*IOSR Journal of Economics and Finance (IOSR-JEF)*
*e-ISSN: 2321-5933, p-ISSN: 2321-5925, Volume 16, Issue 4 Ser.2 (Jul. – Aug. 2025), PP 08-19*
*www.iosrjournals.org*

# Effects of Artificial Intelligence in Indian Economy

Dr.L.Johncy
*Assistant Professor (SF)*
*The American College Madurai.*

Date of Submission: 02-07-2025 Date of Acceptance: 12-07-2025

## I. INTRODUCTION

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think, learn, and solve problems in ways that mimic human cognitive processes. AI enables machines to perform tasks such as understanding natural language, recognizing patterns, making decisions, and adapting to new information. AI can be broken down into four main dimensions: making machines think like humans, making them act like humans, making them think logically, and making them act rationally. So, AI is about creating smart machines that can do tasks as if they were human or as if they were following a well-thought-out plan. AI has the potential to significantly impact the Indian economy, driving growth, enhancing productivity, and fostering innovation across various sectors. Here's an overview of how AI is influencing the Indian economy.

**Economic Growth and Productivity**

Artificial Intelligence (AI) is a transformative technology that has the potential to significantly boost economic growth and productivity by automating tasks, improving decision-making and fostering innovation. Here's how AI contributes to economic growth and productivity**.**AI has the power to enhance the productivity across industries. Because with automation of routine tasks AI can handle repetitive and time-consuming tasks such as data entry, customer support and inventory management, freeing up human workers for more strategic roles. Example: AI-powered chatbots reduce response times and enhance customer service efficiency. Then with the increased speed and accuracy AI systems process large volumes of data faster and more accurately than humans, reducing errors and operational inefficiencies.

Example: In manufacturing, AI-driven predictive maintenance minimizes downtime and boosts production efficiency.

AI enables the creation of entirely new products and services, such as autonomous vehicles, personalized medicine, and virtual assistants.

These innovations open up new markets and revenue streams.

- **Personalized Experiences:**

o AI enables hyper-personalization in sectors like e-commerce, entertainment, and healthcare, leading to better customer satisfaction and loyalty.

o Example: AI-powered virtual assistants like Alexa and Siri transform user interactions with technology.

- **Autonomous Systems:**

o Self-driving cars, drones, and robots are creating new markets and reshaping industries like transportation, logistics and manufacturing.

- **Generative AI:**

o Tools like ChatGPT and DALL·E drive innovation in creative industries by generating content, designs and ideas.

A national AI strategy needs to be premised on a framework which is adapted to India's unique needs and aspirations, while at the same time, is capable of achieving the country's full potential of leveraging AI developments. Such a framework could be seen as an aggregation of the following three distinct, yet inter-related components: a) Opportunity: the economic impact of AI for India b) AI for Greater Good: social development and inclusive growth c) AI Garage for 40% of the world: solution provider of choice for the emerging and developing economies (ex-China) across the globe.

Opportunity: the economic impact of Artificial Intelligence for India AI is emerging as a new factor of production, augmenting the traditional factors of production viz. labour, capital and innovation and technological changes captured in total factor productivity. AI has the potential to overcome the physical limitations of capital and labour, and open up new sources of value and growth. From an economic impact perspective, AI has the potential to drive growth through enabling: (a) intelligent automation i.e. ability to automate complex physical

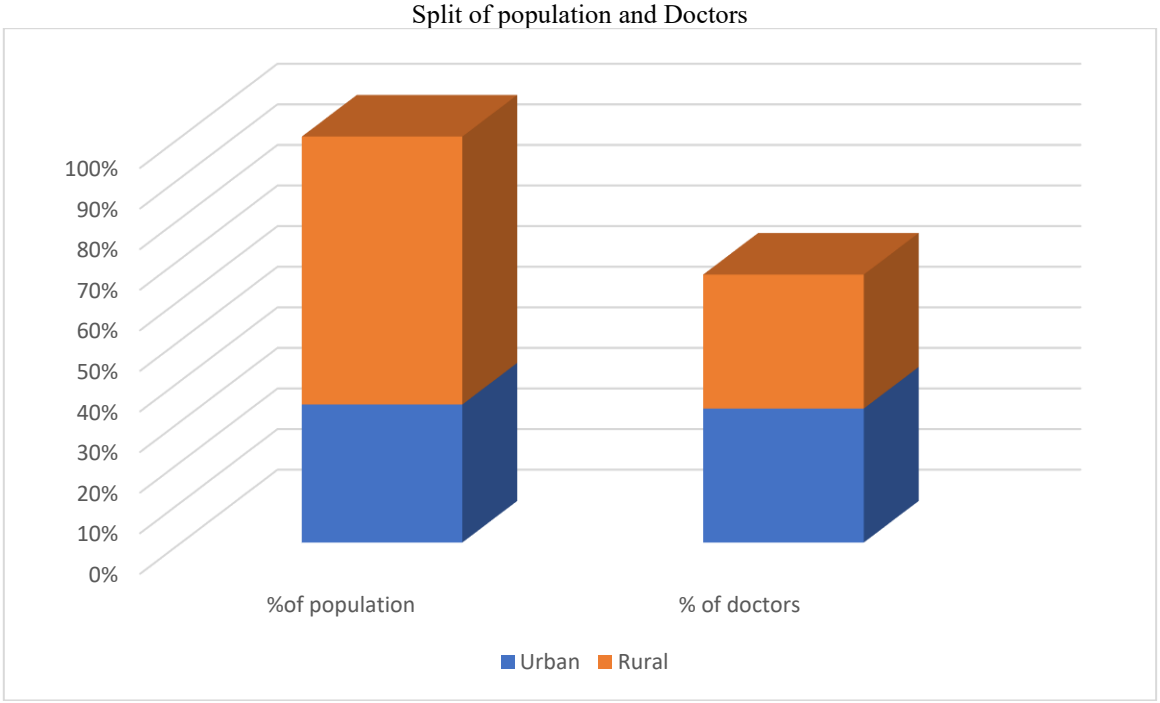
world tasks that require adaptability and agility across industries, (b) labour and capital augmentation: enabling humans to focus on parts of their role that add the most value, complementing human capabilities and improving capital efficiency, and (c) innovation diffusion i.e. propelling innovations as it diffuses through the economy. AI innovations in one sector will have positive consequences in another, as industry sectors are interdependent based on value chain. Economic value is expected to be created from the new goods, services and innovations that AI will enable. Accenture, in its recent AI research reports5, provides a framework for evaluating the economic impact of AI for select G20 countries and estimates AI to boost India's annual growth rate by 1.3 percentage points by 2035.

