

# Agri-tech adoption for climate-resilient agriculture in India

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The convergence of climate resilience and agricultural innovation plays a pivotal role in safeguarding food and fuel security amid the backdrop of environmental uncertainty. With the escalating impacts of climate change, farmers worldwide are grappling with unprecedented obstacles such as unpredictable weather patterns, pest outbreaks, and dwindling resources. In India, where agriculture sustains millions of livelihoods, the adoption of climate-resilient farming practices is not just advantageous but imperative. These practices not only boost productivity but also align with the global mandate to curb greenhouse gas emissions and foster sustainable agriculture. By infusing technology into farming, we can establish adaptive and efficient systems that empower farmers to thrive in the face of a changing climate.

Technological advancements in precision farming are essential in overcoming the challenges faced by modern agriculture. IoT-enabled sensors, data analytics and mobile applications are just a few of the tools that provide farmers with real-time insights into crucial factors, such as weather conditions, soil health, and crop performance. These innovations empower farmers to make well-informed decisions that optimize resource utilization and reduce waste.

The path towards a sustainable future necessitates collaboration among various stakeholders, including farmers, policymakers, researchers and the private sector. By prioritizing education and training in sustainable practices, we can empower farmers to effectively adapt to evolving conditions. Further, implementing innovative financing mechanisms can provide crucial support to smallholder farmers as they transition to climate-resilient practices, all while ensuring their economic viability. In our pursuit of a future where food security and energy security coexist harmoniously, it is essential to acknowledge the interconnectedness of our agricultural systems and to implement holistic solutions that address both challenges. Through coordinated efforts and the adoption of sustainable innovations, we could build resilient agricultural systems capable of withstanding the impacts of climate change, thereby safeguarding our food and energy futures.

The government has implemented several initiatives to bolster the value chain for agribusiness. However, to further advance this sector, it is essential to raise awareness about modern agricultural techniques and promote their adoption. As we navigate the complexities of climate change and its impact on agriculture, ASSOCHAM jointly with EY LLP has come out with this report which aims to provide a roadmap for future initiatives that prioritize climate resilience in agriculture while enhancing food security and promoting sustainable energy solutions. We acknowledge the efforts made by the experts in preparing the report being presented at the National Conference on 'Climate Resilient Farming Solutions: Food Security to Fuel Security'. We hope the report would provide useful information and insights to the stakeholders.

# Foreword



# Foreword



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India is predominantly an agrarian economy, where agriculture contributes over 18% to the country's GDP.<sup>1</sup> The nation has attained self-sufficiency in food grain production, contributing to robust economic growth that is expected to persist. With the largest arable land area, constituting 51.95%,<sup>2</sup> and a variety of agro-climatic conditions, agriculture plays a pivotal role in India's economy, politics, and social landscape.

However, the agriculture sector faces multifaceted challenges, with climate change as the central concern. More than 80% of India's population resides in regions that are highly susceptible to climate change.<sup>3</sup> Erratic weather patterns, including unpredictable monsoons, lead to droughts and floods that disrupt agricultural activities. Rising temperatures and changing rainfall patterns threaten crop yields, while the increase in pest and disease outbreaks undermines food security. Additionally, water scarcity and soil degradation intensify these challenges, and insufficient infrastructure restricts farmers' ability to adapt. Addressing these climate-related issues is essential for ensuring the resilience and sustainability of agriculture in India.

The integration of technological interventions offers powerful solutions to address climate-related risks in agriculture. Advanced data analytics and machine learning are optimizing planting schedules, while precision agriculture tools, such as drones and IoT sensors, promote more efficient use of resources. Biotechnology is also playing a key role, with the development of climate-resilient crop varieties that can withstand extreme weather, helping to ensure stable yields.

The Indian government is supporting the adoption of an agri-tech ecosystem across various landscapes through a range of initiatives. A key example is the development of the Agri-stack, a framework that integrates various agricultural services and data, making it easier for farmers and other value chain actors to access resources. By facilitating access to innovative technologies and providing financial assistance, the government is creating an enabling ecosystem that is helping farmers to enhance productivity and sustainability in their operations.

The continued push for agri-tech adoption in India highlights the transformative potential of technology in revolutionizing traditional farming, enhancing efficiency, and promoting long-term sustainability in the face of growing climate challenges. To ensure innovations reach last-mile farmers, an integrated approach is needed, with buy-in from stakeholders at all levels.

This paper sheds light on the agri-tech landscape in India, its pain points, key policies, and pathways to enable the sector to navigate an uncertain climate landscape. We hope this thought paper inspires meaningful action that enhances the resilience of India's agriculture, paving the way for a future where technology, sustainability, and confidence drive long-term success.



# Executive summary

India's agriculture sector is a cornerstone of the nation's economy, contributing approximately 18.2% to GDP and supporting around 42.3% of the population.<sup>1</sup> It plays a vital role in ensuring food security and sustaining rural livelihoods. However, the sector faces significant challenges that threaten its long-term sustainability. These challenges include low productivity, unsustainable practices, and increased vulnerability to climate-related risks. Factors such as human pressures, limited resources, and inadequate technological integration exacerbate these challenges throughout the entire agricultural value chain, from production to distribution.

**These multi-faceted challenges highlight the urgent need for innovative solutions, and agri-tech innovations present a significant opportunity.** Technologies, such as precision farming, artificial intelligence (AI) and the Internet of Things (IoT), provide farmers with powerful tools to optimize

yields and manage resources more efficiently. With US\$1.28 billion<sup>13</sup> invested in agri-tech in FY22, there is increasing recognition among investors of the potential these technologies hold, particularly for start-ups focused on supply chain innovations. **The Indian government has been a force multiplier in this regard, playing a pivotal role in enabling the growth of agri-tech through favorable policy support.** Initiatives like the Digital Agriculture Mission integrate digital tools into farming, giving farmers access to real-time data and enabling informed decision-making. Programs like Nam0 Didi incorporate a gender perspective into the supply chain, empowering women through self-help groups to become entrepreneurs, while the National Mission for Sustainable Agriculture (NMSA) promotes eco-friendly farming practices. **Together, these efforts create a strong ecosystem that addresses current challenges and future demands.**



Despite these efforts, **agri-tech adoption remains low in many Indian states. This can be attributed to several factors, such as a lack of awareness, limited access to resources, inadequate infrastructure, and resistance to change among farmers. An integrated approach that emphasizes collaboration and the developments of locally tailored solutions is essential to address these challenges.** Centralized solutions can streamline stakeholder engagement and improve access to resources, while innovative financial models can provide the necessary funding for agri-tech ventures. Ensuring that farmers receive adequate training and support would be crucial for the effective use of new technologies.

**While the challenges facing India's agriculture sector may seem daunting, leveraging agri-tech innovations offers a promising path forward.** By addressing the bottlenecks in agri-tech adoption and fostering a collaborative ecosystem, India can unlock

the sector's full potential. Effective partnerships among farmers, start-ups, industry and policymakers would be key for utilizing technology to drive sustainable growth, improve productivity, and enhance resilience against climate-related risks.

**Beyond the benefits for farmers and consumers, agri-tech adoption across India would help the country achieve its national and global environmental goals.** Agri-tech can play a vital role in ensuring sustainability. This strategic focus would also help fulfill the objectives of the Sustainable Development Goals (SDG), and other global targets that call for urgent action on climate change. **Through a commitment to innovation and sustainability, India has the opportunity to not only revolutionize its agricultural sector but also to lead by example on the global stage, showcasing how a resilient and sustainable future can be achieved for both its people and the planet.**



An aerial photograph of a blue truck driving through a field, leaving a trail of harvested crops. The field is a mix of green and golden-brown, suggesting a late harvest season. The truck is positioned on the left side of the frame, moving towards the bottom left.

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A close-up photograph of a person's hands holding a large quantity of golden wheat grains. The background is a blurred field of wheat under a warm, golden sunset sky. The entire image is framed by a thin yellow border.

# 1

Agriculture's role in  
India's economy  
and the key  
challenges it faces

## Agriculture in India faces numerous challenges, which pose significant barriers to the sector's growth and profitability

India's agriculture sector is confronted with various interconnected challenges that have a negative impact on its growth and profitability. One of these challenges is the prevalence of small and fragmented landholdings, which limits economies of scale and reduces the efficiency of resource utilization. The decline in soil quality, limited availability of top-notch resources, and ineffective farming techniques contribute to a further decrease in overall productivity. Additionally, the inefficient supply chains and inadequate storage infrastructure contribute to low farm gate prices and increased post-harvest losses. These challenges collectively limit the income potential of farmers and hinder the overall development of agriculture.

