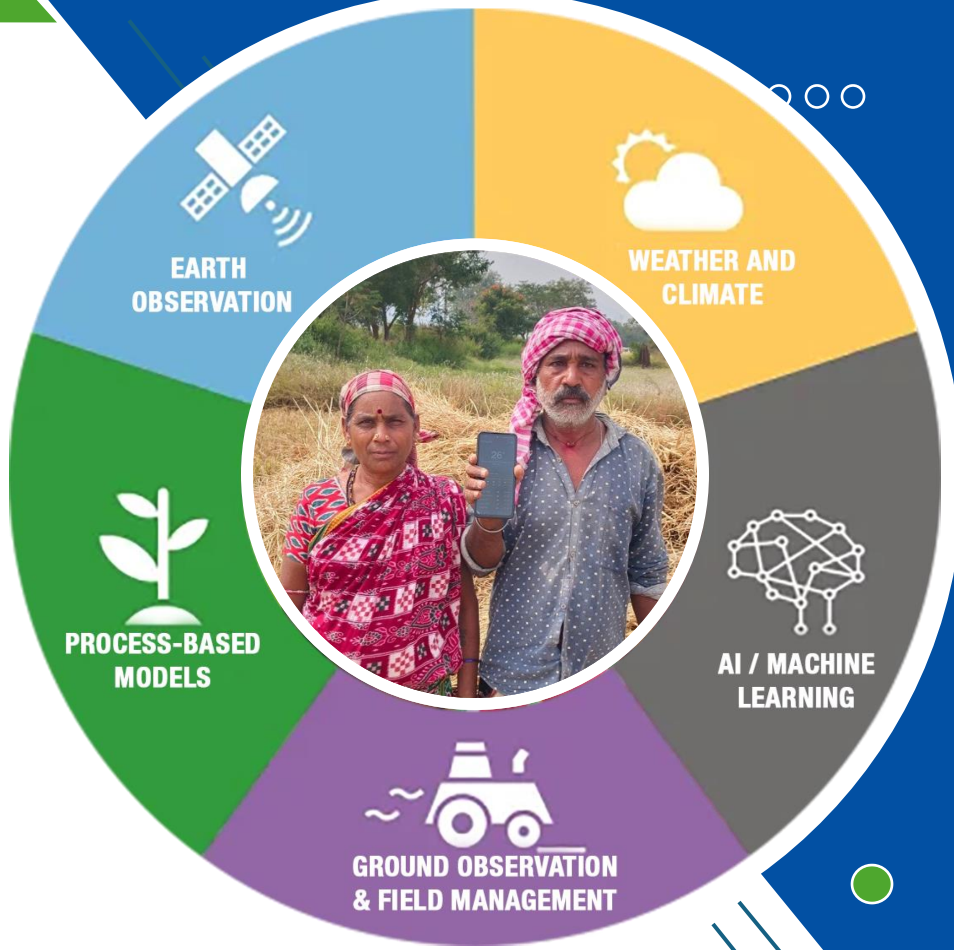
ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

CGIAR

DIGITAL TRANSFORMATION

CLIMATE ACTION

Building Climate Resilience in Agrifood Systems Through AI-Powered Agromet Advisory Services



Team ICRISAT

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Research Program-Enabling Systems Transformation

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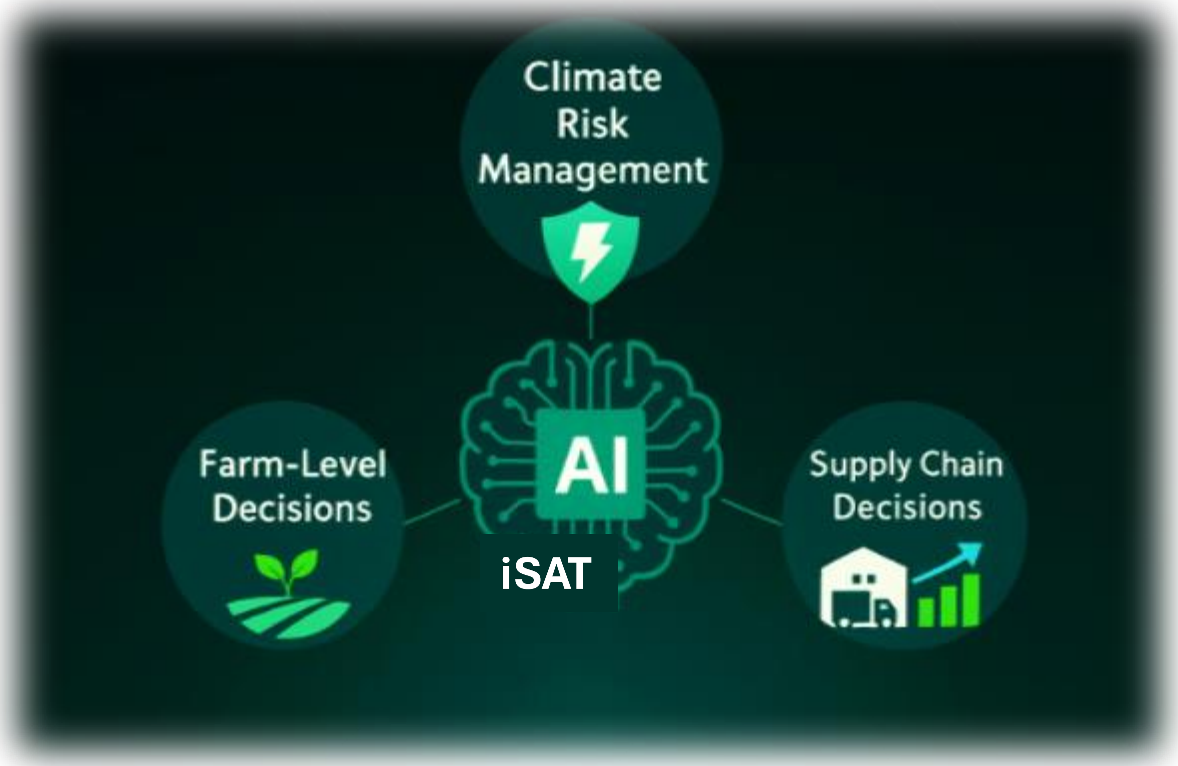
Lecture Series on Agrometeorology, South Asian Forum for Agricultural Meteorology (SAFOAM), 6 Sept 2025

Goal

Our goal is to transform the current agricultural advisory system into an **AI-powered**, data-driven platform that combines real-time weather analytics and crop data to deliver automated, hyperlocal, context-specific agro-advisories, empowering farmers with precise risk-management insights



