TB – ICN: 317/2024

Innovation for a Greener Tomorrow

Exploring the Frontier of Climate Resilient Technologies

Leveraging technology to empower farmers, enhance agricultural sustainability, and foster climate resilience.

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About Pusa Krishi

Nestled in the agricultural landscape of India, Pusa Krishi is a renowned agri-startup incubator, well-known for its cutting-edge technology, extensive industry expertise, and groundbreaking potential. Originally founded in 2014 as an incubator under ICAR-Indian Agricultural Research Institute, it grew into a DST-supported Technology Business Incubator (TBI) and a meta-incubator for agriculture under the Ministry of Agriculture & Farmers' Welfare in 2018. Serving as the exclusive nodal organisation for the Ministry of Agriculture & Farmers' Welfare, Government of India, Pusa Krishi is in charge of the biggest programme for agribusiness incubation, called Rashtriya Krishi Vikas Yojana (RKVY) – Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RAFTAAR). It oversees a network of 24 RAFTAAR Agri Business Incubators and 5 Knowledge Partners across India. Under several pre-incubation, incubation and agripreneurship development programmes, the unit has worked with more than 350 startups thus far, providing them with a wide range of services and support.

PUSA KRISHI

Innovation For a Greener Tomorrow

Exploring the Frontier of Climate Resilient Technologies

What is "Climate Resilience"?

The scientific evidence is overwhelming: The climate is changing, and human activity is the primary factor in the acceleration of climate change over the past century. Regardless of successful humans' activities to limit the root causes of our warming planet, society is facing significant impacts—from more frequent and severe weather, ocean warming and acidification, extended periods of drought and extreme temperatures, and other deleterious effects of climate change. The ability to prepare for, recover from, and adapt to these impacts is called "climate resilience."

Factors Influencing Climate Resilience

Climate resilience is influenced by a combination of natural, social, economic, and technological factors. Understanding these factors is crucial for developing effective strategies to enhance resilience to the impacts of climate change. Here are some key factors that influence climate resilience:

Geography & Climate Conditions :

The geographical location and climate of a region play a significant role. Coastal areas may be vulnerable to sea-level rise and storms, while inland areas may face challenges like drought or extreme heat.

Economic Stability & Development :

Economically stable regions often have more resources to invest in resilient infrastructure, early warning systems, and adaptation measures. Economic development can contribute to increased adaptive capacity.

Infrastructure & Urban Planning :

Well-designed and climate-resilient infrastructure, including buildings, roads, and energy systems, can mitigate the impacts of extreme weather events. Urban planning that considers climate risks is crucial for resilient cities.

Natural Resources & Ecosystem :

Healthy ecosystems provide essential services such as water purification, flood control, and biodiversity, contributing to climate resilience. Degraded ecosystems may increase vulnerability to climate-related hazards.

Governance and Institutions :

Effective governance, transparent institutions, and well-defined policies contribute to climate resilience. Strong institutions can facilitate the implementation of adaptive measures and the allocation of resources for resilience-building activities.

Education and Community :

Education and awareness programs can empower communities to understand climate risks and adopt resilient practices. Informed individuals are more likely to take proactive measures to protect themselves and their communities.

Technology and Innovation :

Access to and adoption of climate-resilient technologies can significantly enhance adaptive capacity. Innovations in agriculture, energy, and infrastructure contribute to building resilience to climate-related challenges.

Access to Financial Resources :

Adequate financial resources are essential for implementing climate resilience measures. Access to funds for infrastructure projects, disaster preparedness, and community-based adaptation initiatives is critical.

