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Research Article

VALIDATION AND ASSESSMENT OF AGRO ADVISORIES ISSUED BASED ON MEDIUM RANGE WEATHER FORECAST FOR THRISSUR DISTRICT OF KERALA

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Abstract: The medium range weather forecast issued from National Centre for Medium Range Weather Forecast (NCMRWF) on various weather parameters and impact of agro advisories issued based on this medium range weather forecast for Thrissur district of Kerala state during the period from 2013 -2016 are discussed in this paper. The mean usability of different forecasted weather elements was near to and more than 50 percent in most of the seasons except for rainfall in pre monsoon, monsoon and post monsoon seasons and wind direction in post monsoon season.

Keywords: Agro-advisories, Percent usability, Weather forecast

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Introduction

Weather decides success or failure of agricultural crop production. Weather manifests its influence on agricultural operations and farm production through its effects on soil and plant growth. Out of total annual crop losses, a substantial portion is because of aberrant weather. The loss could be minimized by making adjustment with likely occurrence through timely and accurate weather forecasting. Agricultural operations can be advanced or delayed with the help of advanced weather forecast from three to ten days. A weather forecast which is relevant to agriculture will lead to precise impact assessment along with efficient management of farm inputs [1]. The Agro Advisory Bulletin prepared based on medium range weather forecast is an efficient tool for increasing the crop production and income [2]. The region is located between 10°31' N latitude and 76°13' N longitude. The centre is located at an altitude of 25 m above mean sea level. The average annual rainfall of the region is 2854 mm. The main crops are rice, coconut, banana, pepper, vegetables *etc*. The South West monsoon season is more important for crop production in this region and it was highly useful to the small and marginal farmers. This paper attempt to verify the suitability of the medium range weather forecasts and its impact on economic returns for the crops grown in this region.

Materials and Methods

Medium range weather forecast was given by India Meteorological Department, New Delhi on various weather parameters viz., amount of rainfall, cloud cover, maximum and minimum temperature, wind direction for the period from 2013 to 2016 for the Thrissur district. Forecasted data was compared with the observed values of the respective weather parameters recorded at the Agro meteorological observatory located at Kerala Agricultural University, Vellanikkara. Different verification methods were used to assess the reliability of forecast values of weather parameters. The forecast of rainfall, cloud cover, temperature, wind direction have been verified by calculating the error structure. Initially, the error structure was used to categorize the forecast given as correct, usable or unusable based on the percent deviation in the forecast values as compared to observed values as per the guidelines of National Centre for Medium Range Weather Forecasting (NCMRWF) [3]. The correct and usable cases were summed up and the combined value indicates the percent usability of the forecasts of various parameters to the total events occurred in respective parameter. If the observed rainfall is found to be correct if the absolute difference is less than or equal to 25% of the observed, it is usable if the absolute difference lies between 25% of the observed and 50% of the observed and is unusable otherwise. The Ratio Score was also worked out for rainfall forecast and this score varied from 0 to 100, with 100 indicating perfect forecast [4]. In addition, Hanssen and Kuipers Score (H.K. Score) was also worked out for rainfall forecast which indicated the skill of the forecast given [3]. It ranged between -1 to +1, with 0 indicating no skill. If all forecast is wrong *(i.e.*, YY=NN=0) then it is -1, and if all forecast is perfect (*i.e.*, YN=NY=0) then it is +1, and random forecasts receive a score of 0. The accuracy of the forecast can be measured by Critical Success Index (CSI) and it ranges from 0 to 1. If the CSI value is 1, then it will be a perfect forecast and if the value is 0, then there is no skill for the forecast. Probability of Detection (POD) is another skill score used for forecast verification. It is Sensitive to hits, but ignores false alarms. It ranged between 0 to 1 and perfect score is 1. False Alarm Ratio (FAR) is sensitive to false alarms, but ignores misses. It should be used in conjunction with the probability of detection. It ranges between 0 to 1 and perfect score is 0. Heidke Skill score was worked out to verify the weather forecast. The fraction of correct forecasts will be measured in this skill score. The range belongs to -1 to 1, 0 indicates no skill and perfect score is 1. Lowest value of Root mean square error indicate better forecast. Positive value is good for correlation. Parameters like the wind direction, temperature, cloud cover are quasi-continues variables. Error Structure for verification of temperature is the observed temperature is correct if the absolute difference is less than 1°C, it is usable if the absolute difference lies between 1°C to 2°C and is unusable otherwise. Error Structure for verification of wind direction is the observed wind direction is correct if the absolute difference is less than 30° it is usable if the absolute difference lies between 30° to 40° and is unusable otherwise. Error structure for verification of cloud cover is the observed cloud cover is correct if the absolute difference is less than 2 okta it is usable correct if the absolute difference lies between 2 okta to 3 okta and is unusable otherwise. Verification of weather forecasts was done for four seasons *viz*., Pre-monsoon (March to May), monsoon (June-September), Post-monsoon (October and November) and winter (Dec to Feb) as per the guidelines of NCMRWF [3].

