

SukhaRakshak AI - Anticipatory Drought Intelligence for India

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Key messages

1. India's heavy dependence on monsoon rainfall exposes nearly 68% of cultivated land to drought risk, threatening livelihoods of over 100 million smallholder farmers. Historical droughts (e.g., 1987, 2002, 2015–16) led to double-digit food grain losses and GDP contractions, highlighting the systemic vulnerability of India's agrarian economy.
2. Despite an extensive institutional network (India Meteorological Department (IMD), National Disaster Management Authority (NDMA), Central Water Commission (CWC), Ministry of Agriculture and Farmers Welfare (MoA&FW)), India's drought response remains largely reactive and relief-oriented. Existing systems emphasize post-impact compensation rather than anticipatory mitigation, constrained by data fragmentation, slow coordination, and limited localization of advisories.
3. Rising temperatures, erratic monsoons, and increased evapotranspiration are intensifying the frequency and severity of drought events. IPCC projections for South Asia warn of escalating agricultural droughts, heightening risks to food security, farm incomes, and rural migration pressures.
4. The South Asia Drought Monitoring System (SADMS), developed by IWMI in collaboration with Indian Council of Agricultural Research (ICAR), provided a regional foundation for drought tracking. However, its macro-level monitoring lacked field connectivity. SukhaRakshak AI builds on this legacy—linking early warning with localized, actionable, and language-inclusive advisories for farmers and district authorities.
5. SukhaRakshak AI marks a paradigm shift from relief to resilience, integrating AI, satellite data, multi-scale forecasts, and contingency plans into one intelligent platform. It delivers hyper-local, predictive advisories in 22 Indian languages, empowering farmers and policymakers to anticipate, act, and adapt—transforming drought management into a proactive, data-driven enterprise.

1. Introduction

Droughts are among the most devastating slow-onset disasters worldwide, causing wide-ranging social, economic, and environmental damage. In India, droughts pose a persistent threat due to the country's heavy reliance on monsoon rainfall and its large agrarian economy. Approximately 68% of India's cultivated area is drought-prone, exposing millions of farming families to periodic water scarcity, crop failures, and income losses (Bahinipati 2020; Taha 2021).

Historically, India has faced major droughts in 1965–1967, 1979, 1987, 2002, 2009, and 2015–2016 — each leading to substantial agricultural production losses and food insecurity. For example, the 1987 drought reduced national agricultural GDP by nearly 2% and cut food grain production by over 10 million tons. Similarly, in 2002, food grain output dropped by about 29 million tons, severely affecting rural livelihoods (Gupta et al. 2011).

Smallholder farmers, who make up over 80% of India's farming community, are particularly vulnerable. Limited access to irrigation, formal credit, crop insurance, and adaptive technologies leaves them disproportionately affected by rainfall variability and prolonged dry spells. Fragmented landholdings and weak market linkages further restrict their capacity to adapt.

While India's institutional architecture for drought management includes the Ministry of Agriculture and Farmers' Welfare, the India Meteorological Department (IMD), the Central Water Commission, and the National Disaster Management Authority (NDMA), existing systems often emphasize relief rather than prevention. Delays and coordination gaps (Wilhite 2003) hinder timely action, with efforts largely focused on crisis response such as compensation payments and emergency water supply rather than proactive mitigation (Wilhite et al. 2005).

Climate change is intensifying drought risks, leading to more frequent and severe rainfall deficits, rising temperatures, and erratic monsoon patterns. The IPCC projects an increase in agricultural drought frequency in South Asia, threatening food security and pushing farmers deeper into debt and distress migration.

In response, SukhaRakshak AI ("Drought Protector") emerges as India's first integrated, AI-powered drought advisory system. It combines advanced artificial intelligence, satellite-based earth observation data, multi-scale forecasts, and localized contingency plans to deliver actionable insights in local languages. By bridging early warning and early action, SukhaRakshak AI empowers farmers, extension officers, and drought managers to anticipate droughts and take proactive measures — marking a decisive shift from relief to resilience.