Role of Climate Resilient Technologies in Boosting Resilience Towards the Effects of Climate Change

Climate-resilient technologies are crucial in the context of climate-resilient agriculture, as agriculture is particularly vulnerable to the impacts of climate change. Climate-resilient agriculture involves the integration of innovative technologies and practices to enhance the capacity of agricultural systems to adapt to and mitigate the effects of changing climatic conditions. Here are key aspects of the role of climate-resilient technologies in agriculture:

Drought-Resistant Crop Varieties

Precision Farming

Water Management Technologies

Climate-Adaptive Farming Practices

ICT in Agriculture

Climate-Smart Livestock Management

Innovative Pest & Disease Management

Soil Health Management

Weather-Resilient Greenhouses

Capacity Building and Education

The Global Climate Crisis is already underway, and will continue to Dramatically alter the operating Landscape of Global Agriculture in the coming decades

INPUTS

Changing temperature patterns: Rising average temperatures, more extreme heat, longer and shorter cold periods

Changing precipitation patterns: Longer dry spells, increased duration of heavy rainfall and related weather events

Sea level rise: Sea ingress, coastal surges, increased soil salinity

Climate Change Trends

+

Industrial Amplifiers

Degradation of soils due to overploughing, intensive agrochemical use, monocropping, and deforestation

Decline in water tables caused by unregulated and overuse of water, suboptimal cropping, and deforestation

Vicious cycle of increased agrochemical uses to counter lower fertility and pest attacks

Simplification of landscapes and ecosystems to allow for vast monocropping systems

=

OUTPUTS

1. **Crop, livestock, and fisheries viability:** All crop and animal varieties have an optimum range of environmental parameters. As these parameters change in every agro-climatic region, the health and survival of organisms grown by farmers will decline, and the breeding and selection of species and varieties will have to change.

2. **Pests, pathogens, and weeds:** Changing environmental parameters are shifting the habitable zones for harmful pests, pathogens, and weeds. This will mean a rise and change in use of agrochemicals and pest control mechanisms that farmers are accustomed to for decades, as well as increased costs of food testing at every stage of production.

3. **Extreme weather events:** The combined impacts of climate change trends are making floods, droughts and freak weather events like cyclones and hurricanes more common and severe, leading to unavoidable crop losses. Expensive physical protection and insurance schemes will become non-negotiable needs of farmers.