AI for Greater Good: social development and inclusive growth Beyond just the headline numbers of economic impact, a disruptive technology such as AI needs to be seen from the perspective of the transformative impact it could have on the greater good – improving the quality of life and access of choice to a large section of the country. In that sense, the recent advancements in AI seem to be custom-made for the unique opportunities and challenges that India faces. Increased access to quality health facilities (including addressing the locational access barriers), inclusive financial growth for large sections of population that have hitherto been excluded from formal financial products, providing real-time advisory to farmers and help address unforeseen factors towards increasing productivity, building smart and efficient cities and infrastructure to meet the demands of rapidly urbanising population are some of the examples that can be most effectively solved through the non-incremental advantages that a technology such as AI can provide.

Focus areas for AI intervention

Healthcare is one of the most dynamic, yet challenging, sectors in India, and is expected to grow to USD280 billion by 2020, at a CAGR of upwards of 16%, from the current ~USD100 billion8. Yet, it faces major challenges of quality, accessibility and affordability for a large section of the population: a) Shortage of qualified healthcare professionals and services like qualified doctors, nurses, technicians and infrastructure: as evidenced in 0.76 doctors and 2.09 nurses per 1,000 population (as compared to WHO recommendations of 1 doctor and 2.5 nurses per 1,000 population respectively) and 1.3 hospital beds per 1,000 population as compared to WHO recommended 3.5 hospital beds per 1,000 population. b) Non-uniform accessibility to healthcare across the country with physical access continuing to be the major barrier to both preventive and curative health services, and glaring disparity between rural and urban India.

Fig:1 Accessibility of health care across India
Split of population and Doctors




Source: PwC Analysis, World Bank data (2017).

Despite the obvious economic potential, the healthcare sector in India remains multi-layered and complex, and is ripe for disruption from emerging technologies at multiple levels. It is probably the most intuitive and obvious use case primed for intervention by AI driven solutions, as evidenced by the increasing activity from large corporates and startups alike in developing AI focused healthcare solutions. Adoption of AI for healthcare

applications is expected to see an exponential increase in next few years. The healthcare market globally driven by AI is expected to register an explosive CAGR of 40% through Care in pregnancy and child-birth 1 2 3 4 Neonatal, infant health care services Childhood and adolescent healthcare Family planning / reproductive healthcare Communicable diseases (TB, Malaria etc.) 5 6 Screening, prevention and control of NCDs Common ophthalmic and ENT care 7 8 9 10 Out-patient care for acute simple illnesses / ailments Basic oral healthcare Manageable emergency medical services Screening / management of mental health ailments 11 12 Elderly and palliative health care services Comprehensive primary health care through HWCs Robust IT system, MLHP and payment reforms Expansion to 12 basic services, integration with AYUSH, health promotion Hub and spoke model for connecting HWCs with PHCs Drug storage and dispensation, waiting area for 30+ people Telemedicine facilities and point of care diagnostics Equipped with consulting spaces and wellness rooms National Strategy for Artificial Intelligence 2021, and what was a USD600 million market in 2014 is expected to reach USD6.6 billion by 202111. The increased advances in technology, and interest and activity from innovators, provides opportunity for India to solve some of its long existing challenges in providing appropriate healthcare to a large section of its population. AI combined with robotics and Internet of Medical Things (IoMT) could potentially be the new nervous system for healthcare, presenting solutions to address healthcare problems and helping the government in meeting the above objectives.

AI solutions can augment the scarce personnel and lab facilities; help overcome the barriers to access and solve the accessibility problem; through early detection, diagnostic, decision making and treatment, cater to a large part of India. Cancer screening and treatment is an area where AI provides tremendous scope for targeted large-scale interventions. India sees an incidence of more than 1 million new cases of cancer every year, and early detection and management can be crucial in an optimum cancer treatment regimen across the country. NITI Aayog is in an advanced stage for launching a programme to develop a national repository of annotated and curated pathology images. Another related project under discussions is an Imaging Biobank for Cancer.