Table-1 Qualitative analysis of rainfall forecast and realization received at AMFU Thrissur

	2013-2014	2014-2015	2015-2016	Mean
Ratio score (%)				
Premonsoon	42.62	27.87	42.62	37.70
Monsoon	77.87	79.51	77.87	78.42
Post monsoon	60.66	44.26	60.66	55.19
Winter	88.89	84.44	84.44	85.92
Wholeyear	71.26	64.97	68.66	68.30
Hanssen and Kuiper's Score				
Pre monsoon	0.01	-0.03	0.01	0.00
Monsoon	0.24	0.07	0.24	0.18
Post monsoon	0.13	-0.01	0.13	0.08
Winter	0.62	0.27	0.27	0.39
Wholeyear	0.46	0.35	0.4	0.40
Probability of Detection				
Pre monsoon	0.88	0.85	0.88	0.87
Monsoon	0.97	0.91	0.97	0.95
Post monsoon	0.91	0.85	0.91	0.89
Winter	0.71	0.4	0.56	0.56
Wholeyear	0.93	0.88	0.92	0.91
False Alarm Ratio				
Pre monsoon	0.6	0.79	0.6	0.66
Monsoon	0.22	0.15	0.22	0.20
Post monsoon	0.4	0.58	0.4	0.46
Winter	0.62	0.85	0.75	0.74
Wholeyear	0.37	0.43	0.39	0.40
Critical Success Index				
Pre monsoon	0.38	0.2	0.38	0.32
Monsoon	0.76	0.79	0.76	0.77
Post monsoon	0.56	0.39	0.56	0.50
Winter	0.53	0.13	0.21	0.22
Wholeyear	0.6	0.52	0.58	0.57
Heidke Skill Score				
Pre monsoon	0.01	-0.01	0.01	0.003
Monsoon	0.3	0.08	0.3	0.23
Post monsoon	0.14	-0.01	0.14	0.09
Winter	0.44	0.15	0.24	0.28
Wholeyear	0.44	0.33	0.39	0.39
Root Mean Square Error				
Pre monsoon	15.08	21.2	15.08	17.15
Monsoon	20.63	24.43	20.63	21.90
Post monsoon	14.08	14.23	14.08	14.13
Winter	6.4	3.13	6.99	5.51
Wholeyear	15.63	18.45	15.68	16.59
Correlation				
Pre monsoon	0.18	-0.04	0.18	0.11
Monsoon	0.29	-0.005	0.29	0.19
Post monsoon	0.3	0.23	0.3	0.28
Winter	0.12	-0.02	0.08	0.06
Wholeyear	0.39	0.23	0.38	0.33

Table-3 Range and mean usability (%) for temperatures and cloudiness for the period 2013 -2016

