Verification of medium range weather forecast for the Kandi region of Punjab

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ABSTRACT. The weather forecasts received from India Meteorological Department (IMD), Chandigarh and actual weather data recorded at Agrometeorological observatory of Regional research Station, Ballowal Saunkhri were compared to check the validity and accuracy of weather forecast during 2017-18. The usability analysis for the weather parameters was done using skill scores and critical values for the error structure for the different seasons. The ratio scores derived between the forecasted and observed values during post-monsoon and winter seasons were observed to be relatively higher as compared to those for the monsoon seasons, indicating the performance of forecast models to be better in post-monsoon and winter seasons than in the summer and monsoon seasons. The relatively higher usability of maximum temperature and minimum temperature was observed during post-monsoon season, which are important to the farmers for the pre-sowing operations of the rabi crop. Forecasting of wind speed plays an important role in saving the crop from lodging especially in the rabi crop season and it was observed that in this season (2017-18) the wind speed forecasting was 74 per cent correct. The accuracy of forecast of weather parameters in advance is found to be useful for farmers for doing appropriate field operations and crop management practices.

Key words – Medium range weather forecast, Ratio score, Skill score, RMSE (Root mean square error), Correlation.

1. Introduction

Weather forecast plays an important role in agriculture as agriculture production is highly dependent on variability in weather conditions. An accurate weather forecast not only helps in increasing agriculture production and quality of produce but helps in efficient use of limited resources. Forecast of onset of monsoon is therefore important for sowing and different crop management practices during kharif season and the prediction of winter season rainfall is important for the rabi crops in the northern and central parts of the country. The accurate forecasting of different weather parameters continues to be a major challenge for scientific community. Different types of forecasts can be made for few hours to one day (now casting), 1-3 days (short range), 3-10 days (medium) and month/season (long range) periods. The medium range weather forecasts are used for preparing agromet advisory bulletins which are very useful for scheduling of sowing, irrigation, agricultural operations and management of pest and diseases of field crops (Vashishth et al., 2008). Therefore, the capacity to provide timely, skillful weather forecasts offers the great potential to reduce vulnerability to the unpredictable weather conditions (Hansen, 2002). Khichar and Bishnoi (2003) have also assessed the accuracy of
weather forecast for western agro-climatic zone of Haryana during _kharif_ season. Different methods are available to test the accuracy of medium range weather forecast. Although the rainfall in _kandi_ region is more as compared to the other areas of Punjab, the farmers in the _kandi_ region of Punjab are highly dependent on the rainfall due to rainfed conditions. Therefore, the accuracy of weather forecast becomes more important. Keeping this in mind, the medium range forecast for the year 2017-18 has been tested using these methods to assess its accuracy for the _kandi_ region of Punjab.

2. Materials and method

The value-added weather forecast received from India meteorological department, Chandigarh and actual weather data recorded at Agrometeorological observatory of Regional Research Station, Ballowal Saunkhri were compared to check the validity and accuracy of weather forecast during the year 2017-18. For the verification of the forecast, the year was divided into four groups on seasonal basis viz., Pre-monsoon, (April-May), monsoon (June-September), Post-monsoon (October-December) and winter (January-March). The usability analysis for the six weather parameters viz., cloud cover, rainfall, wind speed, wind direction, maximum temperature and minimum temperature were carried out using critical values for the error structure for the different seasons except relative humidity (Table 1). The correlation and RMSE analysis have also been done to establish relationship between eight observed and forecasted weather parameters (cloud cover, rainfall, wind speed, wind direction, maximum temperature, minimum temperature, morning and evening relative humidity) for the different seasons of the year.