Source: Omnivore – The Future of Indian Agriculture & Food Systems: Vision 2030

Quick Snapshot of Climate Resilient Technologies

Key Statistics ~ Global

7162 Total Companies

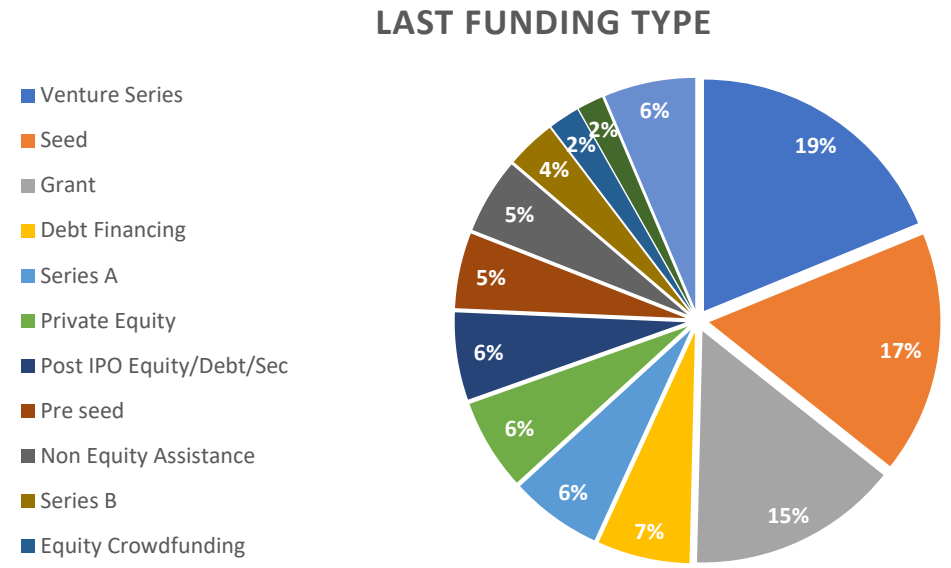
15 $1B to $10 B Evaluation Companies

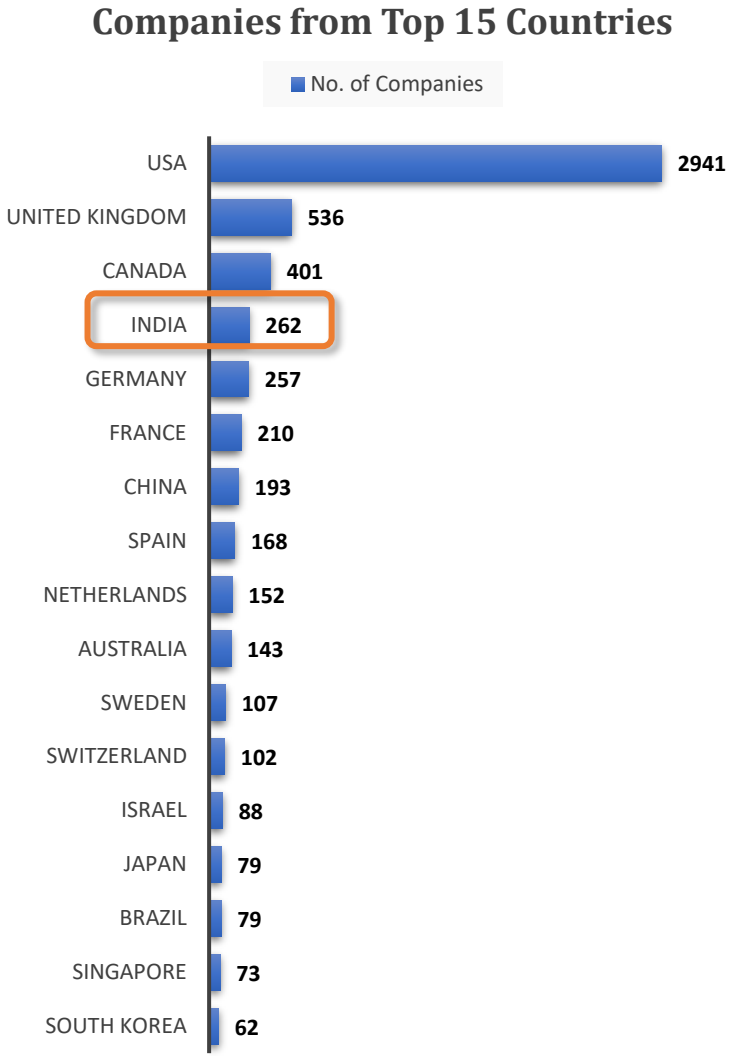
1591 Companies Funded in last 1 year

262 Indian Companies

1062 Mergers & Acquisitions

468 Publicly Listed (IPOs)



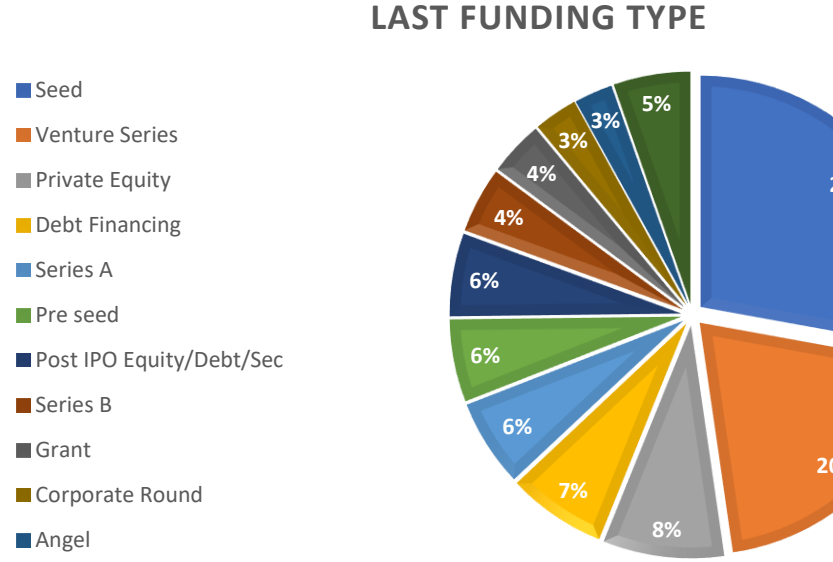


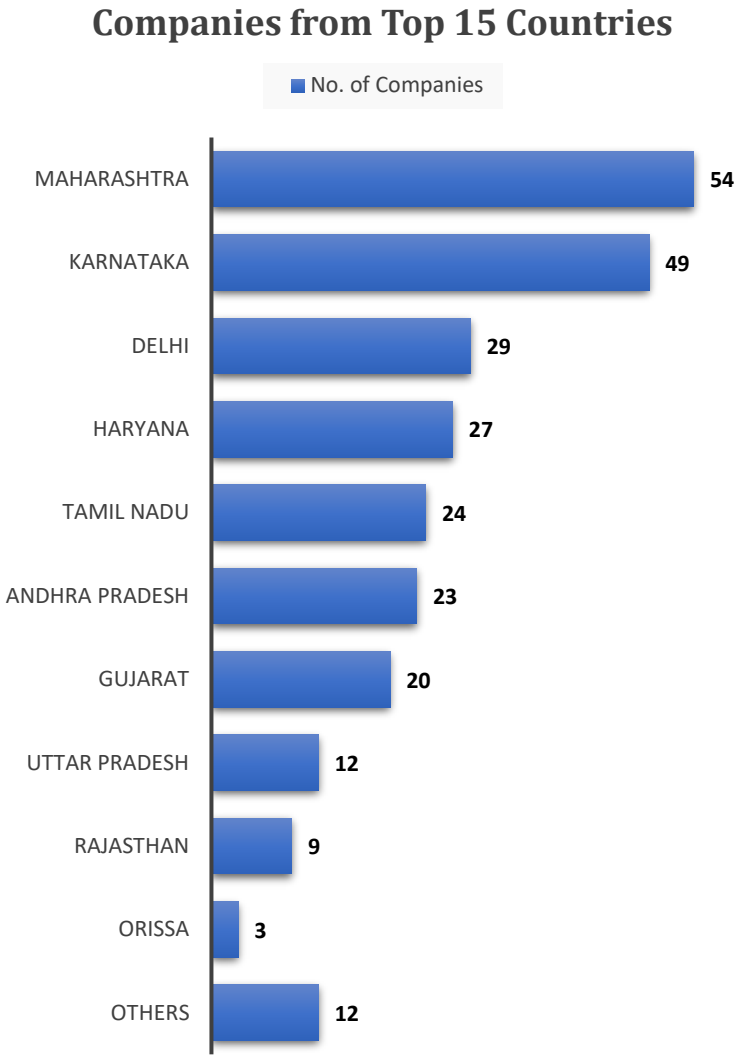
Source: Crunchbase Analysis (with keywords description: Climate Smart, Biosolutions, Digital Credit, Risk Mitigation, Early Warning Systems, Climate-Responsive Crop Management, Digital Supply Chain, Digital Finance, Precision Agriculture, Climate Data Analytics, Climate Risk, Biodiversity Conservation, Carbon Capture, Eco-Friendly Technology, Sustainable Transportation, Smart Grid, Water Management, Climate Monitoring, Disaster Resilience, Climate Mitigation, Clean Energy, Resilient Infrastructure, Green Infrastructure, Environmental Technology, Renewable Energy, Sustainable Technology, Climate Adaptation, Climate Resilience)

Key Statistics ~ India

262	15	68
Total Companies	No. of States	Companies Funded in last 1 year

06	00
Mergers & Acquisitions	Publicly Listed (IPOs)





