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Challenges and Opportunities in Agrometeorology*

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Crops as well as livestock production is highly dependent on weather and climate.Farmer's endeavour is to make best use of benevolent weather and climate and avoid or manage weather and climate risks. The weather and climate risks such as droughts, floods, storms, tropical cyclones, heat/cold waves and windstorms accounts for major losses in the agricultural sector. If advance information on weather and climate is used for farm level decision making these losses can be minimized to a great extent. The farmers with limited access to agro-meteorological information, technological resources and with limited development of infrastructure are more prone to such risks. To cope with agrometeorological risks and uncertainties improved use of climate knowledge and climate risk technologies is essential. Planning, early warning and well-prepared response strategies are the major steps for mitigating losses. Decision-making in agricultural production is a complex process in which many risks need to be considered for an informed decision to be made. Production risk is manifestation of random environmental variability associated withfarming process and includes variability in yield and quality.

The agrometeorological methods aiming to deal with weather and climate induced farm production risks are judged by gain or loss functions of weather information based decisions to solve weather sensitive problems. Agromet advice is nothing but use of weather information in farm management decisions. Assessing the relative profitability and riskiness of crop management decisions is the key avoid taking wrong decisions. The challenge is omnipresent throughout the agrometeorological system which comprises of agrometeorological observations, data, and relation between weather/climate-crop-pest/disease, weather forecast in different temporal ranges, decision making, and dissemination of information to the end user. Lack of attention to preparedness and response strategies is a major challenge. The malevolent weather events have a direct influence on the quantity and quality of agricultural production, and in many cases adversely affect it.

Inappropriate management of agro-ecosystems (or degraded ecosystems) compound the severity of climatic events, such as recurrent droughts have tended to make the drylands increasingly vulnerable and prone to rapid degradation. Similarly, in the high rainfall areas, increased extreme events can cause increased nutrient losses due to excessive leaching, runoff and water logging. To combat such situations, on farm applications of agrometeorological information is highly necessitated. Various sub-components of this challenge include non-availability of agrometeorological observations;using less-than perfect weather information; lack of understanding of Crop Weather Relations as well as understanding of Crop-Pest-Weather Triangle.

Agrometeorological data

Data as a support system for agrometeorological services is often not up to the mark. Agricultural data depicting the state of crops and animals are essential to related to agricultural operations. These complementary data are often collected by non-meteorological personnel. For all agrometeorological applications, in order to prepare advisories to assist farmers in decision makingand longer-term planning, it is necessary to combine agricultural and meteorological data. Unfortunately, measurement of agrometeorological observations such asleaf area, canopy structure,photosynthesis, soil erosion, soil moisture, biological and related phenomena, pest&disease, direct and indirect damage owing to weather and similar observations required for agro-meteorological research and service are inadequately available. Also, phenological observations of crops and trees which are required to form an accurate picture of weather related stress is less than accurate.

We also do not have any data on meteorological variables or local special factors affecting agricultural production on a local mesoscale that are not representative of the general climate of the region. The surface relief (topoclimatology) and character (landscape), regional wind

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circulations, water bodies, forests, urban areas and like characteristics come under these categories. This needs to be done by carrying out agricultural meso-climatological surveys by District Agromet Field Units (DAMU).

Data without metadata are unreliable. Meteorological observations do not provide reliable information about the state of the local atmosphere unless one knows how the observations were made, including the instrument, its installation height and exposure, sampling modalities and averaging times, and the way in which the measurements were processed. This aspect also needs strengthening and to begin with a standard format of metadata with a check list be prepared and used.

Rapid advances in electronic technology facilitate effective exchange of data files, summaries and charts of recording instruments, particularly at the national and international levels. Agrometeorological data should be transferred to electronic media in the same way as conventional climatological data, with an emphasis on automatic processing. Rapid advances in electronic technology facilitate effective exchange of data files, summaries and charts of recording instruments, particularly at the national and international levels. Agrometeorological data should be transferred to electronic media in the same way as conventional climatological data, with an emphasis on automatic processing.

Automation of agrometeorological advisories

Automated Agro Advisory Service (AAS) is a response farming tool, which helps the farmers to get timely weather based agro advisories to make necessary decision for the next few days of farm operations. Weather based agro advisory for multiple crops and different stages of crop growth have been developed with the help of technocrats and incorporated in the database. Weather scenario of each block have to be developed separately for past and future weather and match the scenario of the AAS module keeping in focus the crop status, stage, and advisory to simplify the lab to land with ICT tools. To improve the process of preparing and disseminating agromet bulletins, an effort was made to investigate the building of an IT-based system to ease the preparation of agromet bulletins, called eAgromet. The main objective was to improve the efficiency of preparation and dissemination of agromet bulletins by exploiting the developments in agriculture, and information and communication technologies the eAgromet prototype was developed. (Krishna Reddy *et.al.* 2014). More such efforts are needed for generating block level advisories.