Climate induced risks exacerbate these challenges, adversely affecting the entire value chain and undermining productivity and sustainability.

Climate change poses a critical concern across each segment of the agricultural value chain, and affects crop yields, farmer profitability and overall sustainability. It is projected that rice and wheat yields would reduce by 20% by 2050 in the absence of climate adaptation measures.<sup>4</sup> Overall, the agriculture sector has suffered a loss of US\$159 billion, or 5.4% of GDP due to climate stress.<sup>5</sup>

Figure 01: India's climate vulnerability: an overview<sup>6</sup>

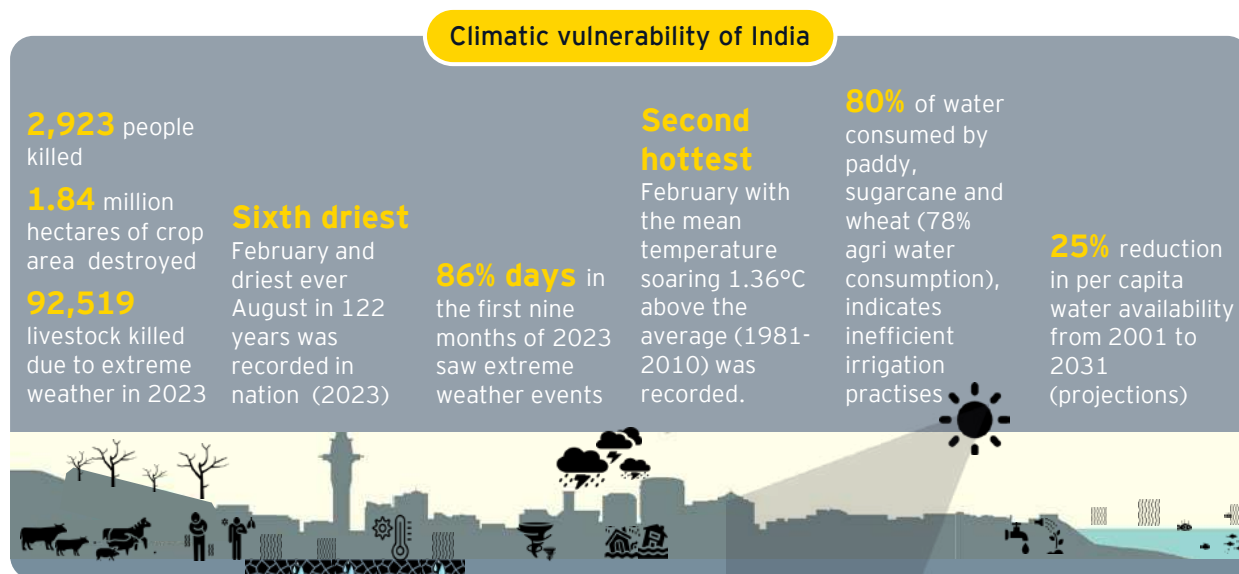













Figure 02: Climate risks at each node of value chain<sup>7</sup>

	Stages	Challenges	Climate risks
Pre-production	 Land preparation	▶ 30% of India's land is degraded	▶ ~30% of soil in India is at risk of soil erosion
	 Input supply	▶ ~30% of seeds are of poor quality	▶ Reduced seed quality and high input cost due to extreme weather conditions
	 Nutrient management	▶ 42% of India's districts account for 85% of the nation's chemical fertilizer consumption	▶ ~35% of Indian soils are deficient in the essential nutrients, which could worsen under climate stress
Production	 Irrigation and water management	▶ Only ~50% of agricultural land is irrigated	▶ Approximately 42% of India's land is susceptible to drought, and the rate of groundwater depletion could triple by the 2080s as a result of rising temperatures
	 Crop management	▶ Agricultural yield in lower than other large producing countries	▶ A rise of 1°C in rabi temperatures has been observed to diminish the gross output value per hectare by 4%
	 Farm mechanization	▶ 47% of agricultural operations in India are mechanized, lower than China (60%) and Brazil (75%) ▶ Only 4.4% of agricultural households' own tractors ▶ Expensive capital cost	▶ Non-mechanized farms are more prone to soil erosion and land degradation
Post-production	 Harvesting	▶ Limited access to and adoption of modern harvesting equipment	▶ Shifts in weather patterns could cause unpredictable harvest schedules and losses
	 Storage	▶ Post-harvest losses are at 20-30%	▶ For every rise of 2°F, the relative humidity decreases by about 7%, leading to a 50% reduction in the shelf life of produce
	 Processing	▶ Less than 10% of agricultural produce is processed	▶ Unpredictable weather conditions could lead to delays and inefficiencies in processing operations
	 Transportation	▶ Poor roads and transportation facilities make it difficult for farmers to sell their produce	▶ Extreme weather could disrupt transportation networks and affect timely delivery
	 Marketing and distribution	▶ Limited market access hampers farmers' ability to sell their produce at fair prices	▶ Climate-induced supply variability could lead to price fluctuations and market instability

Given the risks induced by climate change across the agricultural value chain, it is essential to prioritize the integration of agri-technologies, digital agriculture and the adoption of climate-resilient

practices. This is crucial for fostering sustainable growth and ensuring the long-term viability of India's agriculture sector.





A large yellow number '2' is positioned on the left side of the page, partially overlapping the text below. The background is a photograph of several autonomous agricultural robots in a lush green field. The robots are white and yellow, with articulated arms and sensors. They are moving through rows of crops. In the background, there are rolling green hills under a blue sky with scattered white clouds. The entire scene is framed by a thin yellow border.

# 2












How agri-technology  
is revolutionizing  
the sector



Agri-tech has the potential to address inefficiencies at each node of the value chain, optimizing process, improving productivity while prioritizing the integration of climate resilience at every stage

Agri-tech has a key role in addressing the inefficiencies and enhancing climate resilience within the agricultural value chain. By leveraging digital technologies, such as data digitization, analytics platforms, artificial intelligence, machine learning, and SaaS, farmers could be equipped with the tools to optimize yield, reduce operational costs, and increase profitability.

Figure 03: How agri-tech is addressing the bottlenecks across each value chain node






	Stages	Broad challenges	Potential agritech solutions
Pre-production	 Land preparation	<ul style="list-style-type: none"> <li>▶ High cost of inputs</li> <li>▶ Limited accessibility to quality inputs</li> </ul>	<ul style="list-style-type: none"> <li>▶ Digital marketplace to link farmers to inputs</li> <li>▶ Biotech innovation for climate resilient and better-quality inputs</li> </ul>
	 Input supply	<ul style="list-style-type: none"> <li>▶ Delayed supply of inputs</li> <li>▶ Input adulteration</li> <li>▶ Climatic vulnerabilities</li> </ul>	
	 Nutrient management	<ul style="list-style-type: none"> <li>▶ Fertilizer overuse impact on environment</li> </ul>	
Production	 Irrigation and water management	<ul style="list-style-type: none"> <li>▶ Water shortage</li> <li>▶ Agricultural yield lower than major countries</li> </ul>	<ul style="list-style-type: none"> <li>▶ Enhancing farm operations through precision agriculture</li> <li>▶ Mechanization and automation in farming</li> <li>▶ Farming technologies such as greenhouse system and drip irrigation</li> </ul>
	 Crop management	<ul style="list-style-type: none"> <li>▶ Pests and diseases</li> <li>▶ Limited labor availability</li> </ul>	
	 Farm mechanization	<ul style="list-style-type: none"> <li>▶ Lack of farm machinery leading to inefficient cultivation processes</li> </ul>	
Post-production	 Harvesting	<ul style="list-style-type: none"> <li>▶ Limited access and adoption of modern harvesting equipment</li> <li>▶ Lack of access to warehouse facilities</li> <li>▶ Limited processing facilities</li> <li>▶ Quality issues</li> <li>▶ Delays in transport</li> <li>▶ Poor roads and transportation</li> <li>▶ Limited market access</li> </ul>	<ul style="list-style-type: none"> <li>▶ Traceability through blockchain technology</li> <li>▶ Digital platform to handle post-harvest supply chain</li> </ul>
	 Storage		
	 Processing		
	 Transportation		
	 Marketing and distribution		



Agri-tech players are harnessing a range of technologies to enhance operational efficiencies and build climate resilience

Numerous technologies, including climate smart solutions, precision farming, IoT sensors, AI/ML-based digital tools, are being introduced by agri-tech start-ups to drive efficiencies in the value chain.