Source: Crunchbase Analysis (with keywords description: Climate Smart, Biosolutions, Digital Credit, Risk Mitigation, Early Warning Systems, Climate-Responsive Crop Management, Digital Supply Chain, Digital Finance, Precision Agriculture, Climate Data Analytics, Climate Risk, Biodiversity Conservation, Carbon Capture, Eco-Friendly Technology, Sustainable Transportation, Smart Grid, Water Management, Climate Monitoring, Disaster Resilience, Climate Mitigation, Clean Energy, Resilient Infrastructure, Green Infrastructure, Environmental Technology, Renewable Energy, Sustainable Technology, Climate Adaptation, Climate Resilience)

Climate Resilient Technologies and Startups Working to Mitigate Climate Change

Climate-resilient technologies aim to address the challenges posed by climate change and enhance the ability of systems to adapt and withstand its impacts. In India, several startups are working on innovative solutions across various sectors. Certainly, agriculture is a critical sector where climate-resilient technologies play a significant role.

Here are some technologies being used in, along with examples of Indian startups working in this field:

	**Renewable Energy**	**Solar Power**	Startups like ZunRoof, Orb Energy, and Oorjan are working on solar energy solutions to reduce dependence on conventional energy sources.
		Wind Power	Companies like ReNew Power and Mytrah Energy focus on wind energy projects to harness clean and sustainable power.
	**Water Management**	**Smart Irrigation**	Agrowave, Flybird Farm Innovations, and Fasal are startups working on precision agriculture and smart irrigation technologies to optimize water usage in farming.
		Water Purification	Cleantech startups such as Sarvajal and WaterHealth India are developing water purification technologies to ensure clean and safe drinking water.
	**Climate-Resilient Agriculture**	**Crop Monitoring**	AgroStar, CropIn, and Ninjacart use technology to provide farmers with real-time information on crop health, weather conditions, and market trends.
		Drought-Resistant Crops	GreenAgrevolution (Dehaat) and Absolute Foods is focused on developing crops that are resistant to drought and can thrive in changing climatic conditions.
	**Waste Management**	**Recycling Technologies**	Kabadiwalla Connect and Sampurn(e)arth are startups working on innovative waste management solutions, including waste recycling and upcycling.
		Composting	Daily Dump and Green Worms specialize in decentralized composting solutions to manage organic waste at the source.
	**Climate-Resilient Infrastructure**	**Green Building Technologies**	Startups like CarbonClean Solutions and Green Building Innovation Lab are working on sustainable and energy-efficient building solutions.
		Flood Resilient Infrastructure	Ecologin and Henson Geodata Technologies focus on developing technologies for flood monitoring, early warning systems, and resilient infrastructure.

Climate Monitoring and Analytics	:	**Satellite Technology**	Astrome and Exseed Space are working on satellite-based technologies for climate monitoring, weather prediction, and environmental data collection.
		Data Analytics	Blue Sky Analytics and Climate Connect use data analytics and artificial intelligence to analyze climate data for better decision-making.

An illustrative and diverse range of technologies are being employed in agriculture by Indian startups. The integration of technology in agriculture not only improves productivity but also enhances the sector's resilience to climate change and other environmental challenges. Some comprehensive examples from the Indian startup ecosystem are:

Sector	Company Name	Company Logo	Founder	Total Funding Amount	Funding Round	No. of Investors	Most Recent Investors
Precision Farming	CropIn	Cropin	Krishna Kumar	$46.4 M	11	15	Google and ImpactAssets
	AgNext	AGNEXT	Taranjeet Singh Bhamra	$25.1 M	5	6	Hashgraph Association and Kalaari Capital
	SatSure	SatSure	Abhishek Raju	$24.6 M	6	25	xto10x Technologies and IndigoEdge
Smart Irrigation	Fasal	Fasal	Ananda Verma	$14.0 M	8	20	ITI Growth Opportunities Fund and Wavemaker Partners
	Flybird Farm Innovations	FLYBIRD FARM INNOVATIONS	Satish KS	$223.3 K	2	7	CIBA Centre for Incubation and Business Acceleration and Rianta Capital
	WeGot Utilities	WEGOT UTILITY SOLUTIONS	Mohamed Mohideen	$3.5 M	4	11	Gruhas and Rahul Talwar
Drones/UAVs	Skylark Drones	SKYLARK™ DRONES	Mrinal Pai	₹223.4 M	2	8	Karanpal Singh and Info Edge ventures
	Dhaksha Unmanned Systems	DUMS	Ramanathan Narayanan	₹200.0 M	1	1	Dare Ventures

