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Mangshatabam Annie
Department of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana, Punjab, India

Raj Kumar Pal
Department of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana, Punjab, India

Kakali Konwar
Department of Agronomy, Assam Agricultural University, Jorhat, Assam, India

Corresponding Author:
Mangshatabam Annie
Department of Climate Change and Agricultural Meteorology, Punjab Agricultural University, Ludhiana, Punjab, India

Enhancing agricultural risk management through weather forecasting and agro-meteorological advisory services

Mangshatabam Annie, Raj Kumar Pal and Kakali Konwar

Abstract
Agriculture is a vital sector in India, contributing significantly to the country economy and supporting the livelihoods of a large portion of the population. However, climate change has emerged as a significant threat to the sector, impacting crop yields, altering weather patterns, and creating uncertain growing conditions for farmers. In this situation, providing accurate and timely agromet advisories is essential. The India Meteorological Department, under the Ministry of Earth Sciences, is addressing the issues related to agriculture and also to combat the impact of climate change through Agromet advisory Services. These services provide farmers with specialized advisories that can greatly improve crop production and mitigate the negative effects of extreme weather. Farmers can take the necessary activities at the farm level according to the agromet alerts and advance weather information provided by AAS. The delivery of services is being extended up to the village level in order to improve efficient risk management in agriculture.

Keywords: Climate change, agromet advisories, mitigate, risk management

Introduction
India is an agricultural-based economy, and weather plays a crucial role in determining the success of the agricultural sector. Weather variability and extreme events such as droughts and floods can significantly impact crop yields and food production. To reduce the risks of food production loss owing to the whims of nature, weather forecasts should be one of the primary inputs in agricultural planning. Weather forecast plays a critical role in providing farmers with accurate and timely information on weather patterns, which helps them plan their farming activities, such as planting, irrigation, and harvesting. Weather anomalies may be greatly reduced by timely dissemination of preventative measures to the farming community through Agromet Advisory Services (AAS). Accurate weather forecast enables farmers to manage risks associated with extreme weather events, such as floods, droughts, and storms, which can cause significant losses in agriculture (Chattopadhyay and Rathore, 2013) [1] Therefore, timely and accurate weather forecasting is critical for farmers to plan their agricultural activities and minimize the risks associated with weather variability. Agro-advisory services are an essential tool for farmers to receive tailored information and advice based on weather forecasts and other factors that can affect their crops. In recent years, there have been significant developments in weather forecasting and agro-advisory services in India, and these services have become increasingly accessible to farmers. In combination with agro-meteorological advisory services, weather forecasts can help farmers optimize their crop yields, reduce waste, and enhance the resilience of agriculture to climate change

History and development
The India Meteorological Department (IMD) was established in 1875 during the colonial era to provide weather forecasts and warnings for the shipping industry. Over time, its services expanded to include other sectors, such as agriculture. Initially, weather forecasting was based on simple observations made by a network of weather observers spread across the country, including wind direction, cloud cover, and temperature readings. Meteorologists then analyzed this data to generate weather forecasts. In the 20th century, the IMD adopted more advanced methods for weather forecasting, such as using radiosonde balloons to measure temperature, pressure, and humidity at different altitudes, and radar technology to track storms and other weather phenomena.

In the 1970s, numerical weather prediction models were introduced, which used complex mathematical equations to simulate atmospheric behavior and generate weather forecasts. Today, IMD is providing weather forecasts and alerts for numerous industries today, including agriculture, aviation, and disaster management. IMD has a network of automatic weather stations across the nation to collect real-time weather data and uses a variety of techniques, including satellite imagery, radar data, and numerical weather prediction models, to provide weather predictions. Also it has started a number of projects in recent years to increase the precision and delivery of weather forecasts to various sectors, including the use of mobile phones to provide weather forecasts and agro-advisory services to farmers in remote locations. To increase the precision of weather predictions and warnings for extreme weather occurrences like cyclones, a network of Doppler weather radars has also been set up across the nation.

Weather forecasting

Weather forecasting can be categorized based on the duration of the forecasting period. The six main categories are now-casting, very short range weather forecasting, short range weather forecasting, medium range weather forecasting, extended range weather forecasting, and long range weather forecasting.