Figure 04: Use cases for leveraging technologies

Applications of technology in various segments		
Areas	Description	Issues addressed
 <b>Using imaging and AI for crop monitoring and planning</b>	<ul style="list-style-type: none"> <li>▶ Quality management and traceability</li> <li>▶ Weather forecasting, crop planning and resource management</li> </ul>	<ul style="list-style-type: none"> <li>▶ Crop quality monitoring and improvement through imaging or AI</li> <li>▶ Automation in output grading and yield classification</li> </ul>
 <b>Leveraging data analytics and machine learning for climate resilience</b>	<ul style="list-style-type: none"> <li>▶ Precision agriculture</li> <li>▶ Farm management</li> </ul>	<ul style="list-style-type: none"> <li>▶ Improved productivity through precise weather forecasting</li> <li>▶ Data and insights to guide use of resources, such as water and labor</li> </ul>
 <b>Harnessing data and platforms to improve pricing outcomes</b>	<ul style="list-style-type: none"> <li>▶ Market linkage - farm inputs</li> <li>▶ Supply chain tech and output market linkage</li> </ul>	<ul style="list-style-type: none"> <li>▶ Better returns through higher transparency and online platforms for price discovery</li> <li>▶ Maximize farmers' income by using data to accurately grade the produce</li> </ul>
 <b>Traceability platforms for agricultural produce</b>	<ul style="list-style-type: none"> <li>▶ Supply chain tech through blockchain and output market linkage</li> </ul>	<ul style="list-style-type: none"> <li>▶ Increased visibility and transparency across supply chain</li> <li>▶ Better data in emergency situations</li> </ul>
 <b>Utilizing robotics and drones for farming and harvest operations.</b>	<ul style="list-style-type: none"> <li>▶ Farm mechanization and automation</li> </ul>	<ul style="list-style-type: none"> <li>▶ Help overcome labor shortage</li> <li>▶ Reduces cost of cultivation</li> <li>▶ Improve time to market for produce</li> </ul>

New-age agri-technologies have immense potential for revolutionizing the agriculture sector. By harnessing these innovative tools, we can witness a

shift that would address longstanding challenges and pave the way for a more efficient, sustainable, and resilient future in farming.







# 3

Government initiatives enabling agri-tech adoption in India

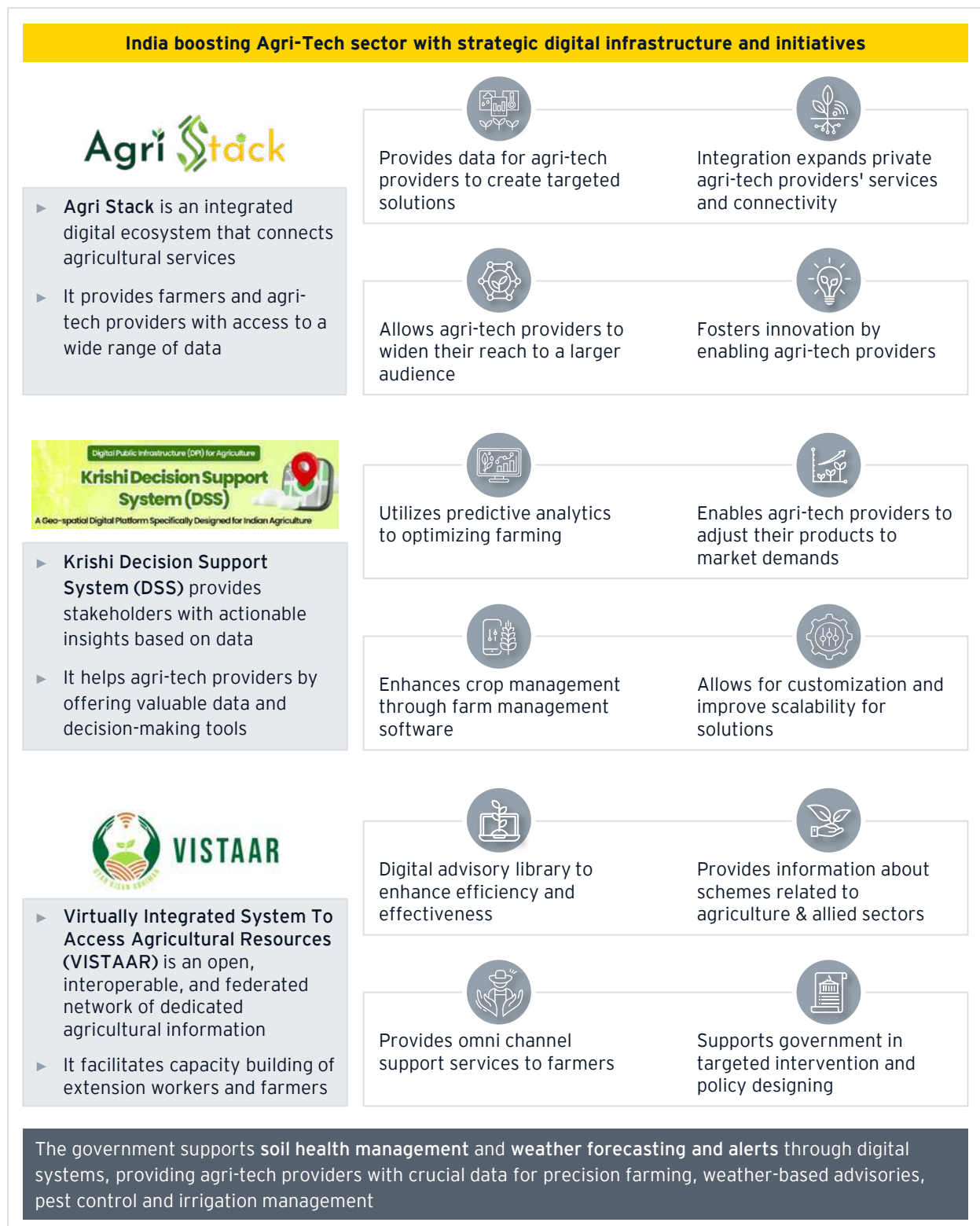


The Government of India is creating an enabling environment to accelerate the adoption of agri technologies across the country

India’s push for agricultural modernization is driven by a robust digital infrastructure, notably through

the Digital Agriculture Mission. This initiative supports agri-tech providers by integrating platforms, such as Agri Stack and the Krishi Decision Support System, offering them access to real-time data and innovative tools.

Figure 05: Government initiatives for building India’s agri digital infrastructure<sup>8</sup>



**Parallely, the government is developing a robust agri-tech ecosystem through active support for agri-incubation and start-up promotion**

Focusing on agri-tech incubation, substantial efforts have been made through targeted support for

developing and promoting start-ups. Initiatives such as RKVY-RAFTAR and the Agri-Sure Fund provide essential resources, financial assistance, and technical guidance. These measures are designed to nurture early-stage start-ups and build a robust agri-tech ecosystem in the country.

