



# Impact Assessment of Block Level Agro Advisories for Saving Input Cost of Farmers under Old Gangetic Plains of West Bengal - A Case Study in Malda

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## Authors' contributions

*This work was carried out in collaboration among all authors. Author DM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors RR and BCR managed the analyses of the study. Author FHR managed the literature searches and edited the whole draft. All authors read and approved the final manuscript.*

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## ABSTRACT

Biweekly block level Agromet bulletins were disseminated based on medium range weather forecast with an objective to assess the effectiveness and usefulness of Block level Agro Advisory Services (AAS) and quantify the economic benefits through adopting the micro scale agromet advisory in their day to day agricultural operations at Malda, West Bengal. Two farmers groups were considered for the study on the basis of adoption and non-adoption of the agro-met advisories. Crop situation of these farmers were compared with nearby fields having the same crops where forecast were not adopted among non AAS farmers. The entire cost incurred along with yield and net returns were calculated from sowing to marketing of goods. Similarly, the weather forecast and actual weather data received from India Meteorological Department, New Delhi were compared to verify the accuracy of rainfall forecast for the year 2019-20 at GKMS

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centre, Malda KVK, West Bengal. It was apparent that the value of ratio score was higher during winter (84%) than pre-monsoon (80%), post-monsoon (79%) and monsoon (74%). However, the value of threat score was also found maximum during pre-monsoon season (79%). Statistical analysis like correlation coefficient, RMSE values of wind direction were found too high in all the four seasons to accept any homogeneity in the predicted and observed values. Blockwise verification of rainfall over the year showed the range of accuracy forecast for rainfall in between 67–76%. This forecast directly had a significant role in profit generation among the AAS adaptive farmers whose additional profit enhancement for maize cultivation was between 12% and 19% only towards cost of irrigation as compared to non-adaptive farmers. The study also showcased that the AAS adaptive farmers had a better livelihood as compared to non-AAS adaptive farmers.

*Keywords: GKMS; agro-advisories; Malda; irrigation; net return.*

## 1. INTRODUCTION

The Indian agriculture highly relies on the South West Monsoon. Scientific studies of climate and meteorology in India show significant increases in the variability and frequency of extreme precipitation events, and variability is projected to increase further [1]. This variability affects rainfall patterns of the monsoon in the semi-arid tropics, where approximately 80% of the total annual rainfall falls within three or four months of the year [2]. Over the decade the monsoons have been showing wide variability in terms of intensity, number of rainy days and duration. The Indian sub-continent is already facing the uncalled challenges of extreme weather events. Weather and climatic information plays a vital role before and during the cropping season and if the information on weather is provided well in advance it is always helpful for the farmer to use their own resources judiciously and thereby maximize the net return. The National Centre for Medium Range Weather Forecasting (NCMRWF) under the Ministry of Earth Sciences (MoES), Government of India in collaboration with India Meteorological Department (IMD), Indian Council of Agricultural Research and State Agricultural Universities had been providing agrometeorological Advisory Services (AAS) at the district level since 2007. The emerging capacity to provide timely and skilful weather forecasts offer the potentiality to reduce vulnerability and losses incurred due to vagaries of different weather hazards [3]. Thus, the AAS set up exhibits a multi-institutional and multidisciplinary synergy to render an operational service for use of the farming community. The medium range weather forecast based agro advisories are not only useful for efficient crop production management of farm inputs but also leads to precise impact assessment [4]. Majumder and Kumar [5] showed that the net income and profits of the farmers have enhanced significantly by avoiding the bad effect of the

climate and weather aberrations with the judicious use of natural resources.

