Journal of Agrometeorology 7 (2) : 297 - 303 (Dec 2005)

Reliability of medium range weather forecast in mid hill region of Himachal Pradesh

RANBIR SINGH RANA, RAJENDRA PRASAD and SURESH KUMAR
Department of Agronomy, CSKHPKV , PALAMPUR (H.P.) – 176062

ABSTRACT

For effective agricultural decision making, Medium Range Weather Forecasting (MRWF) was found useful. The weather parameters like rainfall, temperature and cloud cover, forecasted and recorded during 1995 to 2000 were assessed. During south west monsoon period, the accuracy for rainfall was 40 percent compared to more than 62 % for other season. Ratio Score (RS) and Hanssen and Kuipers (HK) scores ranged between 58-87 percent and 0.25-0.31, respectively. RMSE for rainfall was below 5.5 except during south west monsoon season which recorded the highest RMSE of 20.4 indicating lower accuracy. The utility of MRWF was found encouraging indicating 8.9-14.7 percent economic benefit in maize, rice and wheat on university research farm.

Key words: Weather Forecast, Reliability, Rainfall, Cloud Cover, Temperature

Weather is a vital factor which controls the success or failure of agricultural crops productivity. The vagaries of weather encountered during crop duration often create instability in food production. Sustainable agricultural production calls for minimizing weather hazards. It is fact that weather cannot be modified except on limited scale but agricultural operations can be reoriented to the three-day to ten days weather forecasts. The utility of weather forecast further depends upon their accuracy and applicability at micro level. An estimate made by agribusiness a community in western countries indicates that the forecast can be put to economical use if it is 50-60 percent corrects (Seeley, 1994).

An agriculturally relevant forecast is not only useful for efficient management of farm inputs but also leads to précise impact assessment (Gadgil, 1989). The paper makes an attempt to verify the suitability of the medium range weather forecast for Palampur agro climate of Himachal Pradesh.

MATERIALS AND METHODS

The State of Himachal Pradesh is located between 32°22'40" and 33°12'40" N latitude and between 75°37'55" and 79° 04'22" E longitudes. The elevation varies between 350 m above mean sea level and > 6975 m snow clad peaks of Himalayas. The

State is delineated to four agroclmatic zones. The geographical location of study area falls in mid hill sub humid region of Himachal Pradesh which has an altitude ranging from 650 to 1800 m above mean sea level. The station is located at 32 °60′N latitude and 76°30′ E longitude where weather data were recorded for verification. The annual rainfall ranges between 1500 and 3000 mm with an average value of 2300 mm. The agroclmatic region represents 35 percent of the total area and 53 percent of the total cropped area of the State. The main crops are wheat, maize, rice, oil seeds, off-season vegetables, Stone and Citrus fruit and tea. In addition, poultry, dairy and mushroom cultivations are important agricultural other enterprises in the region. For small and marginal farmers, the south west (SW) monsoon season is more important as cultivation is carried out in all available sloping marginal lands.

Medium Range Weather Forecasts (MRWF) on rainfall cloud cover, maximum and minimum temperature received from National Centre for Medium Range Weather Forecasting (NCMRWF) for 3 days from 1995 to 2000 for Palampur region of Himachal Pradesh were verified. The forecasts were compared with daily-observed weather data for the respective days from the actual data recorded at agrometeorological observatory situated at CSK Himachal Pradesh Krishi Vishvavidyalaya Palampur. To asses the reliability of different weather parameters of the forecast, different verification methods were used. The forecasts of rainfall, temperature and cloud cover were verified by calculating the error structure. The correct and usable cases were summed up and combined values indicate the percent usability of the forecasts. Root Mean Square Error (RMSE) which indicates the average deviation from the observed data was also calculated for rainfall and temperature. Ratio score (R. score) describes the success rate of correct forecasts of occurrence of rainfall to the total events. It varies from 0 to 1 with 1 indicating perfect forecast and Hanssen and Kuipers score (H.K. score) indicates the ability to discriminate between rainy and non rainy days. It ranges between −1 and +1 through 0. Zero indicating no skill. The verification of weather forecasts was done for four seasons viz., hot weather period (March-May), south west monsoon (June-September), north east monsoon (October-December) and Winter Season (January-February) as defined by India Meteorological Department. The verification methods were used as follows as suggested by Singh *et. al.* (1999).

