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WORKING PAPER

Customization, Parameterization, and Scaling of the iSAT: An ICT based Agro Advisory platform for location-specific Informed Decision-Making

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Abstract

Following the successful demonstration of the iSAT system's ability to generate data-driven, science-based weather advisories, efforts were undertaken to scale the system and improve its capabilities. The focus was on four key areas; expanded crop coverage to cover a wider range of crops, flexible information access to accommodate local information and user preferences, targeted and timely advisories tailored to specific crop growth stages and delivered at the right time and multilingual and multi-format advisories (SMS, mobile app, WhatsApp, website) to reach a diverse audience. To achieve these goals, the ISAT system was modified in several ways. Location-specific information was incorporated through lookup tables, mobile apps, and direct input, the decision-making process was refined to generate advisories that align with farmers' specific needs, advisories were produced in two formats: SMS-friendly and detailed versions for mobile apps, WhatsApp, and websites and options were added to translate advisories into local languages. The challenges and limitations in realising the full potential of context-specific advisories include availability of reliable and consistent data, tailoring advisories to specific conditions that requires further refinement and adaptation, effective delivery through various mobile devices and platforms, government policies on bulk SMS and data privacy, language barriers requiring translation and localization for reaching a wider audience and user awareness and capacity to utilize them information effectively. By addressing these challenges, the ISAT system can continue to evolve and provide even more valuable and impactful services to farmers and agricultural stakeholders.

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1. Background

Rainfed agriculture, particularly in regions like South Asia and Sub-Saharan Africa, faces significant challenges due to the high variability and uncertainty of rainfall patterns. Fluctuating rainfall directly impacts soil moisture availability, hindering crop growth and development. Moreover, the inherent uncertainty associated with rainfall discourages the adoption of improved technologies essential for boosting productivity (Agarwal et al., 2009, Prasanna, 2014, Brida and Owiyo, 2013 and Singh et al., 2013).

Climate change exacerbates these challenges, leading to increasingly erratic weather patterns, including irregular rainfall, rising temperatures, prolonged dry spells, and more frequent extreme events. (Hansen et al. 2018; Falco et al. 2018). Smallholder farmers, especially those in semi-arid regions of South Asia and Sub-Saharan Africa, are particularly vulnerable to these climate-induced uncertainties. For instance, farmers in Mahbubnagar, India, often experience severe droughts, resulting in substantial crop yield losses and decreased farm income. This region's annual rainfall of around 391 mm, coupled with a high probability of moderate and severe droughts, severely limits agricultural productivity and farmers' ability to produce sufficient food and cash income (Shalander Kumar et al., 2020). Additionally, inadequate irrigation facilities and poor soil quality add to these challenges, making farmers heavily reliant on unpredictable rainfall. Agriculture in its different forms and locations remains highly vulnerable to climatic variability, which is a major factor of interannual variation in food production (Howden et al. 2007).

To mitigate these risks and maximize opportunities, farmers must rely on science-based, data-driven decision-making. Without accurate and timely data, farmers often rely on personal observations and traditional knowledge, which may not accurately reflect the complex and unpredictable nature of the climate system. This can lead to suboptimal decisions and significant economic losses. While the variability in the amount and distribution of rainfall during the season directly effects the plant available water content, the uncertainty and risk associated with this variability over the seasons and years makes decision-making difficult for farmers. This uncertainty reduces profitability and jeopardizes the overall viability of agricultural systems (Rao et al., 2011). Given the increasing challenges posed by climate variability, effective and efficient management of agricultural systems should focus on both reducing risks and capitalizing on potential opportunities. Proactive risk management practices particularly those based on scientific information can help mitigate the impacts of climate variability. Unfortunately, these approaches have not yet been widely adopted (Rao et al., 2019).

Timely access to weather forecasts, value-added agricultural advisories, and market information empowers farming communities to better address both climate and market risks (Singh and Meena, 2012). Weather-based crop advisory services can provide real-time information on weather patterns, crop health, and recommended management practices, enabling farmers to make informed decisions that lead to improved yields and increased incomes (Ogutu, 2023; HMAARI Agro Advisory Services, 2021). By embracing data-driven approaches and adopting climate-smart agricultural practices, farmers can enhance their resilience to climate change and secure a sustainable future for agriculture.

Intelligent farming is one such approach in which farmers are supported with required information to make better and informed decisions. It hinges on managing agricultural systems to minimize risks and maximize opportunities using reliable, data-driven, locally relevant, and actionable information with due consideration to the impacts of dynamic and uncertain weather conditions from the start of the season. The weather-based advisory system currently being implemented by the Indian Meteorological Department is a step in this direction but the limitations in reliability and usability of the information provided has constrained its implementation and acceptance by farmers. To address these challenges, ICRISAT, ICAR, and other partners have developed the Intelligent Agricultural Systems Advisory Tool (iSAT).

iSAT is a cutting-edge digital platform that leverages advancements in Information and Communication Technologies (ICTs) and improved weather forecasting capabilities. By analyzing historical climate data, real-time seasonal progress, and short- to long-range forecasts, ISAT translates complex climate information into actionable advisories. These advisories are delivered in user-friendly formats to farmers in a timely manner. Pilot studies in Anantapur (Andhra Pradesh) and Parbhani (Maharashtra) have demonstrated ISAT's effectiveness in empowering farmers to make informed decisions, leading to increased productivity and profitability (Figure 1).

Figure 1: Pilot Study locations of Intelligent Systems Advisory Tool (ISAT)

The pilots have established that weather-based advisories have played an important role in influencing farmers' decision-making and conducting various farm operations timely. Approximately 80% of the farmers reported that the advisories were beneficial, particularly for timely sowing and safe harvesting of crops. However, the influence of the advisories was slightly lower for other operations, such as land preparation (65%), inter-cultural activities (56%), and fertilizer and pesticide application (54%). Overall, the pilot resulted in crop productivity increases ranging from 1% to 56% across climate-informed villages (Ramaraj et al., 2023). Farmers especially found the advisories valuable during normal and below-normal seasons.

As an automated system, iSAT has the potential to provide location-specific agro-advisory services to millions of farmers in a timely manner. To realize this potential, the system requires customization and parameterization of its input and output options. This would enable ISAT to dynamically select relevant information based on location, crop type, growth stage, and prevailing weather conditions.

While much of the necessary information is available, organizing it in a format accessible and interpretable by the system presents a significant challenge. Odisha's Livelihoods Mission (OLM), in collaboration with CGIAR's Digital Innovation initiative, has undertaken efforts to address this challenge.

This working paper outlines the steps involved in customizing, parameterizing, and implementing the scaling up of iSAT platform, and shares key lessons learned from operationalising the system. Additionally, the paper discusses the platform's flexibility in adapting to specific regional needs.

2. Overview of ISAT

The iSAT framework is built on the methodology where the tasks of compiling the required data and information on climate and agriculture, analysing the data to answer many questions and provide insights for selecting best bets and generating the advisory with context specific and actionable information (Figure 2). Accordingly, the iSAT system is underpinned by four key pillars.

First, a robust virtual database aggregates climate and weather data sourced from national meteorological services, such as the IMD in India, to provide insights into historical, current, and forecasted conditions.

Second, a comprehensive dashboard, equipped with advanced data analytics tools, enables users to delve into historical trends, monitor dynamic current weather patterns, and assess the reliability and utility of forecasted data.

Third, a vast repository houses invaluable agricultural information, encompassing crops, soil, and water resources, along with their optimal management strategies tailored to prevailing weather conditions. This repository is structured as a decision support system.

Fourth, the core of the iSAT system lies in its ability to generate location-specific, weather-informed advisories. By emulating the decision-making processes of farmers, the system leverages the data and information from the climate database and agricultural information repository to provide actionable recommendations.

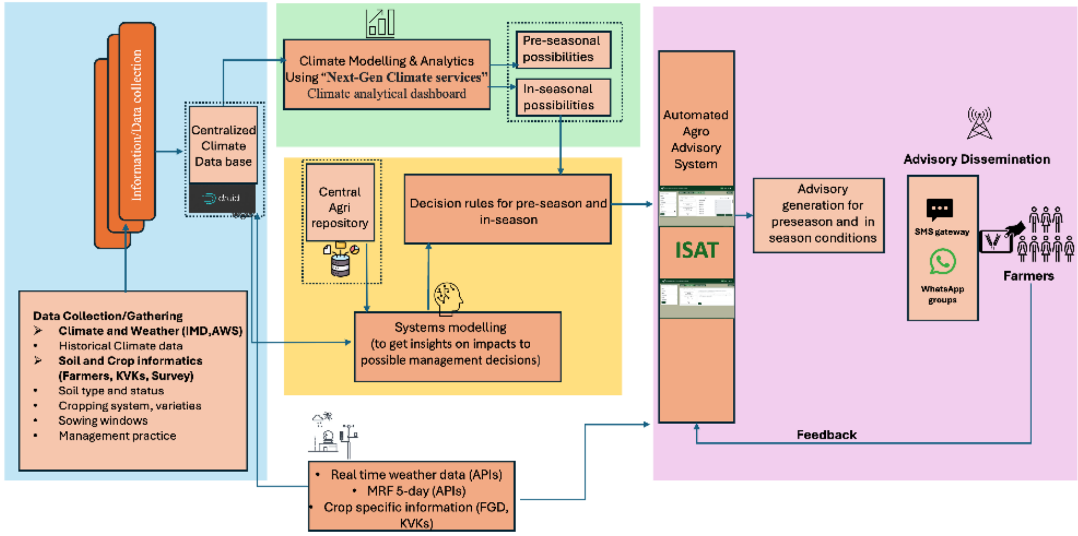


Figure 2. Operational Framework of the ISAT

iSAT serves as a central hub for synthesizing insights from historical climate data and linking them with weather information and an agricultural repository. This allows it to generate advisories tailored to specific crops, growth stages, and observed and forecasted weather conditions, closely mimicking the decision-making process of farmers. This process is facilitated by ICT-enabled tools and technologies, including *Next-Gen Climate Services* which offer advanced forecasting capabilities by integrating real-time data with predictive models. These services, in conjunction with the decision-tree approach (Rao et al., 2019), enhance iSAT's ability to provide precise, location-specific advisories.

iSAT's architectural flow designed to support both pre-seasons planning and in-season management decisions. The pre-season advisories are based on seasonal climate forecasts issued by the **Indian Meteorological Department (IMD)**, global climate anomaly indicators like ENSO, and long-term observed data. These advisories are issued once per season following the release of the seasonal climate forecast by IMD. In contrast, the in-season advisories are generated weekly, considering rainfall recorded in the past week, the current week's forecast, and the outlook for the upcoming week. The iSAT system automatically generates these advisories by utilizing information from the dashboard, ensuring timely, data-driven decision support for farmers.

3. Need for customization and parameterization of iSAT

The pilot version of ISAT faces several limitations hindering its scalability and applicability to large, diverse agricultural regions. Key limitations include:

a. ***Limited Crop Coverage:*** The system's current structure restricts it to a specific set of crops, making it difficult to incorporate additional ones.
b. ***Lack of Flexibility for Local Data:*** While rainfall data can be manually input, the system lacks the ability to easily integrate other crucial variables like soil characteristics.
c. ***Rigid Planting Assumptions:*** The system assumes that planting occurs immediately following a favorable advisory, limiting its capacity to provide advice for different crop growth stages.
d. ***SMS Format Constraints:*** The SMS format imposes character limits, hindering the presentation of detailed and easily understandable information.

