# *Original Research Article*

**Validation and feedback analysis of Agromet Advisory Services in Khammam district of Telangana under KVK, Wyra**

**Abstract:** The success or failure of a crop is heavily depends on accumulation of received amount and intensity of rainfall mostly from southwest and northeast monsoon. Crop loss can be minimized by making adjustment through timely and accurate weather forecasting. Hence, there is necessity to validate the coming five days rainfall forecast analysis to determine the accuracy skill for managing strategic decisions by farmers. For validation of rainfall forecast qualitative and quantitative verification methods were adopted by India Meteorological Department, New Delhi. In these results, validation of qualitative and quantitative verification methods for southwest and northeast monsoon, 2021 indicated that high skill score for all ASD (agro sub divisional) level and moderate skill score for Khammam district level. A survey was conducted randomly for 230 farmers during year 2021-22 for reviewing effectiveness of agromet advisory services (AAS). The results indicated that most of farmers have been following AAS and checking weather forecast for post harvest operations like sowing / transplanting, harvesting / threshing, pesticide application, irrigation application, fertilizer application and other farm operations. It was observed from survey that 60.4 % of respondents rated AAS as highly satisfactory service.

**Key words:** Validation, forecast, feedback, satisfaction, agromet advisory services (AAS)

## 1. Introduction:

Agriculture in India depends heavily on weather and climate conditions. Out of the total annual crop losses, a substantial portion is because of aberrant weather. The loss can be minimized by making adjustment with coming weather through timely and accurate weather forecasting. Weather forecasts are useful for making decisions regarding crop choice, crop variety, planting/harvesting dates and investments in farm inputs such as irrigation, fertilizers, pesticides and herbicide, *etc*. Hence, improved weather forecast based agromet advisory services greatly help farmers to take advantage of benevolent weather and mitigate the impact of

malevolent weather conditions. An agriculturally relevant forecast is not only useful for efficient management of farm operations but also leads to precise impact assessment [1].

Agromet advisory bulletins include coming five days weather forecast and particularly advices on agricultural and horticultural crops, livestock and other farm related operations on which farmers need to act upon. Five days before weather forecast based agro-meteorological advisory service strive to improve and protect agricultural production which is crucial for food security of the country. These AAS bulletins are prepared weekly twice on every Tuesday and Friday bilingually in Telugu and English, disseminated to the farming community, district agriculture and allied departments majorly through the WhatsApp groups made at block/agro-sub divisional level.

Validations of weather forecasts analysis by different quantitative and qualitative methods were helpful in determining the degree of accuracy that is needed to further improve the service. The statistical and mathematical methods can be used to increase the trustworthiness of the weather prediction [2]. Hence, the accurate prediction is essential to make strategic decisions, so that farmers can use natural resources in an effectual manner both in quantity and quality [3]. AAS is helping the farmers to capitalize the situation of weather condition in order to utilize the resource and minimize the loss due to climate vagaries [4].

Feedback analysis determine the aspects of AAS like importance, adoption, usefulness, perception of farmers for their farm operations and further improvement of services at village level. This also shows the current awareness of famers and need to create awareness about agromet advisory services.

Hence, the present study was undertaken to validate the rainfall forecast of southwest and northwest monsoon during 2021 at district and ASD level of Khammam, to know impact of AAS in the jurisdiction of KVK, Wyra, Khammam and the feedback analysis was carried out during year 2021-22 from the farming community.

## 2. Materials and methods

District Agro-Met Unit (DAMU) KVK, Wyra, Khammam is catering AAS for five agro sub-divisions (ASD) namely Kusumanchi, Khammam Urban, Madhira, Wyra and Sathupally by preparing and disseminating AAS bulletins to the farmers.

This unit has been conducting capacity building programmes such as farmer awareness programmes, group discussions, farmer interactions, field visits, and activities for creating

awareness on weather based agro advisories. These AAS bulletins and messages were disseminated majorly through (WhatsApp) WAP groups, print media, short message service (SMS), voice calls, Annapoorna Krishi Prasaar Seva (AKPS), display boards at KVK and *etc.*

The southwest (June-September) and northeast (October to December) monsoon rainfall forecast validations were carried out for the year, 2021 by quantitative and qualitative verification methods as per the guidelines of NCMRWF [5].

**2.1. Formulae and error structure for rainfall forecast verification**

**2.1.1. Quantitative verification**.

**2.1.1.1.** Error structure for quantitative verification of rainfall

Correct Diff ≤ 25% of obs

Usable 25% of obs< Diff ≤ 50% of obs

Unusable Diff > 50% of obs

Where, Diff stands for Absolute difference of observed and forecasted in mm and obs stands for observed rainfall (in mm)

**2.1.1.2.** Root mean square error (RMSE) between the sum of absolute difference between observed values and forecasted values.