Dissemination of agromet advisories

To make better use of the agrometeorological advisories in supporting agrometeorological services and to provide for effective transfer of the knowledge of agrometeorology to farmers at farm level, the science of information technology is also very useful. New dimensions ininformation technology are advancing very rapidly. There is good reason to claim that the present century will be the century of information technology. Easily available fast Internet facilities, supercomputers, high-capacity servers and efficient linking between information points have given a much-needed boost to information technology. While in the last century the communication systems were mostly one-way communications, in the present century interactive communication systems are being developed more extensively.

Community radio which offers radio broadcasting can be a strong media. Hence, there is need to set up Agromet Community Radio Stations which may serve agro-climatic zones through joint participation by scientists, extension specialists and farmers to serve farmers and rural masses. The Agromet community radio should broadcast content that is relevant to the local farming community and specific audience. Itshould be more of community than radio. This means that it should focus on getting the community talking on agrometeorological information. In 2006, the government of India (GOI) implemented new Community Radio Guidelines, which permit NGOs, educational institutions and agricultural institutions to own and operate community radio stations. Indian government has been promoting content exchange especially radio programmes, good practices, case studies etc. to facilitate meaningful utilisation of available resources. Ministry of Earth Sciences (MoES) should prepare guidelines and facilitate opening of Agromet Community Radio Stations in different agro-climatic zones of the country through providing finance for infrastructure and operating costs.

Social media engagement

The emergence of social media communications can enhance agrometeorological information dissemination opportunities within and beyond the scientific community. It is not an understatement to say that social media on the one hand is revolutionizing the communications industry but there are very few scientists who make use of social media to share useful information. Traditionally, when we interacted with family and friends as a scientist, once in a while we discuss our work. Today, on the Internet and through social media you can interact with farmers and can tell them about weather and climate and inform them as to how they can manage their crops or live-stock weather wise. Hence, all Agrometeorologists, particularly those working for agromet advisory service must engage themselves with social media to set up two way and highly personal communication channels with their contact farmers.

Challenges are also opportunities

The opportune use of agrometeorological information in crop planning and management not only result in to higher crop yield but also lower the production costs with a host of other side benefits such as better product quality, environmental protection, efficient Water management and combat climate change. It also makes the land management far more efficient through appropriate microclimate modification, crop and soil management. The benefits accrued by agrometeorological information use through Integrated Pest Management and Integrated Nutrient Management Plan are seldom quantified but they are there. Its role in adapting the breeds and varieties to local climatic & soil conditions and choice of product depending on these conditions (soil potential) also needs to be highlighted. While role of agrometeorological information & service in combating unfavourable consequences of the weather (including parasites and diseases) is fairly well documented and used on routine basis, a better consideration of meteorological factors that affect animal behaviour, nutrition, shelter, health, growth, development and production is need of the hour.

Currently there are many opportunities that can assist in coping effectively with agrometeorological risks and uncertainties. One of the most important strategies is improved use of climate knowledge and technology.It includes development of monitoring and response mechanisms to current weather situations as rendered under agrometeorological advisory service named Gramin Krishi Mausam Sewa by Ministry of Earth Sciences and Ministry of Agriculture and Farmer's Welfare in association with Agricultural Universities. By providing quantitative information about the weather in different temporal ranges within which the farmers operate or about the likely outcome of alternative or relief management options, uncertainties in crop productivity can be reduced. Quantification is essential and computer simulations can assist such information and may be particularly useful to quantitatively compare alternative management and relief options in areas where seasonal climatic variability is high and/or that are prone to extremes. Both structural and non-structural measures can be used to reduce the impacts of the variability (including extremes) of climate resources on crop production. The structural measures include irrigation, water harvesting, windbreaks, frost protection, artificial and controlled climates (greenhouses), microclimate management and manipulation and other structural preparedness measures. The non-structural measures include use of seasonal to inter-annual climate forecasts, improved application of medium-range weather forecasts, now-cast and crop insurance.

Crop insurance can be resorted to only when there is sufficient spatial variability of the environmental stress (e.g. with hail). But it remains extremely difficult to implement for some of the major risks, such as drought, which typically affect large areas, sometimes whole countries. One of the techniques that have been adopted with credit and insurance is to make them conditional to the adoption by farmers of improved risk-reducing practices, like early planting. Contingency planning is an important part of such strategies, as ways must be found to avoid, reduce, or cope with risks. In some of the drought-prone areas contingency planning is commonly used as an effective strategy to cope with risks. Given the current recognition of the importance of preparedness to cope with risks and uncertainties as compared to the practice of reactive responses, it is necessary to link agromet information in coping with risks to develop suitable practices/strategies and to disseminate them widely.

