AICRPAM - NICRA

All India Coordinated Research Project on Agrometeorology

Annual Report

2023

ICAR - Central Research Institute for Dryland Agriculture
Santoshnagar, Hyderabad - 500059

National Innovations in Climate Resilient Agriculture (NICRA)

AICRPAM Component

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भाकृअनुप - केंद्रीय बारानी कृषि अनुसंधान संस्थान

ICAR-Central Research Institute for Dryland Agriculture

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Foreword

The frequency and intensity of extreme weather events, such as droughts, floods, and heat waves, are escalating due to climate change, severely impacting agricultural productivity. This underscores the urgent need for advanced agrometeorological advisory services to provide timely, location-specific guidance to farmers for mitigating risks. Strengthening these services can enhance resilience, safeguard livelihoods, and ensure food security amid climatic uncertainties.

All India Coordinated Research Project on Agrometeorology (AICRPAM) component of National Innovations on Climate Resilient Agriculture (NICRA) plays a significant role in characterizing the extreme weather events and their impacts on crop production; improving the content of micro-level agromet advisory services and quantifying the positive and negative effects of climate change on agriculture. Apart from these objectives, the project also conducts awareness programs on climate change for farmers at the community level. Micro-level agromet advisory services are crucial for delivering precise, location-specific weather information and crop management recommendations tailored to smallholder farmers' needs. At the national level, these services can optimize resource use, reduce crop losses, and enhance agricultural resilience against climate variability. Integrating micro-level advisories with national agricultural policies can boost productivity, support sustainable farming practices, and contribute to food security and rural development. By providing information on the potential risks and opportunities associated with climate change, advisories can help farmers make strategic decisions regarding crop selection, planting dates, and resource management. The efforts of the 20 cooperating centres ofAICRPAM-NICRA in pursuing the assigned research programs are commendable.

The Annual Progress Report of 2023 includes the prominent research results of 20 centres of AICRPAM-NICRA. I take this opportunity to congratulate Dr Santanu Kumar Bal, Project Coordinator (AICRPAM) his team, and other supporting staff in the coordinating unit, as well as the scientific staff of all 20 coordinating centres for their efforts in compiling this excellent report. I hope that the information presented in this report will be useful for formulating strategies and policy implementation of improved micro-level agromet advisories at the national level.

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The sincere efforts of the Agrometeorologists and other staff of all 20 Cooperating centers are highly acknowledged for carrying out the mandated activities for preparing this comprehensive report.

Help rendered by Dr. A.V.M. Subba Rao, Dr. Sarath Chandran, M.A. and Dr. Timmanna for the compilation of this report is greatly acknowledged. My appreciation and thanks to Dr. Deepti Verma for her contribution in preparing this report.

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1. Introduction

Agriculture and the allied sector are the principal sources of livelihood for nearly 48% of the population in India and contribute 20% to the country's Gross Domestic Product. According to the National Rainfed Area Authority of India, around 52% of the net sown area in India falls under rainfed agriculture, contributing 46% of food grain production and supporting the livelihood of 40% of the population in the country. The recent annual economic survey of the Indian government opined that climate change-related issues could affect the farmers' income by up to 20-25% in the medium term. Indian farmers, who are mostly small and marginal, are a vulnerable population where the social, market, and economic pressures are huge, often leading to considerable distress. Climate change can profoundly impact global food production by varying intensity, as any change in climatic variables (e.g., temperature, precipitation, CO_2 concentration, solar radiation, etc.) is bound to impact crop yield significantly. The recurrent occurrence of extreme weather events led to higher variability in agricultural production due to increased natural and anthropogenic greenhouse gas emissions.

The impact of climate change on agriculture and allied sectors is evident. One or other part of the country is experiencing frequent extreme weather events causing severe yield and income loss. It was found that the average global yield of wheat, rice, maize, and soybean crops would plummet by 6, 3.2, 7.4 and 3.1%, respectively owing to each degree rise in surface air temperature. Extreme shocks have highly divergent effects in unirrigated and irrigated areas (and consequently in crops that are dependent on rainfall), almost twice as high in the unirrigated compared to the irrigated. And given the fact that around 52% (73.2 million hectares area of a total 141.4 million hectares net sown area) of India's total land under agriculture is still unirrigated and rain-fed, the agricultural sector could be in trouble.

Intergovernmental Panel on Climate Change (IPCC) predicted that temperatures in India are likely to rise between 3-4 °C by the end of the 21st century. These predictions, combined with the regression estimates showing the negative impact of the rise in temperature on crops, imply that in the absence of any adaptation by farmers, farm incomes will be lower by around 12% on average in the coming years, and unirrigated areas will be the most severely affected, with potential losses amounting to 18% of annual revenue.

Recognizing the urgency of the increased frequency and intensity of weather extremes, it is important to accelerate climate change research toward developing resilient technologies and their upscaling. Realizing the impact of climate change, the Government of India prioritized climate change research and a flagship project 'National Innovations in Climate Resilient Agriculture (NICRA)' was initiated in 2010-2011. In the vulnerable regions, the

outcome of the project is expected to bring enhanced resilience of agricultural production systems to climate variability. It is a known fact that weather plays a dominant role in year-to-year fluctuations in crop production, both in rainfed and irrigated agriculture. Similarly, extreme weather events are directly impacting agricultural productivity. Though complete avoidance of farm losses due to weather is not possible, losses can be minimized to a considerable extent by timely agricultural operations based on accurate weather forecasts. Another observation is, that climate change doesn't have only negative impacts. In many instances, it has been found to have beneficial effects like an increased length of the growing period, favourable thermal conditions in cold regions, etc.

Generalized forecasts have, however, limited use in farming. Weather information for agricultural operations will be a tailored product that can be effectively used in crop planning and its management. A comprehensive weather-based farm advisory is an interpretation of how the weather parameters of the present and in the future will affect crops, livestock, and farm operations and suggests actions to be taken. To make the agromet advisory services a more successful and continuous process, it should be supported with an agrometeorological database, crop conditions, real-time weather, research results on crop-weather relationships, skilled manpower in multi-disciplinary resources, and user interface. AICRPAM-NICRA project was thus initiated to address these issues with the following objectives.

- To characterize the extreme weather events and their impacts on crop production in the domain study regions
- To quantify the positive and negative impacts of climate change in the domain study regions
- To improve the content of micro-level Agromet Advisory Services by using a dynamic crop weather calendar
- Customizing micro-level agromet advisories and their dissemination through ICTs
- Conduct awareness/training programs on climate change and workshops for capacity building on agromet advisories

2. Micro-level Agroclimatic Characterization and Extreme Weather Events

Akola

Trends in Taluk-level monsoon rainfall, rainy days, and rainfall spells in Akola district, Maharashtra

Trend analysis of rainfall, rainy days, and rain events of seven talukas of Akola was done using the recent 31 years of rainfall data (1993-2023). The Mann-Kendall test statistics were performed to evaluate the trend of monsoon rainfall, rainy days, and monsoonal rainfall events (10<25 mm, 25<50 mm, 50<75 mm, 75<100 mm, ≥100 mm) in the district. The Mann-Kendall statistic estimate under different rainfall events is presented in Table 2.1.

Table 2.1 Abstract of Mann Kendall statistic test for rainfall variability during recent 30 years (1993-2023) in talukas of Akola district

Talukas	Rainfall	Rainy Days	Rainfall events				
	SWM	SWM	10<25 mm	25<50 mm	50<75 mm	75-100 mm	>100 mm
Akola	-0.610 (NS)	2.680 S (0.05)	1.156 S (0.05)	-0.532 (NS)	-0.013 (NS)	-1.194 (NS)	-1.147 (NS)
Akot	0.871 (NS)	3.121 S (0.05)	-0.987 (NS)	0.897 (NS)	-1.983 S (0.1)	-0.237 (NS)	0.578 (NS)
Balapur	0.615 (NS)	2.315 S (0.01)	2.217 S (0.05)	-0.210 (NS)	-0.632 (NS)	-0.986 (NS)	-0.530 (NS)
Barshitakli	-0.243 (NS)	3.152 S (0.05)	1.231 (NS)	-0.213 (NS)	-1.994 S (0.05)	-0.528 (NS)	-0.244 (NS)
Murtijapur	0.017 (NS)	2.521 S (0.01)	2.102 S (0.05)	1.423 S (0.1)	-1.364 (NS)	0.001 (NS)	-0.244 (NS)
Patur	-0.731 (NS)	3.280 S (0.05)	1.326 S (0.1)	-0.614 (NS)	0.257 (NS)	-1.82 S (0.1)	-0.565 (NS)
Telhara	-0.532 (NS)	3.474 S (0.1)	1.024 (NS)	0.915 S (0.1)	-0.731 S (0.1)	-0.912 S (0.1)	-0.488 (NS)

None of the talukas showed a statistically significant increasing trend of southwest monsoon rainfall. A non-significant decreasing trend was noticed in the majority of the districts (Akola, Barshitakli, Patur and Telhara of Akola districts), whereas Akot, Balapur and Murtijapur talukas showed a non-significant increasing trend of monsoonal rainfall. The majority of the talukas (Akola, Akot, Barshitakli, and Patur) showed a significantly increasing trend ($p<0.05$) of rainy days during the southwest monsoon season. For the single-day rain event of 10<25 mm Akola, Balapur and Murtijapur talukas showed a significant increasing trend

($p<0.05$) and only Patur talukas showed an increasing trend ($p<0.1$) whereas the remaining talukas Akot, Barshitakli and Telhara indicated non-significant increasing trend. For single-day rain events of 25<50 mm only Murtijapur and Telhara taluka showed a significant increasing trend ($p<0.1$).

Anand

Trends in warm nights during winter in Gujarat

An increase in warm nights is one of the important signs of warming. CCl/CLIVAR Expert Team on Climate Change Detection, Monitoring and Indices (ETCCDMI, Klein Tank and Zwier, 2009) defined warm night as the day when the minimum temperature is greater than the 90th percentile of the reference period. Warm nights during winter also affect temperature-sensitive rabi crops like wheat. The analysis is aimed at detecting trends of the count of warm nights during winter (November to February) in Gujarat state. The period of 1961-1990 is considered a reference period to explore the threshold of minimum temperature at the 90th percentile. The warm nights (TN90p) in the winters of the recent past (years 1991-2023) were considered for trend analysis. The gridded daily maximum temperature data (IMD) of Gujarat state and border regions (29 grid points) for the period of 1961-2023 were used in the study. Baseline period data were analyzed to determine the minimum temperature value at the 90th percentile during the winter period window for each grid. The grid-specific values at the 90th percentile in the base period were used as thresholds to compute grid-specific TN90p in the winters of recent years. Linear trends of the TN90p during the recent 33 years (1991-2023) were computed using simple linear regression. The trend values were tested at a significant level of 1% and 5%.

The minimum temperature at the 90th percentile during winters of the reference period (1961-1990) and trends of warm nights during winters of the recent past (1991-2023) of Gujarat state are depicted in Fig. 2.1a&b. The reference period minimum temperature at the 90th percentile had low values in the east parts of the Gujarat region (18.6 °C) and increased gradually up to 19.4 °C towards the west. The trends of all grids were positive over the state. The trend values ranged from 0 days to 0.6 days per year. All coastal regions, South Gujarat and Surendranagar district of Saurashtra region had high and statistically significant trends in the state. The trend pattern is strong evidence of increasing warming during winter in these regions. The highest increasing and highly significant trend (0.6 days year^{-1} **) in the state was found in the coastal regions of South Gujarat. While, the trends of warm nights during winters in North Gujarat had trend values close to 0, showing no prominent warming in winter. Most parts of the state of mainland Gujarat had trend values ranging from 0.1 days year^{-1} to 0.3 days year^{-1}.

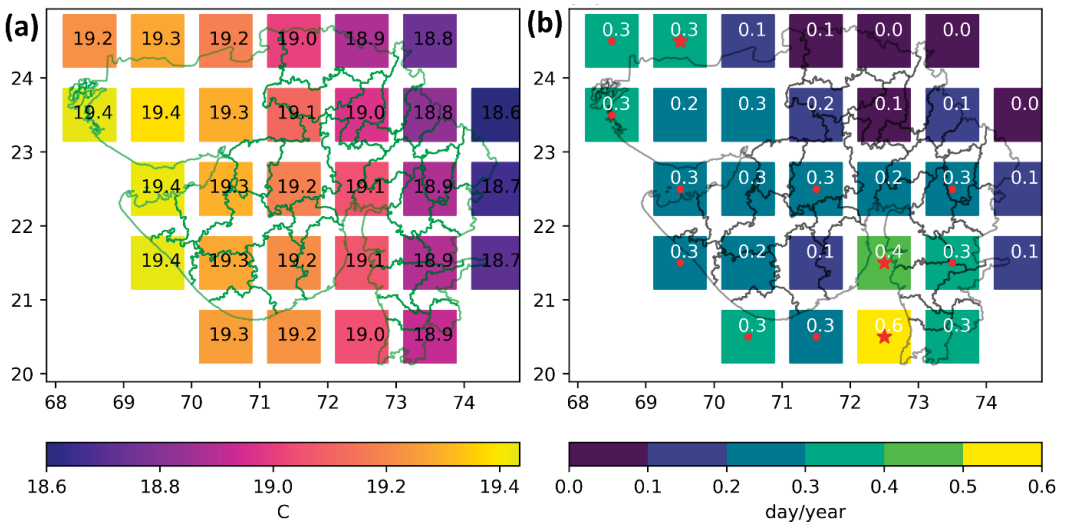


Fig. 2.1 Minimum temperature at 90th percentile (a) during winters of reference period (1961-1990) and trends of warm nights (b) during winters of the recent past (1991-2023) of Gujarat

Bhubaneswar

The trend of Annual Extreme Rainfall in Odisha

The district-wise extreme rainfall events were extracted using the SRC daily rainfall data for 34 years (1991-2023). The non-parametric Modified Mann-Kendall test was performed to detect the trends of Heavy (64.5 to 115.5 mm), Very Heavy (115.6 to 204.4 mm) and Extremely Heavy (>204.4 mm) rainfall events. The analysis revealed that 18 districts showed an increasing trend, out of which eight districts (Boudh, Bargarh, Gajapati, Ganjam, Nuapada, Malkangiri, Koraput and Sambalpur) were significant. In the annual very heavy rainfall trend, 21 districts showed an increasing trend, of which five districts (Jharsuguda, Keonjhar, Koraput, Malkangiri and Subarnapur) were significant. The analysis for extremely heavy rainfall events indicated an increasing trend in 29 districts except the

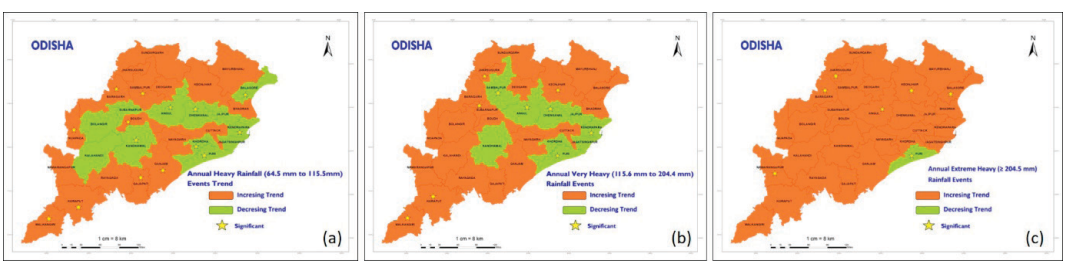


Fig. 2.2 Trends in annual (a) heavy rainfall (b) very heavy rainfall and (c) extremely heavy rainfall at the district level in Odisha (1991-2023)

Puri district. The increasing trend was significant for six districts viz. Angul, Balasore, Bargarh, Jharsuguda, Keonjhar and Nawarangpur. Two southern districts Malkangiri and Koraput showed a significant increasing trend in both annual heavy rainfall and annual very heavy rainfall events. Khordha district showed a decreasing trend in case of annual heavy and very heavy rainfall and an increasing trend in extreme heavy rainfall events.

