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Let noble thoughts come to us from every side
Rig Veda

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YOJANA

About the Issue

Monsoons are that time of the year that is eagerly awaited by all. Bringing respite from the scorching heat, the monsoon rains usher in welcome relief. Every summer, southern Asia, especially India is drenched by rain that comes from moist air masses that move in from the Indian Ocean. These rains, and the air masses that bring them are known as monsoons.

The monsoon or rainy season lasting from June to September is dominated by the humid South West Monsoon that sweeps across the country in early June, first hitting the State of Kerala. The South West Monsoon is generally expected to begin in early June and end by September. Around September the northern land mass of the Indian sub-continent begins to cool off rapidly. Cold wind sweeps down from the Himalayas and the India-Gangetic Plain towards the vast spans of the Indian Ocean, South of the Deccan peninsula, because of the heat that prevails over the Indian Ocean and its surrounding atmosphere. This is known as the North East Monsoon or Retreating Monsoon. About 50-60 percent of the rain received by Tamil Nadu is from the North East Monsoon.

Indian climatic conditions are greatly affected by the phenomena of monsoons. Monsoons affect a large number of people. Indian agriculture is basically dependent on monsoons, and delay of a few days in the arrival of monsoons can badly affect the economy. Good monsoons correlate with a booming economy. Weak or failed monsoons (droughts) result in widespread agricultural losses and sustainability, hinder overall economic growth.

The entire nation therefore eagerly awaits and follows the progress of the South West Monsoon. The South West Monsoon is important as more then 70 percent of India's annual rainfall is from the South West Monsoons and supports nearly 75 percent of the kharif crops. The South West Monsoon is critical to India's food security. If monsoons are normal the nation heaves a sigh of relief and if there is prediction of decreased rainfall it implies that droughts are to follow and the machinery has to be geared up for drought preparedness.

Monsoons also adversely affect the lives of the people during floods caused by heavy rains. Excessive rains cause floods and water logging in cities and towns, and also causes huge loss of life and property, including agricultural loss in rural areas.

A timely and good monsoon with temporal and spatial distribution contributes to a bountiful harvest, which also holds the key to controlling inflation. This is why monsoon forecasting becomes an important tool, and the occurence or non-occurrence of the monsoons continues to be an important aspect of meteorological studies. The official agency for disseminating short, medium and long term prediction is the India Meteorological Department. Several techniques and models are in use for predicting the monsoon rainfall and advanced research is being carried out by various institutions for predicting monsoon rainfall with accuracy and precision.

In this issue of Yojana on Monsoons, noted experts give detailed explanations on monsoons and improved techniques of weather forecasting, government initiatives in developing long term monsoon forecasting skills and analysis of the impact of how monsoon variability impacts upon agricultural production and the way forward. ❑

Monsoon Prediction

Ajit Tyagi
D R Pattanaik

The Indian summer monsoon rainfall (ISMR) has a unique identity due to its large interannual variability

THE INDIAN Summer Monsoon constitutes a part of Asian Summer Monsoon and is thus a unique feature of tropical circulation. The region of South Asia is characterized by unique geographical and physiographical features. This region is spread over vast continental area from equatorial to higher latitudes of northern hemisphere, surrounded by oceans to the south, near the equatorial latitudes. This geographical pattern facilitates the development of centres of intense convection primarily due to differential heating of land and sea, resulting into concentration of rainfall within a particular epoch of the year. This phenomenon of occurrence of rainfall is a result of marked seasonal reversal of winds. For the millions inhabiting monsoonal regions (particularly the Indian sub-continent), the seasonal variation of the rainfall associated with the monsoon system is of far greater importance than the seasonal variation of wind. It is a general perception that life in India revolves around the monsoons. Prior to the onset of monsoon, the Indian monsoon zone is characterized by the presence of a heat low centred near the central Pakistan and adjoining northwestern parts of India. Onset of monsoon over the southern tip of India (Kerala Coast) towards the end of May/beginning of June is marked as the beginning of the monsoon season. Over a large part of the Indian region, most of the rainfall (about 80 percent) occurs in the months of June to September during the summer monsoon season with a long period average (LPA) of 89 cm with a coefficient of variability ≈10 percent. Indian summer monsoon exhibits large spatial variability with regions of high rainfall (the West Coast of the peninsula and over the north-eastern regions) are associated with lowest variability and the regions of lowest rainfall (northwestern parts of India) having highest variability as seen from the

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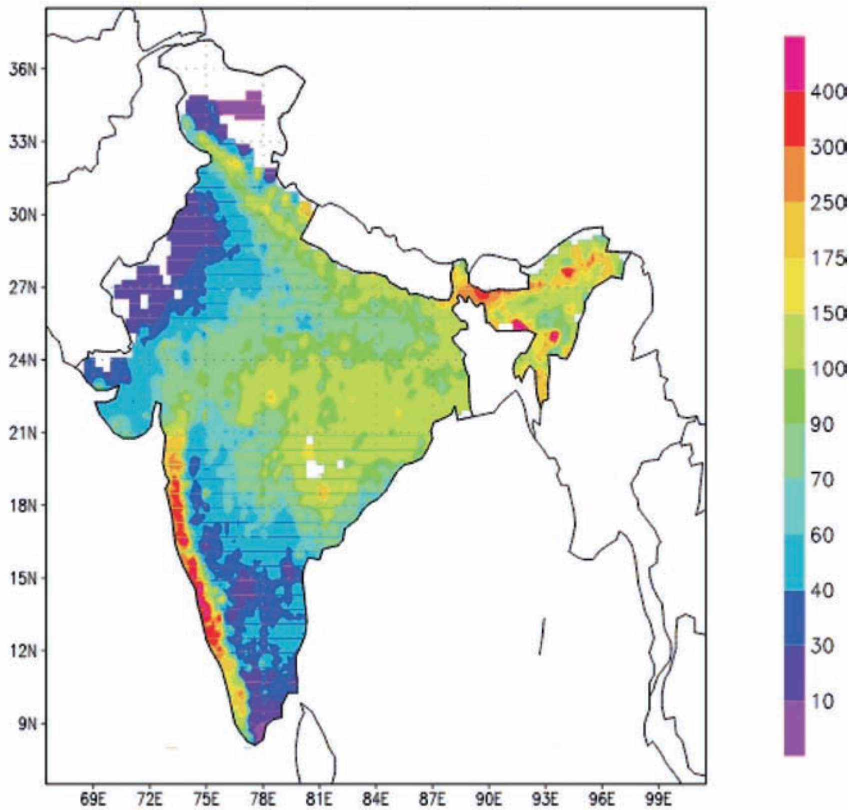
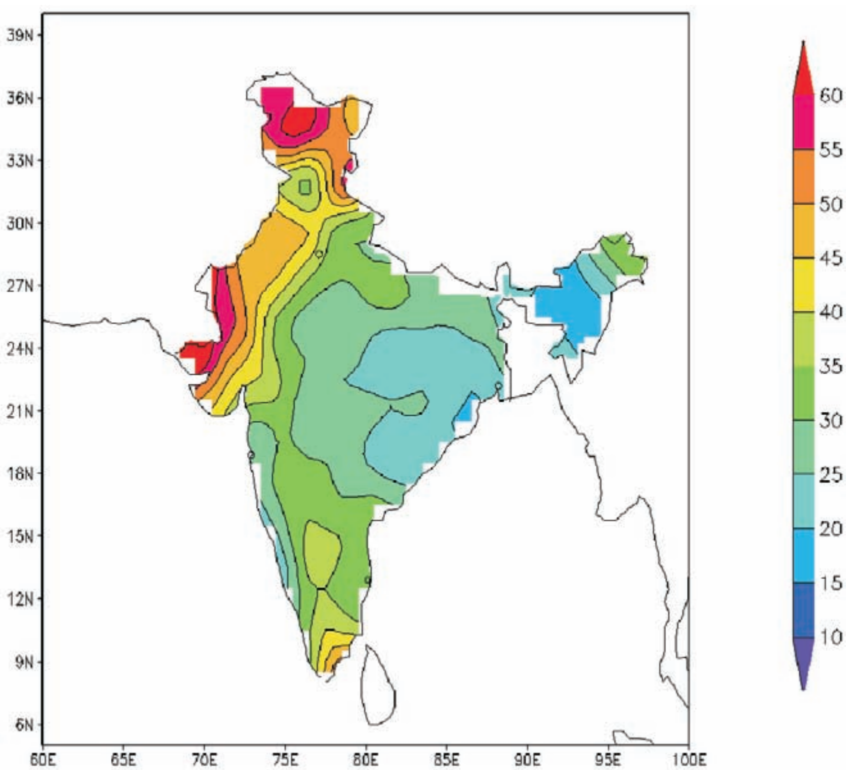


(a)



(b)

Fig. 1 *: (a) Mean All India Summer Monsoon Rainfall (cm) during June to September (1951-2003). (b) Mean Co-efficient of variability (percent)*

mean and coefficient of variability maps of AISMR shown in Fig. 1a & Fig. 1b respectively.

The summer monsoon during June to September is mainly driven by two primary heat sources: sensible heating of the Asian land mass and condensational (latent) heating within the troposphere over the Asian Plateau. Latent heat from moisture collected over the southern subtropical Indian Ocean is transported across the equator and released during precipitation over Asia and Africa. Both sensible and latent heat mechanisms contribute to the land-sea temperature and pressure differences that ultimately drive summer monsoon circulation. Although the Indian monsoon comes with a reassuring regularity, it exhibits a wide range of variability on the spatial, temporal, intra-seasonal, inter-annual, decadal and millennium scale. However, the variation of monsoon rainfall in inter-annual and intra-seasonal time scales are very crucial.

Monsoon, Agriculture and Economy

The Indian summer monsoon rainfall (ISMR) has a unique identity due to its large interannual variability. The erratic nature of ISMR directly affects the agriculture, water resource, transportation, health, power and the very livelihood of everyone. The droughts (Deficient rainfall) and floods (Excess rainfall) are two extremes of the interannual variability of monsoon rainfall. The inter-annual variation of seasonal monsoon rainfall over India during June to September during 1875-2011 is shown in Fig. 2. As seen from Fig. 2 the period from 1875 to 2011 witnessed many

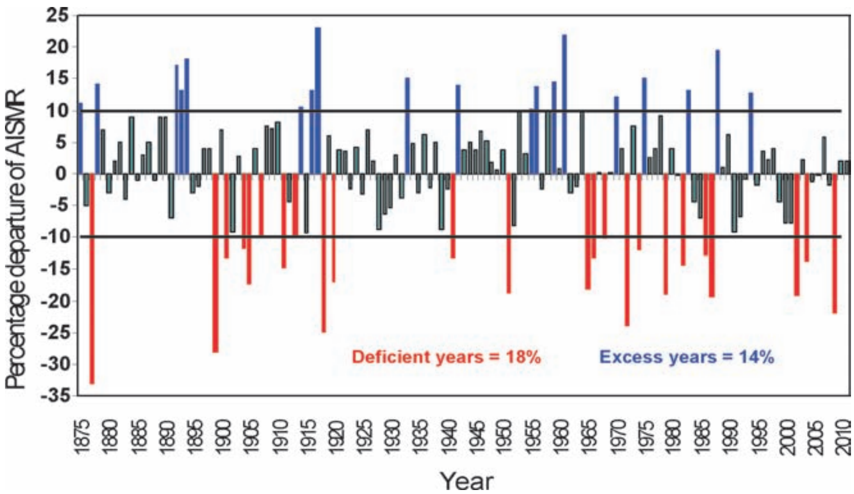


Fig. 2 : Mean All India Summer Monsoon Rainfall (AISMR) departure (percent) during 1875 to 2011

deficient and excess monsoon years. The deficient or excess years are identified based on the rainfall departure of ±1 Standard Deviation (≈10percent). The southwest monsoon has a stranglehold on agriculture, the Indian economy and consequently, the livelihoods of a vast majority of the rural populace. An overwhelming majority of cropped area in India (around 68 percent) falls within the medium and low rainfall ranges regions. Large areas are therefore affected if the southwest monsoon plays truant. Most parts of peninsular, central and northwest India regions are most prone to periodic drought. These regions receive less than 1,00 cm of rainfall. The drought of 1965-67 and 1979-80 affected relatively high rainfall regions, while the drought of 1972, 1987, 2002, 2004 and 2009 affected low-rainfall regions, mostly semi-arid and sub-humid regions.

Drought poses many problems. Irrigation facilities available in country are limited and therefore, when drought occurs, they cause partial or complete crop failure. If failures occur in consecutive years, it becomes a national calamity, putting great strain on the economy of the country. Meteorological drought happens when the actual rainfall in an area is significantly less than the climatological mean of that area. Drought has both direct and indirect impacts on the economic, social and environmental fabric of the country. The immediate visible impact of monsoon failure leading to drought is felt by the agricultural sector. The impact passes on to other sectors, including industry. The three recent worst drought years are 1987, 2002 and 2009. Drought of the year 2002 caused reduction in food grain production to the tune of 13 percent in India. In the year 2009 the all India seasonal rainfall departure was ≈ -22 percent and percentage area affected by moderate drought (when rainfall is 26-50 percent below normal) was 59.2 percent. Due to this drought condition there was a fall in GDP by about 0.5 percent.

Forecasting of Monsoon

Monsoon forecasting is a challenging problem over the Indian subcontinent, where monsoon constitute a major weather system affecting a large population. Short range, medium range, extended range and long range forecasts are essential for various weather sensitive activities such as farming operations, flood forecasting, water resource management, sports, transport etc. The fluctuation in monsoon rainfall in different time scale is influenced by occurrence and movements of different weather systems during the season. Depending on the time-scale the monsoon prediction can be classified in to following four categories viz.,

(i) Short range - Up to 3 days

(ii) Medium range (about 4 to 7 days in tropics)

(iii) Extended range or intra-seasonal (Beyond 7 days up to a month)

(iv) Long range or seasonal (one season)

Short Range

Heavy rainfall associated with the monsoon current and synoptic systems are very common during the southwest monsoon over India along the monsoon trough axis. Forecasting of location specific heavy rainfall event during the southwest monsoon season are the main challenging areas of monsoon forecasting in this time scale. Synoptic charts, satellite pictures, Radar products etc. are very useful in forecasting monsoon in this time scale. In addition to the synoptic method the numerical models are also being used for the weather forecasting in the short range. Currently, weather forecast services in the short range are based on conventional Synoptic methods supplemented by use of NWP products of different centres. Forecasting monsoon weather systems and associated rainfall is one of the difficult areas in NWP due to complex issues involved. These include impact of topography, accurate genesis and movement of synoptic scale systems, representation of mesoscale convective systems and also problem of mesoscale good quality observations, particularly over the ocean. In the past, synoptic methods have been the mainstay of tropical weather forecasting. Of late, NWP methods have acquired greater skills and are playing increasingly important role in the tropical weather prediction, though the progress of dynamical modelling efforts in the tropics has been rather slow as compared with the extra tropics. The roots of numerical weather prediction can be traced back to the work of Vilhelm Bjerknes in 1904, a Norwegian physicist who has been called the father of modern meteorology, where he suggested that it would be possible to forecast the weather by solving a system of nonlinear partial differential equations. After 1975 there have been significant developments in the field of NWP starting from short range weather prediction (1 to 3 days) using NWP model to seasonal prediction using coupled model. Work on short-range NWP scale in an organized manner began in India in 1960s. Use of meso-scale models for short range weather forecasting was also commenced in India since 1990s. Many scientists in India have contributed in developing NWP system for short range forecasting of weather.

Medium Range

A Medium Range Weather Forecast (MRF) is defined as a weather forecast beyond 3 days up to 10 days. The European Centre for Medium Range Weather Forecasting (ECMWF) Charter defines medium range as "the time scale beyond a few days in which the initial conditions are still important"). Thus, in tropics the medium range can be considered to be forecast from days 4 to days 7. The main tools used for medium range weather forecasting are the numerical models that are based on thermo-hydrodynamics of the earth's atmosphere (i.e. using General Circulation Models of the Atmosphere - AGCM). Starting from 1950s use of dynamical models for predicting weather on the above scales has made tremendous advances in advanced countries. These advances came as a result of developments in theory, computational aspects, data availability upto stratosphere levels, data initialization and data assimilation systems, introduction of higher resolution in the models and parametrization of a variety of physical processes for the atmospheric boundary layer , convection, radiation etc. Many researchers, mostly in advanced countries of Europe, North America, Japan and Australia, have contributed to original research in modeling. Medium range weather forecasting in India got a much-needed thrust with the establishment of the National Centre for Medium Range Weather Forecasting (NCMRWF) in 1988. Since 1992 NCMRWF started generating forecast products operationally using Global AGCM. An accurate medium range prediction of 7 days during monsoon season is of great importance as it will give better guidance about the Monsoon Onset and its advancement, genesis, movement and decay of monsoon Lows and Depressions; persistence and cessation of dry spells etc.

