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## Agrometeorological Services: Linking Weather Forecasts with Agricultural Management

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Agriculture is one of the sectors most strongly influenced by weather. Rainfall, temperature, humidity, wind, sunshine and extreme events such as heat waves, droughts, floods, hailstorms and unseasonal rainfall can significantly affect crop growth, livestock, farm operations and farmers' income. While weather cannot be controlled, its adverse effects can often be reduced through timely information and appropriate management. Agrometeorological services perform this important function by converting weather observations and forecasts into practical, farm-level recommendations. In India, the India Meteorological Department (IMD), ICAR institutions, State Agricultural Universities, Krishi Vigyan Kendras (KVKs) and other agencies work together to provide weather-based agricultural advisories. These services assist farmers in decisions related to sowing, irrigation, fertilizer application, pest and disease management, harvesting and protection from extreme weather. Recent initiatives such as KALP and Mausam SANKALP are moving agrometeorological services from general weather information towards location-, crop- and crop-stage-specific decision support. With advances in digital technology, artificial intelligence, high-resolution forecasting and mobile communication, agrometeorological services are becoming an increasingly important tool for climate-resilient and sustainable agriculture.

**Keywords:** Agrometeorology, Weather Forecast, Agricultural Advisory, Climate Resilience, KVK, IMD, Weather-Based Agriculture, Farmers, Crop Management, Climate-Smart Agriculture

### Introduction

The success of agriculture depends greatly on the interaction between soil, crop, water, weather and management. Among these factors, weather is particularly important because it changes continuously and cannot be controlled by farmers. A few days of heavy rainfall, an extended dry spell, a sudden heat wave or strong winds can change the outcome of an entire crop season. For a farmer, therefore, knowing the expected weather is not merely a matter of curiosity. It can influence important decisions such as when to sow, when to irrigate, when to spray pesticides, when to apply fertilizer and when to harvest. This is the importance of agrometeorological services. Their basic objective is to transform scientific weather information into useful agricultural decisions. The Agricultural Meteorology Division of IMD was established at Pune in 1932 specifically to reduce the adverse effects of weather on agriculture and utilize favourable weather conditions to improve production. India Meteorological Department

Today, the concept has developed much further. Modern agrometeorological services increasingly ask not only "What weather is expected?", but also "What will this weather do to the crop, and what should the farmer do?"

## From Weather Forecast to Farm Advisory

A conventional weather forecast may say that rainfall is expected in a particular area. However, a farmer needs more information.

For example: Forecast: Moderate rainfall is expected.

Agricultural meaning: Irrigation may not be necessary.

Farm action: Postpone irrigation and avoid fertilizer application immediately before heavy rainfall.

This simple example shows the importance of an agrometeorological advisory. It converts weather information into a management decision.

IMD's newer KALP initiative follows a Forecast–Impact–Action framework. It combines location-specific weather forecasts with crop growth stages and crop sensitivity to determine the likely impact and recommend appropriate action. India Meteorological Department

## Major Components of Agrometeorological Services

### 1. Weather Observation

The first requirement is reliable weather observation. Parameters such as rainfall, maximum and minimum temperature, relative humidity, wind speed, wind direction and cloud cover are continuously monitored.

Weather stations and other observation systems provide the basic information required for agricultural forecasting.

### 2. Weather Forecasting

Forecasts provide information about expected weather conditions over different time periods. For agriculture, medium-range forecasts are particularly useful because many farm operations need to be planned several days in advance.

Under India's Gramin Krishi Mausam Sewa, IMD provides weather forecasts and supports preparation of agricultural advisories for farmers. Recent Government information notes that operational services include forecasts for rainfall, temperature, relative humidity, cloud cover and wind at district and block levels. Press Information Bureau

### 3. Crop-Weather Relationship

Weather does not affect every crop in the same way. The impact depends on the crop, variety, soil, weather conditions and growth stage.

For example, high temperature may be particularly damaging during flowering in some crops, while rainfall during harvesting may seriously affect grain quality.

Therefore, an agrometeorologist must understand both weather behaviour and crop response.

### 4. Agricultural Advisory

The final and most important step is preparing an advisory.

An advisory may recommend:

- Delay sowing because rainfall is inadequate.
- Irrigate the crop before a predicted dry spell.
- Avoid spraying before expected rainfall.
- Harvest mature crops before heavy rainfall.
- Provide additional protection to livestock during heat waves.
- Improve drainage before heavy rainfall.
- Monitor crops for pests and diseases under favourable weather conditions.

Thus, the advisory converts scientific information into practical action.

## Role in Agricultural Management

### 1. Sowing and Crop Establishment

Weather information helps farmers determine suitable sowing windows. In rainfed areas, rainfall forecasts are particularly valuable.

If adequate rainfall is expected, farmers can prepare land and sow at an appropriate time. If rainfall is delayed, alternative crops, varieties or contingency plans may be considered.

This is especially important in regions dependent on the monsoon.

## 2. Irrigation Management

Water is becoming an increasingly valuable agricultural resource. Weather-based irrigation planning can prevent unnecessary irrigation when rainfall is expected.

During a forecast dry period, farmers can prioritize irrigation during critical crop-growth stages.