The H K score (Kothiyal, 2017) and ratio score (Kothiyal, 2017) were calculated to test the weather forecast for rainfall during 2017-18. These scores are explained as below:

2.1. _Hanssen and Kuipers (True skill score)_

\[ H.K.Score = \frac{YYNN - YNNY}{(YY + YN)(YN + NN)} \]

- \( YY = \) No of days when rain was forecasted and also observed,
- \( YN = \) No of days when rain was forecasted but not observed,
- \( NY = \) No of days when rain was not forecasted but observed,
- \( NN = \) No of days when rain was not forecasted and also not observed.

The value of H K score ranges between -1 to 1, 0 indicates no skill and 1 indicate perfect score. It explain how well did the forecast separate the yes event from the no event.

2.2. Ratio score

Ratio score is the ratio of correct forecast to total number of forecast for rainfall events. It was worked out on Yes/No basis for pre-monsoon, monsoon, post-monsoon and winter season. Ratio score was calculated as follows:

\[ \text{Ratio score} = \frac{(hits + correct negative)}{N} \times 100 \]

It range between 0 to 1, 0 indicates no skill and 1 indicate perfect score (Kothyal, 2017).

2.3. Root mean square error (RMSE)

The root mean square error (RMSE) of weather parameters was worked out to find out absolute error between predicted and observed weather data of the station. The root mean square error (RMSE) is computed using the expression (Kothiyal 2017):

\[ \text{RMSE} = \sqrt{\frac{1}{n} \sum (F_i - O_i)^2} \]

where, \( F_i = \) Forecasted values, \( O_i = \) Observed values and \( n = \) Number of observations.

3. Results and discussion

3.1. Usability analysis and correctness of the forecasted weather parameters

The usability analysis of the different forecasted weather parameters in relation to observed ones using critical values for error structure was carried out. The season-wise analysis is given as:

3.1.1. Rainfall

Out of 61, 115, 92 and 90 days observation period for Pre-monsoon 2017, _Monsoon_ 2017, Post-monsoon
2017 and Winter 2018, the accuracy of rainfall forecast was 95%, 54%, 100% and 99%, respectively (Table 2). The rainfall prediction was found to be highly erratic during monsoon season. The rainfall during the monsoon season of 2017 was 887 mm which was almost 6.8 per cent higher than the normal. Dry spells during monsoon affect kharif season crops particularly in rainfed areas. Therefore, the rainfall prediction should be more accurate during the monsoon season as compared to other seasons because kharif season is most important for crops from farmer point of view particularly in rainfed agriculture. The percent unusable forecast was more during the monsoon season, thus it needs to be improved. During the post monsoon 2017 there was 34.4 mm rainfall whereas forecast during that period was 41.0 mm. The rainfall recorded during pre-monsoon 2017 and winter 2018 was 74.0 mm and 66.8 mm, whereas forecasted rainfall during this period was 62.0 mm and 15.0 mm, respectively. The comparative forecast for the entire year 2017-18 was 83% correct, 1% usable and 16% unusable (Table 2). Ray (2016) observed similar pattern of the usability of annual rainfall.

3.1.1.1. Skill scores for rainfall

For verification of rainfall forecast $2 \times 2$ contingency table between daily forecasted and observed rainfall events was made and based upon this table, different scores for evaluating the skill rainfall forecast were worked out and presented in Table 3. The ratio scores

| TABLE 1 |
| Critical values for error structure for different weather parameters |

| Usability | Rainfall (mm) | Tmax and Tmin (°C) | Cloud cover (okta) | Wind speed (kmph) | Wind direction (degree) |
|-----------|---------------|-------------------|-------------------|-----------------|------------------------|
| Correct   | Diff ≤ 0.2 mm | Diff ≤ 2% of obs  | Diff ≤ 1°C        | Diff ≤ 3 kmph   | Diff ≤ 10°             |
| Usable    | 0.2 mm < Diff ≤ 2.0 mm | 2% of obs < Diff ≤ 20% of obs | 1°C < Diff ≤ 2°C | 1 okta < Diff ≤ 2 okta | 3 kmph < Diff ≤ 6 kmph | 10° < Diff ≤ 30° |
| Unusable  | Diff > 2.0 mm | Diff > 20% of obs | Diff > 2°C        | Diff > 2 okta   | Diff > 6 kmph          | Diff > 30°         |