		IoTechWorld	IOTECH	Anup Kumar Upadhyay	$4.0 M	1	1	Undisclosed
	**AgTech Marketplaces & Digital Supply Chain**	AgroStar	AgroStar Helping Farmers Win	Shardul Sheth	$112.9 M	10	14	British International Investment and Aavishkaar Venture Capital
		Ninjacart	ninjacart	Thirukumaran Nagarajan	$357.6 M	15	24	Mainstreet Investment and STIC Investment
		DeHaat	DeHaat Seeds to Market	Shashank Kumar	$254.3 M	8	12	Temasek Holdings and Prosus Ventures
	**Biotechnology and Genomics**	RML AgTech	RML FARMER	Amit Mehra, Sumantra Mukherjee, Sunil Jain	$6.9 M	3	1	IvyCap Ventures
		Bioprime Agrisolutions	BioPrime AGRISOLUTIONS PVT LTD	Shekhar Bhosale	$2.6 M	3	3	Inflexor Ventures and Omnivore
		Absolute Foods		Agam Khare	$115.5 M	6	7	Assam AgriFin and Alpha Wave Global
	**Vertical Farming**	Future Farms		Sriram Gopal	$122K	1	1	Symbiotics Group
		UrbanKisaan		Vihari Kanukollu	$7.0 M	4	11	Jon Oringer and Pareto Holdings
		Clover	CLOVER	Santosh Narasipura	$16.8 M	5	5	IvyCap Ventures and Alteria Capital
	**Soil Health Monitoring**	Gramophone	Gramophone TRANSFORMING AGRICULTURE	Tauseef Khan	$20.5 M	7	17	Info Edge and Z3Partners
		NeerX	neerx	Harsh Agrawal	$150K	5	2	BIRAC and CIIE.CO

	Krishitantra	KRISHITANTRA	Sandeep Kondaji	$1.0 M	1	2	Nabventures and Omnivore
	Grow Indigo	growindigo	Rajendra Badrinarayan Barwale	$6.0 M	1	2	Mahyco Seeds Ltd. and Indigo
Digital Finance	Jai Kisan	Jai Kisan	Arjun Ahluwalia	$98.8 M	11	29	British International Investment and GMO Venture Partners
	Origo Commodities	ORIGO	Sunoor Kaul	$52.8 M	5	8	U.S. International Development Finance Corp and Yes Bank
	KrishiHub	K	Jyotiska Khasnabish	$168.1K	2	3	Rockstart and INVENT
	AgriFi	agrifi	Abhilash Thirupathy	$100K	3	5	AgFunder and Tenity

Source: Crunchbase Analysis

Steps Taken by Indian Government to Make Agriculture Climate Resilient

The Government of India is implementing the following:

National Action Plan on Climate Change (NAPCC) which provides an overarching policy framework for climate action in the country. National Mission for Sustainable Agriculture (NMSA) is one of the Missions within the National Action Plan on Climate Change (NAPCC). The mission aims to evolve and implement strategies to make Indian agriculture more resilient to the changing climate. NMSA was approved for three major components i.e. Rainfed Area Development (RAD); On Farm Water Management (OFWM); and Soil Health Management (SHM).

Subsequently, four new programmes were introduced namely Soil Health Card (SHC), Paramparagat Krishi Vikas Yojana (PKVY), Mission Organic Value Chain Development in Northeastern Region (MOVCDNER) and Per Drop More Crop. In addition to aforementioned programmes under NMSA, restructured National Bamboo Mission (NBM) was launched in April 2018.