Using the same data, the spatial distribution of meteorological drought frequency was also worked out using IMD criteria. The results indicated a relatively higher frequency of moderate drought (11-20%) existed in central and south-eastern districts.

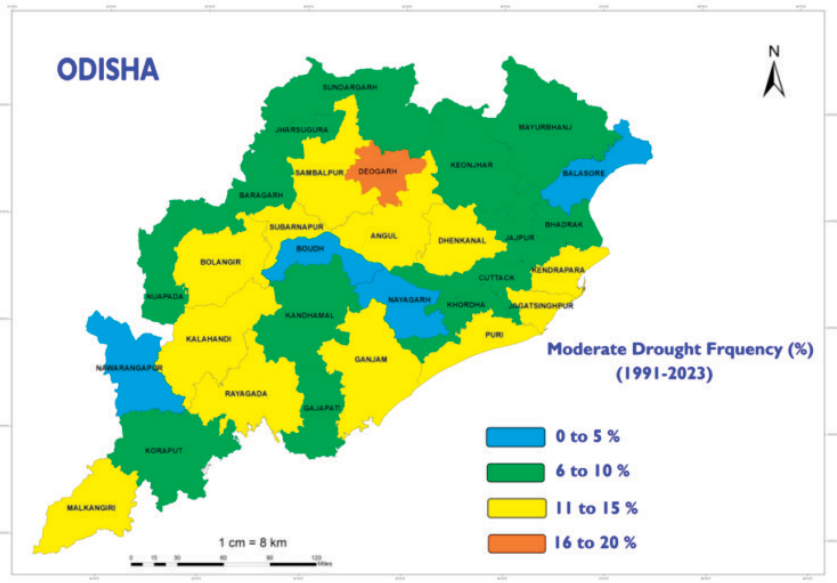


Fig. 2.3 The frequency of moderate meteorological drought (1991-2023) over the districts of Odisha

Hisar

Frequency Analysis of Dry and Wet Western Disturbance at Hisar

The winter rainfall in North Indian states like Haryana occurs mainly due to western disturbances (WD). The WD is advantageous to the rabi crops as it supplies moisture to rabi crops but it also sometimes causes damage as it is accompanied by thunderstorms/ hailstorms. The WD is classified into two types i.e. Dry-WD (D_WD) and Wet-WD (W_WD). The WD associated with cloudy weather, lightning & thundering, moderately westerly winds, and no rainfall is termed as D_WD and on the other hand, while it is associated with rainfall and occasionally hailstorms it is termed as W_WD. The variation in frequencies of western disturbance either dry or wet WD was observed among the different months of the study period (2012-2023) as presented in Table 2.2.

Table 2.2 The western disturbance (WD) events frequencies in Haryana from 2012-13 to 2023-24

Years	Monthly Western Disturbance frequency (days)																Total (days/year) and percentage of Dry WD & Wet WD				
	Oct		Nov		Dec		Jan		Feb		Mar		April		May		Total WD	Total Dry WD	Total Wet WD	D_WD %	W_WD %
	D	W	D	W	D	W	D	W	D	W	D	W	D	W	D	W					
2012-13	1	2	2	2	4	0	1	4	3	2	3	7	6	7	4	1	49	24	25	49	51
2013-14	3	3	2	3	5	3	2	4	2	3	1	5	6	2	3	4	51	24	27	47	53
2014-15	1	2	3	1	4	2	2	3	4	2	3	4	6	5	4	1	47	27	20	57	43
2015-16	1	2	2	1	2	0	1	4	3	2	3	7	6	7	4	1	46	22	24	48	52
2016-17	4	1	1	0	2	0	3	0	0	3	4	5	5	0	6	4	38	25	13	66	34
2017-18	1	0	0	2	3	1	3	5	2	0	4	4	2	2	4	2	35	19	16	54	46
2018-19	2	0	2	1	3	0	0	2	2	1	5	0	2	2	3	2	27	19	8	70	30
2019-20	3	2	1	2	2	3	3	3	3	2	4	2	3	2	3	1	39	22	17	56	44
2020-21	2	0	3	2	3	0	4	3	1	1	3	2	4	3	4	5	40	24	16	60	40
2021-22	2	2	2	1	2	1	8	6	3	1	1	0	1	1	3	3	37	22	15	59	41
2022-23	4	2	5	1	3	0	8	2	2	0	17	3	7	1	7	7	69	53	16	77	23
2023-24	5	1	4	0	1	0	10	0	5	2	12	1	14	0	8	0	63	59	4	94	6
Total	29	17	27	16	34	10	45	36	30	19	60	40	62	32	53	31	541	340	201	738	462
Av.	2	1	2	1	3	1	4	3	3	2	5	3	5	3	4	3	45	28	17	62	38
SD	1.4	1.0	1.4	0.9	1.1	1.2	3.2	1.8	1.3	1.0	4.7	2.4	3.4	2.4	1.7	2.1	11.9	13.2	6.7	13.5	13.5
CV%	57.1	70.3	60.3	66.6	39.3	143.2	85.2	60.3	52.6	62.9	94.2	72.7	65.9	90.9	38.0	79.9	26.4	46.5	40.0	22.0	35.2

Note: WD: Western disturbance, D: Dry, W: Wet, %D_WD: Percentage of dry western disturbance, %W_WD: Percentage of wet western disturbance, SD: Standard deviation, CV%: coefficient of variance (%)

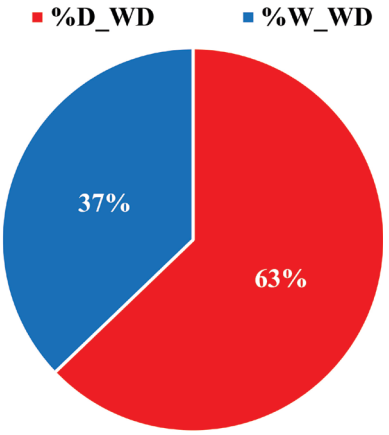


Fig. 2.4 Relative proportion of Wet Western disturbance (W_WD) and Dry Western disturbance (D-WD) period at Hisar during 2012-13 to 2023-24

The relative proportion of wet and dry western disturbances from 2012-13 to 2023-24 was studied. The result indicated that about 63% of the western disturbance events were contributed by wet events and the remaining 37% by dry events (Fig. 2.4).

Jorhat

The analysis of rainfall characterization is helpful for computation of the Length of Growing Period (LGP) which states the beginning and ending of rainfed crop growing season delineated in terms of Standard Meteorological Weeks (SMW). For the computation of LGP, a ratio of weekly rainfall (RF) to weekly potential evapotranspiration (PET) was

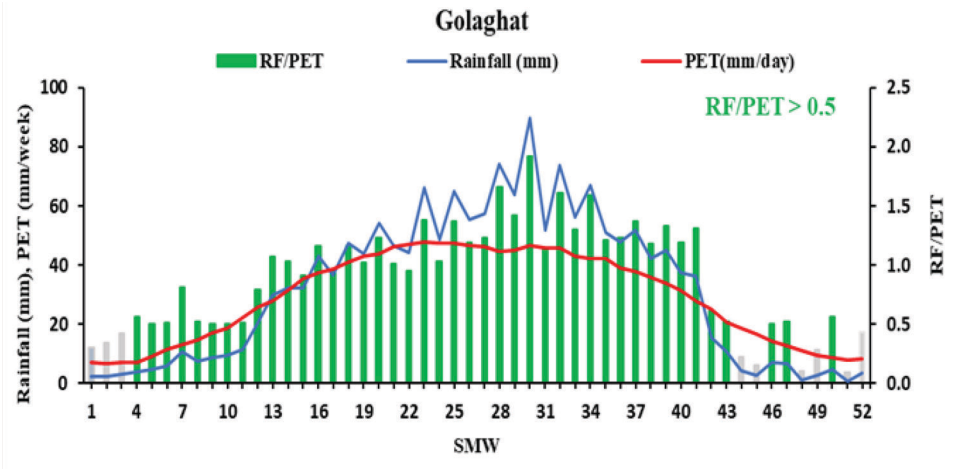


Fig. 2.5 Length of growing period (LGP) of Golaghat district (1991-2021)

worked out and the onset of the growing period was considered, where the ratio was found to be more than or equal to 0.5 (Reddy, 1983). The LGP computed for Golaghat district was found lowest i.e., 300 days relative to other districts of UBVZ of Assam (Fig. 2.5). Overall, the mean LGP (days) accounts for 314 ± 12 days with RF/PET ratio greater than 0.5 over the districts of UBVZ of Assam (Table 2.3).

Table 2.3 Length of growing period (1991-2021)

District	RF/PET >0.5	
	LGP (weeks)	LGP (days)
Golaghat	42	300
Jorhat	45	320
Sivasagar	43	301
Dibrugarh	46	326
Tinsukia	45	321
UBVZ	44	314

Seasonal trend of rainfall, rainy days, and temperature over UBVZ of Assam

The mean seasonal trend in maximum temperature revealed a substantial increasing trend during pre-monsoon (0.04 °C year^{-1}); monsoon (0.02 °C year^{-1}) and winter season (0.07 °C year^{-1}) over the UBVZ of Assam. In the case of minimum temperature, a significant positive trend was observed during the pre-monsoon (0.02 °C year^{-1}) season only. On the other hand, the seasonal rainfall trend was found positive during the pre-monsoon (1.21 mm year^{-1}) season, whereas it was negative during monsoon (6.11 mm year^{-1}), post-monsoon (2.41 mm year^{-1}) and winter (1.77 mm year^{-1}) season, although non-significant. Similarly, the number of rainy days was in decreasing order in all four seasons; though the decreasing trend was significant in the winter (0.17 days year^{-1}) season only over the zone (Table 2.5). The decreasing trend of rainfall, rainy days, and minimum and maximum temperature over the UBVZ was mainly attributed to a decreasing trend in all those parameters at the individual district level.

Overall the rise in seasonal mean minimum and maximum temperature was observed in all four seasons (except the winter season in Jorhat) in both the selected stations i.e. Jorhat and Dibrugarh district of UBVZ based on available data. However, the rise in maximum temperature was significant during pre-monsoon, monsoon, and winter seasons in both stations. On the other hand, a decreasing trend in rainfall was observed during the monsoon, post-monsoon, and winter seasons in all five districts of UBVZ of Assam. However, except in Sibasagar, a positive trend in mean seasonal rainfall was observed during pre-monsoon in the remaining four districts of UBVZ. A decreasing trend in rainfall

was found significant in Tinsukia (8.46 mm year^{-1}) during monsoon; whereas a similar substantial decreasing trend was observed during the post-monsoon (2.83 mm year^{-1}) and winter (1.35 mm year^{-1}) season in Jorhat. Irrespective of the seasons, all five districts of UBVZ experience a decreasing trend on rainy days. Amongst five districts, Golaghat and Jorhat experience substantial decreasing trends in rainy days during post-monsoon and winter seasons; whereas Dibrugarh and Tinsukia district experiences significant decreasing trends respectively during post-monsoon (0.17 days year^{-1}) and winter (0.20 days year^{-1}) season only (Table 2.4).

Table 2.4 Sen's estimator of the slope of seasonal rainfall, rainy days and mean seasonal temperature regimes over the period 1986-2015 in different districts of UBVZ of Assam

Districts	Pre-Monsoon				Monsoon				Post-Monsoon				Winter			
	Tmax	Tmin	RF	Rdays	Tmax	Tmin	RF	Rdays	Tmax	Tmin	RF	Rdays	Tmax	Tmin	RF	Rdays
Golaghat	-	-	0.45	-0.06	-	-	-8.7	-0.12	-	-	-2.97	-0.14*	-	-	-0.91	-0.16*
Jorhat	0.03*	0.03	0.70	-0.05	0.02*	0.01*	-1.11	-0.12	0.02	0.004	-2.83*	-0.14*	0.05*	-0.007	-1.35*	-0.16*
Sivsagar	-	-	-0.44	-0.02	-	-	-6.06	-0.16	-	-	-4.14	-0.10	-	-	-1.24	-0.10
Dibrugarh	0.06**	0.03*	2.22	-0.07	0.02*	0.01	-7.11	-0.26	0.04**	0.03	-2.15	-0.17*	0.07*	0.03	-1.61	-0.13
Tinsukia	-	-	2.63	-0.05	-	-	-8.46*	-0.16	-	-	-0.12	-0.10	-	-	-2.23	-0.20*
UBVZ	0.04**	0.02*	1.21	-0.08	0.02*	0.01	-6.11	-0.16	0.02	0.02	-2.41	-0.12	0.07*	0.01	-1.77	-0.17*

Raipur

Trend analysis of rainfall and rainy days during the southwest monsoon and annual levels in different blocks of Mahasamund district, Chhattisgarh was undertaken.

Table 2.5 Trend analysis for rainfall and rainy days of different blocks of Mahasamund district, Chhattisgarh

Name of the Block	Rainfall		Rainy day	
	Annual	SWM	Annual	SWM
Bagbahara (1984-2022)	3.651 (NS)	2.973 (NS)	-0.042 (NS)	-0.057 (NS)
Basna (1990-2022)	9.60 (NS)	6.399 (NS)	0.008 (NS)	-0.125 (NS)
Mahasamund (1973-2022)	0.401 (NS)	-0.335 (NS)	0.127 (NS)	0.122 (NS)
Saraipali (1981-2021)	0.383 (NS)	-1.614 (NS)	-0.029 (NS)	0.007(NS)
Pithora (2001-2022)	9.37 (NS)	-11.77 (NS)	-0.389 (NS)	0.458 (0.05)

Rainfall was not decreasing significantly. Generally, the perception of farmers was that the rainfall has decreased on an annual and SWM basis. However, rainy days which determine the length of the crop growing season were found to be increasing for the Pithora block (Table 2.5).

Extreme weather events

Drought affected sunflower

Drought affected sorghum

Lodging in banana plantation

Paddy affected by heavy rainfall

Hailstorm effect on vegetables and orchard

Flood affected cotton field

Fruit crops affected by hailstorm

Maize crop uprooted by heavy winds

Extreme weather events

Vegetable crops affected by heavy rainfall

Fruit drop in mango orchard due to heavy wind

Maize crop wilted by prolonged dry spell

Lodging in wheat due to unseasonal rainfall

Heat wave affected wheat crop

Wheat affected by unseasonal rainfall

Flood affected maize field

Banana plantation affected by Michaung cyclone

3. Positive and Negative Impacts of Climate Change and Variability

Climate change has both positive and negative impacts on agriculture. On the positive side, rising temperatures and increased CO_2 levels can sometimes enhance plant growth and extend growing seasons in certain regions, potentially boosting crop yields. However, the negative impacts are more widespread and severe. Extreme weather events like droughts, floods, and heatwaves can reduce crop productivity, damage infrastructure, and disrupt food supply chains. Shifting climate patterns also affect pests and disease distribution, threatening crop health. Additionally, changing rainfall patterns and the loss of arable land due to desertification and rising sea levels further threaten global food security. This chapter describes the positive and negative impacts reported by AICRPAM centres.

Positive Impacts

Anantapur

Shift in sowing time

In general, groundnut sowing is taken up from late July to early August in the Anantapuramu district of Andhra Pradesh. The altered trend in pre-monsoon rainfall during May month facilitates optimum conditions for field preparation. There is also a significant increase in June month rainfall in the Anantapuramu district which allows the farming community to take up groundnut sowing well in advance compared to late sowings (late July-early August). This helps the groundnut growers in harvesting the crop early i.e. October instead of November. Further, higher pod yields were obtained as the crop escaped the terminal drought during November. In addition, harvesting groundnut in October permits to take up a subsequent crop like horse gram/fodder jowar, thereby increasing productivity as well as farm income.

Increased rainwater harvesting in farm ponds

Rainfall events with >25 mm showed an increasing trend during the southwest monsoon period and hence resulted in increased rainwater harvesting in farm ponds. The harvested water was used for irrigating the crops during dry spells, thereby sustainable crop yields were realized. Further, high rainfall events were beneficial in improving the groundwater table in the district from 10.81 meters (below ground level) in February 2001 to 5.82 meters in February 2023. Further, at the macro-level, the majority of the reservoirs, large ponds, and small storage tanks along with farm ponds filled to their brim during 2020-2022 giving good relief to the farmers and bringing copious inflows into underground aquifers.