By knowing the present status of the climate today and the differences between the present and recent past, we can estimate and plan for the near future [6]. Rajegowda et al. [7] reported that, in the eastern dry zone of Karnataka the farmers who have adopted the agromet advisories had realized an average economic benefit of 31.4, 24.7, 16.2 and 20.6% in finger millet, pigeonpea, field bean and tomato respectively. Rathore et al. [8] discussed the weather forecasting scheme operational at NCMRWF for issuing location specific weather forecast five days in advance. It also provides mitigation techniques on vulnerable information about crop management practices viz., irrigation schedule, pest- diseases status and control management, livestock production and management, marketing and trade management, new scientific storage and processing information to the farmers [9]. The demand of the farming community could not be absolutely fulfilled due to certain drawbacks in the agro advisory system, such as non-availability of skilful weather forecast in all temporal and spatial ranges specific to the site of interest to a farmer. Unlikely, non-availability of real time crop data, lack of decision support system for interpretation of weather forecast into farmer friendly advisories in local language and micro-scale acts as a barrier for reaping the maximum benefit of the scheme. In order to address these problems, proper knowledge on agricultural situation prevailing in the regional scale is very much essential. This may include type, state and stage of crops, prevailing pest and diseases, soil moisture status, state of animal health and nutrition and agricultural marketing situations. Priority should be given to predominant crops of the region and most prevailing problems keeping in view their relative economic importance. Pahl and Damrath [10] shared that the statistical

interpretation methods are often used to increase the reliability of the precipitation forecast. In general, it is very difficult to assess the economic benefit of any advisory service given to adopt necessary measures against catastrophes or life-threatening situations; however it is possible to assess the economic benefit of the agrometeorological services [11]. This can be achieved if the scientific methods to be used for weather-based advisories have a direct relationship with the traditional knowledge of the farmers [12]. From a farmer's perspective, the forecast value increases if the weather and climate forecasts are capable of influencing their decisions on key farm management operations [13,14]. Thus, the paper aims to study block level forecast reliability for the first time and justify the importance of agro-advisories by District Agromet Unit (DAMU) at micro scale level in enhancing the margin of profitability.

## 2. MATERIALS AND METHODS

### 2.1 Location of Study

The study was conducted in the district of Malda having geographical boundaries of 25.01°N latitude and 88.14°E longitude with an average elevation of 17 m above mean sea level. The entire district of Malda represents old alluvial agroclimatic zones (OAZ) of West Bengal. The study was conducted during the year June, 2019-March, 2020 after the establishment of the unit for the first time in the district.

District Agromet Unit (DAMU) under Malda Krishi Vigyan Kendra, Uttar Banga Krishi Viswavidyalaya was established with an aim to provide reliable block level weather forecast data directly to the farmers. To do that, it is essential to prepare and disseminate both block level and district level forecast and agro advisories on biweekly basis to the farmers. Both forecast and observed data for each block were essential for verification of data, but due to unavailability of surface observatory at block levels observed data were lacking at the station. Verification of the daily observed rainfall data was done from India Meteorological Department (IMD), Surface observatory data at Malda situated at English

Bazaar block. Verification of the medium range forecast for only rainfall was done through various standard indices which have been discussed below and also statistical parameters like correlation (r) and root mean square error (RMSE) parameters were worked out for other parameters viz. maximum and minimum temperature, rainfall, cloudcover, wind speed and wind direction.

### 2.2 Methods for Dichotomous (Yes/No) Forecasts

A dichotomous forecast says, "yes, an event will happen", or "no, the event will not happen". Rain and fog prediction are common examples of yes/no forecasts. For some applications a threshold may be specified to separate "yes" and "no", for example, winds greater than 50 knots. To verify this type of forecast we start with a contingency table that shows the frequency of "yes" and "no" forecasts and occurrences. The four combinations of forecasts (yes or no) and observations (yes or no), called the joint distribution, are:

**Hit** – Represents that the event was forecast to occur and the event also occurred in reality.

**Miss** – It represents that there was no forecast for a particular event (rainfall), but however, unfortunately the event in reality occurred.

**False alarm** – The event was forecasted to happen but however, the event did not occur.

**Correct negative** – There was no forecast of any event to take place and in reality also there was no occurrence of the same event.

The total numbers of observed and forecast occurrences and non-occurrences are given on the lower and right sides of the contingency table, and are called the marginal distribution (Table 1).

The contingency table is a useful way to see what types of errors are being made. A perfect forecast system would produce only 'hits' and 'correct negatives', and no 'misses' or 'false alarms'.

