

WEATHER FORECASTING AND AGROMET ADVISORY SERVICES IN INDIA

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Weather and climatic information plays a major role before and during the cropping season and if provided in advance can be helpful in inspiring the farmer to organize and activate their own resources in order to reap the benefits. The Agro-meteorological Advisory Service (AAS) rendered by India Meteorological Department (IMD), Ministry of Earth Sciences (MoES) is a mechanism to apply relevant meteorological information to help the farmer make the most efficient use of natural resources, with the aim of improving agricultural production; both in quantity and quality. It becomes more and more important to supply climatological information blended with seasonal climate forecasts before the start of the cropping season in order to adapt the agricultural system to increased weather variability. Subsequent to this, short and medium range weather forecast based Agro-meteorological advisories become vital to stabilize their yields through management of agro-climatic resources as well as other inputs such as irrigation, fertilizer and pesticides. Agro-meteorological service rendered by IMD, MoES is a step to contribute to weather information based crop/livestock management strategies and operations dedicated to enhancing crop production and food security. The main emphasis of the existing AAS system is to collect and organize climate/weather, soil and crop information, and to amalgamate them with weather forecast to assist farmers in taking management decisions. This has helped to develop and apply operational tools to manage weather related uncertainties through agro-meteorological applications for efficient agriculture in rapidly changing environments.

The **information support systems under AAS** include:

- Provision of weather, climate, crop/soil and pest disease data to identify biotic and abiotic stress for on-farm strategic and tactical decisions,
- Provide district specific (Pan India) weather forecast (Rainfall, cloudiness, maximum/minimum temperature, wind speed, wind direction, maximum/minimum relative humidity) up to 5 days with outlook for rainfall for remaining two days of a week,
- Translate weather and climate information into farm advisories using existing research knowledge on making more efficient use of climate and soil resources through applications of medium range weather forecast to maximize benefits of benevolent weather conditions and alleviate the adverse impacts of malevolent weather events. A broad spectrum of advisories include weather sensitive farm operations such as sowing/transplanting of crops, fertilizer application based on wind condition & intensity of rain, pest and disease control, intercultural operations, quantum and timing of irrigation using meteorological threshold and advisories for timely harvest of crops.
- Introduction of technologies such as crop simulation model based decision support system for agro-meteorologists to adapt agricultural production systems to changing

weather & climate variability and to the increasing scarcity of input such as water, seed, fertilizer, pesticide etc.,

- Develop effective mechanism to on time dissemination of agro-Met advisories to farmers,
- Effective training, education and extension on all aspects of agricultural meteorology.

The District level Agromet Advisory Service (DAAS) run by IMD is a multidisciplinary and multi-institutional project. It involves all stake holders such as Indian Council for Agriculture Research (ICAR), State agricultural Universities (SAUs), Krishi Vigyan Kendras (KVKs), Department of Agriculture & Cooperation, State Departments of Agriculture/ Horticulture/ Animal Husbandry/ Forestry (Up to District level offices), NGOs, Media Agencies, etc. This project is being implemented through five tier structure to set up different components of the service spectrum. It includes meteorological (weather observing & forecasting), agricultural (identifying weather sensitive stress & preparing suitable advisory using weather forecast), extension (two way communication with user) and information dissemination (Media, Information Technology, Telecom) agencies. The critical components of DAAS system (Fig. 1) are discussed in the following sections:

Weather Forecasting System

IMD has started issuing quantitative district level (612 districts) weather forecast upto 5 days from 1st June, 2008. The products comprise quantitative forecasts for 7 weather parameters viz., rainfall, maximum and minimum temperatures, wind speed and direction, relative humidity and cloudiness, besides weekly cumulative rainfall forecast. IMD, New Delhi generates these products based on a Multi Model Ensemble (MME) technique (35*35 km grid) using forecast products available from a number models of India and other countries. Ensemble products have skill better than individual members of the ensemble group. The average skill for rainfall during monsoon season has been found to be 70 to 80 %. Individual members include: T-254 model of NCMRWF, T-799 model of European Centre for Medium Range Weather Forecasting (ECMWF); United Kingdom Met Office (UKMO), National Centre for Environmental Prediction (NCEP), USA and Japan Meteorological Agency (JMA). The products are disseminated to Regional Meteorological Centres and Meteorological Centres of IMD located in different states. These offices undertake value addition to these products twice a week on Tuesday and Friday and communicate to 130 AgroMet Field Units (AMFUs) located with State Agriculture Universities (SAUs), ICAR etc.