Bangalore

Increased Length of the growth period (LGP)

Due to the variability in the rainfall, individual crop growing areas, and growing periods are changing. The maximum water available during the grand growth period is shifting towards the end of September and beginning of October in many districts of Southern Karnataka resulting in a change in cropping area as detailed below

- Finger millet area (Staple food crop of southern Karnataka) in Mandya, Mysore, Chikkamagalur, and other south interior districts of Karnataka is increasing.
- The area under groundnut crops in Chitradurga and Tumkur districts has been increasing in recent years.
- The area under cultivation of pigeon peas is increasing in Bangalore rural, Tumukur, Chikkaballapura, and Mandya.

Increased success rate of rabi crops

The NE monsoon season has shown increased cyclones, especially during Nov-Dec in many parts of the state. This has favoured rabi crops, especially in black soil regions alleviating moisture stress during most of the crop growing season.

Bhubaneswar

The positive impact of excess rainfall on kharif paddy yield was studied at the district level using long-term monthly rainfall data (Table 3.1).

Table 3.1 Positive impact of excess rainfall on kharif paddy yield in Odisha

Sl. No.	District	Month	Excess RF (>20%)	
			Coefficients	P value
1	Angul	August	1152.69	0.044
2	Baragarh	August	1231.37	0.001
3	Bolangir	June	1314.62	0.031
		July	1713.96	0.010
4	Deogarh	July	2156.97	0.026
5	Dhenkanal	July	1453.81	0.008
6	Jharsuguda	August	1239.78	0.030
7	Kandhamal	July	438.74	0.034
8	Koraput	June	498.002	0.031
9	Nawarangapur	July	832.36	0.043
10	Sambalpur	August	1261.76	0.006

Jorhat

The trend analysis of long-term rainfall data revealed that an increase in pre-monsoon rainfall and mean maximum and minimum temperatures throughout the four seasons may be helpful for early sowing and transplanting of long-duration photo-insensitive varieties of *Sali* rice. The early transplanting may lead to more accumulation of thermal units and thereby more dry matter production and higher possibilities for better yield. Even the long-term field experiment trial revealed a rise in yield when transplanted within the first fortnight of July, and yield reduces with delay in transplanting. With the decrease in rainfall and the number of rainy days during the monsoon season, farmers may take the opportunity to utilize this negative impact of weather variability in terms of their land preparation activity for the cultivation of *kharif* pulse and millet crops in medium to upland areas of this region.

Ludhiana

Nursery *Langar*: A contingent plan to mitigate floods

Nursery *Langar* (in Punjabi) means providing free nursery to farmers for transplanting. It is a contingency plan of producing a nursery in the shortest time in case of any weather aberrations.

The need for a community nursery

- To fulfill more demand for nurseries in less time under climatic aberrations such as drought, delay in monsoon, flooding, etc.
- To manage seed, labour, and space shortage.
- To mitigate the adverse impact of any sudden eventuality/externalities

A community nursery is a planned and scientific nursery cultivation to fulfill the demand of farmers and other needy growers. For instance, floods in Punjab during July 2023 when more than 2 lakh ha area was flooded due to excessive rainfall in upper catchment /upstream caused floods in lower stream areas. To fulfill the need for a nursery for such a large area, community nursery was raised at places where space and water availability were there. Volunteers came forward to help such flood-affected farmers and systematically raised nurseries. Short-duration varieties were preferred for raising the community nursery to compensate for the time lost in floods. Good quality seed of PR126 and Pusa Basmati 1509 was made available to such volunteers for raising the nursery.

Mohanpur

Impact of winter rainfall on availability of groundwater

Groundwater availability is becoming a crucial factor for cultivating winter and pre-monsoon season crops. The study used the season-wise groundwater storage data from the Central Groundwater Board. The pre-monsoon groundwater storage of Bankura and East Midnapore Districts of West Bengal is maximum, ranging from 953 to 1152.5 mm (Fig. 3.1).

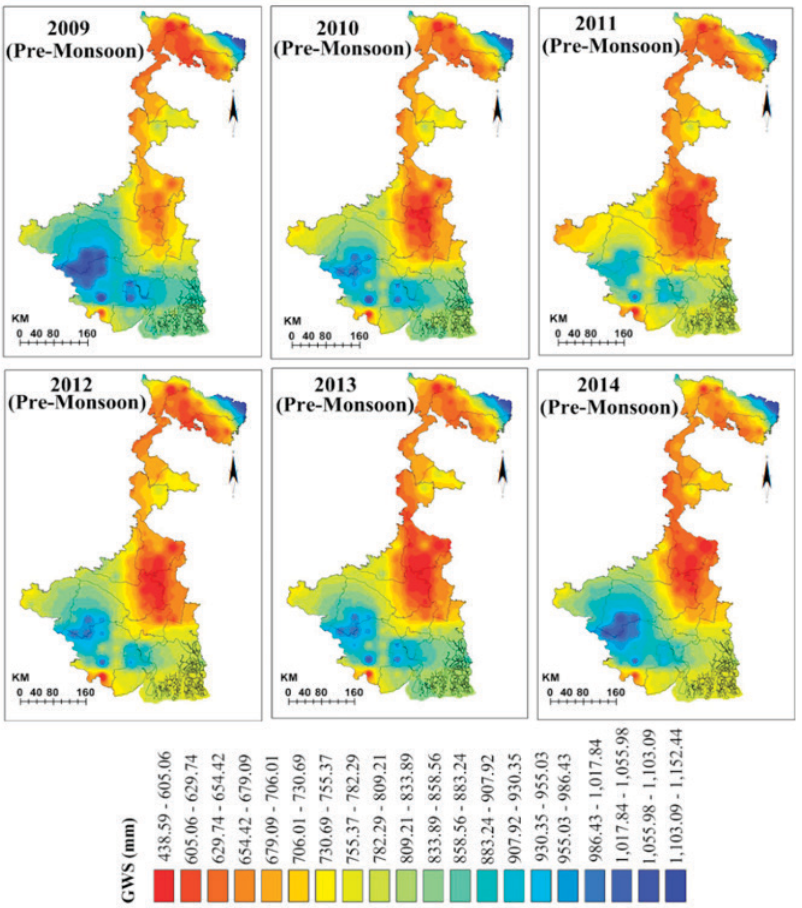


Fig. 3.1 Spatiotemporal changes of groundwater storage for pre-monsoon season from 2009 to 2014

At the same time, it is observed the winter rainfall of Bankura and East Midnapore Districts of West Bengal is showing an increasing trend from 2000 to 2023 (Fig. 3.2a&b). Hence, the positive effect of climatic variability can be observed through the increment of groundwater storage.

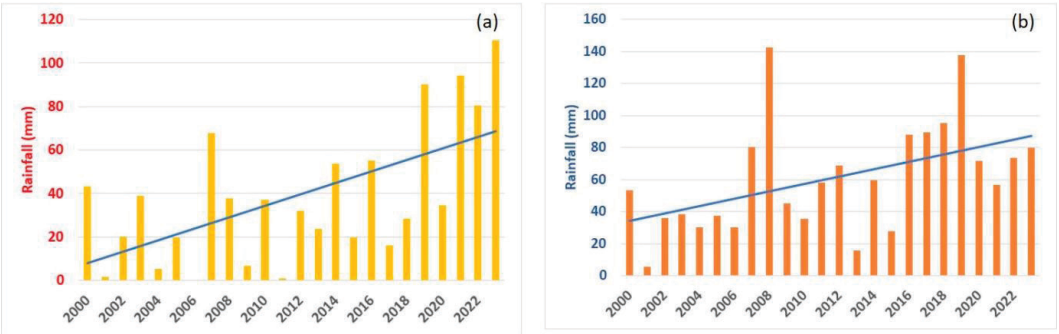


Fig. 3.2 Trend of winter rainfall in (a) Bankura and (b) East Medinipore districts of West Bengal from 2000 to 2023

Impact of CO_2 enhancement on Boro rice yield

A study was designed to assess the positive impact of climate change on *Boro* rice. Three locations were selected from the Lower Gangetic Plains of West Bengal. These three locations *viz*. Balurghat, Krisnanagar, and Diamond Harbour represent the main rice-growing tracts of the state. *Shatabdi* (IET 4786), the most popular rice cultivar, was considered for the study. The entire analysis was done with the DSSAT (version 4.8.0) crop simulation model. Under the environmental modification module, four levels were created. The first one corresponded to the present CO_2 concentration. The present CO_2 concentration is 424 ppm. Another three levels signified the elevated CO_2 conditions. Increments of 100, 150, and 200 ppm were considered for the study. The analysis was performed under three dates of sowing condition; D_1 (second fortnight of December), D_2 (first fortnight of January), and D_3 (second fortnight of January). Other management practices were followed as per the recommendation for these locations.

The results showed that both biomass and yield would show an increasing trend under amplified CO_2 conditions for all the locations. The present biomass is around 7000 kg ha^{-1}. However, this value may reach up to 9000 kg ha^{-1} due to CO_2 fertilization (Fig. 3.3). The biomass accumulation was noted with an 11-21% increment across locations. Among the locations, Balurghat was detected with the highest increase. Biomass from the second date of sowing was projected with more than a 22% increment under C_0+200 ppm condition. The yield enhancement as a result of elevated CO_2 concentration was found to be lower than the biomass. The value in general ranged between 3-5%. Higher atmospheric CO_2 induces stomatal closure and reduced rate of transpiration (Fig. 3.4). This in turn may raise plant temperature and affect the process of reallocation of carbon assimilated into reproductive organs. This phenomenon may be attributed to less yield increment. Unlike biomass, no specific location revealed any significant trend. The increment may be to the tune of 7-8% when CO_2 concentration is 150 or 200 ppm augmented than the present

scenario. So, it can be concluded from the study that higher biomass and yield may be generated under elevated CO_2.

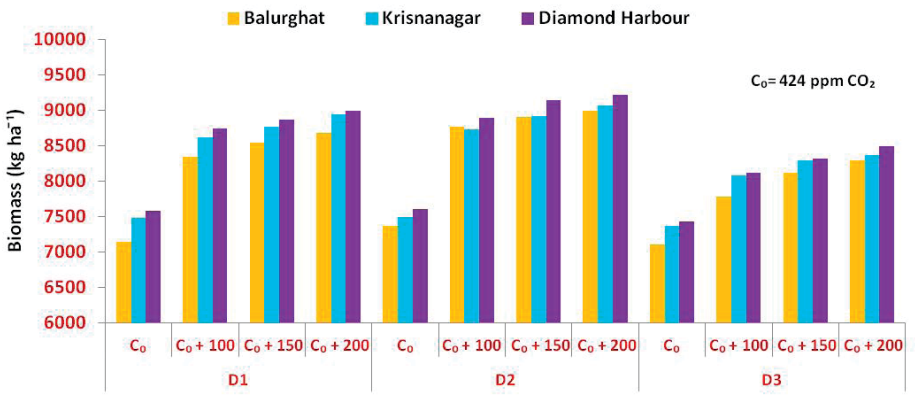


Fig. 3.3 Simulated biomass of *Boro* rice under elevated CO_2 levels

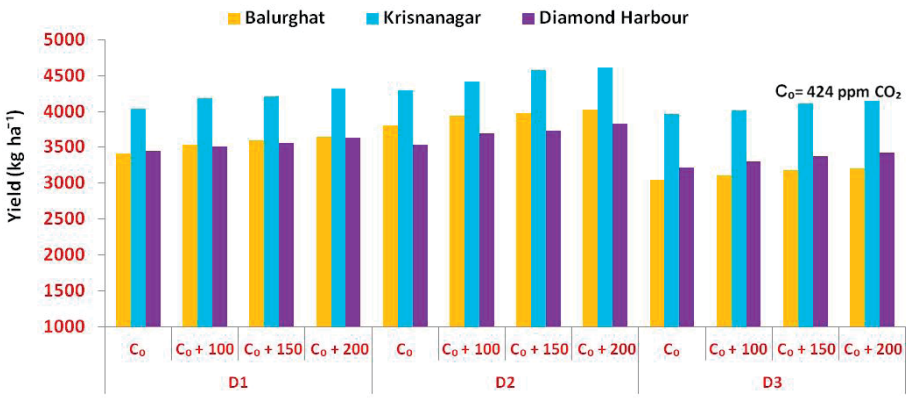


Fig. 3.4 Simulated yield of *Boro* rice under elevated CO_2 levels

Parbhani

An increase in the frequency of heavy rainfall during the end of September and early October has been quantified. Long-duration pigeon pea cultivar does not have to face moisture stress at pod formation to grain filling stage, which produces chaffy grains. Good residual soil moisture for the cultivation of rabbi crops, turmeric, vegetable, and orchard crops. Timely sowing of wheat helps to avoid terminal heat stress and hailstorm damage. Heavy rainfall events help to wash out the insect pests on crops.

Samastipur

Positive impact on wheat yield through changing sowing dates

Terminal heat stress is a serious climatic constraint for wheat production in Bihar. The prevalence of dry westerly wind and sudden rise of day temperature during the fag end of the wheat growing season tends to shorten the grain filling period and negatively impact the grain setting of wheat. Data on the wheat crop, which was planted on five dates viz. 15 November (D_1), 25 November (D_2), 5 December (D_3), 15 December (D_4) and 25 December (D_5) for three consecutive years viz. 2014-15, 2015-16, and 2016-17 with three prominent cultivars of the region viz. RAU-3711, HD-2824, and HD-2733 were used to assess the impact of changing sowing dates on yield.

The effect of high temperature on wheat yield during these three years is presented in Figs. 3.5a&b. The data shows that the wheat grown during 2015-16 faced the highest

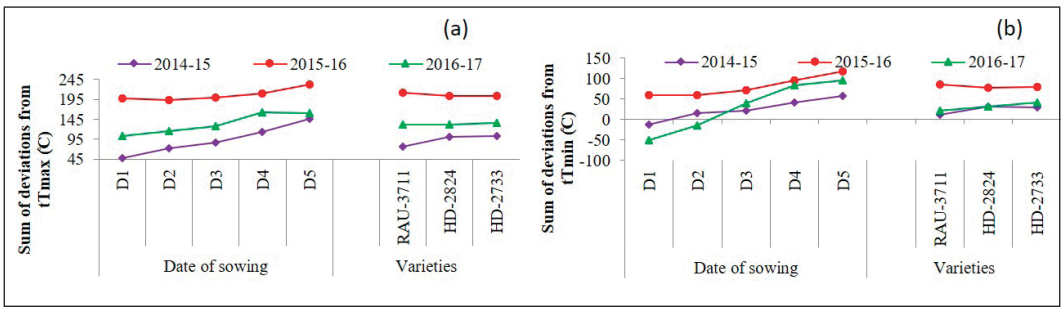


Fig. 3.5 Effect of sowing environment and varieties on the sum of deviations from (a) threshold maximum temperature and (b) threshold minimum temperature from flowering to maturity stage in wheat. (tTmax- threshold maximum temperature; tTmin- threshold minimum temperature)

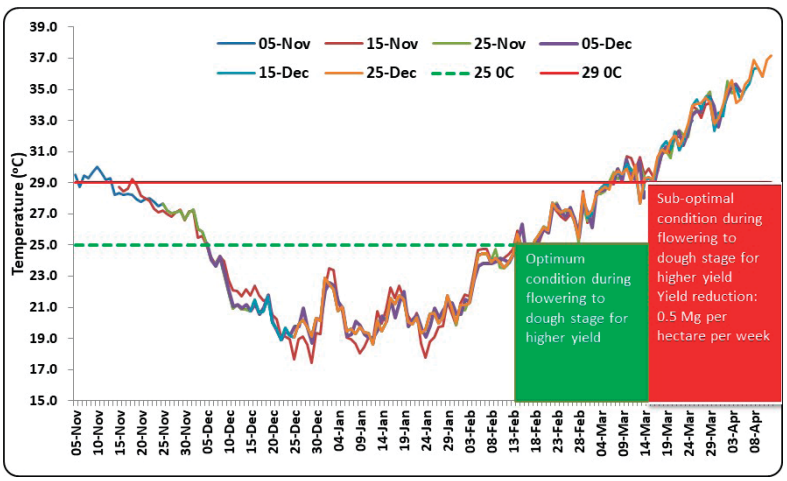


Fig. 3.6 Optimal and sub-optimal conditions during flowering to grain filling stage for higher yield of wheat

magnitude of heat stress. It is observed that if wheat sowing is delayed, the crop faces higher temperature stress. For achieving a higher yield of wheat (>4 ton ha^{-1}) in the region, the period from flowering to dough stage must be completed by 15 March, beyond which yield decreases significantly (0.5 ton ha^{-1} $week^{-1}$) due to high-temperature stress. This can be achieved by early sowing of wheat before 15 November. The optimal and sub-optimal conditions for wheat growth based on yields, normal weather of congenial, and a heat stress year are presented in Fig. 3.6.

