



Unlocking AI's Potential in India

Transforming Agriculture and Healthcare



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Foreword (I)



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Artificial Intelligence (AI) is no longer a futuristic aspiration—it is a present-day necessity. Across the globe, AI is transforming industries, economies, and societies. However, for India, AI is more than just a technological revolution; it is an imperative to address structural gaps in critical sectors such as healthcare and agriculture.

Despite being home to one of the largest skilled workforces, India faces a severe manpower deficit in essential services—not enough doctors to serve our growing population, and an agriculture sector in urgent need of modernization. While infrastructure and digital advancements have progressed in urban areas, rural India still lacks the digital ecosystem necessary for AI to reach its full potential. Addressing these disparities requires a multi-faceted approach that combines AI innovation, infrastructure development, and responsible governance.

Unlocking the Potential of AI in key sectors — Healthcare & Agriculture

In healthcare, AI has already demonstrated its ability to bridge gaps in diagnostics, predictive analytics, and telemedicine. With the right data

frameworks in place, AI can revolutionize early disease detection, optimize hospital workflows, and personalize patient care—especially in rural areas where access to quality healthcare and specialists remains limited. However, the absence of digital health records and fragmented infrastructure hinders large-scale AI deployment. As we move forward, structured data collection, AI-powered decision-making, and responsible governance will be crucial in shaping an inclusive healthcare system.

For agriculture, the challenge is even more fundamental. While India has the second-largest agricultural workforce in the world, digital penetration remains low, and the adoption of AI-enabled precision farming, IoT-based monitoring, and predictive yield analytics is still not scaled to its full potential. AI can transform smallholder farming—which accounts for 85% of Indian agriculture—by improving yield optimization, resource allocation, and market access. However, for AI solutions to be viable, we must build a solid foundational data layer and bridge digital and AI literacy gaps. Government intervention, financial incentives, and infrastructure expansion will be vital in ensuring AI's adoption at scale.

Foreword (II)

From Innovation to Impact

AI adoption is not just about deploying technology; it requires an ecosystem approach. Compute infrastructure, open-access datasets, AI skilling programs, and sector-specific innovation centers must be prioritized. While NITI Aayog and other government agencies have laid the groundwork for AI integration, the collaboration between policymakers, academia, startups, and industry stakeholders must accelerate.

Also, MeitY (Ministry of Electronics and Information Technology) has played a crucial role in enabling inclusive AI development by fostering national AI initiatives, digital infrastructure, and responsible AI governance.

Additionally, AI governance must evolve beyond compliance into proactive enablement. The Digital Personal Data Protection (DPDP) Act is a step forward and policy makers must assess sector specific gaps, ensuring alignment between sectoral requirements and central regulations. This harmonization prevents duplication of efforts while fostering ethical, scalable, and equitable AI adoption.

A Call for Collaborative Action

For India to fully harness AI's potential, the focus must shift from small-scale experiments to systemic transformation. The government must not only fund AI innovation but also actively procure AI-driven solutions for public services—from rural healthcare delivery to precision agriculture advisory systems.

The next decade will define India's role in the AI-driven global economy. By fostering a culture of responsible AI development, prioritizing investments in digital public infrastructure, and ensuring AI reaches the last mile, we can position India as a leader in AI for impact—one that enhances livelihoods, democratizes opportunities, and builds a future where technology serves humanity at scale.

I encourage readers to engage with this report with a sense of urgency and opportunity. AI is not just a tool for efficiency; it is a force multiplier for inclusion, innovation, and national progress.



Executive Summary (I)

The global AI market, driven by generative AI breakthroughs, presents a **\$400 Bn opportunity by 2027**. Governments and businesses **must act now** to harness this potential responsibly. Over 70 countries have already developed comprehensive national AI frameworks, with **\$1.75 Tn in potential public sector productivity gains globally**. This report studies global benchmarks to identify key enablers that can drive the AI agenda in a country, providing actionable insights for effective AI adoption and integration.



6 key principles form the foundation of an adaptable AI strategy

- 01** Establish **secure and scalable data infrastructures** to enable seamless integration, sharing, and utilization of information across AI platforms and apps.
- 02** Invest in **scalable and secure AI platforms, cloud services, and data stacks** to facilitate affordable, interoperable, and inclusive adoption of AI technologies.
- 03** Implement specialized curricula and upskilling programs to **build workforce readiness and enhance AI literacy**, ensuring preparedness for transformations.
- 04** **Foster partnerships among government, industry, and academia** to accelerate research, innovation, and large-scale implementation of AI solutions.
- 05** Develop **policies ensuring ethical AI usage, safeguarding data privacy, and promoting transparency** to build trust while enabling sustainable innovation.
- 06** Launch **pilot programs and sandboxes to test and scale AI applications in priority sectors**, addressing unique challenges and maximizing impact.

Executive Summary (II)

The Opportunity for India

India, with its 1.25 Mn¹ AI talent pool is **uniquely positioned to lead South Asia in AI adoption**. By harnessing targeted innovation in sectors like healthcare and agriculture, India can not only bridge its urban-rural divides but also solidify its position as a global hub for AI-driven solutions.

Defining India's Path Ahead

India is currently a leader in AI readiness within South & Central Asia, driven by its strong focus on skilling, investment, and research. To elevate itself as a global AI powerhouse, India has the opportunity to adopt a bold, mission-driven approach that fosters innovation, inclusion, and impact.

6 Key Pillars to Build a Scalable AI Ecosystem

- 01 Mission-Driven AI Strategy**
Advance AI funding and governance with sector-specific blueprints (e.g., healthcare, agriculture) to position India as a global leader.
- 02 Empowering a Future-Ready Workforce**
Ensure government and private sector collaborations to define curricula for scaled AI literacy to bridge talent gaps and build a skilled workforce across all regions.
- 03 Ethical AI Governance**
Develop a centralized policy framework harmonizing state initiatives, ensuring responsible innovation, data privacy, and trust in high-stakes AI applications.
- 04 Fostering Innovation and Entrepreneurship**
Establish AI-focused venture funds and incentives to drive innovation in priority sectors like health-tech and agri-tech.
- 05 Strengthening Academia-Industry Collaboration**
Explore increasing R&D investments and partnerships to create scalable AI solutions tailored to India's unique challenges.
- 06 Building Inclusive Infrastructure**
Enhance rural connectivity, centralized data-sharing platforms, and regional AI hubs to democratize AI adoption and promote cross-sectoral innovation.

Executive Summary (III)

AI Potential in India's Healthcare Sector

India's healthcare system faces critical challenges, including a doctor-to-patient ratio of 1:900 and 66% of deaths attributable to Non-Communicable Diseases (NCDs). AI offers a transformative opportunity to bridge these gaps and deliver accessible, cost-effective, and high-quality healthcare at scale.



Higher quality: With +20 Mn screenings Qure.AI, reduced diagnosis times from 3 weeks to 2 hours and improved detection rates by 29%



Increased Access: Portable AI from Forus Health enabled +7.5 Mn eye screenings, for early detection of diabetic retinopathy in underserved areas



Lower Costs: Niramai offers 27% higher accuracy in detecting breast cancer at 1/3rd costs, democratizing access to preventive care

India's healthcare sector faces significant challenges in scaling AI, including fragmented health data with limited digitization, limited AI-ready infrastructure in rural areas, and a lack of AI training for healthcare workers, all of which impede seamless integration and accessibility.

4 Enablers based on learnings from global players to help scale AI

- 01 Unified Health Data Ecosystem**
Develop secure, interoperable platforms like Ayushman Bharat and standardize Electronic Health Records (EHRs) to enable seamless AI integration.
- 02 Empowering the Healthcare Workforce**
Train healthcare workers, especially Community Health Workers (CHWs), in AI tools to enhance access in underserved areas.
- 03 Responsible AI Governance**
Assess and develop AI regulations as necessary to safeguard patient data while ensuring safety and trust in high-stakes application.
- 04 Strengthened Rural Infrastructure**
Deploy AI-ready devices and edge solutions in rural centers to enable real-time diagnostics and decision-making in low-resource settings.

Executive Summary (IV)

AI Potential in India's Agriculture Sector

India's agriculture sector faces challenges of fragmentation, resource inefficiency, and climate vulnerabilities, with over 85% of farms under 2 hectares and high post-harvest losses. AI offers transformative solutions to improve productivity, sustainability, and inclusivity across the value chain.



Precision Farming and Monitoring: AI-driven hyper-local weather predictions and irrigation optimization tools reduce water & fertilizer usage by ~28%



Early Disease Detection and Risk Mitigation: AI-tools detect pest outbreaks and diseases in real-time, minimize crop losses leading to ~8% productivity gain



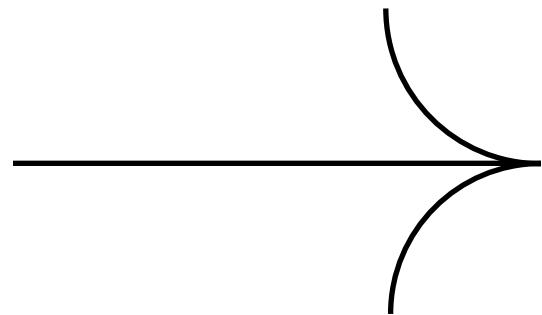
Post-Harvest Optimization: AI-enabled supply chains reduce spoilage, enhance market linkages, leading to ~7% productivity improvements

The agriculture sector struggles with fragmented farm data, low AI adoption due to limited awareness among farmers, high costs of AI tools, and the need for localized solutions tailored to India's diverse agro-climatic conditions, making scaling AI solutions difficult.

5 Enablers based on learnings from global players to help scale AI

- 01 Building a Robust Data Ecosystem**
Digitize land records and integrate datasets into a National Agriculture Data Lake.
- 02 Localized AI Models for Scale**
Develop region-specific AI tools tailored to India's diverse agro-climatic challenges.
- 03 Empowering Farmers and Agri-Entrepreneurs**
Provide AI training programs and mobile learning units for rural farmers and foster mentorship and incubation for agri-tech startups.
- 04 Strengthening Infrastructure**
Expand rural internet connectivity and deploy low-cost IoT sensors to ensure real-time data collection.
- 05 Ensuring Scaled Adoption**
Invest in specialized tools and standardized protocols for secure data sharing, with regional agreements to ensure privacy, compliance, and seamless collaboration.

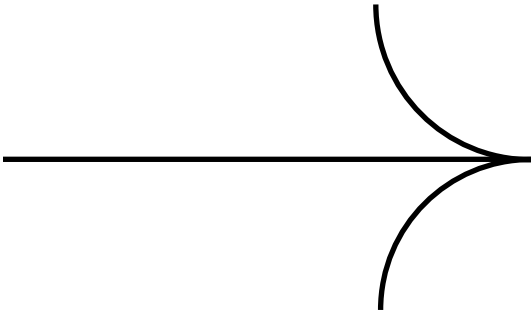
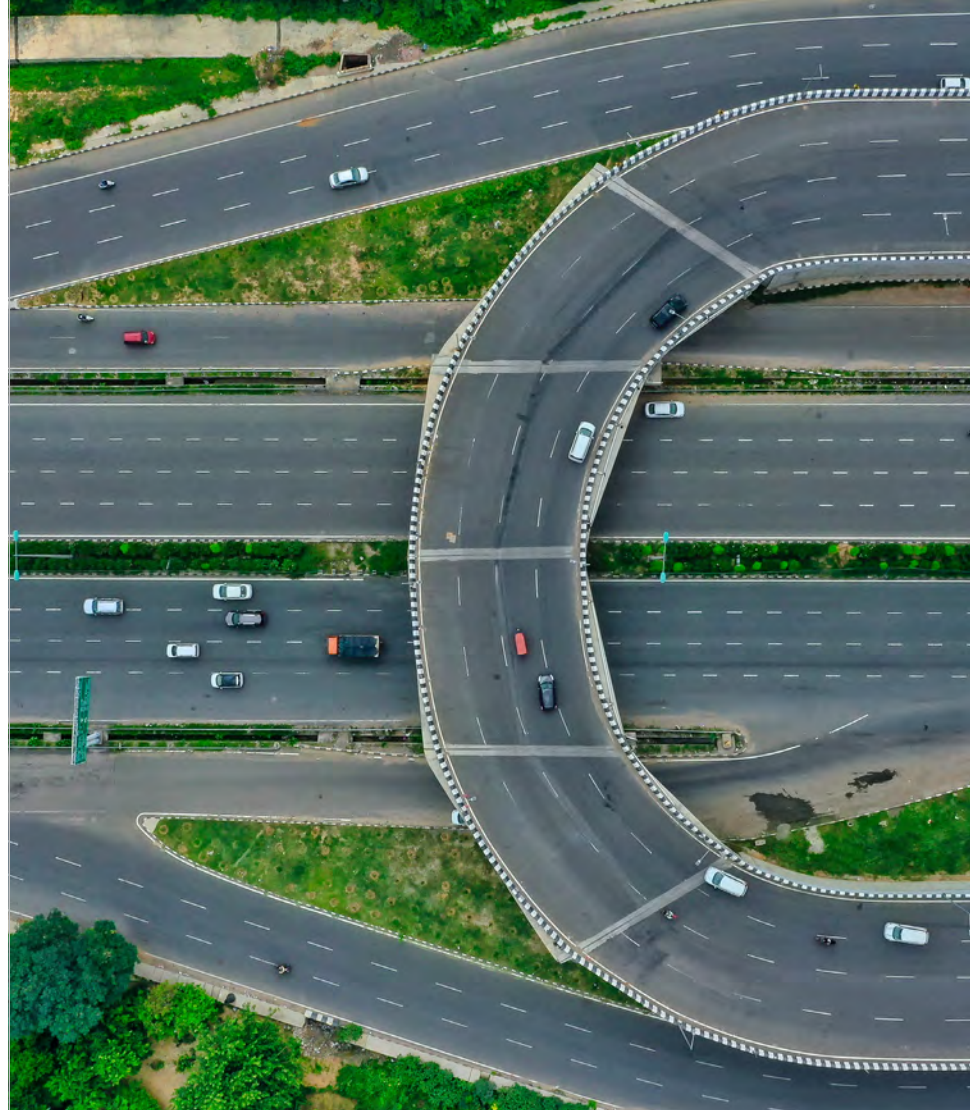
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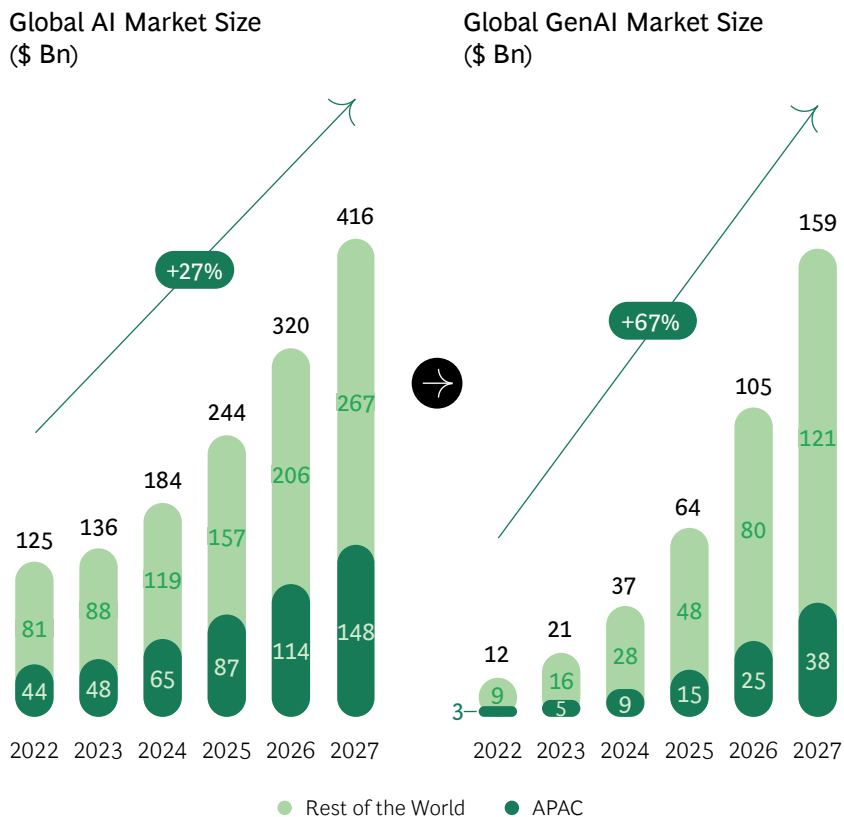
01

Global AI Surge



Global AI market is expected to reach \$400 Bn+ by 2027, driven by major breakthroughs leading to growth in GenAI

GenAI will be the fastest growing sub-segment in the global AI market growing at 67% CAGR



Major GenAI advancements are accelerating global adoption

Breakthrough



Rise of multi-modal models



Access to easy model fine-tuning



Arrival of large context window models



Drop in price and increase in speed



Quantum Computing to scale GenAI



Rise of Agentic AI

Capabilities

Models like GPT-4o can reason over voice, vision & text in real time using one unified model to respond to users

It is now easier to build custom fine-tuned models for specific use cases or audiences, with increasing accuracy

Google's Gemini Pro models have a context window of 2+ Mn tokens (~700,000 words or 1 hour of video). Anthropic's Claude models have a context window of 200,000+ tokens

Cost reductions & speed increases:

→ GPT-4o is 2x faster & 50% cheaper vs GPT-4

→ Claude 3.5 is 80% cheaper than Claude 3 and also performs better

With enhanced computing power, it becomes easy to generate synthetic data, run model on quantum machines and improve GenAI efficiency

From automating repetitive tasks to revolutionizing complex workflows, AI agents are redefining productivity and innovation for businesses

In private sector, companies are leveraging AI for everyday productivity gains, cost takeouts and new revenue growth

	Productivity improvement Automation of tasks frees up teams for strategic work and improves operational efficiency across roles.	Cost transformation Predictive AI optimizes asset use, prevents downtime, and cuts operational costs through better resource management.	Top-line growth AI accelerates innovation, enables personalized offerings, and creates new revenue opportunities through data-driven insights.
	Energy 4 hours Productivity boost (per week) to support growth strategy 	Financial Institution \$1 Bn+ Productivity program (e.g., cost, revenues, balance sheet optimization) 	Insurance 50% Reduction in time required for underwriting, driving top line growth 
	Professional Services 6 hours Productivity benefits (per week) through broad deployment across 30K users 	Biopharma \$1 Bn Value potential by 2027; 'Reshaped' multiple core functions (e.g., Marketing, R&D, Manufacturing) 	Consumer Goods 3% Incremental sales through digital services 

Source: BCG experience

Significant impact estimated in the public sector by adopting AI to drive citizen satisfaction and government efficiency



\$1.75 Tn
Estimated productivity opportunity across national, state and local governments globally each year¹

Key areas of value potential of AI in Public sector



Citizen Satisfaction

AI-powered services and solutions enhance citizen experience

- Personalization
- Rapid response times
- Proactive communications
- Increased accessibility
- Enhanced security
- Streamlined processes and services

India: IRCTC has deployed an AI assistant for IRCTC and an AI-based system to cut wait times and optimize seat allocation, enhancing capacity and boosting revenue. This works alongside the IRCTC’s AskDISHA 2.0 chatbot.