To expand iSAT's applicability across various agricultural contexts, we aimed to enhance its scalability and adaptability. The planned interventions include modularizing the architecture for easier customization and extension to diverse crops and locations, integrating with dynamic data sources by leveraging APIs for real-time access to weather data and other relevant inputs, implementing crop-weather calendars that provide tailored decision support and optimizing decision-making models with adjustable thresholds and parameters for greater flexibility. These improvements are expected to enhance iSAT's scalability and utility, empowering farmers with more precise and adaptable agricultural insights.

a. Improved crop and geographical coverage

India's diverse climatic conditions offer unique opportunities for strategic crop planning. The country experiences three primary agricultural seasons. Kharif (June to September) is the main season characterized by monsoon rains and is the ideal season for moisture-intensive crops like rice, maize, and cotton. This is followed by Rabi (November to March) season with cooler temperatures and relatively drier conditions making this season suitable for pulse and oilseed crops, such as chickpea and mustard. The third season is the Summer (April to June) season with hot and dry weather conditions favouring crops like watermelon, cucumber, and various fodder crops. To harness these seasonal variations and optimize crop planning, iSAT was restructured to access and use this information through a set of lookup tables (Table 1). These tables provide essential information, including suitable crops for each season, optimal planting windows and ideal planting conditions. By leveraging this data-driven approach, advisories can support farmers in making informed decisions to maximize yields by adapting management to make best use of prevailing weather conditions.

Table 1: An example lookup table for capturing season wise crops and planting windows. (LD, MD and SD refer to long, medium and short duration varieties)

CROP	Season			
	Kharif		Rabi	
	Sowing window start	Sowing window end	Sowing window start	Sowing window end
Rice nursery	15/05/2023	20/06/2023	21/11/2023	10/12/2023
RICE (SD)	21/06/2023	07/08/2023	12/12/2023	10/01/2024
RICE (MD)	21/06/2023	07/08/2023	12/12/2023	10/01/2024
RICE (LD)	21/06/2023	07/08/2023	12/12/2023	10/01/2024
MAIZE (SD)	30/05/2023	30/06/2023		
MAIZE (MD)	30/05/2023	30/06/2023		
MAIZE (LD)	30/05/2023	30/06/2023		
Pearl millet (SD)	21/06/2023	27/06/2023		
Pearl millet	21/06/2023	27/06/2023		
Pearl millet (LD)	21/06/2023	27/06/2023		
Sorghum (SD)	21/06/2023	27/06/2023		
Sorghum (MD)	21/06/2023	27/06/2023		
Sorghum (LD)	21/06/2023	27/06/2023		
Pigeonpea (SD)	05/07/2023	14/08/2023		
Pigeonpea (MD)	05/07/2023	14/08/2023		
Pigeonpea (LD)	05/07/2023	14/08/2023		
Greengram	05/07/2023	14/08/2023	05/11/2023	22/12/2023
Greengram	05/07/2023	14/08/2023	05/11/2023	22/12/2023
Greengram (LD)	05/07/2023	14/08/2023	05/11/2023	22/12/2023
Finger millet	21/06/2023	27/06/2023		
Finger millet	21/06/2023	27/06/2023		
Finger millet	21/06/2023	27/06/2023		
Groundnut (SD)	05/07/2023	10/08/2023	15/11/2023	07/01/2024
Groundnut (MD)	05/07/2023	10/08/2023	15/11/2023	07/01/2024
Groundnut (LD)	05/07/2023	10/08/2023	15/11/2023	07/01/2024

b. Integration with locally relevant input data

For generating context and domain specific advisories, iSAT requires local information. The required information includes amount of rainfall received at that location, downscaled forecast for the location, locally relevant crops, varieties and management practices and crop stage or time of planting. The downscaled forecast information is accessed through APIs provided by the IMD and is processed to interpolate using the distance to nearby points. Oberved rainfall is another important input which is again accessed from the IMD gridded data. However, considering the coarse resolution of IMD data, users of the system are encouraged to use locally recorded rainfall data. Where available such data can be accessed by ISAT through an app-based input. Since management varies from location to location and timing of these operations depends on weather conditions, another set of lookup tables are designed to input this information (Table 2). These steps ensure that the advisories reflect the most current and location-specific information.

Table 2: Example lookup tables with locally relevant crop calendars and details of associated operations as a function of weeks after planting.

Week after planting	Maize LD			
	WW	WD	DW	DD
0	Sowing	Sowing	Wait for rain	Wait for rain
1	M1	M2	M3	M4
2	weeding 1	weeding 1	weeding 1	weeding 1
3	M1	M2	M3	M4
4	Wait for dry period	Top dressing 1	Top dressing 1	Wait for good moisture
5	Pest and Disease	Pest and Disease	Pest and Disease	Pest and Disease
6	Pest and Disease	Pest and Disease	Pest and Disease	Pest and Disease
7	Weeding 2	Weeding 2	Weeding 2	Weeding 2
8	Wait for dry period	Top dressing 2	Top dressing 2	Wait for good moisture
9	Pest and Disease	Pest and Disease	Pest and Disease	Pest and Disease
10	Drainage	M2	M3	M4
11	Drainage	M6	M6	M6
12	Drainage	M6	M6	M6
13	Drainage	M5	M5	M5
14	Drainage	M5	M5	M5
15	Wait for dry period	Wait for dry period	Harvesting	Harvesting
16	Wait for dry period	Wait for dry period	Harvesting	Harvesting

Crop	Land preparation	Transplanting	Water management	Sowing	Top dressing 1	Weeding 1	Pest and Disease	Top dressing 2	Weedi
Maize (LD)	One tillage with mouldboard plough followed by two harrowing are needed for good field preparation			seed rate varies according to seed size and spacing, 20-25 kg seed/ha required, maintain row to plant spacing at 50X25cm. half dose of nitrogen and full dose of P&K as basal at the time of sowing, remaing half of the nitrogen should be applied in two equal splits	Top dressing of nitrogen i.e., after weeding	pre-emergence spraying with Atrazine 50 W.P. @ 800-1200 g/ac depending on soil type. * Atrazine is recommended when maize is grown as a pure crop only	Monitor for pests and diseases. Keep a close watch on your crops, and take necessary steps to prevent. Especially Monitor for pink Borer and take necessary precautions	side dressing of nitrogen to support tassel and silk development	spray of 2, sodi salt 80 @500 in 2 litres water cont most c bro leav wee effecti

c. Planting Assumptions and crop stage information

To enhance the precision and relevance of the advisories, it is proposed to incorporate crop stage and current/projected weather conditions as inputs into the weekly advisory generation process. While weather data, including forecasts, is readily available, determining precise planting times and crop stages remains a challenge.

Our current advisories are structured for entire blocks, which are vast areas (10,000-20,000 ha) encompassing thousands of farmers. Crop planting within these areas is staggered, with significant time gaps between early and late planters. Given the stage-specific nature of many farm operations, a generic advisory tied to a single planting date is insufficient.

To address this, our scaled-up version utilizes 'weeks after planting' as a proxy for crop age, allowing us to link operations to specific growth stages. This approach necessitated adjustments to our decision-making framework. The revised decision tree, illustrated in Figure 3, and the modified iSAT (Figure 4) now incorporate 'weeks after planting' as an additional input for generating tailored advisories. ISAT now generates advisories for any week with due consideration to whether the week falls in land preparation period (starts one month before the start of planting window), or planting period or crop growth period.

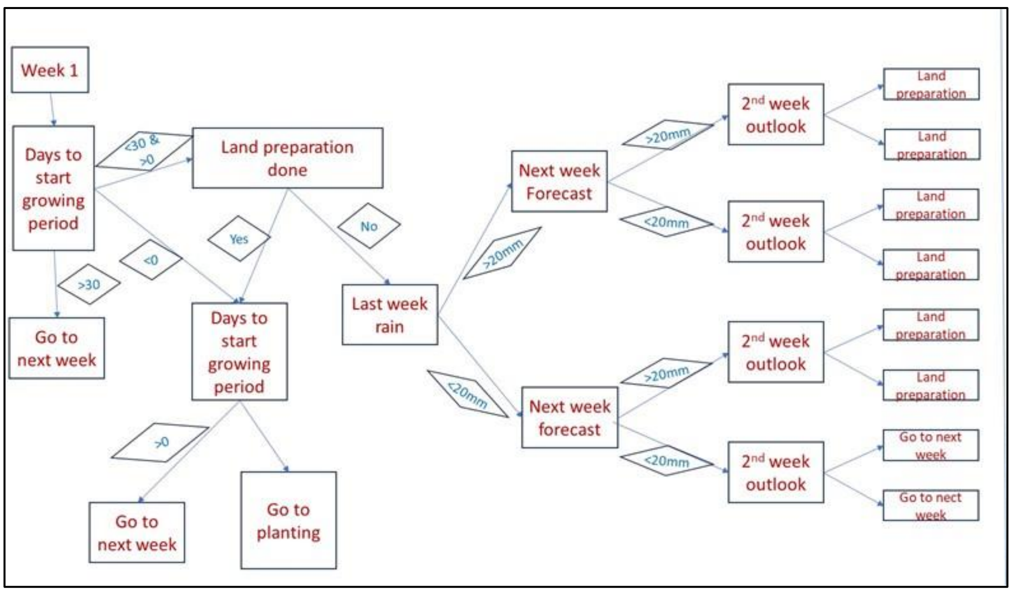


Figure 3: An example of the revised decision tree for generating weekly advisories

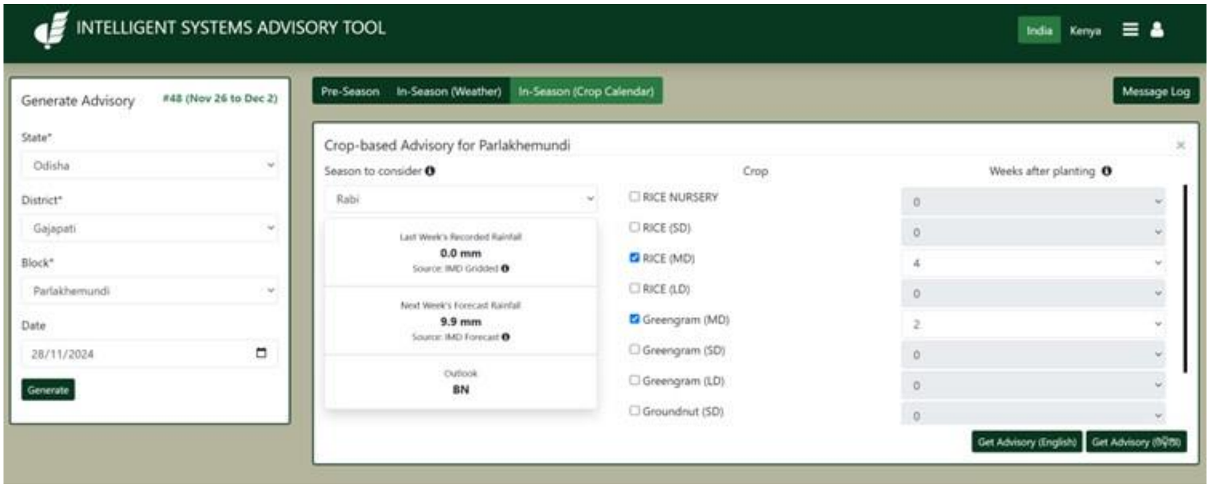


Figure 4: Front end of modified ISAT with days after sowing as an input to generate crop specific advisories.

d. Advisory formats

Effective communication of information is crucial for the adoption and utilization of advisory services. The previous version of iSAT primarily relied on SMS to disseminate short advisories. While SMS is a rapid and efficient method to reach a large audience, it limits the amount of information that can be conveyed. Additionally, translating advisories into local languages is essential to ensure widespread understanding. To address these limitations, we've made significant modifications to ISAT. These changes aim to enhance the user-friendliness of information presentation and expand the range of dissemination channels.

The revised version of iSAT is structured to generate two different types of messages, a short message listing the operations to be carried out during the week sent by SMS and a more detailed message giving the forecast information and details about the operation to be carried out (Figure 5). The latter version is disseminated through a mobile app “Meghdoot”, WhatsApp user groups and internet in addition to the traditional extension system.