| |
|---|
| Box 1: AI for India's cancer woes Cancer screening and treatment is an area where AI provides tremendous scope for targeted large-scale interventions. India sees an incidence of more than 1 million new cases of cancer every year, a number that is likely to increase given the increasing age of Indian population and lifestyle changes. Early detection and management can be crucial in an optimum cancer treatment regimen across the country. Good quality pathology service is the essential building block of cancer care, which unfortunately is not easily available outside select Indian cities. For an annual incidence of more than 1 million new cancer diagnosis every year, India has barely 2,000 pathologists experienced in oncology, and less than 500 11 Frost & Sullivan, "From $600 M to $6 Billion, Artificial Intelligence Systems Poised for Dramatic Market Expansion in Healthcare" 28 National Strategy for Artificial Intelligence 29 pathologists who could be considered an expert onychopathologies. Machine learning solutions aimed at assisting a general pathologist in making quality diagnosis can very well plug this gap in providing essential healthcare. An essential pre-requisite in implementation of such a solution is availability of quality annotated pathology datasets. NITI Aayog is in an advanced stage for launching a programme to develop a national repository of annotated and curated pathology images. The components of such a repository include a move towards "Digital Pathology", which entails all glass slides generated being scanned at high resolution and magnification, followed by accurate, precise and comprehensive annotation of the scanned images using various data sources & levels of clinical & pathological (gross pathology, histopathology and molecular) information available from day-to-day patient care. Another related project under discussions is an Imaging Biobank for Cancer. Human cancers exhibit strong phenotypic differences that may be visualised noninvasively by expert radiologists (using imaging modalities). Recent literature suggests that certain image-based features may correlate to molecular and clinical features like known mutations (KRAS, EGFR, etc.), receptor status, prognostic power, intra-tumour heterogeneity, gene expression patterns, etc. Reports have shown an association between radiographic imaging phenotypes and tumour stage, metabolism, hypoxia, angiogenesis and the underlying gene and/or protein expression profiles. These correlations, if rigorously established, may have a huge clinical impact as imaging is routinely used in clinical practice. Moreover, this provides an unprecedented opportunity to use artificial intelligence to improve decision-support in cancer treatment at low cost especially in countries like India. AI based Radiomics is an emerging field that refers to the comprehensive quantification of tumour phenotypes by applying a large number of quantitative imaging features. It has resulted in improvement to existing biomarker signature panels by adding imaging features. |
| Credit: Tata Memorial Centre for developing the concepts for Digital Pathology and Imaging Biobank |
| |

NITI Aayog is working with Microsoft and Forus Health to roll out a technology for early detection of diabetic retinopathy as a pilot project. 3Nethra, developed by Forus Health, is a portable device that can screen for common eye problem. Integrating AI capabilities to this device using Microsoft's retinal imaging APIs enables operators of 3Nethra device to get AI-powered insights even when they are working at eye checkup camps in remote areas

with nil or intermittent connectivity to the cloud. The resultant technology solution also solves for quality issues with image capture and systems checks in place to evaluate the usability of the image captured. AI based healthcare solutions can also help in making healthcare services more proactive – moving from "sick" care to true "health" care, with emphasis on preventive techniques.

**Agriculture**

While India has come a long way from being categorised as purely an agrarian economy, agriculture and allied sector still accounts for 49% of India's workforce, 16% of the country's gross domestic product (GDP)12, and ensures food security to roughly 1.3 billion people. Agriculture and allied sector are critical to India's growth story. To achieve and maintain an annual growth rate of 8 –10% for the Indian economy, agriculture sector must grow 4% or higher rate. The Government of India has recently prioritised Doubling Farmers' Income as a National Agenda; putting considerable focus on supply chain perspectives in agriculture and market development in addition to productivity augmentation. Despite making impressive progress and receiving government attention, the sector continues to be dependent on unpredictable variables, has weak supply chain and low productivity. India has not been able to completely remove its exploitative dependence on resource intensive agricultural practices. Degradation of land, reduction in soil fertility, increased dependence on inorganic fertilizers for higher production, rapidly dropping water tables and emerging pest resistance are some of the several manifestations of India's unsustainable agricultural practices. As global climate becomes more vulnerable and unpredictable, dependence on unsustainable and resource intensive agriculture will only heighten the risks of food scarcity and agricultural distress. The sector suffers from poor resource utilisation, with the production quantum and productivity still being quite low. For example, yield of cereals, comprising a major share of food grain production, in terms of magnitude is significantly lower than that of China and the USA. Technology adoption and efficient resource usage in these two countries are far higher, thus resulting in higher yields. Similarly, use of water in agriculture continues to be high and sub-optimal. The practice of growing water intensive crops, and inefficient water management, makes India a net exporter of water and puts India's long run agronomic sustainability in question. Despite having just one-third of the gross cropped area under irrigation, agriculture consumes 89% of our extracted groundwater.

In 2016, approximately 50 Indian agricultural, technology-based startups ('AdTech') raised USD313 million17. For the first time, this sector is seeing widespread participation by startups. Intello Labs, for example, uses image-recognition software to monitor crops and predict farm yields. Aibono uses Agri data science and AI to provide solutions to stabilise crop yields. Trithi Robotics uses drone technology to allow farmers to monitor crops in real time and provide precise analysis of their soil. Sat Sure, a startup with roots in India, uses ML techniques to assess images of farms and predict economic value of their future yield. Use of AI and related technologies have the potential to impact productivity and efficiency at all of the above stages of the agricultural value chain.

- Soil health monitoring and restoration: Image recognition and deep learning models have enabled distributed soil health monitoring without the need of laboratory testing infrastructure. AI solutions integrated with data signals from remote satellites, as well as local image capture in the farm, have made it possible for farmers to take immediate actions to restore soil health.

Box 2: Application for soil care Berlin-based agricultural tech startup PEAT has developed a deep learning application called Plan tix that reportedly identifies potential defects and nutrient deficiencies in the soil. The analysis is conducted by software algorithms which correlate particular foliage patterns with certain soil defects, plant pests and diseases. The image recognition app identifies possible defects through images captured by the user's smartphone camera. Users are then provided with soil restoration techniques, tips and other possible solutions.

- Crop health monitoring and providing real time action advisories to farmers: The Indian agriculture sector is vulnerable to climate change due to being rain dependent. Varying weather patterns such as increase in temperature, changes in precipitation levels, and ground water density, can affect farmers especially in the rainfed areas of the country. AI can be used to predict advisories for sowing, pest control, input control can help in ensuring increased income and providing stability for the agricultural community. For example, many agronomic factors (such as vegetation health and soil moisture) can be monitored up to the farm level through remote sensing. Using remote sensed data, high resolution weather data, AI technologies, and AI platform, it is possible to monitor crops holistically and provide additional insights to the extension workers/farmers for their farms as & when required.
- Increasing efficiency of farm mechanisation: Image classification tools combined with remote and local sensed data can bring a revolutionary change in utilisation and efficiency of farm machinery, in areas of weed removal,

early disease identification, produce harvesting and grading. Horticultural practices require a lot of monitoring at all levels of plant growth and AI tools provide round the clock monitoring of these high value products.