(i) Error structure

Rainfall:

	<10mm	≥10mm
Correct	0.2	2%
Usable	2.0	20%

Cloud cover : Correct ±1 okta.
Usable ± 1 to 2 Okta

Temperature : Correct ±1.0°C
Usable ± 1.0 to 2.0 °c

(ii) $RMSE = \sqrt{\frac{\sum_{i=1}^{n}(Pi - Oi)^2}{n}}$ Pi & Oi are the predicted and observed values on i^{th} day and n is the total number of observations/ forecast.

(iii) Ratio score and Hanssen and Kuipers score

Forecast	Observed	
	Rain	No rain
Rain	yy	ny
No rain	yn	nn

Ratio score = (yy+nn)/N*100

where N=yy+nn+yn+ny is the total number of days

Hanssen and Kuipers score

=(yynn-ynny)/(yy+nn) (ny+yn)

where y indicates rainfall event being yes and n rainfall event being no.

The utility of the forecast is defined as the percentage of useful cases of all advisories issued irrespective to the specific field operations. This was assessed by seeking an answer to this effect through pre-tested well designed questions in the questionnaire. A field survey of the study area was conducted and feedback from fifty farmers of the region were collected and summarized. The economic impact was also assessed on the university farm by recording the yield of the crops from two situations viz., recommended practices and recommended practices based on agro advisory. The practices were imposed on experimental plots of 20 square meters each for maize, wheat and rice.

RESULTS AND DISCUSSION

Rainfall and cloud cover

The usability of rainfall was inconsistent from 1995 to 2000 over different seasons (Fig.1) The rainfall usability varied from 20.9 to 89.7 percent over different season. The south west monsoon, which is the main rainfall producing season, recorded low percentage of usability (20.9 to 50.3 percent). This is because of the fact that model did not forecast more than 40 mm rainfall in 24 hours whereas rainfall between 180 and 240 mm was also observed on some occasions during the study period. The forecast on rainfall during north east monsoon, winter and hot weather period showed usability percentage between 55.5 and 89.7 percent, 52 and 83.4 percent and 62.0 and 83.0 percent respectively. The mean values were more than 64 percent in all the seasons except in south west monsoon, which registered the lowest accuracy of 40 percent. The higher values are indicative of higher reliability of forecast. The Ratio score also revealed higher values ranging between 58 and 84.6 percent (Table 1). The values during south west monsoon period varied between 58 and 78.9 percent over different years. The Ratio score was more than 60 percent in all the seasons and mean value being more than 67 percent. Similar observations have also been reported by Singh *et. al.* (1999) for Delhi, Pantnagar and Ludhiana agro-