- **Now-casting (NC):** Now-casting refers to type of weather forecasting that is immediate or very short-term which derived from Doppler weather radar for time periods up to 6 hours. Fast-changing meteorological conditions, such thunderstorms, tornadoes, and flash floods, are forecasted using this technique. Agriculture sector can benefit from nowcasts since they allow farmers to organise their farming activities appropriately. This may result in less input loss, better defence against extreme weather, and more effective use of resources like pesticides and fertilisers. This could thuslead to improved agricultural yields and increased productivity.
- **Very Short Range: Weather Forecasting:** Predicting the weather for the next few hours upto 12 hours, This type of forecasting is helpful in making decisions like scheduling outdoor events or irrigating crops.
- **Short Range Weather Forecasting:** Forecasting the weather for the next few days, typically up to three days in advance, is known as short-range weather forecasting. It is especially helpful for scheduling transportation, managing agricultural activities, and forecasting energy consumption. Newspapers, radio, television, and the internet are just a few of the media outlets that can provide short-range weather forecasts. They are highly accurate, have great practical utility, and are especially helpful to farmers.
- **Medium Range Weather Forecasting:** Medium-range weather forecasting is the process of predicting the weather for the next three to ten days and they are genereated using the GFS-1534 at a spatial resolution of 12.5 km. For tasks like crop management, water resource management, and flood control, this kind of forecasting is helpful. The medium-range weather forecast is crucial for farmers since it helps them make decisions about their agricultural practises. They rely on these projections to determine the optimal times to grow crops, transplant them, fertilise them, spot potential pest and disease outbreaks, and decide what steps to take to control them. The best time to harvest their crops is also determined by farmers using this information for weeding and thinning, irrigation scheduling (including amounts and timing), and other tasks.
- **Extended Range Weather Forecasting:** Forecasting weather for the next two to four weeks is referred to as extended range weather forecasting. The operational extended range forecast (ERF) system of IMD has developed since 2009, commencing with the use of empirical models, dynamic models, and the Multi-model Ensemble (MME)Extended Range Forecasts can provide helpful information well in advance, aiding in the overcoming of monsoon rainfall uncertainty over the commencement of the monsoon, dry spells that stress soil moisture or produce drought, and extremely heavy rains that can bring floods. Since 2009, the IMD has been developing its operational extended range forecast (ERF) system, starting with the use of empirical models, dynamic models, and the Multi-model Ensemble (MME). It is crucial to predict the monsoon break with a lead period of two to four weeks. This information enables farmers to successfully plan activities like sowing, harvesting, and yield forecasting by allowing them to tactically modify their strategic decisions based on longer-lead seasonal projections. It also makes it simpler to review the current monsoon conditions promptly, which might provide farmers with helpful outlooks.
- **Long Range Weather Forecasting:** Long-range weather forecasting is the process of predicting weather for durations longer than four weeks like for the prediction of Southwest monsoon rainfall in India (ISMR). It has been long-range projected using statistical techniques and data spanning more than a century. For the seasonal period from June to September, this forecast is made public in two phases. The first stage forecast is released in April and covers the entire nation. An update is then released in June. The long-range forecast can anticipate rainfall-induced stress by taking into account rainfall quantity and timing, including early, mid, and late droughts. Strategic planning in agriculture can use this forecast's considerable lead time advantage to efficiently plan for and manage.

Agro-meteorological Advisory Service in India

According to Stigter (2011) [2], the term "AAS" refers, to all agrometeorological and agro-climatological information that are specifically relevant for boosting and preserving farmers livelihoods. This improvement/protection applies to yield quantity, quality and income while safeguarding the agricultural resource base from degradation. The Agromet Advisory Services provide a very special kind of inputs to the farmers as advisories that can make a tremendous difference to the agriculture production by taking the advantage of forecasted weather and minimize the adverse impact of extreme weather. The Farmers Weather Bulletin (FWB), a component of the Agrometeorological Advisory Services (AAS) programme operated by the India Meteorological Department (IMD), was first broadcast on All India Radio in 1945. Later In 1976, IMD launched the Agro-Meteorological Agricultural Advisory Service (AAS) in collaboration with the Agriculture Departments of respective State meteorological Centers. Although these services have been