Singapore: AlphaBotSG is Singapore’s AI-driven chatbot designed to streamline public services by providing instant responses to citizen queries across government websites, enhancing accessibility and efficiency in citizen engagement.



Government Efficiency

Streamline and enhance internal government operations

- Automated admin tasks
- Data-driven decision making
- Predictive maintenance & management
- Optimized resource allocation
- Real time fraud detection
- Continuous improvement

Japan: Crime Nabi is an AI-powered tool that predicts crime hotspots by analyzing historical crime data. It helps law enforcement allocate resources effectively, enhancing public safety through targeted, proactive crime prevention.

South Korea: South Korea’s “I-Korea 4.0” initiative prioritizes AI for e-governance, focusing on automating administrative tasks and enhancing cybersecurity within government systems.

¹ Estimated productivity benefit across national, state and local governments globally with GenAI implemented at scale, calculated across public sector professions using best case scenario benchmarks across similar professions. **Source:** BCG analysis

However, despite the potential, AI poses certain risks requiring governments & organizations to implement Responsible AI (RAI)

Range of risks that must be managed and mitigated carefully

	Information integrity and disinformation	AI risks spreading fake news and deepfakes
	Data privacy and security	Sensitive data in AI models risks privacy breaches
	Bias and ethical concerns	Without ethical guidelines, AI may reinforce social biases
	Legal and IP issues	AI may infringe copyrights & complicate accountability
	Operational efficiency and automation risks	AI could disrupt existing job roles and policies

Efforts needed at both country and organization level to develop and operate AI systems in a responsible manner

RAI efforts at a Country Level

Regulatory interventions

Enforcing policies to mitigate AI risks

Governance frameworks

Establishing structures for AI accountability

Technology interventions

Implementing tools to safeguard AI systems

Ethical standards and guiding principles

Frameworks ensuring AI integrity

Education and capacity building

Training workforce on responsible AI practices

RAI efforts at an Organization Level

Strategy

Developing long-term plans for AI and RAI

Governance

Internal oversight for responsible AI usage

Processes

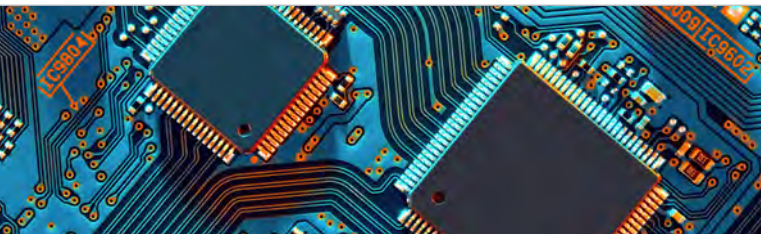
Standardizing procedures to manage AI effectively

Technology

Infrastructure supporting secure AI operations

Culture

Fostering ethical practices within AI deployment



For policy makers, several best practices exist to help establish the ethical and responsible use of AI

Best practices to be followed when designing AI systems



Accountability and Transparency

Public entities must ensure responsible AI outcomes and ethical use. Systems should be explainable, with clear information on purpose, development, and limitations to build trust and accountability.



Fairness and Inclusivity

AI systems should address biases, ensuring fair outcomes across diverse user groups. Design must accommodate varied needs, promoting equitable benefits for all demographics.



Safety, Reliability, and Resilience

AI systems must adhere to data privacy laws, securing user data and minimizing misuse risks. Policies should ensure sensitive information is handled responsibly within legal frameworks.



Privacy and Data Security

Systems should be tested for security and reliability, with safeguards for unexpected behaviors. This helps maintain robustness, ensuring consistent performance in all conditions.



Human Empowerment and Social Impact

AI should enhance user autonomy, fostering positive societal impacts and avoiding harm. Public entities should ensure AI supports sustainable progress and aligns with human values.



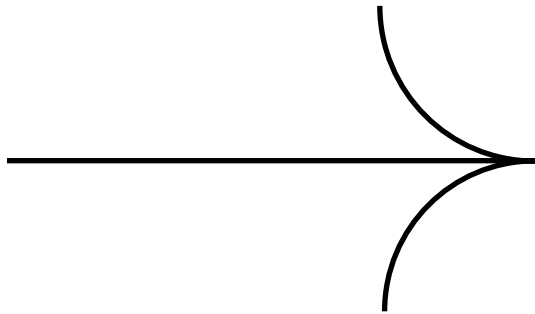
The Government of Canada **created the Artificial Intelligence Assessment questionnaire** designed to help civil servants assess and mitigate the risks associated with deploying an automated decision system.



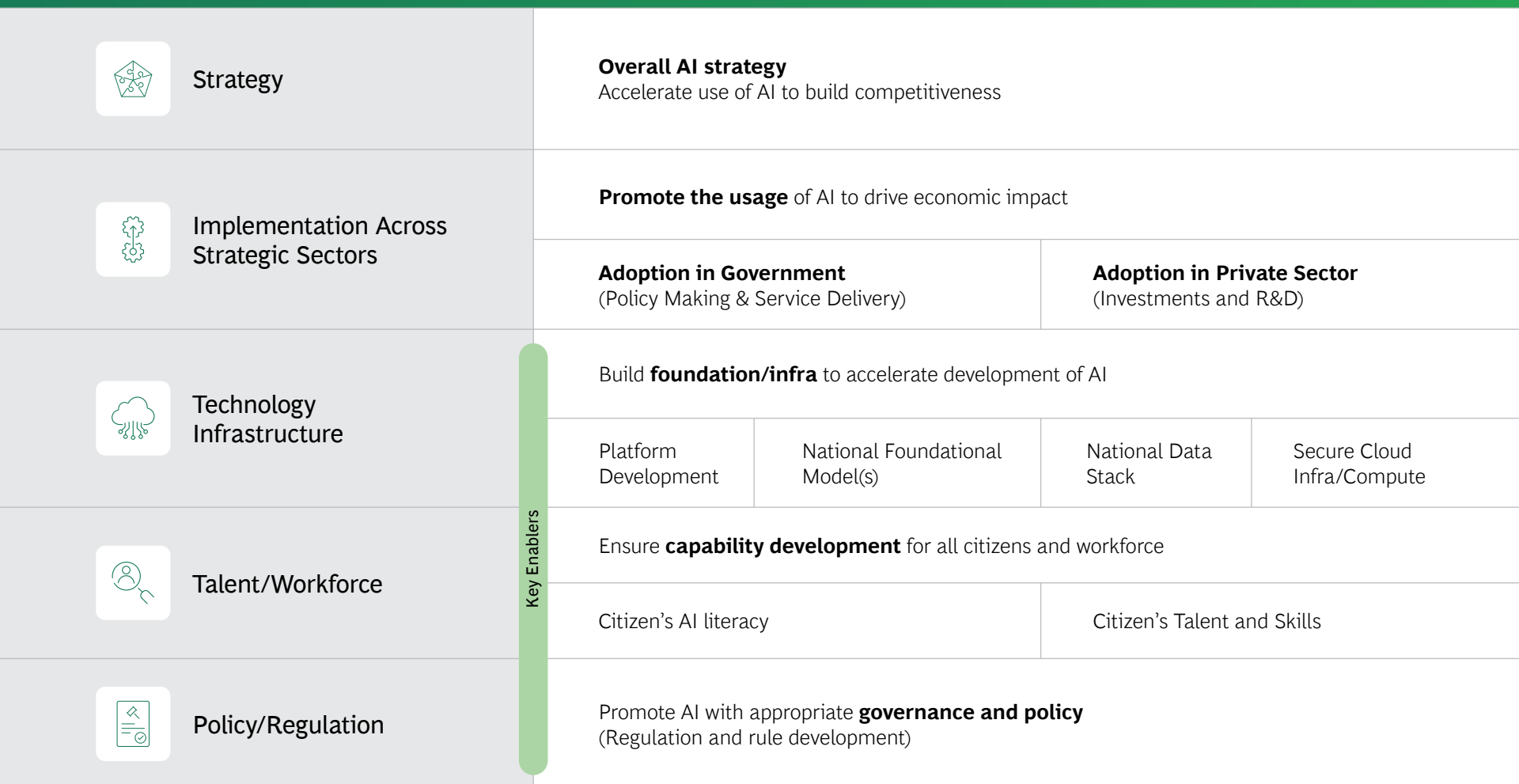
Singapore's Model AI Governance Framework promotes ethical AI adoption through transparency, fairness, and human-centric design. Its AI **Verify Toolkit offers standardized testing and validating AI systems' reliability, fairness, and accountability, ensuring safe deployments.**

02

Learning from Global Players



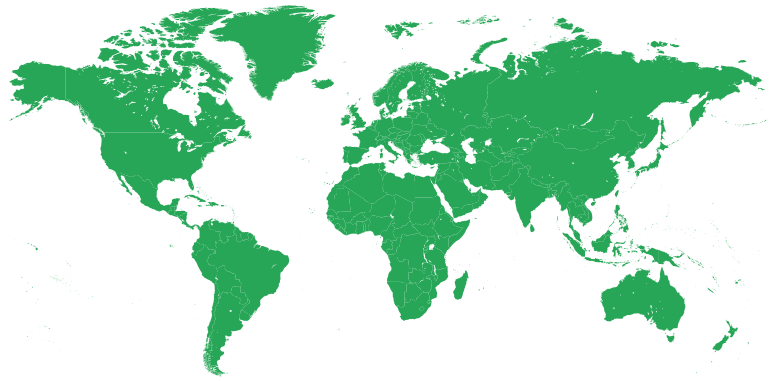
To realize the full potential of AI, nations need to holistically develop and strengthen AI ecosystems



Key Enablers

More than 70 economies are working on developing their national AI strategies

[Select Examples](#)

Asia		Europe	
India National Strategy for Artificial Intelligence	Japan Artificial Intelligence Technology Strategy	United Kingdom AI Sector Deal	Belgium AI 4 Belgium
South Korea Artificial Intelligence Information Industry Development Strategy	China Next Generation Artificial Intelligence Development Plan	Luxembourg Artificial Intelligence: a strategic vision for Luxembourg	Norway The National Strategy for Artificial Intelligence
America			
Canada Pan-Canadian Artificial Intelligence Strategy	Colombia National Policy for Digital Transformation & Artificial Intelligence		
Mexico Towards an AI Strategy in Mexico: Harnessing the AI Revolution	United States American AI Initiative		

Source: BCG experience

Countries are beginning to launch AI initiatives and publish guidelines, with varying levels of government involvement

	Degree of government involvement				
	United States Active use of private sector to drive initiatives	South Korea Emphasis on industrial development	Singapore Emphasis on industrial development	European Union Regulatory-centric approach	Mainland China Strong government oversight
Promotion	→ Subsidies & tax credits on semi-conductors → Focus on collaboration between leading tech companies, universities to drive innovation and commercialization of AI technologies	→ GenAI for doc creation and retrieval in some agencies → ~\$300 Mn investment to become No. 1 in AI → R&D and educational centers	→ \$60 Mn research program to develop LLM for SE languages → Government datasets expanding → Triple AI talent pool to 15,000 through training	→ ~€14 Mn in funding for general-purpose foundation model → Support semiconductor production bases to double production share	→ Specific industries favored for the promotion of AI use → 40+ domestic AI models authorized for use
Regulation	→ Frontier models like OpenAI, Google DeepMind, etc. independently enforce safety protocols for frontier models	→ Guidelines for “moral AI development” → Enhanced protection for copyright holders in training data	→ \$2.2 Bn invested in online safety (e.g., DF detection) → Published discussion paper on RAI	→ Legislation signed to regulate use of AI → Mandatory disclosure of training data and AI-generated content	→ Mandatory labeling of falsified content → Mandatory government approval of GenAI service providers

Globally governments are adopting AI across all stages of policy making

Stages of policy making	Exemplary benchmarks	Lessons for policymakers
01 Agenda setting or Problem Identification Identifying a problem and bringing it to the attention of policymaker	Australia - Identifying health trends to preempt policy making In Victoria, AI analyzes hospital data to detect health trends, offering early warnings for potential outbreaks and guiding proactive, data-driven policy measures.	 AI is a powerful tool: That has the potential to generate value for citizens, if applied responsibly.
02 Policy Formulation Considering available options and crafting solutions to identified problems	AI-Driven Adaptive Learning in Education Singapore uses AI to design customized education programs, addressing diverse student needs with adaptive learning, realtime insights, and enhanced teacher support for better outcomes.	 It enables localized policy-making: By leveraging and analyzing data to generate context specific solutions.
03 Policy Adoption Deciding whether to act on a policy matter, usually involves a period of debate and voting	France - AI for Policy Decision Support France utilizes AI simulations to predict healthcare policy outcomes, aiding policymakers in selecting actions with the highest potential to improve public health.	 Responsible use is critical: To generate maximum positive impact from the use of AI.
04 Policy Implementation Designing steps for implementation and translating the policy into action by delivering the service	United States - Optimizing Ambulance Dispatches The United States leverages AI to optimize ambulance dispatch, using real-time data analysis to improve response times, resource allocation, and overall emergency medical service efficiency.	 Institutionalized AI is key to sustainability: AI enables efficient resource use and sustainable development.
05 Policy Evaluation Assessing whether objectives were achieved and if policy should be altered	United Kingdom - Carbon pricing effectiveness through AI The United Kingdom uses AI to assess carbon pricing policies' impact on emissions, employing simulations to better understand carbon tax effectiveness for informed policy adjustments.	