**Table 1. 2 × 2 contingency table for weather parameter verifications**

FORECAST	OBSERVED			Total
	Yes (Y)	No (N)	Total	
Yes (Y)	Hits	False Alarms	Forecast Yes	
No (N)	Misses	Correct Negative	Forecast No	
Total	Observed Yes	Observed No	Total	

### 2.3 Forecast Accuracy (ACC) or Ratio Score or Hit Score

It is the ratio of correct forecast of the total number of forecasts. It varies from 0 to 1 with 1 indicating perfect forecast.

$$ACC = \frac{\text{CorrectForecast}}{\text{TotalForecast}} = (H + Z)/N = (YY + NN)/(YY+NN+YN+NY) \quad (1)$$

Where, (N = Z + F + M + H)

NN = Number of correct predictions of No Rain [Neither predicted Nor Observed]  
 NY = Number of False Alarms [Predicted but Not Observed]  
 YN = Number of Misses [Observed but Not Predicted]  
 YY = Number of Hits [Predicted and Observe

Bias score (frequency bias):

$$\text{Bias} = \frac{(\text{hits} + \text{false alarms})}{(\text{hits} + \text{misses})} \quad (2)$$

False alarm ratio:

$$\text{FAR} = \frac{(\text{False Alarms})}{(\text{Hits} + \text{Falsealarms})} \quad (3)$$

Probability of detection (hit rate) (POD) – POD is also an important component of the Relative Operating Characteristic (ROC) used widely for probabilistic forecasts. The value range varies from 0 to 1 with 1 determining the perfect score.

$$\text{POD} = \frac{(\text{hits})}{(\text{hits} + \text{misses})} \quad (4)$$

Threat score (critical success index):  

$$\text{TS} = \frac{(\text{hits})}{(\text{hits} + \text{misses} + \text{falsealarms})} \quad (5)$$

Hanssen and Kuipers discriminant (true skill statistic, Peirce's skill score)–

$$\frac{\text{hits}}{\text{hits} + \text{misses}} - \frac{\text{falsealarms}}{\text{falsealarms} + \text{correctnegatives}} \quad (6)$$

(Also denoted TSS and PSS)

Heidkeskill score (Cohen's)

$$\frac{(\text{hits} + \text{correct negatives}) - (\text{expectedcorrect})}{N - (\text{Expectedcorrect})} \quad (7)$$

$$(\text{ExpectedCorrect})_{\text{random}} = \frac{1}{N} [(\text{hits} + \text{misseshits} + \text{false alarms} + (\text{correct negatives} + \text{misses})(\text{correct negatives} + \text{false alarms})]$$

The economic benefit received by farmers following the agrometadvisory has been evaluated for both *Kharif* season and *Rabi* season for some major crops which are extensively cultivated around the district of Malda like paddy, wheat and Maize. Under these contexts we have mainly focused on amount of irrigation cost saved through utilization of AAS as preliminary study to assess the direct benefit of the service. Respondents (50 each) were randomly selected based on random sampling with the help of random number table for two groups from four randomly selected villages (25 respondents each per group per block) having equal proportion of the participants in two classes i.e the farmers who received regular advisories (AAS) and follows it and another group who either not receives regular agromet advisories or inspite of receiving the advisories did not follow the scientific advisories (Non-AAS). Thus, the total respondents for the study were 100 from two respective villages. For paddy and wheat assessment two villages randomly selected villages were namely Rukundipur (Block – Ratua-I) and Brojolaltola (Block - Manikchak). Similarly, for maize assessment study two different villages namely Pirganj (Ratua-II) and Kumedpur (Chanchal-I) were selected randomly to have a broader area of assessment study. A detailed benefit cost ratio and statistical parameters (Mean, Standard error, standard deviation and t-test) were analyzed for assessing the profit margin and benefit of the district agromet service. It is noteworthy to mention that the return-cost ratio (RCR) indicates the relationship between the cost and return of project or investment for analysing the feasibility and viability of the services rendered. The RCR is expressed as the ratio of return of the production to cost of production against the practise which has been depicted below.

$$\text{Return-Cost Ratio (RCR)} = \frac{\text{Return obtained from the Production}}{\text{Cost of Production}} \quad (8)$$

If the investment has a RCR value greater than 1 then the practise can be expected to return or deliver a positive NPV (net present value) to the business or the firm and their investors. If RCR value is less than 1, then the project cost can be expected to be higher than the returns and therefore it should be discarded. The respective cost benefit ratio under different technological interventions were calculated based on sampling data taking into account gross cultivation cost focussing mainly on irrigation aspects and net

return obtained by following the service as per the formula discussed above.