Figure 06: Key policy support to boost agri-tech ecosystem<sup>9</sup>

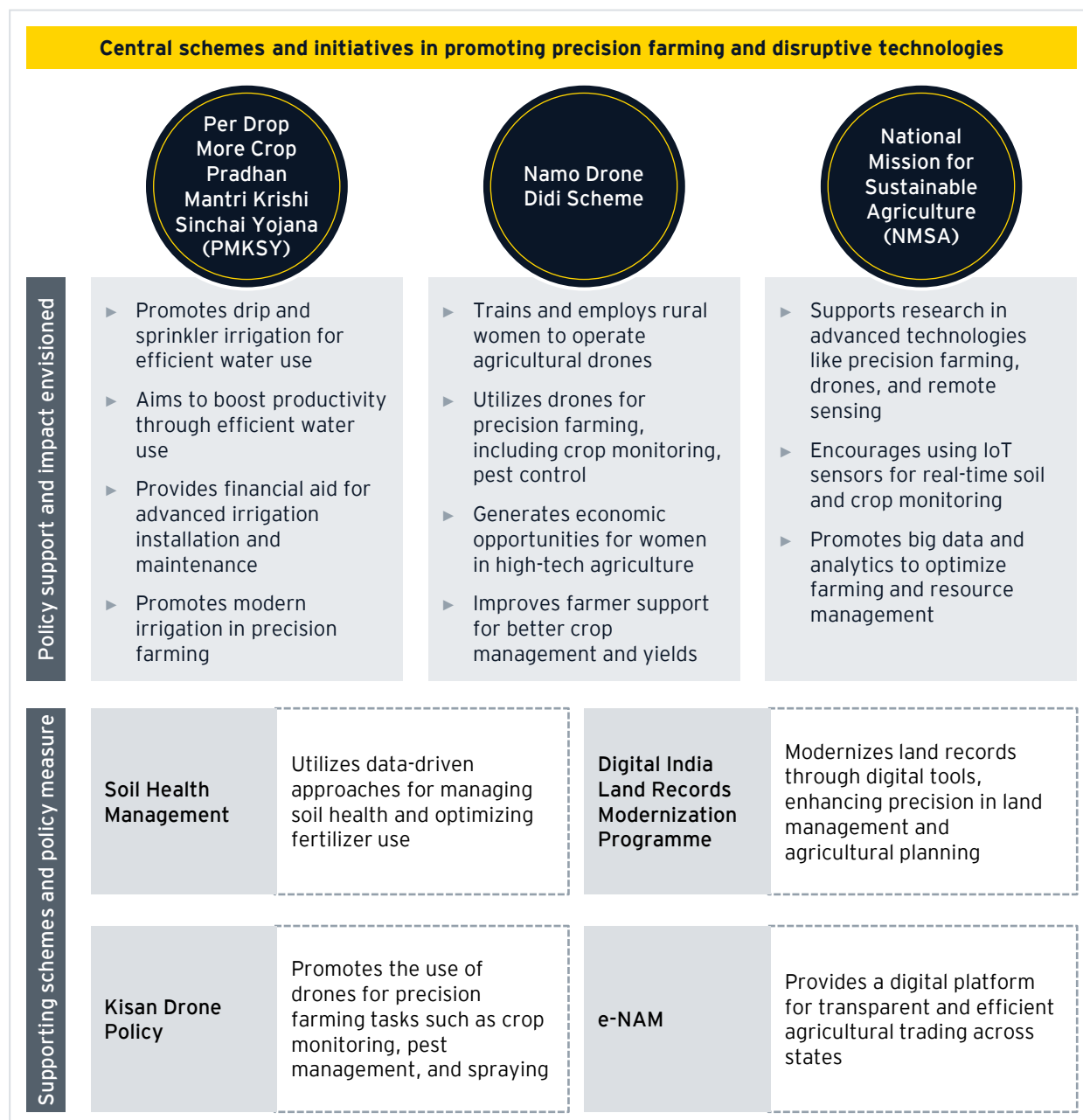


**The government is also supporting advancements in precision farming and other innovations, for enhanced climate resilience and productivity**

Multiple initiatives have been undertaken to promote the adoption of precision farming and climate smart

solution. Programs, such as the Pradhan Mantri Krishi Sinchai Yojana, focus on advancing efficient irrigation solutions. Additionally, the promotion of technologies, such as drones for precision farming, highlights the government’s commitment to improving resource efficiency and sustainability in agriculture.

Figure 07: Government initiatives promoting precision farming and disruptive technologies<sup>10</sup>

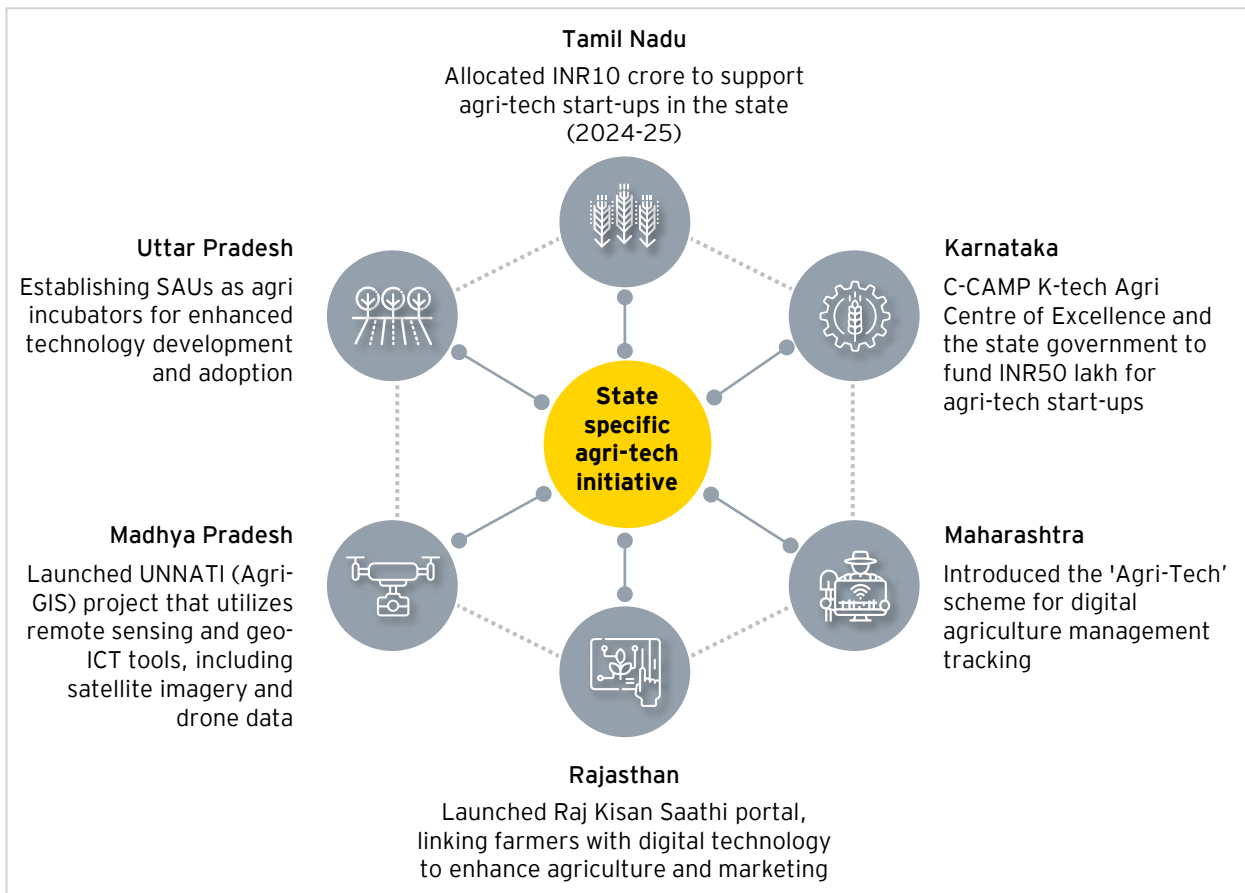


### State governments are also fostering agri-tech growth with supportive policies and enabling initiatives

State governments are advancing agri-tech by creating an enabling environment through targeted

policy initiatives and supportive programs. These measures include providing financial incentives, facilitating access to technology, and implementing regulations that promote innovation and adoption of advanced agricultural solutions.

Figure 08: Initiatives in key states<sup>11</sup>







# 4

Navigating  
challenges in  
agri-tech adoption



## Agri-tech landscape in India needs to adopt innovative and evolving solutions to scale up advanced innovations for an efficient and climate resilient agriculture

The key to transforming India's agriculture lie in the adoption of agri-technologies by farmers. However,

the agri-tech potential is largely untapped with current agri-tech market penetration at ~1% only.<sup>12</sup> Comprehensive solutions across different ecosystem stakeholders need to be developed to unlock the sector's full potential and drive sustainable agricultural growth.