Diff = Absolute difference between observed and forecasted weather parameter; Obs = Observed

| TABLE 2 |
| Usability analysis of the rainfall forecast |

| Season                        | Total | Correct | Usable | Unusable | Success | %age |
|-------------------------------|-------|---------|--------|----------|---------|------|
| April-May 2017                | 61    | 58 (96)| 0 (0)  | 3 (4)    | 58      | 95   |
| June-September 2017           | 115   | 58 (50)| 4 (3)  | 54 (47)  | 62      | 54   |
| October-December 2017         | 92    | 92 (100)| 0 (0) | 0 (0)    | 92      | 100  |
| January-March 2018            | 90    | 89 (99)| 0 (0)  | 1 (1)    | 89      | 99   |
| Total (2017-18)               | 358   | 297 (83)| 4 (1) | 58 (16)  | 301     | 84   |

*Figures in parentheses indicate percentage

| TABLE 3 |
| Skill score - Rainfall forecast |

| Season               | NN | YY | NY | YN | Ratio Score | H. K. Score |
|----------------------|----|----|----|----|-------------|-------------|
| April-May, 2017      | 45 | 2  | 6  | 8  | 77.05       | 0.08        |
| June-September, 2017 | 31 | 31 | 51 | 6  | 53.91       | 0.22        |
| October-December, 2017| 83 | 0  | 8  | 1  | 90.22       | -0.09       |
| January-March, 2018  | 77 | 1  | 5  | 7  | 86.67       | 0.06        |
| Total                | 236| 34 | 70 | 2  | 76.96       | 0.07        |
3.1.2. Cloud cover

From the usability analysis of cloud cover, it has been observed that the overall forecast (April 2017-March 2018) was 56% correct, 18% usable and 26% unusable. Among different seasons, the highest accuracy was during October-December 2017 (89%) followed by January-March 2018 (78%), April-May 2017 (77%) and June-September 2017 (58%) (Table 4). The prediction of cloud cover forecast was correct almost in all the seasons. Vashisht et al. (2008) also observed similar results in cloud cover forecast.

3.1.3. Maximum and minimum temperature

Relatively higher usability of maximum and minimum temperature was observed during post-monsoon which was of some importance to the farmers as far as the pre-sowing operations of the rabi crop are concerned (Table 5). The analysis for the maximum temperature reveals that the highest accuracy of forecast was during post-monsoon 2017 (79%) followed by pre-monsoon 2017 and winter 2018 (64%). During monsoon 2017 accuracy was 62%.

The analysis for the minimum temperature reveals that the forecast was 35% correct, 23% usable and 42% unusable for the entire year. During monsoon 2017, it was 34% correct. The overall highest success rate of the forecast was 66% for winter 2018 followed by post-monsoon 2017 (64%). The highest unusable forecast was 56% for pre-monsoon, 2017 (Table 6). Vashisht et al. (2008) also reported similar results of the maximum and minimum temperature.

3.1.4. Wind speed and wind direction

Forecasting of wind speed has a vital role in saving the crop from lodging especially in the Rabi (winter) crop during post-monsoon and winter seasons were relatively higher as compared to monsoon seasons indicating the performance of forecasting models to be better in post-monsoon and winter seasons under rainfed area. It was highest (90.2 %) for post-monsoon season and lowest (53.9%) for monsoon season, whereas it was 76.9 per cent for overall period. The ratio score for the rainfall forecast for pre-monsoon and winter was 77.05% and 86.67%, respectively (Table 3). Similar results were reported by Vashisht et al. (2008).

The H K scores for pre-monsoon, monsoon, post-monsoon and winter period were 0.08, 0.22, 0.09 and 0.06, respectively. It was 0.07 for whole year (Table 3). The highest value for the monsoon season indicates that a good forecast during monsoon is more economical as compared to the other seasons.