Source: Victoria State Government; Liberal Forum; United Kingdom Centre for Energy Policy and Economics; Smart Nation Singapore; BCG analysis

In APAC there are several use cases of government institutions implementing AI technologies to enhance service delivery across sectors

	 Healthcare Services India	 Employment Support Singapore	 Public Transportation Singapore	 Healthcare Services Malaysia	 Banking Services Indonesia	
	→ Government's flagship institution AIIMS has implemented iOncology.ai → An AI solution for early cancer detection, supporting public hospitals across the country → Capable of analyzing complex medical data, including diagnosis, with unprecedented accuracy and efficiency	→ Singapore launched a jobs portal, using machine learning and other AI methods to find the best job matches for each jobseeker's skills → Job matches are quantified based on analysis of job descriptions and necessary skills relative to employee profile → Government schemes providing training support	→ Singapore government's AI-powered data fusion platform optimizes its bus public transport system by predicting and addressing service disruptions → Based on analyzing transit time across each link in the network and the dwell times at each stop, on a day-by-day basis and in the short term → Incorporate weather across geographic zones to enable accurate predictions	→ Malaysia uses AI to improve public service delivery through intelligent automation, enhancing efficiency in sectors such as healthcare services → AI technologies are being developed to evaluate medical pictures such as X-rays, CT scans, and MRIs to assist doctors in diagnosing and treating ailments	→ Indonesian government also supports AI in banking systems, with GenAI enhancing operations and customer service for Bank Rakyat Indonesia → Combining digital and physical presence to enable better customer experience → Technology is expected to enable 25% growth in investments into real-time capabilities in the country	

Governments are providing holistic ecosystem support to stimulate AI activity in countries

	 Provide financial support and incentives	 Promote collaboration with privates and other stakeholders	 Establish a central body to oversee and coordinate efforts	 Provide robust and accessible infrastructure for Research and Innovation (R&I)	
	Providing targeted support to prioritized sectors, reducing cost burden and providing credits to reduce future cost pressure.	Share risk with private sector and gather synergy from resource sharing, enabling effective Research and Innovation (R&I) efforts and impactful innovation.	Create a new agency or assign an existing agency with the jurisdiction to oversee and coordinate Research and Innovation (R&I) efforts by stakeholders.	Ensure sufficient compute capacity, data accessibility and high-speed connectivity network to support AI research and innovation.	
	United Kingdom SME R&D Relief Scheme: SMBs can deduct upto ~186% of their tax component for spend in AI R&D. Under India AI Mission, the government has approved a plan of ~\$1.2 Bn for India AI mission to build infra and provide funding to startups.	AI Singapore – 100E Program (2017) offers co-funding up to \$245K & AI experts to organizations seeking support. Private organizations match the funding in-kind (AI/engineering/IT/domain manpower) and in cash.	Singapore created AI Singapore to drive national Research and Innovation (R&I) agenda. France positioned Inria as central coordination body for national AI Research and Innovation (R&I).	France built Jean Zay supercomputer to support high-performance computing & AI researchers	

1. USD INR conversion as of March 25, 2024 @83.346

Source: Bpifrance; United Kingdom Guidance on R&D Tax reliefs; AI Singapore 100E Program

Countries varied approaches towards building AI tech stack depend on need to serve local markets and support sovereign interests

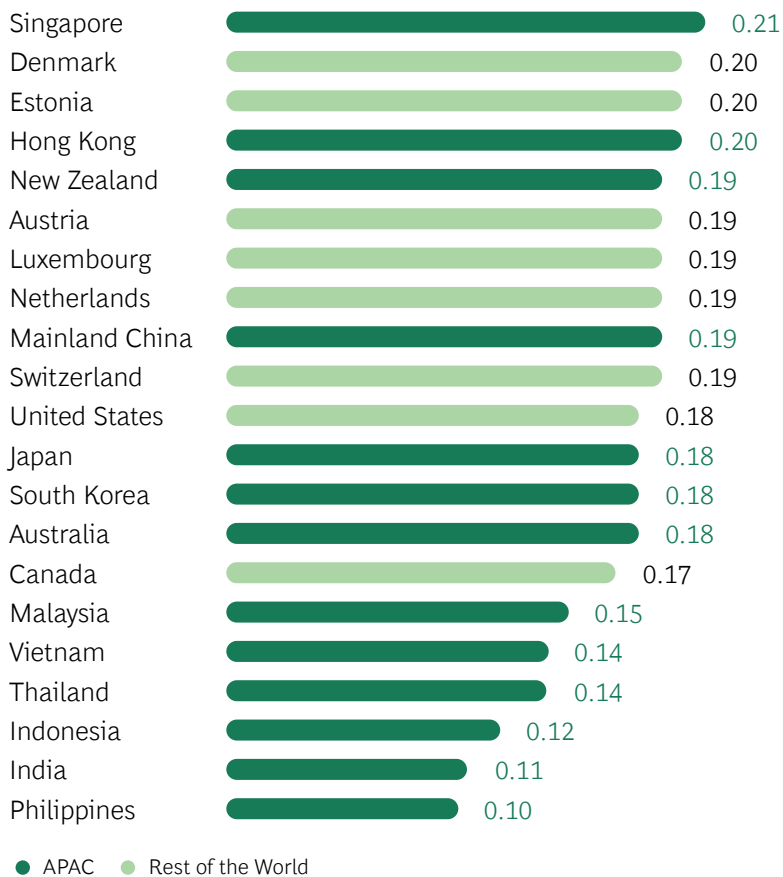
	Build and Own Complete Stack	Hybrid Build and Integration	Rely on Foreign Stack Build
 Bespoke local (language/culture) needs	Local integration focus: Tailored solutions integrate local languages and cultures ensuring services resonate well with the population	Localized adoption: Local needs are addressed through fine-tuning, like adapting AI models for language or cultural context	Standardized development: Foreign stacks typically align with universal standards, for quicker deployment and consistency
 Sovereign interest protection	Data sovereignty: Full control over data storage and processing ensures national security and sovereignty is maintained	Partial control: Parts of the stack like computing infrastructure may lie outside national borders, giving only partial control over the stack	Sovereign risks: Relying on foreign infra introduces potential risks to sovereignty, as these solutions are governed by external standards
 Foreign profile elevation	Strong influence in tech decisions: Having a national stack strengthens a nation's position in regional tech coalitions	Shared knowledge use: By integrating open-source models, countries can leverage shared knowledge to replicate apps	Limited influence: This limits opportunities to protect national interests or assert influence in regional technology dialogues
 Economic upside	Economic benefits: While costly, developing a local stack creates jobs and fosters tech talent, with long-term economic benefits	Cost effective: A hybrid stack allows for cost-effective development, through integration of open-source solutions	Minimal investment needs: Require minimal initial investment but involve recurring costs due to licensing fees
 Example	Falcon LLM: Streamlined processes for training and fine-tuning medium-sized GPTs; implemented within UAE's healthcare system and across Serbia, Uzbekistan, and Brazil	Bhashini AI: Automated speech recognition, text-to-speech, OCR, video translation, document translation, and language detection; integrated into various government services	Most markets



Markets like India and SEA, with high level of diversity and specialized language needs, warrant hybrid models to drive localized adoption

Several APAC nations at-par with developed nations w.r.t tech-infra readiness with Singapore leading the way within APAC (I)

Tech Infrastructure Index¹ (AI Preparedness)



APAC aggressively investing in tech enhancements to support AI transformation (I)



Nations undergoing rapid AI development

Singapore, Mainland China, and Korea are leading with advanced connectivity. Singapore was among the first with nationwide 5G, China has the largest 5G network globally, and Korea's 5G covers over 80% of the population, establishing a strong foundation for AI integration across industries.



Developing APAC nations face hurdles

For example, limited internet penetration, especially in rural areas, and outdated network infrastructure. For instance, in India, with over 55% population residing in rural areas, only 24% have internet access, which creates challenges in digital inclusion and infrastructure readiness for AI. These challenges slow the adoption of emerging technologies like AI.



Improving tech readiness for AI across APAC

A clear focus on enhancing cloud capabilities, expanding data centers, and improving digital infrastructure. Mainland China is aggressively building foundational tech infrastructure to position itself as a global AI powerhouse, while India is taking steps to scale data access and connectivity nationwide.

1. IMF AI Preparedness Index (Tech Infrastructure Index 2023 – Assessment of public indexes/ranking to define accessible, affordable, and secured internet access along with a mature ecommerce infrastructure)

Several APAC nations at-par with developed nations w.r.t tech-infra readiness with Singapore leading the way within APAC (II)

APAC aggressively investing in tech enhancements to support AI transformation (II)



Platform Development

- Over next 5 years, Singapore will invest \$200 Mn to upgrade supercomputing capability and network speed and quality
- Japan's Society 5.0 and South Korea's "I-Korea 4.0" initiatives places strong emphasis on building local AI platforms



National Data Stack

- China ranks 4th globally with ~450 data centers
- India ranked 14th with 152 data centers. By 2025, 45 new data centers with a combined 13 Mn square feet and 1,015 MW of capacity are scheduled to be developed



National Foundational Model(s)

- Significant AI foundation model dominance of the United States and Mainland China (61 and 15 notable ML models respectively), while countries like Singapore, Japan and Australia consider development of own models
- Singapore stands 8th with 3 notable ML models



Secure Cloud Infra

- Singapore is working toward a cloud-first economy, plan to invest 30% IT budget in 2023 on cloud-based apps
- India Stack builds on the Indian government's investment in digital identity and payment infra



India continues to strengthen its tech infrastructure through investments and building strong digital infrastructure to boost AI adoption

India undertakes targeted initiatives to ensure stronger AI and digital infra

India is undertaking strategic initiatives to strengthen its AI and digital infrastructure, aiming to position itself as a global leader in AI adoption. The government is focusing on several key areas to build a resilient, future-ready digital ecosystem:



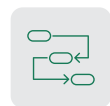
Building foundational infrastructure

To improve digital accessibility, India is enhancing foundational infrastructure, including high-speed internet and cybersecurity. Major telecoms like Reliance Jio and Airtel are extending 4G and fiber networks to underserved regions, laying groundwork for nationwide 5G deployment.



Partnerships with global tech firms

The Indian government is partnering with leading global tech firms to strengthen the national AI ecosystem. These partnerships aim to leverage industry expertise and resources for AI applications and digital transformation. For instance, Google has announced the launch of Google for startups AI academy India 2024 with MeitY.



Establishing CoEs and R&D programmes

India is setting up Centers of Excellence (CoEs) across states, driven by MeitY's national AI R&D program. The focus is on skill development, research, and fostering collaboration between government, academia, and industry. For example, NEURON at Mohali has been set up as a CoE in AI, IoT by MeitY, ISB and Government of Punjab.



Building data centers

India is investing heavily in data center infrastructure, with states like Maharashtra, Tamil Nadu, and Karnataka launching targeted policies to develop data centers. This expansion supports data-intensive AI applications and enhances digital resilience.



Building supercomputing facilities

The National Supercomputing Mission (NSM) aims to create a network of High-Performance Computing (HPC) facilities across India. These supercomputing resources are essential for advanced AI research, applications across various sectors.

Select Examples



Multiple states like Tamil Nadu, Maharashtra, Uttar Pradesh, Karnataka, Telangana, West Bengal, and Rajasthan **have launched focused data center development policies**



India plans to invest in an **AI computing infrastructure** equipped with at least **10,000 Graphics Processing Units (GPUs)**



MeitY developed a **national program to facilitate AI R&D**, especially in strategic areas, **including AI applications in cybersecurity and natural language processing**

Developing APAC markets are upskilling in AI to bridge talent gap and enhance global competitiveness

Globally, there is a need to address the AI talent shortage...



Global tech shortage of 85 Mn AI positions, and 6.4% decline in overall workforce displaced by AI by 2025¹



Leading nations are striving to build awareness and motivation across demographics; 50%² of the global population lacks trust in AI



Leading countries are focused on covering full AI talent value chain (including awareness, talent development, talent mobility)



...APAC is taking initiative in building an AI ready workforce, to potentially become a key market to bridge the talent gap globally



National AI skilling and initiatives

India for SWAYAM-NPTEL: It offers AI-focused courses led by IIT and IISc experts, providing accessible, high-quality AI education to students and professionals. These courses, available via SWAYAM platform, include lectures, assignments, and affordable certifications.



Industry partnerships

Google investment: In Malaysia, Google is investing \$2 Bn to develop a data center and cloud infrastructure to strengthen AI capabilities and support digital transformation across the region.



Youth focused AI education programs

Responsible AI for youth: Aimed at equipping students across India with foundational AI skills, preparing them for the digital future. Through hands-on workshops, interactive courses, and AI-based projects, the program fosters understanding of AI technologies.



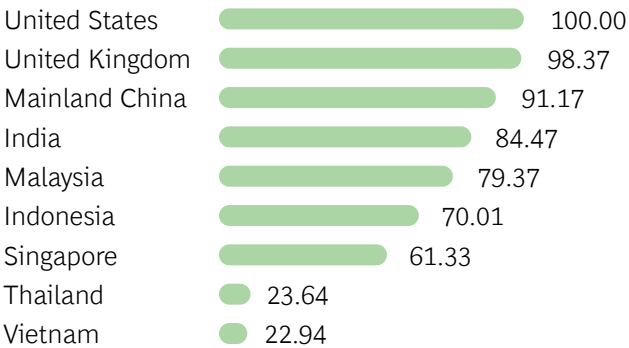
Incentivized training programs

Subsidy for research: The Ministry of Health, India has said that it will grant subsidies to 16 medical institutions to establish 3 types of AI centers - responsible AI implementation, clinical AI verification, and AI impact research centers.

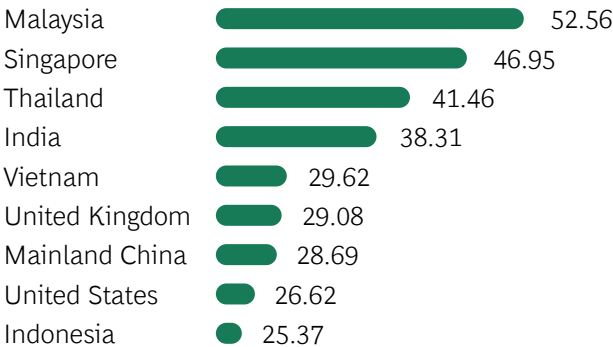
1. Declining roles displaced by AI and leading to potential unemployment; Quant Hub "Data Scientist Shortage"; 2. Ipsos 2022 survey (n = 19,504) "Global opinions and expectations about Artificial Intelligence";
Other Sources: National AI strategies of benchmarked countries

India is actively pursuing upskilling initiatives to have an AI ready next generation

India competes strongly with developed countries and APAC peers in STEM graduate numbers and quality of higher education in the field of tech



● Quality of Engineering and Technology Higher Education (Index Value)¹



● Graduates in STEM/CSE (Index Value)

Hyper-scalers (for example, **Google, Microsoft**) are investing in **India's AI talent** through grants, training programs, and partnerships

India has built a strong tech workforce

India's focus on STEM education, with a robust pipeline of tech graduates, evidenced by the substantial number of Indian professionals leading global tech firms. This success stems from a blend of progressive government policies and increasing private-sector involvement.

The National Education Policy (NEP) 2020 aims to make India a "knowledge superpower" by embedding early stage multidisciplinary and experiential learning.

Foundational training programs

Digital India and Skill India, along with private partnerships and initiatives such as Atal Tinkering Labs, have increased access to digital tools and coding skills across the country. These initiatives promote critical thinking and problem-solving skills, preparing students for tech-driven industries and helping India match or even exceed its APAC counterparts in terms of STEM output and readiness for global competitiveness in tech fields.

Specialized training programs

CoEs are further bolstering these efforts. For example, the STPI IoT OpenLab in Bengaluru supports AI and IoT innovation. Institutions are also key players, with IIT Hyderabad's CoE in AI and Robotics focusing on AI in manufacturing and healthcare.

Partnerships to expand AI skill ecosystem

India's ecosystem is expanding rapidly, supported by targeted government initiatives and strategic public-private partnerships. For instance, the Ministry of Electronics and Information Technology (MeitY), through the FutureSkills PRIME platform, has partnered with companies like Microsoft and NASSCOM to deliver industry-aligned AI and data science training to over 500,000 individuals. This multi-level approach—ranging from foundational training to specialized CoEs—has contributed to India ranking 1st across countries in AI skills penetration and has seen a 14x growth in individuals skilled with AI.

Source: 1. IMF AI Preparedness Index (Human Capital and Labor Market Policies 2023); QS University Engineering Rankings (2023); UNESCO (2022); HAI AI Index Report 2023; LinkedIn future of work report; Press Release

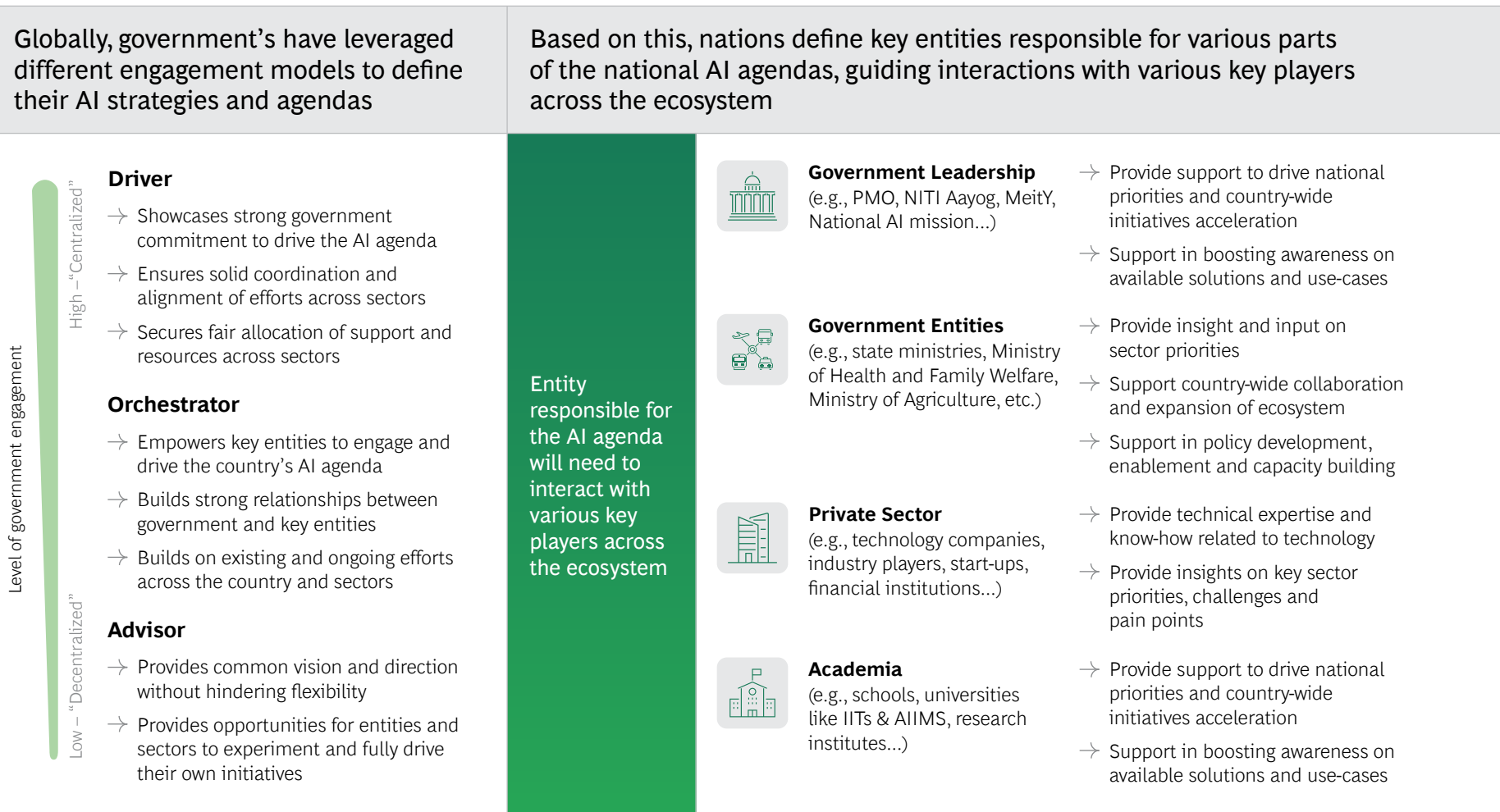
Nations are developing regulatory frameworks to ensure that AI-driven solutions are aligned with various societal needs

	Ethics and Transparency	Australia’s AI Ethics Framework outlines 8 principles to guide AI development, including fairness, transparency, and accountability. The framework encourages firms to consider the ethical implications of AI.
	Infrastructure Development	The United Kingdom government has pledged to invest in advanced computing infrastructure to support the development of sovereign AI models, aiming to mitigate potential AI risks and enhance national capabilities.
	Talent Development	US Government initiated a National AI Talent Surge (2023) to recruit AI professionals for government roles, supporting AI research and policy development to strengthen the AI ecosystem.
	Data Protection	India’s Digital Personal Data Protection Act (DPDP), 2023 regulates digital personal data processing, addressing privacy concerns relevant to AI platforms and GenAI.
	Security & Safety	Singapore’s Model AI Governance Framework and AI Verify testing toolkit emphasize robust security, ethical deployment, and transparency of AI systems. The Digital Trust Centre (DTC) focuses on AI safety research and global collaboration.
	Investments & collaborations	The UAE has attracted significant AI investments, including a \$1.5 Bn investment in the Emirati AI firm G42. This partnership aims to enhance AI infrastructure in the Middle East, Central Asia, and Africa.