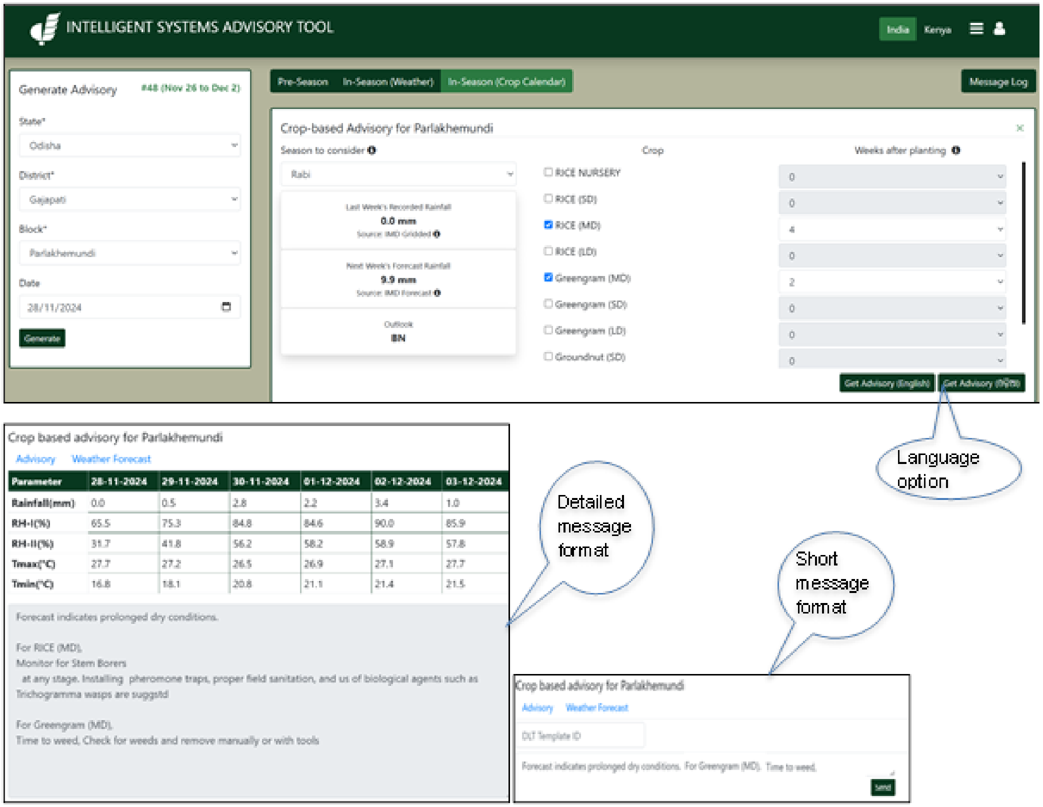


Figure 5: Screen shot of ISAT system showing the language and short and detailed message formats.

4. iSAT system architecture

The iSAT system is developed as a robust, scalable platform that seamlessly integrates four key components to deliver climate services and agro-advisories to farmers and stakeholders. The system facilitates continuous data exchange between internal and external sources, ensuring timely and accurate information delivery. Key components of the system are as given below.

a. Framework: The Python-based web framework Django powers the backend operations, providing a solid foundation for efficient data management and integration with MySQL.

b. Frontend and Backend Integration: The frontend leverages HTML templates and JavaScript (jQuery) to create dynamic and interactive user interfaces. This enables smooth data exchange between the frontend and backend, ensuring a seamless user experience.

c. Styling and User Interface: Bootstrap 4, the CSS framework ensures a responsive and visually appealing design across various devices and screen sizes, making the platform accessible to a wide range of users, including farmers and extension officers.
d. Database Management: The MySQL database serves as the central repository for storing and managing critical data, including advisory information, weather data, and user records.
e. Web Server Interface: The Gunicorn web server interface handles multiple web requests concurrently, enabling the platform to efficiently serve a large number of users.
f. Web Server: The high-performance NGINX web server used in the system optimizes the content delivery, load balancing, and security, ensuring a fast and reliable user experience.

By integrating these components, iSAT is made into a robust and efficient platform that delivers context specific advisories and thereby empowers farmers and stakeholders with timely and accurate agricultural information

5. Scaling up in Odisha

With these customization and parameterization requirements in place, iSAT is now being scaled up in Odisha's Rayagada and Gajapati districts, which are known for their challenging agro-climatic conditions. This scaling is part of the Odisha Livelihoods Mission (OLM) and CGAIR Digital Innovation. Odisha is a state where more than 78.5% of the 87,46,000 ha cropped area falls under rainfed agriculture, making it highly dependent on weather and climate conditions.

5.1. Status of Weather based Agro Advisories in Odisha

To enhance agricultural productivity and resilience, IMD established a network of 130 Agro-Meteorological Field Units (AMFUs) in 2008. These multidisciplinary units are located in State Agricultural Universities, ICAR centers, and other institutions. AMFUs generate crop-specific advisories tailored to the unique agro-climatic conditions using weather forecasts, agro-meteorological products, and data from conventional and automatic weather stations (AWS) provided by IMD and ICAR. Between 2017 and 2020, this network is expanded by establishing District Agro-Met Units (DAMUs) centers across 660 districts under the Gramin Krishi Mausam Sewa (GKMS) initiative. DAMUs focus on generating sub-district or block-level agro-meteorological advisory bulletins.

In Odisha, there are 10 Agro-met Field Units (AMFUs) distributed across different agroclimatic zones, covering the entire state. Additionally, nine DAMUs are operational in the Krishi Vigyan Kendra's of Orissa University of Agriculture and Technology (Figure 6). The advisories issued are disseminated via various channels including Research Stations, KVK and IMD Web portals. However, IMD has decided to close the DAMUS from January 17.

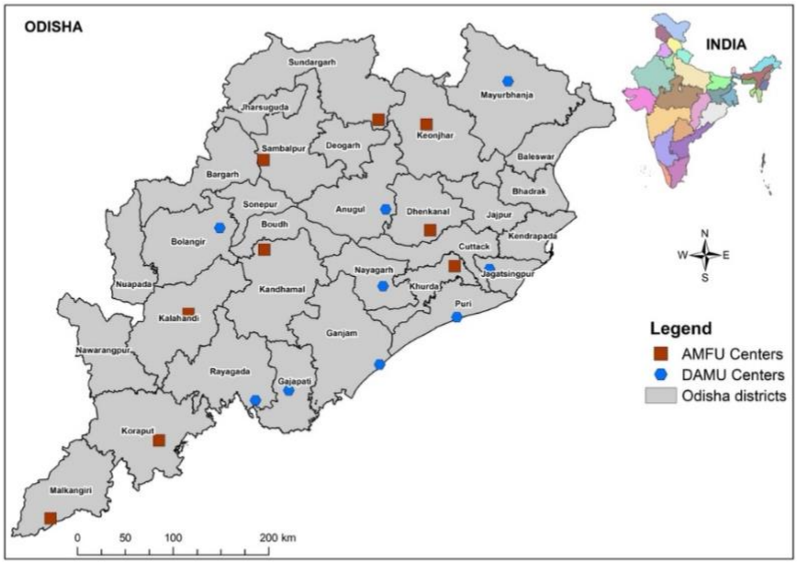


Figure 6: Locations of AMFUs and DAMU Centres in Odisha state

5.2. Scaling the system in Rayagada and Gajapathi Districts

To test the modified iSAT system two districts Rayagada and Gajapati (Figure 7) located in the southern part of the state and within the Northeastern Ghats of Odisha were selected. The selection of these districts for iSAT deployment was based on their vulnerability to climate fluctuations and the complexity of their agroecological zones. Rayagada district lies at a latitude of 19° N and a longitude of 83° 20' E, while Gajapati district is located at 19° N latitude and 84° 18' E longitude. The two districts have a total geographical area of 11,434.7 sq. km and are predominantly hilly and forested. Agriculture forms the backbone of the local economy, with paddy, maize, pulses, and oilseeds being the main crops respectively. The average annual rainfall in Rayagada district is 1,340.3 mm, and in Gajapati district, it is 1,423 mm, with most of the precipitation occurring during the Kharif season. These districts experience a hot and moist sub-humid climate, with significant variability in temperature and precipitation. The soil in these districts is predominantly brown forest soil with lateritic, alluvial, red, and mixed red & black soil types.

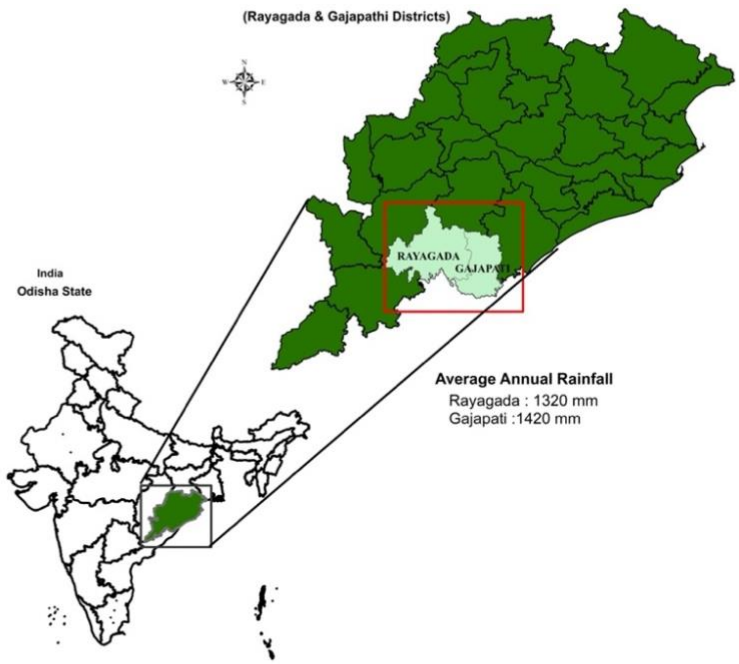
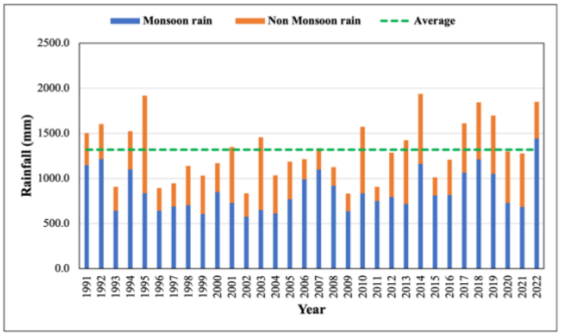


Figure 7: Locations of Rayagada and Gajapati Districts where ISAT scaling up work is tested

The distribution rainfall through the seasons (Figure 8) illustrates the dominance of southwest monsoon contribution to the annual rainfall. During the southwest monsoon the district Rayagada experiences a total of 56 rainy days and Gajapati records 47 rainy days. During this period, temperatures in both districts peak at 37°C and fall to a minimum of 10.5°C. The most critical phase for rainfall occurs between meteorological weeks 20 and 40, as this is when the bulk of the precipitation is recorded (Annexure Figure 1.a, b). This period is particularly important for crop growth, as sufficient rainfall is essential to support agricultural activities. Important characteristics of the climate of the locations are summarised in S Table1.



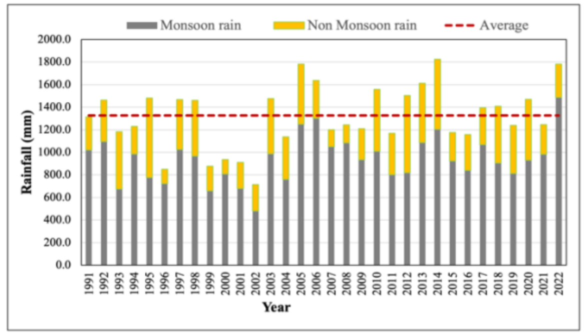


Figure 8: Distribution of southwest monsoon and non-monsoon rainfall in Gajapati and Rayagada districts of Odisha.

6. Data sources and data access methods

6.1. Meteorological data

The seasonal climate forecasts, as well as the medium and extended-range weather forecasts, are primarily sourced from the India Meteorological Department (IMD). The seasonal climate forecast for the southwest monsoon season (June-September) is generally issued in two stages. The first-stage or early alert is issued in mid-April, while the second-stage forecast, which is an update to the April forecast, is issued in late May or early June. These forecasts are generated using the Statistical Ensemble Forecasting System (SEFS) developed by IMD (Pai et al., 2017). Weekly weather forecasts (medium-range) are issued at the block level twice every week, while district level monthly outlooks (extended-range) are issued on every month. These forecasts are accessed through APIs provided by IMD. The weekly weather forecasts are quantitative, providing specific estimates of temperature, precipitation, and other meteorological variables, while the monthly outlooks are probabilistic, offering likelihoods of different weather conditions occurring.

