute to the conservation of land, water, and biodiversity. For instance, AI-driven irrigation systems can dynamically adjust watering schedules based on soil moisture levels, weather forecasts, and crop water requirements, reducing water wastage and conserving scarce resources.

Similarly, AI-enabled precision spraying technology can precisely target pests and weeds, minimizing the use of chemical inputs and reducing the risk of soil and water contamination. AI can spot when plants are lacking certain nutrients and tell the farmer how to fix it without using too many chemicals.

Moreover, AI is empowering smallholder farmers and agricultural communities by providing access to valuable insights and decision support tools. Mobile applications equipped with AI algorithms offer farmers real-time advice on crop management practices, pest control strategies, and market prices.

However, realizing the full potential of AI in agriculture requires addressing several challenges, including data access and privacy concerns. Not everyone has access to AI technology, especially in poorer areas. Governments, industry stakeholders, and research institutions must collaborate to develop policies and initiatives that promote data sharing, protect privacy rights, and ensure access to AI technologies. Moreover, investments in education and training programs are essential to enhance the digital skills of farmers and agricultural extension workers, enabling them to leverage AI tools effectively.

Ultimately, AI holds immense promise for revolutionizing agriculture and addressing the complex challenges facing the global food system. By harnessing the power of AI-driven technologies such as precision farming, crop monitoring, and predictive analytics, farmers can enhance productivity, sustainability, and resilience in the face of climate change and resource constraints. However, realizing this potential requires concerted efforts to overcome barriers and ensure inclusive adoption of AI across the agricultural value chain. With the right policies, investments, and partnerships, AI has the power to transform farming practices and create a more sustainable and food-secure future for generations to come.

STIHL Launches Two Multi-Purpose Stationary Engines; Caters to Various Agricultural Activities with Low Fuel Consumption

In the present time, performing all kinds of tasks with modern tools has become quite convenient. Working with modern tools not only saves costs and time but also yields good profits. In the field of manufacturing modern tools, STIHL has been making significant contributions for the past several decades.

STIHL is a global equipment manufacturer based in Germany, producing various equipment for agriculture and many other tasks. The company's tools are renowned worldwide for their high quality and reliability. Recently, it has launched two new multi-purpose 4-stroke stationary engines, the EHC 605 S with 12.5 Nm torque and the EHC 705 S with 15.6 Nm torque, in the Indian market.

Launched to fulfil the requirements of agriculture, construction, and industrial applications, the 4-stroke stationary multi-purpose engine models EHC 605 S and EHC 705 S from STIHL are available in power ranges of 6 and 7 HP.

Let's understand the features of these multi-purpose engine models in detail:

STIHL EHC 605 S:

The multi-purpose engine model EHC 605 S features a 212-cc engine, generating power of 4.4 kW/6.0 HP. This model produces 4000 (+/-150) RPM. It weighs approximately 15.7 kilograms and comes with a fuel tank capacity of 3.6 litres. Additionally, the company provides a 2-year warranty for the EHC 605 S model.

STIHL EHC 705 S:

The STIHL multi-purpose engine model EHC 705 S features a 252-cc engine, generating power of 5.2 kW/7.0 HP. This model also produces 4000 (+/-150) RPM and weighs approximately 17.3 kilograms. It comes with a fuel tank capacity of 4 liters. Like the EHC 605 S model, the company provides a 2-year warranty for the EHC 705 S model.

Fuel Efficient Technology:

STIHL has developed its new multi-purpose engines with fuel-efficient technology, allowing for more usage with less fuel consumption. Additionally, the company has launched the EHC 605 S and EHC 705 S models with low emissions, low maintenance, and high torque.

Powerful Multi-purpose Engine:

STIHL has launched its 6 HP and 7 HP 4-stroke stationary multi-purpose engine models EHC 605 S and EHC 705 S to fulfil the requirements of various sectors such as agriculture, construction, railways, highways, and marine. These new multi-purpose engines can be used for water pumps and HT/TP sprayers in agriculture.

For More Information:

If you wish to obtain pricing information along with other details about the multi-purpose 4-stroke stationary engine models STIHL EHC 605 S and STIHL EHC 705 S, you can call or WhatsApp the company at this number: 9028411222. Additionally, you can visit the company's official website at www.stihl.in for more information.

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