Box 3: AI for Precision Farming NITI Aayog and IBM have partnered to develop a crop yield prediction model using AI to provide real time advisory to farmers. IBM's AI model for predictive insights to improve crop productivity, soil yield, control agricultural inputs and early warning on pest/disease outbreak will use data from remote sensing (ISRO), soil health cards, IMD's weather prediction and soil moisture/temperature, crop phenology etc. to give accurate prescriptions to farmers. The project is being implemented in 10 Aspirational Districts across the States of Assam, Bihar, Jharkhand, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh.

**AI in Indian Agriculture: Impact, Challenges & Future Prospects**

AI is revolutionizing Indian agriculture by enhancing productivity, reducing costs, and addressing challenges like unpredictable weather, pests, and inefficient supply chains.

**1. Importance of AI in Indian Agriculture**

| Factor | Impact of AI |
|---|---|
| **Yield Optimization** | AI helps improve crop yields by 15-20% through precision farming. |
| **Weather Forecasting** | AI-powered prediction models improve accuracy by 85%. |
| **Pest & Disease Control** | AI-based detection can reduce crop losses by 30-40%. |
| **Soil Health Monitoring** | AI-driven soil analysis helps farmers use 25% less fertilizer. |
| **Supply Chain Efficiency** | AI can reduce post-harvest losses by 20-25%. |

**2. AI Applications in Indian Agriculture**

**A. AI-based Precision Farming**

- AI-powered sensors and **Internet of Things (IoT)** devices monitor soil moisture, temperature, and crop health.
- **Example**: Agri tech startup **Crop In** provides real-time crop monitoring using AI, benefiting over **7 million farmers**.

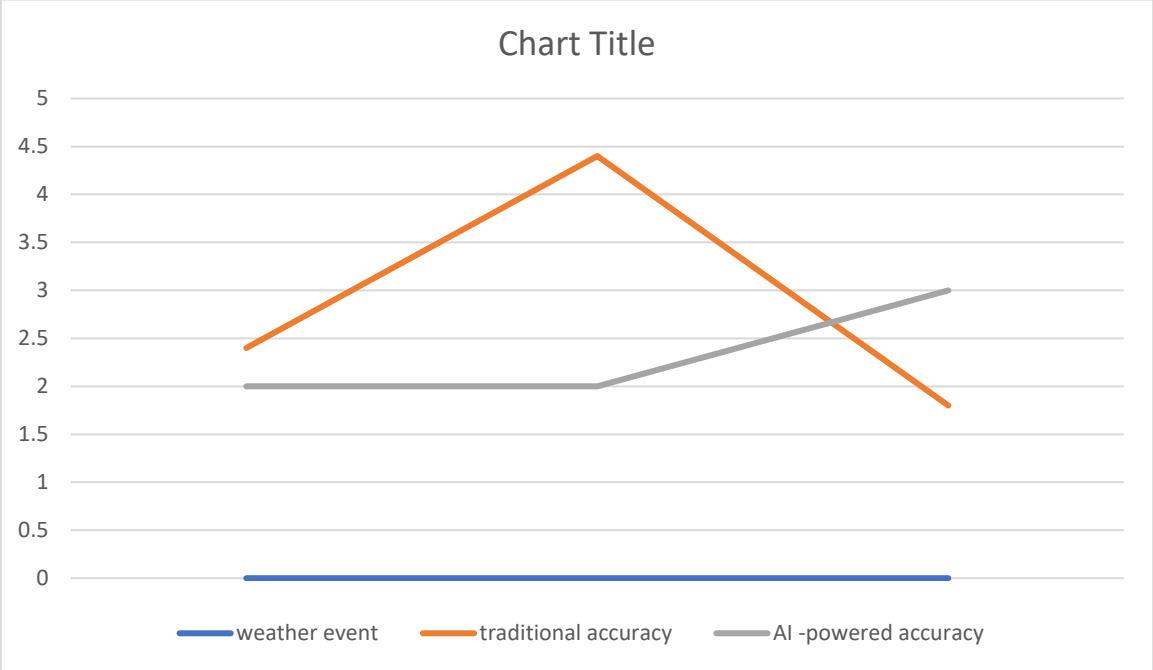
| Parameter | Traditional Farming | AI-Powered Farming |
|---|---|---|
| **Water Usage** | High (Inefficient) | 30% Reduction |
| **Pesticide Use** | Excessive | 25% Lower |
| **Crop Yield** | Moderate | 15-20% Increase |

**B. AI for Weather Forecasting**

- AI models analyse satellite images and historical data to predict rainfall, droughts**,** and storms.
- Example: IBM's Watson Decision Platform provides AI-driven weather forecasts to Indian farmers, improving accuracy by 85%.

