J. Agric. Res. Technol., 47 (1) : 018-022 (2022) https://doi.org/10.56228/JART.2022.47104

Verification of Rainfall Forecast in Latur District of Marathwada Region of Maharashtra

J. M. Naukharkar and M. G. Jadhav
Department of Agricultural Meteorology,
Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani - 431 402 (India)
(Received : 12.05.2021 Accepted : 06.06.2021)

Abstract

Rainfall prediction and weather based advisories assist farmers in protecting their crops from weather threats and enhancing their economic benefits by recommending appropriate management techniques depending on weather conditions. In this study verification for rainfall forecast on annual and seasonal basis, for the period of 2015-2020 was done for Latur district. The verification analysis was carried out using various verification techniques, *viz.*, Ratio Score (RS), Critical Success Index (CSI), Hanssen and Kupiers Score (HK), Root Mean Square Error (RMSE) and usability analysis. The results indicates that, rainfall accuracy reached its highest (88.76%) in 2018. And RS (88.21), CSI (0.75) and HK score (0.75) were observed highest during 2019. Among the seasons, rainfall accuracy was highest (96.91%) during winter season also the ratio score was observed highest during winter season (94.66) indicating the better skill of forecast, while, lowest with monsoon season. The highest HK score (0.66) was recorded in the post-monsoon season and CSI (0.72) in Monsoon season. That indicated good skill of the rainfall forecast during the period, while, poor skill of forecast was found with monsoon season. There is a need to investigate the reliability and suitability of medium-range weather forecasts in order to improve them further.

Key words : Rainfall, usability, accuracy, verification, forecast.

The rainfall is the most vital weather parameters among all the other parameters. Hence, timely and correct rainfall forecast is most important for crop production. Each phase of agricultural activity from preparatory tillage to plant growth, harvest and storage is influenced by weather directly or indirectly (Bhatia, 1999). Weather is important phenomenon which determines the chances of success as well as complete failure of agricultural crops. These phenomenon not completely controlled but can be modified to the need during their cultivation. The verification of forecast is important in order to find out its accuracy by comparing the forecasted weather with the observed weather either qualitatively or quantitatively. Timely weather forecast-based agromet advisories on need-based agricultural activities can help farmers save an amount of revenue by reducing production losses. It's essential to realise that no single verification method can give all of the information needed to assess the forecast's accuracy, quality, and reliability. As a result, any forecast verification report should include as many scores/indices as possible.

Materials and Methods

The study area, Latur is located in Marathwada region of Maharashtra state and located between 17°52' to 18°50' North and 76°18' to 79°18' East in Deccan plateau and at altitude of 631 m above Mean Sea Level. Daily rainfall data were collected from maharain. maharashtra.gov.in website and Forecasted rainfall data from IMD under GKMS project, VNMKV, Parbhani for six years i.e. 2015 to 2020.

1. Associate Professor, 2 Head, Department of Soil Science and Agril. Chemistry MPKV, Rahuri 413 722, 3 and 4. Sr. Res. Asstt.

Verification of Rainfall Forecast : The quantitative and quantitative analysis of the forecasts in reference to observed real time data were worked out using critical values for various rainfall prediction. The validity and accuracy of forecasts were tested using Skill Score Test and RMSE values. Forecasted daily rainfall was verified against actual rainfall data recorded of various rainguage station of Latur district. The various skill scores like Ratio score (RS), Critical success index (CSI), Hanseen and Kupiers score (HK) were calculated for rainfall. Using of all above scores and relationships the accuracy, reliability and skills of rainfall forecast were analyzed on seasonal and annual basis.