provided for many years, the demand from the farming community has not been fully met due to certain system drawbacks. To address this, IMD introduced the Integrated Agromet Service in 2007 in collaboration with different organizations/institutes. Collaboratively initiated by IMD, MoES, ICAR, and State Agriculture Universities, the District Level agro advisories were established in 2008 to improve the Agrometeorological Advisory Services (AAS) system. Quantitative forecasts for seven meteorological variables, including rainfall, maximum and lowest temperatures, wind speed, wind direction, relative humidity, and cloudiness, are included in the AAS products. These goods also contain the forecast for the week total rainfall. IMD, New Delhi uses the Multi Model Ensemble (MME) technique to produce these products, combining forecast data from a number of models from India and other nations. Currently, district-level weather forecasts are provided to 130 Agro-met Field Units (AMFUs) located at State Agricultural University (SAUs), (ICAR) institutes, IITs, and others. However, there is still in need for further improvement in these services by providing weather forecasts at a smaller level than the district, extending the temporal range of forecasts, and implementing a more aggressive extension and outreach system for agro-met advisory.

Method for dissemination of weather forecast, agromet advisories and extension activities

In order to help farmers make wise decisions, Agromet Advisory Services (AAS) intends to dessiminates the weather and climate-related information. The current information flow is primarily one-way, despite efforts to build two-way communication. In order to create weather-based advisories that are distributed through a variety of media, including television, radio, print media, the internet, email, and telephone, weather forecasters from the Indian Meteorological Department (IMD) work with agricultural scientists from research institutes. Farmers are becoming more and more accustomed to using electronic media in particular. The agrometeorological bulletins are regularly updated to reflect the temporal and spatial variability of weather and climate in order to guarantee that the information is accurate. Successful dissemination of the information relies on its relevance to weather and climate-sensitive decision-making in agriculture and effective outreach efforts. Additionally AMFUs are preparing and sending district Agrometeorological Advisory Services (AAS) bulletins twice weekly to private companies, including IFFCO Kisan Sanchar Limited (IKSL), NOKIA, Reuter Market Light (RML), Handygo, and Mahindra Samriddhi, through a public-private partnership (PPP) arrangement. The bulletins contain weather forecasts, advisories on extreme events, and information about crops, pests, diseases, seeds, and fertilizers, and are distributed throughout the country. In Fig.1, a flowchart illustrating the generation and dissemination of district-level medium-range weather forecasts is shown.

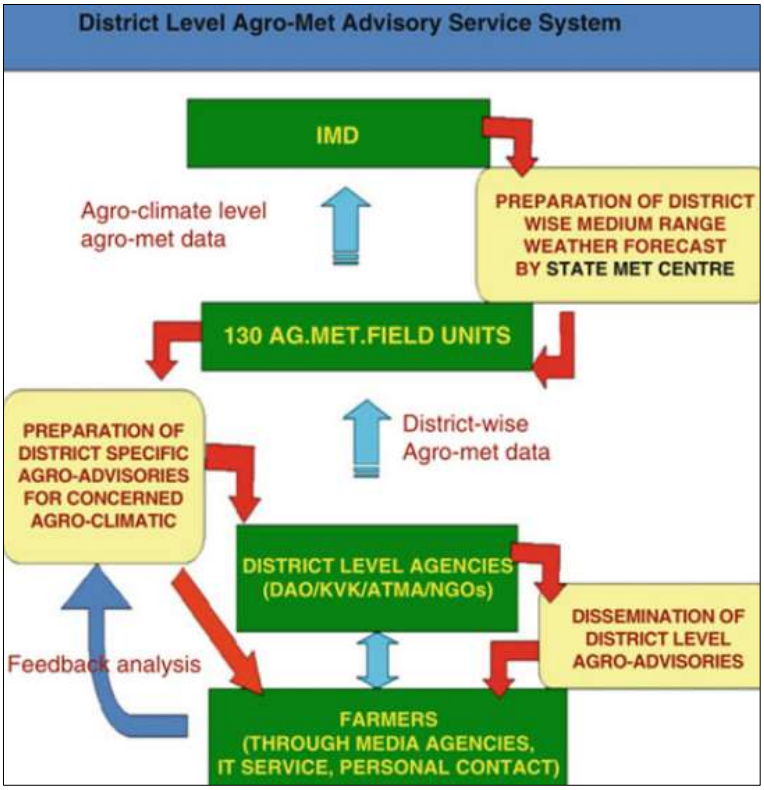

Fig 1: Generation and dissemination of district-level medium-range weather forecast (IMD) (Rathore, *et al*., 2011) [3]