**Table 2: AI-Driven Weather Forecasting Benefits**

| Weather Event | Traditional Accuracy | AI-Powered Accuracy |
|---|---|---|
| Rainfall Prediction | 60% | 85% |
| Drought Forecast | 50% | 80% |
| Cyclone Warnings | 70% | 90% |




**C. AI in Pest & Disease Detection**

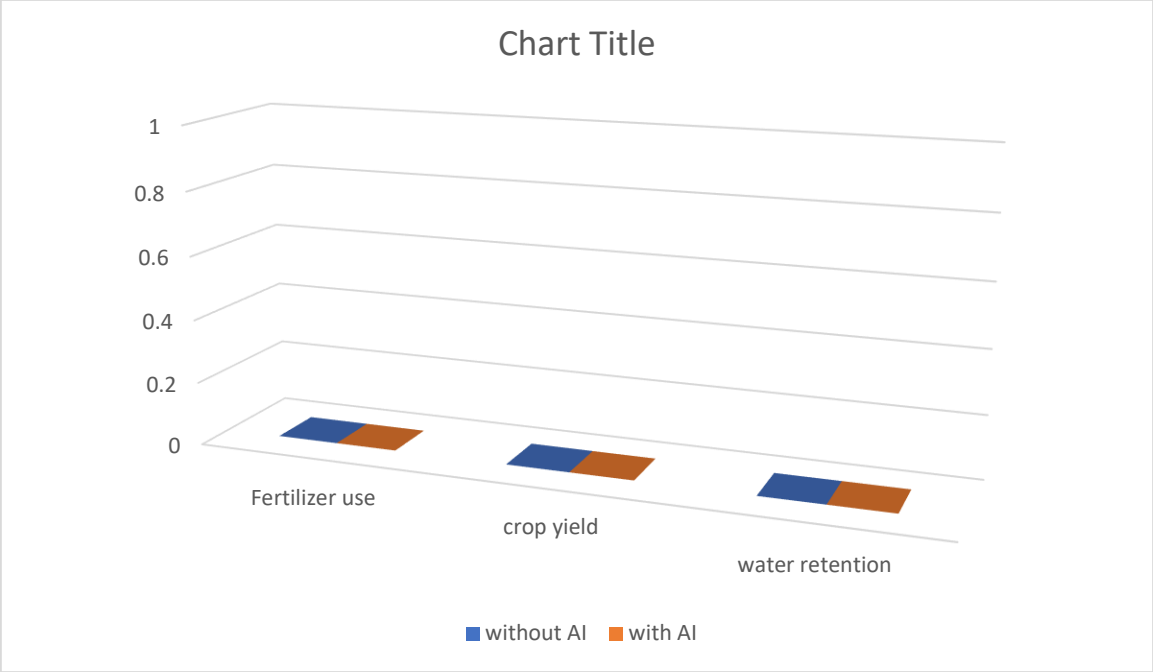
- AI-based apps analyse **plant images** to detect diseases and pests early.
- **Example**: ICRISAT's **Kalagadi AI app** has reduced **pest-related losses by 30%** for farmers.

**D. AI in Soil Health Monitoring**

- AI-powered **soil testing kits** analyse pH levels, moisture, and nutrients, providing recommendations.
- **Example**: **Fasal** AI startup helps farmers optimize fertilizer use, reducing wastage by 25%.

**Table 3: AI Impact on Soil Health Management**

| Factor | Without AI | With AI |
|---|---|---|
| Fertilizer Use | High (Excessive) | 25% Reduction |
| Crop Yield | Moderate | 10-15% Higher |
| Water Retention | Low | 30% Better |




**E. AI in Market Price Prediction & Supply Chain**

- AI analyses market trends and predicts **crop prices**, helping farmers **sell at the right time**.
- AI-powered supply chain models reduce **post-harvest losses by 20%**.
- **Example**: NITI Aayog's **AI-based price forecasting tool** helps farmers get fair prices.

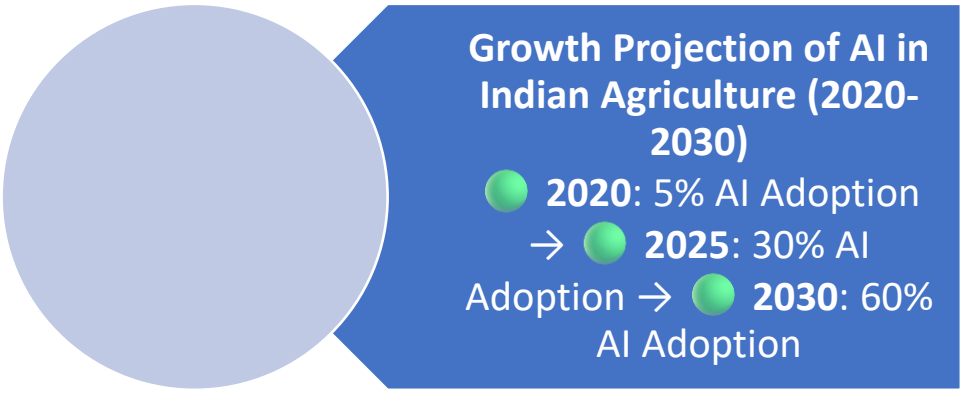

**3. Challenges in AI Adoption for Indian Agriculture**

| Challenge | Impact | Possible Solution |
|---|---|---|
| **High Cost of AI Technology** | Many small farmers can't afford AI-based tools. | Government subsidies & low-cost AI solutions. |
| **Lack of Digital Literacy** | Farmers struggle to use AI-powered apps. | Training programs under Digital India. |
| **Limited Internet in Rural Areas** | AI-based tools require **internet access**. | Expansion of 5G & rural connectivity. |

| Challenge | Impact | Possible Solution |
|---|---|---|
| **Data Privacy Concerns** | AI tools collect **farmers' personal data**. | Stronger data protection laws for agriculture. |

**4. Future of AI in Indian Agriculture**

- By **2025**, AI in Indian agriculture is expected to **increase productivity by 20%**.
- The Indian government's **AgriStack initiative** will create **a national AI-driven agricultural database**.
- AI-driven automation (like **robotic farming**) will further reduce labor costs and improve efficiency.