Table 01: Challenges and solutions framework for agri-tech adoption

Stakeholder	Challenges	Possible solutions	
Technology Provider	Matured start-ups	<ul style="list-style-type: none"> <li>▶ No mechanism to test technologies for regional requirements</li> <li>▶ Standard designs unfit for diverse geographical needs</li> <li>▶ High Data acquisition costs</li> </ul>	<ul style="list-style-type: none"> <li>▶ State level agri-tech sandboxes for testing and refining technologies</li> <li>▶ Innovative distribution and scale up strategies</li> <li>▶ Leveraging Government Digital Public Infrastructure</li> </ul>
	Nascent start-ups	<ul style="list-style-type: none"> <li>▶ High cost involved in R&amp;D, prototyping, testing</li> <li>▶ Low seed funding</li> <li>▶ Lack of mentorship and industry connects</li> <li>▶ Competition from established players</li> </ul>	<ul style="list-style-type: none"> <li>▶ Seed fund for start-ups with a flexible grant structure</li> <li>▶ Digitalizing agri-tech promotion and adoption process (Example: Digital Agri-tech adoption process in Uttar Pradesh)</li> </ul>
Consumer	Farmers	<ul style="list-style-type: none"> <li>▶ Low farmer awareness and trust on new technologies</li> <li>▶ Limited accessibility to market</li> <li>▶ High investment cost of technologies</li> </ul>	<ul style="list-style-type: none"> <li>▶ Extension institutions for tech outreach to the last mile</li> <li>▶ Digital repository for agri-technologies</li> <li>▶ Digital literacy for adoption of digital technologies</li> <li>▶ Innovative distribution models</li> <li>▶ Technology leasing models, subsidy support</li> </ul>
Incubator	Public and Private Incubators	<ul style="list-style-type: none"> <li>▶ Lack of expertise for advanced technologies</li> <li>▶ Difficulty in securing funds to start-ups</li> </ul>	<ul style="list-style-type: none"> <li>▶ Sector specific incubation centers with expertise</li> <li>▶ Partnerships with venture capitalist, others</li> </ul>
Government	Central and state governments	<ul style="list-style-type: none"> <li>▶ Regulatory hurdles for support on new tech</li> <li>▶ Limited focus on agri-start-ups and low financial support</li> </ul>	<ul style="list-style-type: none"> <li>▶ Central/state level digital platform for agri-start-ups</li> <li>▶ Prioritize agri-start-ups for support across incubation, financial assistance and commercialization</li> </ul>
Academia	ICAR, SAU, IIMR	<ul style="list-style-type: none"> <li>▶ Slow scale up of innovations</li> <li>▶ Low collaboration between academia, industry</li> <li>▶ Inadequate funding</li> </ul>	<ul style="list-style-type: none"> <li>▶ Partnerships between academia and industry to align research with market demands</li> <li>▶ Increasing govt support for advanced technologies</li> </ul>
Financing Companies	Credit agencies, venture capitalists	<ul style="list-style-type: none"> <li>▶ Reluctance to invest in new and agri-tech solutions</li> <li>▶ Low availability of agri-tech financial products</li> </ul>	<ul style="list-style-type: none"> <li>▶ Risk sharing mechanism and guarantee support for private investment in agri-tech</li> <li>▶ Agtech focused financial solutions to scale up</li> </ul>



Among the solutions mentioned earlier, three key approaches have been recognized as crucial for expanding agricultural technologies: **incubation**, which promotes innovation and initial development; **agri-tech sandboxing**, which provides a controlled

setting for testing and validating technologies; and **agri-tech outreach and commercialization**, which ensures widespread access and market integration of these innovations.

### 1. Incubation ecosystem needs to align its support areas in line with the requirements of emerging technologies

Incubation is the first and most pivotal stage for the development of agri-technologies. Incubators provide a complete handholding ecosystem for start-ups for transforming nascent innovations to viable technologies. While agri-incubators continue to

support technology development, it is essential to continuously upgrade their capabilities in alignment with evolving market demands to effectively develop and scale innovative agricultural solutions.

Figure 09: Key areas for incubation development



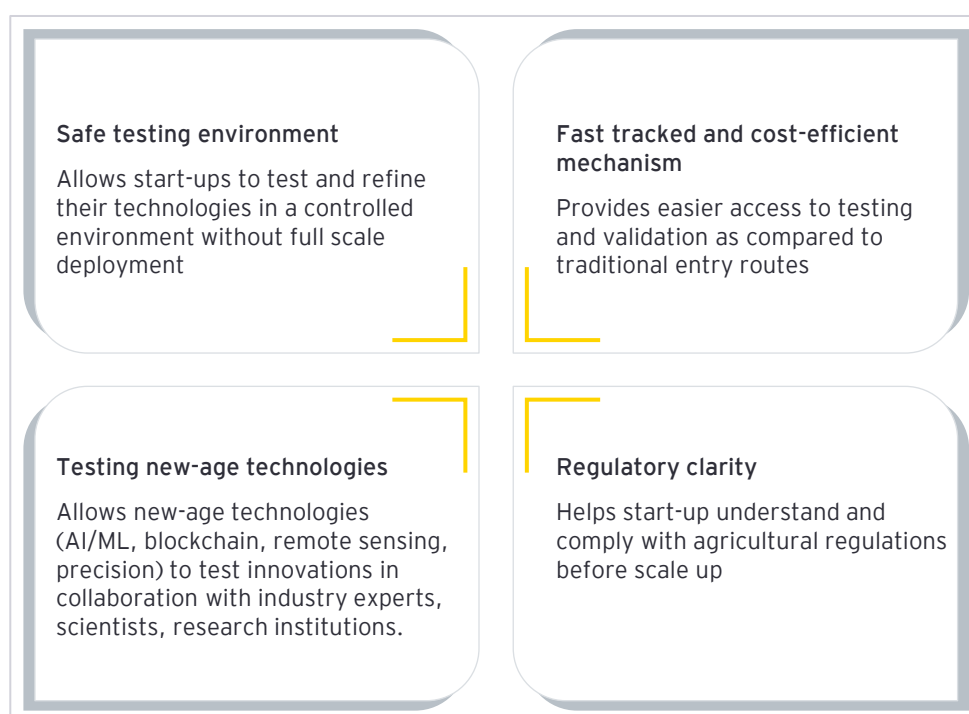
## 2. Agri-tech sandboxes should be developed to enable testing and refinement of cutting-edge technologies before adoption

### What is an agri-tech sandbox?

Agri-tech sandbox is a controlled environment provided to agri-start-ups for limited scale testing and validation of new technologies to test their feasibility in a geography without full scale risk of complete deployment.

With the emergence of many disruptive technologies across AI, precision agriculture, remote sensing, smart advisories, start-ups need to test their technologies on the ground before scaling up. On the other hand, traditional extension institutions and KVKs lack the adequate capabilities to test such technologies for effective input refinement.

Figure 10: Benefits of agri-tech sandbox



**State-level agri-tech sandboxes should be established** to provide a fast-tracked mechanism for start-ups to test their innovations, ensuring their effectiveness, market readiness, and compliances with regulatory requirements. These sandboxes

should include coordinated efforts from diverse stakeholders to ensure that different technologies have access to a fast-tracked centralized mechanism to test and refine their technologies as per varied local requirements.



### 3. Agri-technology field outreach and commercialization strategies need to be strengthened and digitally enabled

A holistic approach is essential for driving the promotion, adoption, and long-term commercial sustainability of agri-tech innovations. In this regard, **three key areas of action** are outlined below.

#### A. Digitalization of agri-tech promotion






The agri-tech ecosystem involves multiple stakeholders, including start-ups, farmers, and government institutions. However, the stakeholders often work in silos, leading to weak coordinated efforts in promoting technologies.

**State-level digital system** should be created dedicated for agri-technology promotion. This digital system should integrate the database of FPOs,

farmers, start-ups, incubators, enabling creation of a common platform for all agri-tech stakeholders to connect and collaborate to advance the reach of agri-technologies on the ground.

#### B. User awareness building through technology field outreach

Technology field outreach should prioritize promotion of climate smart and advanced digital agricultural solutions around AI/ML, IoT, precision techniques that could address the current agricultural challenges and enhance efficiency across the value chain.

Key strategies for user awareness building through agri-technologies	
 <p>Digital literacy for farmers</p>	<ol style="list-style-type: none"> <li>Limited digital literacy among farmers hampers the adoption of digital tools</li> <li>Digital literacy programs should be implemented through extension, SAUs, NGOs, to train farmers on using smart phones</li> <li>Agri-tech platforms should be in vernacular language to enhance ease of usage</li> </ol>
 <p>Pipelining climate smart and digital technologies</p>	<ol style="list-style-type: none"> <li>Cutting edge innovations (AI/ML, block chain, climate smart) should be fielded based on innovation, potential impact and financial viability</li> <li>Pilot programs should be conducted for such technologies to ensure their effectiveness in different field conditions</li> </ol>
 <p>Extension institutions for tech promotion</p>	<ol style="list-style-type: none"> <li>KVKs, agriculture universities should prioritize field trials and demonstrations of advanced agri-technologies, climate smart solutions</li> <li>Farmer collectives should be leveraged to scale the demonstrations to wider number of farmers</li> </ol>
 <p>Leveraging community institutions</p>	<ol style="list-style-type: none"> <li>FPOs, SHGs and other community institutions should be engaged in technology outreach. These institutions have credibility among farmers which can accelerate adoption</li> <li>Progressive farmers who have adopted technologies should be highlighted to motivate adoption among local farmers</li> </ol>
 <p>Implementing TVET model for upskilling farmers on agtech</p>	<ol style="list-style-type: none"> <li>Technical, Vocational and Educational training (TVET) models should be implemented to train farmers on diverse climate smart, digital, and non-digital agri-technologies</li> <li>Cadres of trained farmers developed to further disseminate technologies to the last mile</li> <li>Vocational training to be conducted in partnership with SAUs, KVKs, vocational training institutes, tech providers and others</li> <li>Govt schemes, financial institutions should be leveraged for sustaining the training programs</li> </ol>



### C. New approaches to technology commercialization

Commercialization strategies should focus on innovative methods around financial solutions,

distribution strategies, and government support for emerging technologies, among others, for a wider uptake of technologies by the end farmers and users.