**2.1.1.3.** Calculating the correlation between the observed and the forecasted value (range: -1 to +1).

**2.1.2. Qualitative verification methods**

**2.2.1**. **Forecast Accuracy (ACC) or Ratio Score or Hit Score:** It is the ratio of correct forecasts to the total number of forecasts used to measure of forecasting efficiency. The ratio score was calculated using the below given formula.

$$\text{Ratio score} = \frac{(YY+NN)}{(YY+NN+NY+NY)} \times 100$$

**2.2.2. Hanssen and Kuipers Scores or True Skill Score (HK score):** It is the ratio of economic saving over climatology due to the forecast to that of a set of perfect forecasts. It ranges from –1 to +1 with 0 indicating no skill. The advantage of this method is equal emphasis to yes/no events.

$$\text{HK score} = \frac{[(YY \times NN) - (YN \times NY)]}{[(YY+YN)(NY+NN)]}$$

where, YY- Number of days when rain was forecasted and also observed,

NN- Number of days when rain was not observed and also not forecasted,

YN- Number of days when rain was observed but not forecasted,

NY- Number of days when rain was not observed but forecasted.

The feedback data was collected from randomly selected 230 farmers who volunteered to participate in the survey and analyzed made to know the awareness, adoption, usefulness and further improvement of AAS by taking a questionnaire from Gramin Krishi Mausam Seva (GKMS) [6] of India meteorological Department (IMD), New Delhi. This feedback data was obtained through one to one interaction with farmers of five divisions of Khammam district which is under jurisdiction of KVK, Wyra.

## 3. Results and Discussion

Validation of southwest and northeast monsoon calibration and feedback analysis for effectiveness and further improvement of AAS discussed in detailed as below:

### 3.1. Validation of rainfall forecast at district and agro sub divisional level

The district and agro sub divisional (ASD) level rainfall forecast for Khammam district during southwest and northeast monsoon season of 2021 was verified with the observed rainfall data provided by IMD's Met Centre, Hyderabad.

#### 3.1.1 Validation of southwest monsoon

The quantitative and qualitative methods of validation of southwest monsoon for district and block level forecast for Khammam district were presented in Table 1.

The results of quantitative verifications methods revealed that correctness of rainfall criteria showed high skill score for all agro sub divisions *i.e.,* 82.61 per cent for Madhira, followed by 80.46 per cent for Kusumanchi, 74.39 per cent for Wyra, 70.89 per cent for Sathupally and 70.11 per cent for Khammam Urban, respectively. Low skill score of 34.43 per cent was observed for district level forecast of Khammam but 18.03 per cent usable skill score was observed at district which is high compared to all ASD level. Root mean square error between the sum of absolute difference between observed and forecasted values of lowest 14.56 and highest 19.44 were observed in Khammam Urban and Madhira ASD level, respectively. The results revealed that correlation coefficient (r) of rainfall forecast were observed highest as 0.49 in case of Khammam Urban and lowest as 0.31 was observed in case of Madhira ASD level forecast, respectively.

The qualitative validation of southwest monsoon results of ratio score indicated that high skill score was observed in case of Madhira (75.41 per cent), Khammam Urban (71.31 per cent), Kusumanchi (71.31 per cent) ASD level followed by moderate skill score in case of Wyra (67.21 per cent), Sathupally (64.75 per cent) ASD level, and Khammam (50.00 per cent) district level forecast, respectively. Hanssen & Kuipers Index (H.K. Score) showed that high skill score was observed for all agro sub divisions with highest skill score with 0.37 for Khammam Urban and moderate skill score 0.22 was observed in case of Khammam district level forecast. The H.K. score lowest skill 0.22 was observed Khammam district level forecast.

**3.1.2 Validation of northeast monsoon**

The quantitative and qualitative methods of validation of northeast monsoon for district and block level forecast for Khammam district were presented in Table 1.

The results of quantitative verifications methods revealed that correctness of rainfall criteria showed high skill score for district and all agro sub divisions with 98.68 per cent for Wyra, followed by 98.67 per cent for Kusumanchi, 97.22 per cent for Khammam Urban, 95.83 per cent for Madhira and 95.45 per cent for Sathupally ASD level and 91. 67 per cent for Khammam district level respectively. Root mean square error between the sum of absolute difference between observed and forecasted values of lowest 5.31 and highest 8.94 were observed in Khammam Urban ASD level and Khammam district, respectively. The results revealed that correlation coefficient (r) of rainfall forecast was the highest at 0.21 resembling moderate skill forecast in case of Khammam district level and the lowest as -0.05 which was low skill forecast for Wyra ASD level forecast, respectively.