Necessity of Agromet Advisories Services

Prior to and throughout the cropping season, weather and climate are important factors to consider, and managing the risks associated with them has become more important as a result of climate change. But it also acknowledges the potential benefits of enhanced weather and climate early warning systems in supporting farmers. Given that small-scale farmers make up the majority of the Indian supply base, any increases in output and food production must come from this sector. Additionally, the agricultural sector significantly enhances the lives of the poorest 50% of the population more than any other economic sector. (UN, 2008) [4]. The primary

objective of AAS is to collect and arrange climate/weather, soil, and crop data, and combine it with weather forecasts to furnish farmers with effective guidance to make informed management decisions. Following are the important benefits of Agromet Advisory Services that efficiently help the farmers:

- **Improved crop management:** Agromet advisories can provide farmers with information on the best planting dates, crop varieties, and pest management strategies, leading to improved crop yields and quality.
- **Weather risk management:** By providing information on upcoming weather patterns and associated risks, Agromet advisories can help farmers plan and take appropriate measures to reduce crop losses.
- **Efficient use of inputs:** Agromet advisories can help farmers make informed decisions on the use of inputs such as fertilizer and irrigation, reducing wastage and increasing efficiency.
- **Increased income and livelihoods:** By improving crop yields and reducing risks, Agromet advisories can increase income and improve livelihoods for farmers.
- **Environmental benefits:** Efficient use of inputs and improved crop management can reduce environmental impacts associated with agriculture, such as pollution and water depletion

Thus AAS help in providing informed decisions based on weather and climate information which can lead to more effective policies, better use of resources, and increased production in agriculture, livestock, and fisheries. By reducing risks and seizing opportunities, weather and climate information can enhance decision-making at the policy, institutional, and community levels.

Role & Contribution of Agro-met Services

The impact of agro-met advisory services on agriculture has been significant. These services have helped farmers increase their productivity, which has resulted in a greater availability of food and higher income generation. With the help of these services, farmers have been able to mitigate the negative impacts of changing weather patterns and other problems. Through a variety of media, including radio, television, print, the internet, Kisan Call Centres, and mobile phones, the GKMS scheme is in charge of generating and disseminating weather-based crop and location-specific agro-advisories to farmers in 633 rural districts. Approximately 20.6 million farmers are currently receiving condensed advisories via SMS on their mobile devices. The productivity of grains, oilseeds, and vegetables has greatly increased as a result of this project. According to a recent study by (NCAER, 2020) [5], 3,965 farmers from 121 districts across 11 states of India who participated in the survey modified at least one of nine practises as a result of weather advisories in 98% of cases. Farming households average yearly income increased from Rs. 1,98 lakh, when no modifications were made, to Rs. 3,02 lakh, when all nine practises were used. Each farming household in the Below Poverty Line category in rain-fed areas was projected to get an additional yearly income of Rs. 12,500, and the total increase in income was projected to be Rs. 13,331 crore per year in rain-fed districts. Over the course of five years, an investment of Rs 1000 crore will generate economic benefits of about Rs 50000 crore. Currently, 130 AMFUs and 199 DAMUs prepare agromet advisories every Tuesday and Friday for all the agriculturally significant districts (700) and roughly 3100 blocks.

Agromet Advisory Services in Minimizing Weather Risk in Agriculture

Developing a weather risk management plan based on agro advisory services can be a crucial step towards ensuring food security and improving crop production. This plan could include a range of tools and solutions that farmers can use to mitigate the risks associated with unpredictable weather patterns.

Hansen (2002) [6] summarized critical issues to consider in this regard, including site specificity, temporal specificity, and skill of the forecast. Site specificity refers to farmers' awareness of spatial variability and their ability to recognize mismatches between forecasts and on-farm decisions. Temporal specificity involves timing relative to decisions and impacts, taking into account factors such as rainfall onset, dry spell distribution, and weather conditions during harvest.