Building on Regional Foundations: The Role of SADMS

The South Asia Drought Monitoring System (SADMS), developed in 2016 with ICAR and regional partners, laid a strong foundation for drought risk monitoring. SADMS integrates meteorological and satellite data, providing real-time regional updates using indices like the Integrated Drought Severity Index (IDSI) and Standardized Precipitation Index (SPI).

Governments across South Asia have used SADMS to inform drought declarations and guide relief planning.

However, SADMS primarily supports macro-level monitoring and lacks direct connection to localized action and advisories. Farmers and district officials often struggle to translate regional signals into field-level decisions. Recognizing this, India has moved toward systems that connect early warning to immediate local action — leading to the evolution of SukhaRakshak AI as a hyper-local, farmer-centric solution.²

2. Rationale for an AI-Driven Drought Solution

- **Escalating Drought Risks:** Enhancing decision-making through scenario planning, climate analytics, and forward-looking risk assessments.
- **Gaps in Existing Systems:** Current tools largely focus on observation, not prediction, and require multiple approvals before advisories reach farmers. Language barriers limited digital literacy, and lack of personalized information further constrain effectiveness.

3. Vision and Mission

SukhaRakshak AI represents a shift from reactive relief to anticipatory risk reduction. It empowers stakeholders with predictive insights to make timely decisions before drought impacts escalate, fostering a proactive culture of resilience in Indian agriculture.

4. System Architecture and Core Components

4.1 Foundation Model and Data Sources

- **AI Innovations Powering SukhaRakshak AI:** SukhaRakshak AI integrates advanced artificial intelligence and cloud-native technologies to deliver anticipatory, localized drought intelligence across India. The system ingests multi-source data, including weather and seasonal forecasts, earth observation imagery, and standardized drought manuals and contingency plans. These inputs are processed through the South Asia Drought Management System (SADMS), developed by IWMI, which generates near real-time regional drought risk assessments (Figure 1). A core innovation is the use of a vector database (Qdrant) combined with retrieval-augmented generation (RAG) powered by Gemini AI models. This hybrid architecture enables dynamic query handling, contextual advisory generation, and real-time data fusion. Drought intelligence outputs are further personalized through AI4Bharat and Sarvam, an advanced native language model suite that supports more than 22 Indian languages. Integrated APIs (e.g., FastAPI), scalable cloud infrastructure (AWS, Docker), and geospatial engines (Google Earth Engine) ensure high availability, rapid processing, and georeferenced outputs.

Through this AI-driven pipeline, SukhaRakshak AI delivers actionable, location-specific advisories directly to farmers, extension officers, and government officials. This empowers communities to anticipate, act, and adapt — transforming drought management from reactive relief to proactive resilience.