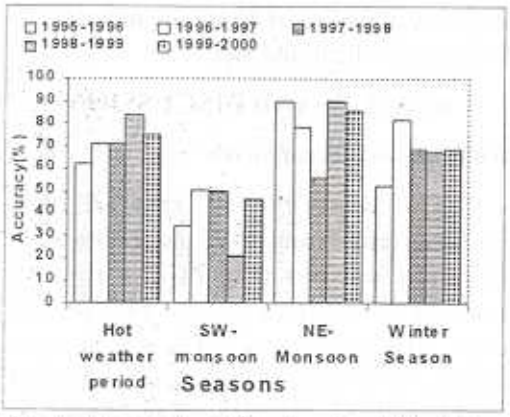

Fig 1: Forecast verification for Rainfall

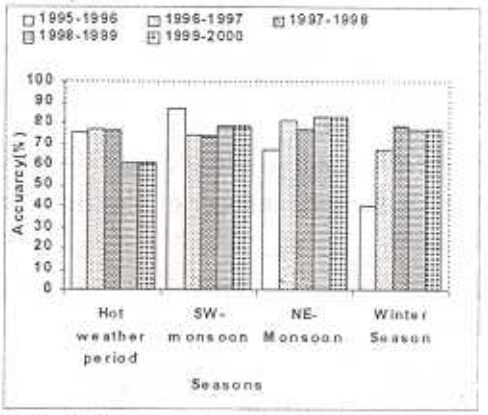

Fig 2: Forecast verification for Cloud cover

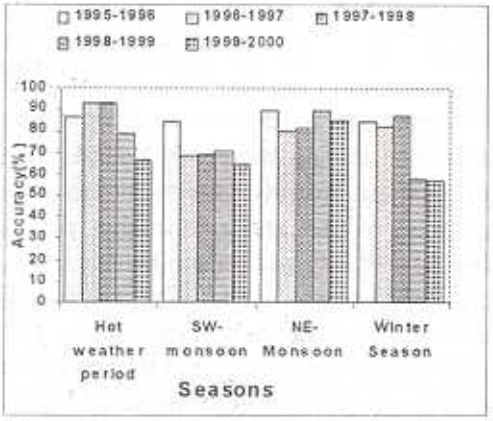

Fig 3: Forecast verification for Maximum temperature

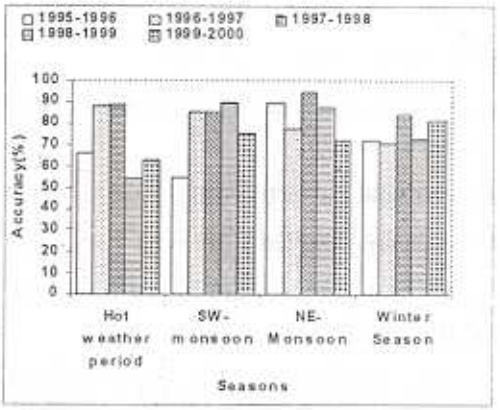

Fig 4: Forecast verification for Minimum temperature

climatic regions. The HK score varied from 0.09 to 0.55 in different seasons over the years. The mean H.K. score was higher in north east and south west monsoon seasons compared to other seasons.

The mean RMSE for seasons showed the highest value for south west monsoon (20.4) whereas others seasons recorded values lower than 5.5. The rainfall forecast during water deficit periods (Standard week 12-23) was highly reliable (60 to 80 percent) and accordingly advisories used on university farm have been proved beneficial.

Over the years, the accuracy of cloud cover forecast during south west monsoon varied between 73.5 and 86.3 percent followed by north east monsoon season varying from 66.7 to 82.2 percent (Fig. 2)

Table 1: Forecast verification for rainfall

Season	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	Mean (1995-2000)
Ratio Score (%)						
Hot weather period	64.9	75.0	75.0	83.0	77.0	75.0
South west monsoon	78.9	66.0	66.0	79.0	58.0	69.6
North east monsoon	84.6	77.8	68.0	87.0	80.0	79.5
Winter season	60.0	81.5	75.0	60.0	60.0	67.3
Hanssen and Kuipers Score (H.K.score)						
Hot weather period	0.24	0.42	0.42	0.09	0.08	0.25
South west monsoon	0.55	0.32	0.32	0.10	0.12	0.28
North east monsoon	0.23	0.16	0.78	0.34	0.06	0.31
Winter season	0.29	0.16	0.23	0.15	0.40	0.25
Root mean square error (RMSE)						
Hot weather period	8.3	5.0	4.9	1.9	6.2	5.2
South west monsoon	28.5	4.9	8.3	26.6	34.0	20.4
North east monsoon	2.1	3.3	8.3	9.4	2.3	5.0
Winter season	6.3	5.6	3.3	4.9	7.5	5.5

Temperature

The accuracy of maximum temperature forecast during north east monsoon season varied between 80.6 to 89.4 percent followed by hot weather period varying from 66.7 to 93.2 percent, winter season varying from 57.5 to 87.5 percent and south west monsoon season varying from 64.1 to 84.0 percent (Fig.3). The accuracy of minimum temperature was more consistent in all the years and seasons showing more than 72 percent reliability. The accuracy during north east monsoon season varied between 71.9 and 94.2 percent, followed by winter season varying between 70.3 and 83.8 percent, south west monsoon season varying from 55.0 to 89.6 percent and hot weather period varying from 54.3 to 88.6 percent (Fig. 4). The mean RMSE of maximum temperature varied between 2.0 and 3.2 and of the minimum temperature between 1.9 and 2.6. RMSE values of maximum temperature in general were also higher than minimum temperature (Table 2).