### TABLE 4

| Season                   | Total | Correct | Usable | Unusable | Success | %age |
|--------------------------|-------|---------|--------|----------|---------|------|
| April-May, 2017          | 61    | 31 (51) | 16 (26) | 14 (23)  | 47      | 77   |
| June-September, 2017     | 115   | 40 (35) | 27 (23) | 48 (42)  | 67      | 58   |
| October-December, 2017   | 92    | 77 (84) | 5 (5)   | 10 (11)  | 82      | 89   |
| January-March, 2018      | 90    | 53 (59) | 17 (19) | 20 (22)  | 70      | 78   |
| **Total (2017-18)**      | 358   | 201(56) | 65 (18) | 92 (26)  | 266     | 74   |

*Figures in parentheses indicate percentage

### TABLE 5

| Season                   | Total | Correct | Usable | Unusable | Success | %age |
|--------------------------|-------|---------|--------|----------|---------|------|
| April-May, 2017          | 61    | 22 (36) | 17 (28) | 22 (36)  | 39      | 64   |
| June-September, 2017     | 115   | 49 (43) | 22 (19) | 44 (38)  | 71      | 62   |
| October-December, 2017   | 92    | 47 (51) | 26 (28) | 19 (21)  | 73      | 79   |
| January-March, 2018      | 90    | 25 (28) | 32 (36) | 33 (37)  | 57      | 63   |
| **Total (2017-18)**      | 358   | 143 (40) | 97 (27) | 118 (33) | 240     | 67   |

*Figures in parentheses indicate percentage
TABLE 6
Usability analysis of the minimum temperature forecast

| Season                  | Total | Correct | Usable | Usable | Success | %age |
|-------------------------|-------|---------|--------|--------|---------|------|
| April-May, 2017         | 61    | 18 (30) | 09 (15)| 34 (56)| 27      | 44   |
| June-September, 2017    | 115   | 39 (34) | 23 (20)| 53 (46)| 62      | 54   |
| October-December, 2017  | 92    | 34 (37)| 25 (27)| 33 (36)| 59      | 64   |
| January-March, 2018     | 90    | 33 (37)| 26 (29)| 31 (34)| 59      | 66   |
| Total (2017-18)         | 358   | 124 (35)| 83 (23)| 151 (42)| 207    | 58   |

*Figures in parentheses indicate percentage

TABLE 7
Usability analysis of the wind speed forecast

| Season                  | Total | Correct | Usable | Usable | Success | %age |
|-------------------------|-------|---------|--------|--------|---------|------|
| April-May, 2017         | 61    | 20 (33)| 24 (39)| 17 (28)| 44      | 72.1 |
| June-September, 2017    | 115   | 19 (17)| 44 (38)| 52 (45)| 63      | 54.8 |
| October-December, 2017  | 92    | 18 (20)| 41 (45)| 33 (36)| 59      | 64.1 |
| January-March, 2018     | 90    | 34 (38)| 33 (37)| 23 (26)| 67      | 74.4 |
| Total (2017-18)         | 358   | 91 (25)| 142 (40)| 125 (35)| 233    | 65.1 |

*Figures in parenthesis indicate percentage

TABLE 8
Usability analysis of the wind direction forecast

| Season                  | Total | Correct | Usable | Usable | Success | %age |
|-------------------------|-------|---------|--------|--------|---------|------|
| April-May, 2017         | 61    | 03 (05)| 07 (11)| 51 (84)| 10      | 16.4 |
| June-September, 2017    | 115   | 13 (11)| 20 (17)| 82 (71)| 33      | 28.7 |
| October-December, 2017  | 92    | 01 (01)| 03 (03)| 88 (96)| 4       | 4.3  |
| January-March, 2018     | 90    | 05 (06)| 18 (20)| 67 (74)| 23      | 25.6 |
| Total (2017-18)         | 358   | 22 (06)| 48 (13)| 288 (80)| 70    | 19.6 |