The qualitative validation of northeast monsoon results of ratio score indicated that high skill score was observed in case of Wyra (82.61 per cent), Kusumanchi (81.52 per cent), Khammam Urban (78.26 per cent), Madhira (78.26 per cent) and Sathupally (71.74 per cent) ASD level followed by moderate skill score in case of Khammam district (65.22 per cent) level forecast, respectively. H.K. Score showed that moderate skill score of 0.14 for Khammam district, 0.11 for Kusumanchi, 0.10 for Khammam Urban and low skill score was observed as 0.05 for Sathupally, 0.04 for Kusumanchi and 0.02 for Wyra were observed.

Similar research methods were used (Parvinder and Rathore) [7] for verification of weather forecast two seasons comprising Kharif and Rabi during 2003–2007 as per the guidelines of NCMRWF. Validation of agro sub divisional level rainfall forecast showed higher

Table 1. **Validation of southwest (SW) and northeast (NE) monsoon rainfall forecast at district and ASD/block level of Khammam district for 2021**

| S. No. | Particulars | | Khammam Dist level | | Khammam Urban ASD level | | Kusumanchi ASD level | | Madhira ASD level | | Sathupally ASD level | | Wyra ASD level | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | SW | NE | SW | NE | SW | NE | SW | NE | SW | NE | SW | NE |
| 1 | Number of days when rain was forecasted and also observed (YY) | | 40 | 5 | 27 | 3 | 18 | 1 | 17 | 3 | 24 | 3 | 21 | 1 |
| 2 | Number of days when rain was observed but not forecasted (YN) | | 56 | 32 | 23 | 15 | 25 | 15 | 14 | 15 | 32 | 21 | 29 | 11 |
| 3 | Number of days when rain was not observed but forecasted (NY) | | 5 | 0 | 12 | 5 | 10 | 2 | 16 | 5 | 11 | 5 | 11 | 5 |
| 4 | Number of days when rain was not observed and also not forecasted (NN) | | 21 | 55 | 60 | 69 | 69 | 74 | 75 | 69 | 55 | 63 | 61 | 75 |
| 5 | Number of matching cases (YY + NN) | | 61 | 60 | 87 | 72 | 87 | 75 | 92 | 72 | 79 | 66 | 82 | 76 |
| 6 | Total number of forecast days (N) = Total number of days - number of missing days | | 122 | 92 | 122 | 92 | 122 | 92 | 122 | 92 | 122 | 92 | 122 | 92 |
| 7 | Skill Score or Ratio Score of rainfall (RS) in per cent | | 50 | 65.2 | 71.3 | 78.3 | 71.3 | 81.5 | 75.4 | 78.3 | 64.8 | 71.7 | 67.2 | 82.6 |
| 8 | Hanssen & Kuipers index (H.K. Score) | | 0.22 | 0.14 | 0.37 | 0.1 | 0.29 | 0.04 | 0.37 | 0.11 | 0.26 | 0.05 | 0.27 | 0.02 |
| 9 | Root Mean Square Error (RMSE) | | 17.1 | 8.94 | 14.6 | 5.86 | 16.8 | 5.31 | 19.4 | 6.27 | 18.5 | 7.25 | 14.7 | 7.11 |
| 10 | Error structure for rainfall criteria in per cent (%) | Correct | 34.4 | 91.7 | 70.1 | 97.2 | 80.5 | 98.7 | 82.6 | 95.8 | 70.9 | 95.5 | 74.4 | 98.7 |
| | | Usable | 18 | 3.33 | 5.75 | 0 | 4.6 | 0 | 1.09 | 0 | 2.53 | 0 | 3.66 | 0 |
| | | Unusable | 47.5 | 5 | 24.1 | 2.78 | 14.9 | 1.33 | 16.3 | 4.17 | 26.6 | 4.55 | 22 | 1.32 |
| 11 | Correlation of rainfall (r) | | 0.35 | 0.21 | 0.49 | 0.17 | 0.32 | 0.03 | 0.31 | 0.08 | 0.34 | 0.15 | 0.36 | -0.05 |

Note: Ratio score: High Skill (>=70%); Moderate skill (>=50% & <70%); Low Skill(<50%).

Hanssen and Kuipers (HK) Score: High Skill (>=0.25); Moderate skill (>=0.10 and <0.25); Low Skill(<0.10)

SW- Southwest rainfall; NE- Northeast rainfall

-accuracy as compared to district level rainfall forecast; it might be due to area coverage of ASD level forecast have higher resolution as compared to district level resolution.

### 3.2 Feedback analysis

#### 3.2.1. Farmers receiving of bi-weekly weather forecast and AAS at ASD level

The data was collected to know whether farmers were aware of daily weather forecast for five days at ASD level by DAMU were presented in Fig 1. In this feedback it was found that 75.7 per cent of farmers were aware and 24.3 per cent farmers are not aware of AAS.