Season	Maximum temperature		Minimum temperature		Cloud amount	
	Range	Mean	Range	Mean	Range	Mean
Pre monsoon	40.98-96.72	59.56	40.98-47.54	44.81	83.87-90.16	87.87
Monsoon	79.51-86.07	81.97	94.29-98.36	96.18	59.83-95.08	83.06
Post monsoon	37.71-49.18	44.26	40.99-49.18	46.45	80.33-90.16	85.79
Winter	56.67-61.11	58.67	50-54.44	52.76	62.22-73-62	68.98
Whole year	76.94-80.3	78.6	84.73-87.76	85.94	66.46-86.52	79.35

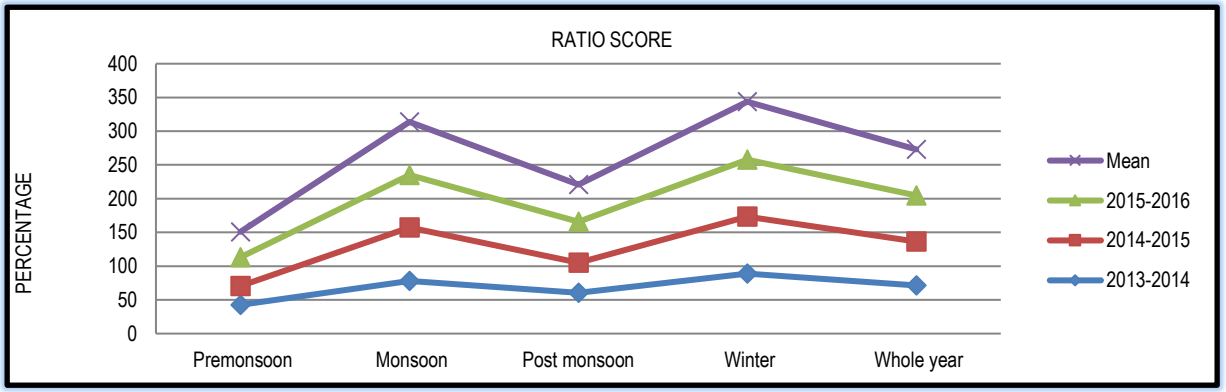

Fig-1 Ratio score obtained during different seasons

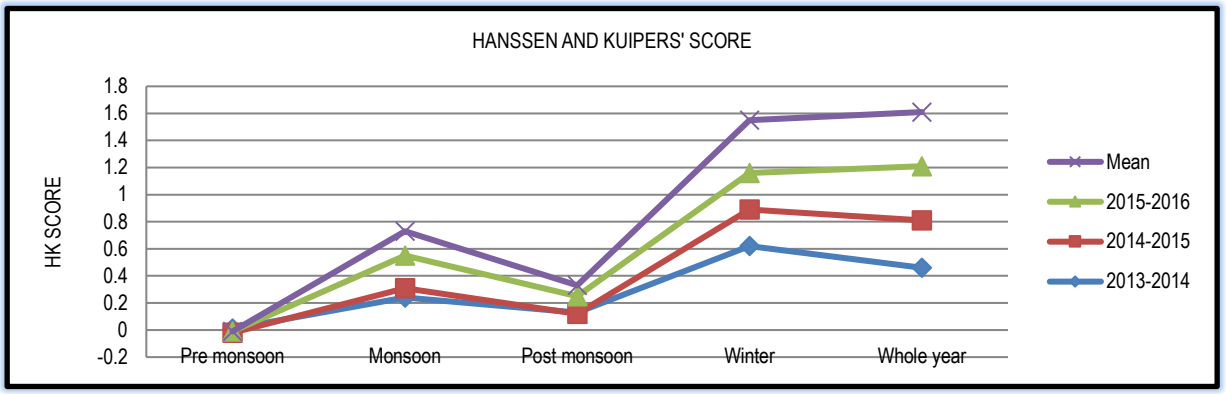

Fig-2 HK score obtained during different seasons

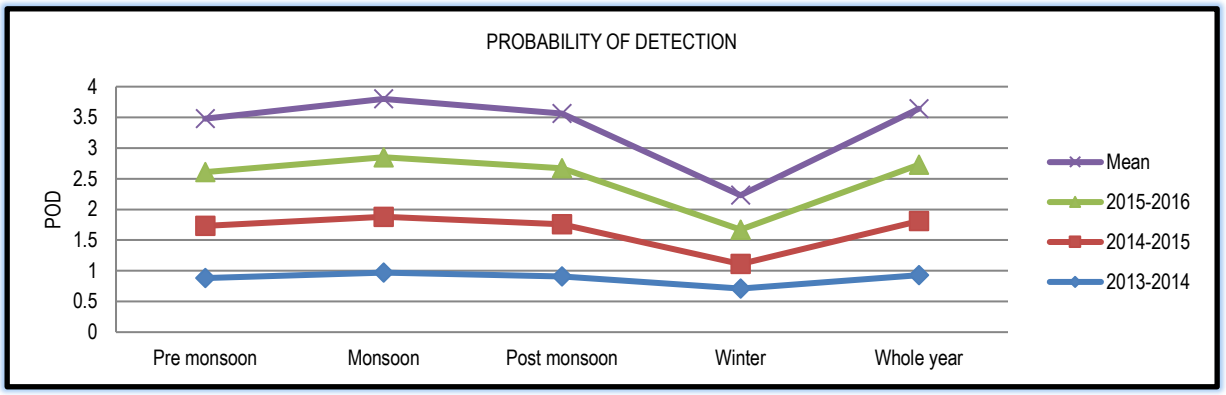

Fig-3 POD score obtained during different seasons

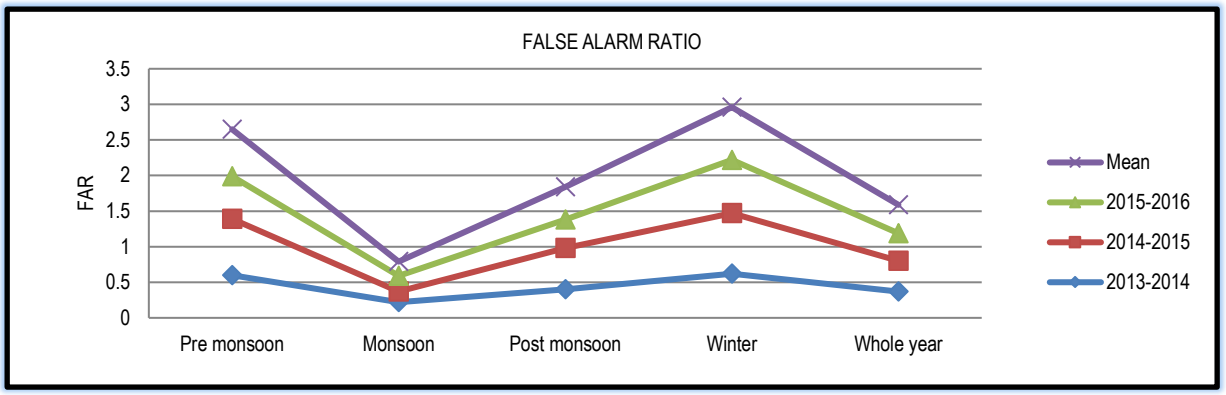

Fig-4 FAR score obtained during different seasons

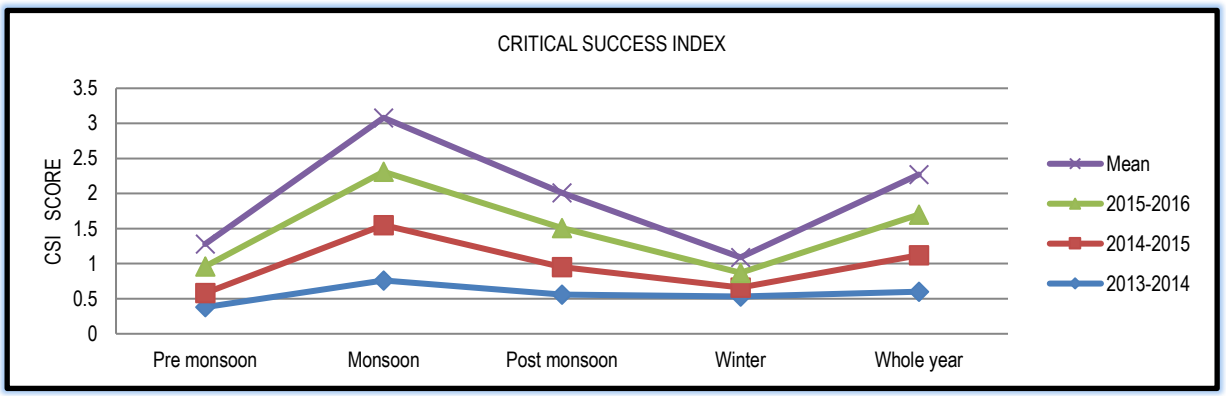

Fig-5 CSI score obtained during different seasons

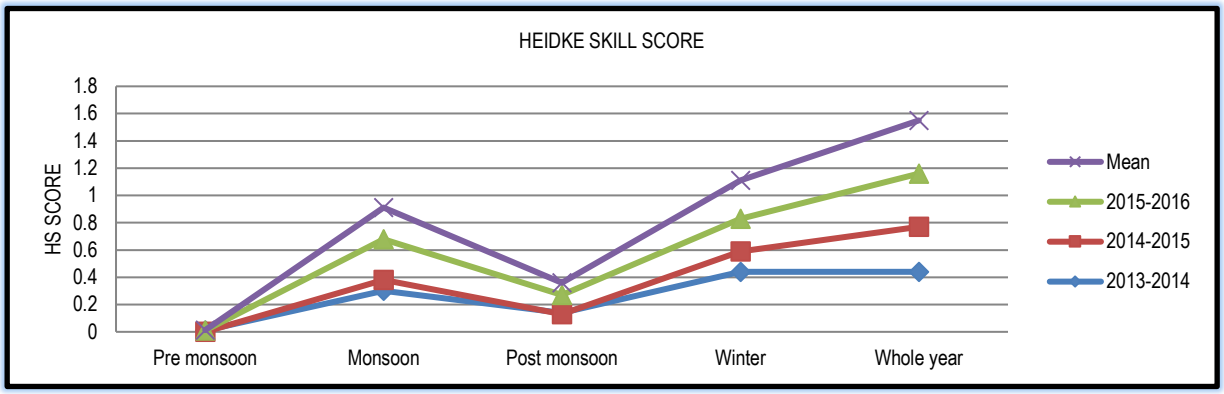

Fig-6 HS score obtained during different seasons

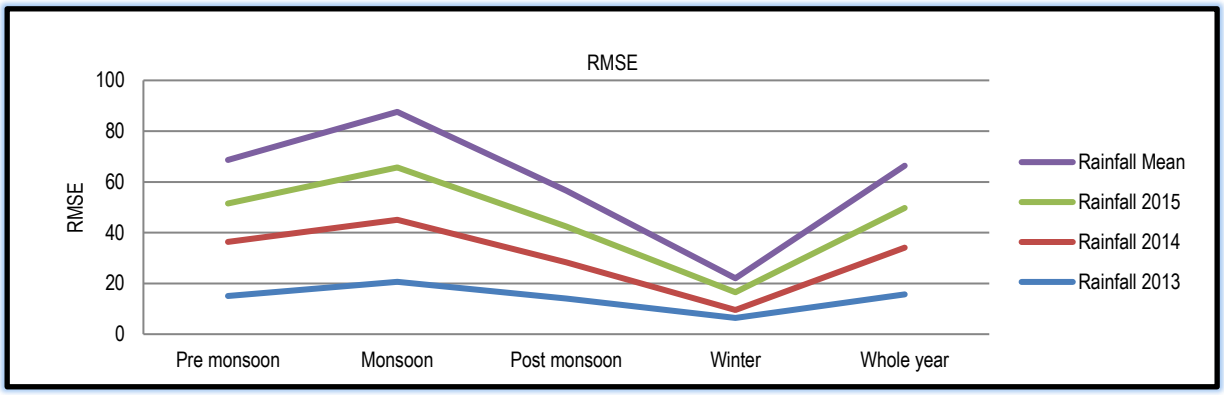

Fig-7 RMSE score obtained during different seasons

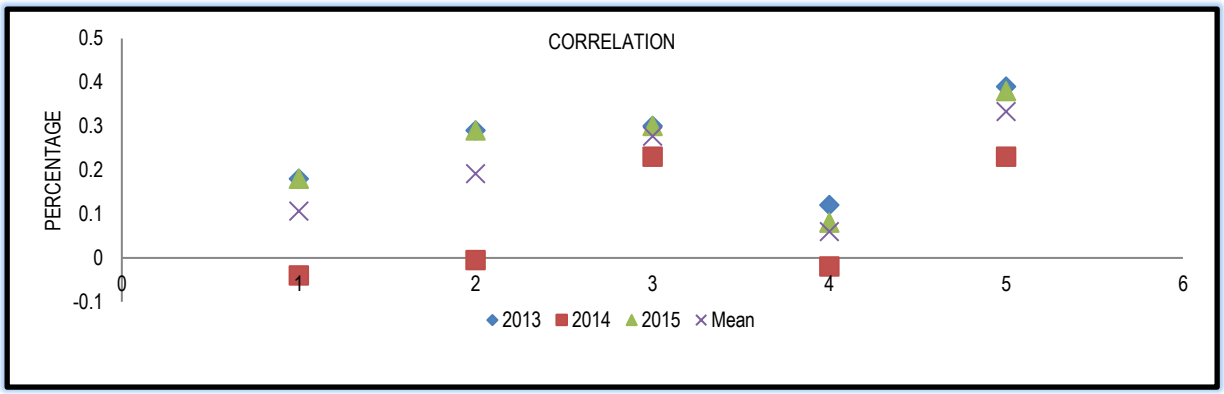

Fig-8 Correlation obtained during different seasons

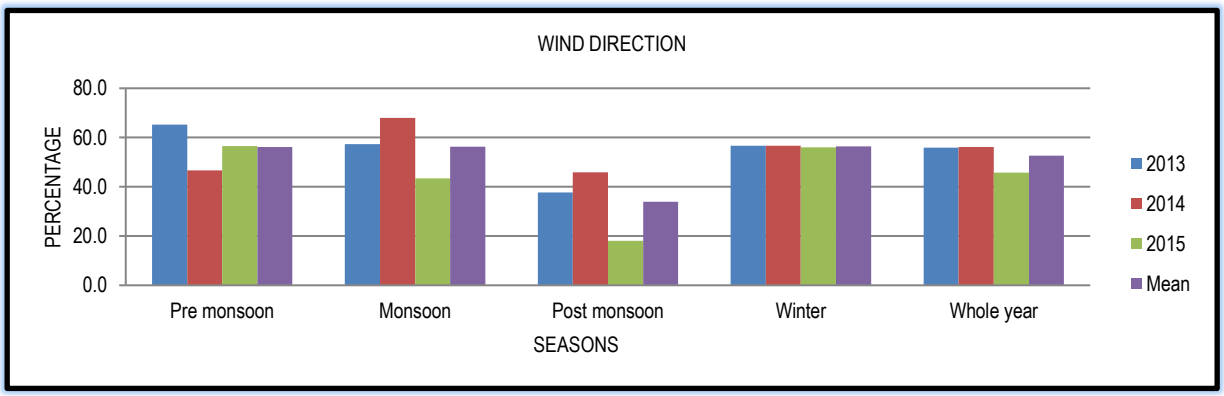