Error structure for rainfall

If observed r/f is out by

Correct:-

Diff $\leq$ 2.5 mm for $\leq$ 10mm

Diff $\leq$ 25% of observed for > 10 mm

Usable:-

2.5 mm < Diff $\leq$ 5mm for $\leq$ 10mm

25% of observed < Diff $\leq$ 50% of observed for > 10 mm

Unusable:-

Diff > 5 mm for $\leq$ 10 mm

Diff > 50% of observed for > 10 mm

Verification methods : The Ratio Score (RS), measures the proportion of correct forecasts out of all forecasts (Woodcock, 1976). It varies from 0 to 1 with 1 indicating perfect forecast. Hanssen and Kupiers score (HK) is the ratio of economic saving over climatology due to forecaster to that of a hypothetical set of perfect forecasts (Woodcock, 1981) and varies from -1 to +1 with 0 indicating no skill. The Critical Success Index (CSI) of an event is a measurement of relative forecasting accuracy in a category (Schaefer, 1990) and varies from 0 to 1 with 1 indicating perfect forecast. The root mean square error (RMSE) was worked out for the absolute error between observed and forecasted rainfall data. The critical values of error structures given by Kumar et al., (2017) were followed to consider success and failure cases for analysis.

Rainfall verification : Skill scores and verification of the rainfall forecast (Singh and Bhardwaj, 2012)

Observed	Predicted	
	Rain	**No Rain**
Rain	H (YY)	M (YN)
No Rain	F (NY)	Z (NN)

Where, H = Predicted and Observed, M = Observed but not predicted F = Not predicted but observed, Z = Neither predicted nor observed fi = Predicted values and oi = Observed values

i) Ratio Score (RS) :

$$RS = \frac{H + Z}{H + M + F + Z}$$

ii) Critical Success Index (CSI) :

$$CSI = \frac{H}{H + M + F}$$

iii) Hanssen & Kupiers score (HK) :

$$HK = \frac{(HZ - MF)}{(Z + F)(H + M)}$$

iv) Root Mean Square Error (RMSE) :

$$RMSE = \{1/n \, \Sigma \, (fi - oi)^2\}^{1/2}$$

Results and Discussion

Usability of rainfall forecast : The data on annual usability of rainfall for the period 2015 to 2020 is given as Table 1 and Fig. 1. The annual usability and correctness of rainfall in percentage varies from 76.67 to 88.76. The maximum percentage (88.76) for correct and usable forecast was observed during 2018 and minimum percentage (75.67) during the year 2020. The maximum percentage of unusable forecast was observed during 2020 and minimum during 2015 i.e., 24.31 and 13.15 respectively. The average usability of annual rainfall forecast was 73.26%. On seasonal basis, the result revealed that the highest correctness 96.91% was found in winter season followed by pre-monsoon (88.5%), post-monsoon (86.41%) and monsoon season (40.43%). The highest usable forecast was observed during monsoon season i.e., 20.62 per cent whereas, pre-monsoon was second highest i.e., 8.5 per cent. Third highest was post-monsoon (3.61%) and fourth was winter season (1.4%). The highest unusable forecast observed in monsoon season (38.92%) followed by post-monsoon (9.77%), pre-monsoon (3.07 per cent) and winter (1.67 per cent) respectively. Similar result was also reported by Manjappa and Yeledalli.

Skill scores for rainfall forecast of Latur district : The data on Ratio Score, CSI, HK score and RMSE on annual and seasonal basis is presented in Table 2 and Fig. 2 to 4. On annual basis, the Ratio score was highest in 2019 and lowest during 2020 i.e., 88.21 and 75.68 per cent. The CSI was observed highest (0.75) during 2019 and lowest (0.46) during 2015. Hanseen and Kupiers score was highest 0.75 during 2019 and lowest 0.53 during 2020. The highest RMSE (12.1) was observed

Table 1. Usability skill of rainfall for Latur (2015 to 2020

Years	Rainfall (%)		
	Correct	Usable	Unusable
Pre-monsoon (March-May)			
2015	79.34	15.21	5.43
2016	93.47	3.26	3.26
2017	94.56	4.34	1.08
2018	91.30	7.60	1.08
2019	95.65	2.17	2.17
2020	76.08	18.47	5.43
Mean	88.40	8.50	3.07
Monsoon (June-September)			
2015	50.81	21.31	27.86
2016	37.70	18.03	44.26
2017	46.72	20.49	32.78
2018	47.54	26.22	26.22
2019	37.70	18.85	43.44
2020	22.13	18.85	59.01
Mean	40.43	20.62	38.92
Post-monsoon (October-December)			
2015	95.65	1.08	3.26
2016	94.56	2.17	3.26
2017	88.04	2.17	8.69
2018	92.39	1.08	6.52
2019	66.30	7.60	26.08
2020	81.52	7.60	10.86
Mean	86.41	3.61	9.77
Winter (January-February)			
2015	96.61	3.38	0
2016	96.66	0	3.33
2017	100	0	0
2018	94.91	1.69	3.38
2019	100	0	0
2020	93.33	3.33	3.33
Mean	96.91	1.40	1.67
Annual (January-December)			
2015	76.71	10.13	13.15
2016	75.68	7.37	16.93
2017	77.80	8.76	13.42
2018	77.53	11.23	11.23
2019	69.58	8.76	21.64
2020	62.29	13.38	24.31
Mean	73.26	9.93	16.78