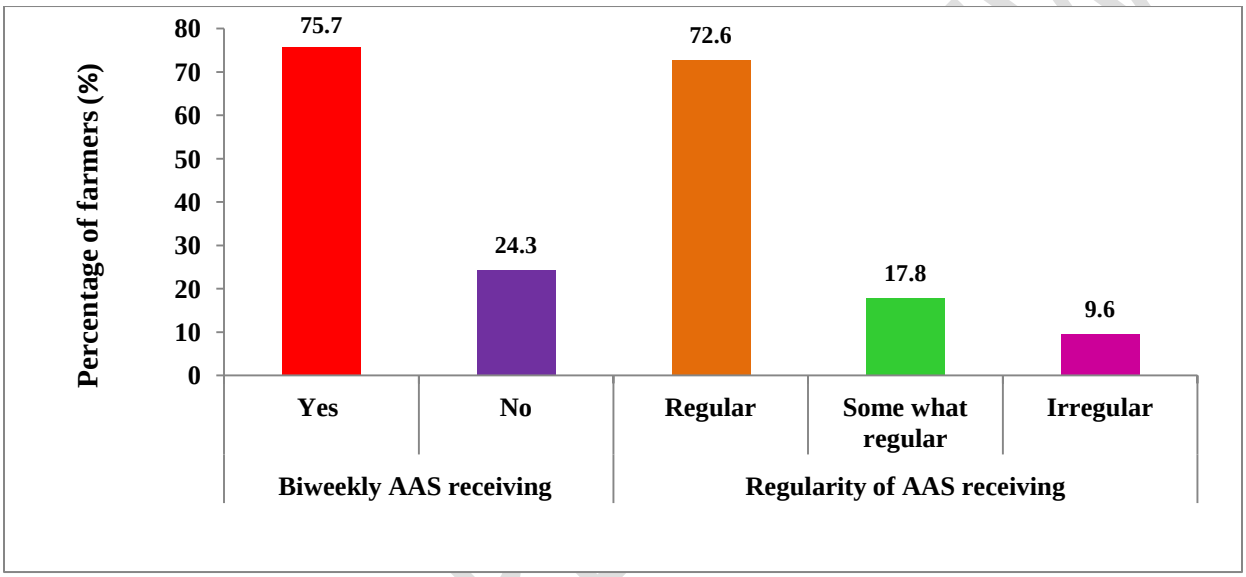


Figure 1: **Regularity of viewing bi-weekly forecast and Agromet Advisory Bulletin**

**Regularity of bi-weekly forecast and Agromet Advisory Bulletin:** The sampled farmers were asked on regularity of receiving daily weather forecast and AAS bulletins. These results revealed that 72.6 per cent farmers regularly viewed, followed by 17.8 per cent of somewhat regular and 9.6 per cent of irregular. Similar results of timely availability of clear information through agro advisory services were reported by Ram Singh *et al.* [8].

#### 3.2.2. Use of mass media for AAS by farmers and most preferred media

The efforts were made to know the source of communication media for weather forecast and agromet advisory services with the farmers and the data, obtained was presented in the Figure. 2. The figure indicates that majority of farmers *i.e.*, 85.7 per cent receiving information through WhatsApp followed by 35.7 per cent through T.V., 21.3 per cent through News paper, and 14.8 per cent though SMS, 9.1 per cent through website, 7.8 per cent with other communication media and 1.3 per with through radio, respectively. Hence it is clearly indicated

that, dissemination of weather based agro advisories through WhatsApp reached most of the people have smart phones compared to other mass media. Similar results of source of weather forecast and agromet advisory services were carried out by Ramachandrappa *et al*. stated that mass media has great potential in disseminating weather forecast to farmers to overcome climate vagaries [9].