Extended Range

The day-to-day variability of Indian monsoon rainfall is characterized by ''active'' periods with high rainfall over central India when the monsoon trough is over the northern plains, and ''break'' periods with weak or no rainfall over central India and high rainfall over

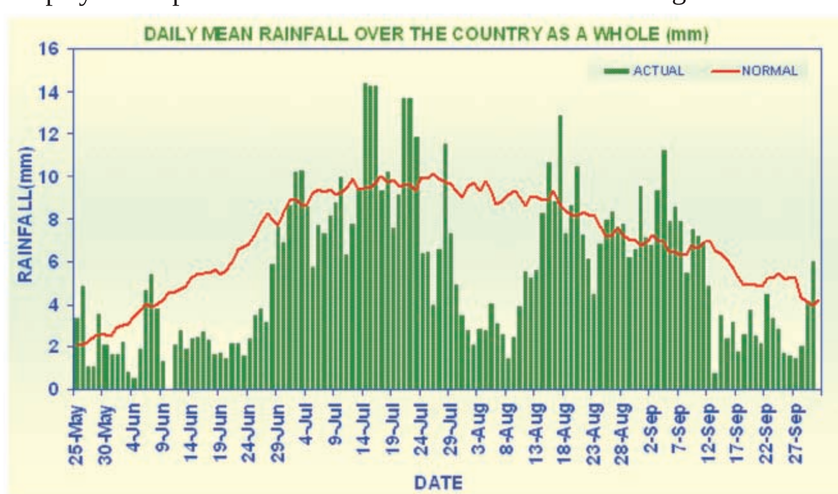


Fig. 3 : All India daily rainfall from 25 May to 30 September, 2009.

northern India when the monsoon trough is over the foothills of the Himalaya. Long breaks in critical growth periods of agricultural crops lead to substantially reduced yield. The forecasting of southwest monsoon rainfall on extended range time scale is vital for the vast farming community of the country. Forecasts of precipitation on this intermediate time scale are critical for the optimization of planting and harvesting. Prediction of monsoon break two to three weeks in advance, therefore, is of great importance for agricultural planning (sowing, harvesting etc) and water management. The forecasts on the time scale of 2-4 weeks can enable tactical adjustments to the strategic decisions that are made based on the longer lead seasonal forecasts, and also, will help in timely review of the on going monsoon conditions for providing outlooks to the farmers. The duration and frequency of the active/break spells within a particular monsoon season contribute to the seasonal mean and thus, also modulates the interannual variability. As seen from the daily all India rainfall during the monsoon season 2009 (Fig. 3), which indicated three long dry spells in the season one during June, second one during last week of July to 1st half of August and the third one is towards the second half of September (Fig. 3). Consequently the seasonal rainfall during 2009 ended with a shortfall of monsoon rainfall of about 22 percent. One of the factors, which, influences the Intra-seasonal oscillation of monsoon is the Madden Julian Oscillation (MJO), which is one of the most important atmosphere-ocean coupled phenomena in the tropics having profound influence on Indian summer monsoon.

Of late, there have been some efforts by various research groups in India (IITM and other groups) to predict the monsoon on extended range time scale using statistical and dynamical models. In the statistical model they used principal components (PC's) of empirical orthogonal function (EOF) analysis of 20-90 days anomalies of outgoing longwave radiation (OLR) and the OLR anomalies is predicted for about 4 pentads. Forecast models are developed for each lead time in the form of OLR anomalies, which represent the convective activity. There are also methods developed based on analogs of the OLR anomalies at lead time period of 1 pentad to 4 pentads. Similarly some other empirical model is also developed for predicting monsoon in intraseasonal rainfall activity based on the non-linear pattern recognition technique known as the Self Organizing Map (SOM). The SOM falls under the class of unsupervised learning of synapses in an Artificial Neural Network algorithm. The wind, geopotential height, specific humidity and the mean sea level pressure are used for the SOM classification of rainfall. The basis of this model is that the non-linear combinations of all the indices sufficiently represent the complex Intra-seasonal variation of the monsoon rainfall and the indices themselves have the capability of capturing the seasonality. Thus, by using current dynamical indices from the observational data in the real time mode the forecast of rainfall anomalies can be done using this method.

The other methods used for forecasting monsoon in this time scale are the use of Atmospheric GCM and coupled GCM. Though, there has been significant improvement in dynamical modeling system through the improvement of the model physics and dynamics in last few years, but present day AGCM could not simulate mean and interannual variability of Indian summer monsoon very successfully. It is also found that the skill of the AGCM is poorer in simulating Indian monsoon, which can be due to lack of proper representation of realistic Sea Surface Temperature (SST). However, in order to use the forecast from dynamical model in a best possible way, combinations of ensemble members are used for reducing the forecast errors. Therefore, the focus is now mainly on multi-model ensemble/super ensemble forecast for the seasonal and interannual prediction of monsoon.

Long Range Forecasting (LRF)

Statistical model

The monsoon prediction in this time scale is mainly done by using statistical and dynamical models. Sir H.F. Blanford, the first Chief Reporter of India Meteorological Department (IMD), was called upon to make attempts for estimating the prospective rains. Blanford issued tentative forecasts from 1882 to 1885 utilizing the indications provided by the snowfall in Himalayas. The first of the regular series of forecasts of seasonal monsoon rainfall during June to September was given on the 4th June 1886. Since then the long range forecasting of monsoon has witnessed many modifications. The efforts for better forecasts continued during the period (1904-1924) of Sir Gilbert T. Walker who took over as the Director General of IMD. Sir Gilbert Walker started the forecasts based on objective techniques. He introduced correlation and regression techniques for preparing long range forecasts. Walker was well aware that seasonal prediction can be put on a scientific footing only on the basis of an accepted theory of general circulation. In his quest for identifying potential predictors for the long range forecasting of monsoon rainfall over India, Walker discovered important large scale see-saw variations in global pressure patterns known as the Southern Oscillation, which has profound influence on monsoon.

In 1988, India Meteorological Department introduced the 16 parameter power regression and parametric models and started issuing forecasts for the southwest monsoon rainfall over the country as a whole. Using the power regression model, quantitative forecasts were prepared. After the failure of forecast in 2002, IMD introduced a new two stage forecast strategy in 2003, according to which the first stage forecast for the seasonal (June to September) rainfall over the country as a whole is issued in April and the update for the April forecasts is issued in June. Along with the update forecast, forecast for seasonal rainfall over broad homogeneous rainfall regions of India and July rainfall over country as a whole are also issued. During the period 2003-2006, the first stage quantitative and 5 category probabilistic forecast for the season rainfall over the country as a whole were issued using 8-parameter power regression (PR) model and Linear Discriminant Analysis (LDA) model respectively. Update for the first stage forecasts were issued using 10 Parameter PR and LDA models. In 2007, IMD introduced new statistical forecasting system based on ensemble technique for the south-west monsoon season (June to September) rainfall over the country as a whole.

Current Status of Monsoon Forecasting in IMD

IMD has the mandate to provide multi-scale weather forecasts ranging from nowcasting to seasonal forecasting. While the existing system of weather and climate forecasting in India is geared up for providing forecast services in the short and medium range time scales there exists a gap in respect of the extended range time scales.

Short and Medium Range Forecast

With the commissioning of High Performance Computing System (HPCS) in 2009, NCEP based Global Forecast System (GFS T382) has been made operational at the IMD Delhi, incorporating Global Statistical Interpolation (GSI) scheme in the global data assimilation system (GDAS). The Global model currently runs twice in a day (00 UTC and 12 UTC) and generate forecast for 7 days. From 2012 IMD has started using higher resolution global model (GFS T574; about 25 km horizontal resolution). In addition to this, for the short range weather forecasting the meso-scale forecast system Weather Research Forecast (WRF) with 3D-VAR data assimilation is being operated daily twice, at 27 km, 9 km and 3 km horizontal resolutions for the forecast up to 3 days using initial and boundary conditions from the IMD global model. In addition, at ten other regional centres, very high resolution mesoscale models (WRF at 3 km resolution) are made operational. The forecast products of these models are routinely made available on the IMD web site www.imd.gov.in.

The short and medium range forecasts (forecast up to 7 days in tropics) are very sensitive to the initial state of atmosphere from which the models begin the prediction. A better initial state will lead to an improved prediction. Hence, higher resolution data are required to be assimilated for success in this range. Under the ongoing modernization programme of the IMD, this issue has been addressed with the process of expansion and digitization of its observational network to achieve seamless data flow. From the ongoing modernization programme of IMD, good quality dense observations (both conventional and non conventional) are expected to be available by means of Doppler Weather Radar (DWR), Satellites (INSAT-3D Radiance), wind profilers, GPS sonde, meso-network (Automatic Weather Stations), buoys and aircrafts in the real time mode to ingest into the assimilation cycle of global and mesoscale NWP models, availing the advantage of advanced telecommunication system.

Considering the need of farming sector, IMD has upgraded the Agro-Meteorological Advisory Service from agro climate zone to district level. As a major step, IMD started issuing district level weather forecasts from 1 June 2008 for meteorological parameters such as rainfall, maximum and minimum temperature, relative humidity, surface wind and cloud octa up to 5 days in quantitative terms. These forecasts are generated through Multi-Model Ensemble (MME) system making use of model outputs of state of the art global models from the leading global NWP centres.

Extended Range Forecast of Monsoon

Weather forecast in extended range time scale (beyond 7 days and up to a month) by using numerical model requires the role of Ocean and thereby a coupled mode is required for the same. For the forecasting of monsoon on this time scale, models must simulate the statistics (amplitude, phase propagation and frequency spectra) of the Intra Seasonal Oscillation (ISO) correctly. It has come to light in the last couple of years that certain amount of air-sea interactions are involved with the summer ISOs and the coupled models are also in the development stage for the accurate prediction of monsoon on this time scale. Since a state of the art dynamical prediction system for extended range prediction of active-break spells is not operational in IMD, it generates the forecast of monsoon in this time scale based on the real time coupled model outputs available from leading international centres such as the National Centre for Environmental Prediction (NCEP), USA, the European Centre for Medium Range Weather Forecasting (ECMWF) and that of Japan Meteorological Agency (JMA), Japan. Forecast for two weeks is prepared using these coupled models output for the extended range forecast. In addition to the two weeks deterministic forecast, IMD has also started generating probability forecast on monthly scale from the beginning of 2010 by using outputs of coupled models from leading international centres. Presently IMD is also working, in collaboration with Indian Institute of Tropical Meteorology, Pune for forecasting the monsoon in extended range time scale.

Long Range Forecasting of Monsoon

IMD has been providing operational long range forecast based on statistical techniques. The statistical approach has shown good skill in generating forecasts for the seasonal rainfall over the country as a whole and four geographical regions (Northwest India, Central India, Northeast India and South Peninsula) and that for the monthly rainfall over the country as a whole for the months of July, August and September. IMD also generates operational forecast for the rainfall during the second half of the monsoon season over the country as a whole. However, the statistical approach has been found to have limited skill for monthly and seasonal forecasts for smaller spatial scales such as state, subdivision, district etc. In addition to statistical operational forecasting system, IMD has also established an experimental dynamical forecasting system for the long range forecasting of Indian summer monsoon rainfall at IMD Pune. The dynamical forecasting system is based on Experimental Climate Prediction Center (ECPC) seasonal forecasting model (SFM). SFM model (AGCM) is being used to prepare monthly and seasonal forecasts during the monsoon season using persistent and forecasted SSTs as boundary forcing. The experimental forecasting system has shown some useful forecast skill. However, further improvement is necessary before the dynamical forecasting system can be used for operational purposes.

Monsoon Mission

Ministry of Earth Sciences through the "National Mission of Monsoon" involved all relevant organizations and research institutes for improving the dynamical prediction of monsoon. This has been approved recently by the Government of India and will be for a period of 5 years. The Pune based Indian Institute of Tropical Meteorology (IITM), Pune will be co-ordinating this programme. IMD has the responsibility of operationalising the monsoon forecast in all time scales achieved through this "Monsoon Mission Programme". For the mission the NCEP CFS coupled model has been chosen as core model.

As the forecast of monsoon rainfall in the extended and seasonal range requires a good coupled model, IITM Pune is working on the coupled model NCEP CFS considered as core model under this mission. ❑

Monsoon Mission

Shailesh Nayak
M Rajeevan

The monsoon mission will be implemented during the next 5 years (2012-2017) with an approximate budget of ₹400.0 crores

THE INDIAN summer monsoon is an important component of the global climate system. A major portion of the annual rainfall over India is received during the southwest (summer) monsoon season (June–September). The typical year to year variation (i.e., the standard deviation) of the all-India Summer Monsoon Rainfall (ISMR) is only about 10 percent of the average rainfall of about 89 cm. The historical records show that the chance of normal monsoon is a little over 68 percent, of droughts (rainfall deficiency more than 10 percent) around 17 percent, and of excess rainfall (rainfall excess more than 10 percent) about 15 percent. Although the amplitude of the variation of ISMR from year to year is not large, it has a substantial impact on the agricultural production in the country, thus implies a large impact on the economy of the country. The impact of the vagaries of the Indian monsoon on critical facets of our economy is perceived to be very significant. Therefore, an accurate monsoon prediction can improve planning to mitigate the adverse impacts of the monsoon variability and to take advantage of beneficial conditions. However, it is important to predict not only the total rainfall for the season, but also the variations within the season. While the average rainfall for the country as a whole is important because it determines to a large extent, the national agricultural production, irrigation potential etc, it is the variation of rainfall over different regions which has a direct impact on the livelihood of the rural populations.

During the summer monsoon season, a substantial component of the variability of rainfall over the Indian region arises from the fluctuation on the intra-seasonal

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scale (within the season) between active spells with good rainfall and weak spells or breaks with little rainfall. Frequent or prolonged breaks during the monsoon season, such as the break in July 2002, can lead to drought conditions. Even in normal monsoon years, an uneven spatial and temporal distribution of rains has an adverse effect on agriculture. Therefore, prediction of active and break spells, and in particular, their duration and intensity, is also important. In addition, the prediction of weather systems in short to medium range time scale (up to 10 days) is also important for disaster management, agriculture and tourism and public transport, etc. Prediction of extreme weather events like heavy rainfall events, flash floods and heat and cold wave events also becomes important for better disaster management.

Monsoon Prediction Methods

Two distinct approaches are adopted for generating predictions at different time and space scales. In the first approach, called the statistical method, empirical models based on analysis of historical data of the variability of the monsoon and its relationship to a variety of atmospheric and oceanic variables over different parts of the world prior to the summer monsoon season are used. In this method, the past climate data are used to develop objective statistical equations which can be used for prediction on real time basis. In the second approach, called the dynamical method, predictions are generated based on the equations governing the physics and dynamics of the atmosphere and oceans from an initial state prior to the season. For the predictions based on dynamical models, large computing and data storage resources are required.

About a decade ago, the skill of the dynamical models in predicting the Indian monsoon rainfall was not all satisfactory. In fact, these models had serious limitations even in simulating the mean spatial distribution of the monsoon rainfall. However, the concentrated efforts by different research groups around the world have led to overall improvement in the dynamical models. Over the past few years, the skill of dynamical models in predicting the tropical climate in general and the Indian monsoon in particular has improved substantially. This achievement was possible due to improvement in model physics, better resolution of the models and better data initialization methods, especially for the oceans. Now, the skill of state-of-the-art coupled climate models (which treat the dynamics and physics of both the atmosphere and oceans) has reached a level comparable to that of statistical models. The advantage of dynamical models is that the output can be further used for many application oriented models like crop-yield models, flood forecasting models, etc. It is obvious that more focused research will lead to further improvement in the skill of dynamical models, thus meeting many more requirements of the users.

Monsoon Mission Objectives

Earth System Science Organization (ESSO), Ministry of Earth Sciences (MoES), Government of India has recently launched the Monsoon Mission, with an overall objective of improving monsoon prediction over the country on all time and space scales. The main objective of the monsoon mission is to set up a state-of-the-art dynamical modeling frame work for improving the skill of

a. Extended range to Seasonal forecasts (15 days to one season) for summer monsoon rainfall over the Indian region.

b. Short to medium range forecasts (up to 10 days) for rainfall, temperature, winds and extreme weather events over the Indian region.

Implementation Strategy

The monsoon mission will be implemented during the next 5 years (2012-2017) with an approximate budget of ₹400.0 crores. The mission will be undertaken through two sub-missions on two different time scales, i) extended range to seasonal time scale to be coordinated by the Indian Institute of Tropical Meteorology (ESSO-IITM) Pune and b) short to medium range scale, to be coordinated by the National Centre for Medium Range Weather Forecasting (ESSO-NCMRWF). The Indian National Center for Ocean Information Services (ESSO-INCOIS) will provide the ocean observations for data assimilation for generating forecasts. The India Meteorological Department/ESSO will implement the research outcome of the efforts in operational mode for generating dynamical model forecasts from short range to seasonal time scales.

Under this mission, it is proposed to make use of two coupled ocean-atmosphere models, the Coupled Forecast System (CFS) version 2.0 of the National Centers for Environmental Prediction (NCEP) and the Unified Model (UM) of the UK Met office as base models which have modest skill over the region at present. These two models were selected for the monsoon mission based on their superior skill in predicting the Indian monsoon on different time and spatial scales. Efforts will be made to improve the skill of these coupled dynamical models by making concentrated research on the identified grey areas. The major thrust of the mission is to have active collaboration with academic and research institutes both in India and abroad to fulfill the objectives of the mission. The mission will support focused research by national and international research groups with definitive objectives and deliverables to improve the models on all time scales through extra mural funding. The mission will also support atmospheric and oceanic observational programmes over the South Asian region that will result in better understanding of the physical processes of the South Asian monsoon. Research would be related to the five broad aspects of i) observations ii) process studies iii) modelling iv) Data assimilation and v) prediction methodology.

With the above objectives, research proposals are invited on the following specific areas:

- Improvement of the CFS model Version 2.0 for improving hindcast skill of dynamical prediction of monsoon rainfall (on short, medium, extended and seasonal time scales) over the Indian region.
- Improvement of the UK Met office Unified model (UM) for improving wind, temperature and rainfall forecasts up to 10 days, including improved monsoon simulations over the Indian region from sub-daily time scale to a season.
- Developing/integrating various modules of data assimilation especially for catering to current and upcoming earth observations into the Unified model.
- Better understanding of atmospheric/oceanic processes and improvement of physical parameterization schemes in the models
- Improvement on flexible portability of components of the models on different computing platforms.
- Integrating various Earth system modules into the CFS model.

