Climate Change and Weather-based Agrometeorological Advisory Service: an Analysis from Farmers' Perspectives

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Abstract: *Poor farmers' livelihood in the coastal area of West Bengal, India, has been threatened during the recent years, mainly after occurrence of the super-cyclone "Aila". The present study primarily focuses on the two aspects, climate change and livelihood. Finding out the farmers' perspective on climate change is in fact helpful for assessing their concern and attitude about climate change. Weather-based Agro Advisories are one of the important services which can not only accelerate the growth of agriculture, but also support livelihood. This research study was carried out in the Sunderban region of West Bengal, India with the help of a pre tested template referring to direct interaction with sample farmers. The results show that those farmers who get weather advisories were more concern about climate change and its consequences. Farmers who managed their crop following weather-based agro advisory used to gain more profit in every aspect of cost concept. Weather-based agro advisories demonstrated to be successfully used for one of the tools to support climate resilient agriculture.*
Keywords: *Climate change, Agrometeorological Advisory Bulletin, Cost, Return, Climate resilient Agriculture.*

Riassunto: *Il basso livello di sostentamento degli agricoltori nella zona costiera del Bengala Occidentale, in India, è stato minacciato negli ultimi anni, principalmente dopo il verificarsi del super-ciclone "Aila". Il presente studio si concentra su due aspetti, il cambiamento climatico e il sostentamento. Conoscere la percezione degli agricoltori sui cambiamenti climatici è utile per valutare la loro preoccupazione e l'atteggiamento nei confronti dei cambiamenti climatici. Gli avvisi Agro basati sulle condizioni meteorologiche sono un importante servizio che non solo può accelerare la crescita dell'agricoltura, ma anche favorire il sostentamento. Lo studio è stato condotto nella regione di Sunderban, nel Bengala Occidentale, in India, con l'aiuto di un template pre-testato e rivolto direttamente ad un campione di agricoltori. I risultati mostrano che gli agricoltori che ricevono le previsioni meteorologiche sono più preoccupati per il cambiamento climatico e le sue conseguenze. Gli agricoltori che gestiscono il loro raccolto seguendo gli avvisi agrometeorologici basati sul clima raggiungono maggiori profitti, in ogni voce di costo. I sevizi agrometeorologici hanno dimostrato di essere utilizzati con successo come strumento a supporto dell'agricoltura resiliente al clima.*
Parole chiave: *Cambiamento climatico, Bollettini di Allerta Agrometeorologico, Costo, Rendimento, Agricoltura resiliente al Clima.*

1. INTRODUCTION

In Asia, cereals production has declined due to increasing water stress arising partly from rising temperature, increasing incidence of El Niño and reduced number of rainy days (Tao *et al.*, 2004). A report on India, Pakistan, Nepal and Bangladesh revealed that water shortages have been aggravated by changing climate and the high climatic variability has adverse impacts on demand, supply and water quality (Cruz *et al.*, 2007). Weather is one of the most important factors for the annual crop losses in the world (Hay, 2007) and it is also responsible for the fluctuation of the world agricultural price and domestic economics (Tobey *et al.*, 1992). Almost half of the earth's population lives in monsoon affected areas. For those areas, slightly deviation of normal monsoon pattern can create greater impact over agriculture and allied sector operations. In major parts in India, monsoon rainfall contributes about 90 per cent of water supply which ultimately determine the fate of agriculture (Singh, 2006). Hence proper weather forecast, mainly rainfall forecast can help the farming operation significantly.

India, with the one-seventh of total world's population, is not only self sufficient on food production but also an important exporter of food grains. Drought, flood, extreme temperature and other climatic hazards like cyclone, etc., cause damages every year in terms of human lives and