*Figures in parenthesis indicate percentage

season and it was observed that the forecast of wind speed was maximum (33%) and minimum (17%) correct during April-May, 2017 and June-September, 2017, respectively. For the entire year the forecast was 25% correct (Table 7). About 40 per cent of wind speed prediction was found to be useful to the farmer during the year. Similarly, during summer when there is scarcity of irrigation water for growing vegetables and other crops, the wind speed also becomes very important as it sweeps the moisture away from the surface. The usable prediction of wind speed was 17 per cent during June-September, 2017. As far as wind direction is concerned, the predictions were found to be highly variable when comparison was made between the predicted wind direction and mean wind direction recorded in the morning and afternoon only. The table on the usability analysis of wind direction reveals that forecast was 6% correct for almost whole of the year being highest (11%) for June-September, 2017 and lowest (1%) for October-December, 2018 (Table 8).

3.2. Root mean square error and correlation between observed and forecasted weather parameters

Among seasons of the year, the RMSE was found in the range from 3.18-21.2 mm, 1.38-3.22 Okta, 1.95-2.91 °C, 2.07-3.54 °C, 4.69-6.74 kmph, 74.26-107.56 degree, 9.77-17.18% and 15.59-20.36% for rainfall, cloud cover, maximum & minimum temperature, wind speed, wind direction, morning relative humidity and evening relative humidity, respectively (Table 9). The
TABLE 9
Root mean square error and correlation analysis

| Parameter       | Months        | RMSE | r   |
|-----------------|---------------|------|-----|
| Rainfall        | Pre-monsoon 2017 | 3.66 | 0.72 |
|                 | Monsoon 2017   | 21.2 | 0.09 |
|                 | Post-monsoon 2017 | 4.19 | -0.02 |
|                 | Winter 2018    | 3.18 | -0.06 |
| Cloud Cover     | Annual 2017-18 | 1.91 | 0.64 |
|                 | Pre-monsoon 2017 | 3.22 | 0.43 |
|                 | Monsoon 2017   | 1.38 | 0.60 |
|                 | Post-monsoon 2017 | 1.94 | 0.67 |
| Max. Temp.      | Winter 2018    | 2.57 | 0.71 |
|                 | Annual 2017-18 | 2.81 | 0.54 |
|                 | Pre-monsoon 2017 | 1.95 | 0.93 |
|                 | Monsoon 2017   | 2.91 | 0.86 |
|                 | Post-monsoon 2017 | 3.54 | 0.75 |
| Min. Temp.      | Winter 2018    | 2.63 | 0.33 |
|                 | Annual 2017-18 | 2.07 | 0.96 |
|                 | Pre-monsoon 2017 | 2.30 | 0.90 |
| Morning RH      | Monsoon 2017   | 18.17 | 0.20 |
|                 | Post-monsoon 2017 | 11.89 | 0.60 |
|                 | Winter 2018    | 9.77 | 0.11 |
|                 | Annual 2017-18 | 10.82 | 0.39 |
| Evening RH      | Pre-monsoon 2017 | 17.73 | -0.04 |
|                 | Monsoon 2017   | 20.36 | 0.62 |
|                 | Post-monsoon 2017 | 15.59 | 0.26 |
|                 | Winter 2018    | 16.82 | 0.31 |
| Wind Direction  | Annual 2017-18 | 79.29 | 0.19 |
|                 | Pre-monsoon 2017 | 74.26 | 0.18 |
|                 | Monsoon 2017   | 107.56 | 0.09 |
|                 | Post-monsoon 2017 | 91.44 | -0.16 |
| Wind Speed      | Winter 2018    | 5.98 | 0.13 |
|                 | Annual 2017-18 | 6.74 | 0.15 |
|                 | Pre-monsoon 2017 | 5.75 | 0.14 |
|                 | Monsoon 2017   | 4.69 | 0.20 |

RMSE value of 4.69 km/h and correlation 0.20 for wind speed of winter months depicts low error with less difference between the forecasted and observed values. Similar results of wind speed and wind direction with high RMSE and low correlation were observed by Kothiyal et al. (2017).