Figure 11: Key approaches for technology commercialization





5

How can finance enable agri-entrepreneurs and start-ups to scale up

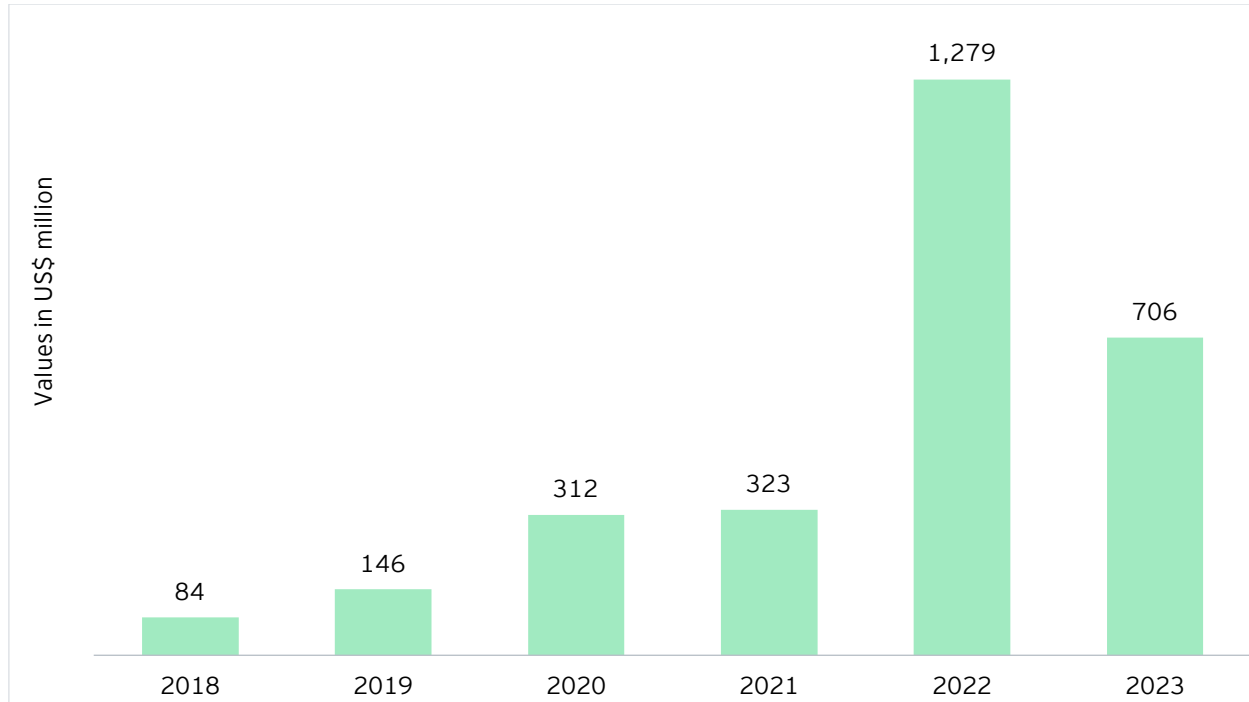


### Investments are continuing to flow and expand in India's agri-tech industry

India has seen a rising trend in agri-tech investments in recent years, with a total of US\$1,279 million

invested in FY22.<sup>13</sup> Investments contracted in the year 2023 in line with the broader global trends due to volatile market conditions. These investments came from diverse investors, including venture capitalists, angel investors, and others.

Figure 12: Investment trends in India's agri-tech industry<sup>13</sup>

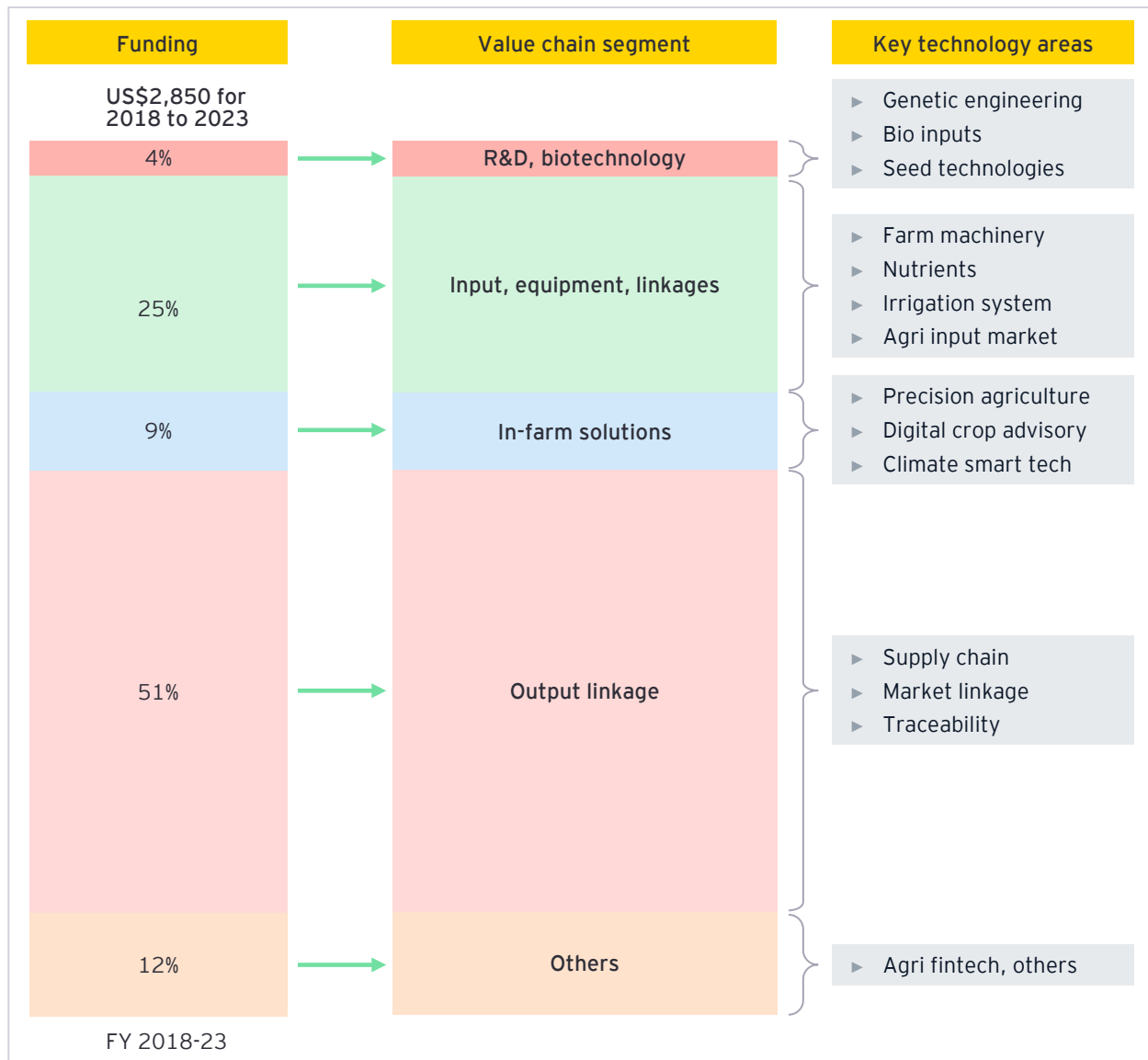


Agri-start-ups working in the output market linkage segment and supply chain technologies have attracted major investments. Start-ups that have scaled up through investments are expanding their presence across different segments to offer holistic solutions across the value chain.

**Precision farming and climate solutions are key spaces that have a wider scope for further investments**

Precision agriculture, digital agriculture, and climate-smart solutions across the agricultural value chain have received fewer investments compared with the input and output segments.

Figure 13: Investments across technology areas<sup>14</sup>



With the growing rise in climate vulnerabilities in agriculture, erratic rainfall, temperature fluctuations, heat waves, floods, droughts, pest infestations adversely affecting farmer productivity, disruptive technologies around precision and digital solutions offer promising areas for investors to invest. To attract investments, technology providers, including entrepreneurs and start-ups, should provide integrated solutions including hardware, software and services. They should focus on risk-sharing models, renting models, to achieve affordability for farmers.

## Innovative funding models for agri-entrepreneurs and start-ups

To address the white space in the agri-tech investment, various funding options can be utilized to support the growth of entrepreneurs and start-ups, particularly those in their early stages, in scaling their operations successfully.