The proposed research work under the monsoon mission involves enormous numerical computations using the coupled atmosphere-ocean models. For the successful implementation of the mission, powerful super computers are absolutely essential. We need an adequate computing system with the capability to take in hundreds of thousands of atmospheric and ocean observations from all over the world which are used as initial conditions for running the models containing more than a million lines of code. At present, ESSO has a computing system with the speed of 120 Terra flop (120 trillion (10^{12}) arithmetic operations per second). However, for the projected research and developmental work, this is not adequate. We need to expand and sustain a computing system with the speed of 2.5-3 Peta flop (10^{15} arithmetic operations per second) to achieve modeling and prediction improvements under the monsoon mission.

Monitoring and Reviewing Mechanism

To implement the mission successfully, the ESSO has constituted two separate committees for monitoring, reviewing and steering the programme. The Scientific Review and Monitoring Committee (SRMC) will review the research proposals from different research groups from India and abroad and monitor the progress of the research work and implementation of the monsoon mission. The SRMC consists of experts from different academic and research institutes in the country. The Scientific Steering Committee (SSC), which is the apex body will steer the monsoon mission, advise and direct midcourse corrections, if any.

Major Impact of the Mission

The successful mission will achieve the implementation of the state-of-the art dynamical prediction system for more accurate monsoon prediction on all spatial and time scales over the Indian region. The forecasts based on this prediction system will cater to the needs of various sectors like agriculture, water resources management, drought management, disaster management, power generation, tourism, and public transport. ❑

Is India a Monsoon Economy ?

Yoginder K Alagh

An agricultural drought has very specific effects on crops and regions, and the rainfall pattern on more important welfare effects like drinking water and employment

IS INDIA a 'monsoon economy'? Not true any longer. Until the mid-1970s, in half the year's growth was negative and in the other half the economy grew between 3 percent and 6 percent, giving us the average Hindu growth rate. But since then, we had only two years with a growth of less than 3 percent. It has been argued by Arvind Panagriya that volatility is higher now. Even that is not the complete picture. If you compare the Sixties of the last century with the post mid seventies period volatility is less now.

A meteorological and an agricultural drought are, to an extent, two different issues. An agricultural drought has very specific effects on crops and regions, and the rainfall pattern on more important welfare effects like drinking water and employment. Human welfare is very important and tracking the events and ameliorating policies in a time-bound manner are essential.

Many weather risk management strategies fit squarely into sustainable agriculture practices and can, therefore, be promoted with several of the programmes and policies targeting environmentally responsible production. Strategies which have paid are;

- Shift of the focus from growing water intensive crops in the rainfed areas of the country to the water abundant regions of North East India which have the potential of becoming the food bowl of the country. The successful eastern region plan of the Ministry of agriculture is an example.
- Changes in cropping patterns and cropping systems, like multiple/mixed cropping, intercropping systems with legume components etc, to suit the local resource and weather conditions

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- Introduce ecological farming practices which can maximize the local resource use. We need to ensure increased production of crops with efficient combination of inputs and the least possible wastage of environmental resources. Many of these practices are based on indigenous knowledge and focus on building soil biological productivity.

- Locally adopt crop varieties especially in saline and flood prone areas, drought prone areas, making suitable selections adopting Participatory Plant Breeding and Participatory Varietal Selection. Agricultural practices and climate synchronization will help to deal with environmental distortions characterized by the Indian agriculture. Bio Technology Plans in a PPP mode with modern 'Chipping technologies for selective breeding' are needed which would drastically reduce the time period for evolution of drought resistant agriculture.

- Since land and water are shrinking resources, and climate change is a real threat, there is an urgency to spread conservation and climate-resilient farming. A conservation-cultivation-consumption-commerce chain should be promoted in every block.

- Incentivise Rashtriya Krishi Vikas Yojna (RKVY) so as to reap maximum benefit out of it as the Approach paper says

2. Water management and pricing:

It is a well known fact that the geographical area of the country or the extensive land frontier for exploitation has reached its limits. In Punjab, and Western UP, so well endowed groundwater level is also falling. A very dramatic effort will thus be needed to harvest and carefully use the available water so that the dependence on Monsoon can be reduced.

We must:

- Use technology in irrigation including computer controlled operating systems

- Maintain the existing vast canal system in the country

- Enforce standardization in micro / drip and other irrigation equipment

- Propagate low water using agronomic practices such as Direct Sown Rice (DSR), System of Rice intensification (SRI), Laser Leveling etc

- Water harvesting and recharging of aquifers on a sustainable basis

- Pricing of power and water and accounting transparently and fairly for that in the MSP and tariff protection calculations, with provision of subsidy to small and marginal farmers. Any ways the farmers are paying for diesel.

- A Nationwide Mission on Sprinkler and Micro irrigation along with a Nation wide programme on irrigation infrastructure

4. Modern technology for weather forecasting and data collection:

We need an estimate of the total quantum of rainfall in the whole country during the four-month monsoon season (June-September) but also its distribution in terms of space and time.

With these objectives I had presented a six-point programme for using satellite data to supplement traditional sources of agricultural and rural statistics and information in an ISRO ISAE Seminar.

- ***Timely data on Land Use Statistics (LUS)*** since the traditional Crop and Season Reports are generally available with a time lag of three to five years.

- ***Space data should be used for checking estimates of errors of crop area and yield statistics***. While at the national level Timely Reporting System (TRS) and National Sample Survey Organization (NSSO) sample checks gave low errors on production, at the state level, area and yield errors could be between 5 percent and 12 percent. Space data would be another check and would give timely results.

- ***Scope of Geographic mapping systems to be increased***. It should be used not only for public sector projects as earlier in. watersheds, etc., but also for cooperative, NGO and private sector projects.

- ***Two-way information systems should be developed with the help of space facilities.*** The farmers should not only be the source of data but should also be the recipient of technology and agro-economic data he needs for agriculture in a liberalizing economy. This is important for markets, technology access and medium term weather forecasts.

- ***Water resource management*** is a must as water is and will be a scarce resource so recharging water bodies, disaster management should be looked into.
- ***Setting up of a small Nucleus Institute***, Centre with experts on deputation from ISRO, Central Statistical Organization (CSO), NSSO, MOA, Indian Meteorological Department (IMD) NABARD, Consulting organizations, COOPS) to build up new systems of man and machine working together for a restructured agricultural information system. This would ultimately involve the private sector as well.

1. Movement of food:

In bad years:

With a network of more than 400,000 Fair Price Shops (FPS), the Public Distribution System (PDS) in India is perhaps the largest distribution machinery of its type in the world. This huge network can play a more meaningful role in adversity. We must

- Better coordinate government's procurement, distribution, and buffer stocking programmes with demand and vulnerability.
- Avoid the regional concentration in procurement of grain now that the eastern region plan is succeeding. Proportion of marketed surplus procured by official agencies across states vary from below 2 percent to more than 85 percent. There are states like Orissa, Bihar, Madhya Pradesh, North Eastern States etc which are food deficit at aggregate state level, but several growth pockets have emerged in these states having surplus food grains that is available for procurement. These pockets are in the first stage of green revolution and agricultural development, and the need is for encouragement
- Price interventions should be such as to encourage agricultural diversification to address imbalances in Indian agriculture.
- In the long run, country needs to develop new mechanism to provide protection to farmers' income. Government should provide support to develop viable crop insurance for protecting crop income.

2. Harmonize trade and tariff policies:

Agricultural price policy is trying to attain the multiple objectives of food security and equity. The need is for trade policy reforms by getting the price right and some suggested measures for the same are as follows;

- To recommend from time to time, in respect of different agricultural commodities, measures necessary to make the price and tariff policy effective.
- The trade policy objectives and the level of MSPs should be integrated. The Commission for Agriculture Costs and Prices (CACP) should be repositioned and emphasis should be laid not only on cost but also on issues such as tariffs, credit policies, market trends, market structure and broad macro economic policy to meet new challenges.
- The CACP should continue to monitor complementary system of trade, tariff, rural credit and marketing and related policy environment and incorporate its recommendations in the price policy reports submitted to the government from time to time.
- India's position on exports is highly unstable and momentous making it difficult for the people involved in trade to make decisions. This needs to be done away with and stability has to be brought in to the whole system.
- We have finite land available at the same time we are competitive in some crops and not so competitive in the others.
- We need to get our policies and act right so that we can acquire agricultural land abroad to meet our food requirements

Conclusion

Reform is necessary anyway but becomes urgent when the going is tough. It is unfortunate that the policy planners have missed out in agricultural related infrastructure in what are called Census Towns, which I have pressed even before the Census results were known. It is silly to now say that the whole concept of plan schemes is under question because of the untimely Rangarajan Committee report, coming as it did at the time of the Approach Paper, full of plan schemes and resources for the plan which that report wants abolished. We need focused plan schemes for agricultural growth. ❑

Monsoon Variability, Climate Change and Agriculture

Sulochana Gadgil

For estimation of the economic value of forecasts of the monsoon or the benefit of alternative strategies etc., a quantitative assessment of the impact of the entire range of variation of the monsoon is required

THE MOST critical climate element for agriculture and well being of the people in the tropics, is the rainfall. Most of the rainfall over the Indian region as a whole, occurs during the summer monsoon months of June to September. The Indian summer monsoon rainfall (ISMR) has remained remarkably stable throughout the past 140 years for which data are available. During this period, the ISMR has varied between 70 percent and 120 percent of the long term average of about 85 cm with a standard deviation of only about 10 percent of the mean. Monsoon seasons with the ISMR less than 90 percent of the average are considered to be droughts, whereas those with rainfall more than of 110 percent are considered as excess rainfall seasons. Although the variation of the ISMR anomaly (defined as the difference between the ISMR for any year and the average ISMR) is not large (e.g. Fig.1 for 1950 onwards), it is well known that monsoon variability has a large impact on the agricultural production and hence the economy in India.

With increased awareness of anthropogenic climate change, a major concern is the effect on the Indian monsoon, which governs the pulse of life in our country. In the fourth assessment report of the Intergovernment Panel on Climate Change, an increase in the ISMR is projected. The year-to-year (interannual) variation of ISMR is also projected to increase. It is important to note that the impact of climate change is much smaller than the interannual variation of the monsoon which we experience. Thus, if the average projection of fifteen climate models is considered for a typical scenario, the ISMR is expected to increase only by about 5 percent of the mean in 100 years. However, the frequency of the extremes (droughts and excess rainfall seasons) is also likely to

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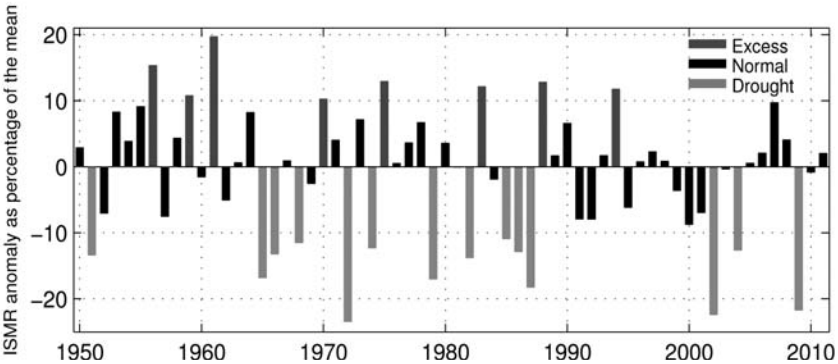
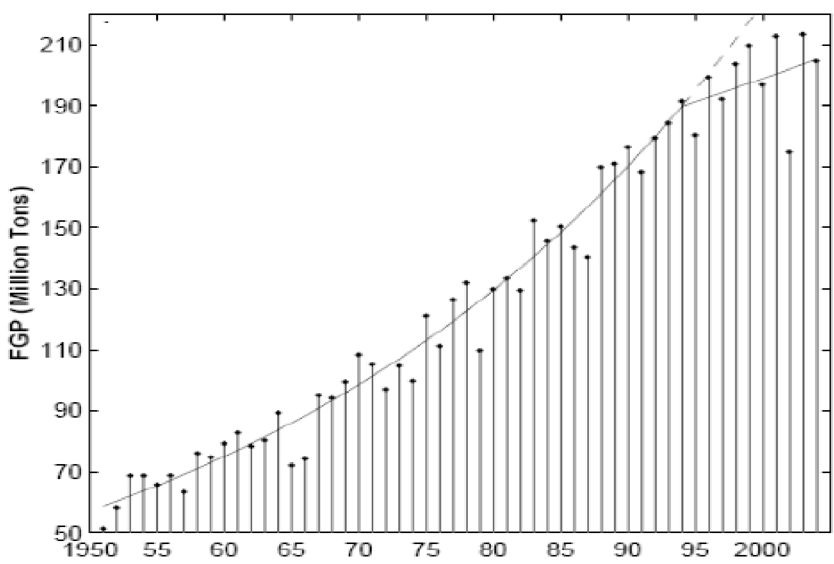
Figure-1



increase. Thus, if we can adopt strategies which are appropriate for dealing with the monsoon variability that we experience at present, we will also be better equipped to deal with the expected climate change. Hence, in this paper, I focus on monsoon variability and agriculture with particular emphasis on food-grain production.

After independence from the colonial rule, the food-grain production (FGP) in the country began to increase and has continued to do so ever since (Fig.2). A sustained growth in production was achieved in the first two decades due to a rapid enhancement of the area under cultivation and massive investments in irrigation. This growth rate could be sustained after the 70s with the green revolution (which involved the introduction of new high yielding semi-dwarf varieties, with a high efficiency of the use of nutrient, water and sunshine), along with a marked increase in the area under irrigation as well as the fertilizer input. The long period trend of FGP is exponential growth at the rate of 2.73 percent from 1950 to 1994 and at a substantially slower rate of 0.78 percent from 1994 to 2004. Thus, since the mid-nineties, there has been a sharp decrease in the rate of growth of FGP (Fig. 2) associated with decreasing rates of growth of rice and wheat over the heartland of the green revolution. A major cause of this fatigue of the green revolution is the declining and deteriorating resource base (land, soil, water, biodiversity). Thus the growth associated with the green revolution has not been sustainable.

Figure-2



It is important to note that the green revolution was largely restricted to rice and wheat cultivated over irrigated regions and there was hardly any growth in the production of rainfed crops like pulses. Thus whereas the high rate of growth of FGP ensured a stable per capita food grain availability since independence, the per capita availability of pulses has been reduced by about 50 percent over this period (Fig. 3). Since at least half the area under cultivation is expected to remain rainfed in the foreseeable future, rainfed agriculture cannot be wished away. It is essential to understand why the production of rainfed crops has not increased and identify ways of achieving sustained high growth in this production for ensuring food security in the future.

In this paper, I first consider the impact of the monsoon on FGP, then discuss why it has not been possible to enhance rainfed production and finally suggest the way forward in our efforts to maximize agricultural production in the face of climate variability and change.

Impact of the monsoon on Food-grain production

The impact of droughts on agricultural production has been known for a long time. It is seen from Figs.1 and 2 that, over and

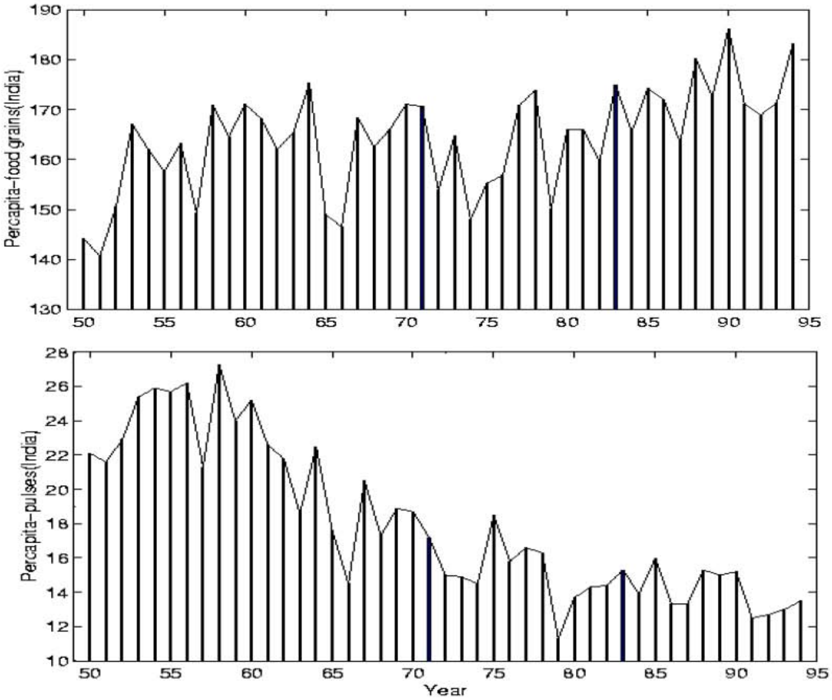


Figure-3

above the long period trend, there are major dips in the FGP in all the droughts beginning with those in 1965,66 and ending with that in 2002. Most of the earlier work on identifying appropriate strategies for monsoon variability was focussed on droughts. Given the success of new varieties in the green revolution, efforts were made to identify drought –prone varieties. Clearly, not much headway was made in enhancing the production with this approach. Here I consider the impact of the variability of the monsoon on FGP, without restricting attention to only the deficit years. For estimation of the economic value of forecasts of the monsoon or the benefit of alternative strategies etc., a quantitative assessment of the impact of the entire range of variation of the monsoon is required.