Correlation coefficients were derived between the forecasted and observed values during 2017-18 for different seasons (Table 9). It was observed that the forecast values were better for cloud cover and wind speed during winter, temperature during post-monsoon, relative humidity during monsoon and rainfall in pre-monsoon.
### TABLE 10
Linear regression relationship between observed and predicted weather parameters

| Parameter          | Months          | Linear regression relationship | Coefficient of determination (R²) |
|--------------------|-----------------|--------------------------------|---------------------------------|
| **Maximum Temperature** |                 |                                |                                 |
|                    | Pre-monsoon 2017| $Y = 0.5846X + 16.539$          | 0.50*                           |
|                    | Monsoon 2017    | $Y = 0.6544X + 11.17$           | 0.29*                           |
| Post-monsoon 2017  | $Y = 0.9316X + 2.1508$ |                              | 0.87*                           |
| Winter 2018        | $Y = 0.7747X + 6.1565$ |                             | 0.74*                           |
| Annual 2017-18     | $Y = 0.8984X + 3.3394$ |                          | 0.85*                           |
| **Minimum Temperature** |                 |                                |                                 |
|                    | Pre-monsoon 2017| $Y = 0.5846X + 16.539$          | 0.57*                           |
|                    | Monsoon 2017    | $Y = 0.3631X + 16.334$          | 0.11*                           |
| Post-monsoon 2017  | $Y = 1.0281X + 1.1966$ |                              | 0.92*                           |
| Winter 2018        | $Y = 0.7761X + 3.2811$ |                             | 0.81*                           |
| Annual 2017-18     | $Y = 0.9474X + 2.2924$ |                          | 0.92*                           |
| **Rainfall**       |                 |                                |                                 |
|                    | Pre-monsoon 2017| $Y = 0.4776X + 0.4378$          | 0.52*                           |
|                    | Monsoon 2017    | $Y = 0.0534X + 7.8854$          | 0.01                            |
| Post-monsoon 2017  | $Y = 0.0134X - 0.1761$ |                              | 0.03*                           |
| Winter 2018        | $Y = 0.0061X - 0.1124$ |                             | 0.05*                           |
| Annual 2017-18     | $Y = -0.0178X + 6.438$ |                          | 0.07*                           |
| **Cloud Cover**    |                 |                                |                                 |
|                    | Pre-monsoon 2017| $Y = 0.5252X + 1.332$           | 0.40*                           |
|                    | Monsoon 2017    | $Y = 0.3877X + 3.2237$          | 0.18*                           |
| Post-monsoon 2017  | $Y = 0.6552X + 0.4376$ |                              | 0.36*                           |
| Winter 2018        | $Y = 0.4628X + 1.0894$ |                             | 0.22*                           |
| Annual 2017-18     | $Y = 0.6181X + 1.4033$ |                          | 0.35*                           |
| **Morning RH**     |                 |                                |                                 |
|                    | Pre-monsoon 2017| $Y = 0.1579X + 35.194$          | 0.04*                           |
|                    | Monsoon 2017    | $Y = 0.7687X + 13.654$          | 0.36*                           |
| Post-monsoon 2017  | $Y = 0.1542X + 68.767$ |                              | 0.01                            |
| Winter 2018        | $Y = 0.4215X + 42.942$ |                             | 0.15*                           |
| Annual 2017-18     | $Y = 0.9546X - 3.2666$ |                          | 0.61*                           |
| **Evening RH**     |                 |                                |                                 |
|                    | Pre-monsoon 2017| $Y = -0.0212X + 22.896$         | 0.0016                          |
|                    | Monsoon 2017    | $Y = 0.6197X + 10.21$           | 0.38*                           |
| Post-monsoon 2017  | $Y = 0.2878X + 40.95$ |                              | 0.09*                           |
| Winter 2018        | $Y = 0.3381X + 30.505$ |                             | 0.16*                           |
| Annual 2017-18     | $Y = 0.6223X + 12.215$ |                          | 0.42*                           |
| **Wind Direction** |                 |                                |                                 |
|                    | Pre-monsoon 2017| $Y = 0.1857X + 75.652$          | 0.03*                           |
|                    | Monsoon 2017    | $Y = 0.1053X + 109.73$          | 0.03*                           |
| Post-monsoon 2017  | $Y = 0.1172X + 185.41$ |                              | 0.007                           |
| Winter 2018        | $Y = -0.275X + 180.21$ |                             | 0.02*                           |
| Annual 2017-18     | $Y = -0.1156X + 156.58$ |                          | 0.02*                           |
| **Wind Speed**     |                 |                                |                                 |
|                    | Pre-monsoon 2017| $Y = 0.1822X + 9.219$           | 0.02*                           |
|                    | Monsoon 2017    | $Y = 0.3413X + 7.5574$          | 0.02*                           |
| Post-monsoon 2017  | $Y = 0.2317X + 6.7108$ |                              | 0.02*                           |
| Winter 2018        | $Y = 0.2808X + 7.1616$ |                             | 0.04*                           |
| Annual 2017-18     | $Y = 0.3815X + 7.093$ |                          | 0.08*                           |