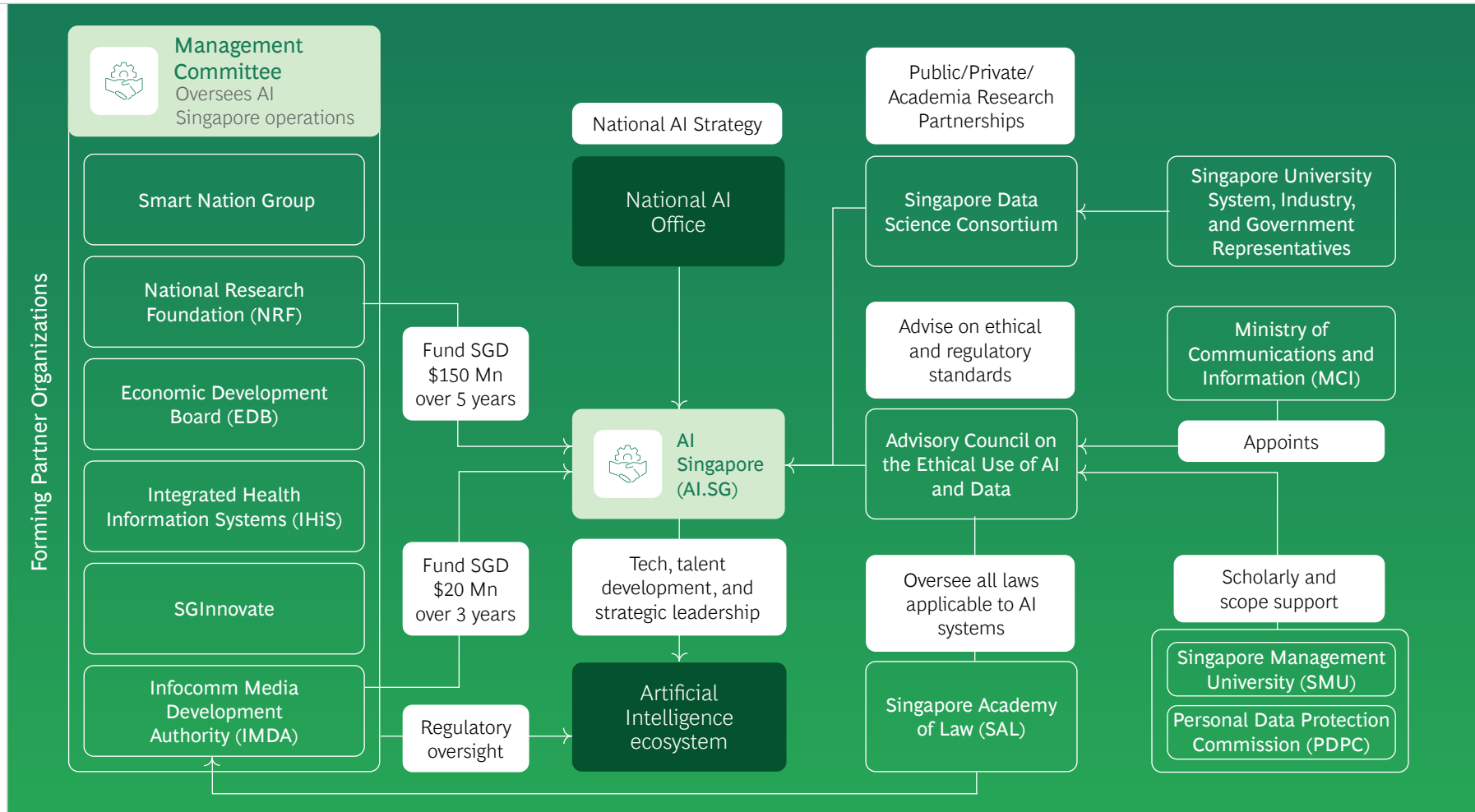
→ Countries can develop robust AI policies after assessing sector-specific gaps, ensuring alignment between sectoral requirements and central regulations. This harmonization prevents duplication of efforts while fostering ethical, scalable, and equitable AI adoption.

Driving the AI agenda requires several stakeholders to play a key role and collaborate across the ecosystem



Note: TRAI - Telecom Regulatory Authority of India; NHA - National Health Authority

Singapore has developed a holistic AI ecosystem connecting various stakeholders, focused on ethical, human-centric development and application



6 key takeaways from global players on building an AI ecosystem

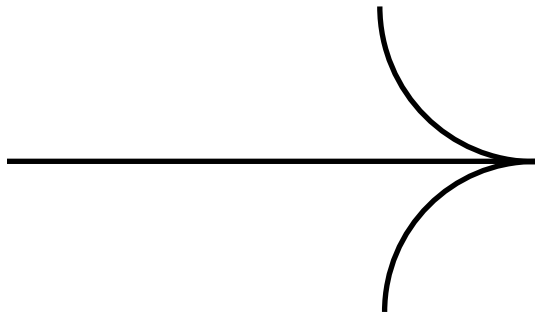
 Tech Infrastructure	01 Establish robust data infrastructures and compute capacity to ensure seamless integration and secure exchange of information across platforms	02 Invest in scalable and secure AI platforms, cloud infrastructure, data stacks and model/LLM development for affordable and interoperable adoption driving inclusivity and innovation
 Talent/Workforce	03 Implement specialized curricula and upskilling programs to build AI literacy and ensure workforce readiness	04 Create collaborations between government, industry, and academia to drive research, innovation, and scalable AI literacy programs
 Policy/Regulations	05 Develop policies ensuring ethical AI usage, data privacy, and transparency for innovation that strike a balance between enabling innovation and safeguarding trust	06 Launch pilot programs and sandboxes to scale AI applications in priority sectors, addressing sector-specific challenges

Tailored across sectors and states for adaptability across diverse ecosystems

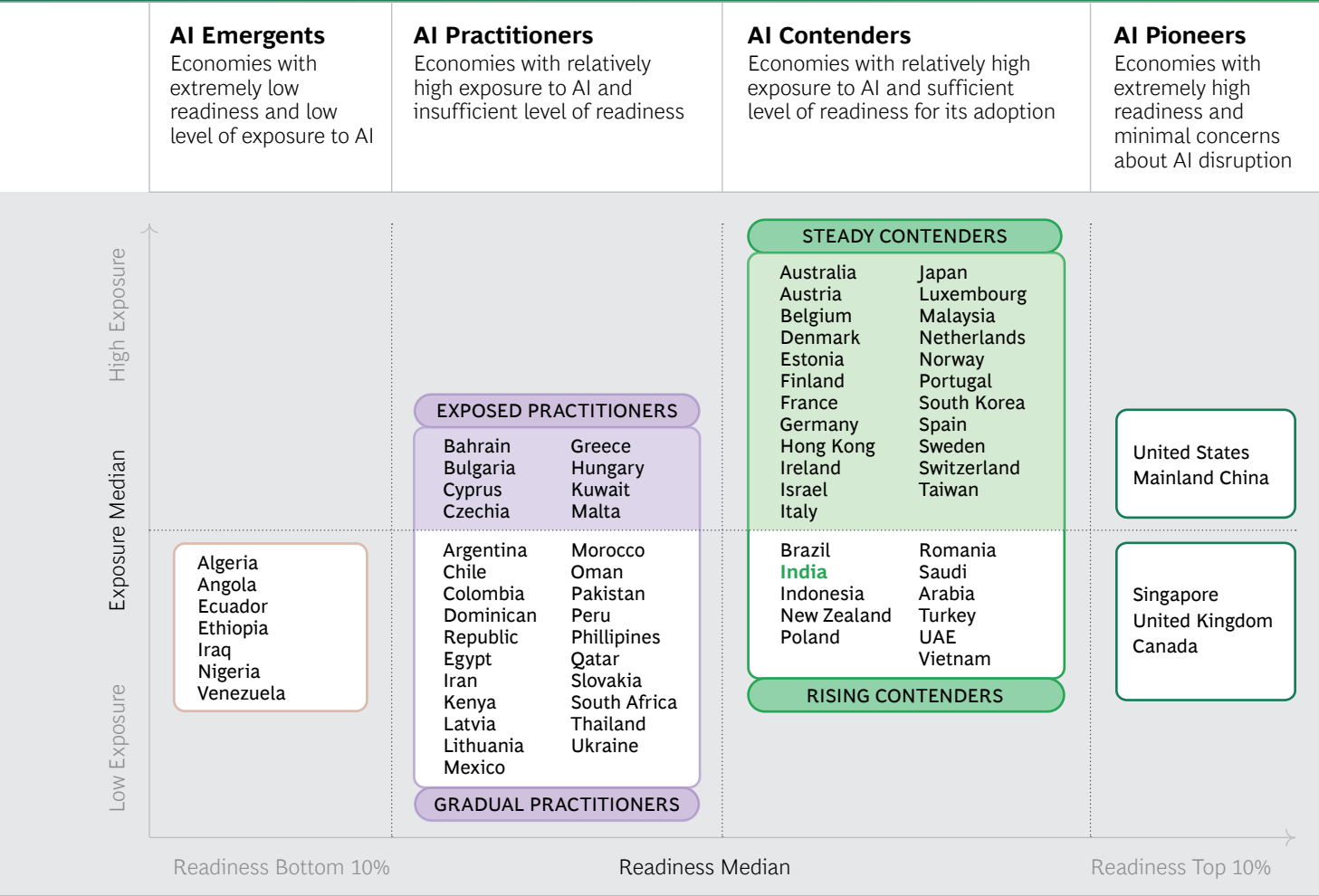


03

Transformative Potential of AI in India



Economies are at different levels of AI maturity due to varying levels of readiness and exposure to AI; India positioned well as a rising contender



Developed markets like the **United States and Europe** are leading owing to stronger governance and infrastructure



India has rapidly advanced its status through **initiatives on building a strong tech infra and AI ready workforce** making it a rising contender when it comes to AI maturity

India is well placed to unlock AI's transformational potential to drive economic growth, enable access, and enhance quality of life for its citizens

AI has the potential to impact the lives of citizens...

...with India uniquely placed as a leader from South Asia



Increase access to essential services

AI-driven platforms can allow service access to 850 Mn citizens in rural areas facing systemic barriers to infrastructure and connectivity



AI can bridge communication gap

Despite India's 22 official languages and over 19,500 dialects, AI can empower citizens to access digital services in their native tongue



Create higher-value jobs

AI can create millions of new job opportunities by automating repetitive tasks and enabling citizens to focus on higher-value, creative work



AI-powered chatbots and automation systems

Reduce wait times for public services, benefiting over \$1.3 Bn citizens

Large AI talent pool

1.25 Mn

India's AI talent pool is expected to go from over 600K today to over 1.25 Mn by 2027

3x

More likely to possess AI skills than peers; India's AI skill penetration factor is 3.09, the highest among G20 and OECD countries

Strong momentum for value & investments

30%

Indian companies are maximizing value through AI, surpassing global average of 26%

₹11K Cr

India's IndiaAI Mission budget to strengthen innovation ecosystem through AI compute infrastructure and start-up support

Learning ground for the world

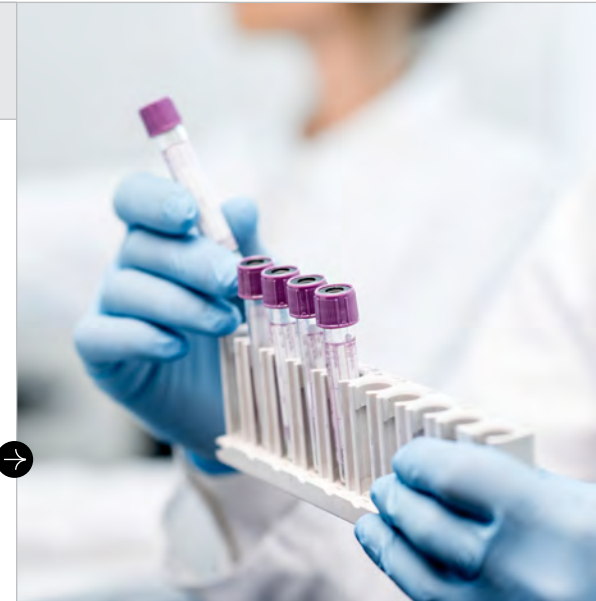
Multiple Indian' innovators creating impact globally

UPI

AADHAR

QURE.AI

CROPIN



India has the potential to become a **hub for AI innovation and solutioning**, building targeted solutions to become the use-case library of the world

AI has the potential to **increase economic output and improve the quality of life for millions** by fostering innovation and competitiveness globally.

In healthcare and agriculture, AI can help address systemic issues to enable a healthy and prosperous citizenry of the future



Healthcare

Healthcare in India faces **critical shortage of doctors and uneven rural distribution of nutrition and healthcare resources**, resulting in a high NCD burden

0.9

Doctor-to-patient ratio (per 1,000 patients)¹ limiting access to timely and quality access to healthcare

33%

Doctors serve 2/3rd of population in rural areas highlighting high degree of regional disparity¹

66%

Deaths caused by NCDs; owing to lack of proper nutrition, care and diagnostics²

63

Universal Health Coverage (UHC) service index; as the developed world is over 80 (United States: 86, Australia: 87, United Kingdom: 88)³



AI can revolutionize India's public healthcare sector by bridging the **doctor-patient gap, enhancing diagnostic precision, and enabling personalized, accessible, and cost-effective care.**



Agriculture

Agriculture in India faces **pressure of rising food demand, low productivity, and climate vulnerabilities**, resulting in low farmer yields making it insufficient to meet future demand

16%

Lower average cereal yield⁴ in comparison to global average (at 3.5 MT/hectare); with up to 15% post-harvest loss annually

400 Mn

Additional people to be fed by 2050⁷, as food demand projected to increase by 50%

85%

Farmers have **small marginal land holdings, limited investments, low productivity, high losses & high costs⁵**

54%

Total net sown area under irrigation, resulting in a large share of farmers relying on rainfall to meet their water needs⁶



AI can boost India's agriculture sector by **addressing inefficiencies** in crop management, irrigation, and pest control, while **enabling precision farming** to meet surging food demand. Further AI augmented mapping could provide governments a **long-term view of patterns and yields.**

3.1 AI application in Healthcare



AI application in Healthcare | Key Highlights

Overview of India's Healthcare Sector

India's healthcare sector is burdened with systemic challenges that hinder equitable access and quality care. The doctor-to-patient ratio stands at a critical 1:900, far below the World Health Organization's recommended ratio of 1:600, and rural areas remain underserved, with only 33% of doctors catering to two-thirds of the population. Non-Communicable Diseases (NCDs) are responsible for 66% of deaths in India, exacerbated by limited access to preventive and diagnostic services. These challenges are compounded by high out-of-pocket expenses, accounting for nearly 50% of healthcare expenditure, making quality healthcare inaccessible for many Indians.

Applications and impact of AI

AI in Indian healthcare enhances diagnostics and access for reduced cost. Solutions like Qure.ai reduces TB diagnosis time by 99%, while Niramai lowers breast cancer screening costs by two-thirds. Platforms like eSanjeevani enable 100+ Mn telemedicine consultations, improving early detection, reducing costs, and bridging urban-rural healthcare gaps.

- **Efficiency:** 46% faster diagnostic reporting in radiology owing to AI enabled diagnostics support
- **Cost Savings:** Reduction of mammography costs by 66% and TB diagnosis costs by significant margins
- **Scalability:** Telemedicine and AI-assisted screenings enable access for millions in rural areas, bridging longstanding gaps in India's healthcare

Learnings from global exemplars

Scaling AI solutions faces challenges like insufficient rural digital infrastructure, limited India-specific data, and lack of interoperable systems. Risks around data privacy hinder adoption, emphasizing the need for robust AI governance, secure frameworks, and targeted skilling initiatives. Learnings from global exemplars can enable India to overcome these:



Technology Infrastructure

- Build a scalable and secure AI infrastructure integrated for seamless interoperability and data sharing
- Develop AI models tailored to India-specific healthcare needs, addressing rural infrastructure gaps
- Incentivize health data digitization, standardize Electronic Medical Records (EMRs) and establish unified health data lakes for AI use-cases



Talent/Workforce

- Introduce modular certification programs and AI-focused training for healthcare workers in diagnostics and telemedicine
- Integrate AI curricula into medical education to prepare future-ready healthcare professionals
- Establish Centers of Excellence (CoEs) in partnership with leading institutions for skilling and foster private sector collaborations



Policy/Regulations

- Assess and develop AI governance frameworks where necessary with clear guidelines on ethics, data privacy, and certifications
- Create regulatory sandboxes to enable safe testing of AI tools
- Promote PPPs to support innovation and scale AI adoption
- Streamline approval processes for AI-driven medical tools aligned with global standards

India has made significant strides in improving healthcare quality and access over the last few years; long path ahead to achieve best-in-class care for all

India has made significant progress in improving health outcomes...