Our analysis is based on the premise that while the monsoon (and hence factors depending on the monsoon) fluctuates from year to year, most of the other factors leading to the growth of agricultural production are characterized by a time-scale of several years. We expect the deviations of the FGP in any year from the long term trends, to be related to the impact of the monsoon of that year. However, it must be noted that other special events which have timescales of the order of a year or so, such as wars, can also contribute to such deviations and impacts of such events are also seen in our analysis.

The deviation of the FGP, from the long term trends, for a specific year is taken as a measure of the impact of the monsoon in that year, and is denoted by IFGP. The variation of IFGP with the ISMR anomaly is shown in Fig. 4. It is seen that the IFGP is negative for all droughts (with values up to -20 percent) and positive for ISMR anomaly larger than 10 percent (with values up to +10 percent). IFGP is highly correlated with the ISMR anomaly, with the correlation coefficient of 0.76, which is significant at 1 percent level. Thus the impact of the monsoon on the all-India food grain production is high, although a large fraction of the FGP comes from the irrigated regions.

The most striking feature of the variation of the IFGP with the anomaly of ISMR (Fig. 4) is the asymmetry in response to deficits versus excess of ISMR. It is seen that the magnitude of the impacts on FGP increases rapidly with increasing deficits of ISMR. However, for positive anomalies of ISMR, the rate of increase of the impact on FGP with ISMR is very small. This asymmetry in response to monsoon variability has important implications for our food security. It implies that even when over a long period, the mean monsoon rainfall does not decrease (i.e. deficits in some seasons are balanced by above normal rainfall in others), the negative impact of the deficit monsoon seasons cannot be made up by increases in FGP in good monsoon seasons.

Some insight into how such an asymmetry can arise is gained by a comparison of the response of the yields of rainfed crops to an increase in the growing season rainfall, on the farmers' fields via a vis on agricultural stations in the same regions (Fig. 5). When the rainfall is low, yields are low at both, but when the rainfall is high, the yield at the agricultural stations is much higher than that of the farmers' fields. Further studies at ICRISAT have shown that there is a similar variation of the yield gap (between what is achievable and what is achieved) with rainfall for other important rainfed crops such

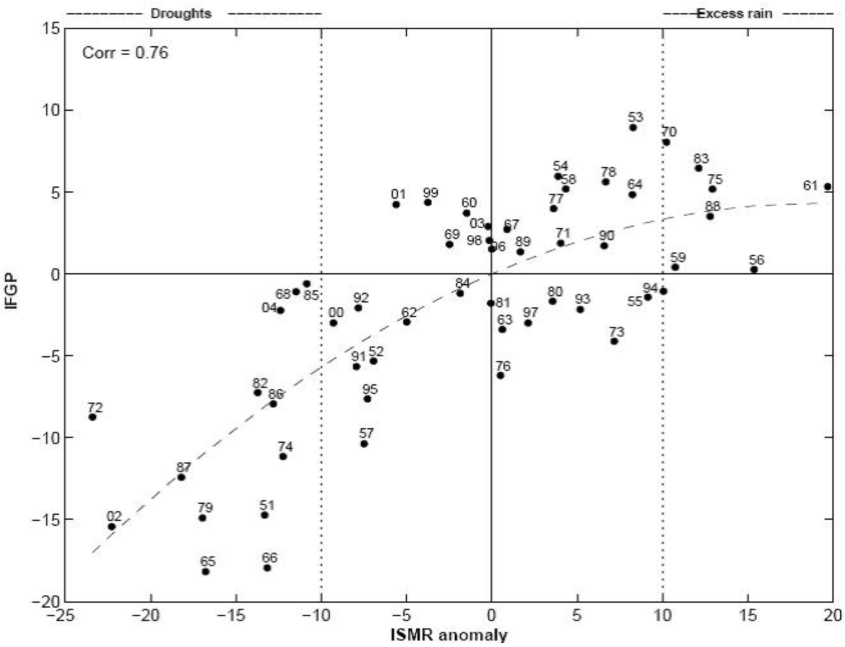


Figure-4

as Groundnut, Chickpea, Pigeonpea and Soybean as well.

The major management differences between the farmers' fields and the agricultural stations are fertilizer and pesticide applications. In rainfed agriculture, such applications enhance yield substantially (and hence are cost-effective) only when there is sufficient rainfall. Farmers do not invest in these applications because it is not economically viable in years of poor rainfall, even though they have the knowhow (and, in fact, do invest in fertilizers and pesticides in irrigated patches). Thus the proven technology package for yield enhancement is not adopted by the farmers because they believe that it is not economically viable. Thus the increase in the yield with rainfall is rather small on the farmers' fields leading to the asymmetry in the response of the FGP to the monsoon.

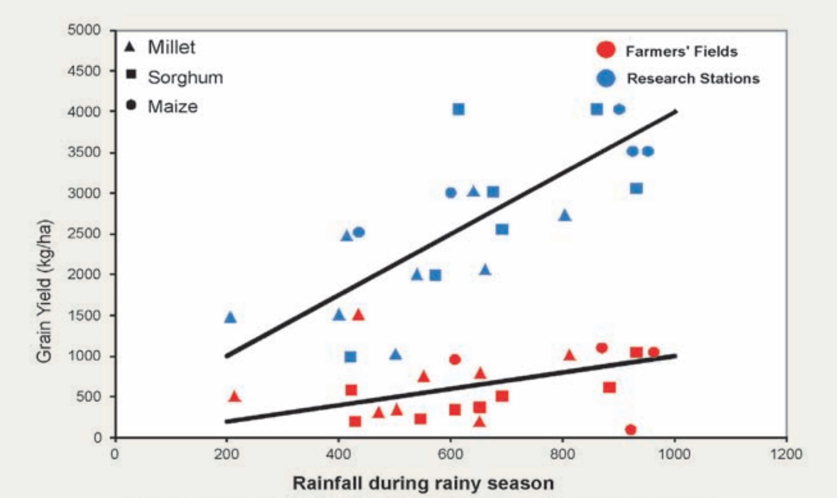
It is important to note that the impact of these applications on the yields has increased in the last three decades. Since the 70s, there have been major changes in the cropping patterns due to various factors including larger impact of the market economy introduction of new varieties etc. and the traditional complex cropping system is now replaced by mono-cropping over large tracts of land. This has led to a large number of pests and diseases becoming endemic. Furthermore, intensive farming has resulted in loss of fertility of the soil. In this situation, application of fertilizers and pesticides has become necessary for getting high yields. If our hypothesis of the asymmetry in response of the FGP arising primarily from the lack of application of fertilizers and pesticides over rainfed areas is correct, we would expect the asymmetry to have increased in the last few decades. We find that the asymmetry has, indeed increased. In the era up to 1980, a deficit in rainfall of 15 percent is expected to reduce the FGP by about 10 percent and a surplus to increase FGP by about 6 percent. In contrast, in the era beginning in 1980, the expected effect of a deficit of 15 percent on the FGP is about 9 percent while the estimated impact of a surplus of 15 percent on the FGP is only 0.7 percent! Thus, in the earlier era, the magnitude of the impacts of a drought and a surplus on FGP were comparable in magnitude; while after 1980 the impact of surpluses has become almost negligible. Clearly there is a window of opportunity of better utilization of normal and good monsoon years for enhancement of production.

Failure to enhance rainfed production and the way forward

Why has rainfed production not increased over the last several decades? An approach, which has been largely focused on productivity/ production enhancement through enhanced availability and access to improved germplasm and technological packages involving inputs (fertilizers, pesticides) management (e.g. ICAR, 2011), which delivered results for the relatively controlled environment of irrigated cultivation, has failed in the case of rainfed cultivation. Rainfall and soil together constitute the key determinants of rainfed farming potential-the two determining the amount and availability of stored water that will support crops. Yet, very little effort has gone into deriving strategies which are tailored to the nature of the rainfall variability of the regions.

In fact, the optimum choice of crops/varieties as well as management practices, such as choice of the sowing window, depends upon the nature of the rainfall variability of the region. Over the Indian region, long time-series of rainfall data

Figure-5



Relationship between rainfall during the rainy season and yield of maize, sorghum and millet at 15 dryland locations in India (after Shivakumar et al. 1983)

at a dense network of stations are readiliy available. If these are used in juxtaposition with crop models (which are also available now for a large number of rainfed crops), it is possible to identify optimum farming strategies for the rainfall variability experienced, as well as for a specific prediction about rainfall, if and when, available. However, such strategies for the important rainfed crops of different agroclimatic zones are yet to be identified by agricultural scientists. Recommendations about sowing window etc. are made without taking rainfall variability into account and have been found to be invalid by the farmers in many cases.

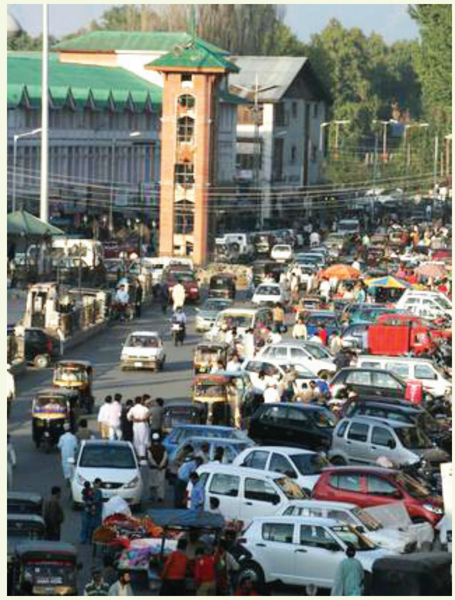
In Dr. M S Swaminathan's assessment the rainfed production has not increased because "*The research farms programmes have mostly been scientist oriented and not farmer or user centered. These were perceived, planned, implemented, supervised and evaluated by scientists. The transfer of results followed a top down approach. In this "take it or leave it approach", the farmer was at best a passive participant. Scientific findings which became the so-called 'technologies' were born from small plots and short-term research and were invariably not associated with critical cost-benefit studies.*"

The large yield gap arising from the lack of economic viability of the application of fertilizers and pesticides, supports the above assessment about the near absence of critical cost-benefit studies. It should be noted that very low rainfall, for which the application of fertilizers and pesticides is not cost effective, is a low probability event. For example, on the all-India scale droughts occur in 17 percent of the years. Given the probability of droughts for any region (and if a reliable prediction of 'no drought' is available), it should be possible to work out the appropriate dosage of fertilizers such that the cost-benefit ratio is highly favourable in a majority of years. If the analysis is done in collaboration with farmers, with information on farm economics and market prices and incorporating an analysis of risks (e.g. due to variability of rainfall in rainfed cultivation), it should be possible to derive a strategy for enhanced production which would be adopted by them. Also, often, in the analysis of farming strategies, those associated with maximum yields are considered optimum. *However, the aim of the farmers is not to maximize yields but rather to maximize profit in most of the years (high enough to compensate for less profit or loss in years of unfavourable monsoon) and minimizing the risks.* Thus, whether the suggested package will be adopted depends on whether it meets the farmers' objectives. Clearly, in place of the top-down approach mentioned by Dr. Swaminathan, a farmer-centric approach is essential for identification of the appropriate technology packages, if they are to be adopted by the farmers and thereby impact the rainfed production.

Recent innovative experiments by some farmers and NGOs suggest that if we are to achieve a substantial enhancement of rainfed production, what is required is a paradigm shift. In place of huge tracts of land under mono-crops, a judicious combination of trees, fodder and crops is grown after the land scape is modified (with ridges, furrows etc) for maximum storage of rainwater. With enhancement of soil fertility and water holding capacity by addition of the locally generated plant biomass, the top layer of the soil becomes very deep, ensuring adequate soil moisture at root level even during intense dry spells. Once established, such an agro-ecosystem is associated with large profits as well as a substantial enhancement in the yields and hence the crop production. The challenge before the scientists is to start understanding, modeling and propagating such an ecosystem, to create a real impact on rainfed cultivation. ❑

J&K WINDOW

A HERITAGE TOUCH FOR DOWNTOWN SRINAGAR



Downtown Srinagar is set to go the New York way. A two-km stretch from Nawakadal to Chattabal will soon have a heritage craft pedestrian trail for tourists on the pattern of the Big Apple. It will house craft bazaars, retail outlets, kiosks, production centres and other facilities. The concept was borrowed from the similar heritage trails in New York, China (Chengdu), Muscat (Oman) and Sabarmati. Chief Minister Omar Abdullah approved the project at a high level meeting recently.

The main objective of the new development concept - translated into a holistic project for the revitalisation of downtown Srinagar - is to provide necessary succour to a large population of artisans by developing craft clusters, generating economic activities, encouraging tourist flow and upgrading basic amenities, along with the beautification of the historic Srinagar city,' Abdullah said.

The state tourism department has already taken several initiatives to open up the old city to high-end tourists. It is constructing a museum named after famous Kashmiri saint Lalla Ded, who is venerated by both Hindus and Muslims, in the old city.

The department had earlier renovated Aali Masjid in Eidgah, constructed in the year 1471 by Sultan Hassan Shah. It is the second largest mosque in Srinagar city after the Grand Mosque at Nowhatta.

Usually, tourists seldom visit old city areas known for heritage sites and old style architecture. The CM said the involvement of tourism, and housing and urban development departments should be factored in the overall roadmap aimed at comprehensive development of the old city and the artisans there. Conservation architects have welcomed the move.

It was long overdue. It would give a new look to the city. But we hope the intervention in the plan's execution would be sympathetic to the historic buildings and heritage sites, said Saleem Beg, head of the Jammu and Kashmir chapter of the Indian National Trust For Art and Cultural Heritage. ❑

3 PILGRIM TOURISM CIRCUITS COMING UP IN JK: JORA

In Jammu & Kashmir three tourism circuits would be developed-- one each in Kashmir, Jammu and Ladakh regions-- for promotion of pilgrim tourism in the State. The government has submitted detailed project reports of Rs. 150 crore in this regard to the Union Ministry of Tourism for approval.

The Centre in principle has agreed to provide funds to the State Government for creation of these circuits and the development of this tourism circuit would be taken up soon after receiving the nod from the Central Government.

A Sufi circuit would be developed at a cost of Rs. 50 crore in Kashmir Valley. In Jammu province a pilgrim tourism circuit would also be developed at a cost of Rs. 50 crore, and Rs. 50 crore would be also expended on development of Buddhist circuit in Ladakh region. ❑

Southwest Monsoon In India and its Forecasting System

S C Bhan

A delay of a few weeks in the arrival of the monsoon, its early withdrawal or prolonged dry spells during the season can badly affect the economy, as evidenced in the numerous droughts in India

MONSOON IS traditionally defined as a seasonal reversal of wind accompanied by corresponding changes in precipitation associated with the asymmetric heating of land and sea. The term was first used in British India and neighbouring countries to refer to the seasonal winds blowing from the Bay of Bengal and Arabian Sea bringing heavy rainfall to the area.

Process of Monsoon creation

Monsoons may be considered as large-scale sea breezes, due to differential heating of land and the adjoining oceans; and the resultant development of a thermal low over a continental landmass. This differential warming happens because heat in the ocean is mixed vertically through a "mixed layer" that may be fifty metres deep, through the action of wind and buoyancy-generated turbulence, whereas the land surface conducts heat slowly, with the seasonal signal penetrating perhaps a metre or so. Additionally, the specific heat capacity of liquid water is significantly higher than that of the land. Together, these factors mean that the heat capacity of the layer participating in the seasonal cycle is much larger over the oceans than over land, with the consequence that the air over the land warms faster and reaches a higher temperature than the air over the ocean. The hot air over the land tends to rise, creating an area of low pressure. This creates a steady wind blowing toward the land, bringing the moist air of maritime origin with it. This moist air is lifted up due to orographic barriers or low pressure areas. The air on lifting cools due to expansion, which in turn produces condensation and precipitation.

In winter, the land cools off quickly, but the ocean retains heat longer. The cold air over the land creates a high pressure area which produces the wind flow from land

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to ocean. Monsoons are similar to sea and land breezes a term usually referring to the localized diurnal cycle of circulation near coastlines, but they are much larger in scale, stronger and seasonal.

Southwest monsoon

The southwest monsoons occur from June through September. The Thar Desert and adjoining areas of the northern and central Indian subcontinent heat up considerably during the hot summers, which cause a low pressure area over the northern and central Indian subcontinent. To fill this void, the moisture-laden winds from the Indian Ocean rush in to the subcontinent. These winds originate in the south Indian Ocean and move northward. On crossing the equator, these winds are deflected to their right due to rotation of the Earth. They approach the Indian land mass from southwest and, therefore, are called southwest monsoon.

Onset and advance of Southwest monsoon

The southwest monsoon is generally expected to begin around start of June and fade down by the end of September. The moisture-laden winds on reaching the southernmost point of the Indian Peninsula, get divided into two parts: the Arabian Sea Branch and the Bay of Bengal Branch. The Arabian Sea Branch of the Southwest Monsoon first hits the state of Kerala around 01 June. This branch of the monsoon moves northwards along the Western Ghats (Konkan and Goa) and reaches Mumbai around 10 June. Simultaneously, the Bay of Bengal Branch flows over the Bay of Bengal heading towards North-East India. Picking up more moisture from the Bay of Bengal, the Monsoon reaches northeast India around 01 June. After the arrival over northeast India, the winds turn towards the west, travelling over the Indo-Gangetic Plain. It reaches upto eastern parts of Uttar Pradesh around middle of June. The Arabian Sea Branch, by the same time reaches upto Gujarat; and the two branches generally merge over central parts of the country. It then progresses as a combined current and covers the remaining parts of the country by middle of July.