Negative Impacts

Akola

Increase in heavy rainfall events

In recent years, heavy rainfall events of >50 mm have been increasingly noticed in most parts of the Vidarbha. Increased flash floods which took lives destroyed homes and agricultural fields as well as resulted in huge revenue losses.

Decline in crop area of green gram and black gram

In Vidarbha, important pulses such as Green gram and Black gram are grown in the Kharif season followed by pigeon pea. As these crops are of short duration, they are cultivated in all three seasons namely Kharif, Rabi, and Summer. Most of its production is taken in Kharif. These crops are also cultivated as main or intercrops, but in the last few years, the area under these crops has decreased due to delayed rains creating uncertainty about productivity. After planting in June, the crop is usually harvested in August. But during this period, the amount of heavy rainfall has increased. So Green gram cannot be harvested. Ripe pods burst due to rain. The seeds from split pods germinate within the pods themselves. As a result, the entire crop is lost or yield is reduced. Drought and rain stress in many areas have also reduced the interest of farmers in green gram and black gram

Increase in damage to Kharif crop at harvest

The most devastating loss for soybeans during harvesting. Untimely rainfall during October end/November damages the plants that have reached maturity and are ready to harvest. Often, they germinate in response to the rainfall inside the pod itself, and intact pods develop a high incidence of fungal diseases. At this point, there is nothing the farmer can do to recover the yield. Post-threshing costs increase, yields are reduced and profit is reduced. The remaining seeds to be planted the next year are also damaged. November is the time of the first picking of cotton, and rainfall at this time is highly detrimental, as a greater percentage of bolls have burst open. The open balls are easily destroyed by small amounts of rainfall.

Increase in incidence of Gusty wind and Hail storm

The incidence of hail storms is increasing during the February-March-April months especially impacting wheat, gram, onion, oranges, mangoes, bananas, mangoes, and vegetable crops. Due to strong winds of high velocity accompanied by hailstones, crops on 50,000 hectares of land have been damaged in the Yavatmal, Akola, Amravati, and Buldhana districts in April 2024,

Anand

During 2023-24, the magnitude of the drop-in temperature was less during the November to January months as compared to previous years. This resulted in a lower production of Wheat (2600 kg ha^{-1}) during rabi 2022-23 year. During rabi 2023-24, due to the partly cloudy condition (March month), and unseasonal rainfall (16 March and 24 March and unseasonal rainfall also occurred on 27 November, 03 December 2023, and 3 March 2024), the quality of tobacco decreased and the price of tobacco dropped down (Table 3.2).

Table 3.2 Yield and the market price of Tobacco and Wheat during rabi seasons of 2022-23 and 2023-24 at Anand

Season	Particulars	Tobacco	Wheat
2021-22	Production (kg ha^{-1})	3300	3500
	Price (Rs kg^{-1})	72.25	19
	Income (Rs)	2,38,425	66,500
2022-23	Production (kg ha^{-1})	3200	2800
	Price (Rs kg^{-1})	55.20	15
	Income (Rs)	1,76,640	42,000
2023-24	Production (kg ha^{-1})	2950	2600
	Price (Rs kg^{-1})	58.45	14.5
	Income (Rs ha^{-1})	1,72,427	37,700

Anantapur

Increase in heavy rainfall events

In recent years, heavy rainfall events of >50 mm have been increasingly noticed in most parts of the state. The frequent flash floods occurrence in towns led to the submergence of low-lying residential areas causing huge damage to human lives, and infrastructure, and in rural areas, led to inundation of crops and horticultural crops causing huge monetary losses.

Frequent crop failures

The erratic distribution of rainfall, increasing frequency of dry spells, considerable reduction in rainy days, and deficit/excess soil moisture during critical stages during the crop growth period severely affected the growth and development of the crops and ultimately led to frequent crop failures. Further, the crop phenological events were altered due to increasing diurnal variation in temperatures affecting the yield attributes resulting in a drastic reduction of yields. Moreover, the crops harvesting time of many crops coinciding with extreme weather events such as cyclones and droughts led to damage of economic parts in the majority of crops or deficit in soil moisture at harvesting time led to soil hardening resulting in leftover more number pods in the soil causing considerable yield reduction.

Thunderstorms, gale and hail storms

Increased incidence of thunderstorms, gales, and hail storms has been noticed in recent years in Andhra Pradesh state. The thunderstorms caused a human toll of approximately 36 and a huge loss of animal life. The occurrence of gales has been increasing causing loss to infrastructure like the uprooting of electric poles, trees, and lodging of standing crops. Further, the occurrence of gales in the April-May months led to severe damage to horticultural crops leading to flower and fruit drop. In addition, the occurrence of hail storms has been increasingly noticed causing heavy damage to horticultural crops like mango, banana, citrus, sweet orange, papaya, etc. in terms of yield as well as quality of the produce. A hail storm caused large-scale damage over 30,000 acres of paddy, maize, chilli, green gram, drum-stick, papaya, mango, banana, and other crops over Ananthapuramu district during 2022-23

Bangalore

Altered sowing windows

Though the variability in rainfall has increased the area under certain crops, it has also resulted in dry spells during June-July. The quantum of May rainfall is increasing, but the rainfall received during the southwest monsoon, i.e., starting from June to July, has become erratic. July was the normal sowing window in the southern parts. The reduced rainfall during the establishment and the grand growth period of crops, negatively affected the crop.

Unseasonal rainfall affecting crop growth

High-intensity unseasonal rainfall affects the crop due to floods and waterlogging under poorly drained soil conditions in the region. The instances of floods have increased in recent years.

Hail storm damage

The incidence of hail storms is increasing during the March-April months especially impacting horticulture crops viz., fruits, plantation, flower, and vegetable crops. The mango is at the flowering to fruiting stage during the stage resulting in flower and fruit drop. Increased damage with hail stones was observed in fruits (watermelon, citrus, and grapes) and vegetables (cole crops, tomato, and cucumbers). Similarly, flower crops are also vulnerable to hailstone, especially in Vijayapura, Chikkaballapur, Kolar, etc.

Faizabad

The maximum temperature during the reproductive stage has a negative correlation with the yield of chickpeas (Fig. 3.7). Yield decreased with successive increases of max. temp. during the reproductive stage from 27.2 to 33.2 °C ($R^2 = 0.96$). The yield of Chickpea decreased by 50 kg ha^{-1} with a unit increase in maximum temperature.

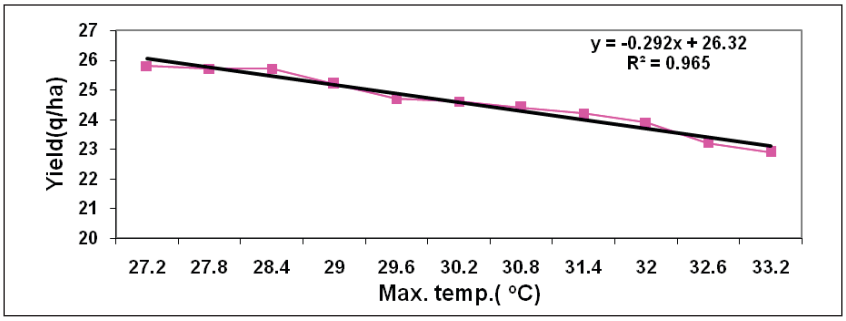


Fig. 3.7 Negative relationship of maximum temperature with pod yield of chickpea

Jorhat

The mean accumulated rainfall received during *Kharif* season (22 to 43 SMW) is 1173.2 mm, 1356.2 mm, 1408.1 mm, 1856.9 mm, and 1746.8 mm in Golaghat, Jorhat, Sivasagar, Dibrugarh and Tinsukia district of Upper Brahmaputra Valley Zone (UBVZ), Assam, respectively. The variability in total rainfall received during the period was found to be less than 20% (Table 3.3). Likewise, the mean number of rainy days varied from 65.3 to 79.4 days over different districts of UBVZ with CV ranging from 10.5 to 13.1%. The Sen's estimator of slope depicts a decreasing trend in rainfall and rainy days throughout the different districts and the zone as a whole. Among the five districts of UBVZ, Golaghat experiences a significant decreasing trend in mean accumulated rainfall (11.5 mm $year^{-1}$) and rainy days (0.42 numbers $year^{-1}$) during the *kharif* season. The decreasing trend in mean accumulated rainfall (-6.30 mm $year^{-1}$) and rainy days (-0.26 days $year^{-1}$) was found to be statistically significant over the UBVZ. Similarly, the mean minimum and

maximum temperature corresponding to *kharif* season over the UBVZ varied from 23.9 to 24.4 °C and 31.1 to 31.5 °C with CV 1.7 to 2.35% and 1.70 to 1.94%, respectively. The analyzed result of station-level data on temperature revealed a substantial rise in mean maximum temperature in both the districts *viz.*, Jorhat (0.02 °C year^{-1}) and Dibrugarh (0.03 °C year^{-1}). Overall, the UBVZ as a whole witnessed a statistically significant rise in mean maximum temperature (0.03 °C year^{-1}); whereas the rising trend was non-significant for minimum temperature (0.01 °C year^{-1}).

Table 3.3 Sen's slope estimator for different weather conditions during *kharif* and rabi season 1986-2015 in Upper Brahmaputra Valley Zone, Assam

Districts	Rainfall			Rainy days			Tmax			Tmin		
	Mean	CV	Q	Mean	CV	Q	Mean	CV	Q	Mean	CV	Q
Kharif												
Golaghat	11173	17.9	-11.5*	65	13.10	-0.42*	-	-	-	-	-	-
Jorhat	1356	12.6	-1.10	70	10.76	-0.23	31.5	1.70	0.02*	24.4	2.35	0.01
Sibasagar	1408	15.8	-2.40	-	-	-	-	-	-	-	-	-
Dibrugarh	1857	15.9	-5.56	79	10.5	-0.40*	31.1	1.94	0.03**	23.9	1.70	0.01
Tinsukia	1747	16.7	-9.78	-	-	-	-	-	-	-	-	-
UBVZ	1511	9.10	-6.30*	72	9.59	-0.26*	31.3	1.73	0.03**	24.1	1.65	0.01
Rabi												
Golaghat	77	76.1	-1.68	7	53.6	-0.15	-	-	-	-	-	-
Jorhat	84	52.7	-2.39*	8	41.8	-0.21**	24.8	3.2	0.02	12.3	4.9	0.03*
Sibasagar	109	60.5	-2.03	-	-	-	-	-	-	-	-	-
Dibrugarh	111	41.7	-2.32*	11	36.3	-0.20*	25.2	3.6	0.04*	12.3	6.0	0.01
Tinsukia	115	63.3	-1.30	-	-	-	-	-	-	-	-	-
UBVZ	97	45.5	-2.05**	9	38.3	-0.19*	25.0	3.3	0.03*	12.3	4.9	0.01

Similarly, mean accumulated rainfall received during *Rabi* season (44 to 8 SMW) is 76.8 mm, 84.0 mm, 109.3 mm, 110.7 mm, and 114.9 mm in Golaghat, Jorhat, Sivasagar, Dibrugarh and Tinsukia district of UBVZ of Assam, respectively. The variability in total rainfall received during the period was found to be more than 40%. Likewise, the mean number of rainy days varied from 7.2 to 10.73 days over different districts of UBVZ with CV ranging from 36.3 to 53.6%. Analogous with *kharif* season, the Sen's estimator of slope depicts a decreasing trend in rainfall and rainy days throughout the different districts and the zone as a whole during *rabi* season too. Overall, the zone receives a mean accumulated rainfall of 97.1mm in 8.8 rainy days with CV 45.5% and 38.3%, respectively during *rabi* season. The decreasing trend in mean accumulated rainfall (2.05 mm year^{-1}) and rainy days (0.19 days year^{-1}) was found to be statistically significant over the zone. Similarly, the

mean minimum and maximum temperature corresponding to *rabi* season over the UBVZ varied from 12.30 to 12.34 °C and 24.8 to 25.2 °C with CV 4.9 to 6.0% and 3.2 to 3.6%, respectively. The zone as a whole witnessed a statistically significant increasing trend in mean maximum temperature (0.03 °C year^{-1}) during the rabi season. However, the rising trend was statistically non-significant for minimum temperature (0.01 °C year^{-1}) over the zone.

The increasing tendency in mean maximum and minimum temperature and decreasing tendency in rainfall and rainy days during both *Kharif* and *rabi* crop growing seasons poses a serious concern in rising possibilities for crop-water stress conditions due to more dry spells and higher rate of evapotranspiration losses from crop field. This may lead to a drop in dry matter production by the crop, and finally reduction in yield. Furthermore, the decrease in seasonal rainfall was mainly attributed to a decrease in small rainy events, thereby affecting the general hydrological balance model over the zone.

Mohanpur

Increase in extreme rainfall events

The number of days in a year with rainfall events > 100 mm per day over 23 locations of West Bengal was calculated from the daily rainfall data during 1990-2023. The days of extreme rainfall events were plotted against the year and it is observed that there is an

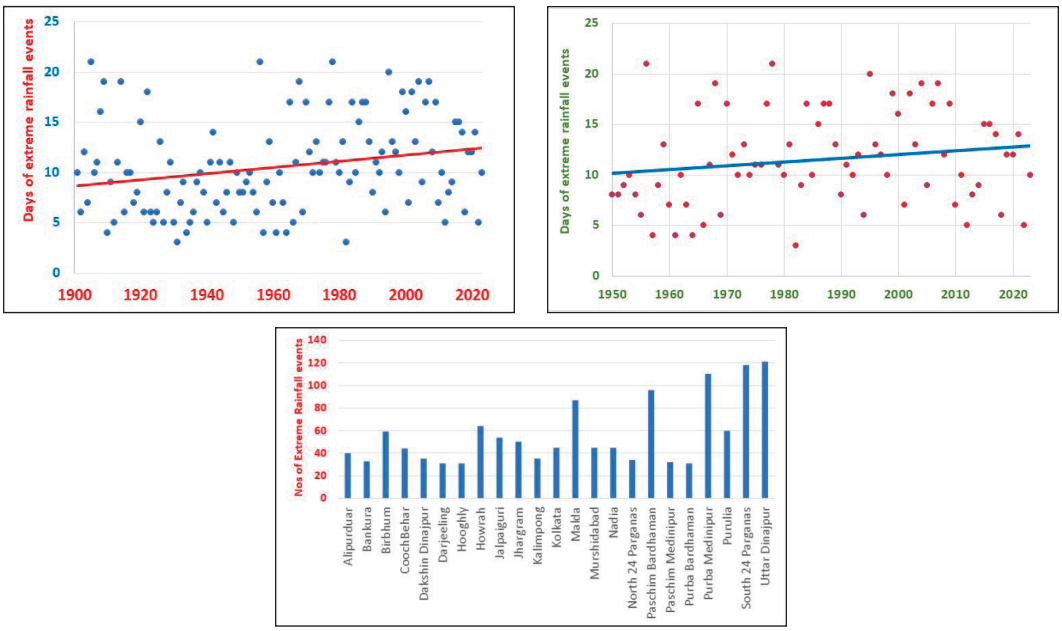


Fig. 3.8 Extreme rainfall events in West Bengal (a. 1900 to 2023; b. 1950 to 2023; c. Occurrence of extreme rainfall events at different locations)

increasing trend of such events. A similar graph was prepared for 1950-2023 which also shows an increasing trend. It is observed that in West Bengal, the extreme rainfall events are increasing at the rate of 0.037 per year. Once the location-wise distribution of the number of extreme rainfall events was observed, it varied from 35-120 events for the last 123 years. North Dinajpur, which is part of Terai region, encounters almost 1 extreme event per year. It is followed by South 24 Parganas which is a cyclone-affected district. Another coastal district, East Midnapore, is the third most vulnerable district concerning extreme rainfall events (Fig. 3.8).