Fig-9 wind direction obtained during different seasons

Result and Discussion

A weather element may be either a continuous or a categorical variable. Parameters like the rainfall take discrete value and hence are a categorical variable. On the other hand parameters like the temperature, wind direction, cloud cover will always occur and hence are quasi-continues variables. The Ratio score and their respective Hanssen and Kuipers Score, Probability of Detection, False Alarm Ratio, Critical Success Index, Heidke Skill Score were presented in [Table-1]. The mean ratio score was higher in winter (85.92) followed by monsoon season (78.42), post monsoon season (55.19) and pre monsoon season (37.70). The mean HK score was higher in winter and monsoon seasons compared to other seasons. Probability of Detection is highest during monsoon season (0.95) followed by post monsoon season (0.89), pre monsoon season (0.87) and winter season (0.56). False Alarm Ratio is highest in winter season (0.74) and lowest in monsoon Season (0.20). Critical Success Index ranging from 0.22 (winter) to 0.77 (Monsoon). Heidke Skill Score highest during winter season (0.28) followed by monsoon (0.23), post monsoon (0.09) and lowest during pre-monsoon season (0.23). The Root Mean Square Error is lowest during winter (5.51) followed by post monsoon season (14.13), pre monsoon (17.15) and monsoon (21.90). Highest correlation value is presented in post monsoon (0.28), monsoon (0.19), pre monsoon (0.11) respectively. The monsoon, which is the main rainfall producing season recorded second lowest percentage of usability. The post monsoon recorded lowest percentage of usability and it varied from 20.22 to 79.73 per cent. The forecast on rainfall during monsoon, winter and pre-monsoon showed usability percentage between 18.85 and 27.05 percent, 73.63 and 83.33 percent and 13.12 and 24.59 percent respectively [Table-2].

Table-2 Overall usability (%) analysis of the forecasted rainfall for all years / seasons

Season	Rainfall			Mean
	2013-2014	2014-2015	2015-2016	
Premonsoon	24.59	13.12	24.59	20.77
Monsoon	27.05	18.85	27.05	24.32
Postmonsoon	21.31	18.03	21.31	20.22
Winter	83.33	82.22	73.63	79.73
Whole year	40.72	34.76	40.72	38.72