Timely, Relevant, and Tailored to a Granular/Farm Scale

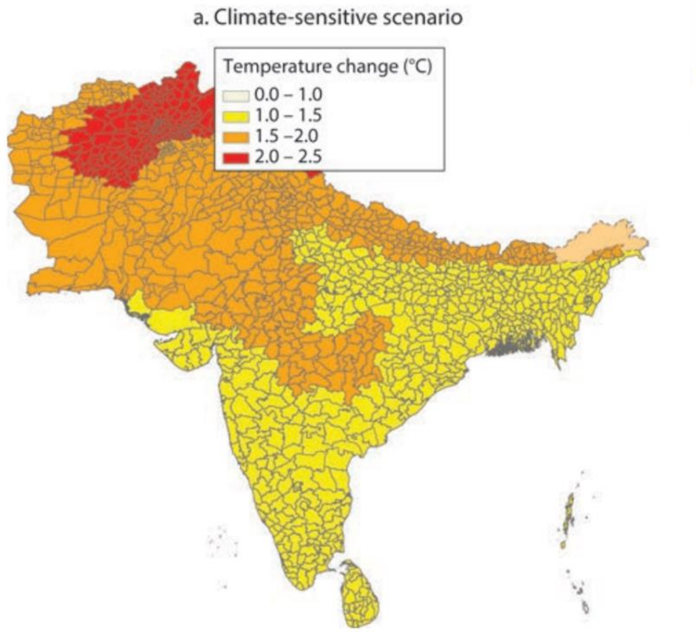
South Asia’s Climate Challenge

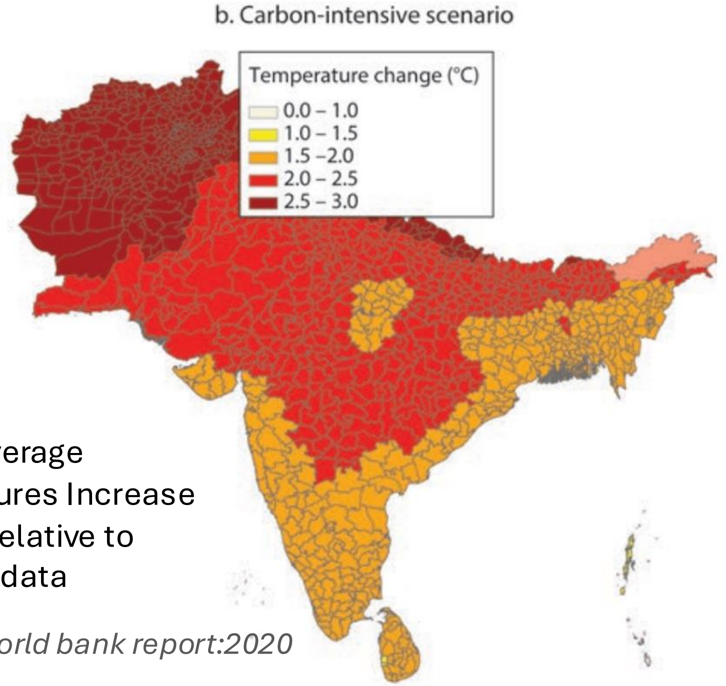
- **Extreme Weather:** Intensifying heatwaves, droughts, floods, and cyclones disrupting lives.
- **Geographical Risks:** Coastal deltas (e.g., Bangladesh) highly exposed; Maldives faces existential threats.
- **Himalayan Glaciers:** Melting glaciers undermine water, food, and energy security.
- **Urbanization:** Rapid growth in hazard-prone areas makes cities more fragile.
- **Population & Poverty:** Large poor population → higher exposure to climate shocks.
- **Climate-Induced Displacement:** Migration pressures from disasters and food insecurity.
- **Rainfed Agriculture:** Majority of farms depend on monsoon rainfall → highly vulnerable.

map indicating South Asian countries. Map not to scale.
(Source: Google Earth)

Pathways to Resilience

- **Climate-smart agriculture:** resilient crops, soil-water conservation, AI-Powered advisories
- **Renewable energy & green infrastructure** for low-carbon growth
- **Community-based adaptation:** Early warning systems & resilient farming as global models
- **Policy & governance:** Policies incentivising green economy, local coordination
- **International collaboration:** regional frameworks (e.g., SAFOAM), World Bank, CGIAR, IMD, WMO partnerships
- **Socio-economic transformation:** diversify livelihoods, invest in education & resilient infrastructure



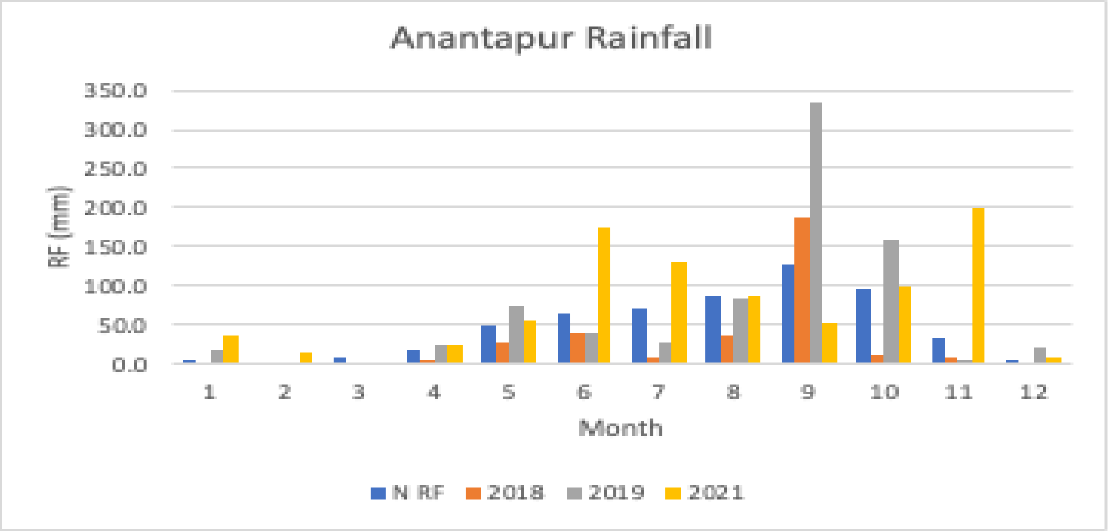


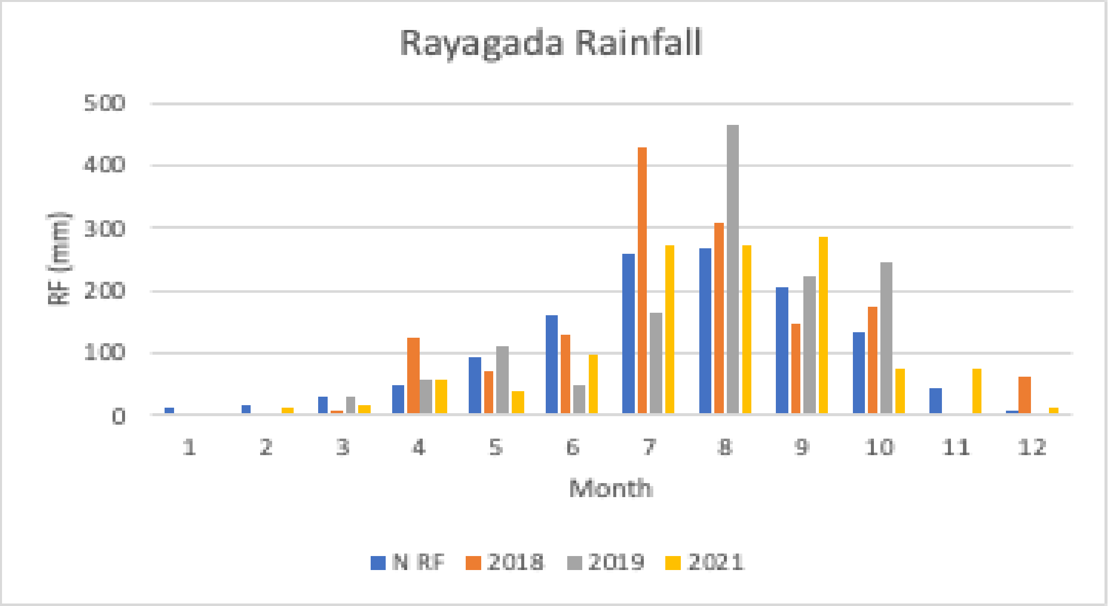
Annual Average Temperatures Increase by 2050 Relative to historical data

Source: World bank report:2020

Climate Variability and Uncertainty

- **SAT climate is highly variable**
- **Variability contributes to uncertainty and risk** that affects productivity and investments
- **In the absence of quality information, farmers rely on their own perceptions which may be biased**
- **Efficient management of risks calls for Informed decision making**





Climate Informed Agro-advisories Matters more for Rainfed Farmers?

- **Rainfed agriculture is climate-sensitive:** Rainfed crops depend entirely on weather conditions, making farmers vulnerable to changes in rainfall patterns, temperature fluctuations, and extreme weather events. (Deficit Rainfall, Excess rainfall, Unseasonal Rainfall, Dry-spells, High-Low Temperatures)

- Changes in weather patterns can have a significant impact on crop yields, making it crucial to have timely and accurate weather forecasts. (not only farmers but other VC actors as well)

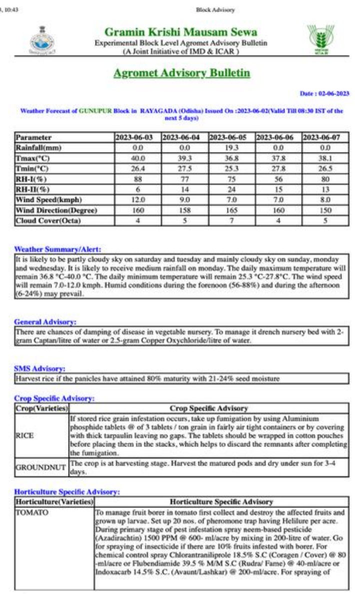
- Timely access to weather forecasts, **value-added agricultural advisories**, and **market information** can empower farming communities to address climate and market risks.