**Education**

An effective education sector has the ability to transform a country through development of human resources and increased productivity. In the context of emerging countries particularly, levels of education and literacy of the population play an important role in development and overall transition to an advanced economy. In India, the importance of a developed education sector is amplified by a large youth population. Estimates indicate that currently over half the population of the country is below the age of 25. As the adoption of digital means of gathering data increases, it is important that these methods are effectively leveraged to deliver improved education and teaching. The adoption of technology in education is improving, though not at the pace required. It is estimated that schools globally spent nearly USD160 billion on education technology, or 'EdTech', in 2016, and forecast spending to grow 17% annually through 2020. Private investment in educational technology, broadly defined as the use of computers or other technology to enhance teaching, grew 32% annually from 2011 through 2015, rising to USD4.5 billion globally. Adoption of new technologies is still lacking, however, often attributed to unwillingness of teachers and students to adopt technology. School education in India has seen substantial progress in recent decades, with efforts at both the Central and State levels, and substantive gains in enrolment have been achieved – Gross Enrolment Ratio (GER) is 97% at elementary level and 80% at secondary level, as per recent figures. However, low retention rates and poor learning outcomes mar the impact of gains in enrolment.
a) Low retention rates: Enrolment of children is of little use if children are not retained in the schooling system. Retention rate of 70.7% at elementary level indicates that one-third of enrolled children drop out before completing Class 8. Retention rate at secondary level is also poor at 57.4%. Low quality of education is one of the causes of poor retention.
b) Poor learning outcomes: There is increasing concern about the poor learning levels of children in school, and a new National Achievement Survey (NAS) was recently conducted in November 2017. Previous rounds of NAS results provide an insight into longitudinal performance over time – average performance of States / UTs on previous rounds showed that over 60% of Class 5 students scored below 50% across subjects; and for majority of the 31 States / UTs tested, performance significantly deteriorated in NAS Cycle-4 versus Cycle-3. Assessments from the perspective of basic foundational skills also indicate poor learning outcomes – in rural areas, only 47.8% of Class 5 children could read Class 2 level text and only 26% could do Class-5-level arithmetic. The above

scenario is a consequence of a complex interplay of factors that pose challenges to improving the quality of education:

a) Multi-grade and multi-level classrooms: For a large proportion of schools, especially in small or remote villages, it is not viable to have separate classrooms and teachers for different grades / classes. Consequently, the teacher is faced with a heterogenous group of children in the same classroom, with wide variations in their classes, ages, abilities and learning levels. This large variation poses a huge challenge to the teacher and is a common cause of poor teaching-learning, thus leading to poor learning outcomes.

c) Lack of interactive pedagogy and ineffective remedial instruction: Teaching-learning processes in most classrooms are highly rote-based and non-interactive. Remedial instruction, where conducted, typically lacks customisation to the child's learning level, abilities, and pace of learning. 35 National Strategy for Artificial Intelligence

d) Inadequate attention / action for likely drop-outs: Several children may be at risk of dropout due to various factors, such as inadequate school infrastructure, poor teachers, poor school readiness, language barriers, large learning gaps with respect to grade level, family circumstances (e.g. migrant families), poor nutritional or health status, etc.

e) large teacher vacancies due to uneven distribution across locations: Large number of teacher vacancies are mostly not due to an overall shortage of teachers in a State – instead, they are due to uneven distribution across different geographical areas within the State. For instance, recent figures for Uttar Pradesh revealed 1.74 lakh teacher vacancies at elementary school level, but a simultaneous surplus of 0.66 lakh teachers across the state.

f) Professional development courses / training do not cater to real needs and have poor coverage Existing teacher training is typically a generic kind of an exercise. It is not linked to the specific weaknesses / requirements of a teacher – for instance, a teacher with poor arithmetic understanding requires corresponding training to clarify arithmetic concepts. Consequently, most teacher training exercises end up as wasted public expenditure, with little or no benefit to the teacher and her / his students. Similar issues exist with respect to training of other staff such as school headmasters/principals. The coverage of existing training programs is also extremely low, typically less than 20% annually.

g) Low adoption of existing technologies: A recent survey found that level of adoption of technology in schools is lacking, and can be largely attributed to lack of teacher training, despite provision of the ICT infrastructure. While 83% of the teachers surveyed use computers, the use is limited primarily to audio / visual display, or student practice. A meagre 41% and 27% use technology for tracking student data and participating in forums respectively. This trend is even more pronounced in the low fee school segment surveyed. Another trend observed is that trained teachers are much more likely to use technology in the classroom. 88% of trained teachers reported making use of available computers as compared to only 53% of untrained teachers. Trained teachers were found to be nearly twice as likely to report using technology for communication purposes and for online forum participation20. According to EdTech Global, EdTech is becoming a global phenomenon, and as distribution and platforms scale internationally, the market is projected to grow at 17.0% per annum, to USD252 billion by 2020. India's digital learning market was valued at USD2 billion in 2016 and is projected to grow at a CAGR of 30%, reaching USD5.7 billion in 2020 as per estimates from Technopak. As per Forbes, in 2017, across every market involved in EdTech, international funding reached a new record of USD9.52 billion, and 813 different EdTech companies received fundings last year. These EdTech investments mark a gain of 30% from 2016. VC interest in the education space continues to grow. For example, one of India's leading EdTech startups Biju's raised USD40 million from Tencent in July 2017, just four months after raising USD30 million from Belgium-based Verlin vest. Among Biju's other investors include Sequoia Capital and The Chan Zuckerberg Foundation. AI has the potential to bring about changes in the sector by supplementing pedagogy and establishing systems to inform and support decision making across stakeholders and administrative levels. However, 19 Cross Square Foundation, Ed Tech Adoption Survey 20 Economic Survey, 2016-17 36 National Strategy for Artificial Intelligence implementation of AI must be preceded by efforts to digitise records of teacher performance, student performance, and curriculum. Several AI tools are being successfully used in other parts of the world, and they can be adapted to the Indian context to target specific challenges. a) Adaptive learning tools for customised learning: While AI may not completely replace a teacher, it has the potential to greatly assist teachers in efficiently and effectively managing multi-level / multi grade classrooms, by judging learning levels of individual students, and allowing automated development of customised educational content adapted to each child's class and learning level. Assessing time spent by a student on each part / page of the learning material, for example, would allow real-time feedback on student performance to help the teacher appropriately tailor her guidance to the child. This concept can be extended to automatic grading of tests, as well. b) Intelligent and interactive tutoring systems: Intelligent Tutoring Systems can provide great benefit to students through delivery of learning materials adapted to the child's proficiency level, learning style, and pace of learning. In-built pop-up questions tailored to students, for example, can help increase interactivity, and catch student's attention and interest. It can also help in assessment of student's level of attention or comprehension to appropriately design remedial instruction. Grade Guardian, for example, uses predictive models and visualisations for student performance with an interactive dashboard showing