### 3. RESULTS AND DISCUSSION

#### 3.1 Verification and Analysis of Weather Forecast

A five day medium range weather forecast was received from regional meteorological centre, Kolkata and IMD (Agrimet), Pune on every Tuesday and Friday of the week. The yearly data related to weather forecast was grouped in four distinct seasons i.e. pre-monsoon, monsoon, post-monsoon and winter for analysis and verification. Both qualitative and quantitative verification analysis of only rainfall data was carried out being the most important parameters and concerning criteria for crop establishment using skill score and critical values for error structure. The correlation co-efficient and root mean square error (RMSE) parameters were used for all the four seasons during the study period to assess or judge the reliability of the forecasted data as discussed below.

#### 3.2 Qualitative Verification Analysis

##### 3.2.1 Rainfall forecast verification

For qualitative analysis verification of rainfall forecast, skill score test has been used as

suggested by NCMRWF (National Centre for Medium Range Weather Forecasting), which are based on 2 x 2 contingencies table. The results of all the four seasons have been presented in table 2.0. It's apparent that the value of ratio score was higher during winter (84%) than pre-monsoon (80%), post-monsoon (79%) and monsoon (74%). However, the value of threat score was also found maximum during pre-monsoon season (79%) because this technique of analysis considered NN cases also. The value of ratio score during winter was found to be highest around 85%. The various indices which have been worked out clearly show that there was a better occupancy of forecast during pre and post-monsoon season. It is also noteworthy to mention that during winter some rare random events which was not forecasted or was not able to be simulated by models which lead to lower confidence level.

Likewise, the value of threat score which considered only YY cases was also found maximum during pre-monsoon season (79%). During monsoon, post-monsoon and winter seasons its value were observed 52, 54 and 0% respectively. Lower threat score during winter signifies that the forecast of sudden winter precipitations was not in line with the actual event. Similarly, Hansen and Kuiper Score analysis showed highest value during pre-monsoon followed by other seasons.

**Table 2. Seasonal rainfall prediction trends at GKMS unit of Malda KVK, West Bengal (year 2019-20)**

Sl. no.	Types of skill score	Seasons			
		Pre-Monsoon	Monsoon	Post-Monsoon	Winter
1.	Ratio Score	0.801	0.741	0.792	0.846
2.	Bias Score	0.881	0.663	0.524	0.635
3.	Probability of Detection	0.811	0.571	0.494	0.003
4.	False Alarm Ratio	0.023	0.042	0.002	0.016
5.	Threat Score	0.794	0.523	0.545	0.004
6.	Haidke Skill Score	0.747	0.587	0.367	-0.733
7.	Hansen and Kuipper Score	0.792	0.456	0.522	-0.071

**Table 3. Season wise correlation co-efficient and root mean square error value of different weather parameters for Malda Sadar block (English Bazaar)**

Sl. no.	Weather parameters	Seasons (2019-20)							
		Pre-Monsoon		Monsoon		Post-Monsoon		Winter	
		r	RMSE	r	RMSE	r	RMSE	r	RMSE
1.	Cloud cover	0.5685	2.0985	0.4429	1.8723	0.5554	2.8643	0.6619	2.0458
2.	Rainfall	0.8474	4.2056	0.2976	21.1475	0.8638	8.9987	0.9203	0.9488
3.	Wind speed	0.7111	2.5903	0.7115	4.1853	1.3469	3.5225	0.3391	3.2119
4.	Wind Dir.	0.5751	99.6382	0.3497	81.1679	0.3392	105.255	0.5883	99.1220
5.	Max. Temp.	0.8921	1.5281	0.7652	2.6330	0.9803	1.8739	0.8410	2.9486
6.	Min. Temp.	0.8879	2.1814	0.2997	1.7285	0.9589	2.2341	0.8184	2.7769

