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Validation of Monsoon Rainfall Forecast and Impact of Application of Agromet Advisory Services at Agro Sub Divisional Level in Khammam District of Telangana

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ABSTRACT: Temporal and spatial variability in weather conditions make significant impact on Indian agriculture from sowing to post harvesting and it is challenging to farmers to take decisions on daily farm operation from unexpected rainfall causing high expenditures. The complete avoidance of any loss from farm to fork due to aberrant weather is not possible, but can be minimized to a great extent with the weather forecasting through agromet advisory services (AAS) bulletins. AAS bulletins provide suitable management practices according to the weather forecast conditions of specific areas. To notice the accuracy of rainfall forecast, analysis was carried out during the southwest monsoon season, 2020. In this qualitative verification methods results revealed that the moderate skill score in Khammam district level and all ASD level weather forecast. A survey was conducted 186 farmers of Khammam district during year 2020-21 for reviewing effectiveness of AAS sent as bulletins, SMS and WhatsApp messages. During the survey farmers opined that AAS were highly useful to 65.05% followed by partially useful 30.11% of farmers for planning of sowing and harvesting operations and pesticide applications, respectively. During *kharif* season 2020 AAS farmers recorded more benefit cost ratio of 1.35, 1.05, and 2.10 in case of cotton, green gram, rice crops respectively than Non AAS farmers who recorded benefit cost ratio 1.14, 0.76 and 1.76 respectively.

Keywords: Validation, monsoon, agromet advisory services, DAMU, weather, forecast.

INTRODUCTION

Among the various factors affecting the agricultural production, weather is the most important one in every phase of crop growth, development and ultimately yield were affected by weather parameters. Among the weather parameters, rainfall and its distribution fluctuates greatly than other parameters. Any variability in the rainfall during the crop season, such as delay in onset of monsoon, excessive rains and prolonged dry spells would affect the crop growth and finally the productivity. Validation of weather forecast analysis by different quantitative and qualitative methods was 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 (Damrath *et al*., 2000). By adopting AAS in agriculture in view of weather forecasts can minimize crop losses.

The District Agro-met Units (DAMU) and Agro-met Field Units (AMFU) in our country provides AAS majorly as bulletins which includes weather forecast information for five days at district and agro sub divisional level on different weather parameters *i.e.,* rainfall (mm), maximum and minimum temperatures (°C), morning and evening relative humidity (%), wind speed (kmph), wind direction (deg.), cloud cover (octa), pest-disease outbreak and strategic management practices of crops for their respective district. These

AAS bulletins are prepared weekly twice on every Tuesday and Friday in bilingual (Telugu and English), disseminated to the farming community and district agriculture officers majorly through the WhatsApp groups made at block/agro-sub divisional level.

The AAS bulletins also includes agricultural activity on crop management, planning of irrigation, time and method of planting, fertilizer application, pesticide and herbicide application along with mitigation practices of weather vagaries so that, farmers can use natural resources in an effectual manner both in quantity and quality (Ray *et al.*, 2017). The major objective of AAS is to help the farmers in capitalizing prevailing weather conditions in order to optimize the resource use and minimize loss due to harsh/aberrant weather conditions (Venkataraman, 2004). Agriculturally relevant forecast is not only useful for efficient management of farm inputs but also leads to precise impact assessment (Gadgil, 1989).

Hence, the present study was undertaken to validate the rainfall forecast of southwest monsoon, 2020 at district and ASD level, to know its impact, and economic benefit of AAS during year 2020-21 from the farming community.

MATERIALS AND METHODS

The project "District Agro-Met Unit (DAMU) was established at KVK, Wyra, Khammam district under Gramin Krishi Mausam Sewa (GKMS) scheme" as a joint initiative of IMD and ICAR to cater agromet advisory services (AAS). This district was split up into five agro sub-divisions (ASD)/block namely Kusumanchi, Khammam Urban, Madhira, Wyra and Sathupally to prepare and disseminate AAS to farmers.

For effective dissemination and popularization of AAS to farming community at large scale various mass communication media have been approached like WhatsApp groups, print media, short message service (SMS), voice calls, Annapoorna Krishi Prasaar Seva (AKPS), mKisan, display boards at KVK, and capacity building programmes such as, farmer awareness programmes, group discussions, farmer interactions, field visits, *etc.*, activities were conducted.