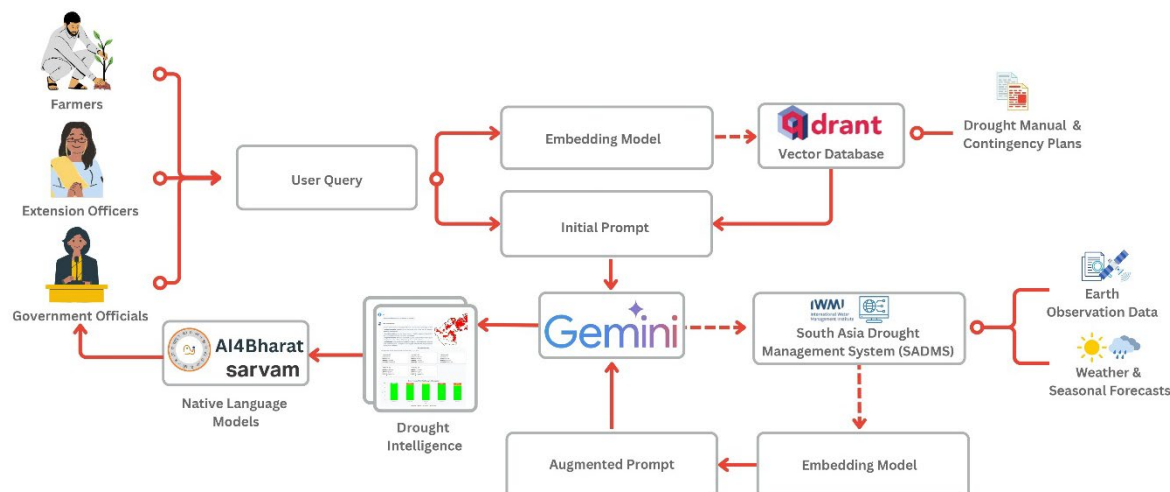


Figure 1: SukhaRakshak AI Architecture for drought intelligence

Seasonal and sub-seasonal forecasts: These forecasts are critical for providing an early outlook on rainfall and temperature anomalies, usually ranging from 1 week to up to 4 weeks ahead.

- **Source models:** Global and regional climate prediction models, including outputs from IMD, ECMWF (European Centre for Medium-Range Weather Forecasts), and NCEP (National Centers for Environmental Prediction).
- **Purpose:** To estimate potential onset of dry spells or delayed monsoon phases that could impact sowing and water availability decisions.
- **Practical application:** Guides pre-season advisories, supports planning of short-duration or drought-tolerant crop varieties, and informs community-level water storage or rainwater harvesting measures before the actual stress period begins.
- **Integration:** Feeds into SukhaRakshak AI's predictive engine to develop risk probabilities for different districts, enabling a lead time advantage for both farmers and planners.

Short-term weather forecasts (up to 10-day): These high-resolution forecasts are used to fine-tune immediate drought onset and progression signals.

- **Source:** Weather prediction centers like IMD, state-level meteorological agencies, and numerical weather prediction models (e.g., WRF, GFS).
- **Purpose:** To confirm or adjust the signals from longer-range seasonal forecasts and to inform near-term agricultural operations such as irrigation scheduling, weeding, or fertilizer application.
- **Practical application:** Farmers receive daily or weekly updates on the likelihood of rainfall or heat stress, allowing them to make quick, practical field-level decisions.
- **Integration:** Combined with the seasonal and sub-seasonal signals to refine short-term drought alerts, ensuring more dynamic and actionable advisories.

South Asia Drought Monitoring System (SADMS): SADMS provides real-time drought severity and spread assessments across South Asia.

- **Data components:** Meteorological data (rainfall deficits), satellite-based vegetation and soil moisture indicators, and ground validation inputs from national networks.
- **Purpose:** To offer spatially explicit maps showing emerging and ongoing drought hotspots, updated bi-weekly or monthly.
- **Practical application:** Supports district-level and national authorities in making official drought declarations and planning targeted interventions (e.g., fodder camps, drinking water arrangements).
- **Integration:** The SADMS outputs form a core layer in SukhaRakshak AI's drought risk detection engine, acting as an operational trigger for activating agriculture contingency plans.

Satellite Earth Observation (EO) Indices: These indices provide detailed, near real-time monitoring of land and vegetation health conditions.

- **NDVI (Normalized Difference Vegetation Index):** Measures plant greenness and vigor; indicates vegetation stress even before visible wilting.
- **VCI (Vegetation Condition Index):** Normalizes NDVI values against long-term records to show relative vegetation health status; crucial for comparing across seasons and years.
- **SPI (Standardized Precipitation Index):** Measures precipitation anomaly over different time scales (1–12 months); key for identifying meteorological drought onset and intensity.
- **SMCI (Soil Moisture Condition Index):** Reflects the relative soil water availability for plant growth; integrates satellite soil moisture datasets (e.g., SMAP, Sentinel-1).
- **Purpose:** To monitor the real-time physiological state of crops and natural vegetation, detect early signs of agricultural drought, and map regional water stress patterns.
- **Practical application:** Helps farmers decide on supplemental irrigation, choose re-sowing options, or apply protective measures (e.g., mulching or staggered irrigation).
- **Integration:** The EO indices are ingested into the AI model to validate and cross-check drought predictions, enhancing the robustness of advisories and confidence levels.

4.2 Drought Detection and Trigger Engine

This component is the analytical brain of SukhaRakshak AI, responsible for converting raw data into actionable drought alerts.