Samastipur

The negative impact of high-temperature stress on wheat yield

Three years of data (2014-15, 2015-16, and 2016-17) on wheat yield and air temperature during the flowering to maturity period was used to ascertain the impact of high temperature on wheat yield. A perusal of Fig 3.9 shows that maximum days of continuous heat stress (T_{max}>29 ˚C) had a significant negative impact on grain yield. Grain yield decreased by 1.1 q ha^{-1} in response to a one-day increase in heat stress period. The impact of elevated maximum temperature and average temperature during the flowering to maturity period area is visible (Fig. 3.10a&b).

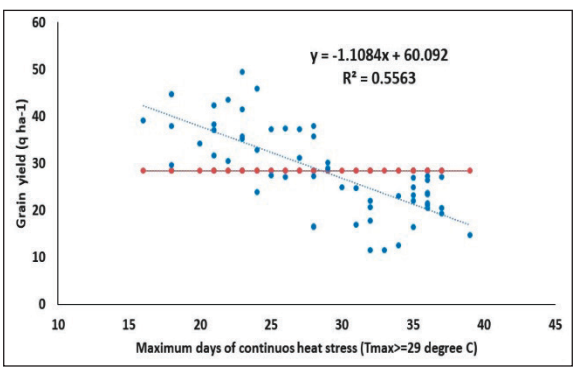


Fig. 3.9 Effect of heat stress on wheat yield at Pusa, Bihar

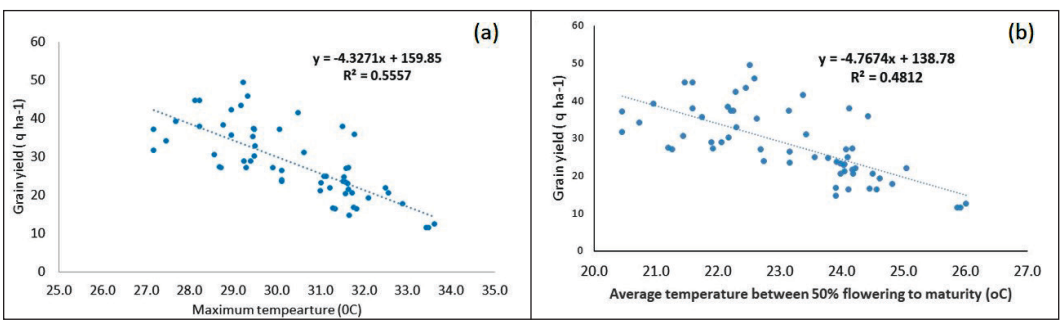


Fig. 3.10 Effect of (a) maximum temperature and (b) average temperature on wheat yield

4. Validation of Block-level Weather Forecast

Akola

Alanda village

Quantitative analysis has been carried out purely on a 'Yes' or 'No' basis for Rainfall, the analysis was done by examining whether the events occurred or not, as per the forecast. The data collected on rainfall for different periods are presented in Table 4.1.

As the analysis indicated the success probability for rainfall during the entire year April 2023-March 2024 was 81.37 percent. Rainfall has a very high success percentage (97.5 %) from December 2023 to March 2024, followed by October-November 2023 i.e. 95.08 percent. The failure percentage was highest from June to September 2023 i.e. (42.6%). The correlation of forecasted and observed rainfall was found to be significant at 5 and 1 percent indicating a significant relationship between forecasted and observed values. The value for root mean square error (RMSE) observed for rainfall was 11.11.

Table 4.1 Simple success probability of rainfall forecast at Alanda

Period	No. of observations	Probability Percentage	
		Success %	Unusable %
April 2023 – March 2024	365	81.4	18.6
April – May 2023	61	83.6	16.4
June – September 2023	122	57.4	42.6
October– November 2023	61	95.1	4.9
December 23– March 24	121	97.5	2.5
R^2	0.409	S	RMSE=11.11

Overall usability analysis of rainfall forecast

Overall usability analysis was carried out for rainfall which is presented in Table 4.1a. The analysis showed that the rainfall forecast for the entire year was highly successful at 74.5 percent, 6.8 percent usable, and 18.6 percent failure during the entire year from April 2023 to March 2024. During the period October-November 2023, the percentage of correct forecast occurrence was 95.1 percent, followed by December 2023 - March 2024 (93.4%). While usable percentage and failure percentage of 13.9 percent and 42.6 percent, respectively were observed during the period of southwest monsoon season i.e., June to September 2023.

Table 4.1a Overall usability analysis of rainfall forecast

Sr. No.	Period	Forecast occurrence						
		Correct (No.)	Correct %	Usable (No.)	Usable %	Fail (No.)	Fail %	Total
1	Apr 2023-Mar 2024	272	74.5	25	6.8	68	18.6	365
2	Apr-May 2023	48	78.7	3	4.9	10	16.4	61
3	Jun-Sep 2023	53	43.4	17	13.9	52	42.6	122
4	Oct-Nov 2023	58	95.1	0	0.0	3	4.9	61
5	Dec 2023-Mar 2024	113	93.4	5	4.1	3	2.5	121

2. Mirzapur (Rainfall)

The results of the analysis in Table 4.2 indicated that the success probability for rainfall during the entire year April 2023-March 2024 was 78.4 percent. Rainfall has a very high success percentage (96.7%) from December 2023 to March 2024 followed by October-November 2023 i.e. 93.44%. The failure percentage was highest from June to September 2023 i.e. (49.2%). The correlation of forecasted and observed rainfall was found to be significant at 5 and 1 percent indicating a significant relationship between forecasted and observed values. The value for root mean square error (RMSE) observed for rainfall was 11.9.

Table 4.2 Simple success probability of rainfall forecast at Mirzapur

Period	No. of observations	Probability Percentage			
		Success	Success %	Unusable	Unusable %
April 2023–March 2024	365	286	78.4	79	21.6
April – May 2023	61	50	82.0	11	18.0
June – September 2023	122	62	51.8	60	49.2
October– November 2023	61	57	93.4	4	6.6
December 2023– March 2024	121	117	96.7	4	3.3
		S	S		

R^2= 0.29; RMSE = 11.9

Overall usability analysis of forecast: Rainfall

Overall usability analysis was carried out for rainfall which is presented in Table 4.2a. The analysis showed that the rainfall forecast for the entire year was highly successful 74.5% correct, 3.8% usable, and 21.6% failure during the entire year from April 2023 to March 2024. From October to November 2023 and December 2023 – March 2024 the percentage of correct forecast occurrence was 93.4%, followed by April – May 2023 (77.0%). While usable percentage and failure percentage of 5.7% and 49.2% respectively were observed from June to September 2023.

Table 4.2a Overall usability analysis of rainfall forecast

Sr. No.	Period	Forecast occurrence						
		Correct (No.)	Correct %	Usable (No.)	Usable %	Fail (No.)	Fail %	Total
1	April 2023 – March 2024	272	74.5	14	3.8	79	21.6	365
2	April – May 2023	47	77.0	3	4.9	11	18.0	61
3	June – September 2023	55	45.1	7	5.7	60	49.2	122
4	October– November 2023	57	93.4	0	0.0	4	6.6	61
5	December 2023– March 2024	113	93.4	4	3.3	4	3.3	121

Skill Score recorded based on Ratio Score (%) for the Kharif season (June-September, 2023) AICRPAM-NICRA Alanda and Mirzapur (Akola) was to the tune of 72.9 and 71.3 percent, respectively. Similarly, the HK Score for AICRPAM-NICRA village Alanda and Mirzapur (Akola) was observed to be 0.39 and 0.24, respectively.

Anantapur

Rainfall

Validation of Block-level Weather Forecasts was carried out at Anantapur and the results of qualitative analysis of rainfall forecast based on different skill scores are presented in Table 4.3.

Table 4.3 Month-wise verification of rainfall forecast at Anantapur

Month	Correct	Usable	Usability %	Unusable	RMSE	Ratio score
January	100.0	0.0	100.0	0.0	0.0	100.0
February	100.0	0.0	100.0	0.0	0.0	100.0
March	90.0	3.3	93.3	6.7	0.8	96.7
April	92.3	0.0	92.3	7.7	4.8	86.7
May	77.8	5.6	83.4	16.6	6.0	58.1
June	72.2	0.0	72.2	27.8	11.4	60.0
July	61.9	9.5	71.4	28.6	12.5	67.7
August	100.0	0.0	100.0	0.0	4.6	90.3
September	52.9	11.8	64.7	35.3	10.8	56.7
October	96.0	4.0	100.0	0.0	3.4	80.7
November	92.6	0.0	92.6	7.4	7.1	90.0
December	100.0	0.0	100.0	0.0	0.7	83.9
Mean	86.3	2.9	89.2	10.8	5.2	80.9

Ananthapuramu block monthly rainfall was verified through error structure, the results observed that the usability of the rainfall forecast was excellent in January, February, August, October, and December. The ratio score should be higher for accurate prediction of rainfall. The ratio score was more than 50% was observed in all the months. When the season-wise predicted rainfall was verified through error structure winter season recorded (100%) usability followed by northeast monsoon season (97.4%) (Table 4.3a).

Table 4.3a Season-wise verification of rainfall forecast (in percentage)

Season	Correct	Usable	Correct +Usable	Un usable	RMSE	Ratio score
Winter	100.0	0.0	100.0	0.0	0.0	100.0
Summer	86.7	3.0	89.7	10.3	3.9	80.5
SWM	75.0	4.8	79.8	20.2	10.3	68.9
NEM	96.2	1.3	97.4	2.6	4.5	84.8
Mean	89.5	2.3	91.7	8.3	4.7	83.6

Maximum temperature

The maximum temperature (Tmax) was verified through error structure. The results indicated that the usability percentage of temperature forecast was more than 50% except in July month (48.4%). The percent of unusable forecasts was highest in the month of July (51.6%) (Table 4.4).

Table 4.4 Month-wise verification of Maximum Temperature forecast (in percentage)

Month	Correct	Usable	Correct+ Usable	Unusable	RMSE
January	87.1	9.7	96.8	3.2	0.9
February	67.9	32.1	100.0	0.0	1.0
March	71.0	19.4	90.4	9.6	1.1
April	43.3	36.7	80.0	20.0	1.7
May	48.4	29.0	77.4	22.6	1.6
June	53.3	26.7	80.0	20.0	1.6
July	32.3	16.1	48.4	51.6	2.8
August	41.9	19.4	61.3	38.7	1.9
September	40.0	30.0	70.0	30.0	2.6
October	54.8	29.0	83.9	16.1	1.3
November	53.3	30.0	83.3	16.7	1.4
December	54.8	29.0	83.9	16.1	2.1
Mean	54.0	25.6	79.6	20.4	1.7

Season-wise Tmax was verified through error structure and the results revealed that usability of forecasted maximum temperature was excellent in the winter season (98.4%) followed by northeast monsoon (83.7%) (Table 4.4a).

Table 4.4a Season-wise verification of Maximum Temperature forecast (in percentage)

Season	Correct	Usable	Correct+ Usable	Unusable	RMSE
Winter	77.5	20.9	98.4	1.6	0.9
Summer	54.2	28.4	82.6	17.4	1.5
SWM	41.9	23.0	64.9	35.1	2.2
NEM	54.3	29.4	83.7	16.3	1.6
Mean	57.0	25.4	82.4	17.6	1.6

Minimum temperature

The minimum temperature (Tmin) was verified through error structure. The results indicated that the usability percentage of the forecast was observed excellent during the months of June and July (Table 4.5).

Table 4.5 Month-wise verification of minimum temperature forecast (in percentage)

Month	Correct	Usable	Correct+ Usable	Unusable	RMSE
January	32.3	41.9	74.2	25.8	2.2
February	21.4	53.6	75.0	25.0	1.8
March	35.5	45.2	80.7	19.3	1.8
April	23.3	26.7	50.0	50.0	3.1
May	35.5	22.6	58.1	41.9	2.7
June	70.0	23.3	93.3	6.7	1.2
July	58.1	38.7	96.8	3.2	1.0
August	45.2	35.5	80.6	19.4	1.4
September	46.7	33.3	80.0	20.0	1.5
October	35.5	16.1	51.6	48.4	2.7
November	36.7	36.7	73.3	26.7	2.0
December	25.8	22.6	48.4	51.6	2.2
Mean	38.8	33.0	71.8	28.2	2.0

Season-wise verification of Tmin through error structure revealed that the usability percentage of Tmin was highest during the southwest monsoon followed by the winter season (Table 4.5a).

Table 4.5a Season-wise verification of minimum temperature forecast (in percentage)

Season	Correct	Usable	Correct+ Usable	Unusable	RMSE
Winter	26.8	47.8	74.6	25.4	2.0
Summer	31.4	31.5	62.9	37.1	2.5
SWM	55.0	32.7	87.7	12.3	1.3
NEM	32.7	25.1	57.8	42.2	2.3
Mean	36.5	34.3	70.8	29.3	2.0

Bangalore

Block-level weather forecasts were validated for their use in Agro-met advisory services. Among the weather parameters, higher number of correct forecasts were given on rainfall (309 forecasts, 84.6 %) indicating a better ability of the model to forecast rainfall on an annual scale. Except for rainfall, maximum temperature (200 forecasts, 54.8%), Tmin (240 forecasts, 65.8%), and wind direction (203 forecasts, 55.6%) were correct. The least number of correctness was observed on Wind speed (10 forecasts, 2.7%) and Cloud cover (39 forecasts, 10.7%) necessitating improvisation in these parameters (Fig.4.1).

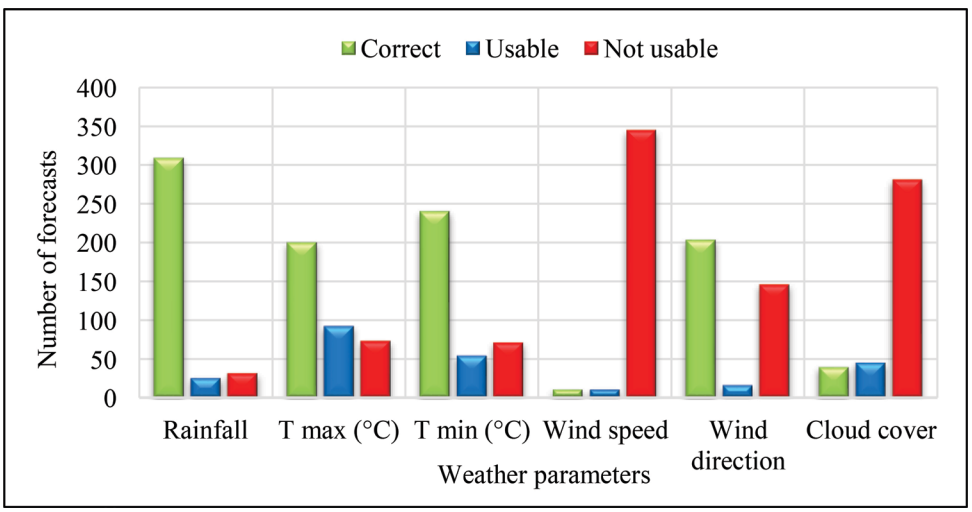


Fig. 4.1 Quantitative analysis of forecasts for the year 2023

Season-wise Quantitative analysis of forecasts

Winter (January & February)

A higher number of correct forecasts were given on rainfall (58 forecasts, 98.3%) indicating a better ability of the model to forecast rainfall in winter followed by wind direction (31 forecasts, 52.5%), maximum temperature (27 forecasts, 45.8%) and minimum temperature

(17 forecasts, 28.8%). The least number of correct were given on wind speed (9 forecasts, 15.3%) and cloud cover (19 forecasts, 32.2%) necessitating improvisation in these aspects (Fig. 4.2).