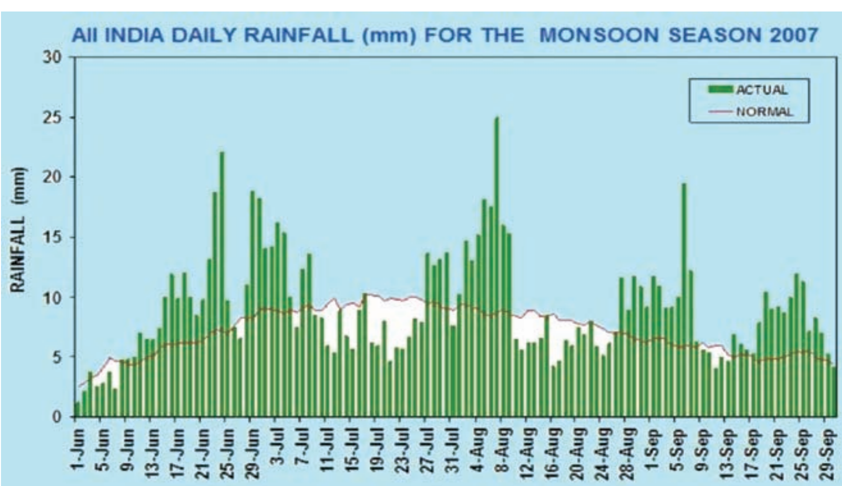

Fig. 1. All India daily actual and normal rainfall for the monsoon season 2007

Rainfall Distribution during Southwest Monsoon

The monsoon accounts for 80 percent of the rainfall in India. Indian agriculture is heavily dependent on the rains, for growing crops especially like cotton, rice, oilseeds and coarse grains. A delay of a few weeks in the arrival of the monsoon, its early withdrawal or prolonged dry spells during the season can badly affect the economy, as evidenced in the numerous droughts in India.

As the prevailing winds blow almost at right angles against the Western Ghats and the Khasi–Jaintia hills, highest seasonal rains are experienced over these regions. In the north Indian plains, a minimum rainfall belt runs from northwest Rajasthan to the central parts of West Bengal, practically along the axis of the monsoon trough. Rainfall decreases considerably with a very steep gradient to the east of the Western Ghats which fall in the rain-shadow zone. With all the significant amounts of rainfall occurring over the Ghats, a saving feature of economic interest is that all the important rivers of south India emerging out of the western Ghats to flow east through the plateau which otherwise receives considerably lower rainfall. Eastern and central parts of the Himalayas also receive heavy rains due to orographic effect. Parts of Jammu and Kashmir, western parts of Rajasthan and extreme southeastern parts of peninsula receive the lowest amounts of rain during the season.

The monsoon rainfall also exhibits large variability in different time scales. Daily rainfall shows large deviations from the normal. Figure 1 shows the daily normal and actual rainfall during the monsoon season 2007. The spells of active and week monsoon are clearly seen in the Figure. Though the country as a whole received 6 percent more rainfall than the normal, five meteorological sub-divisions received deficient rainfall (Figure 2).

Figure 3 shows the interannual variability of all India seasonal monsoon rainfall expressed as the percentage departures from long period average (LPA). The years in which the percentage departures are less than -10 percent (more than +10 percent) are called drought (flood) or deficient (excess) monsoon years. Remaining years are called normal monsoon years. It is seen that during the period 1901 -2011, the lowest seasonal rainfall have occurred in 1918 (75.1 percent of the normal) and 1972 (76.4 percent); and highest in 1917 (122.9 percent) and 1961 (121.8 percent). The red (blue) bars correspond to El Nino (La Nina) years. Out of the 20 drought years during the period of 1901-2011, 13 years (65 percent) were associated with El Nino events. Most of the La Nina years (blue bars) received normal or excess rainfall.

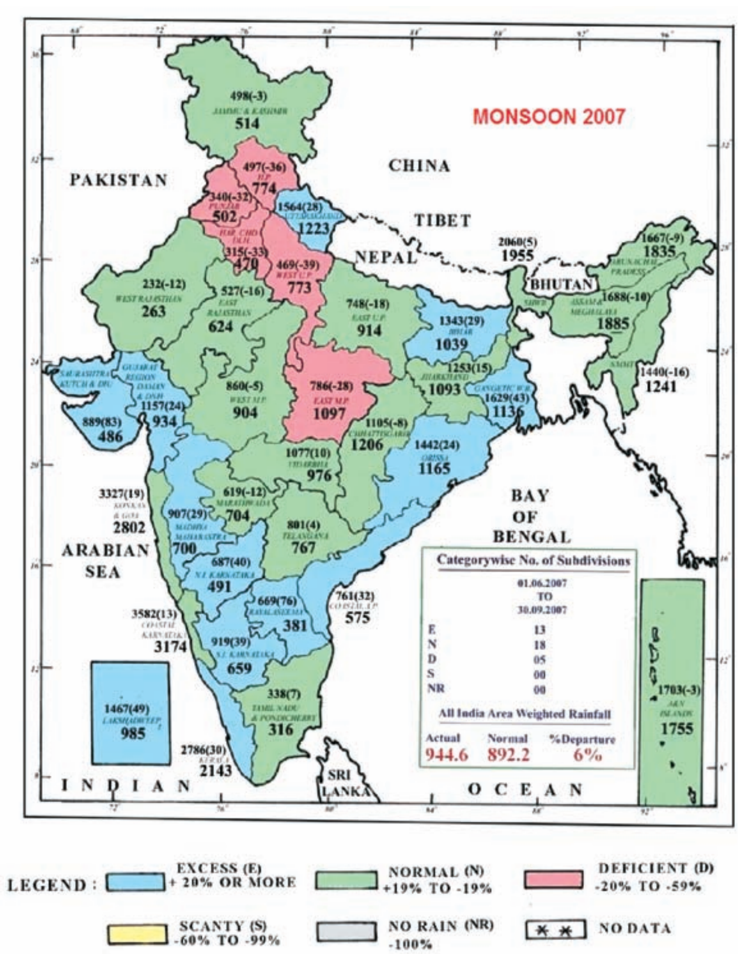

Fig. 2. Sub-division wise rainfall for the monsoon season 2007

Impact of Southwest Monsoon Rainfall on Agricultural Production and GDP

Figure 3 shows that during most of the years, the deviation of rainfall has been within ±10 percent of the normal. Though the amplitude of the variation of monsoon rainfall from year-to year is not large, it has a substantial impact on agricultural production and economy of the country. Initially, large impact of monsoon on the economy of the country was thought to be the result of prime dependence of economy on agriculture. With planned development since independence, the contribution of agriculture to the Gross Domestic Product (GDP) decreased substantially. This should have lessened the impact of monsoon on the economy. However, a recent analysis of the variation of the GDP and the monsoon by Gadgil and Gadgil (2006) has revealed that the impact of severe droughts on GDP has remained between 2 to 5 percent of GDP throughout.

Forecasting the Monsoon rains

Monsoon rains are predicted in three broad temporal ranges – Short Range (1-3 days), Medium Range (4-10 days) and Long Range Forecast (more than 10 days to a season or beyond).

Short and medium range forecasts

The short and medium range weather forecasts are nowadays made using the Numerical Weather Prediction (NWP) Models. The basic idea of NWP is to sample the state of the atmosphere at a given time and use the equations of fluid dynamics and thermodynamics to

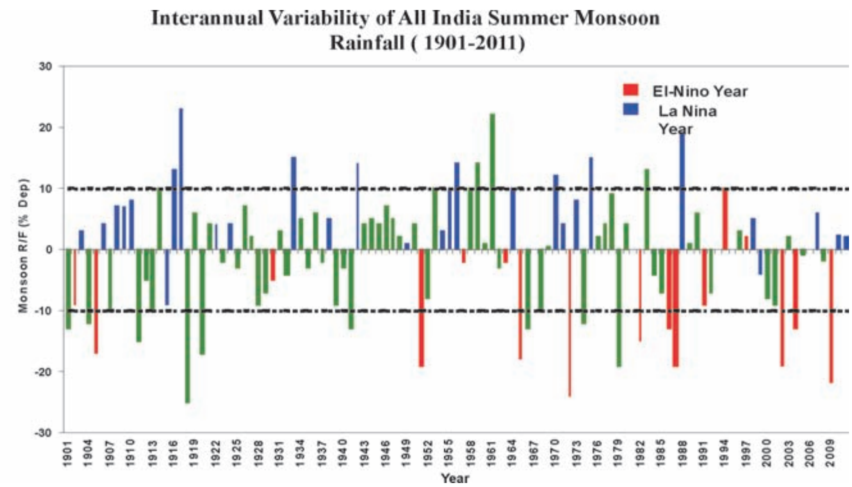

Fig. 3. Year-wise all India monsoon rainfall expressed as the percentage departures from LPA

estimate the state of the atmosphere at some time in the future. The main inputs to these models are surface observations from manned and automated weather stations over the land, weather buoys at sea and observations at different heights of the atmosphere obtained with specialised instruments (radiosonde) flown into the atmosphere with the help of hydrogen filled balloons. Data from weather satellites are used in areas of where traditional data sources are not available. Meteorological radars provide information on precipitation location and intensity, which can be used to estimate precipitation accumulations over time.

The models are initialized using this observed data. The irregularly spaced observations are processed by data assimilation and objective analysis methods, which perform quality control and obtain values at locations usable by the model's mathematical algorithms (usually at evenly spaced grids). The data are then used in the model as the starting point for a forecast. Commonly, a set of equations are used to predict the future state of the atmosphere. These equations are initialized from the analysis data; and rates of change are determined. The rates of change predict the state of the atmosphere a short time into the future. The equations are then applied to this new atmospheric state to find new rates of change, and these new rates of change predict the atmosphere at a yet further time into future. This time stepping procedure is repeated until the solution reaches the desired forecast time.

The visual output produced by a model solution is known as a prognostic chart. The raw output is often modified before being presented as the forecast. This can be in the form of statistical techniques to remove known biases in the model, or of adjustment to take into account consensus among other numerical weather forecasts. Analysis of wind conditions at 1.5 km above sea level for 1730 IST of 20 August, 2010 and the forecast of rainfall 48 hours after that are given in Figure 4 and 5, respectively.

Long Range or Seasonal Forecast of Monsoon

The summer monsoon accounts for major share of the total annual rain in 75 percent of the geographical area of the country. Although the duration of monsoon over various parts of India varies from about 2 months to 6 months, long range forecasts are generally issued for monthly and seasonal scales for June to September.

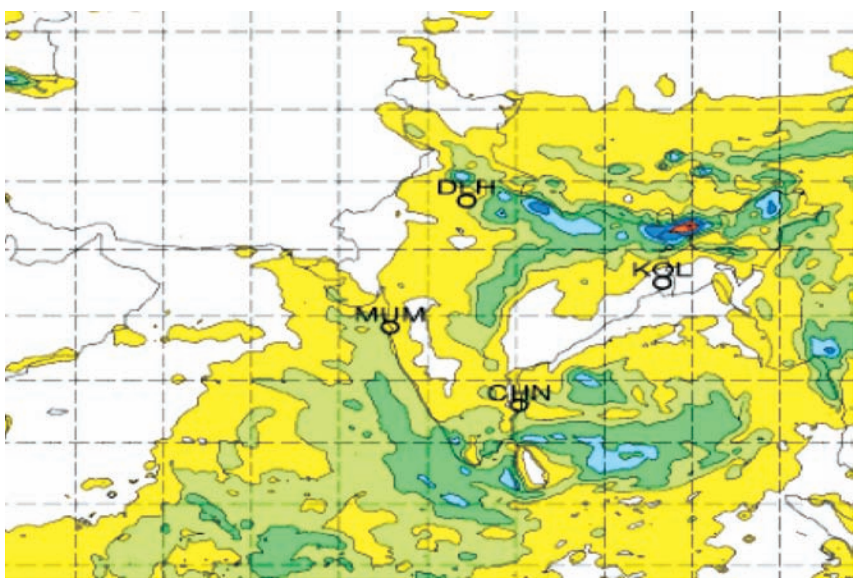

Fig. 4. Forecast of Rainfall 48 hours after 1730 IST of 20 August, 2010

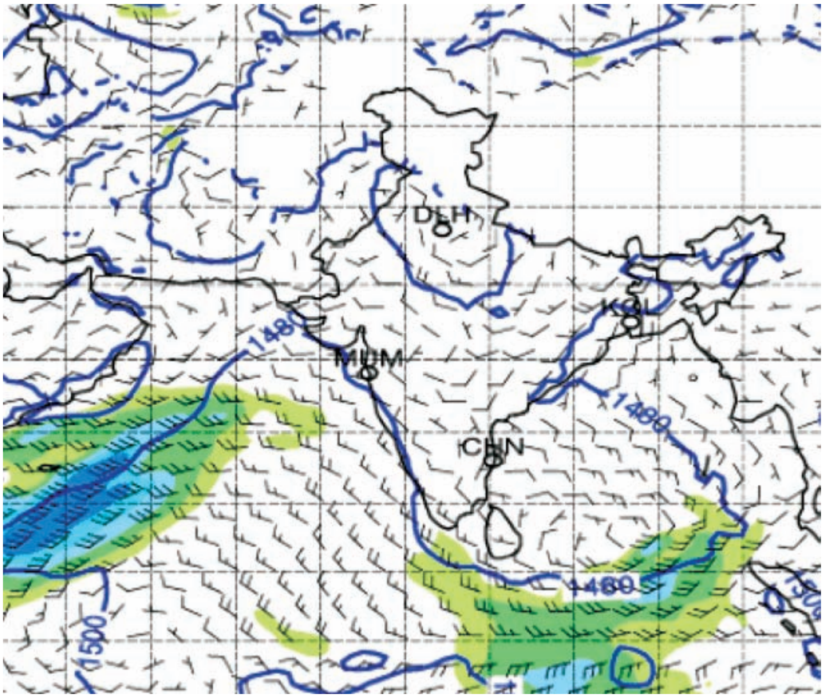

Fig. 5. Analysis of wind at 1.5 km above sea level for 1730 IST of 20 August, 2010

The year to year variation in the Indian summer monsoon rainfall (ISMR) is primarily attributed to its association with the slowly varying boundary forcing such as sea surface temperature, snow cover, soil moisture etc. Two main approaches are used for the long range forecasting (LRF) of the ISMR. The first approach is based on the empirical statistical methods; and the other is based on dynamic models which uses General Circulation Models (GCM) of the atmosphere and oceans to simulate the summer monsoon circulation and associated rainfall.

Statistical Long Range Forecast System

The statistical approach uses the historical relationship between the ISMR and predictors derived from global atmosphere-ocean parameters. The statistical models have shown better skill than the dynamical models for the seasonal forecasts of ISMR. Therefore, India meteorological Department (IMD) currently uses statistical methods for issuing long range forecasts of monthly and seasonal monsoon rainfall over India.

At present, IMD issues forecasts for monthly (for July, August, September), second half (August + September) and seasonal rainfall over the country as a whole and for seasonal rainfall over four geographical regions (Northwest India, Central India, Northeast India and South Peninsula - Figure 6) with useful skill. The seasonal forecast for the country as a whole is issued in two stages - in April and June. A set of 8 predictors that have stable and strong physical linkage with ISMR is used. The 8 predictors used for the statistical forecast system are given in the Table-1. For April forecast, first

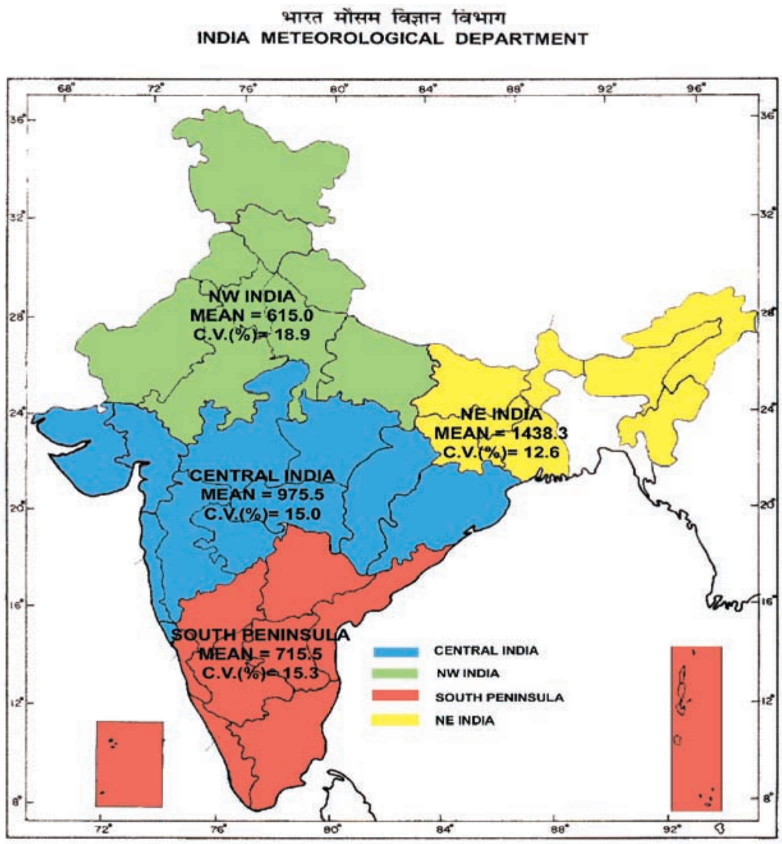

Fig. 6. The four homogeneous regions of India.