- **Predictive Modeling Core:** Uses advanced machine learning architectures (transformer-based models and LSTM time-series networks). These are trained on 20+ years of historical meteorological and drought event data, allowing the system to learn complex non-linear relationships between weather patterns, soil moisture, and vegetation health.
- **Threshold Calibration:** Follows the Government of India Drought Manual, which includes criteria for meteorological, agricultural, and hydrological drought classification. The engine automates the matching of predicted drought signals with official thresholds to reduce subjectivity and improve consistency.
- **Dynamic Hotspot Mapping:** Generates high-resolution risk maps at sub-district levels. It factors in crop calendars, local cropping patterns, and water infrastructure data to assess potential impact zones more precisely.

- **Trigger Alerts:** Issues alerts at progressive severity levels (watch, warning, alert) depending on forecast accuracy and confidence levels. These triggers activate contingency plan modules and prepare advisory content.
- **Validation Mechanism:** Continuously cross-checks forecasts against real-time EO indices and field observations. This adaptive learning loop improves forecast reliability over time.

4.3 Agriculture Contingency Integration

The backbone of actionable response, integrating contingency plans directly into the advisory chain.

- **District Agriculture Contingency Plans (DACP):** These pre-developed plans specify drought mitigation options tailored for each agro-ecological zone, including recommended crop varieties, staggered planting schedules, alternate sowing dates, and input packages.
- **Livestock and Fisheries Measures:** Advisories include strategies for reducing livestock feed deficits, alternative fodder cropping, emergency drinking water sources, and measures for pond and tank water conservation to protect aquaculture livelihoods.
- **Input Supply Linkages:** Proposed to connect with supply chain data and local government schemes to inform farmers about the availability of seeds, fodder kits, water harvesting tools, and other drought-resilient inputs.
- **Market Integration:** Proposed to integrate with price and procurement systems, allowing farmers to plan marketing strategies in case of partial crop failures or reduced yield forecasts, thus reducing economic losses.
- **Operationalization:** During the “watch” stage, the engine pre-populates advisory drafts. As risk escalates to “warning” or “alert,” the system pushes these measures dynamically to farmers and extension officers for immediate field-level action.

4.4 Localized Advisory Generation: AI4Bharat and Sarvam Integration

An essential component to ensure inclusivity, cultural relevance, and last-mile reach.

- **Language Coverage:** Offers both text and voice outputs, including IVR calls for areas with low smartphone penetration and limited literacy. This multimodal strategy ensures every user segment can understand and act on advisories.
- **Communication Modes:** Offers both text and voice outputs, including IVR calls for areas with low smartphone penetration and limited literacy. This multimodal strategy ensures every user segment can understand and act on advisories.
- **Context Adaptation:** Uses retrieval-augmented generation (RAG) to personalize advisories, pulling from contingency plans and real-time forecast data to answer specific farmer questions such as “What crop should I shift to if rainfall is delayed by two weeks?” or “How can I conserve water for my livestock in August?”

- **Feedback Loop:** Farmers and extension officers can provide feedback via the app or IVR, which is analyzed using sentiment analysis and query clustering to continuously improve advisory relevance and trust.
- **Empowerment Focus:** Shifts from one-way information delivery to two-way engagement, encouraging proactive decision-making rather than passive waiting for relief.

4.5 Delivery Channels

Reaching different user groups through diverse, accessible mediums. The below last-mile delivery channels are proposed for national partners to leverage in the existing initiatives or build a robust AI-enabled communication framework to operationalize at sub-national level.

- **Mobile App:** Core interface for smartphone users, including dashboards with risk maps, recommended actions, and dynamic FAQs.
- **WhatsApp Bot:** Leveraging widespread adoption of WhatsApp to provide push notifications, quick query resolution, and guided advisory menus.
- **SMS Broadcasts:** Simple text-based alerts to reach basic phone users, focusing on short, actionable advice.
- **Interactive Voice Response (IVR):** Automated call system allowing farmers to listen to advisories, request specific information, or record questions for follow-up.
- **Web Portals:** Tailored for extension officers and district managers, enabling area-wide risk assessments, monitoring adoption rates, and planning logistics (e.g., seed distribution schedules).
- **Community Radio Templates:** Pre-scripted content packages that local radio stations can broadcast, facilitating mass outreach in remote areas.