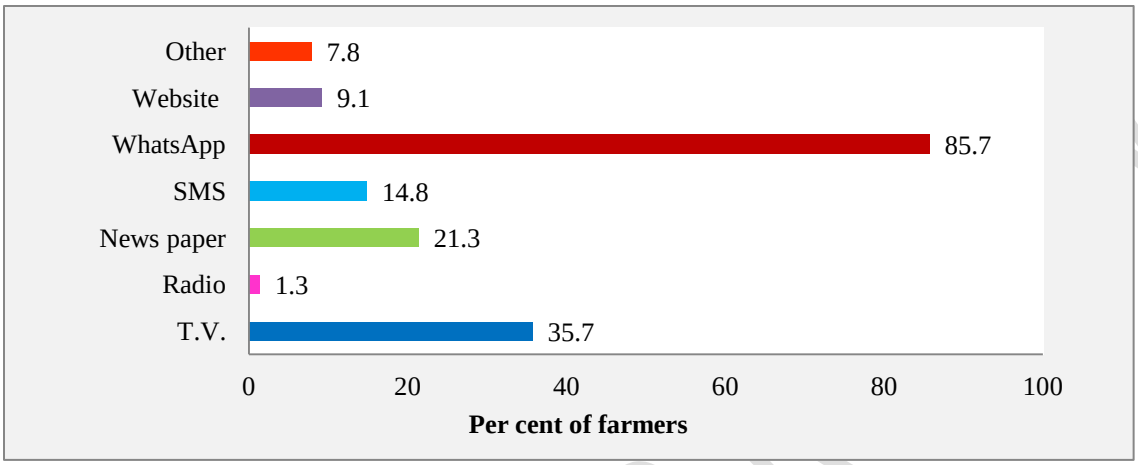


Figure 2: **Source of weather forecast and agromet advisory services**

The efforts were made to know farmers most suitable and preferable medium of weather forecast based agromet advisory services and relevance data were presented in the Table 2. The results found that 90.0 per cent responded with WhatsApp followed by 29.6 per cent with SMS (text message), 28.3 per cent with Television, 19.1 per cent with news paper and 14.8 per cent with website, 12.6 per cent with other media and 1.3 per cent with radio, respectively. With advancing of technology and vast usage of smart phones most of the farmers wish to get agromet advisories information through WhatsApp followed by text messages.

Table 2. **Most suited and preferred medium of weather forecast based agromet advisory**

| S. No. | Parameters | Percentage of farmers |
|---|---|---|
| 1. | Television | 28.3 |
| 2. | Radio | 1.30 |
| 3. | Newspapers | 19.1 |
| 4. | SMS (text message) | 29.6 |
| 5. | WhatsApp | 90.0 |
| 6. | Website | 14.8 |
| 7. | Other | 12.6 |

### 3.2.3. Impact of weather forecasts based agromet advisory bulletin on farm operation

The data was collected from farmers to know the impact of agromet advisory bulletin for farm operation and the data were shown in the Figure 3. In this result the data indicated that 93.0 per cent of farmers opined they have been following agromet advisory bulletins and 7. 0 per cent of farmers are not interested to following agromet advisory bulletins.

**Usefulness of weather based advisories**: The data was recorded regarding relevance/usefulness of weather based advisories for their farm operations and the data was indicated in the figure 3. In this feedback known that 79.1 per cent highly useful and 19.6 per cent they were partially useful. Similar survey conducted by Rana *et al*. [10] at mid hill-region of Himachal Pradesh concluded that 38% of farmers rated agromet advisories as excellent and good by 29% of farmers.

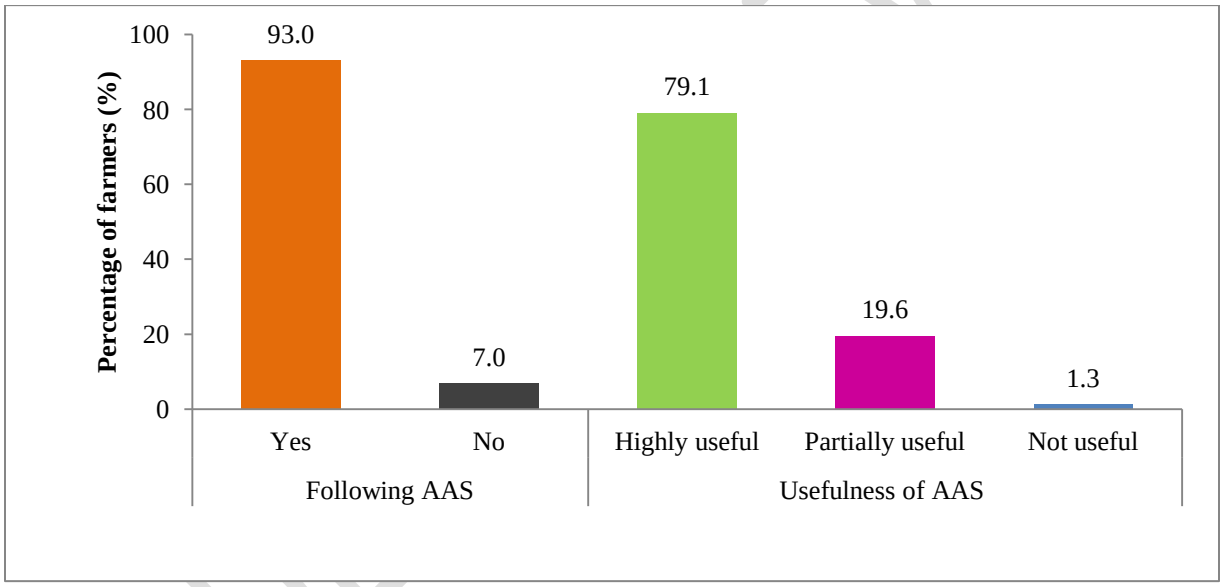


Figure 3: **Impact of weather forecasts based agromet advisory bulletin on farm operation**

### 3.2.4. Usage of farm operation for which weather forecast / agromet advisories

The data was collected to farm operation for which weather forecast / agromet advisories are used and the obtained results were shown in the Figure 4. With reference to the analysis on accuracy of forecast (Table 1) and usefulness of weather based advisories it was revealed that 73.5 per cent of farmers check weather forecast for post harvest operations followed by 64.8 per cent for sowing/ transplanting, 63.0 per cent for harvesting/ threshing, 55.7 per cent for chemical application, 47.8 per cent for irrigation application, 46.1 per cent for fertilizer application, and

28.7 per cent for other farm operations. The farmers following updated weather forecast news have reduced investment, time and labors in farming operations.