Table- 1: Details of the 8 predictors used for the new ensemble forecast system			
S.No	**Predictor**	**Used for forecasts in**	**Correlation Coefficient**
1	NW Europe Land Surface Air Temperature (P1)	April	0.58
2	Equatorial Pacific Warm Water Volume (P2)	April	-0.30
3	North Atlantic Sea Surface Temperature (P3)	April and June	-0.49
4	Equatorial SE Indian Ocean Sea Surface Temperature (P4)	April and June	0.45
5	East Asia Mean Sea Level Pressure (P5)	April and June	0.36
6	Central Pacific (Nino 3.4) Sea Surface Temperature Tendency (P6)	June	-0.49
7	North Atlantic Mean Sea Level Pressure (P7)	June	-0.52
8	North Central Pacific wind at 1.5 Km above sea level (P8)	June	-0.44

5 predictors are used. For the update forecast issued in June, the last 6 predictors are used that include 3 predictors used for April forecast. Figure 7 shows the performance of the method for the June forecast (actual – green bars; forecast – red bars). The Figure shows that the model has been able to predict large deviations in monsoon rainfall both on positive and negative sides. The RMSE of June forecasts for the independent period 1981-2010 is 5.6 percent of LPA.

The months of July and August are the rainiest months of the south-west monsoon season (accounting for 33 percent and 29 percent of the season's total rainfall, respectively) and play important role in production of kharif crops in the country. The monthly rainfall forecasts for July and August over the country as a whole are prepared using a principal component regression models based on separate sets of predictors. Forecast for the rainfall during the second half of the monsoons season (August + September) and for the month of September over the country as a whole is prepared using another regression model.

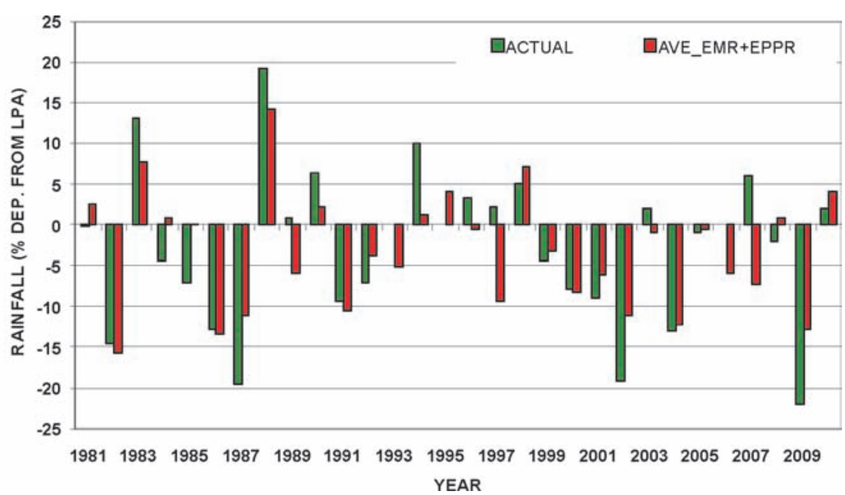

Fig. 7. Performance of June Forecast using Ensemble Forecast System

Dynamical Model Forecasting System

Ministry of Earth Sciences (MoES) has launched the National Monsoon Mission (NMM) for developing a state-of-the-art dynamical prediction system for monsoon rainfall on different time scales. Indian Institute of Tropical Meteorology (IITM) is coordinating and working along with different climate research centres from India and abroad on the development of a coupled model for the forecasting the ISMR. IMD has adopted the latest high resolution research version of the coupled model being implemented at IITM for generating experimental forecast for southwest monsoon rainfall. For the first time, anywhere in the world, such a high resolution coupled model (horizontal resolution of approximately 38 km - T382) has been used for generating seasonal prediction of monsoon rainfall. The model is still in an experimental stage and shall be made operational once the desired level of accuracy is achieved. ❑

YE-59/2012

Long Range Forecasting of Monsoon Rainfall

B N Goswami

Dynamical models now emerge as our best bet for predicting monsoon rainfall, specially when only the dynamical models have the potential for predicting extremes like droughts or floods

THIS IS a time of the year when all Indians await the arrival of the monsoon in Kerala and its regular advance northward with bated breath. It is also time of the year when everyone from farmers to policy makers look forward to hear the good news on long range forecasting of monsoon rainfall. The 'good news' of course refers to prediction of either normal or above normal monsoon rainfall. We all dread to hear predictions of a 'drought' as severe droughts can take GDP growth southwards by 2-5 percent partly directly through decrease in agricultural production but also through negative feedback the news triggers between certain elements of the economy. The India Meteorological Department (IMD) responsible for making these forecasts often has to take the brunt of criticism whether the forecasts are correct or wrong. When the monsoon is normal or above normal IMD forecasts are forgotten even if they were correct. Due to its potential repercussions, the meteorological agency is generally overcautious in giving a drought forecast. The temperature of the waters over the equatorial Indian Ocean has been rising rather rapidly over the past fifty years and has a negative impact on the Indian monsoon rainfall. As a result, we may expect the Indian monsoon to have a tendency to be below normal during coming decade too. Therefore, we may have to brace for more droughts in the coming years. It is imperative, therefore, that a long term strategy to deal with monsoon drought is put in place.

With the forecast of a 'normal' monsoon (nearly 100 percent of long term average, LTA), however, we need not worry much about drought this year. The IMD using an empirical model and input from other global modeling community has forecasted monsoon to be 99 percent of LTA. The empirical models are known to have limited skill and fail to predict the extremes. Until recently unfortunately,

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the dynamical coupled ocean-atmosphere models also did not have forecast skill better than those of the empirical models. However, the scene has changed during the past few years due to slow but steady increase in the skill of long range prediction of Indian monsoon rainfall by dynamical models. The best of dynamical models now have skill comparable to or better than the empirical models. Hence, dynamical models now emerge as our best bet for predicting monsoon rainfall, specially when only the dynamical models have the potential for predicting extremes like droughts or floods. The Indian Institute of Tropical Meteorology (IITM), a constituent of the Earth System Science Organization (ESSO) of the Ministry of Earth Sciences (MoES) has set up a system of state of the art coupled ocean-atmosphere model for long range prediction of monsoon rainfall as part of long term strategy to build a dynamical forecasting system based on laws governing the motions in the atmosphere and the ocean. The skill of this model based on retrospective forecasts of about thirty past years indicates that the model is one of best such models currently available anywhere in the world. Using ocean-atmosphere observations from February, 2012, the experimental forecast for 2012 monsoon by the model indicates normal (100 percent of LTA) June-September rainfall over India. The forecast updated by using data from April, 2012 indicates monsoon to be about 104 percent of LPA. The model also indicates that the El Nino is unlikely to develop to a strong event. This said, we must recognize that models can never give perfect forecast and hence in some years, the forecast is bound to go wrong. The skill of any such model should be evaluated on a large number of sample forecasts.

The difficulty in predicting the seasonal mean monsoon rainfall arises partly from lack of our understanding and ability to identify the drivers for the monsoon in a given year and difficulty in simulating the response of these drivers over the monsoon domain by the climate models. While monsoon research over the past century has identified some important drivers such as the El Nino and Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), Eurasian snow cover etc, the exact drivers for the monsoon in any given year are yet to be established. In addition to contributions from these slowly varying predictable drivers, there is a component of monsoon that is contributed by unpredictable 'climate noise'. Such 'climate noise' arises from high frequency 'internal' feedbacks within the system leading to a residual contribution to the seasonal mean. With the warm waters in the Indian Ocean to the south, the Western Ghats and Himalayas to the north, the Indian monsoon region is a fertile ground for vigorous interactions between organized clouds and air flow leading to a variety of fluctuations. Prominent amongst these are the repeatedly northward propagating east-west oriented cloud band in the form of monsoon intra-seasonal oscillations (MISOs) fluctuating with approximate time scale of about a month. Frequency of occurrence, duration and intensity of these sub-seasonal oscillations during a monsoon season makes a significant residual contribution to the seasonal mean. As the detailed state of such oscillations are fundamentally not predictable three months ahead, this 'internal' contribution to monsoon is very difficult to predict by any model. Thus, the climate models, not only must simulate the contribution of remote drivers like ENSO, IOD etc on the Indian monsoon correctly, they must also simulate the statistics of monsoon sub-seasonal oscillations correctly. The climate models have now become good at simulating and predicting the ENSO about six months ahead of time. The models have also high skill of predicting seasonal mean rainfall one season ahead in places where rainfall is strongly controlled by ENSO such as Indonesia, northern Australia, central Pacific and northern Brazil. However, monsoon rainfall is not strongly controlled by ENSO as many droughts in the past have occurred without an El Nino in the Pacific. The contribution to monsoon rainfall from predictable ENSO and rather unpredictable 'internal' feedbacks seems to be comparable making the Indian monsoon probably the most challenging and difficult system to predict.

The difficulty in predicting the Indian monsoon by climate models is also linked with the fact that most climate models have some systematic deficiency in simulating the present day climate correctly. These deficiencies are related to inability of the models' in representing some of the physical processes with fidelity. The climate like the Indian monsoon is a result of energy (heat) balance not only over the monsoon region but over the entire globe. The heating distribution, in turn, depends not only on the balance between incoming solar radiation and outgoing terrestrial radiation but also on the latent heat released by the clouds when water vapor condenses to become rain. The heating and cooling leads to pressure differences and winds are forced by such pressure gradients. However, it is the lifting of air by convergence of air mass by winds or winds blowing against mountains that lead to condensation of water vapour and rain. Thus, heating produces winds which leads to rain which in turn modifies the heating and winds. In the tropics, a large amount of rainfall takes place and plays a crucial role in maintaining the global climate. Therefore, any climate model must get the tropical rainfall distribution and its annual evolution correctly. However, rain comes from individual clouds that are 1-10 km in size that get organized to larger systems. Within each cloud cell, how water vapour condenses on hygroscopic aerosols known as cloud condensation nuclei (CCN) and how small drops become big drops before falling as rain involve even smaller scale micro-physical processes. To simulate all such clouds well, one not only needs to include all these microphysical processes but also need a global model with horizontal grid size of 1-2 km. Such a model is formidable to run even in the fastest currently available supercomputer in the world. Best of global coupled ocean-atmosphere climate models currently have grid size of 30-50 kms in the horizontal and about 60 levels in the vertical. Such a model has about eight million grid cells where seven nonlinear partial differential equations have to be solved every time step. As clouds could not be simulated explicitly in such models, one needs to have a formulation of contribution of small scale clouds on any given resolved grid based on environmental conditions that is simulated by the resolved grid. This process is called 'parameterization' of the clouds in climate models. This requires a good knowledge of how small scale clouds would grow and decay in different larger scale environments. How do we gain this knowledge? This generally comes from field observations of such interactions and offline cloud models to understand this interaction. Unfortunately, our understanding of this interaction is still in infancy. As a result, parameterization of clouds remains one of major source of errors in climate models.

Considerable further improvements of the coupled climate models are required to build confidence in the monsoon forecasts and also to make the forecasts more useful. While I have highlighted the role of formulation of clouds in these models as one area where improvements are desperately required, there are other areas where equally important improvements are required such as the formulation of turbulent fluxes from the boundary layer, the land-surface processes which also contribute to the heat balance, improved calculation of the radiation balance and proper simulation of sea surface temperature and vertical structure of temperature and salinity in the ocean. Assimilation of appropriate data in the ocean and atmosphere to produce improved balanced initial state of the ocean and atmosphere can also add to significant improvement of forecast skill. Therefore, major effort is also required on data assimilation. In order to improve the skill of monsoon forecasts from the coupled model, a comprehensive research and development strategy on each of these modules is required. This requires a large group of skilled scientists knowledgeable not only on the physics and dynamics of the climate system but also expertise on the individual small scale processes involved in the different modules. It also requires huge computer resources for carrying out a large number of experimental integrations with the coupled model to test each hypothesis. Keeping in view the complexity of the problem and the necessity of improving the skill of the forecast system in a time bound manner, ESSO has launched the Monsoon Mission. This is a mission mode project with a goal to reduce the known deficiencies of the *operational model* and to demonstrate a quantitative improvement of the forecast skill. While the prediction of the all India seasonal mean rainfall is important for certain macro-economic planning and some large scale agricultural decision making, the farmers are more interested in the prediction of spatial distribution of rain and on the active and break spells of rain within the season. The active and break spells are manifestation of the MISO mentioned earlier. While the actual amount of rainfall in a small place may be difficult to predict more than 2-3 days ahead, the phases of MISO or the active and break spells have a potential predictability of about 25 days. The good news is that the coupled model set up by IITM has a skill of predicting the active-break spells 15-20 days in advance. One of the goals of the Monsoon Mission is to extend this skill up to 25 days. ❑

Health Initiatives in Flood Affected Bihar

Priya Khandelwal

Every year, the Government comes up with various schemes to minimize the effect of the floods. The problem, predictably, arises at the implementation level

IT IS that time of the year again, when people in the north Indian plains wait anxiously for the rains to escape the trials of the unbearable Indian summer. The family of Ramdev Safi in Bisphi Block of Madhubani District, Bihar, is waiting too, but with dread and fear: for the water monster, they are sure, will strike again.

Bisphi Block of Madhubani District does not require any introduction. The birthplace of Vidyapati, one of the most ardent worshippers of the Hindu deity Shiva, this region enjoys great religious significance in Indian mythology. But even the prayers of the villagers don't seem enough to save them from this annual disaster caused by floods.

Being India's most flood-prone State, 76 percent of the population in the north Bihar lives under the recurring threat of flood devastation. The area prone to floods in Bihar (before its bifurcation) as assessed by Rashtriya Barh Ayog (RBA) is 42.60 lakh hectares. There are a number of rivers in the plains of Bihar and in adjoining Nepal which have their catchment in the geographically nascent Himalayas. Originating in Nepal, the rivers of Kosi, Burhi Gandak, Gandak, Kamla Balan, Bagmati, Mahananda and Adhwara Group carry huge discharge and heavy sediment load and deposit it in the plains of Bihar which have a mere 35 percent catchments area of these river.

A review by Kale (1997) indicates that the plains of north Bihar have recorded the highest number of floods during the last 30 years. In the years 1978, 1987, 1998, 2004 and 2007, Bihar witnessed floods of particularly high magnitude. The total area affected by floods has also increased during these years. The floods of 2004 demonstrate the severity of the flood problem when a vast area of 23490 Sq Km was badly affected by the floods of Bagmati, Kamla and Adhwara rivers, causing loss of about 800 human lives, despite the Ganga, the master drain flowing low.

Among the most affected by these floods are the regions of Muzzaffarpur, Sitamarhi, Darbhanga and Madhubani. Even though people have become "accustomed" to the sufferings, it is difficult to understand their plight. The worst is the situation of the dwellers of remotely located villages which fail to attract the attention of the administration and media either during or after the disaster. Regions like Madhubani are further marred by the lack of basic facilities.

Bisphi Block in Madhubani holds a population of 2500 to 3000 people, a vast majority of which is represented by Dalits. During the floods, villagers are forced to spend their days in fettered darkness in their broken houses. The period of flooding is disastrous, but once the water level goes down, difficulties only intensify. Water pollution and water logging bring on the wrath of epidemics; typhoid, diarrhoea, and cholera spread insidiously, not only in the affected regions but in villages further away as well. Children are the worst affected; in the absence of correct and timely treatment, their very survival is at stake. Parents struggling to put together two square meals watch helplessly as their little ones waste away in their arms. Fifty-five year old Rajendra Shah, who lost his young son to the disease in the absence of timely treatment, is only one among scores of such tragic narratives that come alive each year, as families wait, yet again, for fate to strike.

For years, villagers have complained of the lack of primary health facilities in the village. Listening to the plight of the villagers, the government has, this year, been proactive in taking pre-flood measures. Recently, the Health Department of the Bihar Government has announced its policy to fight water-borne diseases with determined focus. The State Chief Health Secretary has provided guidelines to the Chief Surgeon to purchase the necessary medicines in adequate stocks and make these available at the Primary Health Centres of the identified flood affected regions of the state. This will hopefully ensure that there is no outbreak of epidemics and guarantee correct and timely treatment of the villagers.

"Our only expectation, after the Almighty, is from the *sarkar*. Most of us live in mud houses, there is no guarantee of our next meal, and we survive on unclean water. We work as daily wagers and earn a meagre salary which, if spent on medicines, leaves us with a hand-to-mouth existence. The current initiatives by the government to strengthen the health services in our region give us hope that even if this natural calamity cannot be avoided, we can at least save the lives of our children," says Ramdev, encouraged by these initiatives of the Health Department.

Every year, the Government comes up with various schemes to minimize the effect of the floods. The problem, predictably, arises at the implementation level. If this initiative is successfully implemented this year, it can indeed set an example for disaster management in every flood affected region of the country.

Charkha Features

Monsoon and Food Inflation

Sandip Das

Normal monsoon is good news for inflation, particularly from the food inflation point of view. If the normal monsoon materializes, this will definitely help in taming food inflation

NIMBA RAM, a small farmer from the Pakur district of Jharkhand, these days eagerly waits for the monsoon rains to arrive so that he can start paddy sowing activities. Ram has already prepared his one and half acre of agricultural land for the monsoon rains. The rains are vital to farmers like Ram's survival as it not only provides food grains security to him and his family but also provides extra income through selling paddy

Like Ram, there are millions of small farmers in mostly rainfed regions of the country eagerly awaiting the arrival of the south-western monsoon into the country. The monsoon which covers close to 80 percent of the land area of the country takes about three to four months to reach most parts of the country during June – September period each year.