anticipated effect of policy changes. Submission includes 3 components packaged as a single web app – a Chatbot that inputs student information, an Advisor Console that shows students at risk, and a prediction module for policymakers. Box 9: Creating 'smart content' for improved interactivity Content Technologies Inc. (CTI), an AI research and development company, develops AI that creates customised educational content. Using deep learning to absorb and analyse existing course materials, textbooks, and course curriculum, the technology creates custom learning materials, including textbooks, chapter summaries, and multiple-choice tests. A recent hackathon conducted by NITI Aayog also featured 'Read Ex', an android application that does real-time question generation using NLP, content recommendations, and flashcard creation. c) Predictive tools to inform pre-emptive action for students predicted to drop out of school: Analysis of test results and attendance records using AI can be used to predict probable student activities and inform pre-emptive action. For instance, in a recent preliminary experiment conducted in Andhra Pradesh, AI applications processed data on all students based on parameters such as gender, socio economic factors, academic performance, school infrastructure, teacher skills, etc., with the objective of helping the government identify students likely to drop out. Test results could inform suggestions to enrol students in vocational studies. Additionally, redressal mechanisms could be put in place to identify students whose performance can be improved by focus of existing schemes to their family.

**Smart Cities and Infrastructure**

India is currently in the midst of a surge of urbanisation. While the percentage of the population living in urban areas was estimated to be 31% in 201121, recent research on satellite data indicates that this figure is close 45% today22, and predicted to rise to up-to 60 percent by 205023. Though seen as an important aspect of a country's economic growth and a major step in the overall development of the country, unplanned urbanisation presents challenges such as congestion, over pollution, high crime rates, poor living standards, and can potentially put a huge burden on the infrastructure and administrative needs of existing Indian cities. To tackle these challenges, the Government of India has embarked on an ambitious initiative to set up Smart Cities across India, aimed at driving economic growth and improving the quality of life, by harnessing IT solutions. As part of the Smart Cities Mission, 99 cities have been selected with expected investment of INR2.04 lakh crores. The strategic components of these Smart Cities include city improvement (retrofitting), city renewal (redevelopment) and city extension (greenfield development) in addition to a pan-city initiative in which smart solutions are applied covering large parts of the city. The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) is another related initiative which targets improving the infrastructure of existing cities. Smart cities attempt to address the challenges of urbanisation through development of features based on IT solutions, some of which are listed below.

a) Poor urban planning: Smart cities aim to solve challenges of inefficient land use, improper land use categorisation, area-based development and lack of open spaces such as parks, playgrounds, and recreational spaces in order to enhance the quality of life of citizens, reduce the urban heat effect, and generally promote improved ecological balance.

b) Inefficient utility distribution: Through large scale deployment of smart meters in both electricity and water, smart cities being developed are trying to solve challenges such as low visibility on usage of utilities such as electricity, water, and waste management. This is also targeted to help address issues of leakages in electricity and water distribution, and improper disposal of waste, and have the potential to significantly reduce cost associate with administration and management.

c) Improved delivery of citizen services: In the domain of service delivery, smart cities aim to harness data to solve issues in low accountability and transparency. By using digital channels, they can help address challenges in administration of offices, and long wait times. Today, poor standards of grievance redressal form another pressing issue that may be addressed by increasing adoption of technology-based solutions.

d) Improving public safety: Cities in India today are hotbeds for a range of crimes. Smart cities aim to address the issues of increase in crime and increased risk of urban emergencies through improved city design and surveillance analytics. Some Smart Cities have already begun implementing these features through specific projects. Pune, for example, has launched The Pune Street Light Project to setup energy efficient street lights that can be remote controlled through a Supervisory Control and Data Acquisition (SCADA) systems. Surat has built a network of more than 600 surveillance cameras which will be expanded to all major locations in the 21 Census 2011 Live Mint: "How much of India is actually urban?" 23LiveMint: "60% of India's population to live in cities by 2050: government" 24 Smartcities.gov.in 39 National Strategy for Artificial Intelligence city, as well as collaborated with Microsoft to develop solutions for water management and urban planning. Due to the large amount of data they can create, smart cities are especially amenable to application of AI, which can make sense of the data being generated, and transform it into predictive intelligence – thus transitioning from a smart city to an 'intelligent city'. However, the wide range of connected devices also gives rise to increased risks in cyber security, with harmful actors such as hackers now capable of affecting city scale infrastructure. Some use cases of AI that can augment the features of a smart city are listed below.