India's healthcare sector has evolved from basic infrastructure at independence to \$372 Bn¹ 2022, facing a growing and ageing population. While mass killers like malaria, small-pox and polio have been eradicated while many other equally dangerous diseases have been controlled.

Improved and more accessible healthcare systems have reduced premature death through disease or accident. Government is trying to move from a selective approach to health care to deliver comprehensive range of services spanning preventive, promotive, curative, rehabilitative and palliative care – through initiatives such as Ayushman Arogya Mandirs.

7.5

Death rate reduced in 2023, from 28 in 1950²

70 years

Life expectancy increased in 2023 from 32 in 1950²

1.3 Mn

Workforce of Allopathic Doctors in India²

309 Mn+

Patients served by eSanjeevani³

10,000+

Healthcare start-ups working in India

172K+

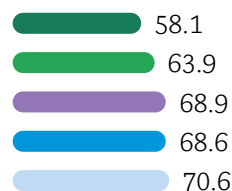
Functional Ayushman Arogya Mandir

...however, has a long path ahead to achieve parity with developed markets

A healthy population is critical for India to leverage its demographic dividend. Rising economic prosperity, a growing population, an expanding middle class, and public policy sensitivities are all key factors driving increased demand for improved healthcare and infrastructure across India.

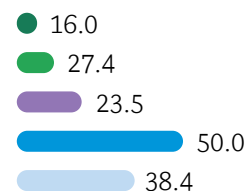
Healthy Life Expectancy

At birth, in years



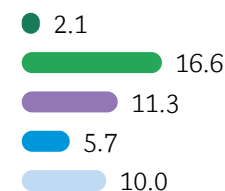
Hospital Bed - Patient Ratio

Beds per 10,000 Population



Public Health Expenditure

Share in current GDP



● India ● United States ● United Kingdom
● Mainland China ● Australia

India's unique healthcare challenges hinder delivery of accessible, quality and affordable healthcare services

India faces unique healthcare challenges owing to its population and size, resulting in need for a comprehensive approach to transform the sector to unlock equitable and quality access for all.

Access	Quality	Cost																														
Unequitable health coverage → Universal Health coverage (UHC) service index at 63, as the developed world is over 80 (United States: 86, Australia: 87, United Kingdom: 88). Universal Health Coverage (UHC) Service Index <table><tr><td>Australia</td><td>87</td></tr><tr><td>United Kingdom</td><td>88</td></tr><tr><td>United States</td><td>86</td></tr><tr><td>Japan</td><td>83</td></tr><tr><td>India</td><td>63</td></tr><tr><td>Indonesia</td><td>55</td></tr><tr><td>Pakistan</td><td>45</td></tr></table>	Australia	87	United Kingdom	88	United States	86	Japan	83	India	63	Indonesia	55	Pakistan	45	Shortage of healthcare resources → India also faces a shortage of diagnostic and treatment infrastructure. → There is also a shortage of trained medical personnel especially specialists and secondary care in Tier-2/3/4 cities and rural areas. → India faces a doctor-to-patient ratio at 1:900.	High out of pocket expenses → High OOPe as a share of health expenditure at ~50%, higher than other LMICs (e.g., Vietnam at 39.6%). OOPe as % of total health expenditure <table><tr><td>India</td><td>50</td></tr><tr><td>Vietnam</td><td>40</td></tr><tr><td>China</td><td>34</td></tr><tr><td>Malaysia</td><td>32</td></tr><tr><td>United Kingdom</td><td>14</td></tr><tr><td>Japan</td><td>12</td></tr><tr><td>United States</td><td>11</td></tr><tr><td>Thailand</td><td>9</td></tr></table>	India	50	Vietnam	40	China	34	Malaysia	32	United Kingdom	14	Japan	12	United States	11	Thailand	9
Australia	87																															
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United Kingdom	14																															
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United States	11																															
Thailand	9																															
Regional Disparity → Rural India housing over 2/3rd of the population, with only 1/3rd doctors. Citizens relying largely on primary health centers.	High prevalence of NCDs → 1 in 4 Indians faces fatal risk from NCDs before the age of 70, accounting for 66% of total deaths) owing to lack of proper nutrition, care and diagnostics.	High-cost Healthcare → Access to quality and specialized healthcare is expensive, making it inaccessible for the masses.																														



However, there is a **struggle to simultaneously deliver across the three tenets of access, cost and quality**; with the need to make trade off across at least one of access, quality or cost.

Note: LMIC: Low- and middle-income countries; NCD: Non communicable diseases; OPD: Out-Patient Department

Source: WHO, Global Health Observatory Database, 2023, ' Out-of-pocket expenditure as percentage of current health expenditure (CHE) (%)

Government has taken several initiatives combining policy, innovation, and strategic partnerships to build a tech-enabled healthcare landscape

The government is integrating tech-enabled digital health as a key enabler for healthcare...

Healthcare in India has undergone significant transformations marked by advancements in infrastructure, technology, and accessibility. The government's digital health initiatives are enabling increased access for all citizens.



Establishing **National Health Stack to monitor E2E care** for patients (~56 Cr ABHA IDs created in last 2 years)



Ayushman Bharat Digital Mission provides **unique Health IDs, digital health records, and insurance coverage** for secondary and tertiary care hospitalization



eSanjeevani and SEHAT platform offers telemedicine services, enabling remote consultations; providing over 100 Mn consultations till remote areas



CoWIN Platform facilitated the registration, scheduling, and certification of vaccinations



eVIN digitizes **vaccine logistics**, ensuring real-time information on vaccine stocks and storage temperatures across all cold chain points

...and employing multiple AI initiatives to improve data collection, healthcare quality, and virtual consultations

India's AI healthcare market is expanding at a rapid pace, growing at a CAGR of 40.5% from 2020-25. India's 2018 National Strategy for AI identified healthcare as a priority, highlighting AI's potential to enhance diagnostics, early detection, decision-making, and treatment outcomes.

Infrastructure

→ Ayushman Bharat Digital Mission will **integrate citizens' health data into a unified digital ecosystem**, enabling interoperable electronic health records and paving the way for AI and ML applications

Access

→ eSanjeevani offers **real-time video consultations, enabling patients to receive online expert advice and treatment**; conducted over 100 Mn consultations, with a significant impact in rural areas

Research

→ AIIMS Delhi, PGIMER Chandigarh, and AIIMS Rishikesh established as Centres of Excellence for AI focused on **creating and implementing AI-based solutions** to address healthcare challenges

Collaboration

→ AIIMS & Centre for Development of Advanced Computing, launched **iOncology.ai for early detection of breast & ovarian cancer**
→ NITI Aayog collaborated with Forus Health to develop **AI tools for early diabetic retinopathy screening**

There is a **need for a holistic approach to integrating AI into India's healthcare landscape**, combining government policy, private innovation, and strategic partnerships to transform patient care.

Developing a unified healthcare data foundation in India could enable seamless integration, accessibility, and AI-driven insights

Unlocking AI's potential requires a strong foundation...

- **Holistic Digital Infrastructure:** Many healthcare facilities, especially in rural areas, need necessary digital infrastructure to support data collection and AI integration
- **Standardized Health Records:** Need for uniform electronic health records complicates data aggregation and analysis, which are crucial for AI applications
- **Healthcare data in India** is often dispersed across various platforms and formats, leading to inconsistencies that hinder seamless integration, resulting in need for consolidated platforms

...with multiple government initiatives underway to develop India's healthcare data foundation



Consolidating national health data under ABDM¹

- **Healthcare Professionals Registry (HPR):** Comprehensive repository of all healthcare professionals involved in delivering healthcare services across both modern and traditional systems of medicine
- **Health Facility Registry (HFR):** Detailed directory of health facilities across the nation, encompassing public and private entities, including hospitals, clinics, diagnostic labs, imaging centers, and pharmacies



Accessing individual health records

- **Ayushman Bharat Health Account (ABHA):** Unique health identifier for every individual, enabling citizens to securely access and share their health records
- **Health Information Exchange and Consent Manager (HIE-CM):** Empowers citizens to securely access and share their health records, ensuring that data exchange is driven by informed consent



Supporting delivery infrastructure

- **Unified Health Interface (UHI):** Facilitates the discovery and delivery of health services, streamlining healthcare interactions and improving service accessibility
- **National Health Claims Exchange (HCX):** Standardizes the insurance payment ecosystem, simplifying and expediting the claim process

Electronic Medical Records (EMR) are a pivotal step in building the foundations for a unified healthcare across India

Imperatives for Electronic Medical Records in Indian healthcare	Case study: HealthPlix - transforming healthcare with EMRs	
→ Centralized patient information Electronic Medical Records (EMRs) provide a unified platform for storing and accessing patient data, enhancing continuity of care. → Data standardization EMRs enable standardized data formats, essential for interoperability and integration with AI systems. → Enhanced clinical decision-making Digital records offer clinicians immediate access to complete patient histories and relevant medical information, supporting evidence-based practice. → Foundation for AI and analytics EMRs capture high-quality, structured data necessary for training AI algorithms that can analyze trends, predict health risks, and improve healthcare delivery. → Regulatory compliance EMRs assist in adhering to healthcare regulations by maintaining accurate and secure patient records, ensuring patient privacy and data security.	HealthPlix is a leading Electronic Medical Record platform in India, pioneering the digitization of patient records and harnessing AI to enhance clinical outcomes.	
	Wide-scale EMR adoption	HealthPlix has been adopted by thousands of doctors across India, processing over 101 Mn consultations and supporting 14 languages due to linguistic diversity.
	Enhanced doctor productivity	By streamlining routine tasks HealthPlix saves doctors approximately 30 seconds per patient, freeing up time for more meaningful patient interactions.
	Real-time clinical insights	Provides real-time alerts for potential drug interactions, allergies, and also suggests additional tests e.g., kidney tests for diabetes patients, aiding in holistic care.
	Conversational AI integration	Utilizing advanced AI, HealthPlix transcribes doctor-patient conversations in real-time with over 97% accuracy, directly updating the EMR.
	HealthPlix exemplifies how EMRs are more than just digital replacements for paper records—they are catalysts for transformation in healthcare delivery. By unlocking the power of EMRs, HealthPlix is enabling AI integration that improves cost efficiency, enhances quality, and expands access to care. The platform's success underscores the importance of foundational data systems in realizing AI's full potential in healthcare.	



For India to achieve best-in-class care for all, it can explore building and strengthening foundational elements critical to supporting real time EMR adoption while ensuring data quality and protecting patient privacy.

Built on a strong foundation, AI might play a critical role to augment the public health ecosystem – ensuring accessible, cost effective and quality healthcare

AI in Healthcare



Access

- > Patient screening and on-demand, personal care
- > Remote personalized health recommendations
- > Preventative healthcare through predictive models
- > Optimal Resource allocation and utilization
- > Accelerated drug discovery and design



Quality

- > Diagnostic image enhancement & interpretation
- > Medical image recognition
- > Public health surveillance
- > Digital clinical voice analysis
- > Disease hotspot identification



Cost

- > Hospital and administrative management
- > Automated document processing
- > Intelligent prior authorization
- > Automation of claim processing
- > Supply chain process augmentation



Diagnostics Augmentation | Large opportunity for AI to improve quality & access through diagnostics augmentation by addressing critical gaps

Critical gaps in the health infrastructure and specialist talent in India...

	Shortage of radiologists	→ About 15,000 professionals serve a population exceeding 1.4 Bn → The deficit of radiologists leads to delays in medical imaging interpretations	1:100,000 Radiologist to patient ratio in India
	Limited access in rural areas	→ Despite housing majority of India's population, rural areas face significant shortage of health specialists → Rural regions often lack access to specialized healthcare services such as diagnostic support, resulting in higher incidence of diseases	70% Health specialist shortage in rural India

...resulting in sub-par health outcomes across manageable diseases

	Delayed detection of communicable diseases	→ Communicable diseases like tuberculosis remains a major public health issue in India → Late diagnosis of conditions like tuberculosis and lung cancer contributes to high mortality rates	27% Global TB case incidence in India
	High risk of NCD burden	→ Rising burden of NCDs, such as strokes, diabetes, cardiovascular diseases, and cancers become a leading cause of deaths in India → Timely treatment is crucial, but many facilities lack the necessary expertise for diagnosis and treatment	119–145 Annual incidence of strokes per 100,000

Diagnostics Augmentation | Multiple start-ups have built AI solutions to automate and enhance medical image analysis addressing key diagnostics gaps

High incidence of diseases highlights need for early detection

AI enabled solutions allow early screening and detection of diseases



Respiratory disease

In 2022, India accounted for 27% of global TB cases, with 2.42 Mn reported cases.¹



Apollo Hospitals

Developed an AI algorithm, in collaboration with Google, capable of accurately interpreting chest X-rays for early signs of TB, addressing the shortage of trained radiologists in rural areas.



Swaasa (HeAR model)

Platform that is using Google's bioacoustic foundation AI model HeAR to help analyze cough sounds for early detection of tuberculosis.



Cancer

In 2023, India reported an estimated 1.5 Mn new cancer cases.²

Approximately 1 in 10 Indians are projected to develop cancer during their lifetime.³



Niramai

Introduced a thermal imaging solution powered by AI for early-stage breast cancer detection, providing a radiation-free and privacy-aware screening alternative.



Qure.ai

Offered AI algorithms that assist in identifying lung nodules in chest scans, aiding in the early detection of lung cancer.



Eye disorders

Diabetic retinopathy is a leading cause of blindness among working-age adults.⁴

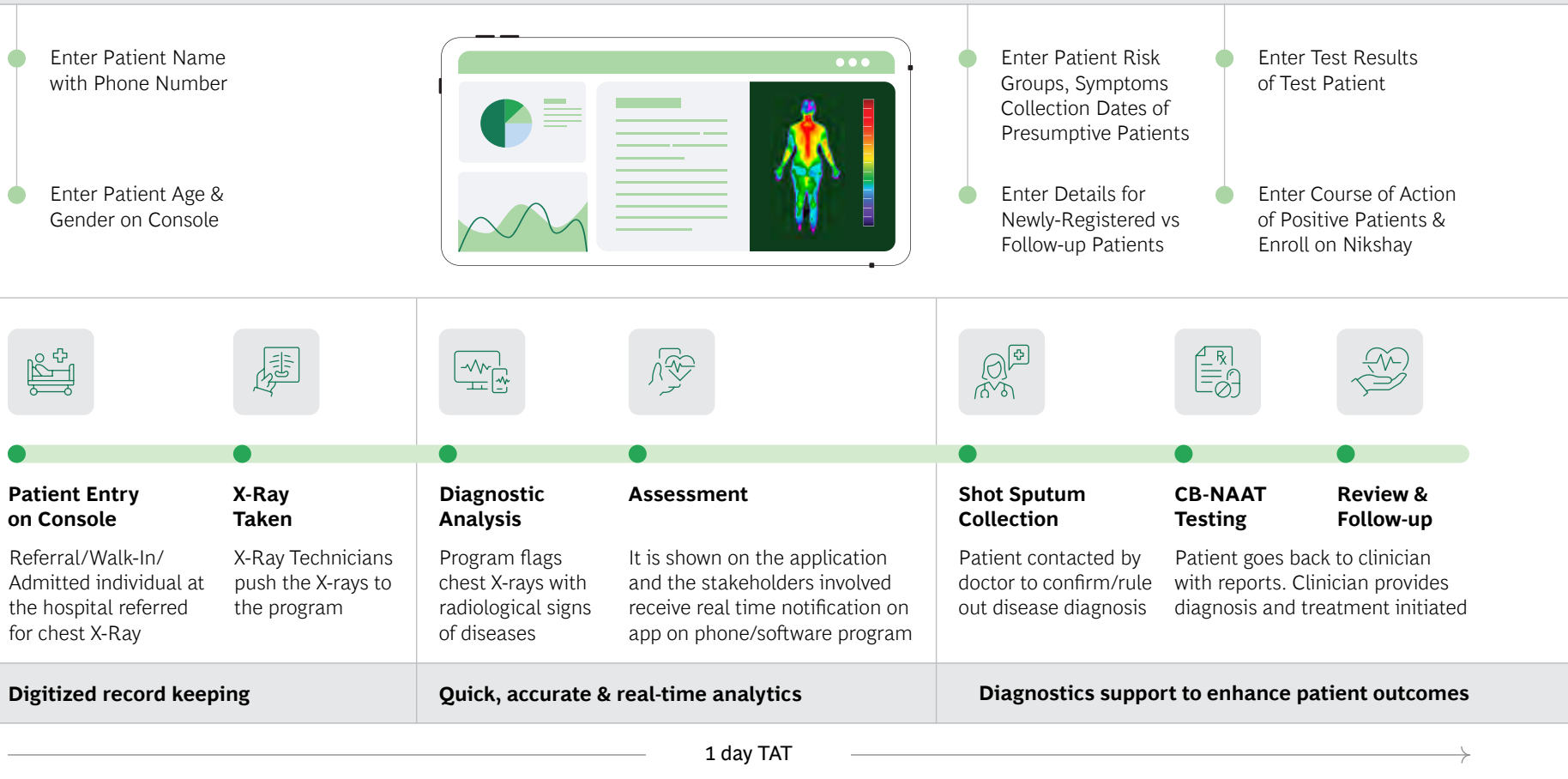


Forus Health

Devices equipped with Google's AI model help screen for diabetic retinopathy enabling early intervention and preventing vision loss.