For validation of south west monsoon rainfall forecast, 2020 here are the quantitative and qualitative verification methods and error structure for rainfall criteria adopted from the standard operating procedure (SOP) of Gramin Krishi Mausam Seva (GKMS) (Anonymous, 2020).

Quantitative verification methods

Error structure for quantitative verification of precipitation.

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 obs stands for observed rainfall; quantity of rainfall of forecasted and observed taken in milli metres.

Root mean square error between the sum of absolute difference between observed values and forecasted values.

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

Qualitative verification methods

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.

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

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.

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

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

To know the impact of AAS in the district a questionnaire was prepared by Agricultural Meteorology Division, Pune and data collected data from 186 farmers through one to one interaction. From 186 farmers, economic benefit of AAS was evaluated with 30 each farmers were selected randomly who follow and who do not follow AAS bulletins from the five agro sub division of the district. The questionnaire prepared for collecting information from farmers was given in the Table 1.

RESULTS AND DISCUSSIONS

The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads:

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 south-west monsoon season (2020) was verified with the observed rainfall data provided by TSDPS website, Government of Telangana. The quantitative and qualitative methods of validation of district and block level forecast for Khammam district were presented in Table 2.

Table 1: Questionnaire of economic importance and impact of application of agromet advisory services (AAS).

Sr. No.	Particulars	Number of farmers
1.	Following of weather based agro advisory bulletin for farm operation	186
2.	Regularity of bi-weekly weather forecast and agromet advisory bulletins	186
3.	Source of weather forecast and agromet advisories	186
4.	Most suited and preferred medium of weather based agro advisory	186
5.	Relevance/usefulness of the weather based agro advisories	186
6.	Farm operation for which weather forecast/ agromet advisories are used (one can select more than one option)	186
7.	Weather event most important for farmer farm operation	186
8.	Farmer's satisfaction by the agromet advisory services	186
9.	Best time for farmers to listen/ watch weather and agromet advisories	186
10.	Farmers spreading weather forecast messages to others	186
11.	Average percentage of production lost during the crop season due to bad weather	186
12.	Economic importance of agromet advisory services (AAS) in Cotton, Green gram and Paddy in *Kharif* season 2020	60

Table 2: Validation of rainfall forecast at district and ASD/block level of Khammam district.

Sr. No.	Particulars		Khammam Dist level	Khammam Urban ASD level	Kusumanchi ASD level	Madhira ASD level	Sathupally ASD level	Wyra ASD level
1.	Number of days when rain was forecasted and also observed (YY)		39	27	23	17	20	25
2.	Number of days when rain was observed but not forecasted (YN)		31	29	32	23	20	26
3.	Number of days when rain was not observed but forecasted (NY)		17	20	17	23	30	17
4.	Number of days when rain was not observed and also not forecasted (NN)		35	46	50	59	52	54
5.	Number of matching cases (YY + NN)		74	73	73	76	72	79
6.	Total number of forecast days (N) = Total number of days - number of missing days		122	122	122	122	122	122
7.	Skill Score or Ratio Score of rainfall (RS)		60.66	59.84	59.84	62.3	59.02	64.75
8.	Hanssen & Kuipers index (H.K. Score)		0.23	0.18	0.16	0.14	0.13	0.25
9.	Root Mean Square Error (RMSE)		15.01	18.4	13.48	18.74	20.6	21.88
10.	Error structure for rainfall criteria in per cent (%)	Correct	50	64.38	69.86	77.63	72.22	68.35
		Usable	10.81	6.85	4.11	2.63	2.78	7.59
		Unusable	39.19	28.77	26.03	19.74	25	24.05
11.	Correlation of rainfall (r)		0.32	0.24	0.28	0.17	0.25	0.24
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								