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livelihood in this country. About 174 million hectares land of India (53 per cent of the total geographical area of the country) is seriously suffering from land degradation (Reddy, 2010). It would have profound effects on agriculture, including natural resources, crops, livestock, and fisheries threatening food security. Indian coastal region are fertile but this area is now facing some severe problems like salinization and inundation (TERI, 1996; IPCC, 1992). In view of such climatic vagaries, the common farmers of India should be aware of climate change related facts and try to follow the weather forecast based agromet advisory service which can help them to minimize the production related risks. An initiative has been taken to compose and disseminate weather forecast based micro level agromet advisory bulletins for the farming community of coastal West Bengal, India under National Initiative on Climate Resilient Agriculture project. The Weather Based Agromet Advisory Bulletins (AAB) have been influencing the growers to take rational decisions keeping in view of predicted weather conditions and finding their way of solution. Moreover the farmers' knowledge-base on climate change aspects should be surveyed for strengthening the agro-meteorological service and formulation of new projects. Keeping these views in mind, the objectives set for the present study are:

(a) To assess the farmers'perception on climate change, and

(b) To observe the impact and the usefulness of weather based agromet advisory bulletin.

2. METHODOLOGY

2.1. Study Area

The coastal and saline zone of Southern West Bengal, India which is very much vulnerable to climate change (UNEP, 1989; IPCC, 2007) was selected for the present investigation. The study site is adjacent to *Sundarban*, world largest mangrove ecosystem. Two villages namely Bongheri (Lat: 22°04' N long: 88°63' E) and Khaikhali Asharm (Lat: 22°02'N long: 88°61'E) were selected for the study. In Bongheri village the agro-advisory bulletin has been disseminated regularly and the village is regarded as 'contact village'. In the other village the agro-advisory bulletin was not in circulation and the village is regarded as 'non-contact village' (Fig. 1). The soil of the study area is mostly clay and clay loam type. The pH of this soil is 7.5 to 8.5. The magnesium, sodium and calcium chloride salts are very common in this area. Average annual rainfall of this region ranges between 1600 to 1800 mm. The average maximum temperature for the summer months is around 34°C and average minimum temperature for the winter months is around 16°C. The agriculture in low-lying coastal areas or adjacent to river deltas may be affected by a rise in sea level in near future (Aydinalp and Cresser, 2008).

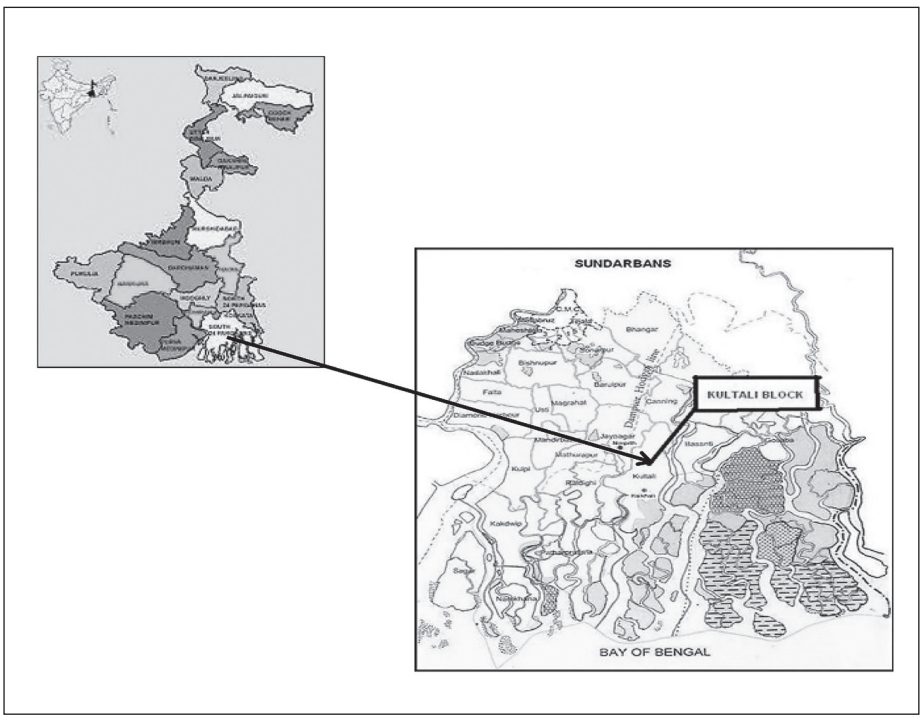

Fig. 1 - Location of the Kultali Block of South 24 Parganas district of West Bengal, India.
Fig. 1 - Localizzazione della comunità di Kultali nel distretto Sud 24 Parganas del Bengala Occidentale, India.