* Significant at 1% level of significance
There was a high value of root mean square values for monsoon rainfall as compared to others seasons (Table 9). Correlation coefficients were derived between the forecasted and observed values during (2018-19) for different seasons (Table 9) and it was observed that the correlation between forecasted and observed values were better for maximum and minimum temperature during all the seasons. The overall results obtained represent a good forecast for winter and poor forecast for monsoon season. There is need for improvement in monsoon season forecast. The skill scores worked efficiently for the post-monsoon season and the correct percentage for cloud cover is highest for the post-monsoon season.

3.3. Regression analysis

Regression analysis of weather forecast parameters for the year 2017-18 was done and linear regression equations were developed between observed and predicted values of different weather parameters and the values of coefficient of determination were worked out for regression analysis between observed and predicted weather parameters (Table 10). The regression analysis of weather forecast for the year 2017-18 shows that the coefficient of determination (R²) value between observed and predicted data were 0.85 and 0.92 each for T_max & T_min, 0.35 for cloud cover, 0.07 for rainfall, 0.61 for morning RH, 0.42 for evening RH, 0.08 for wind speed and 0.02 for wind direction, indicating that stable parameters viz., maximum & minimum temperature had the highest R² value whereas, lowest R² value were for rainfall, wind speed and wind direction. Since, the agricultural production is highly dependent upon weather conditions; weather prediction models need refinement to be modified to predict rainfall and wind speed correctly.

4. Conclusions

The ratio scores during post-monsoon and winter seasons were relatively higher as compared to summer and monsoon seasons indicating the performance of forecast models for the kandi region to be better in post-monsoon and winter seasons than in the other two seasons. Relatively higher usability of maximum temperature and minimum temperature was observed during post-monsoon which was of some importance to the farmers as far as the pre-sowing operations of the rabi crop are concerned. The medium range weather forecasts were used for preparing agromet advisory bulletins for the farmers of study area which were very useful for scheduling of sowing, irrigation, agricultural operations and management of pest and diseases of field crops. The farmers feel it to be useful since they receive advices on appropriate field operations and management practices depending on suitability of weather conditions. The forecast provided by IMD is good enough but precision is needed because as accuracy level for the most important parameter like rainfall, wind speed and direction is poor though they are very important for various farming operations to be taken up by the farmers. There is also need for more accurate prediction of temperature parameters also. So, there is need for further improvement in medium range weather forecasting for its better applicability in farmers’ fields.

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