In addition to IMD forecasts, ENSO conditions are accessed from the web sites of different international agencies. The Bureau of Meteorology (BoM), Australia, and the Climate Prediction Centre (CPC) of the National Oceanic and Atmospheric Administration (NOAA), USA, are the main sources for historical and real-time updates on ENSO conditions. Daily weather conditions for the selected study mandals are accessed through the Automatic Weather Station (AWS) and Automatic Rain Gauge (ARG) network managed by IMD (Table 3). This data is retrieved via AWS ARG NETWORKS website and is supplemented with field-level data collected from the KVKs to ensure localized accuracy in weather monitoring.

Table 3. Meteorological data sources

Data type	**Source**	**Links**
Historical climate data	IMD	**https://www.imdpune.gov.in/cmpg/Griddata/Rainfall_25_NetCDF.html**
Medium Range Forecast	IITM, IMD	**https://www.tropmet.res.in/monsoon/files/short_medium_range.php**
Real time weather data	IMD	**http://aws.imd.gov.in:8091/**

6.2. Agriculture Information and Data

The iSAT platform gathers agricultural information and data from reliable sources to ensure its relevance to local agricultural practices. Crop-related data (Table 4), including the types of crops and varieties grown in the region, is collected from local Agricultural Universities and Krishi Vigyan Kendras (KVKs), Odisha Agrisnet Contingency Plan for Districts, and Crop planning and crop calendar for different agroclimatic zones of Odisha. These institutions and sources provide detailed information about the crops that are most commonly cultivated in the district. The platform accesses the information about the recommended Package of Practices (PoP) for each crop, which covers best practices for planting, pest and disease management, irrigation, and fertilization. The PoP and crop contingency plans are sourced from the Central Research Institute for Dryland Agriculture (CRIDA) (CRIDA Contingency Plan for Odisha), Cotton BN and Rice Knowledge Bank Odisha. The contingency plans offer alternative strategies to manage crops in response to evolving weather conditions during the season. The POPs and contingency plans ensure that advisories are aligned with the latest agronomic recommendations specific to the region. The information from these sources is the primary input into the lookup tables developed for major crops defining the optimal sowing, growth, and harvest periods.

Table 4: Major crops and varieties grown in Gajapati and Rayagada

	Gajapati	**Rayagada**
Kharif	**Paddy:** Lalat, MTU-1010, Khandagiri **Maize-**BIO-9681 **Pigeonpea-**Laxmi	**Cotton-**BUNNY **Paddy-** Lalat, MTU-1010, Khandagiri **Maize-** BIO-9681
Rabi	**Paddy** –Lalat, MTU-1010 **Groundnut -** Smruti **Finger millet-** Chilika	**Paddy-** Lalat, MTU-1010 **Finger millet** –Chilika **Groundnut** – Smruti

7. Developing pre and in-seasonal advisories

7.1. Insights from climate data analysis

The daily precipitation data for Rayagada and Gajapati districts, spanning 30 years (1994-2023), were collected from KVK's in both districts and from the IMD and analysed using the data tools available with the dashboard that was developed by ICRISAT and its partners. The mean annual rainfall of Rayagada district was 1318 mm with the highest and lowest values of 1931 and 791 mm. The rain was received over 85 rainy days with a coefficient of variation of 23.84 %. For Gajapati district, the annual rainfall was 1258 mm with a high of 1888 and low of 681 mm and a CV of 19.74 % (Table 5). One important observation is that the weeks with rainfall below 10 mm were almost NIL during the kharif season and more than 20 weeks received over 20 mm rainfall during the same season in the two districts.

Table 5: Characteristics of annual, seasonal and weekly rainfall amounts recorded at Rayagada and Gajapati KVK stations

	Gunupur (Rayagada)			**R.Udaygiri (Gajapati)**		
Variable	**Annual**	**Kharif**	**Rabi**	**Annual**	**Kharif**	**Rabi**
Rainfall amount(mm)						
Average	1318.15	1091.19	104.71	1258.12	1048.08	134.43
Max	1930.50	1630.71	222.11	1887.81	1577.66	416.39
Min	791.17	705.99	5.89	815.10	680.54	17.69
CV (%)	23.84	23.05	61.32	19.74	18.95	87.09
Number of weeks <10 mm	20	0	20	22	0	19
Number of weeks >20 mm	23	21	0	24	22	2

Parlakemundi, located in Gajapati district, experiences a significant portion of its annual rainfall during the main kharif crop season (June to September). On an average this location receives 809 mm of rainfall during this period, accounting for over 70% of the annual total (Figure 9). The probability of exceedance chart in Figure 9 is a valuable tool for assessing the risk and potential of various agricultural practices. For instance, the chart indicates a 73% probability of receiving 700 mm or more of rainfall between June and September. This information is crucial for selecting suitable crops. Given the rainfall patterns, the region is well-suited for crops like paddy, which requires 600-820 mm of water. Other crops, such as maize (350-400 mm), groundnut (300-350 mm), and cotton (700-1200 mm), may also be viable options, depending on specific rainfall scenarios and crop management practices (Rajashree Khatua, 2017). The analysis indicated that the chance of getting 750 mm rainfall is 85 % in Gajapati and 90 % in Rayagada. Considering that the 80% level is what most farmers consider as the acceptable level of risk, the rainfall at these locations is sufficient to grow crops like direct seeded rice, maize, millet, groundnut and cotton.

Figure 9: Dashboard screenshot showing distribution and probability of exceedance of rainfall over 30 year period in Parlakimidi block of Gajapati district in Odisha state.

Weekly rainfall distribution is another important characteristic to understand the dry and wet spell distribution within the season, especially between the 25th and 40th standard meteorological weeks, with a total growing season of approximately 112 days or 16 weeks. The dashboard allows to explore the trends in distribution of wet and dry spells and develop a comprehensive understanding of weekly weather dynamics for any location (Figures 10a and 10b).

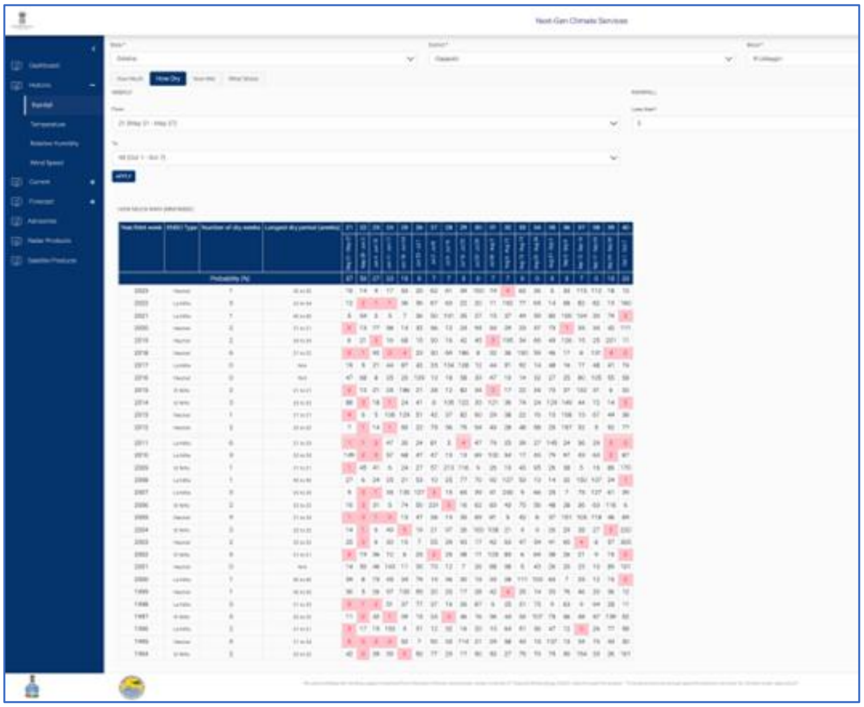


Figure 10a: Screenshot of dashboard displaying the distribution of dry weeks for the 30 year period

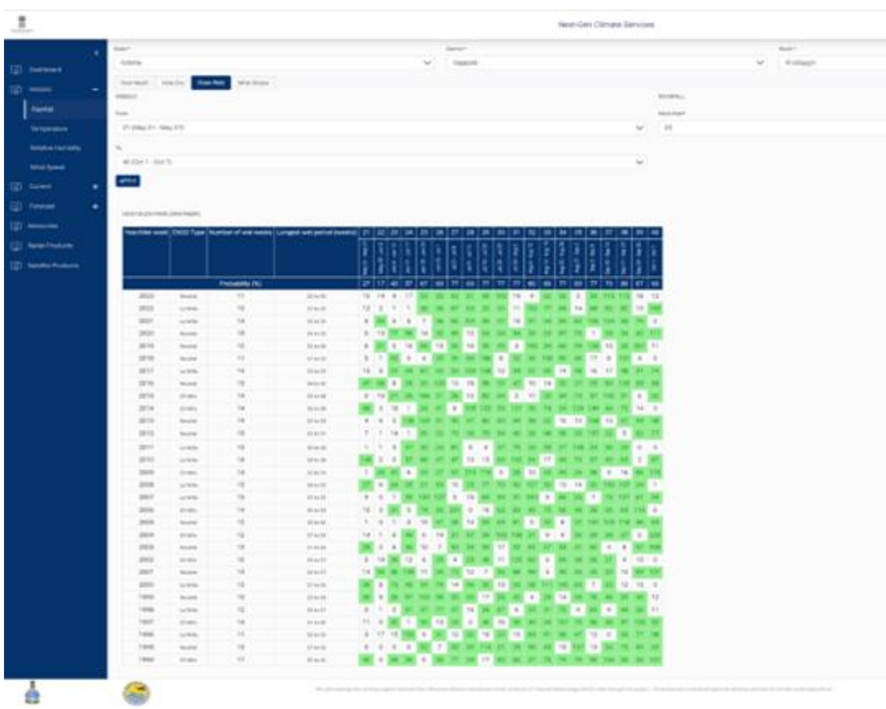


Figure 10b: Screenshot of dashboard displaying the distribution of dry weeks for the 30 year period

In addition to these analyses, the dashboard provides a unique feature "What Stress" which allows the users to explore how the probability of occurrence of rainfall varies during the crop growing period. By selecting a crop, specifying thresholds for weekly rainfall amounts that are required to meet the crop needs and by defining the acceptable level of risk (e.g., 70% or 80%), the user can visualise the distribution of probability of occurring different levels of stress through the crop growing period (Figure 11). This feature helps farmers and their support agents in identifying suitable varieties, optimal planting time and potential requirements for supplemental irrigation.

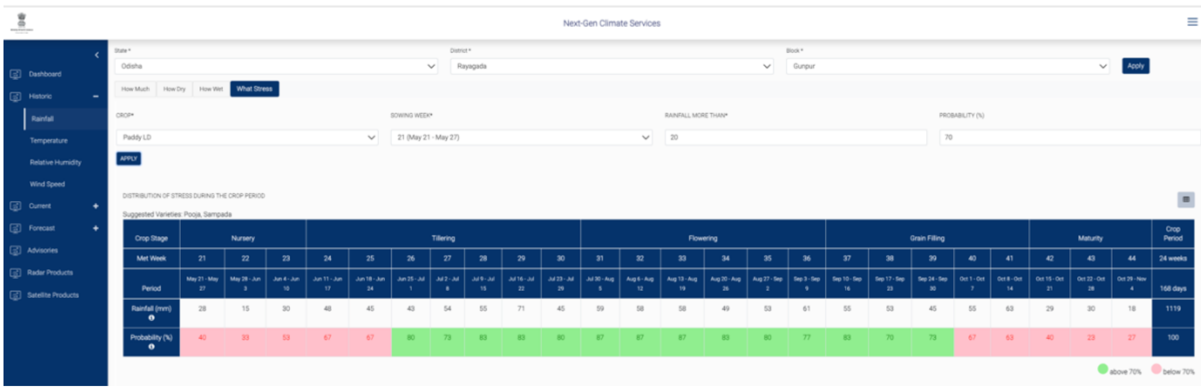


Figure 11: Screenshot showing the crop Calander and weekly probable distribution of rainfall

7.2. Pre-season advisory

The pre-season advisory is based on the seasonal climate forecast issued by IMD and prevailing El Niño or La Niña conditions. The first stage probabilistic seasonal climate forecast for the southwest monsoon season (June-September) was issued by IMD on April 15th, and the second stage forecast was issued on May 27th, 2024 (Figure 12). Based on the latest long-range forecast, the probabilistic outlook for Odisha predicts below-normal rainfall.