5. Use Cases and Stakeholder Benefits — Expanded

5.1 Farmers

- **Early Crop Decision Support:** Farmers receive guidance on shifting to short-duration or drought-resistant varieties before critical planting windows close, reducing potential total crop failure.
- **Water Resource Optimization:** Advisories include water-saving tips, such as mulching, micro-irrigation scheduling, and community water tank use prioritization.
- **Livestock Protection:** Advisories inform about alternate fodder crops, emergency grazing protocols, and locations of government-supported fodder banks.
- **Financial Planning:** Timely yield forecast warnings allow farmers to adjust input investments, manage credit repayment schedules, and consider risk transfer options like weather-based crop insurance.
- **Mental Health and Well-being:** Reducing uncertainty and providing actionable advice improves confidence and reduces distress among smallholders.

5.2 Extension Officers

- **Unified Messaging:** Reduces confusion from multiple advisories by providing standardized, evidence-based messages aligned with national and state guidelines.
- **Geo-Referenced Prioritization:** Maps highlight high-risk villages, allowing officers to prioritize field visits and community meetings strategically.
- **On-the-Spot Support:** Officers can use the AI-powered dashboard to instantly respond to farmer questions during village meetings, strengthening trust and credibility.
- **Training Integration:** Visual tools and simplified modules help train other frontline workers (e.g., panchayat representatives, SHG leaders).

5.3 Drought Managers and Policy Makers

- **Proactive Resource Allocation:** Early hotspot detection enables timely mobilization of water tankers, fodder supplies, and relief materials before situations escalate.
- **Monitoring and Evaluation:** Dashboards provide metrics on advisory reach, farmer adoption rates, and local preparedness levels, aiding transparent governance.
- **Insurance Linkages:** Supports automatic activation of area-yield insurance schemes and facilitates data-driven loss assessment.
- **Policy Development:** Real-time insights help refine long-term drought preparedness strategies and inform updates to contingency plans and resource budgeting.

5.4 Research and Development Organizations

- **Data-Driven Insights:** Access to high-resolution drought predictions and field-level feedback supports research on climate impacts and adaptation strategies.
- **Innovation Testing:** New drought-tolerant technologies, agronomic practices, and risk financing models can be tested and scaled faster using SukhaRakshak AI as a deployment platform.
- **Collaboration Platform:** Facilitates partnerships across academic institutions, NGOs, and startups focused on climate-smart agriculture and disaster risk reduction.

6. Innovations and Technical Advancements

6.1 AI-Based Predictive Modeling

- **Hybrid Learning Framework:** Combines historical drought data with real-time forecasts to capture both statistical patterns and dynamic shifts in climate behavior.
- **Continuous Model Refinement:** Uses live field observations (e.g., crop phenology from extension staff, rainfall data from local gauges) to fine-tune model accuracy, enhancing trust and effectiveness.
- **Explainable AI (XAI) Modules:** Generates simplified visual explanations and confidence scores so that extension officers and policymakers can understand why a particular alert was issued, supporting transparency and accountability.

6.2 Integration of Traditional Knowledge

- **Local Indicators:** Incorporates indigenous forecasting signals, such as changes in flowering or animal migration, validated against scientific data to enhance cultural resonance.
- **Behavioral Adoption:** Farmers are more likely to act when advisories align with familiar, traditional signs — creating a bridge between modern science and community wisdom.
- **Documentation and Scaling:** SukhaRakshak AI also provides a platform to systematically document and analyze traditional knowledge for broader policy integration.

6.3 Inclusive Design and Co-Creation

- **Stakeholder Workshops:** Conducted with farmer groups, panchayats, and women's self-help groups to design interfaces and shape message formats.
- **Gender and Social Inclusion Analysis:** Tailors content for women farmers and marginalized communities who often have different information needs and access barriers.
- **Behavior Change Communication (BCC):** Integrated strategies such as storytelling, community champions, and visual aids to promote proactive behavior beyond just receiving alerts.