In the results of quantitative verifications methods revealed that the correctness of forecast was observed as moderate skill score *i.e.*, 50.00 per cent in case of Khammam district level and moderate skill score *i.e.*, 64.38, 69.86, and 68.35 per cent in case of Khammam Urban, Kusumanchi and Wyra ASD level forecast and high skill score *i.e.*, 77.63 and 72.22 in case of Madhira and Sathupally ASD level forecast, respectively. The usable forecast (in per cent) was found as 10.81 in case of Khammam district and 6.85, 4.11, 2.63, 2.78 and 7.59 in the case of Khammam Urban, Kusumanchi, Madhira, Sathupally and Wyra ASD level forecast, respectively. The unusable forecast (in per cent) was observed as 39.19 in the case of Khammam district level and 28.77, 26.03, 19.74, 25.00 and 25.05 in the case of Khammam Urban, Kusumanchi, Madhira, Sathupally and Wyra ASD level forecast, respectively.

The results revealed that correlation coefficient (r) of rainfall forecast was observed as 0.32 in case of Khammam dist level and 0.24, 0.28, 0.17, 0.25 and 0.24 in case of Khammam Urban, Kusumanchi, Madhira, Sathupally and Wyra ASD level forecast, respectively. In the results the RMSE values were observed highest in Wyra ASD as 21.88 and lowest in Kusumanchi ASD as 13.48.

The results of qualitative verification methods revealed that ratio score (in per cent) of rainfall correctness was moderate skill score *i.e.*, 60.66 for Khammam district level and 59.84 for both Khammam Urban and Kusumanchi ASD level, and 62.30, 59.02, 64.75 for Madhira, Sathupally, Wyra ASD level was observed, respectively. The results showed that Hanssen & Kuipers score (H.K. score) was moderate skill score *i.e.*, 0.23 in case of Khammam district level forecast and 0.18, 0.16, 0.14, 0.13 and 0.25 in case of Khammam Urban, Kusumanchi, Madhira, Sathupally and Wyra ASD level forecast, respectively.

Similar research methods were used (Parvinder and Rathore 2011) for verification of weather forecast for Kharif and Rabi during 2003–2007 as per the guidelines of NCMRWF. The validation of agro sub divisional level rainfall forecast showed more accuracy when compared to district level rainfall forecast and it may be due ASD level forecast have higher resolution as compared to district level.

Impact of Application of Agromet Advisory Services. The impact of agromet advisory services (AAS) results data collected from 186 farmers by a questionnaire is given below.

Data on following of weather based agro advisory bulletin for farm operation. The data was collected to know whether farmers are aware of AAS bulletins given by District Agro-Met Unit (DAMU) on every week of Tuesday and Friday are presented in Table 3. The results were shown that majority of the farmers (88.17 per cent) opined that they follow weather based agro advisory bulletins for farm operation and few farmers (11.83 per cent) opined that they did not follow weather based agro advisory bulletins.

Regularity of bi-weekly weather forecast and agromet advisory bulletins. The data on effectiveness of agromet advisory bulletins and regularity of receiving AAS bulletins are presented in Table 4. The results shown that 83.33% of farmers opined as regular, 12.37% of farmers opined as the somewhat regular and very few farmers 4.30% opined as irregular. Similar results of regularity of biweekly agro advisory services were reported by Ravi *et el.*, 2020 of AAS and 80.00 per cent farmers were received benefitted.

Data on source of weather forecast and agromet advisories followed by farmers. The efforts were made to know the different communication media followed by farmers are presented in the Table 5. In that result, it was found that 74.73 per cent of farmers were getting AAS bulletins through WhatsApp, 38.17 per cent of farmers through Television, 24.19 per cent of farmers through news paper and 20.43 per cent of farmers through SMS. Some of the farmers were also getting information by interacting with other farmers and social media like Facebook and Instagram. Similar results of source of weather forecast and AAS were carried out by Manjusha *et al*. (2019) stated that mass media has great potential in disseminating weather forecast to farmers from an extent 90 per cent to overcome aberrant weather.

Table 3: Following of weather based agro advisory bulletins for farm operation.

Sr. No.	Particulars	Number of farmer	Per cent of farmer
1.	Yes	164	88.17
2.	No	22	11.83

Table 4: Regularity of bi-weekly weather forecast and agromet advisory bulletins.

Sr. No.	Particulars	Number of farmers	Per cent of farmers
1.	Regular	155	83.33
2.	Somewhat regular	23	12.37
3.	Irregular	8	4.30

Table 5: Source of weather forecast and agromet advisories followed by farmers.