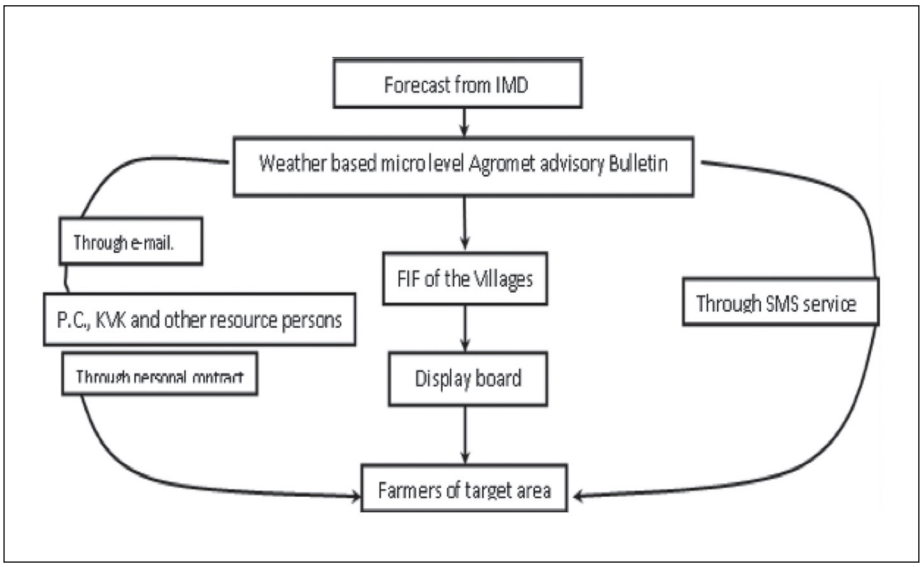

Fig. 2 - Way of preparation and Dissemination of Weather Based Agromet Advisory Bulletin (WBMLAAB) for Contact village.
Fig. 2 - Preparazione e diffusione del Bollettino di allerta agrometeo (WBMLAAB) nei Contact Village.

2.2. Selection of sample farmers

Sixty farmers were selected from each of the contact and non-contact villages. As already discussed, the bulletins are disseminated in the contact village and not disseminated in the non-contact village. Thus, a total number of 120 farmers were selected from South 24 Parganas district of West Bengal following simple random sampling without replacement (SRSWOR) technique. The responses were obtained from the selected farmers by personal interview method with the help of a pre-tested template.

2.3. Agromet Advisory Service System

The AAB is usually prepared based on location specific forecasting system which has eight different weather parameters (rainfall, maximum temperature, minimum temperature, wind direction, wind velocity, cloud cover, morning RH and afternoon RH). It also containsinformation relating to the crop cultivation namely, field preparation, sowing, irrigation, time and method of fertilizer and pesticide application, etc., in relation with weather forecast. AABs are prepared twice in a week with the help of Block level weather forecast of India Meteorological Department and the support from Central Research Institute for Dryland Agriculture (CRIDA). The bulletins prognosticate 5-days in advance which is also very helpful to the farming community to take necessary action in advance at time of crop cultivation. Dissemination of thebulletin is done through resource persons of the target village, who is designated as field information facilitator. Feedback information was collected from both the villages (Fig. 2).

2.4. Assessment of farmer's perception

The modified 'bad consequence' scale of *O'Conor et al.* (1999) was used to assess the level of awareness about consequences of climate change. The respondents were individually interviewed by the researcher with the help of a pre tested template. Awareness of the respondents was recorded on the basis of responses to the statements relating to the facts of climate change on athree point continuum scale.

2.5. Estimation of cost of cultivation

To estimate cost of cultivation, cost concept used in farm management studies were employed in the present study. Cost A_1 means most of the out of pocket expenses. According to Raju *et al.* (1996), Cost B is basically the addition of Cost A_2 and imputed rental value of own land and Interest on owned fixed capital [30 per cent of the output main and by-product] is considered as rental value of owned land. The Cost A_2 is calculated by the following formula:

Cost A_2= Cost A_1 + rent paid for leased-in land

Cost C is the most meaningful cost and epitomizes the estimate of the farm cost when farming is considered to be a strictly commercial proposition. Here it is to be noted that as no sample farmers were cultivatingtheir crops in leased inland situation in the present study, Cost A_2 has not been estimated.