Diagnostics Augmentation | Automated AI workflows integrated into hospitals to ensure faster processing, better analytics and improved patient outcomes

Sample: Screening routinely taken X-rays in IPD and OPD for TB risk



Diagnostics Augmentation | Early evidence reported from current efforts indicates potential to create significant impact in healthcare diagnostics

AI solutions gaining traction...	...and delivering impactful results	
20 Mn+ Lives Impacted through TB screening by Qure.AI	29% More TB cases detected via Incidental pathway	99% TAT Reduction for TB diagnosis; 3 weeks to 2 hours
7.5 Mn+ Screened timely reducing eye disease incidence rates	1.5 Mn People prevented from blindness with early diagnosis over the past decade	7.5 Mn Eye screenings conducted for early detection of multiple eye conditions
250K+ Breast cancer screenings by Niramai across 10K+ screening camps	1/3rd Cost of mammography vs others at ₹1K vs. ₹3.5K	27% Higher accuracy vs. mammography



AI-powered diagnostics solution driving breakthroughs with **faster, accurate, and cost-effective outcomes**

Diagnostics Augmentation | To effectively scale AI based diagnostics solutions it is critical to tackle challenges beyond building the technology

Case Study: Overcoming Barriers to Early Diagnosis in India Through AI				Key learnings
India faces significant hurdles in scaling early diagnosis for diseases: → Infrastructural Gaps Advanced diagnostics are concentrated in urban centers, leaving rural populations underserved → Cost Constraints Mammography remains prohibitively expensive for low-income families → Technical Limitations Mammograms are less effective for younger women and those with dense breast tissue → Specialist Shortage Overburdened public healthcare systems lack sufficient radiologists for timely diagnoses → Cultural Sensitivities Women hesitate to undergo breast screening due to stigma and discomfort in invasive procedures	Qure.AI	→ Non-invasive imaging eliminates need for radiation or physical contact → Compact devices easily deployed in rural areas at a fraction of the cost → AI algorithms detect early-stage abnormalities with high sensitivity and specificity, even in dense breast tissue	270K+ diagnosed early for TB 20 Mn impacted with screening solutions in X-rays and CTs	Scale Preventive Care Integrate AI-powered screening tools into public health programs to make early detection accessible and affordable
	Forus Health	→ Devices utilize AI algorithms to detect eye diseases with high precision → Compact devices ensure widespread accessibility and rapid screenings → Allow minimally trained technicians to capture data analyzed by remote ophthalmologists	7.5 Mn eye screening globally Portable device for ease of use across rural areas	
	Niramai	→ Devices using advanced imaging and AI tools to detect conditions like glaucoma and diabetic retinopathy → Low-cost devices for widespread deployment in underserved areas → Allowing technicians to capture images locally for remote analysis	15K women screened in Punjab Deployed in 20+ countries, scaling globally	Bridge Rural-Urban Divide Deploy portable, AI-enabled solutions in rural health centers to address diagnostic gaps in underserved areas Foster Innovation Support AI startups through public-private partnerships, funding, and streamlined regulatory processes to drive scalable healthcare solutions



Overall, AI solutions have the potential to drive significant impact in India through increased access to quality and affordable healthcare

	Key lever for increased access		Potential impact from AI
	 Increased access to quality public healthcare	Increased access to healthcare via. AI solutions in remote regions with access to internet AI solutions enable quality healthcare delivery remotely by bridging critical gaps in equipment, facilities, and talent, empowering underserved areas without the need for physical infrastructure or specialized professionals on-site	~50% of population has limited access to quality public healthcare¹ → +18% increased access to quality healthcare with meaningful access to internet²
		Increased access to basic healthcare due to increased affordability through AI Increased affordability through AI democratizes access to basic healthcare and diagnostic solutions by reducing costs of consultations, automating routine diagnostics, and optimizing resource utilization, making quality care accessible to a broader population	~50% reduction in costs leveraging AI in healthcare³ → +22% increased access to affordable healthcare⁴

1. Based on access issues to quality healthcare reported by World Bank, Census of India, CBHI India, IMS Health Report, National Sample Survey (NSS) and National Health Authority (NHA); 2. Based on messaging app usage we estimate 75% of adult population meaningfully uses internet applications with ~50% from rural areas; 3. Based on reported outcomes by healthcare startups and expert interviews; 4. Assumes price elasticity of -0.44 for overall medical care based on Harvard study (Health care demand elasticities by type of service)

To unlock AI’s potential in healthcare it is imperative to plan holistically across technology, talent and policy to enable AI adoption in public healthcare

Regulatory clarity, foundational tech/infra and talent/resources necessary to ensure a safe and efficient AI ecosystem enabling large scale adoption in the healthcare space



Tech Infrastructure

Enable access to a **robust, secure, and scalable AI infrastructure that democratizes access** to GenAI-powered healthcare, ensuring interoperability, data security, and affordability



Talent/Workforce

Empower healthcare professional with AI literacy and specialized training, creating a future-ready workforce that can seamlessly integrate AI to deliver equitable and quality healthcare



Policy/Regulations

Assess and strengthen existing regulations to address AI adoption, ensuring a **forward-looking and innovation-friendly governance approach**. This balances innovation, ethics, and safety while promoting inclusive AI adoption



Technology Infrastructure | Scaling of AI solutions requires a healthy AI and digital health ecosystem for equitable access and personalized solutions (I)

AI stack layers		Current limitations to scale	
 Application Layer		AI solution development requires tech partners to address the barriers in mass screening due to limited application builds and gaps in rural digital access. Support from the tech ecosystem is crucial to improve infrastructure.	
 Model Layer		Current AI models lack sufficient India-specific data on diseases and healthcare diversity. This limitation hinders their effectiveness and adoption by healthcare providers.	
 Data Layer		Digitized and standardized health records, multi-cloud infrastructure and interoperable systems are crucial as health data remains siloed without unified standards, challenging AI model training and limiting health insights.	



Technology Infrastructure | Scaling of AI solutions requires a healthy AI and digital health ecosystem for equitable access and personalized solutions (II)

Learnings from leaders in the space

Build holistic tech ecosystem

- **Ensure access to AI-Powered healthcare applications** that integrate with Health IDs for tracking patient data and outcomes. Ensure offline capabilities for rural areas and use in national programs
- **Enable localized and health specific LLMs** leveraging Indian-representative datasets to tackle local issues. Partner with AI researchers to enhance diagnostics, support, and documentation, ensuring Indian languages are included for broad accessibility

Establish foundational infrastructure

- **Develop comprehensive digital health frameworks** by incentivizing health data exchange and interoperability across public and private hospitals. Standardized framework for Electronic Medical Records (EMRs) is critical to ensure consistency and ease of access
- **Build unified data lake & open datasets for health** by digitizing patient records across public & private space in accordance with privacy and security best practices
- **Leverage low-cost energy efficient edge devices** capable of accessing AI solutions in remote healthcare facilities despite lack of advanced tech-infrastructure

Exemplars



Ada Health's platform is available in 11 languages to provide access to information in native language

ImageNet contains over 14 Mn labeled radiology & MIMIC-III² for de-identified ICU patient data of 40K+ patients



US HITECH³ act incentivized providers to adopt EHR² & mandated e-prescribing, information exchange to improve care and coordination

FHIR⁴ is a standard for exchange of healthcare information electronically by integrating healthcare systems for easy and secure data sharing across platforms



1. One of the few public dataset available, ~2m notes and ~40K patients, written from 2001-2012 in ICU of Beth Israel Deaconess Medical Center; 2. HIPPA Journal; 3. EHR - Electronic health records; 4. HITECH - Health Information Technology for Economic and Clinical Health; 5. FHIR: Fast Healthcare Interoperability Resources, developed by Health Level Seven International

Talent/Workforce | Upskilling staff, modernizing facilities, and fostering strategic collaborations could play a key role in building an AI ready workforce

India's healthcare workforce is expected to undergo a surge from 7.5 Mn now to 9 Mn by 2027, with 1-2% of technology experts Multiple training initiatives underway like building CoE in partnership with AIIMS and state initiatives like Applied AI Research Centre in Telangana India can develop an AI ready workforce to fully harness AI's potential in improving healthcare outcomes across the nation. The government and private sector in India have initiated multiple initiatives to foster an AI-ready workforce that can bridge the talent gap in India, and globally. The rising demand for AI professionals in healthcare underscores the urgent need to enable integrated AI skilling initiatives to meet the expanding requirements of the healthcare sector and other industries.	Upskill Existing Practitioners	Expand Skilled AI Workforce
	→ Modular certification programs to help upskill healthcare workers in AI-driven solutions → AI-Specific modules in medical courses and for hospitals to teach the basics of using AI tools and digital health workflows → Conduct cybersecurity awareness campaigns tailored to healthcare professionals	→ Trainings on AI tools for diagnostics, telemedicine and data collection help equip medical staff and Community Health Workers → Point-of-care tools help scale health worker training programs for greater impact → AI training programs for healthcare regulators ensure enforcement of RAI
	Wadhvani AI's Genie AI students and early-stage employees to gain AI skills needed to get job-ready	Armaan NGO's mobile academy integrates tech into CHW skilling TeCHO+ in Gujarat provides a mobile app for ASHAs and ANMs to record, track, and manage health-related data
	Stakeholder Collaborations	
	→ Collaborations with professional bodies to provide Continuous Professional Development credits are effective → Partnerships with leading institutions & state universities help to create specialized centers for skilling doctors, nurses, and paramedics. → Investments from private players aid upskilling and building of digital health centers. Collaborations with global entities help in building skilling programs → Establish advisory boards involving key opinion leaders, caregivers, and patients to provide feedback on AI adoption.	
	Qure.AI's TB screening solution deployed in government-run health camps and diagnostic centers under the NTEP	

Note: IMA - Indian Medical Association; NTEP - National Tuberculosis Elimination Program

Source: IndiaAI; Press Research; Expert Inputs; BCG analysis

Policy/Regulations | AI governance in healthcare could be strengthened through streamlined regulations, privacy laws, and private sector collaborations

Enablers for improved governance in healthcare	Several nations implemented AI governance applicable to healthcare	Key learnings from global players relevant for India
Streamline AI regulation and enable relevant interventions: Efficient regulatory processes are critical to scaling AI adoption in healthcare. Leverage data to identify gaps in healthcare delivery, enabling relevant AI interventions.	Singapore’s light-touch framework includes sandboxes that allow innovators to test healthcare AI solutions in real-world settings under limited regulatory oversight. Under the United States AI strategic plan developed by United States Health and Human Services (HHS) department, evidence on outcomes of AI interventions is used to prioritize resources, align & coordinate efforts & signal priorities.	Regulatory sand-boxes foster innovation through controlled real-world testing environments. Further, AI-augmented regulatory oversight ensures faster and more efficient approval. AI solutions must use data-based approach to identify and address healthcare gaps.
Ensure robust data privacy & security guidelines: Establishing robust frameworks protects sensitive patient information while enabling secure data sharing and interoperability.	United States HIPAA enforces strict standards for the storage, transmission, and sharing of electronic health records. This includes administrative, physical, and technical safeguards to protect patient data.	Robust data protection and interoperability frameworks ensure secure collection, storage and sharing of data. Clear guidelines for consent & accountability promote trust in data sharing, a critical factor for successful AI adoption in healthcare.
Fostering Local Innovation Ecosystems: Promoting innovation ecosystems through public-private collaborations and funding programs accelerates the development and deployment of AI tools tailored to local needs.	Singapore’s AI4I program supports workforce development and incentivizes public-private partnerships to deploy AI tools addressing healthcare challenges. Israel fosters AI innovation in healthcare by offering grants, tax incentives, and access to infrastructure.	Collaboration between governments, private companies, and research institutions accelerates the development of AI solutions. Supporting innovation hubs with access to funding & advanced computing resources enables rapid prototyping and scaling of AI solutions.

3.2 AI application in Agriculture



AI application in Agriculture | Key Highlights

Overview of India's agriculture sector

India's agriculture sector contributes 18.2% to GDP and employs 42.3% of the population. Despite producing staples like rice and wheat, challenges include low yields (50% below global averages), limited irrigation (54% area reliant on rainfall), and post-harvest losses up to 15%. Additionally, 85% of farmers are smallholders with minimal access to resources and real-time data for efficient farming

Applications and impact of AI

AI is revolutionizing Indian agriculture by boosting productivity and minimizing resource wastage. Advanced crop management and pest control reduce input costs, while AI solutions empower over 15 Mn farmers. These technologies enhance yields and bridge rural access gaps, driving sustainable agricultural practices and economic growth across underserved regions.

- **Precision Farming:** Solutions like Fasal optimize irrigation, reducing water usage by 80% and increasing yields by 20–30%
- **Real-Time Insights:** Cropin digitizes farms and delivers insights, improving operational efficiency by 40% and boosting crop yields by 15–25%
- **Market Linkages:** AI platforms connect farmers to buyers, reducing post harvest losses and increasing profitability by improved price realization

Learnings from global exemplars

Scaling AI in India's agriculture sector faces barriers such as limited digitization of land records, insufficient localized datasets, lack of digital literacy among rural farmers, inadequate farmer awareness of AI tools, and the absence of robust regulatory frameworks for AI-enabled solutions. Learnings from global exemplars can enable India to overcome these:



Technology Infrastructure

- Develop localized AI models tailored local diverse agro-climatic conditions
- Build a robust Agri-Stack integrating land records, crop data, and climate information
- Enable real-time farm monitoring using IoT devices and AI-driven tools for predictive analytics



Talent/Workforce

- Train farmers on AI tools for precision farming, pest management, and irrigation through rural workshops and mobile units
- Integrate AI-focused modules into agricultural universities' curricula to foster innovation
- Establish mentorship programs linking agritech startups with agricultural scientists



Policy/Regulations

- Establish AI testing and validation centers for tools in agriculture to ensure reliability and scalability
- Standardize AI certifications and ensure data privacy through regional agreements and frameworks
- Introduce AI-linked credit schemes and subsidies to support smallholders in adopting advanced technologies

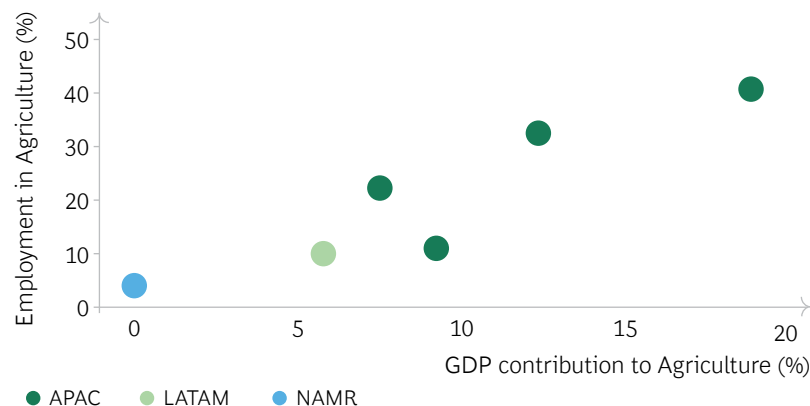
Agriculture forms the backbone of the Indian economy contributing to more than 18% of India's GDP

Agriculture contributes significantly to the Indian economy:

Agriculture accounts for 42.3% of the population and contributes 18.2% to the national GDP. India is among the largest producers of staples such as rice, wheat, and sugarcane, essential to both domestic consumption and exports. India's strong production of key commodities, keeps it competitive internationally while meeting rising domestic demand driven by population growth and higher incomes.

Continuous growth in agricultural output: In recent years, the sector has grown strongly, reaching a record foodgrain production of 332.22 Mn tonnes in 2023-24, led by significant rice (137.82 Mn tonnes) and wheat (113.29 Mn tonnes) outputs. This growth highlights India's capacity to fulfill domestic needs and, to some extent, international demand. Additionally, foreign investments are growing in the sector, signaling confidence in value-added agriculture and opportunities for technological advancements.