- Recent advances in **Climate models, ICTs, AI/ML** which makes possible to convert complex climate information into actionable advices can ensure that right actions are taken at the right time and last mile.

Current Advisory Systems – Gaps

- **Generic & District-Level Advisories**
  - Current existing advisory systems provide district-level advisories.
  - District Agro-Met Units (DAMUs) have been set up to strengthen outreach but shut down last year
  - Advisories often lack micro-level precision for block/village/farm.
- **Limited Localization**
  - Block- or village-level forecasts rarely used in operational advisories.
  - Farmers in rainfed and diverse agro-ecologies find them too broad.
- **Low Adoption by Farmers**
  - Technical & lengthy language; not always in local dialects.
  - Limited contextualization → poor relevance for crop stage or resource availability.
- **Need for Hyper-Local, Actionable Insights**
  - Farmers need when-to-sow, irrigate, fertilize type guidance.
  - Tailored advisories = higher trust, adoption, and resilience.

Example Screenshots illustrate instances where current systems deliver PDF bulletins and grouped messages, that fail to target the intended audience appropriately



10/07/2023, 10:43 Block Advisory

Gramin Krishi Mausam Sewa
Experimental Block Level Agromet Advisory Bulletin
(A Joint Initiative of IMD & ICAR)

Agromet Advisory Bulletin

Date : 02-06-2023

Weather Forecast of GUNUPUR Block in RAYAGADA (Odisha) Issued On :2023-06-02(Valid Till 08:30 IST of the next 5 days)

Parameter	2023-06-03	2023-06-04	2023-06-05	2023-06-06	2023-06-07
Rainfall(mm)	0.0	0.0	19.3	0.0	0.0
Tmax(°C)	40.0	39.3	36.8	37.8	38.1
Tmin(°C)	26.4	27.5	25.3	27.8	26.5
RH-I(%)	88	77	75	56	80
RH-II(%)	6	14	24	15	13
Wind Speed(kmph)	12.0	9.0	7.0	7.0	8.0
Wind Direction(Degree)	160	158	165	160	150
Cloud Cover(Octa)	4	5	7	4	5

Weather Summary/Alert:

It is likely to be partly cloudy sky on saturday and tuesday and mainly cloudy sky on sunday, monday and wednesday. It is likely to receive medium rainfall on monday. The daily maximum temperature will remain 36.8 °C-40.0 °C. The daily minimum temperature will remain 25.3 °C-27.8°C. The wind speed will remain 7.0-12.0 kmph. Humid conditions during the forenoon (56-88%) and during the afternoon (6-24%) may prevail.

General Advisory:

There are chances of damping of disease in vegetable nursery. To manage it drench nursery bed with 2-gram Captan/litre of water or 2.5-gram Copper Oxychloride/litre of water.

SMS Advisory:

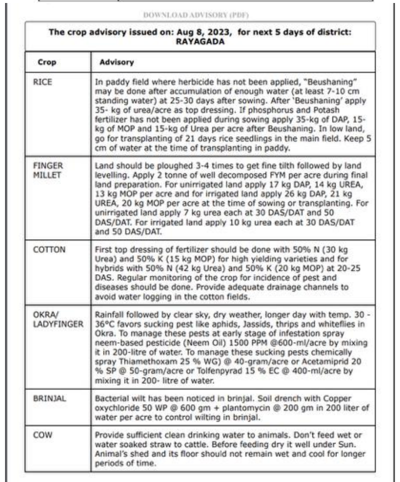
Harvest rice if the panicles have attained 80% maturity with 21-24% seed moisture

Crop Specific Advisory:

Crop(Varieties)	Crop Specific Advisory
RICE	If stored rice grain infestation occurs, take up fumigation by using Aluminium phosphide tablets @ of 3 tablets / ton grain in fairly air tight containers or by covering with thick tarpaulin leaving no gaps. The tablets should be wrapped in cotton pouches before placing them in the stacks, which helps to discard the remnants after completing the fumigation.
GROUNDNUT	The crop is at harvesting stage. Harvest the matured pods and dry under sun for 3-4 days.

Horticulture Specific Advisory:

Horticulture(Varieties)	Horticulture Specific Advisory
TOMATO	To manage fruit borer in tomato first collect and destroy the affected fruits and grown up larvae. Set up 20 nos. of pheromone trap having Helilure per acre. During primary stage of pest infestation spray neem-based pesticide (Azadirachtin) 1500 PPM @ 600- ml/acre by mixing in 200-litre of water. Go for spraying of insecticide if there are 10% fruits infested with borer. For chemical control spray Chlorantraniliprole 18.5% S.C (Coragen / Cover) @ 80 -ml/acre or Flubendiamide 39.5 % M/M S.C (Rudra/ Fame) @ 40-ml/acre or Indoxacarb 14.5% S.C. (Avaunt/Lashkar) @ 200-ml/acre. For spraying of



DOWNLOAD ADVISORY (PDF)

The crop advisory issued on: Aug 8, 2023, for next 5 days of district: RAYAGADA

Crop	Advisory
RICE	In paddy field where herbicide has not been applied, "Beushaning" may be done after accumulation of enough water (at least 7-10 cm standing water) at 25-30 days after sowing. After 'Beushaning' apply 35- kg of urea/acre as top dressing. If phosphorus and Potash fertilizer has not been applied during sowing apply 35-kg of DAP, 15-kg of MOP and 15-kg of Urea per acre after Beushaning. In low land, go for transplanting of 21 days rice seedlings in the main field. Keep 5 cm of water at the time of transplanting in paddy.
FINGER MILLET	Land should be ploughed 3-4 times to get fine tilth followed by land levelling. Apply 2 tonne of well decomposed FYM per acre during final land preparation. For unirrigated land apply 17 kg DAP, 14 kg UREA, 13 kg MOP per acre and for irrigated land apply 26 kg DAP, 21 kg UREA, 20 kg MOP per acre at the time of sowing or transplanting. For unirrigated land apply 7 kg urea each at 30 DAS/DAT and 50 DAS/DAT. For irrigated land apply 10 kg urea each at 30 DAS/DAT and 50 DAS/DAT.
COTTON	First top dressing of fertilizer should be done with 50% N (30 kg Urea) and 50% K (15 kg MOP) for high yielding varieties and for hybrids with 50% N (42 kg Urea) and 50% K (20 kg MOP) at 20-25 DAS. Regular monitoring of the crop for incidence of pest and diseases should be done. Provide adequate drainage channels to avoid water logging in the cotton fields.
OKRA/ LADYFINGER	Rainfall followed by clear sky, dry weather, longer day with temp. 30 - 36°C favors sucking pest like aphids, Jassids, thrips and whiteflies in Okra. To manage these pests at early stage of infestation spray neem-based pesticide (Neem Oil) 1500 PPM @600-ml/acre by mixing it in 200-litre of water. To manage these sucking pests chemically spray Thiamethoxam 25 % WG) @ 40-gram/acre or Acetamiprid 20 % SP @ 50-gram/acre or Tolfenpyrad 15 % EC @ 400-ml/acre by mixing it in 200- litre of water.
BRINJAL	Bacterial wilt has been noticed in brinjal. Soil drench with Copper oxychloride 50 WP @ 600 gm + plantomycin @ 200 gm in 200 liter of water per acre to control wilting in brinjal.
COW	Provide sufficient clean drinking water to animals. Don't feed wet or water soaked straw to cattle. Before feeding dry it well under Sun. Animal's shed and its floor should not remain wet and cool for longer periods of time.