7. Roadmap for Scaling and Replication

7.1 India-Wide Scale-Up

After initial piloting and demonstration phases, SukhaRakshak AI aims to systematically expand to **all drought-prone states and regions** across India. This includes arid and semi-arid states such as Rajasthan, Gujarat, Maharashtra, Telangana, Karnataka, Tamil Nadu, Andhra Pradesh, and parts of Odisha and Jharkhand, among others.

Key strategies for nationwide expansion include:

- **Integration with state-specific contingency plans:** Each state has its own unique cropping systems, agro-ecological zones, and local adaptation practices. SukhaRakshak AI will be configured to incorporate **state-level agriculture contingency plans** and drought codes to ensure relevance and practical adoption.
- **Partnership with State Agriculture Departments:** These departments play a central role in scaling advisories, mobilizing input supplies (e.g., seeds, fodder), and coordinating extension services. Embedding SukhaRakshak AI within state-led programs will accelerate institutionalization and mainstreaming.
- **Collaboration with NDMA and National Agriculture Disaster Management Framework:** This ensures alignment with national drought declaration protocols, financing mechanisms (such as the National Disaster Response Fund), and integration with national-level early warning dissemination networks.

- **Capacity building:** Large-scale training programs will be conducted for extension officers, Krishi Vigyan Kendras (KVKs), panchayat leaders, and community-based organizations to promote effective last-mile delivery and ensure local ownership.
- **Localization and customization:** The advisory content and delivery interfaces will be adapted to local dialects, community cultural preferences, and traditional knowledge systems to foster trust and higher adoption rates.

7.2 Regional Adaptation

Beyond India, SukhaRakshak AI's architecture is intentionally designed to be **modular and adaptable** to different geographies and governance contexts across South Asia and Africa. Many countries in these regions share similar challenges: high dependence on rain-fed agriculture, limited adaptive capacity of smallholder farmers, and gaps in anticipatory risk management.

Key components of regional adaptation include:

- **Data source customization:** Integrating local meteorological datasets (e.g., from national meteorological agencies), regional climate forecasts (e.g., RIMES, SAARC Meteorological Research Centre), and local satellite-based indices to calibrate the model for new environments.
- **Incorporating country-specific contingency frameworks:** Many South Asian and African countries have developed national or sub-national drought contingency plans, which can be integrated into the advisory logic of SukhaRakshak AI.
- **Language and cultural localization:** Advisory content will be translated into regional languages and refined to reflect cultural practices, cropping systems, and local risk perception.
- **Regional institutional partnerships:** Collaborating with organizations such as ICARDA, African Union Commission, national ministries of agriculture, and regional climate centers to build buy-in and ensure coordinated implementation.
- **Cross-learning and knowledge sharing:** Establishing regional communities of practice to share experiences, lessons learned, and continuous model improvements. This encourages peer-to-peer learning among governments, researchers, and farmer networks.

7.3 Integration with Other Hazards

Recognizing that farmers and rural communities face multiple, overlapping risks, future iterations of SukhaRakshak AI will be expanded into a multi-hazard risk advisory platform, creating a holistic climate and disaster resilience ecosystem.

Planned hazard integration includes:

- **Flood risk advisory:** Integrating real-time river flow data, flood forecast models (e.g., from Central Water Commission or global flood monitoring systems), and local vulnerability assessments to provide village-level flood advisories and evacuation planning support.
- **Heatwave monitoring:** Combining temperature forecasts, heat index calculations, and health vulnerability data to issue early warnings and behavioral advisories (e.g., livestock shading, hydration strategies, farm labor adjustments).

- **Pest and disease outbreaks:** Utilizing remote sensing and pest surveillance data to detect favorable conditions for pest proliferation (e.g., locusts, armyworm), and issuing integrated crop protection advisories.
- **Combined risk assessments:** Developing composite risk scores and dynamic dashboards that integrate drought, flood, heat, and pest alerts to guide comprehensive farm-level and district-level decisions.
- **Early action financing and insurance triggers:** By linking multi-hazard forecasts to parametric insurance schemes and risk-based financing mechanisms, SukhaRakshak AI can help unlock anticipatory finance, supporting proactive measures before losses occur.