Table O2: Innovative funding models

	Challenge addressed	Solution provided	Qualitative metrics	Growth support	Funding type
<b>Expedited credit frameworks</b>	<ul style="list-style-type: none"> <li>▶ Lack of collateral</li> <li>▶ Conventional credit assessments</li> <li>▶ Need for quick funding</li> </ul>	<ul style="list-style-type: none"> <li>▶ Collateral-free loans</li> <li>▶ Non-traditional metrics assessment</li> <li>▶ Fast-tracked loan processes</li> </ul>	<ul style="list-style-type: none"> <li>▶ Projected cash flows and innovation potential</li> </ul>	<ul style="list-style-type: none"> <li>▶ Swift access to capital for seizing opportunities</li> </ul>	<ul style="list-style-type: none"> <li>▶ Unsecured working capital loans</li> </ul>
<b>Risk-sharing mechanisms</b>	<ul style="list-style-type: none"> <li>▶ High risk of lending to start-ups</li> <li>▶ Proving business model viability</li> </ul>	<ul style="list-style-type: none"> <li>▶ First loss guarantee support</li> <li>▶ Demonstrating business impact</li> </ul>	<ul style="list-style-type: none"> <li>▶ Social/ environmental impact, market adoption rate</li> </ul>	<ul style="list-style-type: none"> <li>▶ Encourages financing of impactful ventures directly involved in the agri value chain</li> </ul>	<ul style="list-style-type: none"> <li>▶ Guarantees and credit enhancements</li> </ul>
<b>Private Equity and Venture Capital</b>	<ul style="list-style-type: none"> <li>▶ Need for substantial growth capital</li> <li>▶ Achieving scale and market penetration</li> </ul>	<ul style="list-style-type: none"> <li>▶ Access to equity funds and risk capital</li> <li>▶ Support for mergers and acquisitions</li> </ul>	<ul style="list-style-type: none"> <li>▶ Scalability of technology, competitive advantage</li> </ul>	<ul style="list-style-type: none"> <li>▶ Direct investment for scaling</li> </ul>	<ul style="list-style-type: none"> <li>▶ Direct equity and strategic investments</li> </ul>
<b>Adaptive financing</b>	<ul style="list-style-type: none"> <li>▶ High risk nature of agri-tech</li> <li>▶ Need for larger funding as start-ups grow</li> </ul>	<ul style="list-style-type: none"> <li>▶ Conservative loan amounts with significant first-loss guarantees</li> <li>▶ Progressive lending-based on impact</li> </ul>	<ul style="list-style-type: none"> <li>▶ Operational milestones, sustainability measures</li> </ul>	<ul style="list-style-type: none"> <li>▶ Tailored financial support for growth</li> <li>▶ Responsive financing strategy</li> </ul>	<ul style="list-style-type: none"> <li>▶ Flexible loans with evolving terms</li> </ul>



A futuristic agricultural robot with a dual-arm mechanism is shown harvesting cherry tomatoes in a field. The robot is positioned in the center of the frame, with its arms extended towards the plants. The field is filled with rows of cherry tomato plants, and the sky is a clear, bright blue. The robot has a white body with black accents and a digital display on its front. The overall scene is set in a well-maintained agricultural field.

# 6

Learnings from  
Indian and global  
agri-tech models



## Incorporating successful practices from around the world and within India can create a strong agricultural technology ecosystem

While the market penetration of agri-tech innovations has significant room for growth,

unlocking this potential requires a strategic shift. Sector players in India and beyond can gain valuable insights from emerging strategies for scaling advanced climate-resilient agri-tech solutions. Here are key focus areas that can enhance India's agri-tech ecosystem.



### Favourable regulatory environment

The government plays a vital role in creating a favorable regulatory environment for agri-tech companies and making new technologies more accessible to farmers, thus nurturing a strong agri-tech ecosystem.



### Leveraging public-private partnerships

Public-Private Partnerships enable private players to collaborate with the government, scaling agri-tech through shared resources and expertise. These alliances boost funding and infrastructure, accelerating widespread technology adoption among farmers.



### Innovation development through incubation support

Agri-tech incubation is crucial for turning early-stage innovations into scalable solutions by offering mentorship, funding, and technical resources. Continuous upgrades in incubator ecosystems, coupled with emerging technologies, would be vital for addressing challenges.



### Digitalization of the agri-tech ecosystem

The fragmentation of stakeholders hampers agri-tech adoption. A unified digital platform that consolidates agri-tech information and connects sector players can foster collaboration and drive adoption. Integrating stakeholder databases facilitates better access to information.



### Prioritization of climate-smart and digital solutions

Prioritization of climate-smart technologies suited to the needs of the farmers is crucial to facilitate wider adoption. Alongside right technologies, flexible financial models and strong distribution networks can ensure the commercial viability of new models and drive sustainable growth.

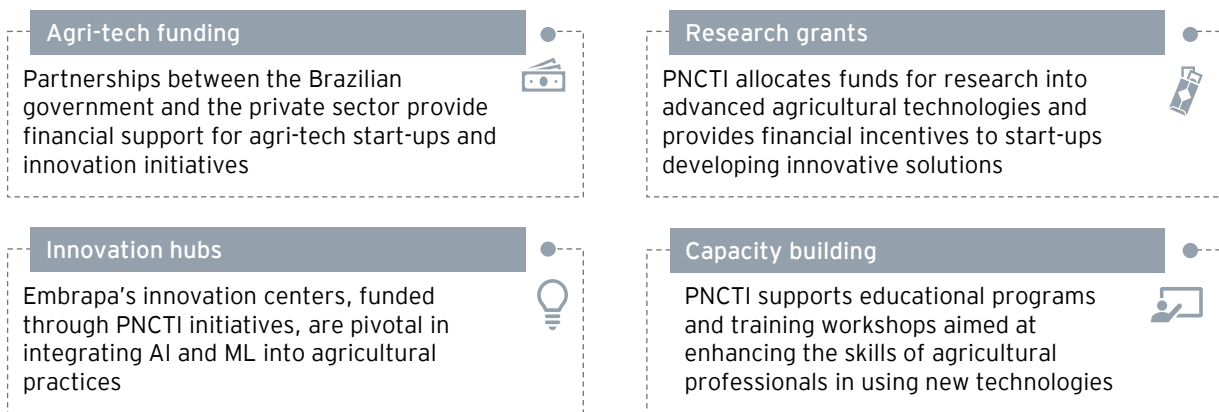


## Case study 1: Government policies in Brazil boost agri-tech through funding and R&D, strengthening climate resilience and adaptability<sup>15</sup>

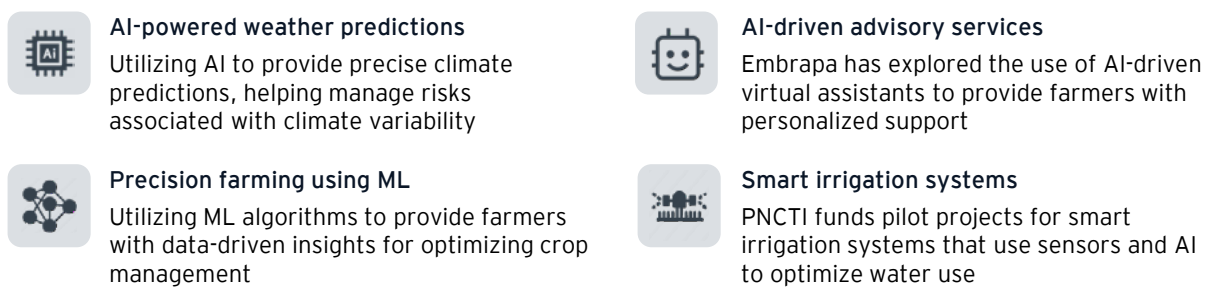
Agri-tech solutions using AI and ML in Brazil have bolstered climate resilience by predicting weather patterns and optimizing crop management strategies



### Government support for developing a robust agri-tech ecosystem



### Technology advancement



In 2022, Brazil's agricultural crop production reached approximately 830 billion Brazilian reais, marking an increase of nearly 12% from 2021 and the highest figure recorded in the past 10 years.