Another cost concept which is incorporated for the purpose of estimation of cost of cultivation is the concept of prime cost that includes all cost items constituting Cost A_1 minus land revenue and cesses plus the imputed value of family labour. They have

been excluded from the computation of prime cost on ground that revenue and cesses are overhead cost from the view point of any particular crop enterprise and are required to be allotted on the basis of some accepted principles. The logic behind the adoption of prime cost concept in computation of cost of cultivation as an alternative of cost concepts used in farm management studies lies in the fact that in India, a small minority of the farmers are in a position to cover Cost C and make net gain. Again, there is a large amount of arbitrariness in the method of estimation of rental value of owned land and interest on fixed capital (Mukhopadhyay, 1990). This concept has also been used by Panse and Bokil (Panse and Bokil, 1996).

2.6. Return structure and return-cost ratio

It is the total money received by farmers from selling of output after harvesting. It includes the value of main products as well as by-products. It is obtained by multiplying quantity of output and by-product by respective market prices prevailed at the time of survey. Net return is estimated by subtracting total cost of cultivation like Cost C or Prime cost ha^{-1} from total return. Return-cost ratio implies that total return obtained from investment of one USD or one unit cost. Obviously, ratio less than one indicate that the farm business is incurring losses and *vice-versa*.

3. RESULT AND DISCUSSION

3.1. Farmers awareness on climate change related phenomenon

Through survey and simple questionnaire, farmers' perception on climate change was assessed. Different phenomenon related to climate change were considered such as, sea level increase, cyclone frequency, temperature anomaly, etc. The meanperception scores of the farmers of the contact village are shown through Tab. 1. It was found that the increase in disease-pest attack scored highest (2.73) followed by increase in rainfall variation and sea level rise (2.65) and reduction in fresh water (2.63). Apart from these three, increase in the number of cyclone per year, less agricultural production, reduction of area under mangrove forest and change in cold wave pattern were also the concern of the farmers, with perception score more than two.

Awareness of the farmers on climate change in the non-contact village (not having the access of AABs) is presented in Tab. 2. The reduction in number of species of forest tree, animal and fish (mean perception score 2.50) was the most concerning observable fact followed by rise in both day and night temperature (2.45) and increase in pest attack and disease incidence (2.36). The phenomenon of increased drought

Sl. No.	Phenomenon related to climate change	No. and percentage of farmers						MS
		Fully aware		Somewhat aware		Not aware at all		
		N	%	N	%	N	%	
1.	Increase in Sea level and reduction in fresh water availability	42	70.0	14	23.3	4	6.7	2.6
2.	Increase in the number of cyclone per year	36	60.0	15	25.0	9	15.0	2.5
3.	Rise in both day and night temperature	5	8.3	33	55.0	22	36.7	1.7
4.	Less agricultural production	36	60.0	14	23.3	10	16.7	2.4
5.	Increase in pest attack and incidence drought and flood	47	78.3	10	16.7	3	5.0	2.7
6.	Phenomenon of increased drought and flood	10	16.7	19	31.7	31	51.7	1.7
7.	Reduction of Area under mangrove forest	31	51.7	12	20.0	17	28.3	2.2
8.	Reduction in number of species of forest tree, animal and fish	16	26.7	21	35.0	23	38.3	1.9
9.	Increased variability in rainfall	41	68.3	17	28.3	2	3.3	2.7
10.	Change in the pattern of cold wave, heavy fog and precipitation	28	46.7	13	21.7	19	31.7	2.2

MS=Mean Perception Score, which may range from 1.0 to 3.0

Tab. 1 - Distribution of respondents according to their awareness about phenomena related to climate change in the Contact village having access to AABs.
Tab. 1 - Distribuzione degli intervistati con accesso al AAB nei Contact villaggi in base alla consapevolezza dei fenomeni legati ai cambiamenti climatici.