Sr. No.	Particulars	Number of farmers	Per cent of farmers
1.	Television	71	38.17
2.	Radio	0	0.00
3.	Newspapers	45	24.19
4.	SMS (text message)	38	20.43
5.	WhatsApp	139	74.73
6.	Website	0	0.00
7.	Any other (facebook etc.)	6	3.23

Data on most suited and preferred medium of weather based agro advisory. The study was made to know the most suitable and preferred communication media followed by the farmers, in this regard data are presented in Table 6. The study has revealed that 65.05 per cent of farmers preferred WhatsApp followed by 58.06 per cent of farmers preferred Television, 29.03 per cent of farmers preferred news paper, 6.99 per cent of farmers preferred SMS, 6.99 per cent of farmers preferred others like Facebook, and other social media.

Relevance/usefulness of the weather based agro advisories bulletins. The sampled farmers were asked to know how relevant / useful of weather based agromet advisory services bulletins are categorized as highly useful, partially useful and not useful. The data thus obtained are presented in Table 7. The results shown that 65.05 per cent farmers opined highly useful followed by 30.11 per cent of farmers partially useful and 1.08 per cent not useful. In addition to this, farmers opined that application of weather based agro advisory bulletin highly useful to enhance the crop production and to minimize the costs of inputs.

Farm operation for which weather forecast/ agromet advisories are used. The efforts were made to know use of agro-met advisory bulletin for planning of farm operations and obtained data are presented in Table 8. In this results revealed that 41.40 per cent, 33.87 per cent and 31.72 per cent of the sampled farmers were using the AAS information for planning the harvesting / threshing operations, sowing time of crops and chemical applications of crops, respectively. This was followed by 13.44 per cent farmers for planning the time of fertilizer application, 14.52 per cent of farmers for post harvest operations and 4.30 per cent irrigation applications. Prasad *et al*. (2020) in their survey showed that 65.0 % of farmers check weather forecast before going to spraying operation, 73.0 % for irrigation and 55.0 % for animal husbandry activities.

Table 6: Most suited and preferred medium of weather based agro advisory.

Sr. No.	Particulars	Number of farmers	Per cent of farmers
1.	Television	108	58.06
2.	Radio	0	0.00
3.	Newspapers	54	29.03
4.	SMS (text message)	13	6.99
5.	WhatsApp	121	65.05
6.	Website	4	2.15
7.	Others (Social media, etc.)	7	3.76

Table 7: Relevance/usefulness of the weather based agro advisories bulletins.

Sr. No.	Particulars	Number of farmer	Per cent of farmer
1.	Highly useful	121	65.05
2.	Partially useful	56	30.11
3.	Not useful	2	1.08

Table 8: Farm operation for which weather forecast/ agromet advisories are used (farmers can select more than one option).

Sr. No.	Particulars	Number of farmers	Per cent of farmers
1.	Sowing/transplanting	63	33.87
2.	Irrigation application	8	4.30
3.	Fertilizer application	25	13.44
4.	Chemical application	59	31.72
5.	Harvesting /Threshing	77	41.40
6.	Post-Harvest Operations	27	14.52

Data collected on weather event most important for farmer farm operation. The data collected to know which one is the most important weather event for farmers among their farm operation. The results shown in Table 9 revealed that 94.62 and 87.10 per cent of farmers responded with heavy rain and rain, respectively. This was followed by 39.78, 31.18 and 26.34 per cent farmers responded with wind, high temperature and thunderstorm activities, respectively. 13.98 per cent and 11.29 per cent of the farmers were responded with cloud coverage and low temperatures, respectively. Very few farmers (3.23 per cent) of farmers responded with low relative humidity. In this survey, farmers were also appreciated the dissemination and accuracy of now cast weather forecast information at district level.

Table 9: Weather event most important for farmers farm operation.