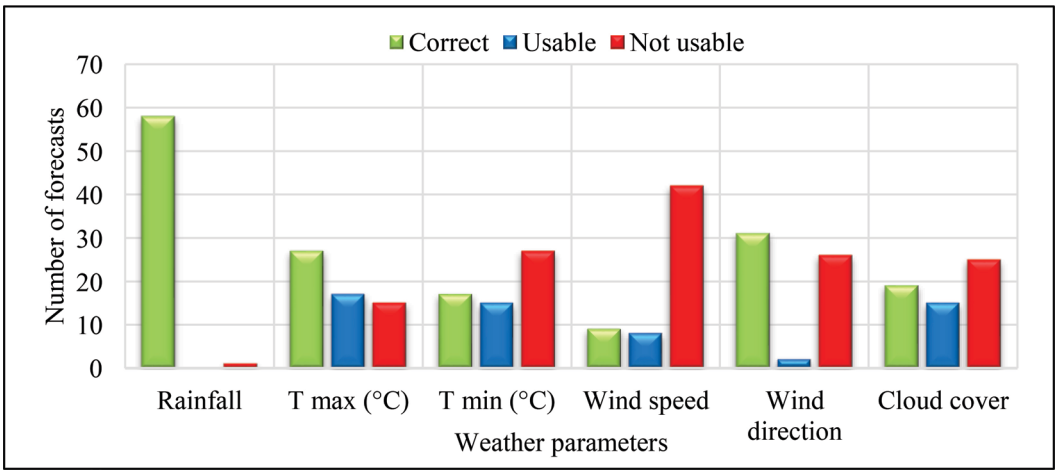


Fig. 4.2 Quantitative analysis of forecasts for Winter 2023

Pre-monsoon (March to May)

A higher number of correct forecasts were given on rainfall (80 forecasts, 86.9%) indicating a better ability of the model to forecast rainfall in the pre-monsoon season, followed by minimum temperature (57 forecasts, 62.0%), maximum temperature (50 forecasts, 54.3%) and wind direction (43 forecasts, 46.7%). The least number of correct forecasts was given on wind speed (1 forecast, 1.1%) and cloud cover (12 forecasts, 13.0%) necessitating improvisation in these models (Figure 4.3).

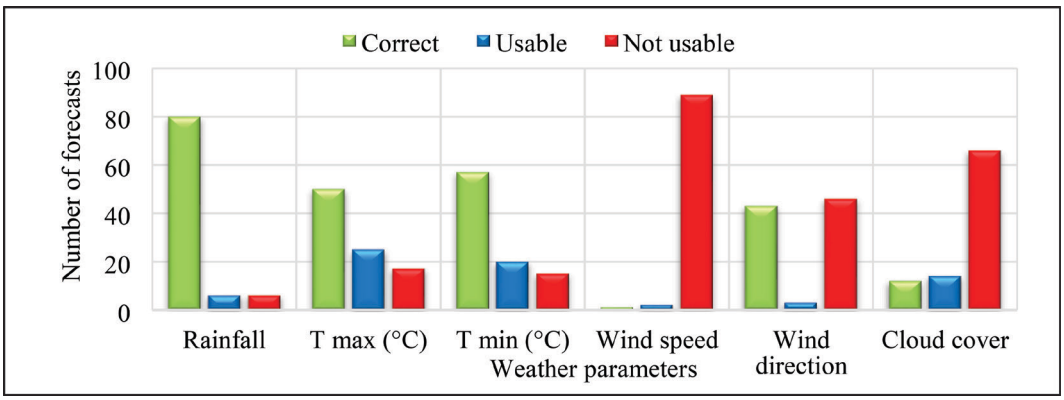


Fig. 4.3 Quantitative analysis of forecasts for the pre-monsoon season of 2023

South-west monsoon (June to September)

A higher number of correct forecasts were given on minimum temperature (100 forecasts, 82.0%), and rainfall (96 forecasts, 78.6%) indicating a better ability of the model to forecast rainfall in the southwest monsoon season followed by maximum temperature (79 forecasts, 64.8%) and wind direction (73 forecasts, 59.8%). The least number of correct forecasts were given on wind speed (0 forecasts, 0%) and cloud cover (3 forecasts, 2.5%) necessitating improvisation of forecasts concerning these parameters (Figure 4.4).

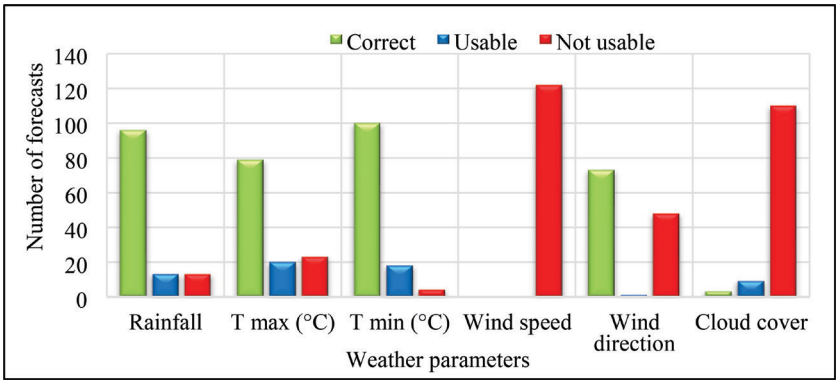


Fig. 4.4 Quantitative analysis of forecasts for the south-west monsoon season of 2023

North-east monsoon (October to December)

A higher number of correct forecasts were given on rainfall (74 forecasts, 80.4%) indicating a better ability of the model to forecast rainfall in the southwest monsoon season followed by minimum temperature (67 forecasts, 72.8%), wind direction (56 forecasts, 60.9%) and maximum temperature (44 forecasts, 47.8%). The least number of correct forecasts were

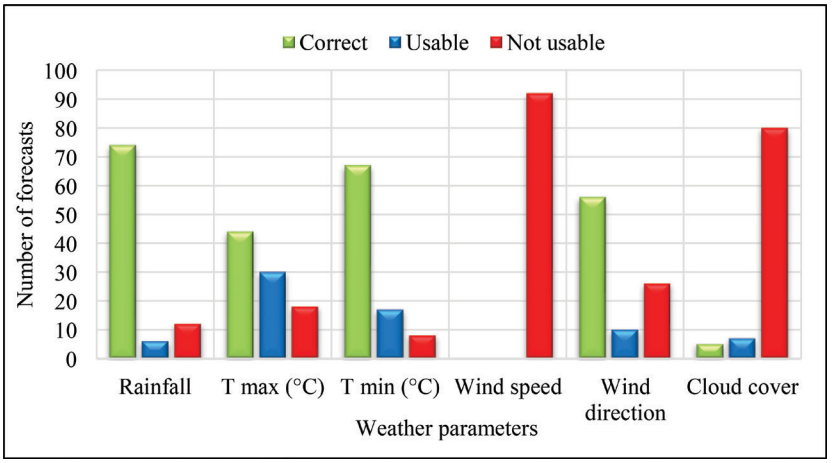


Fig. 4.5 Quantitative analysis of forecasts for the north-east monsoon season of 2023

given on wind speed (0 forecasts, 0 %) and cloud cover (5 forecasts, 5.4%) necessitating improvisation of forecasts concerning these parameters (Fig. 4.5).

Hisar

Rainfall

The season-wise quantitative verification analysis forecast for rainfall was carried out using various error structures for Hisar during 2023-24 (Table 4.6). The data explains that the rainfall forecast was accurate *i.e.* 98.8 % for post-monsoon season, 98.2 % accurate during winter, and 84.1 % correct during pre-monsoon season. The accuracy is comparatively lower during monsoon season (82.1%). In the case of the annual rainfall forecast, the forecast accuracy was 91.1%.

Table 4.6 Quantitative analysis (%) of predicted rainfall events at Hisar using error structures

Error structure	Season				
	Pre-Monsoon	Monsoon	Post Monsoon	Winter	Annual
Correct	84.1	82.1	98.8	98.2	91.1
Usable	0.0	3.0	0.0	1.8	1.1
Unusable	15.9	14.9	1.2	0.0	7.8

Maximum Temperature

The quantitative analysis of the predicted maximum temperature is presented in Table 4.7. It showed that the highest number of correct forecast events were during post-monsoon season (63.0%) followed by pre-monsoon (60.9%) and monsoon (56.6%). The least accuracy in forecast *i.e.* 45.8%. was reported during the winter season. In the case of the annual maximum temperature forecast, 57.5% of the forecasts were correct events with 27.1% usable and unusable events. The highest number of unusable events were recorded during the winter season (27.1%).

Table 4.7 Quantitative analysis (%) of predicted maximum temperature events at Hisar using error structures

Error structure	Season				
	Pre -Monsoon	Monsoon	Post Monsoon	Winter	Annual
Correct	60.9	56.6	63.0	45.8	57.5
Usable	16.3	20.5	23.9	27.1	21.4
Unusable	22.8	23.0	13.0	27.1	21.1

Minimum Temperature

The season-wise minimum temperature forecast verification results (Table 4.8) showed that the highest correct event forecast (59%) was observed during the monsoon season followed by the post-monsoon (58.7%) and pre-monsoon (41.3%) period. The lowest accuracy was observed during the winter season (28.8%). Annual forecast verification of minimum temperature events showed 49.6% accuracy. The annual usable forecast events were 24.4% and 26.0% were unusable. The usable percentage was relatively low during monsoon season (22.1 %).

Table 4.8 Quantitative analysis (%) of predicted minimum temperature events at Hisar using error structures

Error structure	Season				
	Pre-Monsoon	Monsoon	Post Monsoon	Winter	Annual
Correct	41.3	59.0	58.7	28.8	49.6
Usable	25.0	22.1	22.8	30.5	24.4
Unusable	33.7	18.9	18.5	40.7	26.0

The season-wise quantitative verification analysis for maximum relative humidity (Table 4.9) showed that the correctness of forecast events during the winter season was highest (83.1%) followed by monsoon (46.7%) and post-monsoon (45.7 %), whereas the least correct events (18.5%) were observed during pre-monsoon season. In the case of annual maximum relative humidity forecast events, 45.2% was correct and the usable events were 27.4. The unusable percentage was highest during the post-monsoon season (40.2%).

Table 4.9 Quantitative analysis (%) of predicted maximum relative humidity events at Hisar using error structures

Error structure	Season				
	Pre-Monsoon	Monsoon	Post Monsoon	Winter	Annual
Correct	18.5	46.7	45.7	83.1	45.2
Usable	25.0	26.2	40.2	13.6	27.4
Unusable	56.5	27.1	14.1	3.4	27.4

In the case of minimum relative humidity forecast (Table 4.10) the highest (53.3%) correct event was observed during post-monsoon season followed by winter (52.5 %) and monsoon (50.0%). The annual minimum relative humidity forecast events were correct to the extent of 47.1 % and the usable events were 30.1% whereas 22.7% were unusable. The usable percentage was relatively high during the winter season (33.9%).

Table 4.10 Quantitative analysis (%) of predicted minimum relative humidity events at Hisar using error structures

Error structure	Season				
	Pre-Monsoon	Monsoon	Post Monsoon	Winter	Annual
Correct	33.7	50.0	53.3	52.5	47.1
Usable	26.1	31.2	30.4	33.9	30.1
Unusable	40.2	18.9	16.3	13.6	22.7

In the case of wind speed forecast (Table 4.11), the highest (91.5%) correct event was observed during the winter season followed by post-monsoon (89.1%) and pre-monsoon (66.3%). The least correct events were during monsoon season (50.8%). The annual wind speed forecast events were correct to the extent of 71.0% and the usable events were 26.6% whereas 2.5% were unusable. The usable percentage was relatively high during monsoon season (43.4%).

Table 4.11 Quantitative analysis (%) of predicted wind speed events at Hisar

Error structure	Season				
	Pre-Monsoon	Monsoon	Post Monsoon	Winter	Annual
Correct	66.3	50.8	89.1	91.5	71.0
Usable	31.5	43.4	10.9	8.5	26.6
Unusable	2.2	5.7	0.0	0.0	2.5

The graphical comparisons of forecasted and observed values of maximum and minimum temperatures, maximum and minimum relative humidity, and rainfall at Hisar during 2022 are presented in Fig. 4.6 a, b, c, d, respectively.

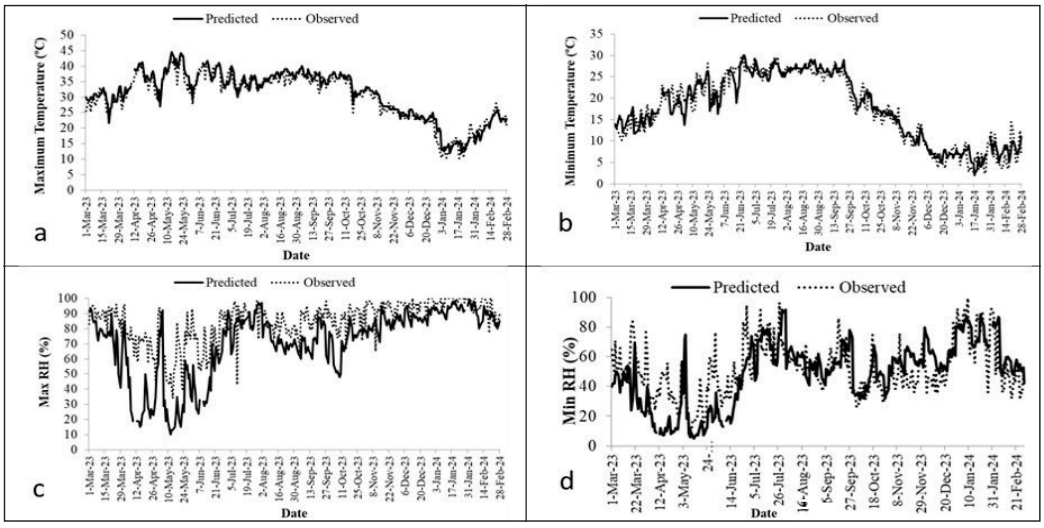


Fig. 4.6a Comparison of predicted and observed daily a. Tmax, b. Tmin, c. RH-I and d. RH-II at Hisar

Jorhat

Seasonal analysis of rainfall forecast

The analysis was carried out using ratio score or Hit score, HK score, HSS score, CSI, POD, and FAR during different seasons at Thengal gaon village are presented in Table 4.12. It was observed that the ratio score during monsoon season was 36.9%. During post-monsoon, the ratio scores were found to be very much accurate i.e., 78.7%. During the winter season, the observed as well as forecasted days with no rainfall were maximum causing the higher ratio score values (84.4%). The HK score was higher (0.12) during the winter season and lowest (-0.07) in the monsoon season indicating the reliability of the forecast was skeptical during monsoon season.

The Probability of Detection (POD) during pre-monsoon, monsoon, and post-monsoon seasons was 0.67, 0.85 and 0.82, respectively. The False Alarm Ratio (FAR) was highest during winter (0.92) and lowest in post-monsoon season i.e., 0.55. The relative forecast accuracy (CSI) was observed very low during winter (0.07) followed by the pre-monsoon (0.25) season. Overall, the study period (annual) records an acceptable limit of hit score (72.3) with POD and FAR as 0.95 and 0.43, respectively.

Table 4.12 Season-wise analysis of rainfall forecasts from March 2023 to February 2024 in Thengal gaon village

Season	Ratio score	HK score	HSS score	CSI	POD	FAR
Pre-monsoon	43.48	0.05	0.03	0.25	0.67	0.71
Monsoon	36.89	-0.07	-0.06	0.37	0.85	0.61
Post-monsoon	78.69	0.60	0.45	0.41	0.82	0.55
Winter	84.44	0.12	0.06	0.07	0.25	0.92
Annual	72.33	0.54	0.48	0.55	0.95	0.43

The RMSE value in different seasons ranged from 3.2 to 23.19 during 2023-24 (Table 4.13). The highest value of RMSE (23.19) was recorded during the monsoon season. The lowest RMSE value was observed during the winter season (3.2) followed by the post-monsoon season (5.9). The ‘r’-values during different seasons varied from -0.05 during winter to 0.44 during the post-monsoon season.