Utility of forecast in farming community

The farm survey conducted to asses the overall utility of the forecast revealed that medium range weather forecasting for undertaking all farm activities is excellent in 38 percent cases; very good in 10 percent cases, good in 29 percent cases and 24 percent as satisfactory. In the region, 76 percent farmers rated the usefulness of forecast between good to excellent. More than 95 percent of the farmers believed that

Table 2 : Forecast verification for temperature Root mean square error.

Season	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	Mean (1995-2000)
Maximum temperature						
Hot weather period	1.6	1.6	1.6	1.7	4.5	2.2
South west monsoon	3.9	2.2	2.2	2.2	5.7	3.2
North east monsoon	1.3	1.6	2.2	2.7	2.3	2.0
Winter season	1.8	2.1	2.3	2.7	6.6	3.1
Minimum Temperature						
Hot weather period	2.4	1.6	1.6	2.0	5.5	2.6
South west monsoon	1.7	1.8	1.8	1.4	5.4	2.4
North east monsoon	1.2	1.7	1.4	1.6	3.5	1.9
Winter season	1.8	1.7	1.7	2.0	4.1	2.3

Table 3 : Economic impacts of agro advisory

Crop	Yield (kg ha^{-1})				Increase in Rs. due to AAS	Percentage Increase in net returns of crops due to AAS
	Recommended practices		Recommended practices based on AAS			
	Grain yield	Straw yield	Grain yield	Straw yield		
Maize	4060	8670	4380	9080	1885	8.9
Rice	3120	6450	3470	7080	1410	9.7
Wheat	3050	8670	3340	6250	1620	14.7

The values are mean of two years 2000-2001

the utility of MRWF was beneficial for sowing/transplanting, pest and disease control, fertilizer and manure application, weed control and harvesting. Such findings were also reported by Patel *et. al.* (1998) who reported that 81 of the percent farmers rated the usefulness of agro advisory bulletins good to excellent. They further reported that agro advisory bulletins would prove an important input for their agricultural operations. The economic impact was also evaluated at university farm by assessing the yield obtained during 1999-2000 and 2000-2001. The results indicated that 9 to 15 percent higher profit was accrued due to agro advisories in rice, wheat and maize, respectively at the agro-climatic region (Table 3). The National report of National Centre for Medium Range Weather Forecasting also indicated the economic benefit of the advisories for different agromet field units and it ranged between Rs. 330/ and 3750/- in maize, wheat and rice (Anon, 2002).

REFERENCES

Anonymous, 2002. Background paper for 11th Annual Review Meeting of National Centre for Medium Range Weather Forecasting (NCMRWF) New Delhi. *In: Status of economic impact.* pp 1-3.

Gadgil, S. 1989. Monsoon variability and its relationship with agricultural strategies. *Paper presented at International symposium on climate variability and food security in developing countries*. Feb 5-7,1987, New Delhi, India pp 249-267.

Patel ,H. R., Shekh, A. M. and Venkatesh, H. 1998. Status of present day weather forecasting to farmers: A case study of middle Gujarat region. *Annals Agric. Res.*, 19(3): 285-289.

Seeley, M. W. 1994. The future of serving agriculture with weather/climate information and forecasting: some indications and observations. *Agric. Forest Meteorol.*. 69:47-59.

Singh, S, V,, Rathore, L. S. and Trivedi, H. K. N. 1999. Verification of medium range weather forecasts.(in) *Guide for Agrometeorological advisory services* pp 73-81. (Eds) National Centre for Medium Range Weather Forecasting, Department of Science and Technology, Government of India.