Sr. No.	Particulars	Number of farmers	Per cent of farmers
1.	Rain	162	87.10
2.	Heavy Rain	176	94.62
3.	Low Temperature	21	11.29
4.	High Temperature	58	31.18
5.	Cloud Coverage	26	13.98
6.	Relative Humidity	6	3.23
7.	Wind	74	39.78
8.	Thunderstorm	49	26.34

Farmer's satisfaction by the agromet advisory services. The data was collected to rate the satisfaction level of the agromet advisory services given in agro-met advisory bulletin by the farmers. It is observed from the results Table 10 that 35.48 per cent and 43.55 per cent of the respondent farmers rated agro-met advisory bulletin as highly satisfied and satisfied, respectively. This was followed by 13.98 per cent partially satisfied and 6.99 per cent not satisfied, respectively. Ravi *et al.* (2020) in their results revealed that 55.0 % of AAS farmers rated the advisories as 'very good' on the scale of very poor to very good.

Table 10: Farmers satisfaction by the agromet advisory services.

Sr. No.	Particulars	Number of farmers	Per cent of farmers
1.	Highly satisfied	66	35.48
2.	Satisfied	81	43.55
3.	Partially satisfied	26	13.98
4.	Not satisfied	13	6.99

Best time for farmers to listen/ watch weather and agromet advisories. The data was also collected to know the best time to listen / watch weather forecast and agromet advisories for their farm operation; the data in this regard presented in the Table 11. In this study results found that 55.91 and 19.35 per cent farmers watch weather advisories at afternoon (3 to 5 PM) and evening (6 to 7 PM), respectively. This was followed by 12.37 and 4.84 per cent of farmers watch weather advisories at early morning (5 to 7 AM) and at morning (7 to 9 AM) and very few farmers watch weather advisories at Noon (12 to 2 PM) and respectively.

Table 11: Best time for farmers to listen / watch weather and Agromet Advisories.

Sr. No.	Particulars	Number of farmers	Per cent of farmers
1.	Early Morning (5 to 7AM)	23	12.37
2.	Morning (7 to 9AM)	9	4.84
3.	Noon (12 to 2 PM)	5	2.69
4.	Afternoon (3 to 5 PM)	104	55.91
5.	Evening (6 to 7 PM)	36	19.35
6.	Night (8 to 10 PM)	9	4.84

Data on farmers spreading weather forecast message to others. The data was collected to know spreading of AAS bulletins and messages one to others through different communication media. The results obtained are presented in Table 10. In this study also farmers can choose more than one option. The results of Table 12 revealed that more spreading (45.16 per cent) was observed through oral / discussion with other farmers, followed by 34.95 per cent of farmers through WhatsApp / SMS to others and 20.43 per cent of farmers through group discussions / meetings / clubs. 12.37 per cent farmers were not disseminating to others.

Table 12: Spreading weather forecast message to others.

Sr. No.	Particulars	Number of farmers	Per cent of farmers
1.	Oral / Discussion with other farmers	84	45.16
2.	WhatsApp / SMS to others	65	34.95
3.	Group discussions / Meetings / Clubs	38	20.43
4.	Displaying in common place	01	0.54
5.	Do not disseminate	23	12.37

Data on average percentage of production lost during the crop season due to bad weather. The data also collected on average percentage of production lost during the *kharif* season 2020 due to bad weather. By this feedback we can improve the suggestions of mitigation practices of different crops due to bad weather like heavy and continuous rainfall, high wind speed, etc. The results of Table 13 revealed that highest loss was observed in particular of more than 40 % by 30.65 per cent of farmers, followed by less than 10 % loss for 27.96 per cent of farmers, 10-20 % loss for 16.67 per cent of farmers, 31- 40% loss for 12.37 per cent of farmers, 21-30 % loss for 8.60 per cent farmers and no loss was observed for 3.76 per cent of farmers. In addition to this farmers appreciated the dissemination of rainfall alerts within three hours to save their harvested produce by covering with polythene sheet.

Table 13: Average percentage of production lost during the *kharif* season 2020 due to bad weather.

Sr. No.	Particulars	Number of farmers	Per cent of farmers
1.	Nil	7	3.76
2.	Less than 10 % loss	52	27.96
3.	10-20% loss	31	16.67
4.	21-30% loss	16	8.60
5.	31-40%	23	12.37
6.	More than 40 %	57	30.65

Economic importance of agromet advisory services (AAS) in cotton, green gram and paddy in *Kharif* season 2020. The data on economic benefit obtained by 30 farmers who followed the agromet advisory services (AAS farmers) and 30 farmers who not followed the agromet advisory services (Non AAS farmers) has been evaluated for the *kharif* season 2020. The data on total cost of cultivation, crop yield and net returns per acre of land for cotton, green gram and rice grown by the AAS and non AAS farmers during *kharif* season 2020 were also taken and comprehensively discussed below.