a) Smart Parks and public facilities: Public facilities such as parks and other spaces contribute substantially to a city's liveability. Use of AI to monitor patronage and accordingly control associated systems such as pavement

lighting, park maintenance and other operational conditions could lead to cost savings while also improving safety and accessibility.
b) Smart Homes: Smart homes concept is creating buzz with AI technologies being developed to optimise human effort in performing daily activities. Extending this concept to other domestic applications such as smart rooftops, water saving applications optimising domestic water utilisation for different human activities etc.
c) AI driven service delivery: Implementation of AI to leverage data on service delivery could see application such as predictive service delivery on the basis of citizen data, rationalisation of administrative personnel on the basis of predicted service demand and migration trend analysis, and AI based grievance redressal through chat-bots.
d) Crowd management: Use of AI in providing effective solutions in crowd management in recent times have been in vogue and given fruitful results in averting city-scale challenges such as managing mega footfall events, emergency and disasters. Accenture worked with the Singapore Government during their SG50 Celebrations (50th anniversary of Singapore' independence), and developed solution aimed at predicting crowd behavior and potential responses to incidents. The solution resulted in 85% accuracy in high crowd activity, crowd size estimation and object detection. Closer home, the "Kumbh Mela Experiment" is aimed at predicting crowd behavior and possibility of a stampede. Similar Big Data and AI solutions could help with advance prediction and response management.
e) Intelligent safety systems: AI technology could provide safety through smart command centres with sophisticated surveillance systems that could keep checks on people's movement, potential crime incidents, and general security of the residents. Social media intelligence platforms can provide aid to public safety by gathering information from social media and predicting potential activities that could disrupt public peace. In the city of Surat, the crime rate has declined by 27% after the implementation of AI powered safety systems.
f) Cyber-attacks: Cyber-attacks seem to pose a great threat to our institutions and public systems, today. AI technologies possess the capability to detect vulnerabilities and take remedial measures to minimise exposure of secure online platforms containing highly sensitive data from being targeted by unscrupulous social elements.

**Challenges & Problems of AI in India**
India is rapidly adopting Artificial Intelligence (AI) across various sectors, but several challenges hinder its full potential. These issues can be categorized into technological, economic, ethical, and regulatory concerns.

**1. Lack of Skilled Workforce**
- India faces a severe shortage of AI engineers, data scientists, and AI ethicists.
- Most Indian universities lack AI-focused curriculums.
- The demand for AI professionals is rising, but reskilling efforts are slow.
- Small and medium enterprises (SMEs) struggle to afford AI talent.

Example: A NASSCOM report states that India needs over 500,000 AI professionals, but the current supply is much lower.
Solution: Government initiatives like AI for All, Skill India, and Digital India aim to train professionals in AI technologies.

**2. Data Scarcity & Quality Issues**
- AI systems need high-quality, structured data, but India lacks centralized and standardized datasets.
- Many datasets (especially in healthcare, agriculture, and education) are incomplete, unstructured, or unavailable.
- Lack of proper data labelling and annotation reduces AI accuracy.

Example: AI in healthcare struggles due to inconsistent patient records and lack of electronic health records (EHRs).
Solution: Establish data collection frameworks and enforce data-sharing policies to improve AI training quality.

**3. Digital Divide & AI Accessibility**
- AI adoption is concentrated in urban areas, leaving rural India behind.
- Many small businesses cannot afford AI-powered tools.
- Limited internet penetration (especially in remote villages) makes AI-driven solutions less effective.

Example: Farmers in remote areas cannot benefit from AI-driven precision farming due to lack of internet and digital literacy.
Solution: 5G expansion, Digital India push, and AI-powered mobile solutions can bridge the gap.

**4. High Cost of AI Implementation**

- Developing and maintaining AI models requires high computing power and storage.
- Small businesses and startups struggle with high AI infrastructure costs.
- India relies on foreign companies (Google, Microsoft, Nvidia) for AI hardware and cloud computing.

Example: Indian AI startups depend on cloud-based AI models from foreign providers, increasing costs and data privacy risks.
Solution: Invest in India-based AI hardware startups and encourage affordable AI solutions for local businesses.

**5. Ethical & Bias Issues**

- AI models often reflect societal biases, leading to discrimination in hiring, lending, and law enforcement.
- Lack of AI ethics guidelines in India increases the risk of biased decision-making.
- Deepfake technology and AI-based misinformation can manipulate public opinion.

Example: AI-driven facial recognition systems in India have shown bias against darker skin tones, leading to false identifications.
Solution: Implement strict AI ethics policies and ensure transparent AI models with proper testing for biases.

**6. Data Privacy & Cybersecurity Risks**

- India lacks a strong AI-specific data protection law.
- AI models rely on huge amounts of personal data, increasing the risk of data breaches.
- Cyberattacks on AI-driven systems (such as banking fraud and identity theft) are rising.

Example: Aadhaar-based AI authentication faces concerns about data leaks and privacy violations.
Solution: Strengthen data protection laws (like the Digital Personal Data Protection Act) and invest in AI cybersecurity research.

**7. AI Regulation & Government Policies**

- India lacks clear AI regulations on ethics, accountability, and safety.
- There are no clear laws on AI in criminal justice, surveillance, and misinformation.
- Over-regulation may slow down innovation, while under-regulation risks misuse.

Example: China and the EU have strict AI governance laws, but India is still developing a clear framework.
Solution: Introduce AI laws balancing innovation and regulation, ensuring fair and responsible AI usage.

**8. Dependence on Foreign AI Technologies**

- India imports most AI chips, cloud infrastructure, and software from the US, China, and Europe.
- Over-reliance on foreign AI models reduces self-sufficiency and security.
- Limited investment in India-based AI research slows down innovation.

Example: India's AI research funding is much lower than China's or the US's, limiting domestic advancements.
Solution: Promote Make in India AI initiatives, increase funding for AI R&D, and develop Indian AI chips.

## II. Conclusion:

The Path Forward
AI has huge potential for India's growth, but challenges must be addressed for sustainable adoption.
Key Steps for India**:**

- ✅ Invest in AI education & training to build a skilled workforce.
- ✅ Improve data infrastructure with standardized and accessible datasets.
- ✅ Ensure AI accessibility for small businesses and rural areas.
- ✅ Strengthen AI regulations focusing on ethics, privacy, and security.
- ✅ Develop India-made AI solutions to reduce dependence on foreign technology.

With strong policies and investments, India can become a global AI powerhouse while addressing these challenges.

**Reference**


- NITI AAYOG National Strategy for Artificial Intelligence.