Sl. No.	Phenomenon related to climate change	No. and percentage of farmers						MS
		Fully aware		Somewhat aware		Not aware at all		
		N	%	N	%	N	%	
1.	Increase in Sea level and reduction in fresh water availability	17	28.3	28	46.7	15	25.0	2.0
2.	Increase in the number of cyclone per year	10	16.7	23	38.3	27	45.0	1.7
3.	Rise in both day and night temperature	34	57.1	19	31.4	7	11.4	2.5
4.	Less agricultural production	12	20.0	22	36.7	26	43.3	1.8
5.	Increase in pest attack and incidence drought and flood	29	48.4	24	40.0	7	11.4	2.4
6.	Phenomenon of increased drought and flood	2	2.9	12	20.0	46	77.1	1.3
7.	Reduction of Area under mangrove forest	27	45.7	21	34.3	12	20.0	2.0
8.	Reduction in number of species of forest tree, animal and fish	32	53.3	26	43.3	2	2.9	2.5
9.	Increased variability in rainfall	27	46.7	24	40.0	9	15.0	2.3
10.	Change in the pattern of cold wave, heavy fog and precipitation	10	16.7	36	60.0	14	23.3	1.9

MS= Mean Perception Score, which may range from 1.0 to 3.0

Tab. 2 - Distribution of respondents according to their awareness about phenomena related to climate change in the Non-contact village having no access to AABs.
Tab. 2 - Distribuzione degli intervistati senza accesso al AAB nei Non-contact villaggi in base alla consapevolezza dei fenomeni legati ai cambiamenti climatici.

and flood placed last in the list (mean score level 1.26). But mean perception scores of the variables like reduction of area under mangrove forest, change in the pattern of cold wave, heavy fog and precipitation, less agricultural production, increase in the number of cyclone per year varied between 1 and 2. So the villagers of contact village are well aware about the changing pattern of rainfall, cyclonic activities and sea-level rise. However, the perception score on temperature rise is more for the non-contact village.

3.2. Likelihood of occurrence of climate change related phenomenon: farmers' view:

Sixteen phenomena were chosen to observe the farmers' view on climate change impact in the study region. The respondents of contact village perceived severe consequences of climate change, as seven out of the sixteen phenomena received four and above mean scores (Tab. 3). More than 45% of respondent perceived the most likely phenomenon in term of effect on livelihood, reduction in number of fish species, decrease in standard of living, increasein number of vector and rate of serious diseases and decrease in the availability of fresh water for drinking. Above forty per cent respondent anticipated possibility of heavy reduction in agricultural production, starvation and food shortage and the chance of suffering from serious disease. However, many of the selected farmers were undecided about on frequency of flood (65.00%), storm (51.67), starvation and food shortage (43.33%), impact on biodiversity and coastal ecosystem of *Sundarban* (41.67%). Migration of people and animal from *Sundarban* (46.67%), impact on biodiversity and coastal ecosystem of *Sundarban* (33.33%), heavy inundation (35.00%) and their chance of suffering from serious disease (23.33%) were perceived unlikely phenomenon.

Tab. 4 shows perception of the farmersfor the non-contact village. Here,large scale submergence of forest land and reduction in number of fish species were perceived as most likely phenomenon with mean score more than 4. Farmers also perceived the chance of their livelihood to be affected (2.82). Farmersconsideredmost likely consequences will be heavy inundation (37.14%), large scale submergence of forest land (28.57%), reduction in number of fish species (42.86%)and food shortage in their area (25.71%).

It is revealed from Tab. 1 and 2, the following statementswere above the mean score level: a) increase in sea level and reduction in fresh water availability, b) increase in pest attack and disease incidence and c) increased variability of rain. The mean perception score of eight phenomena (out of total ten) were more in case of contact village