Why AI & ML Matters for Agromet Advisories

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Transforming Dryland Agriculture

✓ Automation & Scale

- AI/ML can process vast climate and crop datasets in real time
- Reduces manual effort → faster, more frequent advisories

✓ Simplifies Complexity

- Translates forecasts and climate models into **clear farm-level actions**
- Guidance on *when to sow, irrigate, fertilize, or protect crops*

✓ Personalized & Inclusive

- Delivers advisories in **local languages** and at **crop-stage level**
- Enhances access for women and smallholders in rainfed systems

✓ Trust & Adoption

- Timely, relevant, context-specific messages → higher farmer adoption
- Moves from "forecast information" to **decision support**

ICRISAT's Innovation – NGCS & iSAT Platforms

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- Recognizing the gaps in current systems, ICRISAT and partners have developed two AI-driven digital platforms:

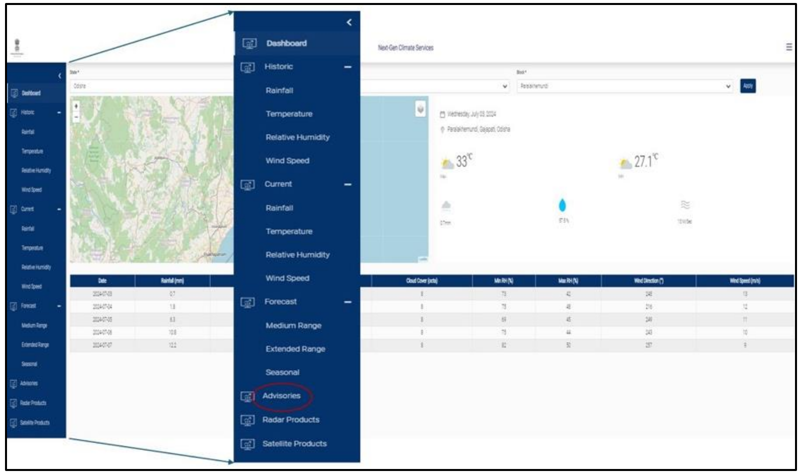
✓ **Next-Gen Climate Services Dashboard (NGCS)**

- Integrates climate data, weather forecasts, and spatial risk indices.
- Enables block-level analysis & visualization.

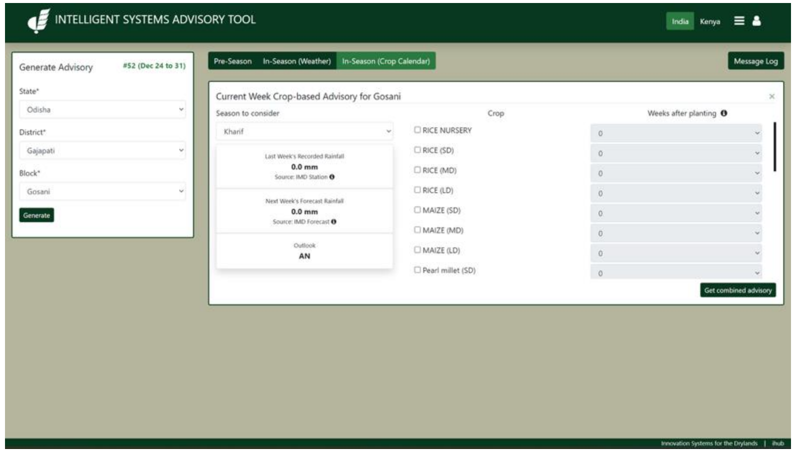
✓ **Intelligent Systems Advisory Tool (iSAT)**

- Automates pre-season & in-season decision trees
- Generates context-specific advisories to local cropping systems & sowing windows.

These AI-driven platforms together capable of analysing the location specific climate and weather understanding and generating, disseminating actionable farm advisories, delivered at scale.



Next-Gen Climate Analytical dashboard



ISAT platform

Next Gen Climate Dashboard– Understanding climate information

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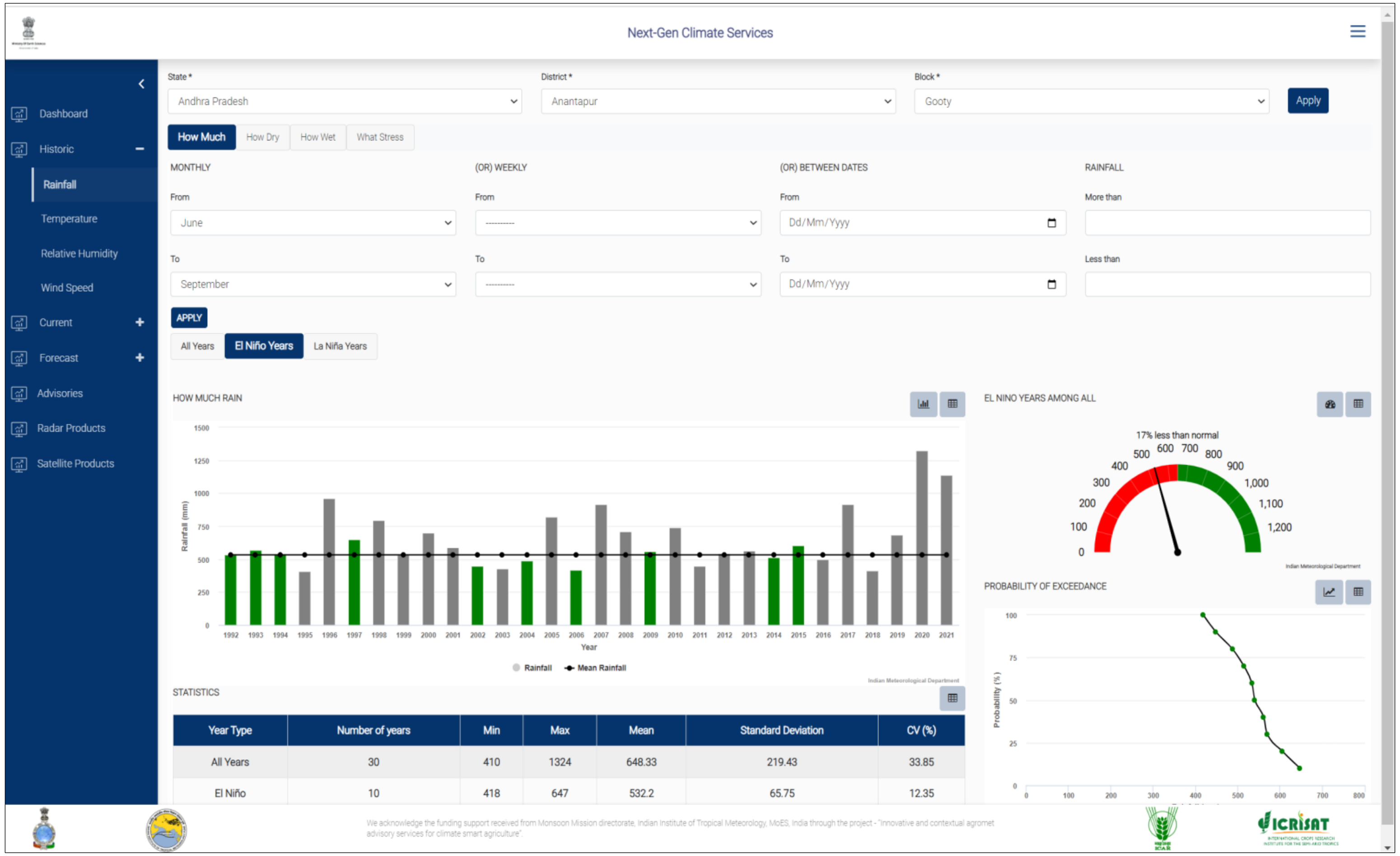
Number of ways to analyze and visualize the climate data