The Regional Meteorological Centers and Meteorological Centers of IMD located in different states undertake value addition to these products. The value addition is based on the inputs from very high resolution meso-scale model (WRF) model, synoptic knowledge, bias correction of district forecast etc. These Centres run the WRF model using initial conditions generated from global model for detailed analysis of rain-bearing systems at higher resolution (9*9 Km grid). Data used in these numerical weather modeling are upper air soundings, land surface (including network of automatic weather stations and automatic rain gauge at sub-district scale), marine surface buoys, aircraft observations, wind profilers, and satellite-data (wind, radiance, rain-rate, etc.).

Performance evaluation of MME generated district level rainfall forecasts for day-1 and day-5 are given for some selected states like Orissa, Rajasthan, Maharashtra, Gujarat and Kerala, which represent east central India – the domain of monsoon Low; northwest India - region of less rainfall; west India; region of mid-tropospheric circulation and extreme south east Peninsula. The results show that performance skill of day-1 district level rainfall forecast for the rainfall amount of moderate range (>10 mm and <65 mm) is reasonably good for all these states, where Probability of Detection (POD) is more than 0.4. For rain/no rain case, POD for these states are more than 0.6. For the heavy rainfall event (>65 mm) POD significantly deteriorates. Among these states, Kerala has the best performance, followed by Orissa, Gujarat, Maharashtra and Rajasthan. POD of Kerala for rain/no rain case has been above 1.0 at all the districts, for light rain it is around 0.3, for moderate rainfall it is around 0.9 and for heavy rainfall close to zero. For Orissa, POD for rain/no rain case has been above 0.8 at all the districts, for light rain it is around 0.6, for moderate rainfall it is between 0.3 to 0.4 and for heavy rainfall it is close to zero. For Rajasthan, POD for rain/no rain case has been between 0.4 to 0.7 at most of the districts, for light rain it ranges between 0.3 to 0.5 for moderate rainfall it is between 0.1 to 0.3 and for heavy rainfall it is zero. At the day-5 forecast, performance deteriorates but pattern remains the same.

Agro-meteorological Field Units (AMFUs) and Agro-advisory

Based on the above forecast products and the crop information available from districts, the AMFU prepares district-wise agro-advisories. Ministry of Earth Sciences has set up a network of 130 AMFUs covering the agro-climatic zones of the country. Each agro-climatic zones covers, on average, 4 to 6 districts. These units are operated at State Agriculture Universities (SAUs), Indian Council of Agricultural Research institutions (ICAR), Indian Institute of Technology (IIT) by providing grant-in-aid from IMD. These units are responsible for recording agro meteorological observations, preparing forecast based Agromet advisories for the districts falling under precinct of concerned agroclimatic zone and dissemination of the same. Concerned university/institute has appointed Nodal Officer and Technical Officers, who prepare the advisory bulletins in consultation with the panel of experts already created at these units. The Agromet bulletins include specific advice on field crops, horticultural crops and livestock, etc. which farmers need to act upon. Its frequency is twice a week i.e. Tuesday and Friday.