The results given in Table 14 shows that the cost of cultivation of cotton in case of AAS farmers was less as compared to non AAS farmers, and also the farmers were getting higher cotton yield (9.54 %) as compared non AAS Farmers. The total cost of cultivation was found to be lower in the case of AAS farmers who have effectively adopted the ago-met advisory compared to non AAS farmers; AAS farmer's net returns were higher than the non AAS farmers. From Table 15 it is observed that the total cost of cultivation, gross returns, net returns and B:C ratio were Rs. 33057.00 / acre, Rs. 44640.00 / acre and Rs. 11583.00 / acre and 1.35 respectively in case of AAS farmers where, Rs. 35599.00 / acre, Rs. 40455.00 / acre and Rs. 4856.00 / acre and 1.14 in case of non-AAS farmers for cotton crop. This profit was might be due to the crop management done by the farmers such as timely land preparation, sowing, adoption of recommended seed rate, suitable varieties, timely weeding, harvesting and pesticide applications, as per agromet advisory bulletins.

Rathore and Parvinder (2008) also showed that impact analysis of agromet advisory services were able to reduce the cost of cultivation by two to five per cent.

Table 14: Economics of cotton as influenced by AAS during *kharif* season 2020 (Rs per acre).

Sr. No.	Particulars	AAS farmers	Non AAS farmers	Net benefit
1.	Land preparation (Rs.)	5852.00	6085.00	233.00
2.	Inter cultivation (Rs.)	4489.00	4754.00	265.00
3.	Cost of seed (Rs.)	1351.00	1597.00	246.00
4.	Fertilizer application (Rs.)	3645.00	3899.00	254.00
5.	Weed management/Herbicides (Rs.)	1856.00	2083.00	227.00
6.	Pesticides application (Rs.)	7450.00	8467.00	1017.00
7.	Irrigation application (Rs.)	0.00	0.00	0.00
8.	Cotton picking cost per acre (Rs.)	7564.00	7864.00	300.00
9.	Transport and marketing per net yield (Rs.)	850.00	850.00	0.00
10.	Yield (q acre^{-1})	9.64	8.72	9.54 %

Table 15: Economics of cotton cultivation (Rs per acre).

Sr. No.	Type	Cost of cultivation (Rs.)	Gross return (Rs.)	Net return (Rs.)	B:C ratio
1.	AAS Framers	33057.00	44640.00	11583.00	1.35
2.	Non AAS Farmers	35599.00	40455.00	4856.00	1.14

It is revealed from the Table 16 that the cost of cultivation of green gram in case AAS farmers was less as compared to Non AAS farmers, and also the farmers were getting higher grain yield (25.29 %) as compared

Non AAS Farmers. The total cost of cultivation was found to be slightly lower in the case of AAS farmers who have effectively adopted the ago-met advisory compared to non AAS farmers; their net returns were greater than the non AAS farmers. From Table 17 it is observed that the total cost of cultivation, gross return, net return and B:C ratio were Rs. 13290.00 / acre, Rs. 14016.00 / acre, Rs. 726 /acre and 1.05, respectively for AAS farmers and Rs. 13918 / acre, Rs. 10470.00 / acre, loss of Rs. 3448 / acre and 0.76 for non-AAS farmers for green gram crop. From this, it is observed that the AAS farmers have realized good benefit than non-AAS farmers with an increase in net profit of 25.29 increases. It is observed from the Table 15 that net return and B:C ratio was more in case of AAS Farmers as compared with non AAS farmers in case of green gram.

Hansen (2002) has mentioned that AAS is an emerging capacity to provide timely, skillful weather forecasts offers the potential improvement in production and productivity of crops by reducing the vulnerability of vagaries of weather.

Table 16: Economics of green gram as influenced by AAS during *Kharif* season 2020 (Rs per acre).

