



Transforming Agriculture through Modern Technology and AI

The global agricultural landscape has drastically been transformed owing to multifaceted factors including, but not limited to, technological advancements, unprecedented climate change, and shifting consumer demands. The present age is prone to drought and is facing ever-growing challenges to feed a 7-billion-plus population. This aspect necessitates the instillation of modern agricultural tools, equipment, and AI.

The challenge of ensuring food security for a growing global population, estimated to reach 9.7 billion by 2050 according to the United Nations, necessitates a paradigm shift in agricultural practices. Traditional methods, while holding historical significance, are demonstrably insufficient to meet the demands of the 21st century. Modern agricultural techniques, encompassing a diverse range of advancements, offer a compelling path towards a more secure and sustainable food system.

UNO effort to elevate food insecurity¹

Under the UNO 2030 SDGs (Sustainable Development Goals) implementation agenda, Pakistan plans to achieve food security for its population by 2030 by adopting modern agriculture and food production methods. We need to focus on research in agriculture, especially biotechnology, in order to improve yield and achieve self-sufficiency in food.

Quote: "UNO Sustainable Development Goals [SDGs] describes that Goal 2 is about creating a world free of hunger by 2030. The global issue of hunger and food insecurity has shown an alarming increase since 2015, a trend exacerbated by a combination of factors including the pandemic, conflict, climate change, and deepening inequalities.

By 2022, approximately 735 million people or 9.2% of the world's population found themselves in a state of chronic hunger, a staggering rise compared to 2019. This data underscores the severity of the situation, revealing a growing crisis. In addition, an estimated 2.4 billion people faced moderate to severe food insecurity in 2022.

This classification signifies their lack of access to sufficient nourishment. This number escalated by an alarming 391 million people compared to 2019.

The persistent surge in hunger and food insecurity, fueled by a complex interplay of factors, demands

immediate attention and coordinated global efforts to alleviate this critical humanitarian challenge.

Two billion people in the world do not have regular access to safe, nutritious, and sufficient food. Despite global efforts, in 2022, an estimated 45 million children under the age of 5 suffered from wasting, 148 million had stunted growth, and 37 million were overweight. A fundamental shift in trajectory is needed to achieve the 2030 nutrition targets."

Unless we act now, the 2030 Agenda will become an epitaph for a world that might have been. [António Guterres-Secretary General, United Nations]

"To achieve zero hunger by 2030, urgent coordinated action and policy solutions are imperative to address entrenched inequalities, transform food systems, invest in sustainable agricultural practices, and reduce and mitigate the impact of conflict and the pandemic on global nutrition and food security." **Unquote**

Pakistan is primarily an agrarian country with the world's best irrigation system. The agriculture sector significantly contributes to GDP, and any shortfall has an adverse effect on the growth rate.

Technology has caused its impact on every walk of life, including agriculture. The use of innovative modes of agriculture tools can be instrumental in enhancing productivity, efficiency, and sustainability.



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¹ [<https://www.un.org/sustainabledevelopment/hunger>]

It enables the production of high-yield seeds, calculated fertilizers, soil exploration, and modern techniques. The use of AI and drones has played a revolutionary impact. Drones equipped with AI take soil samples of predefined areas and send them to research centers. They then enable the assessment of the soil and apprise the desired fertilizer and water requirements in a scientific manner. The use of drones and satellite imaging enables farmers to monitor crops, identify pest infestations, and optimize irrigation, leading to higher yields and reduced resource inputs.

The agri sector is also under pressure owing to the use of outdated irrigation systems, low-quality seeds, lack of research, high input costs, coupled with farmer exploitation by middlemen. The low per-acre yield causes severe food security. The use of quality seeds, fertilizers, and pesticides may contribute to a healthy output, thereby not only contributing to GDP but also ensuring self-sufficiency in food.

Challenges and strategies to explore for enhancing Agriculture

1) Changing Climate: Climate change is one of the most dangerous factors and poses a threat to food security across the globe, especially in the Indo-Pak region. The flood in 2022 wreaked havoc in Pakistan, causing damage to crops, especially in southern Punjab and interior Sindh. It destroyed dams and infrastructure in Balochistan. The torrential rains turned into floods, causing damage to an already sinking economic situation in Pakistan.

The winter of 2023-24 in Pakistan was extremely surprising. The longest dry spell, coupled with smog, created many threats, especially causing fear of water scarcity for crops of the next season. We then experienced another dramatic change and witnessed an unprecedented rain spell in Balochistan and northern areas. Now, the Meteorological Department has warned about a heatwave in Punjab and Sindh.

The ever-changing weather conditions inevitably demand the adoption of innovative solutions, such as drought-resistant crops, climate-smart agricultural practices, and resilient infrastructure. Efforts to moderate climate change, such as reducing greenhouse gas emissions from agriculture, are essential for ensuring the long-term sustainability of food systems.

Climate change may also suggest a changed crop sowing pattern. Research and scientific approaches are paramount to unveil new seeds, suggest sowing

patterns, and develop high-quality seeds resistant to changes in a more effective manner to cope with ever-increasing food insecurity.