Sl. No.	Statement	percentage of farmers					MS
		VL	SL	UD	SU	VU	
1.	Likely increase in frequency of storm	18.3	30.0	51.6	0.0	0.0	3.6
2.	Probably increase in frequency of flood	1.67	15.0	65.0	18.3	0.0	3.0
3.	Likely Heavy inundation	18.3	21.6	25.0	8.3	26.6	2.9
4.	Likely heavy reduction in agricultural production	23.3	58.3	13.3	3.3	1.6	3.9
5.	Probably large scale submergence of forest land	13.3	40.0	35.0	6.6	5.0	3.5
6.	There will be reduction in number of fish species	48.3	36.6	10.0	5.0	0.0	4.2
7.	Probably many people's livelihood will be affected	50.0	35.0	11.6	3.3	0.0	4.3
8.	Likely my livelihood will be affected	50.0	36.6	8.3	3.3	1.6	4.3
9.	Probably standard of living will decrease	45.0	25.0	23.3	5.0	1.6	4.0
10.	Starvation and food shortage will occur in many part of the world	5.0	48.3	43.3	3.3	0.0	3.5
11.	Starvation and food shortage will occur in my area	0.0	61.6	20.0	15.0	3.3	3.4
12.	There will be increase in number of vector and rate of serious diseases	48.3	20.0	25.0	3.3	3.3	4.1
13.	My chance of suffering from serious diseases will increase	3.3	41.6	31.6	18.3	5.0	4.8
14.	Probably some catastrophic impact on biodiversity and coastal ecosystem of *Sunderban*	6.6	18.3	41.6	30.0	3.3	2.9
15.	There will be a large scale migration or exodus of people and animals from *Sunderban*	5.0	28.3	20.0	30.0	16.6	2.7
16.	Increase of sea water will lower the availability of fresh water for drinking	50.0	21.6	15.0	5.0	8.3	4.0

VL: Very Likely; SL: Somewhat Likely; U: Undecided; SU: Somewhat Unlikely and VU: Very Unlikely; MS= Mean Perception Score, which may range from 1.0 to 5.0

Tab. 3 - Farmers' view on likely of occurrence of climate change related phenomenon for the Contact village having access to AABs (N=60).
Tab. 3 - Opinione degli agricoltori con accesso al AAB nei Contact villaggi sulla probabilità che si verifichino fenomeni correlati ai cambiamenti climatici (N = 60).

compared to non-contact village. It indicates the villagers of contact village are more concerned about climate change phenomenon. Likewise, mean perception score of nine statements on climate change impact (out of 16) were more for contract village than non contact village.

3.3. Cost of cultivation for rice: comparison between villages having and not having access to AABs

Tab. 5 summarises the variation of cost of cultivation of rice grown in wet-season and summer season for the farmers having and not having access to the AABs. In case of Wet-season rice, the group of farmers using AABs in cultivation practices had made an expenditure of USD 340.1 ha^{-1} on various cost components constituting Cost A_1, which is USD 8.0 ha^{-1} less than the farmers of non-contact village. Expense on hired labour is also less for farmers of contact village.In case of summer season rice, farmers of this region used to be very much optimistic about the production and productivity of this crop. So, they used to incorporate the best possible inputsand effortsin their cultivation. The productivity of summer rice is generally higher than the wet-season season rice. The use of AABshelped the farmers to utilize their inputs in a judicious way, so input expenses were lower than the non users of AABs. This was reflecting on the cost structures in Tab. 5. Cost A_1 of summer season rice was USD 591.5 $ha^{-1}$for the users and USD 679.8 ha^{-1} for non users of AABs. The area was almost salt affected after the occurrence of cyclonic storm '*Aila*'. The AABs always advocate to incorporate the organic inputs into the cultivation practices. This was also reflected in Tab. 5, where the cost of organic input like manure incurred the expenditure of users. In case of village having access to AABs, the use of organic input was 8.22 times and 1.69 times higher for wet-season and summer rice respectively as compared to non-contact village.One of the