ICRISAT developed dashboard integrates most of these analyses integrating with ISAT for decision makers to use



http://65.0.242.164/ngn_india/#

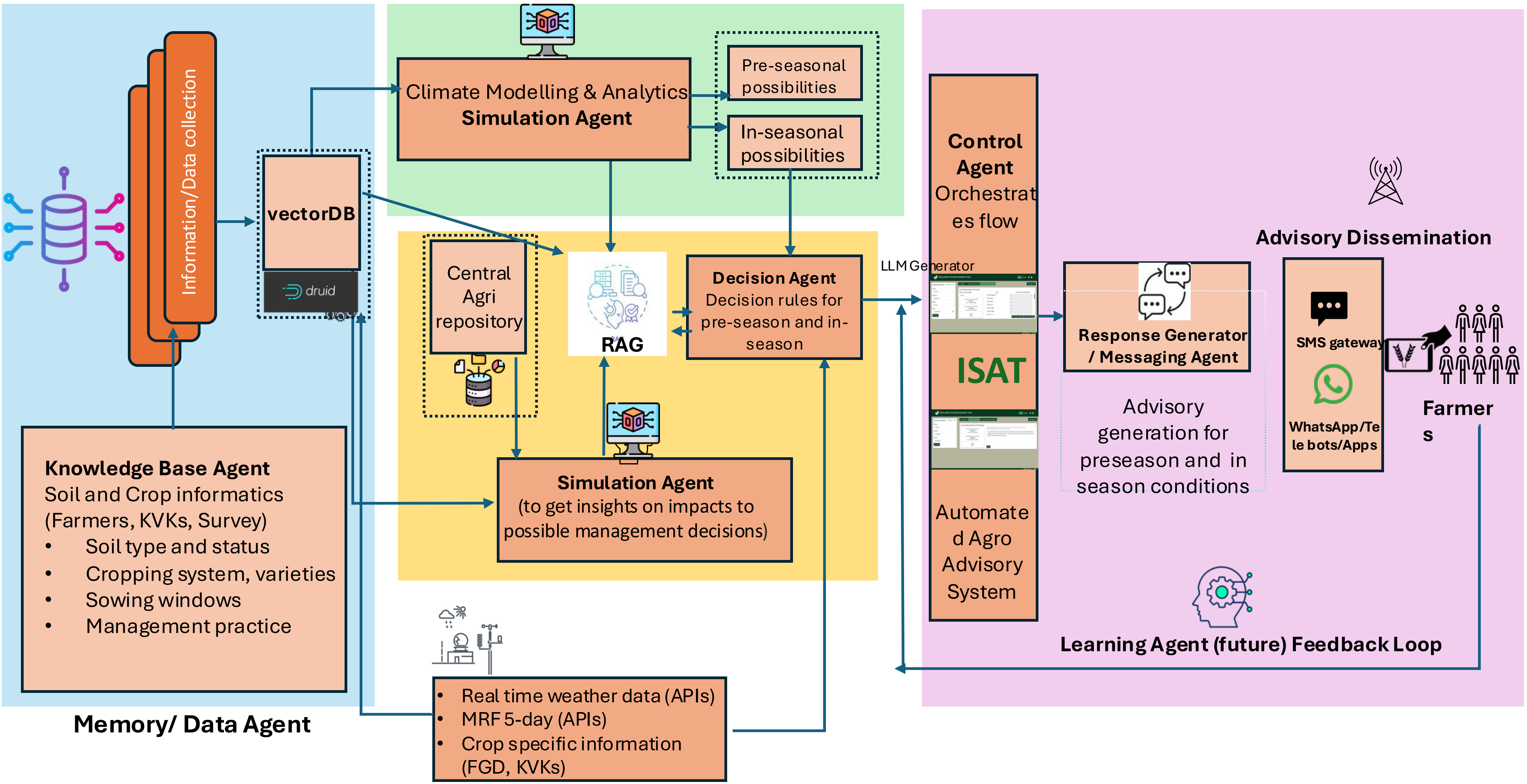
Climate information products

Product	Potential contribution	Pre-conditions for use
Long-term climate data	Understand risks and opportunities, strategic planning	Data quality and analytical skills
Seasonal climate forecasts	Anticipate and plan for the season	Reliability
Medium/short range forecasts	Tactical management by responding to weather conditions	Reliability and availability
Global patterns (El Nino/La Nina)	Anticipate and prepare	Ability to interpret and use

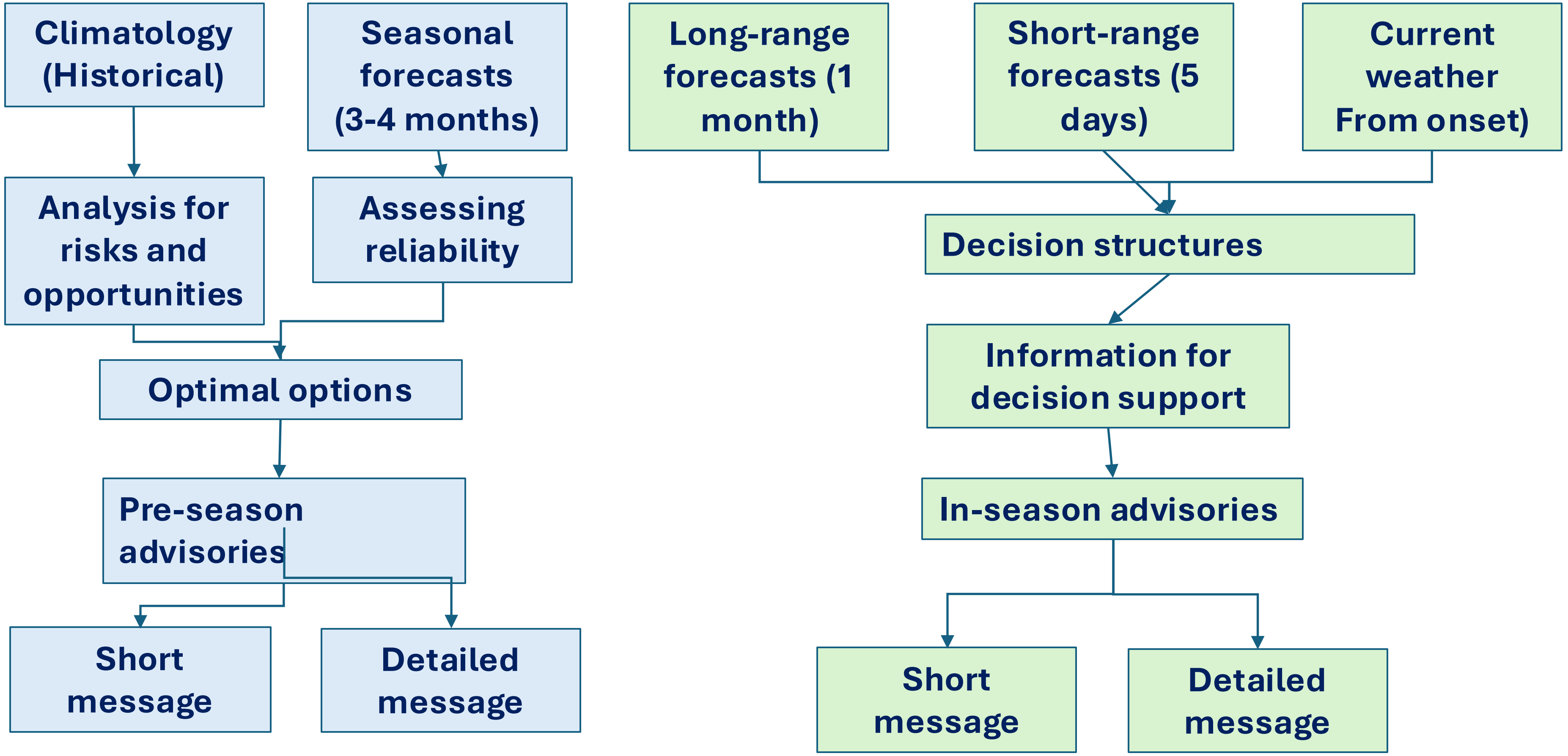
Anticipating conditions during the forthcoming season

- Seasonal, short and medium-range forecast
- The skill in prediction decreases with lead times
- ICRISAT team developed a robust methodology to assess the forecast skill and promote its use in farm level decision making
- ISAT is developed to integrate this information and generate and disseminate two types of advisories : Pre-season and In-season