8. Partnership Opportunities

Government Agencies

- Government agencies play a pivotal role in scaling, institutionalizing, and sustaining SukhaRakshak AI. Partnerships with central ministries, such as the Ministry of Agriculture and Farmers' Welfare, Ministry of Rural Development, Ministry of Jal Shakti (Water Resources), and National Disaster Management Authority (NDMA), ensure alignment with national policy frameworks and drought codes.
- At the state level, Agriculture Departments and State Disaster Management Authorities (SDMAs) can integrate SukhaRakshak AI into existing programs, such as Pradhan Mantri Fasal Bima Yojana (PMFBY), state contingency plans, and localized water conservation missions. By embedding the AI platform into government workflows, proactive drought preparedness measures can be mainstreamed into regular agricultural extension services, relief planning, and rural development schemes.
- Furthermore, local government bodies like panchayats and municipal councils can use SukhaRakshak AI dashboards to guide resource allocation, community-level water conservation drives, and emergency fodder and water distribution. Such partnerships strengthen decentralized governance and improve last-mile service delivery.

Private Sector (Agri-tech, Insurance, Input Supply Chains)

- The private sector is an essential partner for enhancing the financial sustainability and technological advancement of SukhaRakshak AI. Agri-tech companies can collaborate to integrate AI drought advisories into digital farming solutions, precision agriculture platforms, and decision-support apps that already reach millions of farmers.
- **Insurance providers**, particularly those offering index-based or weather-based crop insurance products, can leverage SukhaRakshak AI's early warnings to trigger risk-based payouts, reducing claim settlement delays and improving farmer trust. Additionally, the predictive capabilities enable insurers to design more accurate, data-driven insurance products tailored to localized drought risks.
- **Agri-input companies** (seeds, fertilizers, irrigation equipment) and supply chain actors (processors, aggregators, exporters) can use the forecasts to plan procurement, logistics, and input distribution schedules, minimizing disruptions and market volatility.

By collaborating with SukhaRakshak AI, private firms can enhance their corporate social responsibility (CSR) initiatives and contribute to building resilient supply chains.

Research Organizations and Academia

Partnerships with **universities, international research centers, and think tanks** are critical for continuous model refinement, validation, and adaptation to new scientific insights. Research institutions can contribute to:

- **Algorithm improvement:** Collaborating on refining AI models, incorporating new drought indicators, and integrating multi-hazard analytics.
- **Impact assessment:** Evaluating the effectiveness of anticipatory advisories on crop loss reduction, water use efficiency, farmer income stabilization, and social well-being.
- **Behavioral studies:** Analyzing how farmers and communities perceive and act on advisories, identifying adoption barriers, and informing behavioral change communication strategies.
- **Policy advocacy:** Generating evidence-based recommendations to inform national drought policy updates, resilience frameworks, and climate adaptation strategies.

Through joint pilot studies and field trials, research organizations help ground SukhaRakshak AI in robust scientific evidence, enhancing credibility and scalability.

Farmer Cooperatives, NGOs, and Civil Society Organizations

Farmer producer organizations (FPOs), cooperatives, NGOs, and local community-based organizations (CBOs) are vital connectors to smallholder farmers, especially marginalized and remote populations. These grassroots partners can facilitate:

- **Capacity building:** Conducting on-ground training sessions and demonstrations to help farmers understand and adopt advisories effectively.
- **Trust building:** Using existing social networks and relationships to overcome skepticism toward new technologies and bridge the trust gap.
- **Feedback channels:** Serving as community representatives to relay real-time feedback, indigenous knowledge, and local adaptation practices back into SukhaRakshak AI's learning loop.
- **Inclusivity promotion:** Ensuring that advisories are accessible to women farmers, tribal communities, and landless laborers who are often excluded from formal extension systems.
- **Community mobilization:** Supporting collective action for shared water resources, community fodder banks, or village-level drought mitigation infrastructures.

Through these partnerships, SukhaRakshak AI not only reaches more farmers but also fosters **social capital**, strengthening resilience at the community level.

Multilateral and International Development Agencies

Additionally, collaborations with multilateral organizations (such as FAO, WFP, UNDP, UNCCD, WMO, UN ITU, IFAD, World Bank, ADB) and global climate adaptation funds provide strategic opportunities for scaling, financing, and policy harmonization.