Where, r = Correlation co-efficient; RMSE= Root Mean Square Error

**Table 4. Saving of irrigation cost under Paddy crops to irrigate one acre land (Kharif-2019)**

Sl. no.	Villages	Mean Cost of irrigation and SD				Saving amount (Mean in INR) and SD		Saving (%)
		Non-AAS		AAS		AAS		
		Hiring cost (Rs./irr./ acre)	Own pump set (Rs./irr. /acre)	Hiring cost (Rs./irr./ acre)	Own pump set (Rs./irr./ acre)	Hiring cost (Rs./irr./ acre)	Own pump set (Rs./irr./ acre)	
1	Rukundipur R:C Ratio	1150±85.3 1.19±0.11	750±41.4	900±34.7 1.23±0.09	650±25.2	215±60.0	150±37.0	19.0
2	Brojolaltola R:C Ratio	1100±143.7 1.21±0.08 (1.21)	800±35.1	800±80.5 1.26±0.12	700±18.4	300±112.1	100±26.7	21.0
3	Malda R:C Ratio	1125±114.5 1.20±0.09	775±38.2	850±57.6 1.25±0.11	675±43.6	257.5±86.0	125±31.9	20.0

\*Significance at 95 % level of confidence

**Table 5. Saving of irrigation cost of under wheat crops to irrigate one acre land (Rabi: 2019-20)**

Sl. no.	Villages	Mean Cost of irrigation and SD				Saving amount (Mean in INR) and SD		Saving (%)
		Non-AAS		AAS		AAS		
		Hiring cost (Rs./irr./ acre)	Own pump set (Rs./irr. /acre)	Hiring cost (Rs./irr./ acre)	Own pump set (Rs./irr./ acre)	Hiring cost (Rs./irr./ acre)	Own pump set (Rs./irr./ acre)	
1	Rukundipur R:C ratio	1200±147.6 1.21±0.11	810±55.8	1000±130.2 1.25±0.04	600±87.4	200±68.9	210±93.3	20.0
2	Brojolaltola R:C ratio	1300±118.8 1.28±0.04	800±45.4	1000±143.5 1.36±0.19	650±55.6	300±68.5	300±65.8	29.0
3	Malda district R:C ratio	1250±133.2 1.25±0.08	805±50.6	1000±136.9 1.31±0.23	625±71.5	250±68.7	255±79.5	24.5

\*Significance at 95 % level of confidence

**Table 6. The amount and percentage of saving under maize crop are given below**

Sl. no.	Villages	Cost of irrigation				Saving amount		Saving (%)
		Non-AAS		AAS		AAS		
		Hiring cost (Rs./irr./acre)	Own pump set (Rs./irr./ acre)	Hiring cost (Rs./irr./acre)	Own pump set (Rs./irr./acre)	Hiring cost (Rs./irr./acre)	Own pump set (Rs./irr./acre)	
1	Pirganj R:C ratio	1000±122.4 1.11±0.21	530±70.4	850±101.3 1.13±0.08	500±78.6	150±15.4	30±15.4	12.0
2	Kumedpur R:C ratio	1100±109.7 1.15±0.27	560±70.6	900±95.7 1.18±0.11	500±85.4	200±86.4	60±79.5	17.0
3	Malda R:C ratio	1050±116.0 1.13±0.24	545±70.5	875±98.5 1.16±0.09	500±82.0	175±50.9	45±47.4	14.5

\*Significance at 95 % level of confidence

**Table 7. Monetary benefits due to reduced irrigation**

Sl. no.	Villages	Total no. of Mean irrigation	No. of Mean irrigation saved	Average Cost per irrigation (Rs.)		Average Cost saving (Rs.)	
				Hired	Own pump set	Hired	Own pumpset
1	Pirganj	4±0.86	1±0.51	960±102.5	530±70.2	1920±123.4	1060±95.3
2	Kumedpur	4±0.73	1±0.45	1000±130.4	550±68.4	1000±136.9	550±105.8
3.	Malda	4±0.79	1±0.48	980±116.4	540±69.3	1460±130.1	805±100.6