iSAT – an Agentic AI Platform for Climate-Smart Agro-Advisories



Logic framework behind AI-based ISAT platform



Pre-seasonal logic

In-season logic

ISAT Advisories

Pre-season advisory

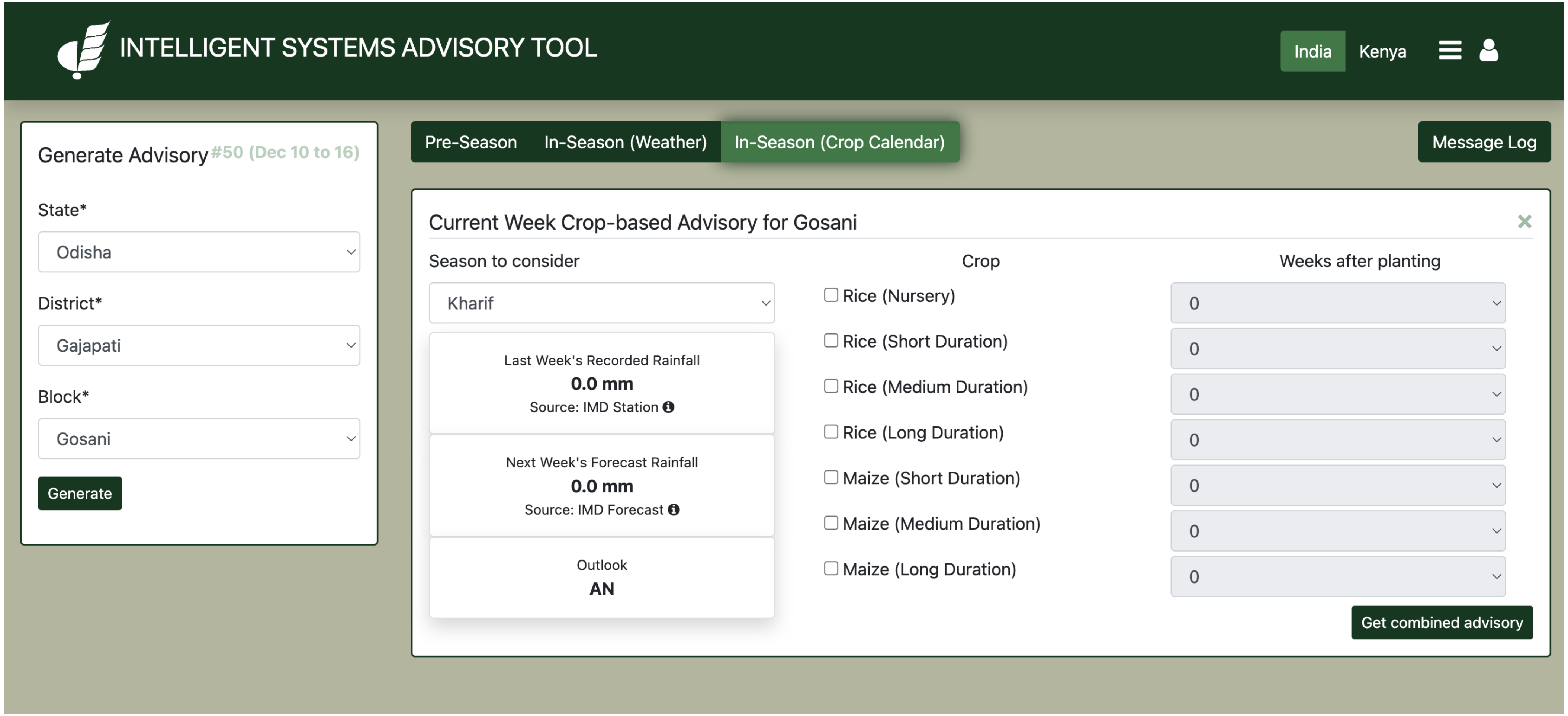
- Based on insights from historical climate data
- SCF
- El Nino/La Nina and other indicators
- Issued once soon after receiving SCF

In-season advisory

- Based on rainfall during the previous week and from the start of the season
- Considers short and medium-range forecasts
- Crop calendar
- Issued weekly after the pre-season advisory

https://isat.icrisat.org/

Intelligent Systems Advisory Tool (ISAT)



Screenshot of in-season (crop calendar)

ISAT-generated advisory with different format options

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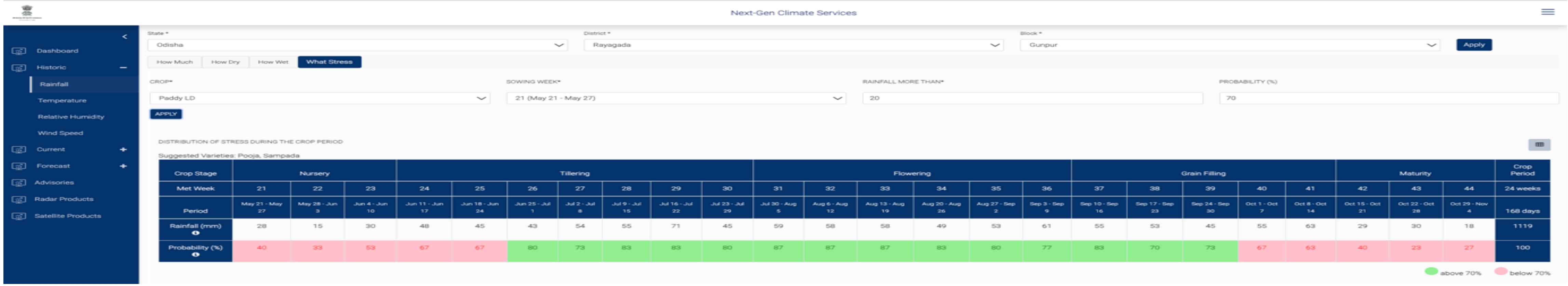
Screenshot of in-season (crop calendar)

Preparation of Weather-Based Agro Advisories

For easy handling, based on the date of sowing, the stages of crop can be divided into land preparation (1 week before sowing), seedling, vegetative, reproductive, grain development, harvest and post-harvest (1 week after harvest).



Crop Stage	Nursery			Tillering							Flowering						Grain Filling					Maturity			Crop Period
Met Week	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	24 weeks
Period	May 21 - May 27	May 28 - Jun 3	Jun 4 - Jun 10	Jun 11 - Jun 17	Jun 18 - Jun 24	Jun 25 - Jul 1	Jul 2 - Jul 8	Jul 9 - Jul 15	Jul 16 - Jul 22	Jul 23 - Jul 29	Jul 30 - Aug 5	Aug 6 - Aug 12	Aug 13 - Aug 19	Aug 20 - Aug 26	Aug 27 - Sep 2	Sep 3 - Sep 9	Sep 10 - Sep 16	Sep 17 - Sep 23	Sep 24 - Sep 30	Oct 1 - Oct 7	Oct 8 - Oct 14	Oct 15 - Oct 21	Oct 22 - Oct 28	Oct 29 - Nov 4	168 days
Rainfall (mm)	28	15	30	48	45	43	54	55	71	45	59	58	58	49	53	61	55	53	45	55	63	29	30	18	1119
Probability (%)	40	33	53	67	67	80	73	83	83	80	87	87	87	83	80	77	83	70	73	67	63	40	23	27	100

crop Calander and weekly probable distribution of rainfall

MAY			JUNE					JULY				AUGUST				SEPTEMBER					OCTOBER		
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Sowing			Transplanting					Tillering					Heading				Flowering		Grain filling		Maturity		

1. Recommendations on soil preparation, seed selection, and fertilizer application based on soil health and forecasted weather conditions.
2. Timing recommendations based on rainfall forecasts and soil moisture levels to ensure optimal germination and reduce the risk of crop failure.
3. Guidance on nutrient application, irrigation schedules, and early pest detection to promote healthy growth while minimizing excess input use.
4. Flowering and Fruiting: Targeted pest and disease advisories, water management tips, and weather-based adjustments to protect yield potential.
5. Advisories on optimal harvest timing and strategies to reduce post-harvest losses, such as grain drying recommendations based on humidity levels.

Example of a crop Calander based advisory generation

Decisions influenced by climate information

Decision	Potential application
Land preparation	Limited
Selecting crops and varieties	Medium
Planning allocation of land	Medium
Sowing	High
Use of inputs (fertilizers)	High
Weeding	Limited
Pests and diseases	High
Labor allocation	Limited
Harvest	Medium to High

Decision tree: Pre-Seasonal advisory (Ex: Groundnut systems)