Advisory Dissemination Mechanism

The agromet district advisories, generated by 130 AMFUs, are being disseminated to the farmers through mass media (Radio, Print and TV), Internet, etc. A mechanism has also been developed to obtain feedback from the farmers on quality of weather forecast, relevance and content of agromet advisory and effectiveness of information dissemination system. A multi-media system for dissemination of agro-meteorological advisories to the farming community has been put in place in which beside the conventional modes e.g. radio, television & print media, concerted efforts are made to reach farmers through emerging modes of communication such as mobile phones and the internet. Short message service (SMS) and voice messages are being send to subscribing farmers by Govt. and private companies such as Reuters Market Light, IFFCO Kisan Sanchar Limited, MahaAgri, Vritti Solutions, NOKIA, eFresh and State Govt. agencies. Beside these companies there are many companies such as TATA Consultancy Service, NABARD, ICT, Infosys, Infronics etc. are like to start the service in near future. SMS service as on date covers 3.0 million users spread across 16 states while IVRS covers around 30000 farmers spread across 5 states.

The agro-meteorological advisory service has also developed a mechanism to assess the users' needs and strive to meet them in order to play an efficient role for the improvement of the agricultural production. A study aiming to assess Economic Impact of AAS carried out during 2003 to 2007 at 15 AAS units covering 3 *kharif* and 3 *rabi* seasons, concluded that the farmers could save significant losses of farm input like seeds, water, pesticides and fertilizers and reaped better harvest and made their farming more profitable by using the AAS. In general there is net gain ranging from 8 to 10 percent by those farmers who used the information provided by the AAS system.

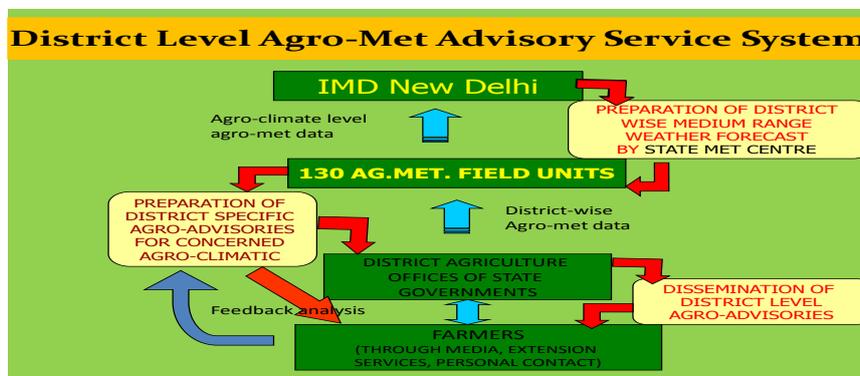


Figure 1: The flow chart for District Level Agro-Met Advisory Service (DAAS) System

Crop Yield Forecasting

Reliable and timely forecast provide important and useful input for proper, foresighted and informed planning. Early prediction of crop yield is important for planning and for taking various policy decisions. Final production estimates based on the sampling method become available long after the crops are actually harvested. In recent past Department of Agriculture and Cooperation (DAC), Min. of Agriculture in collaboration with Department of Space, IMD and Institute for Economic Growth launched FASAL (Forecasting Agricultural output using Space, Agrometeorology and Land based observations) scheme for crop acreage estimation and crop yield forecast by integrating technological advancement and adoption of emerging methodologies, in particular, those of remote sensing and geographic information. Objective is to develop, validate and issue multiple crop yield forecast for major crops at mid season (F2) and pre-harvest stage (F3) of crops.

The crop yield forecasting models are developed at different stages of the crops combining statistical, crop growth simulation and other methods/techniques, which take into account the influence of weather and technological advances on crop yield. The model requires the meteorological data (rainfall, temperature, humidity, bright hours of sunshine with wind speed, wet spell etc.) as well as technological data as the inputs to estimate the yield. Using agromet models and database developed, IMD is providing the yield forecast at district/ state/ national scale to DAC since monsoon 2011.

Although, a good progress has been made in this regard but much is required to be done. There is need to develop methodologies for Remote Sensing and Conventional Data Merging. Concerted efforts are needed for ground based data collection, satellite data collection, GIS software applications, operational applications of meteorological satellite data, weather radars and the monitoring of cropping season by meteorological and remote sensing data to equip AAS units to generate better advisories. The system is working to improve these aspects of the service.