**Table 8. Extent of variation in net return in maize among respondents**

Category of Farmers	Mean	Standard error	SD	CV (%)	t value	p value
AAS adaptive	42501.23	271.84	1216.00	3.70		
AAS non-adaptive	29880.01	268.63	1201.00	4.01	28.55*	0.00002

\*Represents significant value at P=0.05, n=50

**Table 9. Benefits due to AAS under rice-wheat-maize cropping system**

Particulars (Rs.)	AAS		Non-AAS		Saving through AAS in Rs. and (%)	
	Paddy/Wheat	Maize	Paddy/Wheat	Maize	Paddy/Wheat	Maize
Irrigation cost (on hiring basis)	2100±389.1	4000±349.4	3000±342.2	6000±310.5	900±157.2(30.0)	2000±375.8(33.3)
Spraying cost(including insecticide, fungicide, herbicides and labour cost)	1000±133.6	4000±329.2	1400±302.3	5112±853.5	400±70.0(28.5)	1112±591.3(21.7)
Fertilizer cost (including labour cost)	1300±296.7	1500±237.1	1503±181.8	2145±365.2	203±239.0(13.5)	645±238.1(30.0)
Total(Rs.)	4400±273.1	9500±305.2	5903±275.4	13257±5099.7	1503±155.4(25.4)	3757±401.7(28.3)

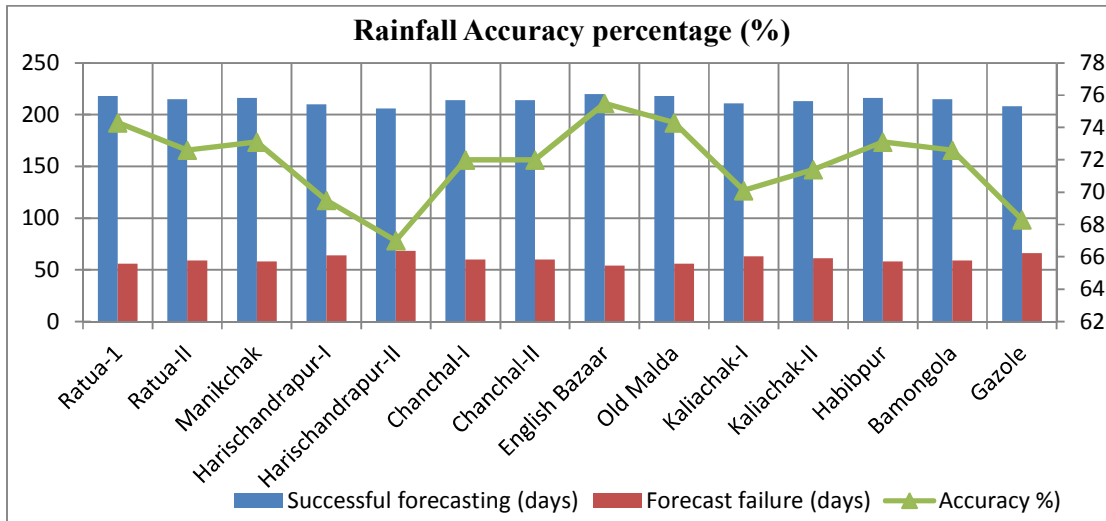


Fig. 1. Block wise forecast accuracy of rainfall during 2019-20 at Malda

**3.2.2 Analysis verification of other weather parameters**

Qualitative analysis verification of other weather parameters like Cloud coverage, wind speed and directions, maximum and minimum temperature was also carried out using standard statistical procedure for all the four meteorological seasons and has been presented in Table 3. The perusal of correlation co-efficient and root mean square errors data which were analysed using standard statistical procedure between weather forecast and actual weather prevailed during the same period indicated that the forecasts made by this GKMS were more or less close to correctness excluding wind direction. The RMSE values of wind direction were found too high (81.1-105.2) in all the four seasons to accept any homogeneity in the predicted and observed values.