Prasad *et al*., (2020) [11] in their survey revealed that 65.0 per cent of farmers check weather forecast before going for spraying operation, 73.0 per cent for irrigation and 55.0 per cent for animal husbandry activities.

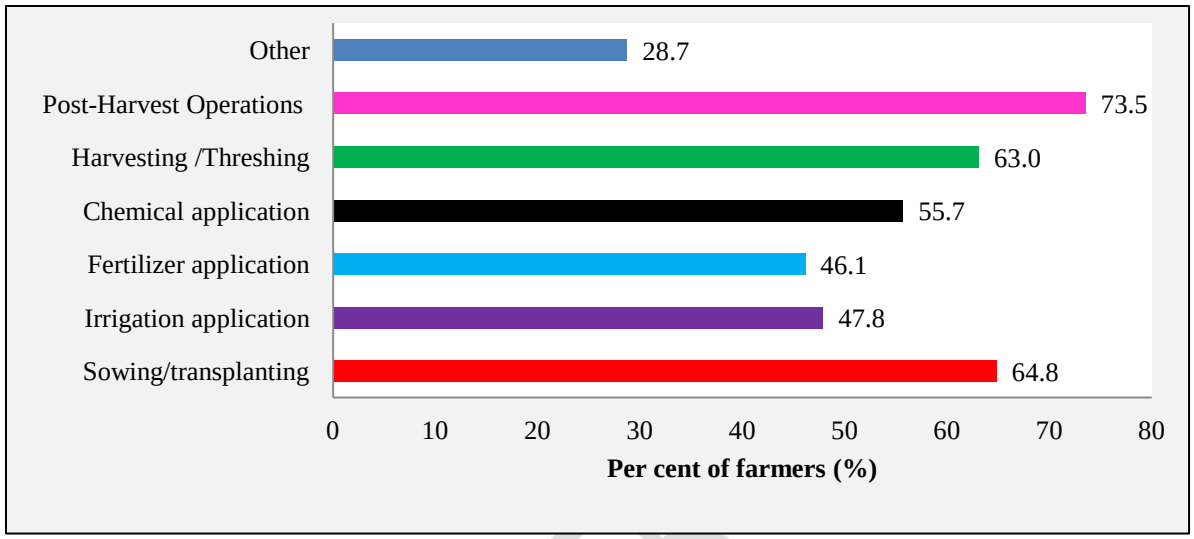


Figure 4: **Farm operation for which weather forecast/ agromet advisories are used**

### 3.2.5. Relevance of weather to farm operations

The data was recorded from the sampled farmers to know the weather event is most important for farm operation and the data were shown in the Figure 5. In this figure results showed that 67.8 per cent of sampled farmers responded that rain, followed by 47.0 per cent as wind, 41.7 per cent as heavy rain and 23.9 per cent as thunder storm. Below 20.9 per cent of sampled farmers reacted for all other weather events.