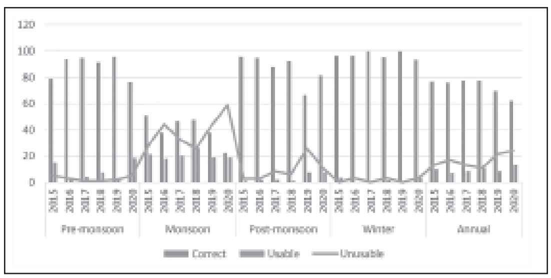

Fig. 1. Usability of rainfall forecast for Latur distrist

Table 2. Skill scores of rainfall forecast for Latur (2015 to 2020)

Years	RS	CSI	HK	RMSE
Pre-monsoon (March-May)				
2015	80.43	0.33	0.51	3.78
2016	76.08	0.26	0.24	3.42
2017	81.52	0.10	0.07	1.26
2018	81.52	0.26	0.44	1.21
2019	91.30	0	0	1.85
2020	68.47	0.21	0.18	2.07
Mean	79.88	0.19	0.24	2.26
Monsoon (June-September)				
2015	60.65	0.51	0.24	10.74
2016	71.31	0.67	0.23	18.89
2017	70.49	0.87	0.24	17.44
2018	66.39	0.60	0.22	9.01
2019	83.60	0.82	0.20	15.59
2020	86.88	0.86	0.04	13.90
Mean	73.22	0.72	0.19	14.26
Post-monsoon (Octomber-December)				
2015	95.65	0.42	0.95	3.51
2016	96.73	0.70	0.76	9.81
2017	89.13	0.52	0.69	3.05
2018	92.39	0.46	0.69	2.37
2019	85.86	0.71	0.71	8.78
2020	57.60	0.27	0.20	5.76
Mean	86.22	0.51	0.66	5.54
Winter (January-February)				
2015	91.52	0	-0.03	0.89
2016	95	0	-0.03	1.41
2017	100	0	0	0
2018	93.22	0.20	0.44	2.13
2019	96.61	0	0	0.18
2020	91.66	0.16	0.28	1.59
Mean	94.66	0.06	0.11	1.03
Annual (January-December)				
2015	79.88	0.46	0.61	6.74
2016	82.78	0.58	0.60	12.10
2017	82.73	0.57	0.63	10.22
2018	81.09	0.52	0.63	5.45
2019	88.21	0.75	0.75	10.08
2020	75.68	0.59	0.53	8.61
Mean	81.72	0.57	0.62	8.86

during 2016 and lowest (6.74) during the year 2015. On an average for the six years data, Ratio score was 81.72 per cent. CSI 0.57, HK score 0.62, and RMSE 8.86. On seasonal basis, the result observed that the average Ratio Score was highest in winter (94.66%), followed by post-monsoon (86.22%), pre-monsoon (79.88%) and monsoon (73.22%). The H. K. score was highest in post-monsoon (0.66),