It has been observed that the probability of success was 98% during the winter season. The lowest success rate was observed during monsoon season (40.0%) due to higher variability in the spatio-temporal distribution of rainfall. Overall rainfall forecast was moderately good during this year with a success rate of 69% over the year.

Table 4.13 Season-wise analysis of rainfall forecast from March 2023 to February 2024 Thengal gaon village

Season	RMSE	r-value	Error structure (%)			Probability %	
			Correct	Usable	Unusable	Success	Failure
Pre-monsoon	8.88	0.2	70	7.5	22.5	77.5	22.5
Monsoon	23.19	-0.01	17.78	22.22	60	40.0	60
Post monsoon	5.9	0.44	85.42	4.17	10.42	89.59	10.42
Winter	3.2	-0.05	98.68	0	1.32	98.68	1.32
Annual	27.84	0.43	60.61	8.33	31.06	68.94	31.06

Maximum temperature

The station level realized maximum temperature data from Jorhat Agromet station was considered for forecast verification study in block level as spatial variation in temperature within or adjacent district is not significant. The season-wise 'r' values varied between 0.02 in winter and 0.41 in pre-monsoon season (Table 4.14). The lowest RMSE value was obtained in the monsoon season (4.32) followed by the pre-monsoon season (4.87). Monsoon season recorded the highest probability of success rate (63.1%) for maximum temperature forecast. Overall annual success rate of forecast was 77.5 percent with a rate of failure of 22.5 percent.

Table 4.14 Season-wise error structure of maximum temperature forecasts from March 2023 to February 2024 in Thengal gaon village

Season	RMSE	r-value	Error structure (%)			Probability %	
			Correct	Usable	Unusable	Success	Failure
Pre-monsoon	4.87	0.41	30.43	17.39	52.17	47.8	52.2
Monsoon	4.32	0.32	48.36	14.75	36.89	63.1	36.9
Post monsoon	7.12	0.20	42.62	9.84	47.54	52.5	47.5
Winter	6.76	0.02	11.11	5.56	83.33	16.7	83.3
Annual	2.17	0.77	54.25	23.29	22.47	77.5	22.5

5. Economic Impact of Micro-level Agromet Advisory Services

Customization of micro-level agromet advisories and their dissemination through the latest Information Communication Technologies (ICTs) is a major objective of the AICRPAM-NICRA project. The cooperating centers have started using block-level weather forecasts issued by IMD since September 2014. These forecasts have shown great improvement in the accuracy of the forecast. The concept of block-level AAS is depicted in Fig. 5.1.

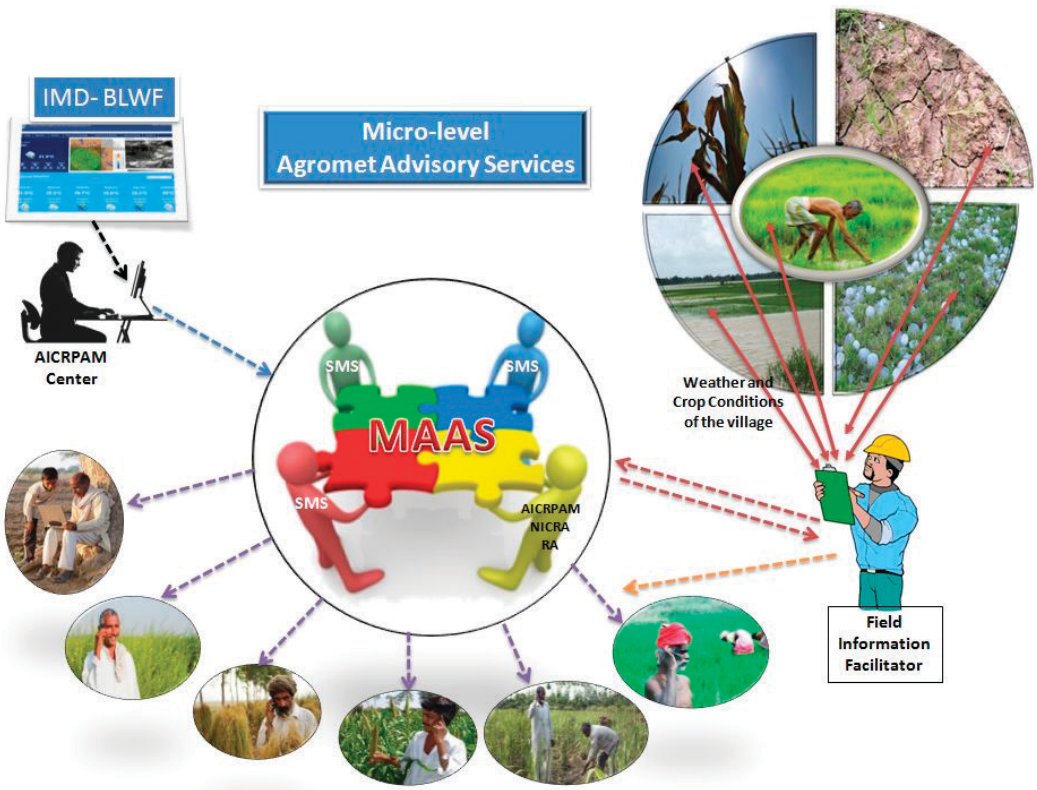


Fig. 5.1 Concept of micro-level of Agromet Advisory Services

The scientific staff receives block-level weather forecasts from the IMD website, and advisories are developed in consultation with Subject Matter Specialists of respective KVKs. Another important and useful component has been introduced in micro-level AAS in the form of appointing a Field Information Facilitator (FIF)' to serve as the

interface among the farmers, AICRPAM, and KVK. Further, FIF collects information (prevailing local weather conditions, crops and their growth stage, vigour, incidence of pests and diseases, etc.) and disseminates advisories to the farmers. Generally, a young and progressive farmer in the concerned village is identified for this purpose. Based on the feedback from FIF, which provides real situations at the village level, and the block-level weather forecast from IMD, micro-level agromet advisories are prepared. Thus, the Agrometeorologist of the AICRPAM centre develops the agromet advisory bulletins with the help of SMS at KVK using the field-level crop information blended with the weather forecast and communicates to the FIFs by email who pass on the bulletins to farmers. The micro-level AAS is generated in the name of the Program Coordinator, KVK, and is disseminated by multiple communication modes, *viz.,* mobile text and voice SMS, display at public places, personal contact, etc. The feedback obtained from the farmers is being evaluated for improving and expanding services for the benefit of the farming community.

Selection of AICRPAM-NICRA villages

The selection procedure for districts/ villages was defined clearly. A district that has been selected under the NICRA-ACRPAM program should not be an IMD-GKMS operating district. After the selection of the district, two villages were selected by each AICRPAM center from a district for the implementation of micro-level AAS under the AICRPAM-NICRA project. A pictorial representation of site selection is given in Fig 5.2.

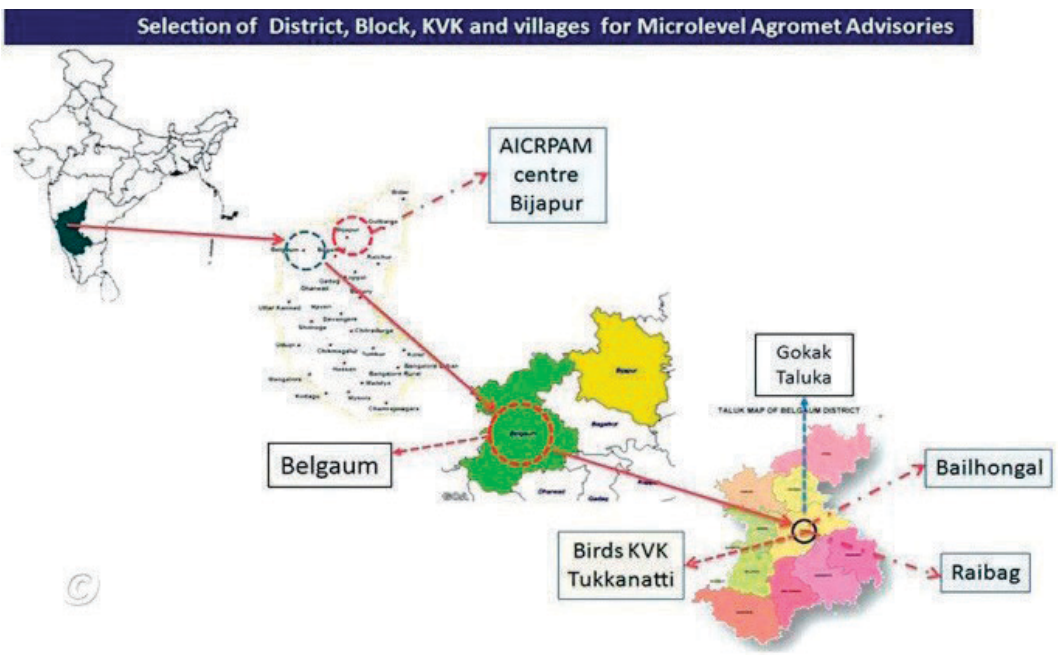


Fig. 5.2 Selection of district, block, KVK, and villages for micro-level AAS

Modes of AAS dissemination

The success of any AAS depends on the timely dissemination of them to farmers. In this era of information communication technology, plenty of options are available to ensure the timely dissemination of AAS to farmers. Under the AICRPAM-NICRA project, both conventional and latest ICT tools are used for the dissemination of micro-level AAS. A pictorial representation of various modes of dissemination used in the AICRPAM-NICRA project is given in Fig 5.3.

Fig. 5.3 Various methods of micro-level AAS dissemination adopted by AICRPAM centres

A brief description of the methods adopted for AAS dissemination is given below:

- Displaying AAS bulletins in common places like milk booths, PDS shops, Panchayat offices etc, which farmers will visit frequently.
- Text SMS: AAS is sent to farmers as text SMS through mobile phones, mobile apps like Havamaana Krishi, Vyavasaya Vathavaranam, ASK and Mewar Ritu, etc.,
- Nowadays, many government and private agencies allow bulk SMS facilities.
- Voice SMS: AAS is sent to farmers in the form of voice SMS, which will be helpful for illiterate farmers.
- Personal contact: Field Information Facilitator (FIF) distributes micro-level AAS developed to individual farmers through personal contact.

- Whatsapp: AAS information is provided through the Whatsapp group for tech-savvy farmers.
- Dandora method: It is followed by Anantapuramu centre in the event of extreme weather event forecast. A person with a drum will travel through the adopted village to inform the farmers about the forecast of heavy rainfall, hailstorms, etc. so that livestock and harvest-ready crops can be saved.

Economic impact of block-level AAS

The ultimate aim of weather-based AAS is to help the farmers in increasing the economic benefit by suggesting management practices suiting the anticipated weather conditions. Impact assessment is an essential tool for assessing the viability of any activity. Economic impact assessments of AAS issued to farmers of NICRA-adopted villages were carried out by various centers. There were mixed impacts, some farmers gained from the agromet advisories while others suffered losses. Some of the examples are listed in the ensuing table.

Table 5.1 Economic Impact of Micro-level Agromet Advisory Services

Akola

Table. 5.1 Economic impact assessment of Microlevel Agromet Advisory Services at villages adopted under AICRPAM-NICRA for Soybean, Pigeonpea and Cotton crops

Village	Date	Farmers	Problem/ weather event	Solution recommended	Benefit/loss
Alanda and Mirzapur	04/07/2023	All farmers	Cloudy weather and forecast for the next 5 days with widespread light to moderate rainfall.	Farmers were advised to adopt various measures such as water conservation in the soil, and water conservation in the crop to maximize the rainfall in the coming Month and also complete remaining soybean sowings immediately by this week, judging soil workability and clear weather. Preferably follow BBF layout for sowing.	The farmers who sown crops on beds with broad bed furrow (BBF) increased soybean seed yield by 10-15%.
Mirzapur	11/07/2023	All farmers	Cloudy weather and forecast next few days with widespread light to moderate rainfall from 11 to 15 July. Infestation of weed problems	For weed control in earlier sown soybean and cotton, recommended to undertake early post-emergence herbicidal spray (with label claim) at a proper stage during clear weather.	The weed population controlled in Kharif crops by undertaking herbicide spray/ weeding
Alanda and Mirzapur	18/07/2023	All farmers	Cloudy weather and forecast next few days with widespread (at most places) light to moderate rainfall from 18 to 19 July and fairly widespread (at many places) light to moderate rainfall from 20 to 22 July. Water logging in low-lying areas of crop fields due to moderate to heavy rainfall during the last four days.	Because of forecasted rainfall farmers were advised to drain out excess water from crops.	Drainage of excess water improved field and crop conditions.

Village	Date	Farmers	Problem/ weather event	Solution recommended	Benefit/loss
Alanda and Mirzapur	25/07/2023	All farmers	Cloudy weather and forecast next few days with widespread (at most places) light to moderate rainfall from 25 to 29 July. Water logging in low-lying areas of crop fields due to moderate to heavy rainfall during the last four days.	Drain out excess water from fields. Undertake intercultural operations (weeding/hoeing) judging soil workability, for the management of weeds and improving soil aeration in kharif crops. Opening of conservation furrows is advisable at the 30-day stage after every three rows of soybean and every two crop rows of cotton at hoeing by tying a rope to hoe tine.	Drainage of excess water improved field and crop conditions. Controlled weed population and improved soil aeration in kharif crops. With conservation furrow, the yield of 1950 kg ha^{-1} and 1600 kg ha^{-1} was obtained with a yield advantage of 350 kg ha^{-1} and 220 kg ha^{-1} over no conservation furrow (1500 kg ha^{-1}) and (1320 kg ha^{-1}) in a sole soybean and cotton respectively.
Alanda and Mirzapur	01/08/2023	All farmers	Cloudy weather and forecast next few days with light to moderate rains next 5 days. leaf eating caterpillar incidence in Soybean.	For control of leaf-eating caterpillar rot incidence in soybeans, farmers were advised to undertake a spray of Chlorantraniliprole 18.5% SC @ 3.0 ml or Indoxacarb 15.8% EC @ 6.7 ml per 10 liters of water during clear weather conditions.	Farmers followed the advisory and undertook spraying on a clear weather day with no rains received on the spraying day. Insect pest control observed in soybean.
Alanda and Mirzapur	08/08/2023	All farmers	Cloudy weather and forecast of light to moderate rainfall during the next 5 days. parawilt and root rot incidence observed in waterlogged areas in cotton fields. .	Undertake inter-culture operations (weeding/hoeing) judging soil workability, for management of weeds and improving soil aeration in kharif crops. For para wilt and root rot incidence observed in waterlogged areas in cotton crop, farmers were advised to undertake soil drenching to affected plants with copper oxychloride @ 25 g per + Urea 100 g in 10 litres of water during clear weather.	Controlled weed population and improved soil aeration in kharif crops. Effective recovery observed parawilt and root rot of cotton disappeared the following week.
Alanda	15/08/2023	All farmers	Forecast of scattered light to moderate rainfall. Moderate to high Infestation of sucking pest in cotton and leaf-eating caterpillar in soybean.	Because of forecasted rainfall, farmers on 18 and 19 Aug, Alanda farmers were advised to Postpone insecticide spraying for control of sap-sucking pests (Aphid/Jassid) in cotton.	Advisory adopted farmers avoided the wash off of insecticidal Spray and saved approximately Rs.2500 ha^{-1} towards one plant protection spray.