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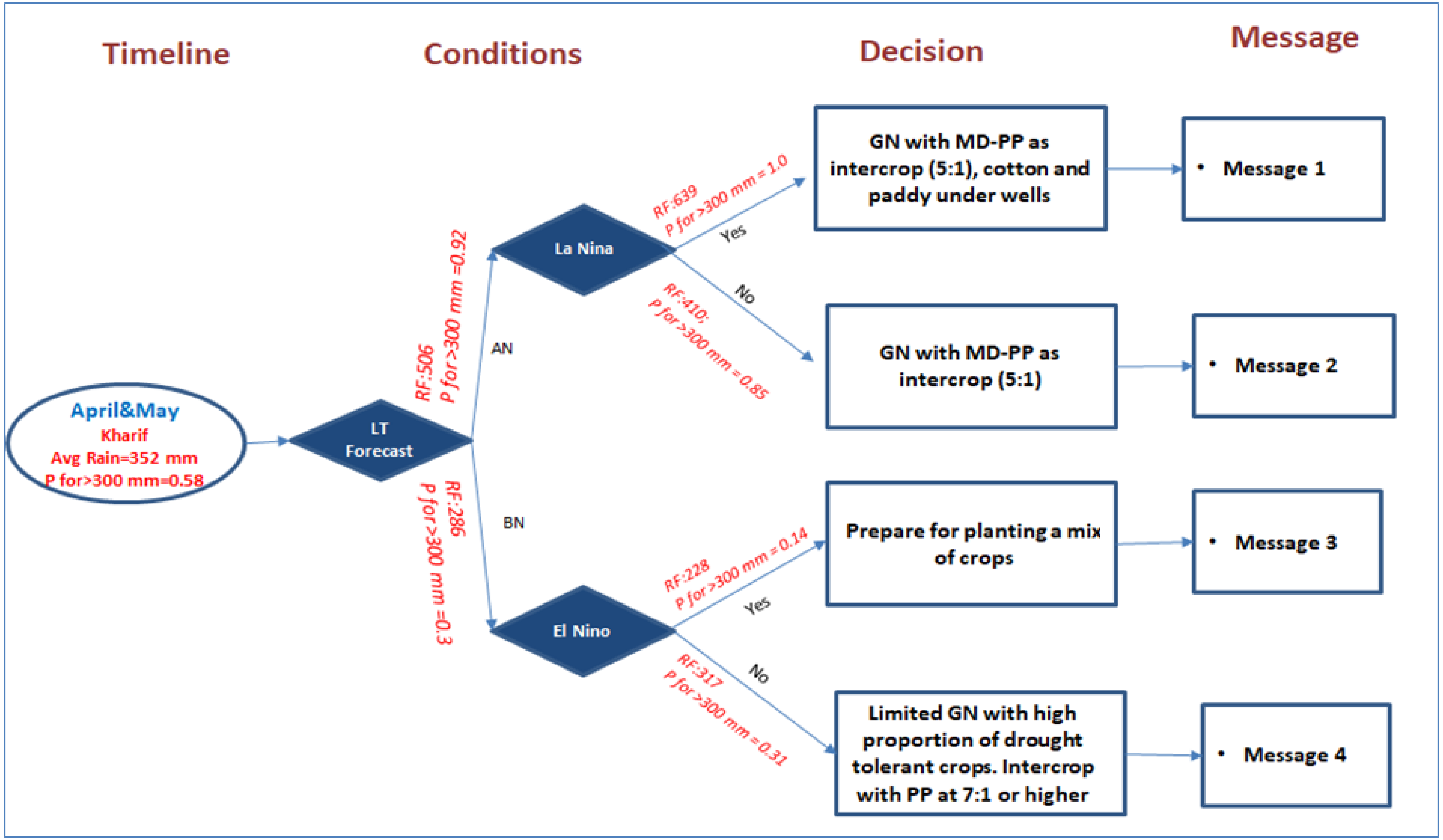
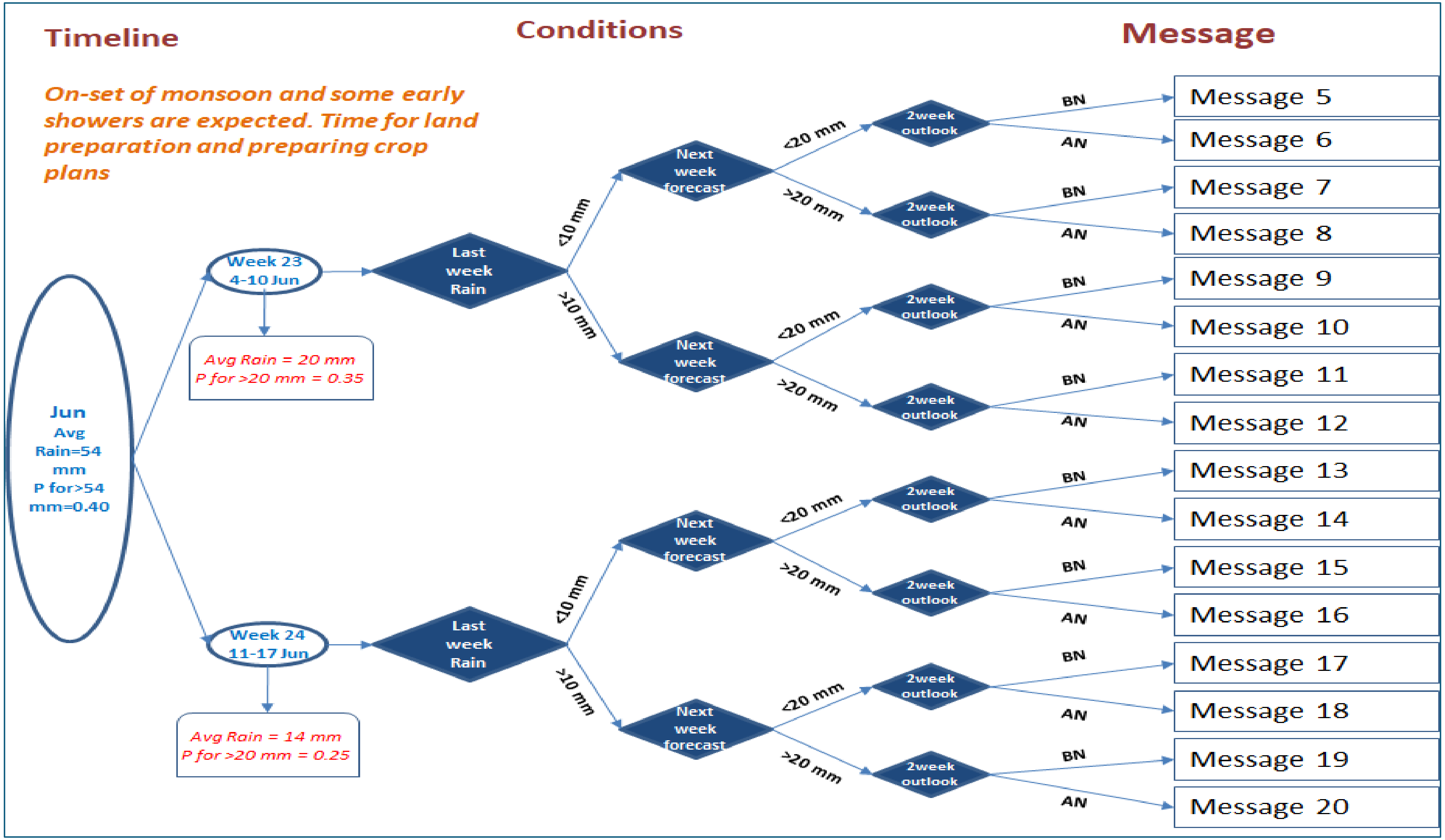