There was higher accuracy and acceptability for both temperature parameters (Max. Temp. and Min. Temp.) during all the seasons with highest reliability during Post Monsoon season varying between 98% for maximum temperature and 96% in case of minimum temperature. The RMSE value of rainfall during monsoon season was also higher which clearly indicated that there lies an underlying significant differences between observed and forecasted value and needs more accuracy. However, unlikely from the statistical analysis it was observed that higher inaccuracies was observed in case of wind direction with RMSE values ranging between 81.1 to 105.2 which may be due the fact that average wind directions was not taken into consideration

throughout the day rather it was taken at standard specified hours. The rainfall accuracy for individual 15 blocks of Malda was carried out during June 2019 to March 2020 and was found that out of total 274 Calendar days the successful forecast of rainfall occurrence varied between 208 to 220 and the forecast of rainfall accuracy was found to be highest at English bazaar block (76%) and lowest accuracy was found at Harischandrapur-II block (67%) denoting further scope of forecast accuracy by increasing more number of rainfall stations.

**3.3 Economic Aspects and Importance of Block Level AAS**

The survey based study showed that paddy and wheat growers (Tables 4 and 5) in general applied 3-4 heavy irrigation irrespective of the quantity and spell of rainfall. The supplemental water requirements are being fulfilled by monsoonal/winter rainfall. As per the feedback collected from farmers, during last monsoonal seasonal due to late arrival and uneven distribution of the rainfall during the vegetative growth stages and nursery stage of paddy, it was not possible to save total cost of the heavy irrigation, however, the AAS adaptive farmers who relied on the forecast provided by the agromet unit for the first time during later period of crop growth stages saved irrigation cost significantly by reducing the duration or time of irrigation requirement due to uniform distribution of the precipitations. The survey conducted considering Malda district as single unit showed that the farmers following the advisories on regular basis for cultivation of paddy (*Kharif*)



could save nearly 20% cost towards and have been benefitted having higher return-cost ratio of 1.25 as compared to farmers who did not follow AAS having RCR of nearly 1.19. Whereas, during *Rabi* AAS adaptive cultivators where at a higher gain with calculated RCR around 1.25 against non-AAS adaptive farmers having RCR around 1.20. The t- statistics clearly depicts that significant benefits were incurred by AAS adaptive farmers as compared to non-AAS farmers. Similarly, survey at village level shows that there was a saving of 19% input cost towards irrigation among AAS farmers in respect to Non-AAS in *kharif* rice in Rukundipur and 21% in Brojolaltola where as in case of wheat it was around 20% in Rukundipur and 29% in Brojolaltola. The R:C ratio of the AAS adaptive farmers were always found to have higher marginal significance as compared to non-AAS adaptive farmers both for paddy and wheat. Further, as a Malda district as a whole with respect to irrigation management, it was observed that AAS adopted farmers were slightly on advantageous side having a return-cost ratio of 1.26 with SD around 0.12. The RCR though was found to be significant but was low of the fact that the scheme was not much familiar among the farming community and hence is expected to become more and more popular in upcoming days by gradual enrichment of knowledge and understandings.

### 3.4 Saving of Irrigation Cost under Maize Crops to Irrigate One Acre Land

Unlikely, from a survey which was conducted randomly amongst 100 farmers (50 each) at two villages of Pirganj and Kumedpur for analysing the impact of AAS on maize farmers, it was observed that at Pirganj average savings was found to vary between 12% where AAS adaptive farmers had a higher RC ratio of 1.13 with standard deviation of 0.08 as compared to non-AAS adaptive farmers whose RCR was found to be around 1.11. The conducted district survey also clearly depicts that AAS adaptive farmers were slightly significantly at a fairer side with RCR of 1.16 (SD=0.04) against non-AAS adaptive farmers having RCR of 1.13 with deviation of 0.24. Whereas, at Kumedpur the average saving was found to be around 17% (Table 6) where AAS adaptive farmers had a RC ratio of 1.18 as compared to RCR (1.15) of non-AAS adoptive farmers. Generally, 4-5 irrigations are provided in case of maize cultivation. The study conducted during the growing season, it was clear that the farmers did not considered crop rainy day for