India leads among peers in agriculture's contribution to employment and GDP⁵



₹38K Cr

India's global agriculture exports in 2024

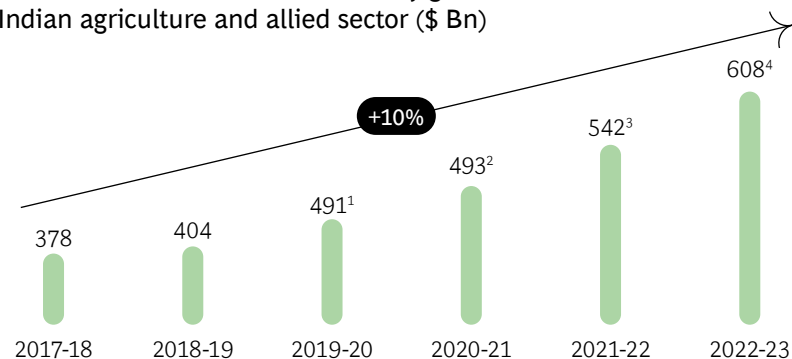


\$12.5 Bn

Cumulative FDI in the food processing industry between 2000 to 2024



Gross Value Added continues steady growth for Indian agriculture and allied sector (\$ Bn)



Note: 1. 3rd revised estimate; 2. 2nd revised estimate; 3. 1st revised estimate; 4. Provisional estimate as on 31 May 2023; 5. Statistics as of 2022, India 2023-24

Source: PIB; IBEF; Ministry of Agriculture; World Bank data 2022; India Budget 2023-24

India has significant potential to grow further by addressing key challenges faced across the farming value chain; technology to play a key role

Inefficiencies across the agricultural value chain...		...lead to suboptimal results												
 Pre - Production → Limited access to quality inputs: Indian farmers struggle to obtain high-quality seeds, fertilizers, and chemicals, leading to poor crop yields and soil health. Furthermore, over 85% of farmers hold less than 2 hectares of land¹, limiting their ability to invest in better inputs → Information asymmetry: Farmers face challenges due to lack of awareness of best practices and price inefficiencies for agricultural inputs due to multiple intermediaries	15–20% Yield/hectare below global averages² Yield per hectare (tonnes) <table><tr><td>United States</td><td>8.07</td></tr><tr><td>China</td><td>6.38</td></tr><tr><td>Indonesia</td><td>5.39</td></tr><tr><td>Brazil</td><td>4.90</td></tr><tr><td>Malaysia</td><td>3.75</td></tr><tr><td>India</td><td>3.57</td></tr></table>	United States	8.07	China	6.38	Indonesia	5.39	Brazil	4.90	Malaysia	3.75	India	3.57	 Technological interventions will play a key role in addressing these efficiencies and unlock significant value with automation, real-time insights and accurate data
United States	8.07													
China	6.38													
Indonesia	5.39													
Brazil	4.90													
Malaysia	3.75													
India	3.57													
 Production → Lack of real-time data for informed farming: Farmers are not able to access real-time data such as soil health, water availability, and pest conditions, which results in poor cost and yield management → Manual and dated farming practices: Only half of the cultivated land in India has irrigation facilities. Relying on age-old methods, results in inefficiencies, such as improper water usage, pest control, and the inability to leverage high yielding variety														
 Post - Harvest → Market access and pricing inefficiencies: Limited access to markets often results in unfair price realization due to middlemen which contributes to a lower share of the final produce for farmers. As per NABARD, farmer price is just 29% of the actual consumer price → High transportation and storage costs: Inadequate transportation infrastructure and lack of cold storage facilities causes farmers to suffer from high logistics costs and significant post-harvest losses	6–15% Post harvest losses in fruits, and ~5-11% in vegetables³													

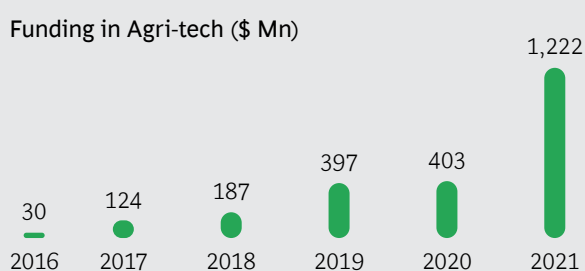
Note: Cereal (include wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains) Yield per hectare (FAO, UN, 2022)
Source: 1. NABARD; 2. World Bank, 2022; 3. PIB; Ministry of Agriculture & Farmers Welfare; Niti Aayog; NABARD; Directorate of economics and statistics

Given the importance of technology, government has invested significantly across tech-based initiatives, leading to the rise of Agri-tech startups

Agri sector is incorporating tech across the value chain

The agriculture sector is going through a transformation, integrating technological advancements with traditional farming practices to enhance productivity and sustainability. As India looks towards modernizing its agriculture practices, the sector is witnessing a rise in use of agri-tech solutions such as precision farming, digital platforms for market access, and AI-driven tools for advisory services.

Funding in Agri-tech (\$ Mn)



15
Players who have
GMV over \$100 Mn

15 Mn+
Farmers leveraged
services of the agri-
tech players

Providing quality input

AgroStar DeHaat Seeds to Market Freshokartz Gramophone BharatAgri BigHaat

Supporting field operations

Fasal ● Cropin ● DeHaat Waycool ● AgroStar GramworkX

Enabling market linkages

Bijak Ninjacart Freshokartz Agrowave Waycool ● Crofarm

Optimizing logistics

Apnagodam Agrowave Arya.ag Ergos empowering participation Waycool ● FarMart

Supported by government initiatives

Kisan Drones Initiative

A government effort to deploy drones for precision-based farming, improving crop health monitoring and spraying.

Namo Drone Didi

A Central sector scheme for providing drones, sustainable business and livelihood support to 15,000 women Self Help Groups.

e-NAM (National Agriculture Market)

A digital platform connecting farmers to nationwide agriculture markets for better pricing and transparency.

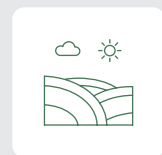


Agri-tech sector in India has grown substantially in the past few years

AI will enable the **next tier of growth**, by incorporating more productive and efficient agricultural practices

Building a robust agricultural data foundation will be an important first step to unlocking the potential of AI in Indian agriculture

3 Steps needed to build a robust agri-data foundation



India is highly fragmented with Over 85%¹ of farms in India are smaller than 2 hectares, limiting land ownership monitoring

Current efforts to digitize land records are manual, costly and quickly become outdated

1

Identify individual farm-lands

Generating insights at an individual field level is critical given the diversity in Indian agriculture with respect to crop types, farming practices, etc.

2

Assign unique ownership to each farm-land

Indian farmers are reliant on government schemes and distribution. **Unclear ownership of farm-lands prevents fair and equitable access to government initiatives** (e.g., crop insurance)

3

Monitor status of each farm-land

Updated information on state of each farmland is requiring **for performing the right analytics and provide advisory to improve farming yield**

Multiple efforts are underway

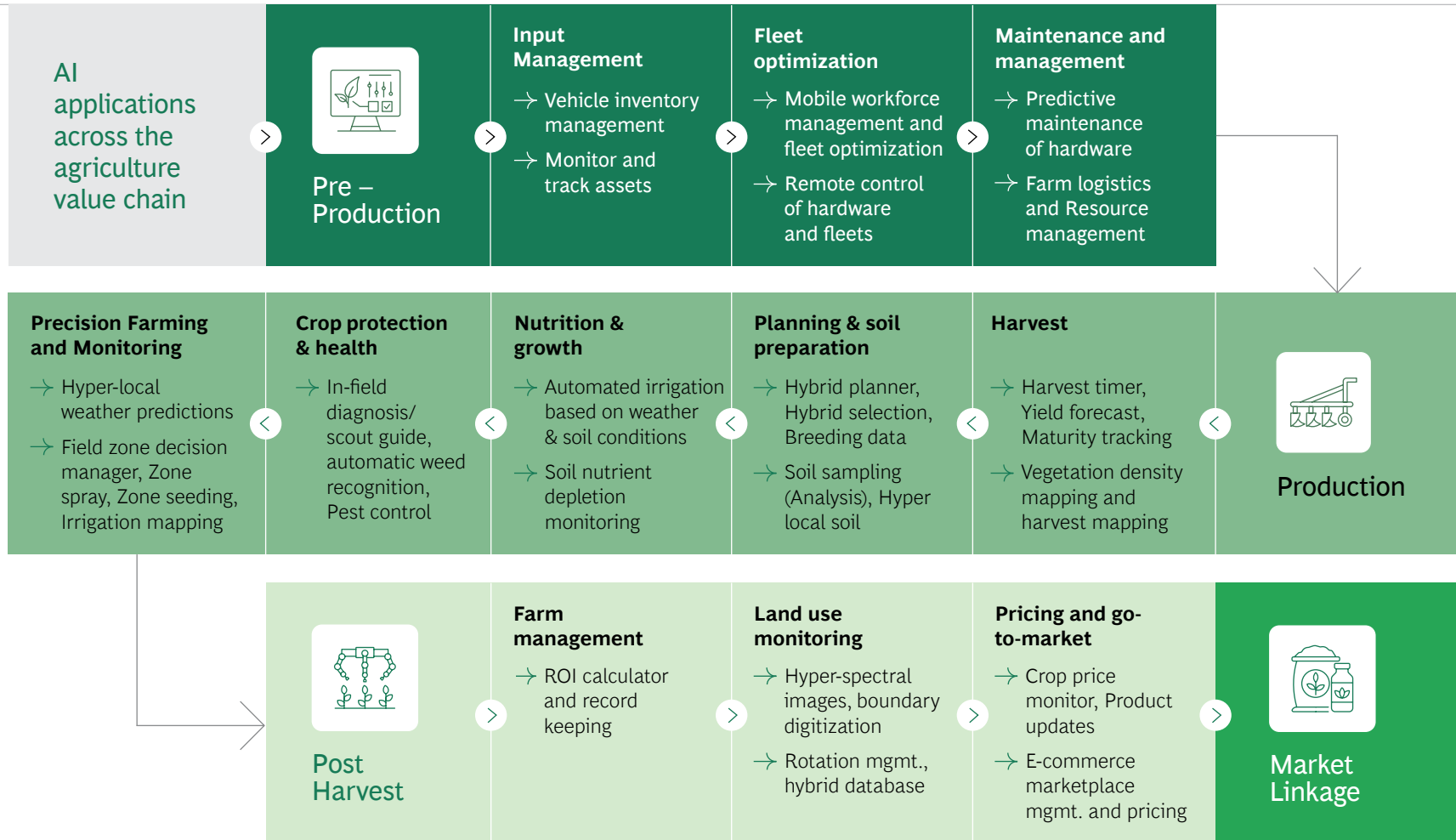
- Google is **leveraging satellite imagery and AI to digitize agricultural land records** to detect field boundaries with pixel-level accuracy. It captures field-level details such as soil patterns, vegetation indices, and water bodies with real-time insights
- The **Government of Telangana along with local startup TeamUp**, integrated Google's Agricultural Landscape Understanding (ALU) algorithm's outputs into their existing crop booking application to **enable more precise and actionable insights for sustainable agricultural practices**
- **India's Agri-stack** is being developed, in partnership with tech-players and state-governments, as a unified platform to **integrate all agricultural data** to assist in integrating AI-powered tools and analytics
- Uttar Pradesh government is **developing an Agri-stack leveraging satellite imagery** to digitize agricultural land records, monitor crop patterns, and integrate farm-level data
- Karnataka government's eSehmati platform conducts **comprehensive crop surveys for around 40 lakh farmers** to accurately map crop patterns, assess productivity, and ensure the efficient distribution of subsidies and benefits
- Andhra Pradesh's e-Panta application **assesses crop details, cropping patterns and damage, insurance claims, and crop loan verifications** using tablets, which is then uploaded to a central server each season

Ensuring a strong foundation helps unlock benefits for different stakeholders in the agricultural ecosystem



	Government →	AI-powered remote sensing models assess crop health and yield , helping governments and insurance companies efficiently settle claims .
	Farmers →	AI-powered solutions analyze soil health, weather data, and crop conditions to provide tailored recommendations on irrigation, fertilization, and pest control , optimizing yields and reducing input costs.
	Financial Institutions →	AI-based tools assess farm creditworthiness by analyzing multi-year crop performance, satellite data, and financial history. Banks monitor loan performance and crop health in real time .
	Seed companies →	AI supports dynamic crop models to handle seasonal shifts, delayed rains, or unexpected weather patterns to help optimize inventory, develop region-specific products, and provide advice during different crop stages .
	Agri-businesses →	Trading companies and agro-chemical firms use AI for pre-harvest yield forecasting, leveraging district-level crop data and remote sensing to enable hedging strategies, inventory management, etc.

In farming AI has the potential to create impact across the full value chain



Production optimization | Indian farmers face multiple challenges in delivering high yield on their farms



Unpredictable weather patterns



80%

of marginal farmers in India have **suffered crop losses** due to adverse climate conditions over **past 5 years**¹

- Indian farmers, especially small and marginal farmers, face increasing risks due to **climate change and erratic weather patterns**, leading to unpredictable yields and crop losses
- Findings by a survey of 6,615 farmers across 21 states conducted by Forum of Enterprises for Equitable Development (FEED) reveals that the **primary causes of crop damage were drought (41%) and irregular rainfalls (32%)**



Water scarcity



50%

of the total **water requirement** would be available in India **by 2030**²

- India is the **largest consumer of groundwater globally**, leading to alarming depletion levels. Over 70% of wheat-growing regions are projected to face severe water shortages in the near future (Indian Government, 2019)
- Traditional **irrigation methods**, coupled with a **lack of water management** techniques, result in **excessive water use**, further straining already scarce resources and threatening long-term agricultural sustainability



Pest attacks and crop diseases



20-40%

yield losses in India due to pest attacks annually³

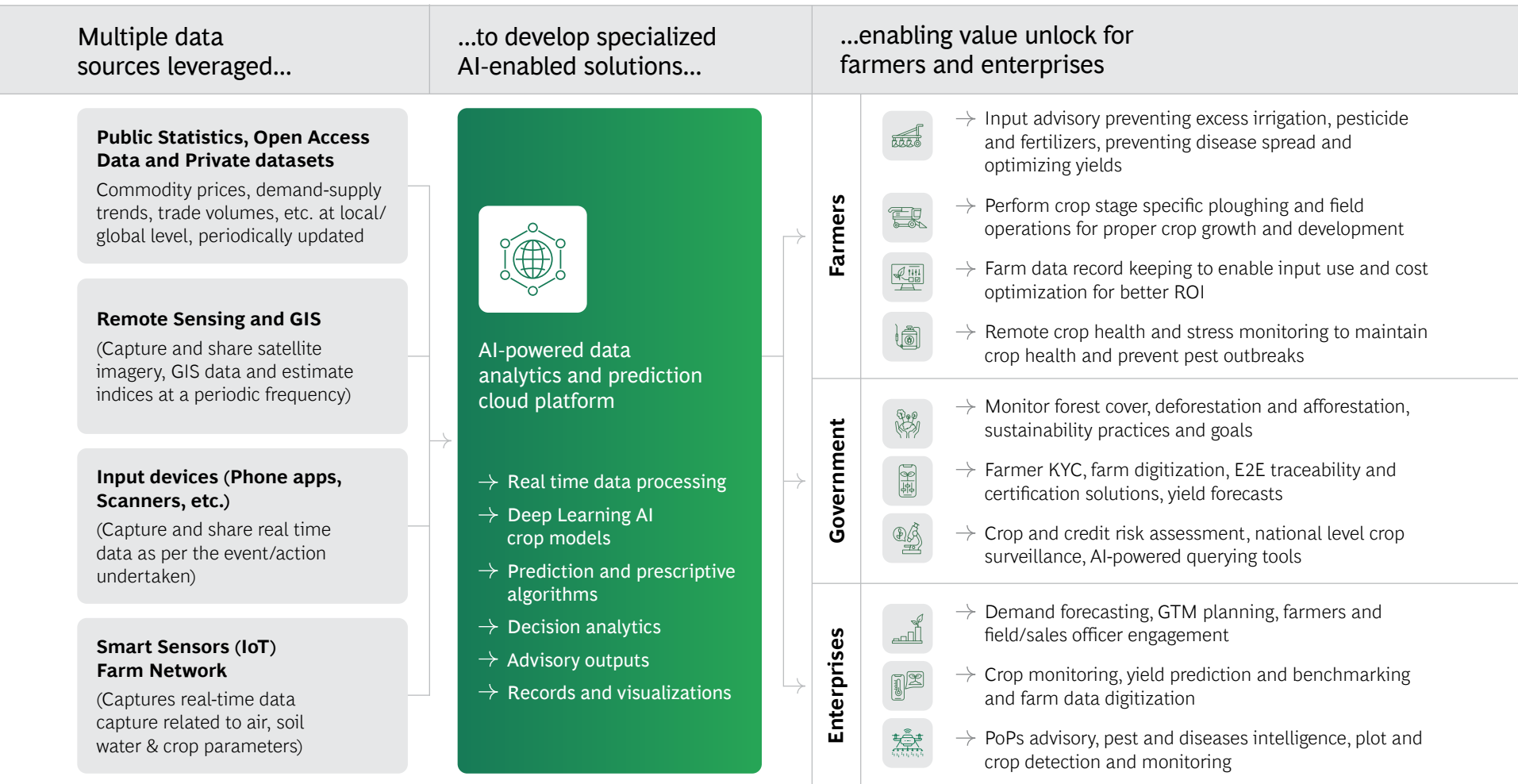
- Many farmers rely on **intuition for crop management**, lacking access to timely data on soil health and crop conditions, leading to **reactive rather than proactive decision-making**
- Without **real-time monitoring** of pest outbreaks and crop diseases farmers are unable to respond swiftly, resulting in **reduced yields and higher input costs**

Production optimization | Innovators in the space are building AI based solutions to tackle the challenges and improve yield efficiency

	AI solutions...	...solving key issues in farming
 Fasal Farm management solutions to monitor crops, predict weather, and optimize irrigation and input use	→ IoT sensors and AI to collect real-time data on soil moisture, weather, and crop health → Hyperlocal weather forecasts, optimizing irrigation, fertilizer use, and pest control → Algorithms predict and notify farmers of potential pest or disease outbreaks → Irrigation scheduling, reducing water usage by up to 40%	→ Increases crop productivity by providing data-driven farming insights and practices → Reduces input costs for farmers by optimizing fertilizer and pesticide usage → Enhances decision-making for smallholder farmers tailored to specific crops and regional conditions, improving productivity → Integrates AI insights into farmers' daily operations through a mobile app interface
 Cropin Real-time farm monitoring, digitizing farm operations, and providing insights	→ Satellite imagery, weather data, and AI to provide insights on crop health, pest risks, and yield forecasts → Tracking of crop growth, identifying abnormalities like water stress or disease early → Tools to monitor and improve soil health and reduce environmental impact of farming	→ Region-specific recommendations for pest management, irrigation, and nutrient application → Forecasts crop yields with high accuracy, allowing better resource planning and market predictions → Equips farmers with accessible, actionable insights for optimized resource usage and timely interventions



Production optimization | Tailored AI-powered solutions built on reliable data help address diverse needs for different stakeholders in the ecosystem



Note: PoPs: Package of Practices; GTM: Go-To-Market

Production optimization | AI solutions showing strong on-ground results by delivering tangible benefits to farmers

Fasal: Precision agriculture revolutionizing farming		Cropin: Scaling Indian agri-tech innovations worldwide	
Fasal delivers actionable intelligence through IoT and AI-powered solutions helping to directly address the challenges of smallholder farmers while achieving measurable results.		Cropin, a pioneer in smart farming solutions, began its journey in India by digitizing agriculture and empowering stakeholders with real-time insights. Cropin has now expanded its impact to over 52 countries, transforming farming practices across diverse geographies.	
Water optimization	Fasal's irrigation advisories have led to up to 80% reduction in water usage.	Yield and Quality Improvement	Cropin's predictive analytics tools have delivered 15-25% increases in crop yields and ensured consistent quality.
Cost savings	Offering real-time alerts on pests and diseases, Fasal has helped farmers reduce pest management costs by 18-50%.	Operational Efficiency	Achieved a 40% increase in operational efficiency for six paddy varieties, with 99.5% of plots yielding top-quality rice and reduced monitoring time by 60%.
Yield improvement	Leveraging Fasal's predictive insights, farmers have increased yields by 20-30%.	Global Reach, Local Impact	→ In North America, delivered 90% weather prediction accuracy and 87% disease warning accuracy → In Zambia, Cropin digitized 1,500 hectares while managing 10,000+ small-scale farmers
Fasal works with over 60,000 farmers across India , directly contributing to improved livelihoods and profitability. Fasal's technology is operational across 13 states and 15+ crop types , helping farmers in diverse regions tackle local challenges effectively.		Cropin's latest breakthrough, Cropin Sage, is a real-time, generative AI agri-intelligence platform powered by Gemini that combines vast agricultural and climate data, providing actionable insights for crop suitability, food supply sustainability, and procurement optimization .	