Decision tree: In-Seasonal advisory

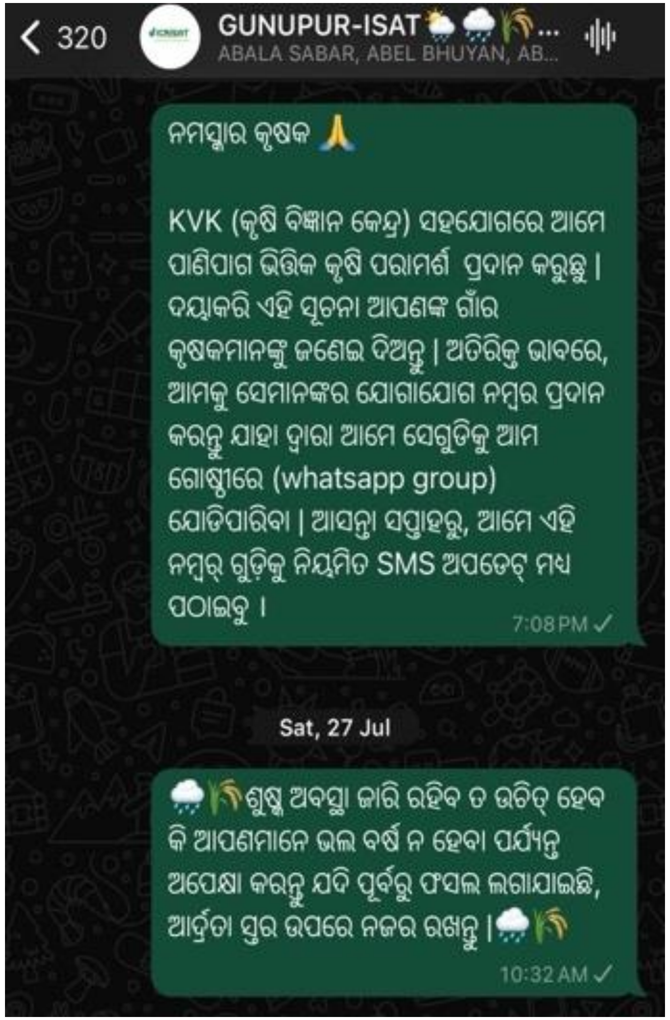


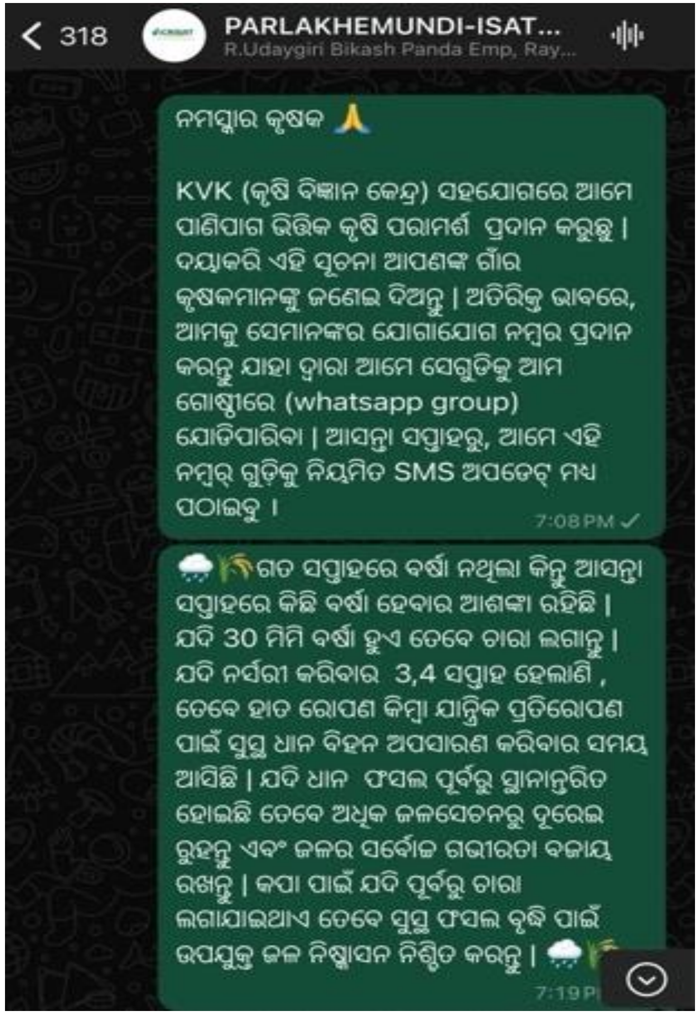
Format and lookup for agro advisory
(Farmer/ date of sowing specific)

			RICE (SD)			
SMW	DATE	STAGE	WW (2-week outlook)	WD (2-week outlook)	DW (2-week outlook)	DD (2-week outlook)
21	21/05/2023	Land Preparation	M1	M2	M3	M4
22	28/05/2023	Nursery	M5	M6	M7	M8
23	04/06/2023	Nursery	M9	M10	M11	M12
24	11/06/2023	Transplanting	M13	M14	M15	M16

Format and lookup for agro advisory
(Farmer/ date of sowing specific)

Example Block-wise WhatsApp Groups for Advisory Dissemination





Awareness Programme for Farmers on Climate services

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Farmers Awareness Programme conducted in study locations

IMPACT

- As part of pilot **ISAT** was field tested and under scaling in India.
- Across the villages, **72%** of farmers rated the short message advisories as highly reliable and useful, significantly influencing decisions on **land preparation, sowing, and harvesting**, leading to **1-56%** increases in crop productivity.
- In a recent pilot, around **6,000** farmers received advisories through WhatsApp and SMS gateways as part of the ongoing scaling-up efforts.
- Extending the experiences to Africa (Kenya and Zambia):

Encouraged by the positive outcome from the studies in India, efforts were made to extend the system to African countries under the project Accelerating Impacts of CGIAR Climate Research for Africa **(AICCRA)** supported by World Bank.

Raising Awareness of ISAT Climate Information Services in Odisha

Farmers in Rayagada and Gajapati Districts Benefit from Region-Specific Farming Guidance

In a continued effort to empower farmers with timely and accurate farming advisories, a team from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) recently conducted a field visit to Rayagada and Gajapati districts in Odisha from 23-26 August 2024. This visit marked a significant step in enhancing farmers' awareness of region-specific digital climate advisories, while also gathering valuable feedback on the pre-seasonal and in-season guidance delivered via the ISAT platform.

The ISAT platform, a collaborative effort between ICRISAT, Microsoft, and the India Meteorological Department, with support from the Indian Council of Agricultural Research (ICAR), has been at the forefront of providing farmers with vital information that can significantly enhance their decision-making processes. Digital tools such as ISAT are also closely aligned with the Government of India's recently launched Digital Agriculture Mission.

Future Pathways – Scaling AI-Powered Advisory Systems

✓ **National Integration**

- Embed iSAT & NGCS into **IMD's Agro-Advisory framework**, SAUs, and KVK networks.
- Strengthen linkages with **AMFUs** to deliver block/village-level advisories.

✓ **Monsoon Mission–III Roadmap**

- Pilot in Maharashtra under MM-III → refine, validate, scale across India.
- Expand partnerships with CRIDA, ILRI, IITM, IMD, IISc, CSIR for long-term sustainability.

✓ **Regional Scaling via different organisations and networks like SAFOAM**

- Collaborate with South Asian partners for cross-country advisory systems.
- Share lessons, data standards, and governance models across the region.

✓ **Global Public Good**

- Position iSAT integrating with MausamGPT as open, adaptable platforms for Africa & Asia.
- Build on successful pilots in Senegal, Kenya, Ethiopia for continental adoption.

✓ **Long-Term Vision**

AI-driven **adaptive agriculture ecosystems**: predictive, participatory, inclusive.
Farmers not only receive advisories but also **co-create knowledge**.

Conclusions – Science to Farmers and Ag VC actors, at Scale

✓ Climate Reality

- South Asia's rainfed systems face intensifying climate shocks.
- Traditional advisories, though valuable, are not enough for scale & precision.

✓ AI as the Game-Changer

- Bridges climate science ↔ farm decisions.
- Enables automation, localization, personalization, and trust-building

✓ ICRISAT's Contribution

- Through iSAT & NGN, ICRISAT and partners deliver hyper-local, AI-powered advisories.
- MausamGPT represents the next frontier, conversational, context-aware farmer support.

✓ Acknowledgement & Invitation

- Thank you to SAFOAM for the platform and partnership.

Open for questions, dialogue, and collaboration.

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Recent Project Launch – Monsoon Mission-III, Govt. of India

&

Customizing to Ethiopia under CGIAR Digital Transformation Accelerator

Title: AI-powered Context-Specific Agromet Advisory Services for Climate-Resilient Agriculture at Scale

Funded by: Ministry of Earth Sciences, Govt. of India

Consortium: ICRISAT, Indian Counsil of Agricultural Research (ICAR), ILRI, Indian Meteorological Department (IMD), Indian Institute of Tropical Meteorological (IITM)

Focus: Scale-up of ISAT → AI-integrated, automated, explainable advisories

Controlled scaling: Maharashtra state, India

Global Outlook: Contributions to MausamGPT, Govt of India's Initiative & scaling up to Africa under South-South Collaboration. https://issca.icrisat.org/scalable-solutions/intelligent-agricultural-systems-advisory-tool-isat

For Ethiopia: Integrating AI-based advisory generation for Ethiopian cropping systems- Customizing & Parameterization of ISAT

Support: CGIAR Digital transformation Accelerator

Focus: Standardizing dataset templates and logic layer for context-specific advisory prototyping

Thank YOU

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