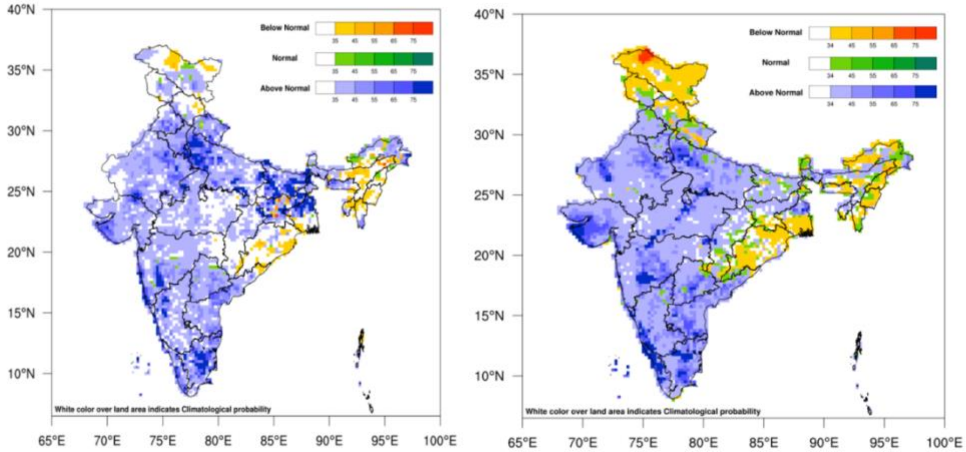


Figure 12: The first and second stage probabilistic seasonal rainfall forecast for the 2024 southwest monsoon season (June-September) issued by IMD.

Two distinct seasonal scenarios, each with varying probabilities of receiving at least 750 mm of rainfall, were identified. This is done using the hindcasts provided by IITM. The below normal and above normal forecasts are analysed to find out the probability of getting 750 mm rainfall during the years forecasted to get above and below normal rainfall. The threshold of 750 mm represents the minimum rainfall necessary to meet the water requirements of multiple crops grown in these districts. This threshold was established through an analysis of historical climate data, complemented by scenario analysis using the APSIM simulation model. Based on these insights, a pre-season decision tree (DT) was developed which classifies the years into four groups with different potential. For each group a separate advisory was prepared by identifying crops and varieties that perform during the years with identified potential (Figure 13). ISAT identifies the appropriate message based on the seasonal climate forecast issued by IMD and alerts the farmers with best bet options for the type of season predicted.

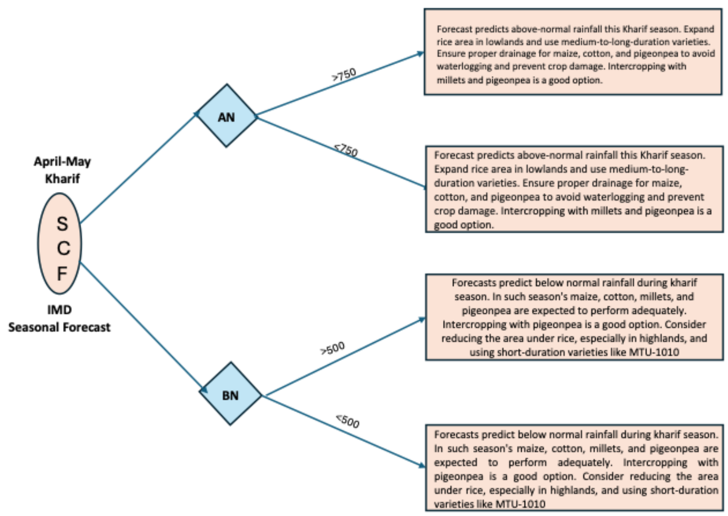


Figure 13: Decision tree used for developing pre-season advisories

7.3. In-season advisories

The in-season advisories are the weekly advisories driven by the rainfall during the past week and forecast for the next week. The 5–7day medium-range forecast is accessed directly from the IMD database using APIs. Rainfall during the past week is the observed station data where available and IMD gridded data where the station data is not available. The decision trees are adopted to these districts by defining appropriate thresholds which classify the week as wet or dry. The thresholds are generated using the results from the scenario analysis conducted with system simulation model APSIM. The decision tree classifies the week into WW, WD, DW and DD using these thresholds. For these districts we used a weekly rainfall amount of 20 mm to classify the week as wet or dry. Using this threshold amount of rainfall, the iSAT system identifies group into which the week falls and develops appropriate advisory by picking the operations listed in the lookup tables. Depending on the availability of data and requirements additional weather parameters like temperature and humidity and soil moisture observations can be integrated with the system. For these districts, much of the decision making is influenced by the amount of rainfall. Hence, we used the observed and forecasts rainfall amounts to drive the advisory generation. This logic is used by the decision tree (Figure 14) algorithm to automatically generate an appropriate advisory with context-specific information.

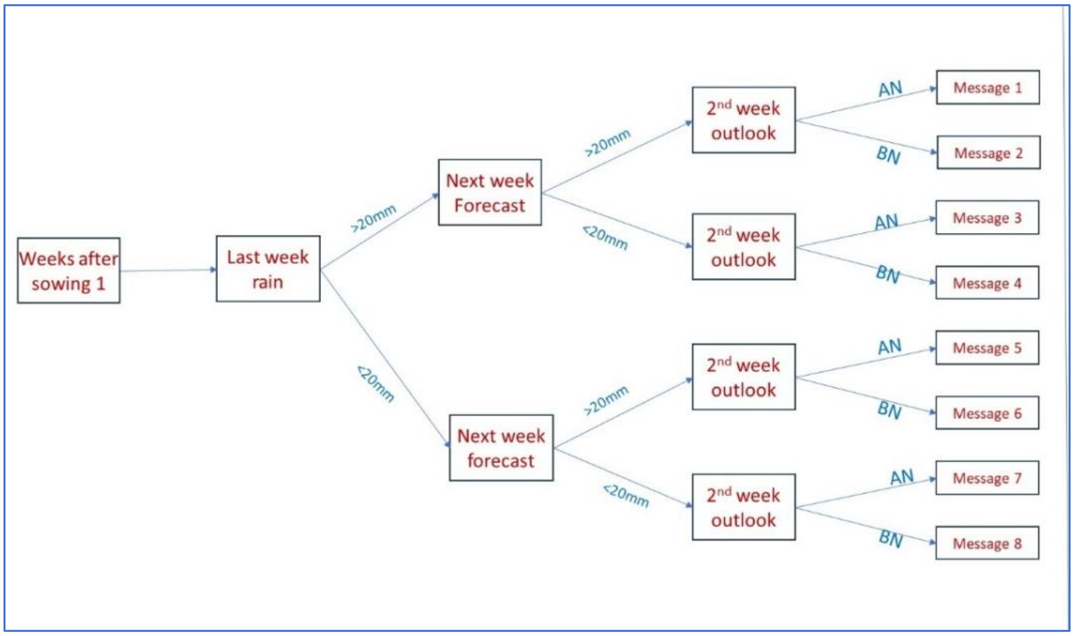


Figure 14: Decision tree used for developing in-season advisories

8. Operationalisation of iSAT to develop weather-based agro-advisories

8.1. Farmer decision making process

The iSAT system is developed to mimic the farmer decision making process in planning and managing agricultural systems. To capture the thought process of farmers, Focus Group Discussions (FGDs) were held in the districts with KVK scientists and progressive farmers from the four selected blocks of Muniguda, Gunupur, R. Udayagiri and Paralekhamundi in two districts (Figure 15). The discussions in the groups focused on identifying the key decisions that the farmers make before and during the season and understand the factors influencing those decisions.

Figure 15: FGD with the KVK staff and farmers

At all locations, farmers consistently identified climate variability as the biggest challenge they face during the growing season. According to the farmers, they are experiencing increasingly erratic weather patterns, characterized by delayed monsoon onsets and early withdrawals causing considerable disruption to their farm operations.

Most farmers recognized rainfall as the most influential climatic factor in agricultural decision-making. Specifically, over 70% of respondents emphasized the critical role of rainfall in determining the timing of sowing operations. Other key agricultural activities affected by variable weather conditions included irrigation scheduling, fertilizer and pesticide application, pest and disease management, and harvesting. During the discussions, farmers in Rayagada and Gajapati districts narrated the important decisions that they make while growing Paddy, Maize, and Cotton crops and factors driving these decisions, from pre-season planning to in-season management (Table 6).

Table 6: Key farm decisions and factors driving those decisions as identified by farmers.

Month	Major on farm decisions	Drivers Behind Decisions
May	-Land preparation -Field bunding -Seed selection	-Expectations on June rainfall -Soil condition -Availability of FYM -Past season experience
June	-Seedling preparation and nursery establishment -Maize sowing (3rd week) -Cotton sowing (Late June)	-season start rains -locally available seeds and kvk suggested seeds
July	- Transplanting Paddy seedlings (late July) -Pending sowings of maize and cotton	-labor availabity and machines - expecting good rainfall distribution
August	-Top dressing -Pest management	-Rainfall status -PD surveillance
September	-Harvesting of early maize -paddy field management -PD management in paddy and cotton	-soil moisture and rainfall conditions -market prices - PD surveillance
October	-maize harvest -paddy maturing (late oct to nov) -pest control	-weather forecast -available of labor -advisories
November	-harvesting matured crop -1st picking of cotton (late nov)	-weather conditions -forecast

Although rainfall was considered as the primary factor driving various farm operations, many farmers also emphasized the role of temperature, particularly for its influence on pest and disease outbreaks (Figure 16). This is taken into consideration while developing advisories with pest and disease alerts.

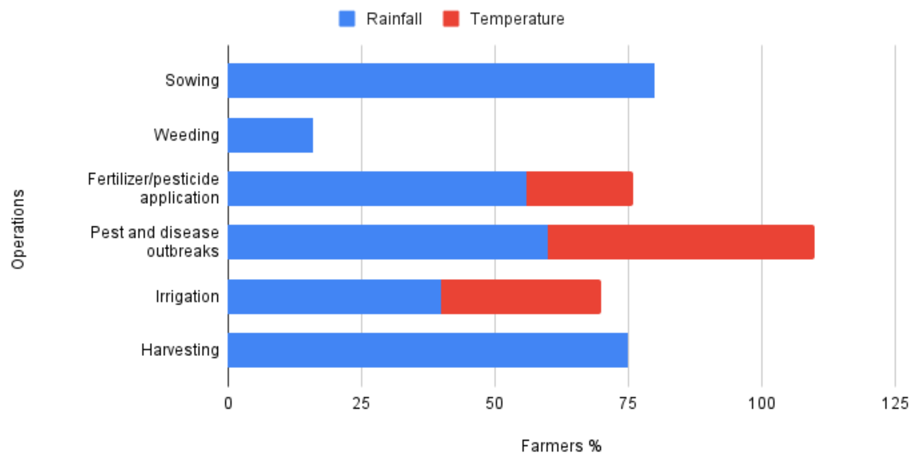


Figure 16. Influence of Rainfall and Temperature on key operations by Farmers

8.2. Location specific agricultural information

Another important step in operationalising iSAT is to populate the lookup tables with locally relevant agricultural information. This includes crops and varieties grown in that area, crop clendars, POPs, and contingency plans. An example of weekly condition-based weather advisories aligned with crop stages is presented in Annexure table 2. This information was compiled from various sources. This included consultations with experts from various fields and reports and publications on various aspects like agronomy, soils, entomology and pathology for major cropping system from local university and research institutions. The information compiled is organized crop stage wise using weeks after planting as the proxy. These advisories were customized for every growth stage of the crop (Figure 17) covering land preparation (1 month before the planting window start), planting (during the pre-defined planting window). seedling, vegetative, reproductive, grain development, harvest, and post-harvest (1 week after harvest) stages. Sample of weekly weather conditions aligned with the different crop stages are shown in the S. Table 3. This information is added to lookup tables that the ISAT system accesses. The required information is sourced through extensive review of published and unpublished information after conducting quality checks and vetted by the local subject matter specialists for its relevance.