The June-September monsoon rains are the vital for agricultural output and economic growth of the country as the rains during these four months irrigates around 60 percent of agricultural land in India, the world's second-biggest producer of rice, wheat, sugar and cotton. Southwest monsoon normally sets in over Kerala around 1st June. It advances northwards.

Not only for food grains productions, the monsoon rains are vital for the reservoir management as big dams mostly gets water from the monsoon rains and water level at 90 odd big reservoirs. Monsoon rains replenish reservoirs and lift ground-water levels, allowing better irrigation and higher hydropower output also. Higher rainfall levels also lead to reduction in demand for subsidised diesel, which is largely used by farmers to lift water from well or tank for irrigation in case the rains fail.

While the impact on summer or kharif crops may be more direct, there is also an indirect impact on rabi (winter) crops like wheat and oilseeds. "Rainfall during

The author is a Delhi based journalist.

June-September season impacts ground water and reservoir levels and is also critical for irrigation of rabi crops," PK Joshi, South Asian Director, International Food Policy Research Institute (IFPRI) said.

With agriculture contributing to 17 percent of India's GDP and it provides employment to close to 60 percent of the population, any impact of monsoons on agricultural growth would feed into prices, incomes and GDP growth. "The impact of monsoon is reflected in the inflation figure," a Planning Commission official noted. Better monsoon rains reflect in higher demand for goods and services could boost economic growth.

"As normal monsoon results in better farm income, it would also reflects in higher rural consumption of goods and services," Joshi of IFPRI said.

Inflation has remained a major point of concern for the country for the last many years and monsoon rains would followed more closely this year. The Reserve Bank has been trying hard to curb the menace of rising inflation graph, as India's wholesale price inflation rose to 7.23 percent in April, compared with 6.89 percent in the previous month, as food and manufactured items turned dearer.

Amidst concern about rising inflation graph, India Meteorological Department (IMD) has predicted a 'normal' monsoon 2012 for the three straight years, which is expected to boost prospects of food production and could bring in much needed relief to the government.

The rainfall in the June-September season is likely to be 99 percent of the 50-year average of 89 cm with a margin of +/–5 percent, science and technology minister Vilasrao Deshmukh had stated in April after releasing IMD prediction in April. IMD defines normal monsoon rains as 96 percent-104 percent of the long-period average, which refers to the average showers received between 1951 and 2000.

According to third advance estimate of crop production released by the agriculture ministry earlier this year, India is estimated to have witnessed a record production of rice, wheat and cotton in 2011-12 and experts say a favourable monsoon in 2012 would ensure that the prices of these would remain stable or go down. India's grain production is estimated at a record 252.56 million tonnes for 2011-12, mainly due to bumper production of wheat and rice.

"Due to record rice and wheat production during last three years, the prices of key food items have remained stable and monsoon rains this year would decide whether we could surpass last year bumper output or not," according a food ministry official.

"And once food prices declined in November 2011, core inflation followed as well. There is little doubt that core inflation is very important and has declined recently warranting a more dovish outlook, but it could easily again rise if food inflation persists. RBI assumes monsoons in 2012-13 to be normal but is always a risk given large supply constraints in the Indian economy," RBI said in its annual monetary policy review for 2012-13.

The drought in 2009, the worst since 1972, forced India to import sugar for meeting domestic demand. This pushed up global sugar prices to record highs and fuelled food inflation.

The country's growing and rising middleclass population will continue to increase the demand for food. Climate change is expected to make monsoon rains more variable and unpredictable. This will make the challenges facing the country's agriculture industry of huge importance in coming years.

Leading credit rating agency CRISIL recently stated 'normal monsoon is good news for inflation, particularly from the food inflation point of view. If the normal monsoon materializes, this will definitely help in taming food inflation.

''This is a good sentiment booster. This is a first cut good news for the economy because monsoon always remains a risk for India from the inflation perspective," a leading economist with CRISIL observed.

At present, IMD provides city wise weather forecast for five days in advance and long term rainfall for the country. For providing better rainfall forecasts to farmers, IMD in association with Indian Council of Agricultural Research, agriculture ministry and state agricultural universities dessiminates weather-based agro advisories through Integrated Agromet Advisory Service to farmers. These advisories are circulated through several means of communication, such as SMSs.

As per the National Council of Applied Economic Research (NCAER) report on 'impact assessment and economic benefits of weather and marine services', roughly 24 percent of farmers in over 550 districts are using the Agromet services, while two million farmers are availing the mobile SMS service which started few years back.

"In most countries, weather and climate are forecast by National Meteorological Services which also provide weather forecasts tailored to support agriculture, municipal services, disaster management, water resources planning and management, transport, environmental protection, public health and other sectors," NCAER report released last year had stated. An estimated 30 sectors such as aviation, agriculture, tourism, fishery, forestry, insurance, port and harbour management, commerce and retail trade depend directly on the weather condition.

IMD's new initiative

In what could prove to be a revolution of sorts for key sectors of the economy, such as agriculture, tourism, transport, sports and travel, the IMD is also planning a foray into short-term weather forecasting on the lines of the models used in the US and Europe.

The IMD, currently, uses the statistical model to make seasonal climate forecast. This has often proved to be an unreliable method for predicting the rainfall pattern.

"The statistical models are not proving too accurate and we don't have enough skills for using the dynamic models," Shailesh Nayak, Secretary, Ministry of Earth Science, said. "Within the next couple of years, we will be able to make short-term forecasts using the dynamic model," he noted.

IMD had predicted deficient rainfall for 2009. But the actual rainfall turned out to be far below the IMD estimates. IMD had also failed to predict the droughts of 2002 and 2004. Nayak admits that while IMD's macro forecast for the entire country had largely been 'accurate' during the last few years, "we have been unable to predict variability in the rainfall pattern in specific regions".

Dynamic models are used for predicting rainfall over a smaller scale, which is not possible in the statistical forecasting system where the forecast is generated using various information received from agencies in the US, Europe and Australia. The southwest monsoon (June–September) rainfall, crucial to the economy, is currently calculated as the area weighted average of the seasonal monsoon rainfall data of all 36 meteorological sub-divisions in the country. ❑

Mobile Spray Painting Device

SHEIKH JAHANGIR (50) has made a painting device that can be easily mounted on a two-wheeler scooter and carried to a customer's place. Deriving power from the two-wheeler's engine to run the compressor, this device lends flexibility of usage to the painter. Jahangir has been running a small spray painting shop, 'Khandesh Spray Painters' in Jalgaon for the past eighteen years. He has ten dependents in his family, his eight children, wife and his mother.

He was born at Vijaynagar in Chennai district of Tamil Nadu. He could not study beyond second standard because a poor economic condition of his family. When he was eleven years old, his family shifted to Jalagaon. There he started to work as an ice candy man during summers. During off-season, he used to assist his father in painting work. He started working as a full time painter when he was fifteen years old and since then has perfected the art.

Genesis

By the time he reached twenty years of age, he started getting a lot of work for painting vehicles. To complete the customer's work, he started hiring electricity based air compressor from other vendors. But this solution hardly saved any money for him. He thought of buying compressor but the constraint was money and he was not having electricity connection at his shop. Thus, continuous fiddling for finding alternative source let him to develop the 'mobile spray painting device'.

His first prototype was developed using a moped engine. It worked well but imparted a lot of vibrations while working. Also, being stationary its immobility became a constraint for him to meet customers' demand. Next, he

mounted spraying kit on a moped and took drive from its engine to run the compressor thus making the unit completely mobile. For the next ten years he used the same moped based mobile spray painting device to earn his living. Finally, in 1993, he was able to buy a scooter and put his spraying kit assembly on it after a few modifications.

Innovation

The spraying unit consists of a one air compressor head and a cylindrical air tank to store the pressurized air. The scooter engine power is taken to the compressor head through a belt drive.

The compressor head pressurizes air, which is transferred to the air tank through the connecting exhaust port. The pressurized air from air tank is supplied to spray-painting unit through its delivery point. Apart from this, the rotary motion of engine is used to pump water, to generate electricity, for grinding tools, for drilling, for running fan and for washing vehicles.

The unit is portable and can be transported to any location at the doorstep of customer. About a litre of petrol is consumed for painting a 407 Tata truck/Ambassador, taking almost an hour's time to complete the task. This is at half the charge for normal painting.

Sheikh Jahangir is proud of his innovation. An ardent believer in hard work, he is always willing to help others in any way possible. This innovation won Sheikh Jahangir a consolation prize in NIF's Fourth National Competition for Grassroots Innovations and Traditional Knowledge in 2007. NIF also filed a patent application for the same and supported him through the Micro Venture Innovation Fund. He has also made a scooter mounted washing machine and a scooter mounted flour mill, which was featured in the famous Hindi movie '3 Idiots'. ❑

The Reign of Rain

Rajiv Vijayakar

Rain will continue to shower Hindi cinema with rich and varied stories, sequences and songs

THE PARCHED summer is a thing of the past – the monsoon is here, bringing immense relief to all of us. Mumbai, the citadel of the Hindi film industry, has a four-month long annual affair with the season – a key reason, perhaps, why showbiz has allowed rain to reign (!) in Hindi cinema. Apart from the sheer joy of getting wet outdoors and watching cloudbursts or swirling seas, it is also the perfect season for sitting indoors, with nears and dears, in either relaxed or extra-romantic mode. As a practical aspect, if one has to shoot anywhere within Maharashtra, it is simpler and more economical to conceive songs or sequences that are shot in soaked streets rather than in studio sets needing artificial rains!

And this long reign of rain in Hindi films seemed to be pre-ordained. India's first (and silent film) *Raja Harishchandra* (1913), a film owned by historians of both Hindi (as India's representative film industry) and Marathi (as almost the entire team of this Mumbai-made film was of Marathi-speaking people) cinema actually had a wet sari sequence! Unable to find women to act in his film (the first female actor appeared only in India's second or third feature), Dadasaheb Phalke had to get his male actors who were playing women to indulge in *jal-krida* (water sports) in a key sequence!

(B) rainstorm!

Rain has been used in various ways in Hindi cinema, and it is certainly not limited to the canvas of shooting in wet regions of Maharashtra. In songs, sequences or even the basic storyline, rains have represented myriad sentiments like passion, ignited or revived (the 2007 *Life In A...Metro*, in which the romantic liaison of all the lead artistes is connected with this season), erotica (the sequence in the 1969 *Aradhana* or the song *Ab ke saawan mein jee dare* from the 1973 *Jaise Ko Taisa*) and seduction (*Haaye haaye yeh majboori* from the 1974 *Roti Kapada Au Makaan*), loneliness and despair (Vinod Khanna remembering his late wife in the 1989 *Chandni* and Dilip Kumar wanting help for his injured wife in

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the 1984 *Mashaal*) and even danger and murder (the 2002 *Company* and the climax of the 2007 *Johnny Gaddaar*). On the other hand, rain can also denote the euphoria of sudden love at first sight where the hero has got just an unforgettable glimpse of a beautiful girl that he will never forget (the song sequence *Zindagi bhar nahin bhoolegi woh barsaat ki raat* from the 1960 *Barsat Ki Raat*) or a heartfelt relief to a draught-afflicted zone (the 2001 *Lagaan*) and equally memorably in the climax of *Guide* (1965) where a 'god-man' claims to engineer the much-needed rain!

Of course, rains were also celebrated for their own sake by urban characters like Neetu Singh (*Chham chham barse ghata* in the 1977 *Priyatama*) or had Madhuri Dixit dancing with kids on the street (*Chak dhoom dhoom* in the 1997 *Dil To Pagal Hai*). Last but not the least, this season also has helped depict comedy (Kishore Kumar's antics in *Chalti Ka Naam Gaadi* where a drenched Madhubala walks in) and horror (*Krishna Cottage*).

Storyline and titles

It was not at all necessary that a film was titled with words referring to the rain, like *sawan, barsaat* or *baarish* when the rain had a pivotal significance in the story. The 2009 *Tum Mile* saw estranged lovers reuniting because of the torrential downpour that turned Mumbai into a water-body on July 26, 2005. The rain was also integral to the plot in so many other films, in the 2004 *Chameli* wherein the widowed banker meets and falls for the streetwalker (Kareena Kapoor) he meets on a rainy night. The banker, it turns out, had also lost his wife on one such night.

In the 1981 *Barsaat Ki Ek Raat*, we actually had the story of two nights, one wherein the villain (Amjad Khan) tries to molest the heroine (Raakhee) and the other when he attacks her, leading to the death of her unborn child.

The 1973 *Daag* saw all the crucial happenings occur amidst heavy downpour, which included the police van carrying Rajesh Khanna to jail (for a crime he did not commit) falling off a mountainside and the hero presumed dead.

However, the 1949 *Barsaat* – the milestone movies that established so many talents and trends - used this word purely as a metaphor despite the title-track that went *Barsaat mein tumse mile hum sajan* – it represented the flow of human desire that resembled the constant fall of rain, drenching the earth (which was a symbol for man and woman).

Most other films with titles pertaining to rain, like the 1966 *Sawan Ki Ghata,* 1969 *Aaya Sawan Jhoom Ke,* the 1979 *Sawan Ko Aane Do,*the 1981 *Pyaasa Sawan*, the 1995 and 2005 *Barsaat*'s, the 1998 *Barsaat Ki Raat* and the 1957 and '90s *Baarish* had plots that had nothing to do with the rains. In the millennium, however, came the crossover film, Mira Nair's *Monsoon Wedding* that had some connection with rain, the first being a comedy about a Punjabi NRI wedding being held in that season in India.

Sawan ka mahina

And so we finally come to the greatest representatives of monsoon in Hindi films – the 'rain songs', some of which have been already been mentioned above.

Here is where we literally see a torrent of melody and a storm of beautiful lyrics, with of course the entire paraphernalia of visuals like real or artificial rains, cloudbursts and lightning, sinuously moving waists and macho men drenched to their muscle and bone. Oddly enough again, one of the biggest chartbusters in this league, *Sawan ka mahina* from the 1967 *Milan*, was a song in which a boatman teaches his beloved how to sing and has nothing to do with monsoon in the visual or situational sense.

From a *Pyar hua ikraar hua* that etched the Raj Kapoor-Nargis-under-an-umbrella image forever in film history (the 1955 *Shree 420*) to a *Tip tip barsa paani* (*Mohra* in 1994) and beyond, the affair with wet songs has maintained its flow.

Barsaat mein tak dhina dhin went Nimmi on-screen in *Barsaat*, Amitabh Bachchan and Smita Patil serenaded to *Aaj rapat jaaye* in the 1982 *Namak Halaal*, while a Sunny Deol and Amrita Singh kindled their love in *Badal yun garajta hai* in the 1983 *Betaab*. Two major benchmark Kishore Kumar 'wetties' were *Ek ladki bheegi bhaagi si* (*Chalti Ka Naam Gaadi* /1958, which eh also enacted) and *Kaate nahin kat-te yeh din yeh raat* from the 1987 *Mr India*.

Besides *Betaab*, R.D.Burman had a fair share of such numbers, including the *Jaise Ko Taisa* number mentioned earlier – we had *Rimjhim gire saawan* (*Manzil*/1979), *Bheega bheega pyaara pyaar* (*Jawani* / 1984), *Bheegi bheegi raaton mein* (*Ajnabee*/1974) and *Rimjhim rimjhim* (*1942 – A Love Story* /1994), but his contemporaries Laxmikant-Pyarelal (including *Roti Kapada Aur Makaan* and *Mr India* and of course *Sawan ka mahina*) matched if not surpassed him in the monsoon notes through masterpieces like *Paani re paani* (*Shor*/ 1972), the title-track of *Aya Sawan Jhoom Ke, Rimjhim ke geet sawan* (*Anjaana*/1969), *O ghata sanwari* (*Abhinetri*/1970), *Haaye re haaye* (*Humjoli*/1970) *Zindagi ki na toote ladi* (*Kranti*/1981) and *Megha re megha re* (*Pyaasa Sawan*/1981) *Dil tera diwana* from the 1962 film of the same name, *Dum dum diga diga* in *Chhalia* (1961), *Rimjhim ke tarane* from *Kala Bazar* (1960), *Aayo re saawan aayo re* from *Bandhan* (1970) were among the many songs of other composers that made their mark. In *Yeh raat bheegi bheegi* (*Chori Chori*/1956), the lovers (Raj Kapoor and Nargis) yearn for each other even as they express poetic storms of desire in separate solitude.

Even in the lyrics, monsoon spawned some fantastic poetry and philosophies. Bharat Vyas' words *Jab sanan pawan ko lagaa teer/ Baadal ko chir nikla re neer / Jhar jhar jhar ab dhaar jhare / O dharti jal se maang bhare* (The waters burst through the clouds in a stream, and the earth adorned its forehead with the cascade) in the song *Umad ghumad kar aayi re ghata* from *Do Ankhen Barah Hath* (1957) present a vivid imagery. And Verma Malik simply states *Teri do takiyaan di naukri ve mere laakhon da saawan jaaye* (ain the song *Haaye haaye re majboori* from *Roti Kapada Aur Makaan*.

Though *Zindagi ki na toote ladi* (*Kranti*/1981) was filmed on freedom fighter lovers imprisoned on a British ship caught in a rainstorm, Santosh Anand's lyrics had little to do with rain itself but were suffused with deep truisms in lines like *Lambi lambi umariya ko chhodo pyar ki ek ghadi hai badi* (One moment of love is bigger than a long and loveless life) and *Lakh gehra ho saagar to kya pyar se kuchh bhi gehra nahin* (Love is deeper than the deepest ocean).