The Agromet Advisory bulletins convey various adaptive measures, that include

- **Planting heat-resistant crop varieties:** This method involves utilizing genetic resources to cultivate crops that are better adapted to warmer and drier conditions. Heat-resistant crops can withstand high temperatures and drought conditions.
- **Adjusting planting dates:** Planting dates can be adjusted to minimize the effect of temperature increase-induced spikelet sterility and reduce yield instability. By avoiding having the flowering period coincide with the hottest period, farmers can reduce the negative impacts of climate change on crop yield.
- **Changing cropping calendars:** Cropping calendars can be altered to take advantage of the wet period and avoid extreme weather events, such as cyclones and storms, during the growing season.
- **Cultivating crop varieties resistant to lodging:** Crop varieties that are resistant to lodging, such as short rice cultivars, can withstand strong winds during the sensitive stage of crop growth.
- **Adopting new farm techniques:** New farm techniques can respond to the management of crops under stressful conditions, such as plant pests and disease, and can help crops to thrive even under difficult environmental conditions.
- **Shifting sowing dates:** Sowing dates can be shifted to make more effective use of the soil moisture content and reduce the negative effects of drought.
- **Increasing crop intensities:** Crop intensities, or the number of successive crops produced per unit area per year, can be increased to make more efficient use of the land and resources.
- **Growing suitable cultivars:** Growing cultivars that are suitable for the specific environmental conditions, such as moisture and temperature, can counteract the compression of crop development.
- **Planting different types of crops:** Planting different types of crops, such as vegetables with short growth periods, can help to diversify the crop portfolio and reduce the negative effects of climate change.

Future prospects

There is a need to develop infrastructure that can accommodate the demand for these services in order to meet

the rising food demand and mitigate the effects of climate change. For the government and other stakeholders, this would be a serious task. To boost output, boost revenue, and cut losses, it is crucial to guarantee that all farmers have access to agro-met advice services. All agricultural universities need to increase capacity building in the interdisciplinary field of agrometeorology. Agricultural meteorology should be established a requirement for postgraduate programmes. Additionally, there is a lot of room for the growth of "extension agrometeorology" as a means of educating farmers about AAS, disseminating advisories, and gathering their feedback. (Bal, *et al*., 2021) [7]. Establishing a specialised platform for high-quality meteorological and climate data gathered from both public and private institutions/agencies. The Government of India Ministries of Earth Sciences and Agriculture and Farmers Welfare must collaborate on this. With the development of computing technology throughout time and the increasing importance of micro-scale advisories, spatial resolution and forecast accuracy will both increase. For places with a variety of agro-ecologies, the implementation of AAS using block-level weather forecast will necessitate processing for creation and dissemination procedures with minimal human interference. Although IMD has already taken the lead in this area, there is still room for improvement in its partnerships.

Conclusion

Agro-advisory services in India offer farmers guidance on weather, pest management, soil fertility, water management, and climate change adaptation. These services are essential for improving agricultural productivity, promoting sustainable practices, and enhancing farmer livelihoods. With climate change causing more severe weather events, agro-advisory services can help farmers prepare by offering information on resilient crop varieties and other adaptation measures. By investing more in these services, the government of India can help more to reduce the risk against extreme weather and climatic event to ensure the long-term success of its agricultural sector and support the millions of farmers who depend on it for their income and well-being.

References

1. Chattopadhyay N, Rathore LS. Extreme Events: Weather service for Indian Agriculture. Geography and You. 2013;13(79):12-16.
2. Stigter CJ. Agrometeorological services: reaching all farmers with operational information products in new educational commitments. World Meteorological Organization. CAgM report 104. Geneva, Switzerland; c2011.
3. Rathore LS, Roy Bhomik SK, Chattopadhyay N. Integrated agrometeorological advisory services in India. In: Attri SD, Rathore LS, Sivakumar MVK, Dash SK. Challenges and opportunities in agrometeorology. Springer, Berlin Heidelberg; c2011. p. 195-205.
4. United Nations, 'Trends in Sustainable Development – Agriculture, rural development, land, desertification and drought', Department of Economic and Social Affairs of the United Nations, New York; c2008. http://www.un.org/esa/sustdev/publications/trends2008/fullreport.pdf
5. National Council of Applied Economic Research (NCAER). New Delhi: Supported by Ministry of Earth Sciences; c2020.
6. Hansen JW. Realizing the potential benefits of climate prediction to agriculture: issues, approaches, challenges. Agricultural systems. 2002;74(3):309-30.
7. Bal SK, Sarath Chandran MA. Minimizing Weather-Related Risks in Agriculture Through Agromet Advisory Services in India. Climate Change and Resilient Food Systems: Issues, Challenges, and Way Forward; c2021. p. 245-60.