2) Lack of investment in Agri-technology:

Investment in agricultural technology is crucial for driving innovation and promoting sustainable development in the sector. Governments, private investors, and development agencies must allocate resources to support research and development. To ensure food security and self-sufficiency, investment in areas such as biotechnologies, precision agriculture, and renewable energies is inevitable. By fostering an enabling environment for technological innovations, policymakers can unlock the full potential of agriculture to address food security challenges. The provision of state-of-the-art soil and water testing labs to apprise soil, water, and micronutrient analysis shall enable farmers to practice balanced use of fertilizers in line with the dynamics of their farmland.

3) Lack of Role of Microfinance Institutions in Agriculture:

Microfinance institutions play a vital role in providing financial services to smallholder farmers and rural entrepreneurs, who often lack access to formal banking channels. By offering tailored financial products such as microloans, savings accounts, and insurance, these institutions empower farmers to invest in improved seeds, fertilizers, and equipment, thereby enhancing productivity and resilience. However, efforts to expand financial inclusion in rural areas must be accompanied by measures to promote responsible lending practices and build financial literacy. The provision of loans through microfinancing at subsidized/concessional rates may save farmers from being exploited by traditional moneylenders. The provision of loans for the purchase of modern agricultural equipment on a rental basis may also help to promote mechanized farming techniques.

4) Digital Farming Technologies:

Digital farming technologies, including farm management software, sensors, drones equipped with AI, and Internet of Things (IoT) devices, are transforming agriculture by enabling real-time monitoring, data-driven decision-making, and precision agriculture. By harnessing the power of big data analytics and artificial intelligence, farmers can optimize resource use, minimize environmental impacts, and increase profitability. Moreover, digital platforms facilitate market access, connecting farmers directly with buyers and consumers, thereby reducing transaction costs and improving market efficiencies.



Promotion of modern agricultural techniques pivots to increase per-acre yield through optimum utilization of agricultural inputs.

- 5) Agriculture Value Chain Dynamics in Pakistan:** In Pakistan, agriculture plays a central role in the economy, employs a significant portion of the workforce, and contributes to both food security and rural livelihoods. However, the sector faces numerous challenges, including limited access to finances, outdated infrastructure, and fragmented value chains. To modernize agriculture and enhance food security, stakeholders must address these constraints through targeted interventions such as investment in infrastructure, value chain developments, and capacity building. The countrywide construction of warehouses and storage godowns may facilitate farmers to store crops at very low or subsidized costs, keeping them safe from middlemen. This shall also support farmers to sell output at better rates as per their discretion.
- 6) Corporate Farming and Public-Private Partnership:** Public-private partnerships have the potential to drive agricultural modernization by leveraging the resources and expertise of both the public and private sectors. Corporate farming, characterized by large-scale commercial operations, can bring economies of scale, technology transfers, and investment capital to agriculture. However, it is essential to ensure that such partnerships benefit smallholder farmers and rural communities, promote inclusive growth, and uphold environmental and social safeguards.
- 7) Farm Mechanization for Enhancing Productivity:** Farm mechanization is critical for increasing agricultural productivity, reducing labor requirements, and improving the efficiency of farming operations. From tractors and harvesters to irrigation systems and post-harvest machinery, mechanization technologies enable farmers to scale up production, reduce post-harvest losses, and enhance market access. However, the adoption of mechanization must be accompanied by appropriate training, maintenance services, and access to affordable equipment to ensure sustainability and inclusivity.

8) The Future of AI-Powered Drones in Agriculture:

Farmers typically used to spray crops manually, which is outdated, time-consuming, and results in the wastage of pesticides, as well as improper distribution. Drones, driven by AI, can cover areas efficiently, saving time and ensuring the equal and proper distribution of pesticides.

Drone technology makes AI more affordable, easier to manage, and more accurate. Farmers who use it could see even more significant returns. Soon, it could become a staple in the agriculture industry.

Although drones streamline many agricultural processes, minimize crop compaction, and improve early disease detection, many farmers may hesitate to adopt them despite AI's added benefits. This hesitation isn't too surprising, given that agriculture is often slow to implement modern technologies.

When equipped with sensors, high-resolution cameras, and imaging technology, drones provide a constant data feed for algorithms to analyze in real-time.

Drones have cameras for capturing images from a distance, sensors for monitoring, and nozzle systems for spraying fertilizer or pesticides. Farmers can add extra accessories, such as thermal imaging to measure soil moisture tension or detect nearby predators.

Conclusion

Modernizing agriculture is crucial for ensuring food security, reducing poverty, and fostering sustainable development. Through the embrace of innovations, utilization of technologies, and adoption of sustainable practices, stakeholders can surmount the challenges confronting the agricultural sector and establish a robust and inclusive food system for the future. However, realizing these objectives demands coordinated efforts from governments, private sector entities, civil society organizations, and the international community to invest in agriculture, empower smallholder farmers, and advocate for food sovereignty for all.

References

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