Use of remotely sensed data

Remote sensing is used for a variety of applications in agriculture such as crop production forecasting, assessment of crop damage, crop progress, horticulture cropping systems analysis, crop identification, crop acreage estimation, crop condition assessment and stress detection, identification of planting and harvesting dates, crop yield modelling and estimation, identification of pests and disease infestation, soil moisture estimation, irrigation monitoring and management, soil mapping, monitoring of droughts, identification of problem soils, crop yield forecasting, flood mapping and monitoring, collection of past and current weather data. We have gained experience to use the data acquired from geostationary and polar orbiting satellites.Geostationary satellites can measure frequent meteorological parameters, three dimensionally, and unlike polar orbiting satellites, they can provide continuous monitoring of the Earth's atmosphere and surface over a large region. These satellites monitor potential severe weather conditions, such as tornadoes, flash floods, hail storms, and hurricanes. Newer technologies on the horizon such as Tropical Rainfall Measuring Mission (TRMM) satellite is being investigated for their accuracy in estimating the magnitude and spatial distribution of rainfall. TRMM is designed to measure rainfall in the tropical belt over a wide range of temporal and spatial scales. Because of the high spatial and temporal variability of tropical rainfall intensity, estimation of rainfall patterns by in situ networks and remote sensing platforms require special attention to spatial and temporal statistical properties of rainfall. But more understanding is needed to measure rain rate intensity distributions, and spatial and temporal variability. (Doraiswamy *et. al.* 2000).

Although RS data of radiance and atmospheric measurements are fairly good and widely used in numerical weather prediction, quality of crop, soil and pest/disease data needs improvement. The NDVI index is used most frequently to determine the condition, developmental stages and biomass of cultivated plants and to forecasts their yields. The integration of remote sensing data with ground-based climate data has been demonstrated for monitoring evapotranspiration and vegetation growth at watershed scales. Proper calibration and atmospheric correction of imagery data is still a major concern in data processing especially for application in retrieval of crop growth parameters. Programs such as the Famine Early Warning System (FEWS) sponsored by the US State Department rely on remotely sensed data as a surrogate for agrometeorological data when no ground data is available.

Ground-based remote sensing using handheld instruments are very useful for small-scale operational field monitoring of biotic and abiotic stress agents.This technology has better temporal, spectral, and spatial resolutions in comparison to airborne and satellite remote sensing. A limiting factor of handheld remote sensing is its efficiency,both in time and space, when compared with aircraft and satellite mounted sensors, which can be used to evaluate much larger areas at a time.

Airborne remote sensing using Unmanned Aerial Vehicles (UAVs) are typically low cost solution for remotely sensed data gathering. It allows for observation of individual plants, patches, gaps and patterns over the landscapes that have not previously been possible. UAVs with a typical spatial resolution of 1–20 cm could fill the resolution gap between satellite and ground-based platforms. Providing a swath width of 50–500 m and a spatial resolution of 1-20 cm, UAV platforms may be able to provide high resolution inputs necessary for site-specific crop management. UAVs with avery high resolution might be used also in agronomical research, management of specialty crops and studies of the within-field variability.

In India we have no investment made on both ground based and air borne remote sensing. It is high time that MoES should consider deploying these techniques for agrometeorological research and service.

Graphics

The presentation of agrometeorological data in graphical form is made easier via today's computer applications. While some of us may not care about graphical software packages, it may be important to have suitable package to graph information that can be presented in agromet bulletins in a farmer friendly way. A wide variety of software now exists to plot both time series and spatial information. Information about some such time series plotting can be found at (http://www.wrcc.sage.dri.edu) and information on spatial plotting can be found at (http://grads.iges.org/grads/head.htm). There are many others which must be used in agromet bulletins for effective comprehension by a less educated user. A graphic is worth a million words. Hence, IMD may get some graphic packages developed for smarter agromet bulletin.

REFERENCES

P.C. Doraiswamy, P.A. Pasteris, K.C. Jones, R.P. Motha, P. Nejedlik (2000). Techniques for methods of collection, database management and distribution of agrometeorological data. *Agric. Forest Meteorol.,* 103 : 83–97.

Guide to Agricultural Meteorological Practices (GAMP). (2010) Edition, WMO-No.134.

Krishna Reddy P, A.V.Trinath, M.Kumaraswamy, B.Bhaskar Reddy, K.Nagarani, D.Raji Reddy, G. Sreeniva , K.Dakshina Murthy, L.S.Rathore, K.K.Singh, N.Chattopadhyay. (2014). Development of eAgromet Prototype to Improve the Performance of Integrated Agromet Advisory Service. Databases in Networked Information Systems (DNIS2014) Report No: IIIT/TR/2014/-1.