irrigating their crops or for irrigation scheduling, rather they rely simply upon own presumptions. Thus, under the context of light rainfall condition, they could save approximately, around 12% and 17% of irrigation cost against single applications in Pirganj and Kumedpur village respectively, where Malda district average savings was found to be around 14.5%. It was also very much evident from the survey that, by following the forecast and block level advisory have significant economic benefit for an individual farmer. The significant t-test value which was found to be 3.97 and 4.36 at Pirganj and Kumedpur respectively for AAS farmers as compared to non-AAS farmer shows higher reliability and true justifications. But under good rainfall condition they could save single number of irrigation cost (Table 7). Statistical analysis showed that AAS adaptive farmers in the district had achieved higher returns. The significantly higher RC ratio was case of AAS Farmers as compared with non AAS farmers in case of maize cultivation in the study area thus shows the benefits of the agro advisory in the area. The net return (Rs. ha<sup>-1</sup>) in case AAS farmers was significantly higher as non-AAS Farmers in maize cultivation and this might be due to adoption of recommended practices like integrated nutrient management and integrated pest management etc. [15]. Statistical analysis for the survey conducted among the maize farmers showed that standard error for AAS adaptive farmers were found to be 271.8 and non-AAS farmers was found to be 268.6. Also, significantly higher CV was found for non-AAS farmers 4.01 as compared to AAS adaptive farmers' i.e. 3.7 which may be due to the fact of higher variations in input cost or productivity differences amongst the farmers who did not utilize the benefit of the advisory services (Table 8).

Also feedback was randomly collected from farmers from 50 progressive farmers of Malda district. It was also evident from the survey that on an average a saving of Rs.900/- (some amount of irrigation) in paddy during nursery raising (Table 9) as there was pre-monsoon rainfall occurred during last year (2019). The survey showed that in case of maize cultivation, the farmers were able to cut at least two irrigations with an average cost saving of Rs. 2000/- per acre with standard deviation of Rs.375.8. Likely, an amount of Rs.400/- and Rs.1112/- were also saved in spraying operation under paddy/wheat and maize respectively. Further, Rs.645/- was also saved under maize crop under fertilizer input and Rs.203/- could be

saved towards fertilizer input cost under paddy and wheat cropping system as per timely recommendation. The study also showed that, a significant amount was also saved against the cost incurred towards application of irrigation in paddy at flowering stage during September/early October month, 2019 due to high rainfall events. The economics clearly showed that AAS adopting farmers incurred a significantly higher profitable margin for both Rice/wheat (25.4%) and maize cultivation (28.4%). Similar observational trend were also reported by Singh et al. [16] and Venkataraman [17].

#### 4. CONCLUSION

The study shows that forecast accuracy of different meteorological parameters (except wind directions and velocity) at block level though not being highly accurate but to a good satisfactory level till date and needs better accuracy in the near future. However, the AAS bulletins generated by Malda KVK, West Bengal has tremendously helped in bringing out substantial awareness among farmers about adoption of weather-based agro-advisories, their timely availability and quality of the advisory service. The economic impact studies indicated that there was considerable benefit to farmers who adopted the advisories made from GKMS Unit Malda. Through India Meteorological Department (IMD)'s Gramin Krishi Mausam Sewa, farmers across the district been receiving, weather-based, crop-focused agro-meteorological advisories at district level as well as block levels. The AAS adaptive farmers had significant higher profitable margins in saving input costs with a margin of around 25% in case of rice-wheat cropping system and 28% in case of maize cultivation.

Thus, altogether, present system of delivering the services at microscale (block level) has proved to meet the end user's requirements in both under the irrigated as well as in rain-fed production systems. However, precision, accuracy of forecast as discussed earlier, needs to be improved on spatial and temporal scale. Hence, it can be concluded that the weather forecast and related advisories issued at Block level from the Agromet Advisory Service Unit undoubtedly benefitted the farming community.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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