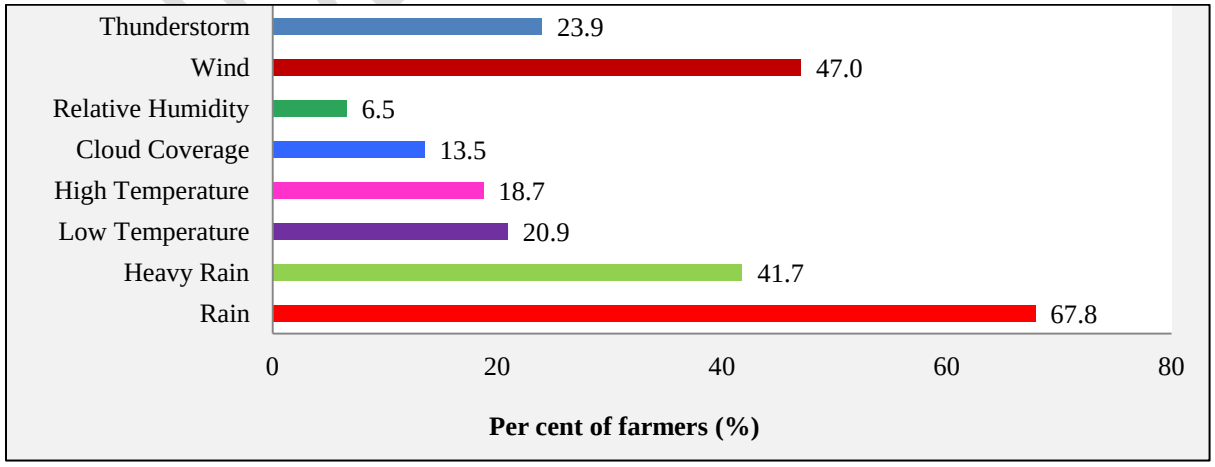


Figure 5: **Weather event most important for farmer's farm operation**

### 3.2.6. Farmer's satisfaction by the agromet advisory services

The sampled farmers were asked to rate the information given in Agro-met Advisory services as highly satisfied, satisfied, partially satisfied and not satisfied. The data thus obtained were presented in Figure 6 and observed that 60.4 and 24.3 per cent of the respondent farmers rated AAS as highly satisfied and satisfied, respectively. This was followed by 13.5 and 1.7 per cent of farmers partially satisfied and not satisfied, respectively. Thus, the majority of farmers are highly satisfied and satisfied it may be due to regular monitoring of updated weather forecast information at ASD level through smart phones. Ravi *et al.* [12] in their results revealed that 55% of AAS farmers rated the advisories as 'very good' on the scale of very poor to very good.

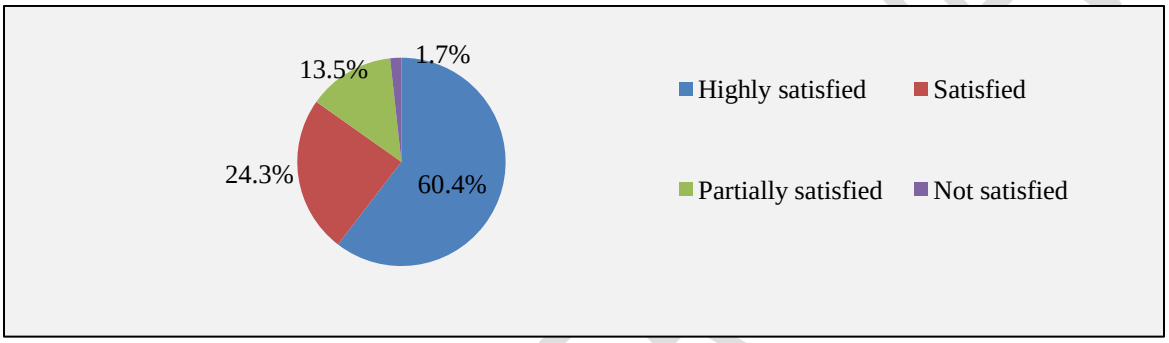


Figure 6: **Farmer's satisfaction by the agromet advisory services**

### 3.2.7. Timing to listen / watch weather and agromet advisories by farmers

The preference for farmers to listen / watch weather forecast and agromet advisories varied among the respondents and the detailed data were shown in the Figure 7. Maximum 54.8 per cent of farmers need by afternoon followed by 20.9 per cent need by evening, 11.3 per cent need by early morning, 5.7 per cent need by morning, 4.8 per cent need by noon and 2.6 per cent need by night, respectively. Hence, it is known that majority of the farmers require weather forecast and agromet advisories to plan their farm operations and management of labors mostly in the specified period of 3.0 pm to 7 pm only.

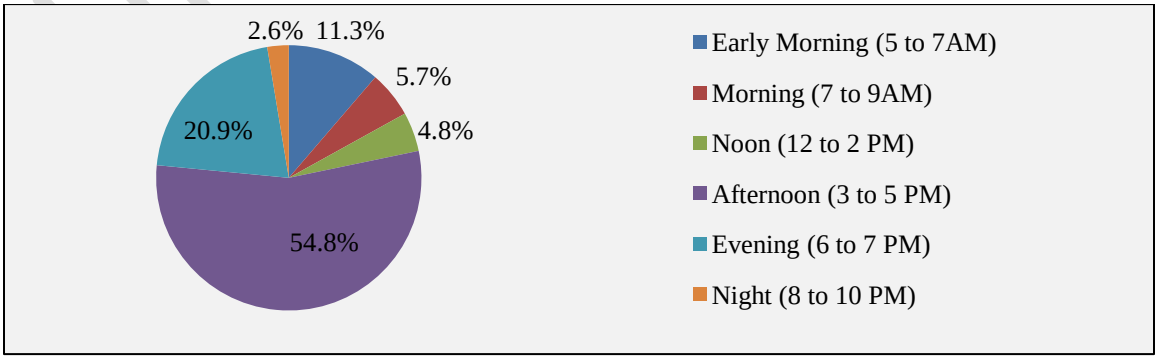

Figure 7: **The best time for farmers to listen / to watch weather and agromet advisories**