<table>
<tr><td colspan="3">MAY</td><td colspan="5">JUNE</td><td colspan="4">JULY</td><td colspan="4">AUGUST</td><td colspan="5">SEPTEMBER</td><td colspan="3">OCTOBER</td></tr>
<tr><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td>24</td><td>25</td><td>26</td><td>27</td><td>28</td><td>29</td><td>30</td><td>31</td><td>32</td><td>33</td><td>34</td><td>35</td><td>36</td><td>37</td><td>38</td><td>39</td><td>40</td><td>41</td><td>42</td></tr>
<tr><td colspan="3">Sowing</td><td colspan="5">Transplanting</td><td colspan="5">Tillering</td><td colspan="4">Heading</td><td colspan="2">Flowering</td><td colspan="2">Grain filling</td><td colspan="3">Maturity</td></tr>
<tr><td colspan="24">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.</td></tr>
</table>

Figure 17: Example of a crop Calander based advisory generation

9. Generating location specific advisories using iSAT

Generation of advisories using iSAT is simple once the required information is compiled and integrated with the ISAT. The following screenshots (Figure 18) display the ISAT frontend used to generate relevant messages and the input information required. The input parameters include information about the block for which the advisory is to be generated, the week of the year, last week's recorded rainfall, the forecast for next week, and the outlook for the following week. The program automatically accesses and displays the rainfall information once the location is selected. After selecting the location, the user is required to select the crop and age of the crop as days after planting. For each crop, there will be three options depending on the number of days that the variety takes from sowing to harvest. These are designated as LD (Long duration), MD (Medium duration) and SD (Short duration).

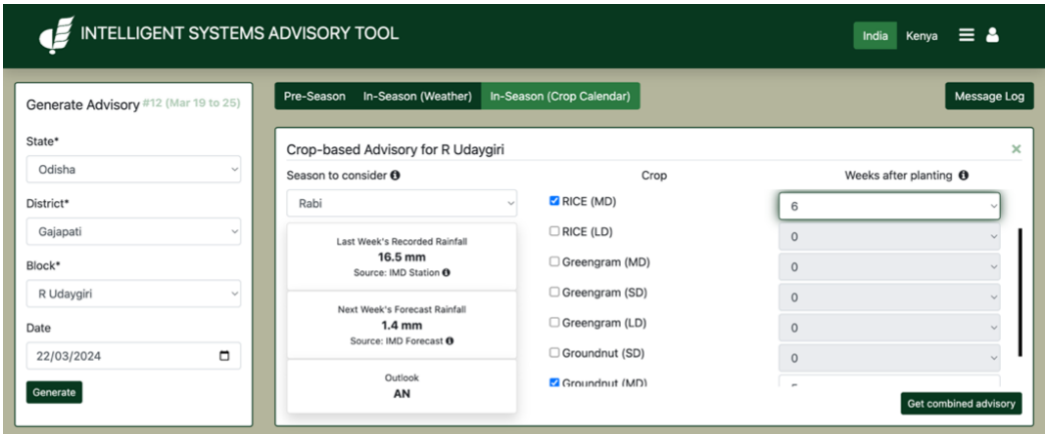


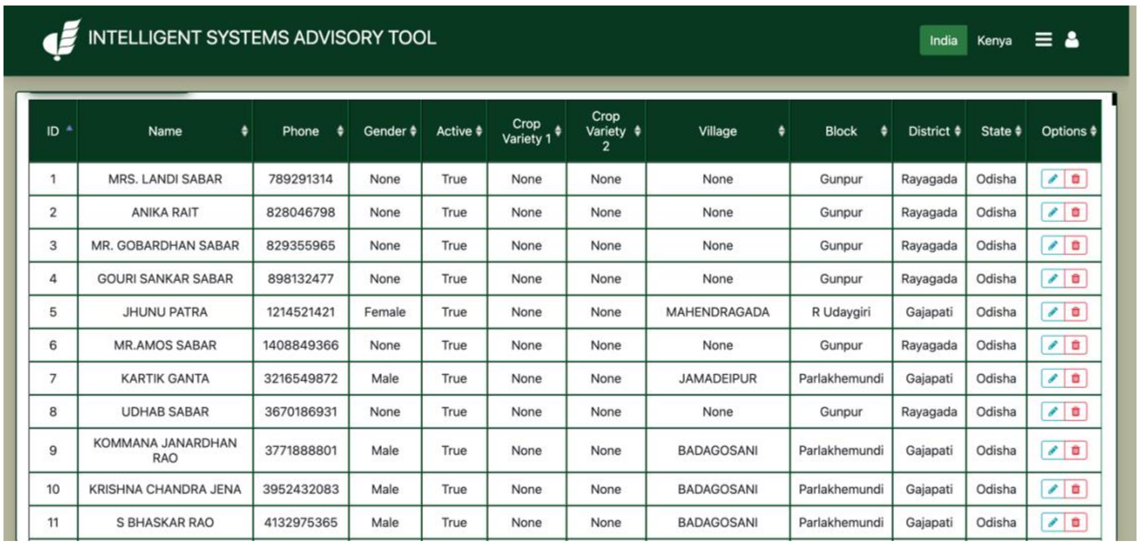
Figure 18: Screenshot of ISAT frontend with various input options

The program allows the user to select multiple crops and input age of the crop by inputting weeks after planting. After selecting the required input parameters, the advisory can be generated by clicking on the button "Get Advisory" (Figure 19). Advisories are also linked to include plant protection measures, with weather scenarios helping to forecast the emergence and spread of pests and diseases. These are mapped to the crop's vulnerability at specific stages of growth. It's important that these advisories are concise, adhering to SMS length limits (150-200 characters) and yet provide clear and actionable guidance to farmers. Since these messages are intended for widespread use among farmers, ISAT includes an option to translate the advisory into local language Odiya. Currently, advisories have been developed and disseminate for 9 different crops in these two districts.

Figure 19: ISAT-generated advisory with different format options

10. Dissemination of the advisory

To facilitate the dissemination of advisories, contacts of about 6000 farmers were collected from KVK and Block Agriculture offices across and onboarded to the advisory platform (Figure 20). For the dissemination of advisories via SMS, the Telecom Regulatory Authority of India (TRAI) mandates that all organizations sending SMS messages domestically must register on Distributed Ledger Technology (DLT) platforms. This registration process, along with sender whitelisting, is designed to mitigate unsolicited commercial communication (UCC), control promotional content, and reduce instances of SMS fraud.



ID	Name	Phone	Gender	Active	Crop Variety 1	Crop Variety 2	Village	Block	District	State	Options
1	MRS. LANDI SABAR	789291314	None	True	None	None	None	Gunpur	Rayagada	Odisha	
2	ANIKA RAIT	828046798	None	True	None	None	None	Gunpur	Rayagada	Odisha	
3	MR. GOBARDHAN SABAR	829355965	None	True	None	None	None	Gunpur	Rayagada	Odisha	
4	GOURI SANKAR SABAR	898132477	None	True	None	None	None	Gunpur	Rayagada	Odisha	
5	JHUNU PATRA	1214521421	Female	True	None	None	MAHENDRAGADA	R Udaygiri	Gajapati	Odisha	
6	MR.AMOS SABAR	1408849366	None	True	None	None	None	Gunpur	Rayagada	Odisha	
7	KARTIK GANTA	3216549872	Male	True	None	None	JAMADEIPUR	Parlakhemundi	Gajapati	Odisha	
8	UDHAB SABAR	3670186931	None	True	None	None	None	Gunpur	Rayagada	Odisha	
9	KOMMANA JANARDHAN RAO	3771888801	Male	True	None	None	BADAGOSANI	Parlakhemundi	Gajapati	Odisha	
10	KRISHNA CHANDRA JENA	3952432083	Male	True	None	None	BADAGOSANI	Parlakhemundi	Gajapati	Odisha	
11	S BHASKAR RAO	4132975365	Male	True	None	None	BADAGOSANI	Parlakhemundi	Gajapati	Odisha	

Figure 20: Farmers' Information from the target blocks

Farmer advisory services are also required to register on the DLT platform and pre-register all advisory templates (i.e., the messages that will be sent to farmers). While this process has commenced, several challenges have raised. One such issue involves the service provider's inability to classify before approval the advisory templates as "service implicit," resulting in a request to register them as "service explicit." However, registering advisories as "service explicit" could lead to delivery failures for recipients who have activated Do Not Disturb (DND) services. This becomes particularly problematic when advisories need to be adjusted in real-time scenarios field conditions on the forecast day.

To avoid delays and ensure timely dissemination, particularly during pre-season and in-season advisories have also been sent via WhatsApp. Currently, around 50% of farmers are using WhatsApp

(Figure 21), and dedicated block-wise WhatsApp groups have been created to deliver weekly advisory messages efficiently through this platform.

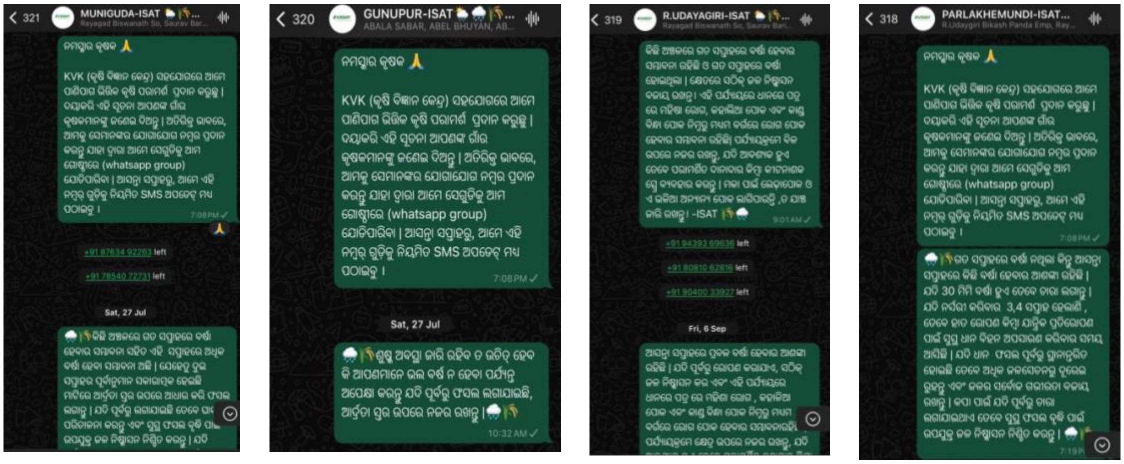


Figure 21: Block-wise WhatsApp Groups for Advisory Dissemination

The iSAT generated advisories are structured for compatibility with multiple platforms, ensuring that they can also be pushed to mobile applications and webpages. Advisory message formats are designed to align with different Information and Communication Technology (ICT) platforms, thereby enabling farmers to access critical information across various digital channels.

11. Awareness Programme for Farmers on Climate services:

As part of the ongoing efforts to equip farmers with timely and accurate farming advisories, awareness programmes were conducted in Rayagada and Gajapati districts of Odisha. This initiative aimed to inform farmers about the benefits of tailored digital climate advisories delivered through ISAT platform and gather feedback on the effectiveness of pre-seasonal and in-season advisories in supporting their farming decisions.