Considering the quantitative data usability of temperature (maximum and minimum) and cloud amount parameters have been worked out and presented in [Table-3]. The mean usability of maximum temperature, minimum temperature and cloud amount recorded between 44.26 and 81.97, 44.81 and 96.18 and 68.98 and 87.87 percent respectively indicated that the predictability in terms of these three parameters during four seasons of the year during 2013 to 2016 were more accurate.

Table-4 Season wise usability analysis of forecasted wind direction

Season	2013	2014	2015	Mean
Pre monsoon	65.2	46.7	56.5	56.1
Monsoon	57.37	68.03	43.43	56.3
Post monsoon	37.69	45.9	18.02	33.9
Winter	56.66	56.66	56.03	56.5
Whole year	55.88	56.16	45.75	52.6

The range and overall usability of wind direction was presented on [Table-4]. The accuracy of forecast on wind direction ranged between 33.92 to 56.5. Mean usability value of post monsoon was low (33.9). However on an average over whole years the accuracy of wind direction is near to 50%.

Conclusion

Forecast verification is the process and practice of determining the quality of forecasts and it represents an essential component of any scientific forecasting system. Forecast verification serves many important purposes, including assessment of the state-of-the-art of forecasting and recent trends in forecast quality, improving forecasting procedures and ultimately the forecasts themselves and providing required information to the user for making effective decisions. Based on the findings of this research, it can be concluded that the mean usability of different forecasted weather elements was near to and more than 50 percent in most of the seasons except for rainfall in pre monsoon, monsoon and post monsoon seasons and wind direction in post monsoon season.

Application of research: This study will help to improve the quality and accuracy of the weather forecast and thus it will finally benefitted by the stakeholders of agromet advisory services, mainly farmers by enhancing the crop productivity and quality.

Research Category: 1,2 Keywords

Abbreviations

NCMRWF – National Centre for Medium Range Weather Forecasting
H.K. Score - Hanssen and Kuipers score
CSI - Critical Success Index
POD - Probability of Detection
FAR - False Alarm Ratio
RMSE – Root Mean Square Error

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Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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