This can improve water-use efficiency, reduce energy consumption and lower production costs.

## 3. Fertilizer Management

Weather forecasting also helps in planning fertilizer application.

Applying fertilizer immediately before heavy rainfall can result in nutrient losses through runoff or leaching. Similarly, application under unsuitable moisture conditions may reduce nutrient-use efficiency.

Weather-based recommendations can therefore help farmers select a more appropriate time for fertilizer application.

## 4. Pest and Disease Management

Temperature, humidity and rainfall influence insect pests and plant diseases.

Agrometeorological information can help farmers anticipate conditions favourable for pest and disease development. Instead of spraying pesticides routinely, farmers can monitor the crop and undertake appropriate measures when weather conditions and field observations indicate increased risk.

This supports integrated pest management and safer agriculture.

## 5. Crop Protection from Extreme Weather

Extreme weather events are becoming an important agricultural risk. Heat waves, droughts, heavy rainfall, thunderstorms, hailstorms and strong winds can cause significant losses.

Advance warnings allow farmers to take preventive measures.

For example:

- Provide irrigation before severe heat conditions where appropriate.
- Protect horticultural crops from frost.
- Provide shade and water to livestock during heat waves.
- Strengthen drainage before heavy rainfall.
- Move harvested produce to safer storage.
- Delay harvesting when severe weather is imminent.

## Helping Farmers Manage Harvesting and Post-Harvest Operations

Harvesting is a critical stage because a crop that has been successfully produced can still suffer losses if adverse weather occurs during harvest. Weather forecasts help farmers select suitable harvesting days. Dry weather is generally preferred for harvesting, threshing and transportation of many crops. Similarly, farmers can arrange storage and transportation in advance when adverse weather is expected. This is particularly important for fruits, vegetables, grains and other perishable commodities.

## Role of KVKs and SMSs

Krishi Vigyan Kendras are an important link between weather science and farmers. Subject Matter Specialists (SMSs), agrometeorologists and other KVK personnel interpret weather information in relation to local crops and farming systems.

ICAR has established District Agro-Meteorological Units in KVKs to support the delivery of agrometeorological advisory services in local languages. ICAR reports that DAMUs were established in 199 KVKs, with SMSs and agro-met observers involved in the programme. Indian Council of Agricultural Research

This local-level interpretation is extremely important. A general weather forecast becomes much more useful when an SMS explains:

“Rain is expected in the next few days; therefore, farmers growing cotton should postpone irrigation and avoid spraying pesticides until suitable weather conditions return.”

This is the real meaning of weather-based agricultural management.

## Digital Technology and the Future of Agrometeorological Services

The delivery of weather advisories has changed rapidly with the growth of smartphones and digital communication.

Farmers can now receive information through mobile applications, websites, SMS, WhatsApp and other digital platforms. IMD provides services through platforms including Meghdoot, Mausam and Panchayat Mausam Seva. Press Information Bureau

The Mausam SANKALP platform represents another important development. It integrates historical information, real-time observations and forecasts with crop stages and weather thresholds to support more analytical and crop-specific advisories. India Meteorological Department

Artificial intelligence, machine learning, satellite observations, weather radar, automatic weather stations and high-resolution numerical weather prediction can further improve the accuracy and usefulness of these services.



## Agrometeorology and Climate-Resilient Agriculture

Climate variability has made weather-based agricultural planning even more important. Farmers increasingly face irregular rainfall, temperature extremes, prolonged dry periods and sudden heavy rainfall. Agrometeorological services can help farmers move from reaction to preparedness. Recent agricultural initiatives demonstrate this approach. For example, ICAR-KVK Rayagada used seasonal weather information and contingency crop planning to prepare for anticipated rainfall deficits during Kharif 2026. The initiative combined weather-based advisories, field monitoring and coordination among agricultural departments. Thus, agrometeorology is no longer simply about recording weather. It has become a key component of risk management and climate adaptation.

## Challenges and the Way Forward

Despite substantial progress, several challenges remain. Weather can vary considerably even within a small geographical area, and forecast uncertainty increases with longer lead times. Farmers may also have different levels of access to smartphones, internet connectivity and scientific information.

Future agrometeorological services should focus on:

- More accurate location-specific forecasts
- Village- and farm-level advisories
- Crop- and growth-stage-specific recommendations
- Better prediction of extreme weather
- Greater use of AI and machine learning
- Integration of weather, soil and crop data
- Local-language communication
- Stronger KVK and extension networks
- Two-way feedback from farmers
- Better integration with crop insurance and contingency planning

## Conclusion

Agrometeorological services are the bridge between weather science and agricultural decision-making. Their importance lies not merely in predicting rainfall or temperature but in explaining how expected weather will affect crops and what farmers can do to reduce risk. From sowing and irrigation to pest management, harvesting and livestock protection, weather-based advisories can help farmers make timely and scientifically informed decisions. India's growing network of IMD, ICAR, KVKs, agricultural universities and digital platforms provides a strong foundation for this service. The future of agriculture will increasingly depend on the ability to anticipate weather risks and respond before losses occur. The goal should therefore be simple:

“Forecast the weather, understand its impact, and convert it into timely action on the farm.”

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