Sl. No.	Statement	No. and percentage of farmers					MS
		VL	SL	UD	SU	VU	
1.	Likely increase in frequency of storm	20.0	40.0	25.7	0.0	14.3	3.5
2.	Probably increase in frequency of flood	11.4	31.4	40.0	0.0	17.1	3.2
3.	Likely Heavy inundation	37.1	37.1	14.3	2.9	8.6	3.9
4.	Likely heavy reduction in agricultural production	17.1	42.9	25.7	2.9	11.4	3.5
5.	Probably large scale submergence of forest land	28.6	57.1	14.3	0.0	0.0	4.1
6.	There will be reduction in number of fish species	42.9	42.9	11.4	2.9	0.0	4.3
7.	Probably many people's livelihood will be affected	20.0	34.3	31.4	2.9	11.4	2.8
8.	Likely my livelihood will be affected	11.4	57.1	34.3	0.0	17.1	3.3
9.	Probably standard of living will decrease	8.6	42.9	42.6	0.0	5.7	3.5
10.	Starvation and food shortage will occur in many part of the world	5.7	42.9	37.1	0.0	14.3	3.2
11.	Starvation and food shortage will occur in my area	25.7	28.6	37.1	5.7	2.9	3.6
12.	There will be increase in number of vector and rate of serious diseases	11.4	57.1	20.0	5.7	5.7	3.6
13.	My chance of suffering from serious diseases will increase	5.7	45.7	31.5	8.6	8.6	3.3
14.	Probably some catastrophic impact on biodiversity and coastal ecosystem of Sunderban	5.7	37.1	45.7	2.9	8.6	3.7
15.	There will be a large scale migration or exodus of people and animals from Sunderban	11.4	62.9	17.1	2.9	5.7	3.8
16.	Increase of sea water will lower the availability of fresh water for drinking	20.0	45.2	28.6	2.9	2.9	3.8

VL: Very Likely; *SL*: Somewhat Likely; *U*: Undecided; *SU*: Somewhat Unlikely and *VU*: Very Unlikely; MS= Mean Perception Score, which may range from 1.0 to 5.0

Tab. 4 - Farmers' view on likely of occurrence of climate change related phenomenon in the Non-contact village (N=60).

Tab. 4 - Opinione degli agricoltori senza accesso al AAB nei Non-contact villaggi sulla probabilità che si verifichino fenomeni correlati ai cambiamenti climatici (N = 60).

important objectives of AAB was to encourage climate resilient agriculture, so the application of Plant Protection Chemicals (PPCL) was used as per recommendationas well as appropriate amount after checking of economic threshold level of pest infestation. In this particular point, the cost over PPCL was calculated much higher in case of not users of AABs in comparison with the users of AABs. Tab. 5 also reflects that the users of AABs know the rainfall pattern, rainfall amount, maximum and minimum Temperature, wind direction, wind velocity and cloud cover in advance of five days and through the advisories they also know the appropriate cultivation package and practices of that particular situation. With the help of this informative tool (AAB), they arrange their daily schedule of farming practices. Adoption of AABs they can control the wastage of inputs like irrigation water, PPCL, seed, fertilizer and most vital hired labour arrangements and incorporation into the cultural practices. Everingham *et al.* (2002), Gadgil *et al.* (2002) and Ingram *et al.* (2002) mentioned that the weather based forecasts are capable of influencing farmer's decision on key farm management operations.Understandable and reasonable forecast can help the farmers to grow the crop in a minimum expenditure and to get maximum return from it. Therefore, it can help to increase the acceptability, reliability and adoptability of the forecast. Thus, adoption of the weather based agromet advisory service helps farmers to adapt to some of the adverse conditions of climate change.

The economic return structures were explored for both the groups of farmers. In case of wet-season rice, the final output was 3396.08 Kg ha^{-1} for the contact farmers who adopted the advisory and 3119.28 Kg ha^{1} for farmers who not followed the advisory. For summer rice, the yields were 5,733.07 Kg ha^{-1} 5,296.55 Kg ha^{-1} for advisory-adopted and advisory-non adopted farmers,