## Case study 2: Telangana is implementing an integrated approach for driving agri-tech adoption through Project Saagu Baagu<sup>16</sup>

Project Saagu Baagu uses agri-tech to advance crop management with cutting-edge solutions, aiming to boost farmers' prosperity

### Challenges

- ▶ Limited access to land
- ▶ Limited access to technology
- ▶ Dominance of traditional practices
- ▶ Climate change risks
- ▶ Limited post-harvest infrastructure



### Key initiatives

- ▶ Adopted a PPP framework with the World Economic Forum to scale digital agriculture
- ▶ Project Saagu Baagu fosters public-private tech collaborations to enhance small and marginal farmers' incomes
- ▶ Expanding cost-effective data linkages for sustainable impact

### Drivers for leveraging agri-tech and innovations

#### Agri value chain transformation

Improving agri-tech service delivery to customers with administrative support, policy backing, and digital infrastructure



#### Agri-tech sandbox

Providing a controlled environment for testing and certifying new agri-tech products for compliance with standards and regulations



#### Agriculture data exchange

Developing an open-source technology platform to facilitate data exchange between providers and consumers supporting farmers with digital services



#### Agriculture data management framework

Ensuring the responsible development of the data-sharing ecosystem. Protecting users, preventing harm and promoting innovation in agriculture.



### Technology advancement



#### AI-based soil testing

AI-based soil testing facility with results on 12 parameters in 20 minutes



#### AI-based digital extension

Introduced an AI-based WhatsApp chatbot for real-time, customized advisories to farmers



#### Android based app for data integration

Utilization of AI and spectroscopy-based quality testing for issuing quality certificate



#### E-commerce based market linkages

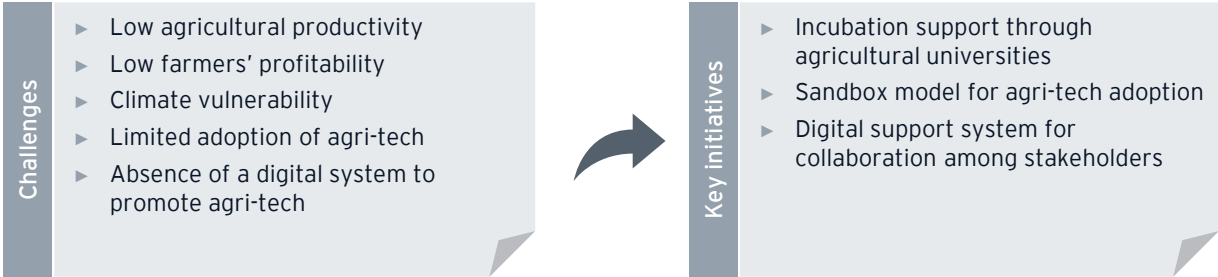
An e-commerce solution that offers market linkages for inputs and outputs, along with advisories for farmers

**Chili yields increased by 21%, pesticide use dropped by 9%, and unit prices rose by 8% due to quality improvements. Farmers' incomes grew by over INR66,000, effectively doubling their earnings.**

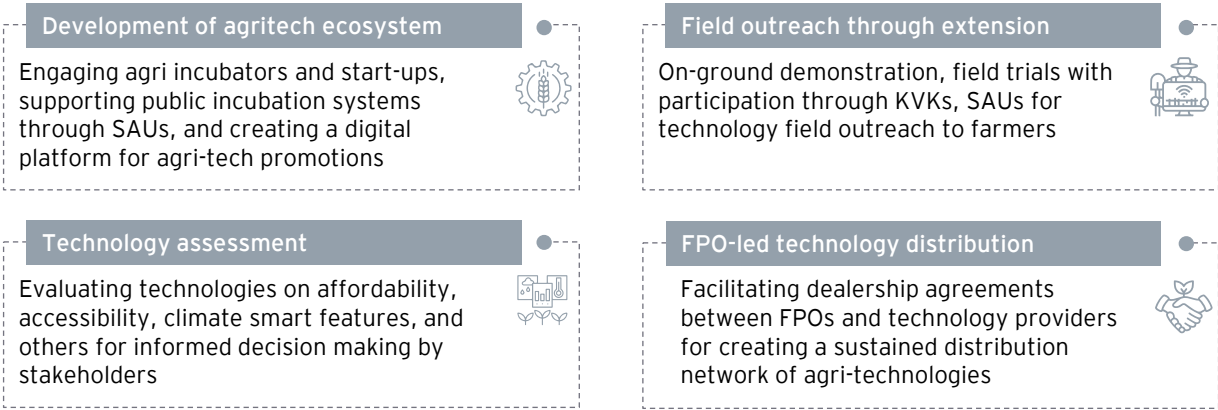


### Case study 3: Uttar Pradesh is driving agri-tech adoption through digital enablement, incubation support and promotion of climate-smart technologies

Uttar Pradesh is building a robust agri-tech ecosystem for enhanced tech adoption by farmers



#### Drivers for agri-tech adoption



#### Technology advancement



Linked 200,00+ SSPs to 50+ agri technologies	60+ FPOs as tech dealers	Improvement in crop yield	74% FPOs reported increase in income
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# Conclusion

Agri-tech is set to transform the agriculture sector significantly. To integrate agri-tech effectively, stakeholders must adopt a systems perspective, focusing on key pathways: strengthening incubation support, establishing agri-tech sandboxes, and enhancing outreach and commercialization, supported by favorable policies and innovative financial models.

Some of the key recommendations for advancing agri-tech integration are:

- ▶ **Strengthening the incubation ecosystem:** Enhancing agri-incubators to align with emerging technologies and market needs, providing essential mentorship and resources for start-ups
- ▶ **Establishing agri-tech sandboxes:** Implementing state-level sandboxes for controlled testing of technologies, allowing start-ups to refine solutions in real-world conditions while ensuring regulatory compliance
- ▶ **Enhancing digital outreach and commercialization:** Developing a robust digital system to connect stakeholders and provide farmers with access to information and sustainable practices
- ▶ **Investing in key areas:** Focus investments on precision agriculture and climate-smart technologies to enhance resilience among farmers
- ▶ **Exploring innovative funding models:** Utilizing diverse funding mechanisms, such as expedited credit and risk-sharing models, to support the scaling of agri-tech start-ups.

India stands poised to unlock the full potential of its agri-tech sector, paving the way for sustainable agricultural growth that boosts productivity and enhances resilience to climate-related challenges. This is particularly relevant for achieving SDG 13 and other global goals. By embracing innovative agri-tech solutions, India can effectively reduce greenhouse gas emissions and implement climate-smart practices that protect the agricultural sector from climate impacts. However, it is crucial to understand that technology is simply an enabler. The real transformation lies in the hands of those involved in agriculture. They must effectively utilize the tools of technological innovation to foster an inclusive and dynamic agricultural ecosystem, ultimately benefiting farmers, consumers, and the broader environment.



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Off. Western Express Highway  
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Building No. 1  
MindSpace Airoli West (Gigaplex)  
Located at Plot No. IT-5  
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Airoli (West)  
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## ASSOCHAM

Ideate. Innovate. Impact

### About ASSOCHAM

The Associated Chambers of Commerce & Industry of India (ASSOCHAM) is the country's oldest apex chamber. It brings in actionable insights to strengthen the Indian ecosystem, leveraging its network of more than 4,50,000 members, of which MSMEs represent a large segment. With a strong presence in states, and key cities globally, ASSOCHAM also has more than 400 associations, federations and regional chambers in its fold.

Aligned with the vision of creating a New India, ASSOCHAM works as a conduit between the industry and the Government. The Chamber is an agile and forward-looking institution, leading various initiatives to enhance the global competitiveness of the Indian industry, while strengthening the domestic ecosystem.

With more than 100 national and regional sector councils, ASSOCHAM is an impactful representative of the Indian industry. These Councils are led by well-known industry leaders, academicians, economists and independent professionals. The Chamber focuses on aligning critical needs and interests of the industry with the growth aspirations of the nation.

ASSOCHAM is driving four strategic priorities - Sustainability, Empowerment, Entrepreneurship and Digitization. The Chamber believes that affirmative action in these areas would help drive an inclusive and sustainable socio-economic growth for the country.

ASSOCHAM is working hand in hand with the government, regulators and national and international think tanks to contribute to the policy making process and share vital feedback on implementation of decisions of far-reaching consequences. In line with its focus on being future-ready, the Chamber is building a strong network of knowledge architects. Thus, ASSOCHAM is all set to redefine the dynamics of growth and development in the technology-driven 'Knowledge-Based Economy'. The Chamber aims to empower stakeholders in the Indian economy by inculcating knowledge that will be the catalyst of growth in the dynamic global environment.

The Chamber also supports civil society through citizenship programmes, to drive inclusive development. ASSOCHAM's member network leads initiatives in various segments such as empowerment, healthcare, education and skilling, hygiene, affirmative action, road safety, livelihood, life skills, sustainability, to name a few.

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