Indian Council of Agricultural Research (ICAR) under Ministry of Agriculture and Farmers Welfare, Government of India has launched a flagship network project namely National Innovations in Climate Resilient Agriculture (NICRA) to promote climate resilient agricultural practices. NICRA project is a multi-sectoral, multi-location program carrying the major mandate of addressing climate change and variability and addressing range of

stake holders need across the country. Research, demonstration, and capacity building are the three major components, besides providing policy briefs on several aspects related to agriculture and climate change.

The salient achievements of ICAR on climate resilient agriculture includes the following:

In total, 1888 climate resilient crop varieties have been developed including:

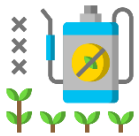
891	319	338	103	182	45	10
Cereals	**Oilseeds**	**Pulses**	**Forage crops**	**Fibre crops**	**Sugar crops**	**Other crops**

Participatory technology development of climate resilient practices has been undertaken involving farmers in risk assessment, demonstration, and adaptation techniques in:

151	2.13 Lac	454	2.36 Lac
Clusters	**Household Footprints**	**Villages Covered**	**Land Hectares**

During 2014 – 2023.

68	454	15857
Climate Resilient Technologies	**Villages Demonstrated**	**Farmers' Field Covered**



Biocontrol Agents, Biopesticides and Biofertilizers documented & circulated are:

88	31	41
Biocontrol Agents	**Biopesticides**	**Biofertilizers**

Drip fertigation schedules for 35 crops and cropping systems for achieving higher water and nutrient use efficiency have been standardized.

District Agriculture Contingency Plans (DACPs) developed for:

650
Districts

Source: [Rajya Sabha Question 190]

Governance on Climate Change Adaptation & Mitigation

The Food and Agriculture Organization (FAO) of the United Nations plays a significant role in addressing climate change, particularly in the context of agriculture and food security. The FAO is involved in various mechanisms related to governance on climate change adaptation and mitigation.

Here are some key aspects of FAO's involvement in governance on climate change adaptation and mitigation:

					
Planning and Policy Making	**System-Wide Capacity Development & Technical Support**	**Environmental Market-Based Instruments**	**Climate Risk-Based Instruments**	**Voluntary Instruments**	**Monitoring Strategies**
Integrate climate change mitigation, adaptation, and disaster risk reduction, into national, regional, and local policy strategies, plans and investments. Ensure alignment of environmental policies and investments across global, regional, national, and sub-national levels.	Strengthen vertical and horizontal coordination mechanisms across national and sub-national levels to streamline climate resilient practices. Provide operational guidance and technical support with policy interventions, and coordination mechanisms. Ensure transparency in spending, investments, and revenues.	Engage national and international climate investments, public and private funds for climate adaptation and mitigation. Support environmental taxation and charges on specific activities along with climate insurance schemes to improve resilience among farming, agro-forestry, and fishing communities	Ensure direct involvement of climate/meteorological/agronomic experts, researchers, and institutions in the decision-making process. Deliver climate and weather information services tailored to end users' needs and according to their level of exposure, vulnerability, and adaptive capacity.	Promote certification procedures: sustainable and ecological labels, certifications, and standards. Promote reward systems for good environmental practices. Promote voluntary agreements and partnerships between public and private sector.	Monitor the environmental, social, sanitary, and economic sustainability of the project and relative impacts. Use a combination of long-term climate projections and short-term weather monitoring to ensure both robustness and flexibility of the project.

Source: FAO Climate Resilient Practices

Climate Resilient Technologies stand as the vanguard in shaping a sustainable future for our planet. By harnessing innovation and scientific advancements, we have the power to mitigate the impacts of climate change and foster resilience in the face of environmental challenges. These pioneering technologies not only address the urgent need for sustainability but also represent a beacon of hope for future generations. As we continue to embrace and refine these solutions, we embark on a journey towards a more resilient, eco-friendly, and harmonious coexistence with our planet. Let these strides in technology inspire collective action, as we pave the way for a greener, more sustainable world.

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