The awareness programs were held across four key blocks Muniguda, Gunupur, R. Udayagiri, and Paralekhamundi (Figure 22) where farmers were introduced to the importance of digital climate services and advisories specifically designed for their region. During these interactive sessions, the team was engaged with farmers to understand how these advisories were influencing their crop planning, soil management, and irrigation practices. The discussions provided valuable insights into how these advisories were being utilized and areas where further refinement might be needed.

Figure 22: Farmers Awareness Programme conducted in Rayagada and Gajapati

11.1. Feedback from the farmers

A key takeaway from the sessions was the importance of village-level training to ensure that farmers can fully harness the potential of digital climate services. Farmers emphasized that pre-seasonal advisories had significantly contributed to their crop planning, allowing them to make informed decisions based on weather forecasts and expected rainfall patterns. Their feedback helped in refining the advisory services, as farmers need advisories mainly on the sowing time, plant protection, fertilizer applications and management practices under forecasted weather. A proper feedback mechanism needs to be developed to regularly collect the farmers responses on the advisories. An example feedback from few farmers' is given below.

Tara Ranjit, a farmer in Ranalli village in Gajapati district	He initially was planned to sow long duration paddy, but after receiving the pre-season advisory indicating a Below-normal forecast he opted for medium duration variety as recommended in the advisory. He noted that the rainfall distribution so far is very uneven.
Tila Kasi, a farmer from Kumadabali village in Rayagada district	After few days of sowing, he decided to irrigate his cotton crop. However, after receiving the advisory which indicated the rain forecast, the same was postponed leading to cost savings.

12. Early season survey

A survey was conducted during the early part of the season after the dissemination of pre-season advisories with an aim to assess farmers' decision-making processes at the start of the season, specifically focusing on land preparation, seed selection, and sowing practices. The survey covered four blocks Muniguda, Gunupur, R. Udayagiri, and Paralekhamundi and involved a total of 200 farmers, 50 farmers from each block. More than 80% of the participating farmers have indicated that they are receiving the advisories and following them (Table 7).

Table 6: % of farmers following the messages and major crops grown

Block	No. of Farmers Surveyed	% of Farmers following the advisories	Main crops grown	
			Crop 1	Crop 2
Muniguda	50	93.00 %	Paddy	Cotton
Gunupur	50	89.50 %	Paddy	Cotton
R. Udayagiri	50	96.30 %	Paddy	Maize
Paralekhamundi	50	78.50 %	Paddy	-

Key findings from the survey include significant influence of the pre-seasonal advisories in making decisions on timing of land preparation, crop selection and sowing time. The survey also revealed that consistent communication is essential to motivate the farmers to regularly follow the information provided in the advisory messages. The overall findings from the survey will be published once the post survey is done, still the crop is at pre-maturity stage and one survey is pending which will be post season.

A. Adoption of Climate Services:

Farmers in these districts have utilised climate services for various agricultural activities (Figure 23). The survey showed that: 82% of farmers accessed climate advisories for general information. Among them, 84% reported following these advisories for specific farm activities. Sowing decisions were the most influenced by climate advisories (67% adoption), followed by crop protection (69%) and fertilizer application (57%). Other operations like irrigation and harvest showed lower adoption levels (24% and 52%, respectively).

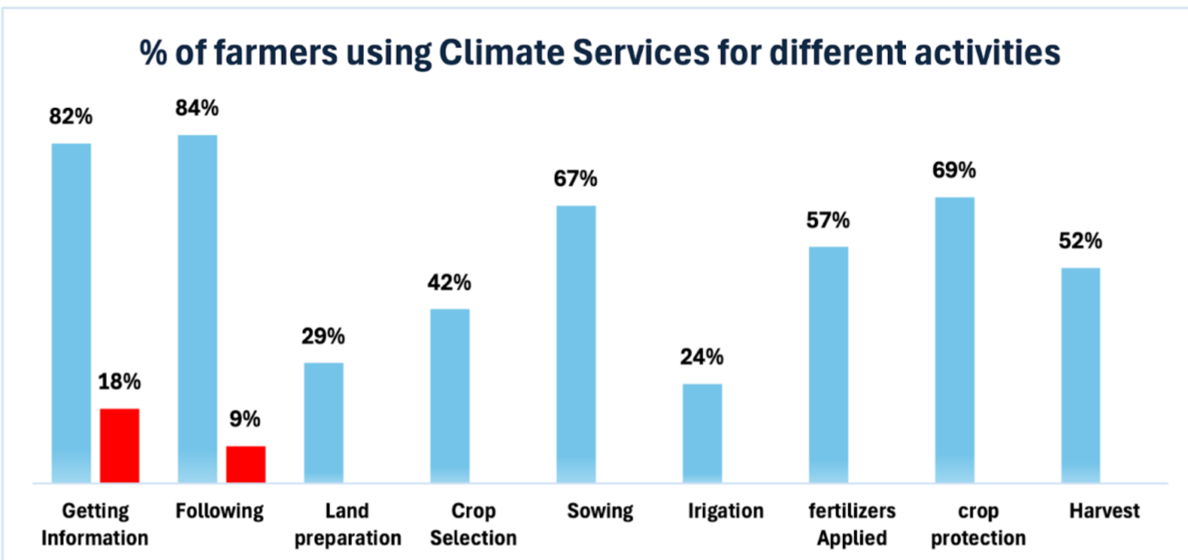


Figure 23: Adoption of Climate Services for Farming Operations

13. Challenges in scaling up

Several challenges were faced in scaling up weather-based agro-advisories which varied from data availability to limitations in the capacity.

a. **Data Availability: A**vailability of real-time weather data at the block level is one of the main limitations in tailoring the advisories and in making them more location specific. In the absence of this data the system uses the coarse gridded data which effects the quality of the advisory. We are trying to develop a process to overcome this by using certain bias correction methods to eliminate systemic bias that normally occurs while interpolating the data. Obtaining accurate data on cropping systems timely is another problem. The system is currently accessing district-level data through contingency plans. This approach often generalizes cropping patterns, making it difficult to identify block-specific crops without partnering with local organizations. The absence of such granular data compromises the precision of the advisories.

b. **Advisory Customization:** Customizing the advisories to reflect the specific conditions of each block, such as local crops, soil types, and farming practices, requires in-depth contextual knowledge and is resource-intensive. But with the extensive network of research and developmental institutions, it is possible compile such information by involving and collaborating with relevant institutions. There are also problems with the format of the advisories. Farmers use a wide variety of mobile devices that include basic phones, feature phones, and smartphones that support WhatsApp. This imposes limits on character size, display format, and file compatibility. Hence, there is a need to tailor advisory formats to suit multiple device types.

c. Dissemination and Integration of Channels: Integrating the chosen dissemination channel SMS with the advisory platform also posed significant difficulties. To comply with TRAI (Telecom Regulatory Authority of India) regulations, every SMS message had to be registered and approved before dissemination, due to increasing concerns about fraud and spam. This process required us to integrate a Distributed Ledger Technology (DLT) registration, as mandated by TRAI. However, in urgent situations where real-time advisories were needed, the TRAI approval process often caused delays, compromising the timeliness of advisory messages. At times, when the SMS gateway was delayed, we had to rely on alternative dissemination methods, which were not always as effective or immediate.

d. Advisory Translation: Another critical challenge is translating advisories into the local language. While the platform generates content in English, manual translation into the regional language is a time-consuming and labor-intensive task. We attempted to integrate automatic translation tools, but they often failed to capture the nuances of the message in a way that was both understandable and relevant to the farmers. This discrepancy between the generated and translated content made it difficult for farmers to fully comprehend and act upon the advisories.

e. **Farmer Engagement:** Engaging farmers effectively and ensuring their active participation has been a persistent challenge. Collecting the contact details of all farmers across different blocks and onboarding them onto the platform is a big task, exacerbated by limited digital literacy and awareness of climate services among many farmers. Even after onboarding, maintaining consistent engagement with farmers and encouraging them to follow the advisories has proven difficult. Additionally, gathering feedback from farmers on the usefulness and relevance of the advisories is nearly impossible on a large scale, further complicating efforts to refine and improve the service.

f. **Capacity Building and Training:** Organizing capacity-building programs on climate services also faced hurdles. Although these programs are essential to equip farmers and extension officers with the knowledge and tools to use the advisory services effectively, logistical and resource constraints made widespread implementation challenging. Coordinating training sessions across large areas, ensuring attendance, and delivering content in an accessible manner were some of the key difficulties. Additionally, many of the local extension officers required further training themselves on digital tools and climate data interpretation before they could adequately support farmers.

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Annexure

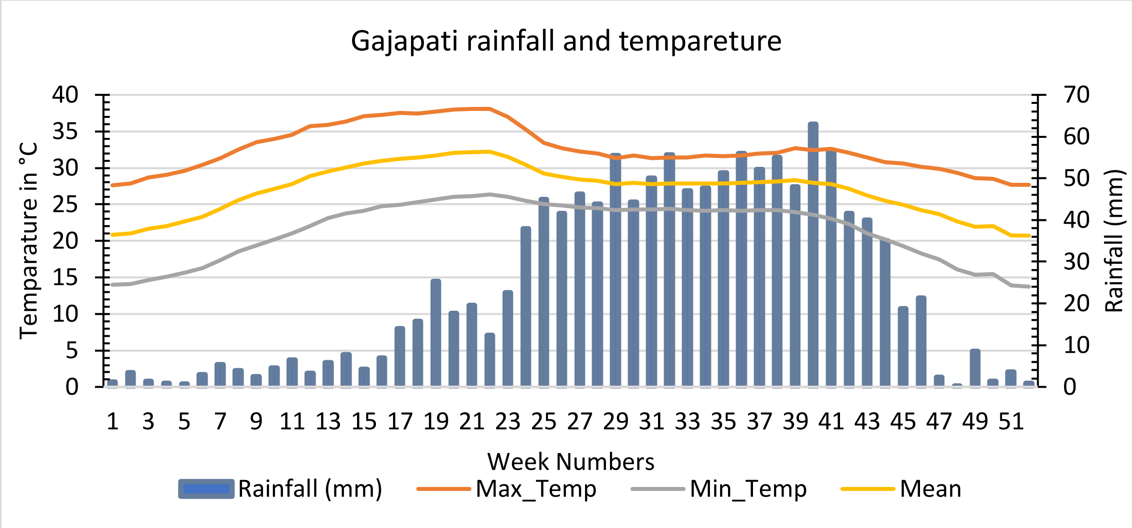

Fig. 1.a: Weekly average rainfall and temperatures for Gajapati

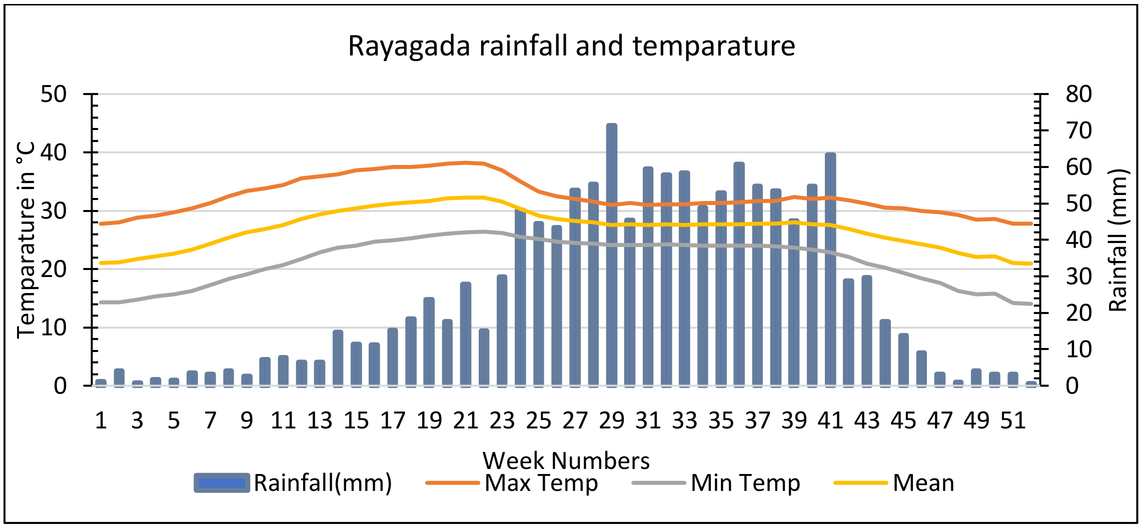

Fig. 1.b: Weekly average rainfall and temperatures for Rayagada

S. Table 1: Seasonal Rainfall and Onset Times in Rayagada and Gajapati Districts

Rainfall (Seasonal)	Normal RF		Normal Rainy days		Onset time	
	Rayagada	**Gajapati**	**Rayagada**	**Gajapati**	**Rayagada**	**Gajapati**
South West monsoon (June-Sep)	868.40	922.10	56	47	2nd week of June	2nd week of June
NE monsoon (Oct-Dec)	275.55	256.1	9	9		
Winter (Jan-Feb)	22.80	72.4	5	4		
Summer (Mar-May)	151.80	173.0	7	10		
Annual	1320.55	1258.6	78	71		