Sl. No.	Particulars	Wet-season Rice		Summer Rice	
		AABs used	AABs not Used	AABs used	AABs not Used
A.	Components of Cost A1				
i.	Seed (USD ha^{-1})	19.5	19.5	46.1	57.9
ii.	Manure (USD ha^{-1})	9.4	1.1	17.5	10.4
iii.	Fertilizer (USD ha^{-1})	35.6	28.5	108.1	82.5
iv.	PPCL (USD ha^{-1})	9.4	17.8	34.5	81.8
v.	Irrigation charges (USD ha^{-1})	0.0	0.0	141.0	188.9
vi.	Bullock Labour (USD ha^{-1})	5.3	11.4	1.2	17.1
vii.	Tractor Labour (USD ha^{-1})	40.0	41.4	60.2	55.4
viii.	Hired human Labour (USD ha^{-1})	209.9	217.3	163.9	164.7
ix.	Miscellaneous Cost (USD ha^{-1})	0.0	0.0	0.0	0.0
x.	Interest on working capital @10%p.a. (USD ha^{-1})	11.0	11.2	19.1	21.2
B.	Total Cost A1 (USD ha^{-1})	340.1	348.3	591.5	679.9
xi.	Imputed rental value of owned land (USD ha^{-1})	207.7	187.1	397.0	367.0
C.	Cost B (USD ha^{-1})	547.8	535.4	988.5	1046.9
xii.	Imputed value of family labour (USD ha^{-1})	141.5	166.3	188.1	211.4
D.	Cost C (USD ha^{-1})	689.3	701.7	1176.7	1259.1
E	Prime Cost (USD ha^{-1}) (Cost A1+ Imputed value of family labour)	481.6	514.6	779.7	892.0
F.	Return structure				
i.	Physical Main Product (kg h^{-1})	3396.1	3119.3	5733.1	5296.6
ii.	Total return (a+b)	46387.0	41775.0	88674.1	81972.4
	a. Main Product	42451.0	38991.0	83129.5	76800.0
	b. By product	3936.0	2784.0	5544.6	5172.4
iii	Cost of production (USD kg^{-1})	0.2	0.2	0.2	0.2
iv.	Net return over Cost A1 (USD ha^{-1})	352.2	275.2	731.9	542.7
v.	Net return over Cost B (USD ha^{-1})	144.5	88.2	334.9	175.8
vi.	Net return over Cost C (USD ha^{-1})	3.0	-78.1	146.8	-35.6
vii.	Net return over Prime Cost (USD ha^{-1})	210.7	108.9	543.8	331.4
viii.	Return cost ratio over Cost A1	2.0	1.8	2.2	1.8
ix.	Return cost ratio over Cost B	1.3	1.2	1.3	1.2
x.	Return cost ratio over Cost C	1.0	0.9	1.1	1.0
xi.	Return cost ratio over Prime Cost	1.4	1.2	1.7	1.4

Tab. 5 - Comparison between cost of cultivation of Rice in the contact and non-contact villages.
Tab. 5 - Confronto fra i costi di coltivazione del riso nei Non-contact e Contact villaggi.

respectively. Total return is always a vital issue for farmers. Rice growers basically sell their output in two forms, namely, grain and straw, both have its different market and price. Total returns in case of the users of AABs were USD 633.6 per ha and USD 1240.0 per ha from main product of wet-season and summer rice respectively, which were about USD 50.0 and USD 95.0 more compared to non-contact farmers. Considering return-cost ratio, all the AABs users placed them over one or unity scale which means in every cost aspect they earned profit from the cultivation. On the other hand, non users were not earning profit when Cost C was considered. This similar trend also found in the net return over Cost C. Prime cost is also an important cost concept for the farmers of

developing countries and incorporation of prime cost in cost of cultivation can ensure farmers to get a sensible price for their output. For the advisory adopted farmers, prime cost was less for both the season. Return cost ratio from prime cost was relatively higher in case of farmers using AABs than the non users. Thus the farmers who follow the weather forecast based agro-meteorological advisories are not only more aware about the climate change phenomena, but also make more profit out of farming activities.

4. CONCLUSION

It can be concluded that the farmers in the contact village are well aware about the changing pattern of rainfall, cyclonic activities and sea-level rise. However, farming community of non-contact village is also concerned about temperature rise. The migration of people and animal from coastal region, heavy inundation and chance of suffering from serious disease are not likely to happen in near future as per the perception of farmers. The weather forecast based agro-meteorological advisories helps the farmers to take decisions for agricultural operations. The farmers of contact village using agrometeorological advisory bulletins make more profit out of farming activities. In case of rice, the advisory adopted farmers used to get USD 50.0 to USD 95.0 more profit per ha of land compared to advisory non-adopted farmers. The return-cost ratio analysis depicts that in every cost aspect the advisory adopted farmers earned profit from the cultivation.

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