These agencies can help position SukhaRakshak AI as a regional or global public good, enabling replication in other drought-prone regions worldwide.

9. Global Relevance and SDG Alignment

SukhaRakshak AI directly advances multiple Sustainable Development Goals by strengthening climate-smart agriculture and resource management. It supports SDG 2 (Zero Hunger) by enabling resilient farming decisions that protect yields under drought stress; SDG 6 (Clean Water and Sanitation) by improving on-farm water use and conserving scarce water resources; SDG 13 (Climate Action) by enhancing early warning, preparedness, and adaptive capacity; and SDG 15 (Life on Land) by promoting practices that safeguard ecosystems and reduce land degradation.

10. Implementation Roadmap and Recommendations

To maximize SukhaRakshak AI's impact as India's first AI-powered drought preparedness system, several strategic enhancements are recommended across institutional, technical, and implementation domains.

- **Strengthen Institutional Anchoring and Governance:** Embed SukhaRakshak AI within national and state drought management frameworks—particularly NDMA, IMD, Ministry of Agriculture, and State Disaster Management Authorities—to ensure continuity, official recognition of alerts, and integration with drought codes and contingency plans. Establish a multi-agency steering mechanism for coordinated decision-making and rapid approval of advisories.
- **Enhance Data Ecosystem and Model Accuracy:** Deepen integration with national data systems (IMD forecasts, CWC hydrological data, state agricultural databases) and local ground observations to improve reliability and reduce uncertainty. Expand explainable AI (XAI) modules to increase transparency for policymakers and extension officers.
- **Accelerate Last-Mile Delivery and Inclusivity:** Invest in multi-channel dissemination—WhatsApp, IVR, SMS, community radio, and offline dashboards—to ensure access among low-literacy, low-connectivity populations. Strengthen gender and social inclusion features by customizing advisories for women farmers, tribal communities, and socioeconomically vulnerable groups.
- **Expand Contingency Planning and Early Action Protocols:** Operationalize district-level triggers linked to the Government of India Drought Manual. Automatically activate DACP recommendations and early response measures (e.g., seed distribution, livestock feed arrangements) based on severity thresholds. Integrate risk-financing instruments such as parametric insurance and anticipatory funds.

- **Invest in Capacity Building and Co-Creation:** Scale structured training for extension officers, KVKs, panchayats, and farmer groups on interpreting forecasts and acting on advisories. Promote iterative co-design with farmers, SHGs, and local organizations to increase adoption, trust, and behavioral change.
- **Build Strong Public–Private Partnerships:** Leverage partnerships with agri-tech firms, telecoms, insurers, and seed/input companies to expand reach, support financial sustainability, and mainstream drought-smart inputs. Enable insurers and supply-chain actors to use forecasts for risk pricing, logistics planning, and market stabilization.
- **Position SukhaRakshak AI as a Multi-Hazard Platform:** Gradually expand the system to include flood, heatwave, and pest/disease advisories, enabling a unified climate-risk intelligence platform i.e. Climate Smart Governance Dashboard for farmers and governments. Integrate hazard layers into a composite risk dashboard to support district planning and anticipatory action.
- **Enable Regional Replication and Global Public-Good Positioning:** Develop country adaptation modules for South Asia and Africa, focusing on localized data pipelines, language support, and integration with national contingency frameworks. Collaborate with FAO, UNDP, WMO, IFAD, and regional climate centers to scale the platform as a regional public good.
- **Integrate Monitoring, Evaluation, and Learning (MEL):** Establish an outcomes-focused MEL system measuring adoption, yield protection, water savings, risk reduction, insurance triggers, and socio-economic benefits. Use analytics and farmer feedback loops to continually refine models and advisory relevance.
- **Mobilize Sustainable Finance and Investment:** Align SukhaRakshak AI with climate adaptation finance from GCF, Adaptation Fund, multilateral banks, CSR budgets, and blended finance mechanisms. Prioritize investments in data infrastructure, local capacity building, and multi-hazard expansion to ensure long-term sustainability.

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