### 3.2.8. Average percentage of production lost during the crop season due to bad weather during Kharif and Rabi

The data was collected to assess the average percentage of production lost during the crop season due to bad weather during Kharif and Rabi and recorded data was presented in Figure 8. This survey revealed that 30.9 per cent of farmers responded with lost their crop production more than 40 per cent followed by 20.9 per cent responded with 31-40 per cent loss, 17.8 per cent responded with 21-30 per cent loss, 15.2 per cent responded with less than 10 per cent loss, 10.4 per cent responded with 10-20 per cent loss and 4.8 per cent of farmers responded with no loss. Most of the farmers expressed that loss of crop production due to heavy and high intensity rainfall received especially in July and second fortnight of September 2021 could have been high but still AAS services helped in reducing the crop damage by 10 - 30 per cent. Hence, it is to be noted that there is need to improve impact based agromet advisories to mitigate possible adverse weather conditions and also need create awareness on agromet advisory services to the farmers.

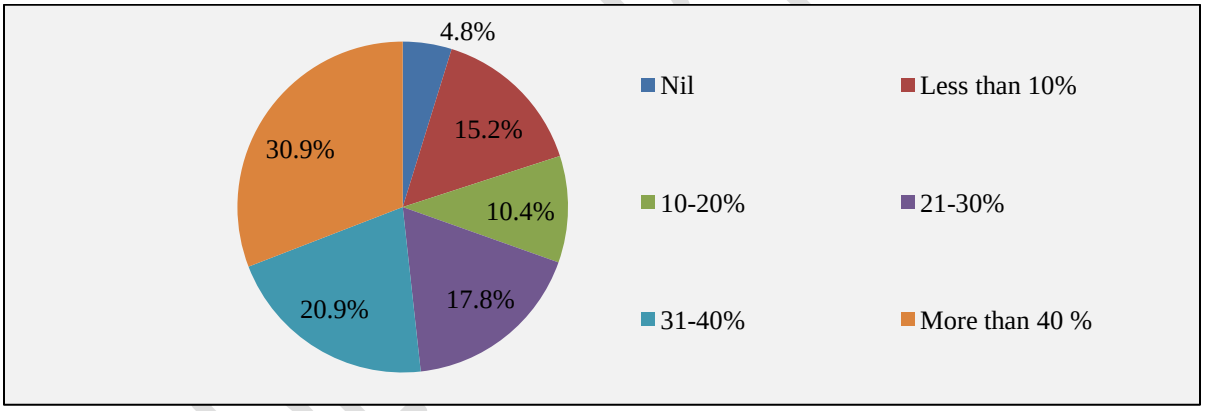


Figure 8: **Average percentage of production lost during the crop season due to bad weather during Kharif and Rabi**

### 3.2.9. Spreading of messages to others

The data was collected to recognize the circulation of agromet advisory services among the farmers through different communication media. The results shown in Figure 9 revealed that 61.3 per cent through WhatsApp / SMS with other farmers followed by 50.4 per cent through oral/discussion to others, 24.3 per cent through Group discussions / Meetings / Clubs, 0.9 per cent through displaying in common place and few farmers (10.0 per cent) they do not disseminate to any others.

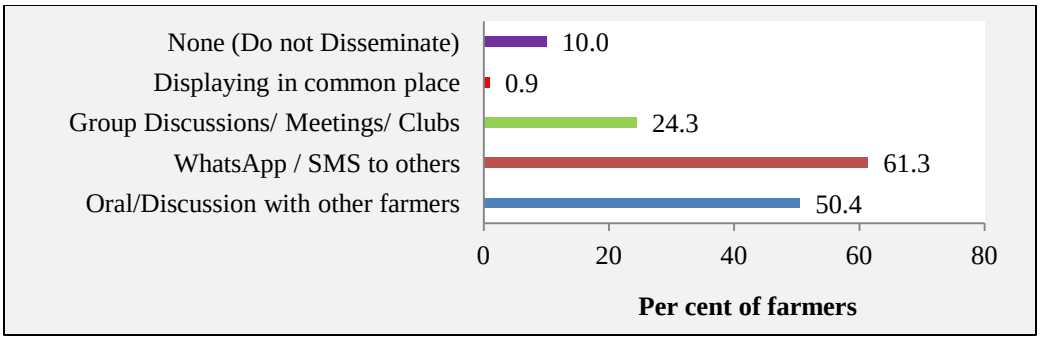


Figure 9: **Spreading of messages to others**

## 4. Conclusion:

The survey concluded that validation of qualitative and quantitative verification methods for northeast and southwest indicated that high skill score for all ASD (agro sub divisional) level and moderate skill was observed in Khammam district level rainfall forecast. In the survey most of the farmers opined that AAS in the form of bulletins, SMS and WhatsApp messages were highly useful to take strategic decisions for managing day to day farm operations. The feedback analysis showed that timely availability and high accuracy of rainfall forecast information are highly useful for avoiding of aberrant weather conditions on crop and to improve production and productivity of crops.

## DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge and benefit of farmers.

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