It is this poetry that gradually gave way to more overt physical passion in the later love songs like *Ankhon se tumne jo* (*Ghulam* /1998) and many more trivial numbers including *Barso re* from the 2007 *Guru*. But even in this last phase we had three meaningful numbers conceived with a lot of imagination – Anand Bakshi's *Megha re megha* (*Lamhe* / 1991*)* has Anil Kapoor watching Sridevi dance in abandon with her *sakhis* (companions) to terrific lines like *Meri sakhiyaan aisi batiyaan karen meri ankhiyaan jhuken* (The girls say such naughty things that I feel shy) and *Mere khwabon mein jo aaye* (*Dilwale Dulhania Le Jayenge*/1995) saw Kajol cavort in the rain describing her dream life partner to her indulgent mother. Rahat Indori too penned some interesting thoughts on life in the imaginatively-shot *Barsaat ke mausam mein Naajayaz* in 1995.

Rain will continue to shower Hindi cinema with rich and varied stories, sequences and songs. *Wet* - and watch. ❑

CORRIGENDUM

In Page No. 28 of May 2012 issue of Yojana the stretch from Jammu to Srinagar was wrongly printed as NH44, it should be NH1A. The error is regretted.

Editor

Dream Season: The Monsoon Magic of Kerala

Gracious James

The Kerala Monsoons have generated much interest among the tourist community and many overseas travellers choose a trip in the monsoon season to enjoy the romantic milieu of the tropical rainy season

KERALA IS a land where the 'season' never ends. Kerala experiences a moderate climate throughout the year. In the hilly regions it is quite cold but it is warmer in the plains and along the sea coast. Two monsoon visit Kerala, bringing plenty of rain. The South West Monsoon begins either in the end of May or in the beginning of June and fades out by September. Moving towards north, this seems to gain intensity. During this period Peerumedu in Idukki and Vaithiri-Kuttiyadi range in Malabar receive the highest rainfall. The rainfall is comparatively low in the Lakshadweep islands. In the southern areas the monsoon is around 40-50 percent and in the northern areas it is around 80 percent. The North East Monsoon commences in October, dry weather setting in by the end of December. The Kanjirappalli-Peerumedu range and Kuttiyadi area experience the abundance of North East Monsoon. The northern parts of the state account for a mere 10 percent of the annual rainfall. Kerala tourism's objective is to bring out the positive aspects of monsoon and encourage the tourism activities during monsoon season. Monsoon tourism holidays let tourists rediscover the fact that why Kerala is God's own country.

Monsoon: the "dream season"

Monsoon - the word itself makes one joyous! Monsoon, the season of rainbows and raindrops, is certainly not to be wasted indoors. India being a favourite tourist destination for the travellers is much visited by tourists from all over the world who travel to the various hot spots of the country during the various seasons. There are many tourists who prefer to travel to India and its various destinations during the monsoon season. They seem to know and appreciate the beauty of Indian monsoons. Perhaps, they know that the monsoon season is the best time to really explore a country like India. Besides being a blessing for the budget conscious travellers, monsoon tourism appears to have proved to be a blessing for the Indian tourism industry also, which normally witnesses a sharp

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drop in the number of travelers at the end of the summer season, once the clouds appear in the sky overhead. While most travellers have typically avoided India during the wet season, some are beginning to appreciate the unique thrills offered by the Indian monsoon.

Promotion of monsoon tourism in Kerala

Monsoon tourism is being promoted by adopting interesting and unique activities in Kerala. Of late Kerala has become an all season destination with no marked off season. The Kerala Monsoons have generated much interest among the tourist community and many overseas travellers choose a trip in the monsoon season to enjoy the romantic milieu of the tropical rainy season. Even the Kerala Tourism Department has come up with innovative monsoon promotion packages this year as part of their "dream season" campaign to attract more tourists and to give it a better publicity".

The "monsoon magic"

The Southwest Monsoon in Kerala is traditionally called *'Edava-ppathy'*, as it comes in the middle of the month of Edavam on the Malayalam Calendar. All the elements of nature working together to make sure Kerala remains wet and green, The state is the first and most blessed beneficiary of the generous monsoons, year after year. Kerala is all set for the 'monsoon magic' of ayurveda. The God's own country is welcoming people around the globe for rejuvenation programmes based on the traditional texts of Ayurveda. Government of Kerala and Kerala Tourism department is promoting Monsoon Tourism in Kerala. Monsoon is considered the best season for Ayurveda rejuvenation programmes as the atmosphere remains dust-free and moist, which in turn opens up the body pores making them more receptive to herbal oils and massages. In addition, during the rains the herbs and medicinal plants, which form vital ingredients of these medicines, grow in plenty. Probably, the most popular among it all is the rejuvenation package of *'panchakarma'* which consists of an array of beneficial massages. Tourists also make use of body slimming, stress management and beauty care packages. Resorts offer shorter version Ayurveda programmes also part from the conventional one-to three-week-long treatment protocols, to match the needs and budgets of the tourists.

The ayurvedic clinics in Kerala are getting a large number of domestic as well as foreign visitors. Some tour operators have come up with monsoon packages for visitors from foreign countries. According to the Kerala Tourism authorities, these special monsoon packages are attracting more and more people.

The monsoon rains give fresh lease of life to plants and animals every year. Kerala's famed elephants, for an example. These giants who roam Kerala's temple and festival grounds love the wetness of rains and are in the best mood to play with tourists. The art forms of Kerala demand the utmost dedication and training. These native art forms require complete control over each nerve of the body. As part of this training the artists undergo ayurvedic therapies. Special herbal oils and medications are applied on the body of the artist during the Monsoon time to ensure muscle flexibility and dexterity of movement.

Mud Football - A favourite pastime of Rural Kerala during Monsoons

For sheer fun and novelty, nothing can beat the unique pastime of Mud Football in rural Kerala during Monsoons. Take a muddy paddy field, throw in a bunch of soccer crazed youth and a host of supporters on a lazy afternoon - and an exciting new sport is born. Mud football is as exciting for the participant as it is entertaining for the audience. Mud Football Tournaments during Monsoon in Kerala are total crowd pullers. The players wallow in shin deep mud, where every step takes enormous effort. They chase a soggy ball, which becomes heavier with the sticky mud. It is a complete chaos yet completely fun – for instance a powerful kick can land the attacker deep in mud while splashing mud into the face of the defenders while the ball reluctantly hops all of six inches in any which direction. Participating or simply watching a Mud Football game is an experience that you will recount and chuckle about for a long time.

Monsoon Festivals

Kerala Tourism is known for organising a five-day "Monsoon Festival" in June at the *Kanakakunnu palace* in the capital with a view to promoting monsoon aggressively "that rejuvenates the environment, nourishes the land and replenishes the waterways." Held towards June-end every year, the festival is organised as part of the efforts to market the State as a destination for holiday makers to savour during the southwest monsoon that commences in June. Tourism authorities are trying to market Kerala as the first port of call of the southwest monsoon and a rare wet spectacle that follows. The festival also offers a platform for artistes to present art forms, classical dance and music before a tourist audience. A food festival is also organised to enable tourists to get to know about the cuisine of Gods Own Country. Local artistes are roped in artistes locally. Kerala Tourism

TABLE -1 MONTH WISE FOREIGN TOURIST VISITS AND SEASONALITY INDICES										
Sl. No.	**Month**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**percent variation**	**Seasonality indices**
1	January	45,630	43,345	58,858	72,814	85,028	77,839	87553	12.48	171.53
2	February	43,418	41,314	56,530	66,131	78,155	71,136	86747	21.95	160.23
3	March	35,006	33,479	39,584	56,151	71,026	57,250	61334	7.13	126.74
4	April	23,546	20,191	32,377	34,487	39,538	43,473	50910	17.11	126.74
5	May	23,546	14,919	20,470	21,098	26,348	25,386	26783	5.50	53.38
6	**June**	12,734	13,239	16,209	18,262	20,578	19,499	24685	26.60	43.97
7	**July**	**17,228**	**17,593**	**23,578**	**25,199**	**31,610**	**28,914**	**36188**	**25.16**	61.39
8	**August**	**27,341**	**24,398**	**28,821**	**35,563**	**45,711**	**39,079**	**49518**	**26.71**	84.61
9	**September**	**21,103**	**20,064**	**21,888**	**24,708**	**28,292**	**29,283**	**37859**	**29.29**	**61.37**
10	October	22,160	28,068	28,681	33,534	39,748	38,870	49512	27.38	78.87
11	November	38,118	42,324	44,421	55,647	59,923	56,880	66526	16.96	122.67
12	December	44,392	47,565	57,117	72,214	72,972	69,649	81650	17.23	148.54
	Total	345,546	346,499	428,534	515,808	598,929	557,258	659,265	18.31	

Source: Tourist Statistics, Department Tourism, Government of Kerala

is working on a schedule of events, which include a Monsoon Food Festival, a Monsoon Music Festival and a Monsoon Theatre Festival eyeing the international and also the domestic tourist. Monsoon folklore festivals are being planned as well.

Tourist inflow during Monsoon season

The Tourism department claims that additional influx of tourists is likely to happen from Gulf countries during the period referred to as 'dream season.' It recently completed a series of road shows and campaigns in the Gulf. The flow of tourists from Europe decreases during June-September owing to monsoon. The focus is on Gulf countries from this year to utilize the spell of hot weather there. Table 1 presents the month wise foreign tourist arrivals and seasonality indices from 2004 to 2010. This shows that the monsoon season (June-September) receives low inflow of tourists as compared to other months. As per data provided by the department, 6.8 lakh tourists visited Kerala during monsoon in 2010 and 7.3 lakh in 2011. This year it is expecting an increase of 5 to 10 percent as they have received a positive response from Jeddah, Riyadh and Dammam to their recent marketing campaign. Dream season package is a big hit among honeymooners. Citizens from France and Scandinavian countries form a major chunk of the few European visitors during this season. Nearly 8 percent of tourists come exclusively to undergo ayurvedic rejuvenation therapy available in the state.

The campaign has proved to be a remarkable success with the hotels in major destinations witnessing 60 percent occupancy, compared with 35 percent earlier during this season. The monsoon, which is traditionally seen as an off-season in the tourism industry, has taken off very well this year. Monsoon tourism, has performed beyond the expectations of tour operators, garnering a 50 percent increase in both in-bound and out-bound traffic. Last year, the industry saw an increase of only 15-20 percent in monsoon tourism.

Conclusion

The results of India's promotional push for monsoon tourism have been extremely positive, with significant rises in both international and domestic tourism. India's tourism ministry continues to combat this historical low season by pushing for better and more diverse tourist services as well as new employment opportunities within the tourism industry. A sharp fall in the number of tourists during the Monsoon was the phenomenon of the past. Winter and summer are the peak tourist seasons. A cruise in the houseboats on the backwaters of Kerala, or experiencing the beauty of sunset over the Arabian sea from Kovalam beach during summer and boating in the Thekkady lake, or trekking the highlands of Kerala during winter, are for sure, going to be never to forget experiences. But for those, who really want to enjoy the day under the cloudy sky, and feel the bracing scent of the wet soil, revitalizing the body, mind and soul, monsoons are for you. Other states are set to follow the examples of such monsoon tourism success stories of Kerala. ❑

YOJANA invites its readers to send in their valuable feedback and suggestions about the articles carried in the journal at the e-mail id yojanace@gmail.com

DO YOU KNOW?

STOCK EXCHANGES IN INDIA

What is BSE ?

The Bombay Stock Exchange (BSE) first ever stock exchange in Asia (established in 1875) and the first in the country to be granted permanent recognition under the Securities Contract Regulation Act, 1956, BSE Limited has had an interesting rise to prominence over the past 137 years. BSE has facilitated the growth of the Indian corporate sector by providing it with an efficient capital raising platform.

Today, BSE is the world's number 1 exchange in terms of the number of listed companies (over 4900). It is the world's 5th most active exchange in terms of number of transactions handled through its electronic trading system.

BSE Limited is the oldest stock exchange in Asia What is now popularly known as the BSE was established as "The Native Share & Stock Brokers' Association" in 1875.

What is NSE ?

The National Stock Exchange (NSE) of India Limited has genesis in the report of the High Powered Study Group on Establishment of New Stock Exchanges. It recommended promotion of a National Stock Exchange by financial institutions (FIs) to provide access to investors from all across the country on an equal footing. Based on the recommendations, NSE was promoted by leading Financial Institutions at the behest of the Government of India and was incorporated in November 1992 as a tax-paying company unlike other stock exchanges in the country.

NSE operates a nation-wide, electronic market, offering trading in Capital Market, Derivatives Market and Currency Derivatives segments including equities, equities based derivatives, Currency futures and options, equity based ETFs, Gold ETF and Retail Government Securities. Today NSE network stretches to more than 1,500 locations in the country and supports more than 2, 30,000 terminals.

With more than 10 asset classes in offering, NSE has taken many initiatives to strengthen the securities industry and provides several new products like Mini Nifty, Long Dated Options and Mutual Fund Service System. Responding to market needs, NSE has introduced services like DMA, FIX capabilities, co-location facility and mobile trading to cater to the evolving need of the market and various categories of market participants.

NSE has made its global presence felt with cross-listing arrangements, including license agreements covering benchmark indexes for U.S. and Indian equities with CME Group and has also signed a Memorandum of Understanding (MOU) with Singapore Exchange (SGX) to cooperate in the development of a market for India-linked products and services to be listed on SGX. The two exchanges also will look into a bilateral securities trading link to enable investors in one country to seamlessly trade on the other country's exchange.

What is Sensex and Nifty?

The Sensex is an "index" which is basically an indicator and gives a general idea about whether most of the stocks have gone up or most of the stocks have gone down. Sensex is an indicator of all the major companies of the Bombay Stock Exchange (BSE) and the Nifty is an indicator of all the major companies of the National Stock Exchange (NSE).

If the Sensex goes up, it means that the prices of the stocks of most of the major companies on the BSE have gone up. If the Sensex goes down, this tells that the stock price of most of the major stocks on the BSE have gone down. Just like the Sensex represents the top stocks of the BSE, the Nifty represents the top stocks of the NSE.

The BSE is situated at Bombay and the NSE is situated at Delhi. These are the major stock exchanges in the country. There are other stock exchanges like the Calcutta Stock Exchange etc. but they are not as popular as the BSE and the NSE. Most of the stock trading in the country is done through the BSE and NSE.

Introduction of SMEs Platform by BSE.

The Prime Minister's Task Force (Jan. 2010) has recommended to set-up a dedicated Stock Exchange/ Platform for SME(Small and medium enterprises). SEBI has also laid down the regulation for the governance of SME Platform. Bombay Stock Exchange Ltd, an Exchange which has founded the equity cult in the country has witnessed many companies becoming big from small by raising funds from Capital Market. The necessary changes and amendments are being made in the rules, bye-laws and regulations of the cash market for making a provision for SME Platform. ❑

NORTH EAST DIARY

SEARCH FOR QUALITY MITHUNS IN NORTHEAST'S MOUNTAINS

Scientists at the National Research Centre on Mithun (NRCM) at Jharnapani in Nagaland have broken new grounds by carrying out a successful embryo transfer, leading to the birth of the first ever mithun calf through this method. Mohan, as the newly-born calf has been christened, was delivered by a healthy female mithun on May 12 after she played the role of a surrogate mother.

It is a landmark case, especially because the population of this animal is not in a comfortable status. The embryo transfer technology (ETT) that we resorted to will definitely help propagate quality germplasm of this magnificent species of animal," says NRCM principal scientist K K Baruah. The NRCM in Nagaland is one of the several such research centres for different animals under the Indian Council of Agricultural Research (ICAR).

Similar efforts have been successfully carried out on cow, sheep, goat and horse, but this is the first time such an experiment has succeeded on mithun. Mithuns being exposed to the wild have been suffering from cross-breeding as well as in-breeding, posing a major threat to this animal so dear to the tribal communities in the Northeastern states. The ETT method has raised hopes of creating a quality stock of mithuns.

Mithun *(Bos frontalis)* is the domesticated form of gaur *(Bos gaurus)* and is often referred to as the "ship of the highland" or "cattle of the mountains". It is an example of the integration of agro-ecology, subsistence livelihood, culture and livestock rearing. People, however, mostly do not keep them at home, and let them remain in the jungles. They are reared under free range condition in dense forests in a very unique manner, with zero input, at altitudes ranging from 300 to 3,000 metres above sea level.

The last census conducted for mithuns in 2007 had put the number of this animal at around 2.64 lakh, of which Arunachal Pradesh alone had roughly 82 percent of them. Nagaland (12.6%), Manipur (3.8%) and Mizoram (0.8%) are the other states where mithuns can be seen. While mithun is also consumed as meat, its milk is very rich in fat, proteins and other nutrients, compared to other milch animals. Moreover, its hides, when processed, give one of the best quality leathers.

The NRCM that has been engaged in propagation of mithuns in the region has been working on this project for the last five years. "Since mithuns are largely used as a meat animal, it is very important to promote better animals, which we have been trying to do through preservation and propagation of quality germ-plasm," says Baruah.

Healthy female mithuns ovulate every 21 days, and give birth to one calf a year. Since a sizeable population of female mithuns are not in a state of normal ovulation, converting them to surrogate mothers by ETT will lead to faster multiplication of mithuns.

Comparing ETT to artificial insemination, Baruah says while the latter process only spreads superior male genetics across a herd of animals, embryo transfer technology would now help spread superior female genetics across a specific herd or even in many herds. Each of these offspring like Mohan would potentially carry superior traits of the original mother, such as increased weight gain and more milk apart from disease control. ❑