Sr. No.	Particulars	AAS farmers	Non AAS farmers	Net benefit
1.	Land preparation (Rs.)	3500.00	3500.00	0.00
2.	Inter cultivation (Rs.)	0.00	0.00	0.00
3.	Cost of seed (Rs.)	1050.00	1050.00	0.00
4.	Fertilizer application (Rs.)	0.00	0.00	0.00
5.	Weed management/Herbicides (Rs.)	2186.00	2598.00	412.00
6.	Pesticides application (Rs.)	2254.00	2685.00	431.00
7.	Irrigation application (Rs.)	0.00	0.00	0.00
8.	Cost of harvesting per acre (Rs.)	4050.00	3850.00	200.00
9.	Transport and marketing per net yield (Rs.)	250.00	235.00	15.00
10.	Yield (q acre^{-1})	2.53	1.89	25.29 %

Table 17: Economics of green gram cultivation (Rs per acre).

Sr. No.	Type	Cost of cultivation (Rs.)	Gross return (Rs.)	Net return (Rs.)	B:C ratio
1.	AAS Framers	13290.00	14016.00	726.00	1.05
2.	Non AAS Farmers	13918.00	10470.00	-3448.00	0.76

It is found from the Table 17 that the cost of cultivation of transplanted rice in case AAS farmers was less as compared to Non AAS farmers, and also the farmers were getting higher grain yield (10.33 %) as compared Non AAS Farmers. The total cost of cultivation was found to be lower in the case of AAS farmers who have effectively adopted the ago-met advisory compared to non AAS farmers; their net returns were greater than the non AAS farmers. From Table 18 it is observed that the total cost of cultivation, gross return, net return and B:C ratio were Rs. 23905.00 / acre, Rs. 50135.00 / acre, Rs. 26230.00 / acre and 2.10 respectively in case of AAS farmers and Rs. 25604.00 / acre, Rs. 44955.00 / acre and Rs. 19351.00 / acre and 1.76 in case of Non AAS farmers for green gram crop. This profit might be due to management done by the farmers such as timely sowing, suitable varieties, timely application of herbicides, pesticide applications, timely harvesting and management of post harvesting operations according to weather forecast and agromet advisory bulletins.

Singh *et al.* (2020) also revealed that AAS farmers have got 22 per cent more net returns and then non-AAS farmers due to proper utilization of inputs and reducing input cost.

Table 18: Economics of transplanted paddy as influenced by AAS during *Kharif* season 2020 (Rs. per acre).

Sr. No.	Particulars	AAS farmers	Non AAS farmers	Net benefit
1.	Puddling (Rs.)	7200.00	7200.00	0.00
2.	Seed (Rs.)	1000.00	1000.00	0.00
3.	Fertilizer application (Rs.)	5050.00	5250.00	200.00
4.	Weed management/Herbicides (Rs.)	1648.00	1986.00	338.00
5.	Pesticides (Rs.)	3157.00	3688.00	531.00
6.	Irrigation (Rs.)	0.00	0.00	0.00
7.	Harvesting (Rs.)	3550.00	3980.00	430.00
8.	Post harvesting (Rs.)	1250.00	1550.00	300.00
9.	Transport and marketing per net yield (Rs.)	1050.00	950.00	100.00
10.	Yield (q acre^{-1})	27.10	24.30	10.33 %

Table 19: Economics of paddy cultivation (Rs. per acre).

Sr. No.	Type	Cost of cultivation (Rs.)	Gross return (Rs.)	Net return (Rs.)	B:C ratio
1.	AAS Framers	23905.00	50135.00	26230.00	2.10
2.	Non AAS Farmers	25604.00	44955.00	19351.00	1.76

CONCLUSION

The survey concluded that qualitative verification methods results revealed that the moderate skill score in Khammam district level and all ASD level weather forecasts. It was found that by AAS in the form of bulletins, SMS and WhatsApp messages were highly useful to mitigate the vagaries of weather on different crops of agriculture, horticulture and livestock. The survey revealed that quality of AAS bulletins, timely availability and accuracy of rainfall forecast information are the important tools for reduction of input cost of crops and increment of income level of farmers by managing the agricultural practices.

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