Table 1: Probability index for weekly rainfall

WEEK	Probability Rayagada				Probability of Gajapati			
	Average	90%	75%	50%	Average	90%	75%	50%
1	1.07	0.00	0.00	0.00	1.20	0.00	0.00	0.00
2	3.99	0.00	0.00	0.00	3.50	0.00	0.00	0.00
3	0.71	0.00	0.00	0.00	1.40	0.00	0.00	0.00
4	1.70	0.00	0.00	0.00	0.89	0.00	0.00	0.00
5	1.46	0.00	0.00	0.00	0.75	0.00	0.00	0.00
6	3.54	0.00	0.00	0.00	2.98	0.00	0.00	0.00
7	3.17	0.00	0.00	0.00	5.27	0.00	0.00	0.00
8	4.07	0.00	0.00	0.00	3.85	0.00	0.00	0.00
9	2.52	0.00	0.00	0.00	2.46	0.00	0.00	0.00
10	7.05	0.00	0.00	0.00	4.55	0.00	0.00	0.06
11	7.67	0.00	0.00	0.36	6.39	0.00	0.00	0.05
12	6.48	0.00	0.00	0.00	3.20	0.00	0.00	0.00
13	6.45	0.00	0.00	1.79	5.79	0.00	0.00	1.07
14	14.68	0.00	0.00	4.39	7.71	0.00	0.00	2.25
15	11.29	0.00	0.00	2.45	4.16	0.00	0.00	2.64
16	11.24	0.00	0.00	6.38	6.95	0.00	0.11	1.65
17	15.19	0.00	0.63	6.10	13.99	0.00	0.09	7.34
18	18.38	0.00	2.67	9.46	15.64	0.00	1.68	5.68
19	23.62	0.00	1.06	10.13	25.21	0.00	0.91	4.94
20	17.57	1.19	6.25	12.61	17.56	0.44	2.61	7.03
21	27.78	0.60	8.37	16.51	19.48	0.38	1.77	9.94
22	14.92	0.47	2.53	8.89	12.32	0.00	1.19	4.34
23	29.86	2.35	8.75	23.28	22.57	0.96	3.54	15.12
24	48.04	1.32	9.27	35.99	37.91	0.25	4.52	25.44
25	44.50	2.94	15.63	30.02	44.96	4.93	10.95	32.46
26	43.26	8.07	23.43	36.18	41.58	13.74	22.38	34.29
27	53.53	12.54	18.21	47.90	46.22	8.55	19.19	34.25
28	55.28	11.05	34.14	47.39	43.85	5.96	14.21	27.54
29	71.32	12.77	23.49	44.27	55.52	13.70	21.03	38.83
30	45.29	7.65	25.43	41.36	44.33	11.38	19.84	34.45
31	59.35	16.97	27.77	43.78	50.06	6.94	24.67	41.92
32	57.77	13.48	27.46	40.03	55.60	6.39	24.65	36.75
33	58.26	12.25	27.07	49.22	47.02	9.10	22.50	42.99
34	48.84	12.54	27.52	43.30	47.69	13.13	22.43	48.79
35	52.95	10.74	25.73	48.78	51.31	10.68	25.88	44.35
36	60.65	13.90	22.00	48.36	55.96	8.07	19.46	35.04
37	54.71	6.99	28.66	43.21	52.11	5.63	17.30	35.87
38	53.50	11.57	17.97	44.55	54.98	9.84	23.99	41.31
39	45.26	1.45	15.47	40.57	48.03	2.88	15.03	41.70
40	54.62	0.45	7.45	38.55	63.00	0.03	6.04	38.91
41	63.36	0.44	7.74	31.90	56.46	0.15	5.79	10.22
42	28.69	0.13	1.08	12.42	41.50	0.00	0.61	15.17
43	29.72	0.00	0.00	4.35	40.01	0.00	0.00	4.54
44	17.50	0.00	0.00	5.74	35.10	0.00	0.00	9.05
45	13.65	0.00	0.00	1.10	18.72	0.00	0.00	0.30
46	8.94	0.00	0.00	0.15	21.37	0.00	0.00	0.00
47	3.04	0.00	0.00	0.00	2.37	0.00	0.00	0.00
48	0.92	0.00	0.00	0.00	0.17	0.00	0.00	0.00
49	3.99	0.00	0.00	0.00	8.54	0.00	0.00	0.00
50	3.10	0.00	0.00	0.00	1.37	0.00	0.00	0.00
51	3.17	0.00	0.00	0.00	3.65	0.00	0.00	0.00
52	0.53	0.00	0.00	0.00	0.91	0.00	0.00	0.00

S. Table 2: Crop Stage Classification by Days After Sowing (DAS)

S. No	Crop	Initial stage (Land preparation/ Nursery/ sowing)	Vegetative	Reproductive	Maturity	Harvest
	Rice (sd)	20	40	65	105	120
	Rice (md)	35	70	105	150	170
	Maize	15	40	62	105	120
	Pigeon pea	15	35	60	120	130
	Groundnut	14	35	50	96	110
	Cotton	15	40	120	160	175

S. Table3: Weekly Scenario-Based Weather Advisories for RICE (short-duration)

From Zero Week	RICE (SD)	2 Week outlook			
	STAGE	DD	DW	WD	WW
-3	Land preparation/Nursery	Dry weather is expected. Do nursery preparation	Anticipating rainfall, prepare for nursery	Dry weather is expected. Do nursery preparation	By utilising rainfall, prepare nursery for sowing.
-2	Land preparation/ Nursery	Dry weather is expected. Do nursery preparation	Anticipating rainfall, prepare for nursery	Dry weather is expected. Do nursery preparation	By utilising rainfall, prepare nursery for sowing.
-1	Land preparation/ Nursery	Dry weather is expected. Do nursery preparation	Anticipating rainfall, prepare for nursery	Dry weather is expected. Do nursery preparation	By utilising rainfall, prepare nursery for sowing.

0	Transplanting	Dry period is continuing, if there is optimal depth of water go for transplanting	Anticipating rainfall, transplanting can be done	By utilising last week rainfall, prepare main field for transplanting	Rainfall expected provide adequate drainage. Postpone transplanting until the depth of water is optimal
1	Vegetative	Forecast indicates Continued dry weather, Ensure water management with efficient irrigation	Prepare for wetter conditions next week after a dry week; based on the field condition avoid irrigation and maintain optimal depth of water	After a good amount of rain last week, next week's forecast predicts dry conditions with no rain expected, ensure proper water management in the rice fields to maintain an optimal level or depth	Last week received good amount of rainfall and expecting rainfall for the next week, provide adequate drainage and postpone fertiliser application
2	Vegetative	Dry weather is expecting favouring sucking pest like thrips and mites. Perform manual weeding, to remove emerging weeds	Anticipating rainfall, avoid irrigation. Perform manual weeding, to remove emerging weeds	Dry weather is expected, favouring sucking pest like thrips and mites. Perform manual weeding, to remove emerging weeds	Last week received good amount of rainfall and expecting rainfall for the next week, provide adequate drainage.

3	Vegetative	Dry weather is expecting favouring sucking pest like thrips and mites. Avoid top dressing.	Anticipating rainfall, avoid irrigation. Top dressing can be done.	Dry weather is expected, favouring sucking pest like thrips and mites. Keep monitoring	Last week received good amount of rainfall and expecting rainfall for the next week, provide adequate drainage and postpone fertiliser application
4	Vegetative	Dry period is continuing. Monitor for Stem Borers at any stage.	Anticipating rainfall. Monitor for Stem Borers at any stage. use of biological agents such as Trichogramma wasps are suggested	Dry weather is expecting. Monitor for Stem Borers at any stage.	Expecting good amount of rainfall as last week. Monitor for Stem Borers at any stage. use of biological agents such as Trichogramma wasps are suggested
5	Reproductive	Perform manual weeding, especially in this stage of rice growth, to remove emerging weeds	Perform manual weeding, especially in this stage of rice growth, to remove emerging weeds	Perform manual weeding, especially in this stage of rice growth, to remove emerging weeds	Due to continued rain provide adequate drainage and remove emerging weeds
6	Reproductive	Forecast indicates Continued dry weather,	Prepare for wetter conditions next week	After a good amount of rain last week, next	Anticipate continued rainfall in the upcoming week,

		Ensure water management with efficient irrigation	after a dry week; based on the field condition avoid irrigation and maintain optimal depth of water	week's forecast indicates dry conditions, ensure proper water management in the rice fields to maintain an optimal level or depth	avoid excess irrigation and maintain optimal depth of water
7	Reproductive	Dry period is continuing, second top dressing can be done with the required amount.	Forecast indicates rain next week; second top dressing can be done with the required amount.	Forecast indicates no rain; second top dressing can be done with the required amount.	Forecast indicates continued rain, postpone 2nd top dressing and wait for better condition
8	Reproductive	Dry period is continuing, maintain the optimal water level for your rice crop	Forecast indicates rain next week; maintain the optimal water level for your rice crop	Forecast indicates no rain; maintain the optimal water level for your rice crop	Forecast indicates continued rain, provide adequate drainage
9	Reproductive	Dry period is continuing. Monitor for Stem Borers at any stage.	Anticipating rainfall. Monitor for Stem Borers at any stage. use of biological agents such as Trichogramma	Dry weather is expecting. Monitor for Stem Borers at any stage.	Expecting good amount of rainfall as last week. Monitor for Stem Borers at any stage. use of biological agents such as Trichogramma

			wasps are suggested		wasps are suggested
10	Maturity	Continued dry weather necessitates careful water resource management, efficient irrigation	Prepare for wetter conditions next week after a dry week; ensure proper field management	Prepare for drier conditions next week; monitor moisture levels and adjust farming practices accordingly	Anticipate continued rainfall next week; ensure proper drainage for healthy crop growth
11	Maturity	Continued dry weather necessitates careful water resource management, efficient irrigation	Prepare for wetter conditions next week after a dry week; ensure proper field management	Prepare for drier conditions next week; monitor moisture levels and adjust farming practices accordingly	Anticipate continued rainfall next week; ensure proper drainage for healthy crop growth
12	Maturity	Continued dry weather, Harvest time approaches; prepare and protect your crops from damage	Prepare for wetter conditions next week. Harvest time approaches; prepare and protect your crops from damage	Prepare for drier conditions next week. Harvest time approaches; prepare and protect your crops from damage	Continuous rainfall calls for the maintenance of effective drainage systems. Harvest time approaches.
13	Maturity	Continued dry weather, Harvest time	Prepare for wetter conditions	Prepare for drier conditions	Continuous rainfall calls for the maintenance

		approaches; prepare and protect your crops from damage	next week. Harvest time approaches; prepare and protect your crops from damage	next week. Harvest time approaches; prepare and protect your crops from damage	of effective drainage systems. Harvest time approaches.
14	Harvest	Harvest when 75% grains matured and dry for 2-3 days to reduce moisture.	Forecast indicates rain next week, harvest and keep your grains safe from moisture.	Forecast indicates no rain next week. Harvest when 75% grains matured.	Postpone harvest as forecast indicates continued rains.