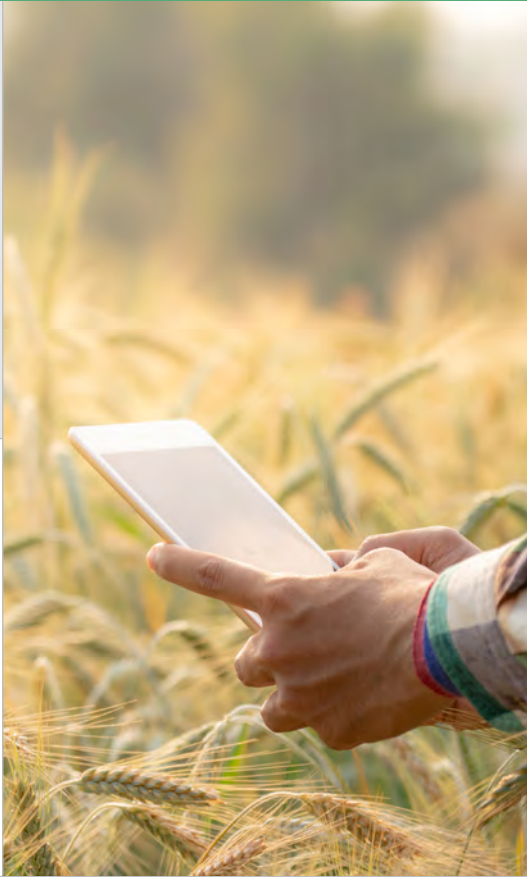
Strong results from innovators indicate potential for AI to increase on-farm productivity & efficiency creating meaningful impact for farmers in India

Key lever to increase productivity		Potential impact from AI	
 Crop monitoring and disease recognition	→ Early Warning Systems: AI-powered satellite monitoring predicts weather, optimizes harvest timing etc. → Disease Recognition: Mobile apps and AI models diagnose crop diseases and predict pest outbreaks.	Reduces crop losses, improves yield quality, and boosts farmer income through timely interventions.	~8% Productivity gain¹
 Post-harvest efficiency	→ Supply Chain Optimization: Real-time route planning and demand forecasting minimize transport costs. → Market Linkage Platforms: AI-driven platforms connect farmers directly with buyers for better prices.	Reduces spoilage, lowers consumer costs, and increases farmer profits by optimizing logistics and market access.	~7% Productivity gain²
 Resource management	→ Water Management: Precision irrigation systems analyze soil and weather data for efficient water use. → Fertilizer Optimization: AI recommends targeted fertilizer use based on soil health analytics.	Lowers input costs, ensures sustainable practices, and mitigates water scarcity.	~28% Less water & fertilizer used³

¹. Assumed 30% losses from pest/disease in India today (FAO,UN) and 25% productivity improvement based on reported outcomes from Indian agri-tech players and global players; ². Assumes 22% losses in post harvest (ICAR,2022) and 30% improvement based on inputs from global experts; ³. Assumes 40% savings possible through precision farming with 70% attributable to AI based on outcomes reported by expert

Imperative to plan holistically across technology, talent and policy to enable scaled AI adoption in agriculture

Regulatory clarity, foundational tech/infra and talent/resources necessary to ensure a safe and efficient AI ecosystem enabling large scale adoption in the agricultural space		
		
Tech Infrastructure	Talent/Workforce	Policy/Regulations
Build a robust, secure, and scalable AI infrastructure that democratizes access to AI-powered agriculture solutions, enabling real-time data collection, interoperability, and localized insights	Empower Agri-workers with AI literacy and tailored training, creating a digitally skilled agricultural workforce that can leverage AI for precision farming, pest management, and yield optimization	Assess and strengthen existing regulations to address AI adoption, ensuring a forward-looking and innovation-friendly governance approach . This balances innovation, ethics, and safety while promoting inclusive AI adoption



Technology Infrastructure | Accelerating AI in agriculture requires localized solutions built on solid foundational layer of data and infrastructure

	Solidifying base data layer	Customizing localized models	Providing access to farmers
	Digitizing land records and field-level data	Developing India-specific custom agricultural models	Providing farmers access to impactful AI-solutions
Challenges of today	→ Land records management and data collection is largely manual, resulting in limited information on land ownership, crop patterns and yields → Limited data availability limits the ability to predict yields, plan plantation cycles, manage climatic conditions, etc.	→ AI models are often not trained on India-specific datasets, failing to address local agricultural challenges → Limited region-specific accuracy in predictions and recommendations due to limited representative datasets based on India's diverse agro-climatic conditions	→ Mobile and internet infrastructure in rural India hinders AI adoption → Multiple applications across states, with need for centralization applications with localized use-cases → Awareness in farmers of AI-enabled apps and trust on advisory needs to be developed
Key learnings from global best practices	→ National Agriculture Data Lake to integrate datasets across states and center (soil health, crop patterns, climate) and provide anonymized data for AI model development and training → Low-cost IoT sensors and edge devices in rural areas for real-time data collection on soil moisture, weather, and pest conditions	→ AI models tailored to India-specific challenges, like drought prediction and pest outbreaks for smallholder farms → Centralized cloud-based platforms for agri-tech startups to access computational resources for AI model development and deployment	→ Unified AI-platforms to provide personalized crop recommendations and predictions based on local data → AI-enabled apps in regional languages to assist farmers with market insights and sustainable practices → AI-driven advisory and supply chain platforms for real-time tracking bundled with government schemes to boost adoption
	Exemplar: United States' FieldView offers personalized inputs to optimize planting, irrigation, and harvesting using real-time weather & soil data	Exemplar: DeepMind X Google provides drought prediction and pest outbreaks, leveraging vast amounts of regional data	Exemplar: Netherland's AgroVision provides farm-specific recommendations in easy-to-understand formats focusing on small and medium-scale farmers

Talent/Workforce | Bridging digital and AI literacy gaps could help empower rural farmers and foster agricultural innovation

Solving key issues today...	...with key enablers from learnings from global players		
Only 19% of rural Indians are digitally literate , creating a significant barrier to AI adoption in agriculture	 Skilling initiatives to enable and educate farmers	→ “AI for Farmers” workshops in collaboration with local Agri-centers to demonstrate practical use cases of AI in pest management and crop planning → Mobile training units in rural areas to ensure access to skilling programs for farmers with limited connectivity	Australia’s government-led Smart Farms Program funds mobile training units and digital literacy workshops for farmers to adopt precision farming techniques using AI tools
→ Limited professionals are trained in the intersection of agriculture and AI, hindering the development of tailored solutions for diverse farming needs → Rural skilling programs on AI need to focus on practical applications for local crop patterns, climate conditions, and pest management → Rural entrepreneurs require mentorship and training to launch AI-based agri-tech solutions, further slowing grassroots-level AI adoption → Agricultural universities in India in need to integrate AI training into their curriculum, leading to a lack of awareness and expertise in AI among future agricultural scientist	 Implement AI Training for Agri-Scientists for greater impact	→ AI-based modules in agricultural universities to equip students and researchers with skills to integrate AI into crop research and management → Fellowships for researchers to collaborate with agri-tech startups on developing region-centric AI solutions	Germany’s Agri-Gaia platform promotes AI development by connecting agricultural scientists with agritech startups to co-develop AI-based solutions tailored to local farmers
	 Empower Local Entrepreneurs	→ Mentorship programs linking rural entrepreneurs with experts from agri-tech startups and government agencies to guide AI-based business initiatives → Startup incubators focusing on agri-tech, providing financial and technical support	Israel’s AgriVest program incubates startups focused on AI in agriculture, offers funding, mentorship, and access to global markets to scale innovative farming technologies

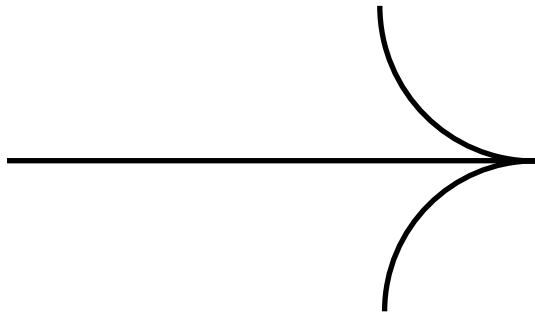
Policy/Regulations | Strengthening regulations, privacy frameworks, and collaborations could play a key role in scaling AI adoption in agriculture

	Consistent Regulations and Standards for AI in Agriculture	Address Concerns on Privacy & Security	Increase Innovation and Collaborations
Efforts being made by policy makers	→ Ministry of Agriculture's Digital Agri Stack designed to facilitate data-sharing → Indian Standards provides general standards for agri-tech tools, but not for AI-specific certifications	→ DPDP Act provides a foundational framework for leveraging data and ensuring privacy and security → India AI mission is building a dataset platform with anonymizing tools to ensure access in-line with privacy and security norms	→ e-NAM (National Agriculture Market) integrate private players to improve digital market access for farmers → Ministry of Agriculture's state-led sandbox models (e.g., Maharashtra's agritech sandbox) to test region-specific tools
Key enablers from learnings from global players	→ AI testing and validation centers for agriculture can ensure solutions meet standards of accuracy, usability, and scalability → Standardized AI certifications for tools integrated into national programs like e-NAM will ensure reliability and performance → Strong privacy framework for agriculture interoperability with national context	→ Investing in specialized tools, training and capacity for anonymizing sensitive data → Developing a standardized protocol for secure data sharing can ensure compliance while maintaining the utility of agricultural datasets for AI applications → Regional data-sharing agreements to enable smoother collaboration between different parties while maintaining privacy	→ Partnerships between agri-tech startups, global AI initiatives, & agri-cooperatives during sandbox trials for real-world feedback and scalable solutions → AI-linked credit schemes enable farmers using AI tools to gain easier access to loans → AI-specific subsidies and financing mechanisms hinder small-hold farmers and startups from adopting advanced AI tools
	Singapore's AI Certification framework focuses on transparency, fairness, and explainability of AI systems. Also, certifications under IMDA are designed to foster trust in AI while giving flexibility to meet criteria	United States promotes the use of privacy-preserving techniques to enable secure data sharing across sectors, including agriculture. This allows for data analysis while protecting individual privacy	Netherlands offers Green Growth Loans and AI-specific subsidies to support farmers in adopting advanced technologies



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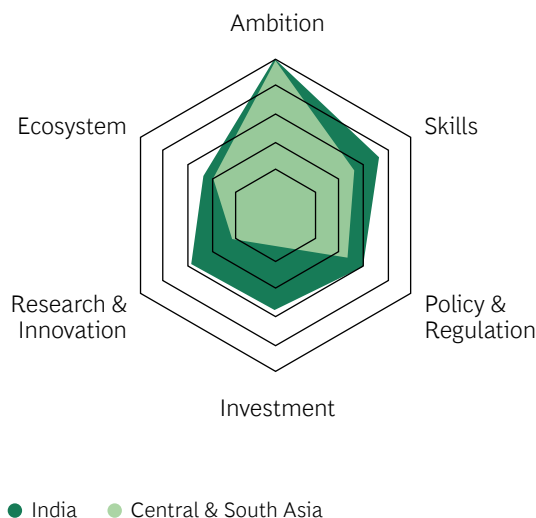
Path Forward in India



India is in a strong position with respect to AI readiness establishing itself as a leader in South & Central Asia

India leads AI readiness in Central & South Asia...

...with multiple initiatives undertaken by India to develop its AI ecosystem



Ambition

→ **National AI Strategy:** IndiaAI Mission defined a clear roadmap for India's AI ambition by building foundational infrastructure, computing facilities etc. The mission aligns efforts across sectors to build a cohesive & inclusive AI strategy for national progress

Skills

→ **Up-/Re-Skilling Program:** Ministry of Education's Future Ready Talent Program virtual internships for 100K+ students. MeitY & NASSCOM's "Future Skills Prime" is reskilling professionals and "AI for All" self-paced learning programs for 1 Mn citizens in 1 year

Policy & Regulation

→ **AI Governance & Open Data:** India's policies on open data:
→ Open government data platform & National Data Sharing/Accessibility Policy
→ State-level Open Data Initiatives like Karnataka and Telangana's data portals

Investment

→ **Start-Up Financing:** ~₹2K Cr allocated under India AI Mission for AI-related startups
→ **Innovation Hubs:** T-HUB to support AI start-ups and 25 innovation hubs under Mission on Interdisciplinary Cyber-Physical Systems

Research & Innovation

→ **National Center for Research:** Government approved creation of 3 Centers of Excellence (COE) including Healthcare and Agriculture
→ **AI Research Labs:** CAIR under DRDO and INAI at IIIT Hyderabad fostering cutting-edge research in defense applications

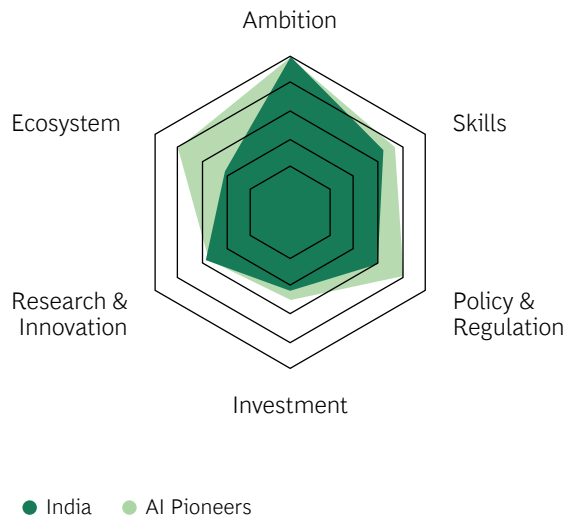
Ecosystem

→ **Digital India:** Expanded digital infrastructure under Digital India
→ **India AI Mission:** Creating robust AI ecosystem, supercomputing capacity of 100K GPUs
→ **National AI Portal:** Serving as a central hub for AI-related developments & initiatives

Potential to build on current strengths to become a global leader in AI with dedicated efforts to strengthen AI readiness

India has further potential to improve vs. AI Pioneers (Singapore, Mainland China, United States, United Kingdom, Canada)...

...through dedicated efforts to holistically strengthen its AI readiness to become a global leader



→ **Enhance AI strategy through AI funding, mission-driven governance,** and developing sector specific blueprints in national priorities (e.g., healthcare and agriculture) to position India as a global AI leader

→ **Continue empowering citizens with AI literacy and vocational training,** bridging talent gaps across regions to remain a leader when it comes to a future-ready workforce

→ **Develop centralized AI policy framework emphasizing ethical AI and harmonizing state level initiatives** to ensure responsible innovation, safeguard trust, and enable scaling of high-risk AI applications

→ **Create AI-focused venture funds and incentives for startups** to attract global investments, foster entrepreneurship, and drive innovation in priority sectors like agri-tech and health-tech

→ **Explore increasing AI R&D funding and academia-industry collaboration** to catalyze transformative innovation and create cutting-edge solutions for local challenges

→ **Enhance foundational infrastructure by improving rural connectivity, establishing centralized data-sharing platforms, and developing regional AI hubs.** These measures will help increase AI adoption, promote inclusivity, and enable large-scale cross-sectoral innovation

Opportunities

India trails AI Pioneers on Ecosystem and policy regulation

Note: CoE – Center of Excellence

Source: AI Economic Maturity Matrix Analysis – BCG and Center for Public Economics (September 2024); BCG analysis



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