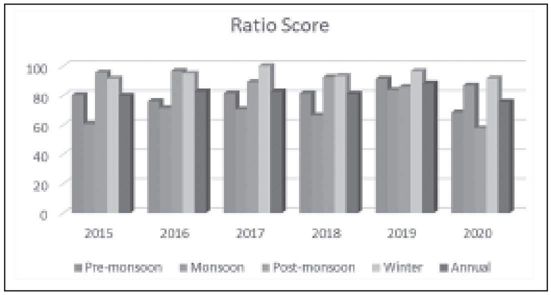

Fig. 2. Verification of rainfall forecast based on Ratio score for Latur

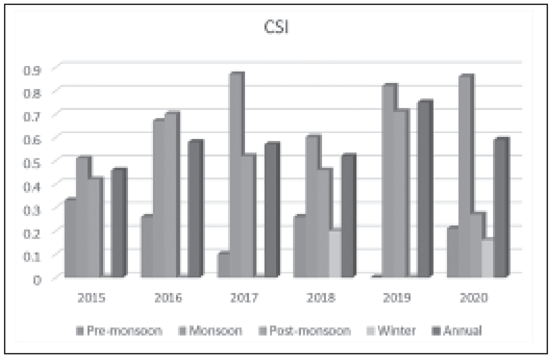

Fig. 3. Verification of rainfall forecast based on Critical Success index for Latur

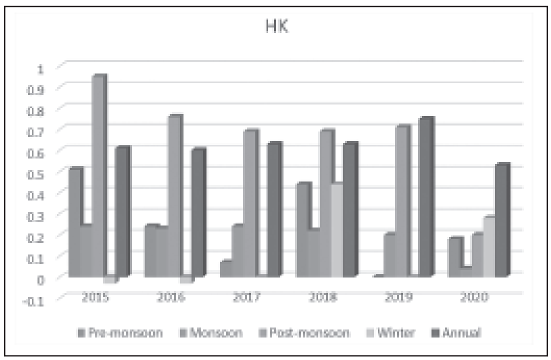

Fig. 4. Verificational of rainfall forecast based on HK score for Latur

followed by pre-monsoon (0.24), monsoon (0.19) and winter (0.11). The positive HK score indicated the reliability of forecast to be satisfactory level. The CSI was highest during monsoon (0.72) followed by post-monsoon (0.66), pre-monsoon (0.14) and winter (0.06). RMSE was highest in monsoon (14.26) followed by post-monsoon (5.54), pre-monsoon (2.26) and winter (1.03). The similar result also observed by Sarmah *et al*. (2015) for north bank plain of Assam, India. except monsoon season, the quantitative forecast revealed higher reliability over percent accuracy of forecast (ratio score) may be due to frequency of rainy days was more in monsoon season.

Conclusions

The rainfall forecast performance was good with low RMSE considering all seasons except in monsoon. In the Latur district, the highest annual Ratio score (88.21%) was recorded in 2019 and the maximum rainfall accuracy (88.76%) was obtained in 2018. The winter season had the highest accuracy (96.91%), followed by the pre-monsoon, post-monsoon, and monsoon seasons. It need to be improvement in usability of rainfall mainly for monsoon season because rainfall is an important parameter to make decision on the crop production.

References

Bhatia, P. C. 1999. Crops and weather resources. In: 50 years of Natural Resource Management Research, (Eds. Singh, G. B and Sharma, B. R), ICAR Publication: 49-62.

Kumar, A., Chattopadhayay, N., Ramarao, Y. V., Singh, K. K., Durai, V. R., Das, A. K., ... & Soni, A. 2017. Block level weather forecast using direct model output from NWP models during monsoon season in India. Mausam, 68(1), 23-40.

Manjappa, K. and Yelledalli, S. B. 2013. Validation and assessment of economic impact of agro advisories issued based on medium range weather forecast for Uttara Kannada district of Karnataka. Karnataka journal of Agriculture Science., 26(1): 36-39.

Sarmah, Kushal., Prasanta Neog, Rajbongshi, R. and Sarma, A. 2015. Verification and usability of Medium Range Weather Forecasting for North bank plain zone of Assam, India. Mausam, 66, 3; 585-594

Schaefer, C. T. 1990. The Critical Success index as an indicator of warning skill, Wea. And Forecasting, 5, 570-575.

Singh, M. and Bhardwaj, S. S. 2012. Verification and usability of location specific medium range weather forecast for Kullu valley. Mausam, 63 (4), 543-52.

Woodcock, F. 1976. The evaluation of yes/no forecast for scientific and administrative purposes. Mon. Wea. Rev., 83, 249-252.

Woodcock, F. 1981. Hanssen and Kuipers discriminant related to the utility of yes/no forecasts, Mon. Wea. Rev., 109, 172-173.