Village	Date	Farmers	Problem/ weather event	Solution recommended	Benefit/loss
Alanda and Mirzapur	22/08/2023	All farmers	Cloudy weather and forecast next 5 days with isolated very light to light rainfall. Infestation of sucking pest in cotton and whitefly in soybean.	Take up spraying of imidacloprid 17.8% SL with adjuvant on a clear weather day for control of aphids/jassids in cotton. Also, undertake a spray of Thiamethoxam + Lambda Cyhalothrin to control white flies in soybean.	Farmers followed the advisory on a clear weather day with no rains received on the spraying day. pest control observed in cotton and soybean.
Alanda and Mirzapur	29/08/2023	All farmers	Forecast of very light rainfall expected. .	Undertake protective irrigation. Farmers were advised to harvest Greengram crops avoiding rainy weather and keep the harvest produce safe to protect against late season.	Advisory adopted by farmers avoided yield loss with protective irrigation soybean increased by 13 to 17%. Farmers undertook harvest of green gram crop
Alanda and Mirzapur	05/09/2023	All farmers	Cloudy weather and forecast of light to moderate rainfall during the next 5 days. Infestation of sucking pest in cotton and white fly in soybean.	Undertake a spray of imidacloprid 17.8% SL @ 2.0 ml per 10 litres of water to control sap-sucking pest infestation in cotton. To control the infestation of white flies in soybean crops undertake a spray of Thiamethoxam + Lambda Cyhalothrin. And also suggested installing a sex pheromone trap @ 10 traps/ha for early detection of pink bollworm incidence.	Farmers followed the advisory and undertook spraying on a clear weather day with no rains received on the spraying day. Insect pest control observed in cotton and soybean. Installed pheromone trap helped to early deduction of pink bollworm incidence.
Alanda/ Mirzapur	12/09/2023	All farmers	Forecast of very light rainfall expected. .	Undertake protective irrigation. Farmers were advised to undertake foliar spray of 2% Urea (200 g Urea +10 litre water) at the flowering stage and 2% DAP at the boll development stage is advisable for better cotton.	Advisory adopted by farmers avoided yield loss with protective irrigation soybean increased by 13 to 17%. Farmers undertook the harvest of green gram crops. Foliar spray of 2% Urea and 2% DAP at boll development increased cotton production by 10-18%.
Alanda and Mirzapur	19/09/2023	All farmers	Forecast of light to moderate rainfall	Because of light to moderate rain during the next five days, farmers were advised to postpone the spraying of insecticides on cotton crops.	Alanda (106 mm), rainfall received during 19-24 Sep. Advisory-adopted farmers avoided the wash-off of insecticidal Spray. Saved in labour and pesticide costs of approximately Rs.2000 ha^{-1}

Village	Date	Farmers	Problem/ weather event	Solution recommended	Benefit/loss
Alanda and Mirzapur	26/09/2023	All farmers	Forecast of light to moderate rainfall.	Farmers were advised to undertake timely harvesting of matured soybean crops, particularly early duration varieties that are ready to harvest, and ensure safe storage of harvested produce to minimize the yield losses due to shattering as well as quality deterioration due to rains.	Farmers undertook the harvest of early-duration soybean varieties.
Alanda	03/10/2023	All farmers	Dry weather expected	Farmers were advised to undertake foliar spray of 2% Urea (200 g Urea +10 litre water) at the flowering stage and 2% DAP at the boll development stage is advisable for better cotton. Farmers were advised to undertake the remaining harvesting of soybeans and keep the harvest produce safely	Farmers followed the advisory and undertook spraying on a clear weather day with no rains received on the spraying day. Due to undertaking Foliar spray of 2% Urea and 2% DAP at boll development increased cotton production by 10-18%. Farmers followed the advisory and harvested soybeans and kept the harvest produce safe. Ensured better quality of produce and better market price (Rs.4500-4700 q^{-1}).
Alanda and Mirzapur	10/10/2023	All farmers	Dry weather expected	Farmers were advised to undertake the remaining harvesting of soybean and keep the harvest produce safely.	Farmers followed the advisory and harvested soybeans and kept the harvest produce safe. Ensured better quality of produce and better market price (Rs.4500-4700 q^{-1}).
Alanda and Mirzapur	17/10/2023	All farmers	Dry weather is expected. Reddening in cotton	Spraying of 2 kg DAP+ 1 kg magnesium sulfate or 1 kg potassium nitrate per 100 litres of water	Cotton crop condition improved
Alanda and Mirzapur	24/10/2023	All farmers	Dry weather is expected. Leaf spots and fungal boll rot disease in cotton.	Farmers were advised to undertake foliar application of carbendazim 50 WP @10 g	leaf spots and fungal boll rot disease of cotton controlled by spraying carbendazim 50 WP at farmer's field.
Alanda and Mirzapur	31/10/2023	All farmers	Dry weather is expected.	Undertake clean picking of burst bolls in earlier sown cotton and properly dry the produce before safe storage, variety-wise. Complete the sowing of irrigated chickpeas (Jaki 9218, PDKV Kanchan, Vijay, Vishal, ICCV-2, and ICCV-10) by 10 November.	Cotton variety was harvested and stored likewise.

Village	Date	Farmers	Problem/ weather event	Solution recommended	Benefit/loss
Alanda and Mirzapur	07/11/2023	All farmers	Dry weather is expected. First picking stage in cotton.	Harvesting of cotton is recommended on the crop duration basis. Ensure dry place storage of produce	Cotton variety was harvested and stored likewise.
Alanda and Mirzapur	14/11/2023	All farmers	Dry weather is expected. Incidence of Pink bollworm in later developing bolls. wilting/blight symptoms observed in pigeon pea	Undertake spraying of Profenophos 50 EC @ 30ml or Deltamethrin 2.8% EC @ 9.0 ml /10 litres of water. Advisory to undertake drenching with copper oxychloride 50 % WP@ 25 g in 10 litres of water for wilting/ blight of pigeon peas. Need-based protective irrigation is advisable in pigeonpea crops.	Incidence was reduced by spraying Profenophos 50 EC @ 30ml and thereafter improved the development of bolls. Also, the wilting/blight of pigeon peas was reduced by spraying oxychloride 50 %.
Alanda and Mirzapur	21/11/2023	All farmers	Weed infestation in chickpea crop field. Dry weather is expected.	Farmers were advised to undertake weeding & hoeing operations to keep crops weed-free.	Farmers who followed the advisory observed crops in better condition with improved growth and development subsequently.
Alanda and Mirzapur	28/11/2023	All farmers	Cloudy weather conditions and forecast of scattered light to moderate rainfall.	Farmers were advised to undertake need-based drainage of stagnated water in chickpea crops.	Farmers who followed the advisory observed crops in better condition with improved growth and development subsequently.
Alanda and Mirzapur	07/12/2023	All farmers	Cold wave condition is expected during 09-11 December. Incidence of Pink bollworm in later developing bolls	Advisory to undertake spraying of Profenophos 50 EC @ 30ml or Deltamethrin 2.8% EC @ 9.0 ml per 10 liters of water.	Incidence was reduced by spraying Profenophos 50 EC @ 30ml and thereafter improved the development of bolls
Alanda and Mirzapur	12/12/2023	All farmers	Second picking stage in cotton.	Undertake to harvest of cotton variety-wise. Ensure dry place storage of produce	Cotton variety is harvested and stored likewise.

Village	Date	Farmers	Problem/ weather event	Solution recommended	Benefit/loss
Alanda and Mirzapur	19/12/2023	All farmers	Dry weather is expected	Install pheromone traps (hexalure) @ 5 acre^{-1} for monitoring the incidence of pod borer (Helicoverpa) in chickpeas. For higher productivity application of protective irrigation at the flowering and pod development stage is advisable. To avoid pink bollworm, and carry over to the next season, farmers were advised to complete harvesting /picking of cotton by the Month end of December. After harvesting remove cotton stalks from the field. Rationing should be discouraged,	The farmer installed pheromone traps (hexalure) @ 5 acre^{-1} for monitoring the incidence of pod bore. Farmers followed advisory and removed cotton stalks After harvesting of cotton.
Alanda and Mirzapur	26/12/2023	All farmers	Dry weather expected	With prevailing dry weather, for higher productivity application of protective irrigation at flowering and pod development stages was advisable.	Advisory adopted by farmers avoided yield loss with protective irrigation Chickpea yield increased by 15 to 20 %.
Alanda and Mirzapur	02/01/2024	All farmers	Dry weather is expected. Infestation of pod borer in chickpea.	Spraying of Emamectin benzoate 5% SG @ 4.5g per 10 litres of water was advisable	The infestation was reduced by spraying Emamectin benzoate 5% SG @ 4.5g per 10 litres of water and thereafter improved the development of the pod.
Alanda and Mirzapur	10/01/2024				

Anand

Table 5.2 Economic impact assessment of MAAS at village adopted under AICRPAM-NICRA

Crop: Banana (Mahalaxmi variety) cultivation, Farmer: Alpeshbhai Manubhai Patel Village: Napad

Date of issue of AAS	Crop condition / stage	Forecast	Agromet advisory issued	Actual condition	Action taken by the farmer	Remarks
12-06-2022	Planting	Partly cloudy weather conditions. The maximum and minimum temperatures will range between 35-38 °C and 27-28 ºC, respectively	Before planting, wash suckers and then dip them in a solution of Chlorpyriphos 20 EC @2.5 ml litre^{-1} of water to protect against wilt disease of Banana.	Partly cloudy to mainly clear weather conditions. Maximum and minimum temperature range between 34-38 °C and 27-28 ºC, respectively	Seedling treatment was done.	Less incidence of wilt disease in Banana.
29-07-2022	Planting	Partly cloudy weather conditions. maximum and minimum temperature will range between 30-33 °C and 25 ºC respectively	Fertilizer management: Applied nitrogen, phosphorus, and potash as per recommendation after 3 and 5 months	Partly cloudy weather conditions. Maximum and minimum temperature range between 32 °C and 26.7 ºC, respectively	Farmers were applied proper dose of fertilizer.	Proper use of fertilizer and reflected in terms of yield
4-10-2022	Vegetative	Partly cloudy to cloudy weather conditions. maximum and minimum temperature will range between 35-36 °C and 25 ºC, respectively	To control Sigatoka disease in the banana crop, an advanced spray of carbendazim 50 WP 10 g or Propineb 70 WP 20 g or Propiconazole 25 EC 5 ml in 10 liter of water.	Partly cloudy to cloudy weather conditions. Maximum and minimum temperatures range between 31-35 °C and 23-27 ºC, respectively	Sprayed insecticide in advance	Less incidence of Sigatoka disease.

Date of issue of AAS	Crop condition / stage	Forecast	Agromet advisory issued	Actual condition	Action taken by the farmer	Remarks
5-4-2023	Flowering	Partly cloudy to cloudy to mainly clear weather conditions. maximum and minimum temperature will range between 37-39 °C and 23-26 ºC, respectively	Apply irrigation as per soil and weather conditions and requirements of the crop. Spraying with zinc sulphate 0.5% or ferrous sulphate 0.2% in the banana crop at the flowering stage to improve quality and yield.	Partly cloudy to cloudy to mainly clear weather conditions. Maximum and minimum temperatures ranged between 34-38 °C and 21-24 ºC, respectively	Sprayed $ZnSO_4$	Profit in terms of better yield
2-06-2023	Flowering/ Branch de-velopment	Sky will remain in clear condition. Maximum and minimum temperatures will range between 39-41°C and 26-29 ºC, respectively.	Apply irrigation as per soil moisture and weather conditions and requirements of crops. Bunch feeding: After cutting the flower (De-navelled stalk) at the end of the banana bunch, make a solution of 200 g cow dung slurry + 7.5 g urea + 7.5 g potassium sulphate fertilizer and tie the end of the bunch in the plastic bag.	The sky was in clear condition. Maximum and minimum temperatures range between 35-38°C and 21-28 ºC, respectively.	Bunch feeding applied.	Better banana branches grow and reflect in terms of yield and price of Banana. Farmer profit is 50,000 Rs. ha^{-1} who follow AAS as compared to farmers who don't follow AAS.
9-06-2023	Flowering/ Branch development	Sky will remain in partly cloudy to cloudy conditions and chances of light rainfall at isolated places during the next five days. Maximum and minimum temperatures will range between 34-36 °C and 26-27 ºC, respectively. Wind speed will range between 29-32 km hr^{-1}.	Farmers are advised to don't apply irrigation and any spray of fertilizer and insecticide in the next five days because of high wind speed will remain during the next five days.	The sky was partly cloudy to cloudy condition. Light rainfall was during the 13th and 14th of June. Maximum and minimum temperature ranged between 37-39 7 °C and 27-28 ºC, respectively and wind speed ranged between 9-12 km hr^{-1}.	Farmers do not apply irrigation, insecticide, and fertilizer.	Farmers' profit from irrigation and insecticide is Rs. 2000 ha^{-1}

Date of issue of AAS	Crop condition / stage	Forecast	Agromet advisory issued	Actual condition	Action taken by the farmer	Remarks
16-06-2023	Flowering/ Branch development	Sky will remain in partly cloudy to cloudy conditions and chances of light rainfall at isolated places during the next five days. Maximum and minimum temperatures will range between 33-36 °C and 27-28 ºC, respectively. Wind speed will range between 24-40 km hr^{-1}.	Farmers are advised to not apply irrigation or any spray of fertilizer and insecticide in the next five days and also to pick up matured banana branches and put unmatured branches supported with bamboo sticks to avoid lodging of banana plants because of high wind speed will remain during the next five days.	The sky was partly cloudy to cloudy condition. Maximum and minimum temperatures range between 34-36 °C and 27-28 ºC respectively. Wind speed was ranged between 12-15 km hr^{-1}. Heavy rainfall was on 24 June, 2023	Farmers do not apply irrigation, insecticide, and fertilizer and harvest matured banana branches	Save the irrigation and fertilizer loss of around 1000 Rs. ha^{-1}. Save the banana plant to lodging due to high wind

Table 5.3 Economic impact assessment of MAAS at village adopted under AICRPAM-NICRA
Crop: Tobacco (var. GABTH -2), Farmer: Hiteshbharti Dhirajbharti Goswami, Village: Vadod

Date of issue of AAS	Crop condition/ crop stage	Forecast	Agromet advisory issued	Actual condition	Action taken by the farmer	Remarks
19-11-2023	Vegetative stage	Clear weather conditions. Maximum and minimum temperatures range between 32-34 °C and 18-19 °C, respectively.	Carry out intercultural operations and weeding operations at wapsa condition in a tobacco field. Orobanche shoots should be removed regularly and should be burned or disposed of properly. After 30 days of transplanting applied Nitrogen 50 kg ha^{-1}. in the form of urea in clear weather conditions.	Clear weather conditions. Maximum and minimum temperatures ranged between 31-33 °C and 17-21 °C, respectively.	Removed Orobanche shoot from the field and burn it. Applied nitrogen in the form of Urea on 12th December	Vegetative growth of tobacco crop in good condition.

Date of issue of AAS	Crop condition/ crop stage	Forecast	Agromet advisory issued	Actual condition	Action taken by the farmer	Remarks
24-11-2023	Vegetative stage	Light to moderate rainfall and partly cloudy to clear weather condition	Spray insecticides like Methyl-O-Demeton 25 EC or Dimethoate 30 EC 15 ml in 10 liter of water to control leaf thrips after 4-5 days. To control leaf spot disease, apply two sprays of Hexaconazole 5 SC 10 ml or Propineb 70 WP 30 g or Carbendazim 50 WP 5 g in 10 liter of water after 4-5 days. at an interval of 15 days. Carry out hand weeding and don't apply irrigation in next 5 days.	Partly cloudy to cloudy weather conditions and moderate rainfall	Sprayed Dimethoate 30 EC 15 ml in 10 liter of water on 28 November.	Control of sucking pests in tobacco to a great extent.
12-12-2023	Vegetative/ flowering stage	Clear weather conditions. Maximum and minimum temperatures ranged between 28-30 °C and 16-18 °C, respectively.	Carry out topping at the flower bud initiation stage at 24 leaves. Remove suckers regularly or spray Pendymethylene 30 EC 150 ml. + 200 g of urea in 10 liters of water after removal of suckers. Apply nitrogen 50 kg ha^{-1} at 30, 60, and 90 days after planting as top dressing.	Partly cloudy weather conditions. Maximum and minimum temperatures ranged between 28-29 °C and 15-19 °C, respectively.	Sprayed Pendymethylene and urea after removal of sucker. Nitrogen is applied after 30, 60, 90 days.	Sprayed Pendymethylene and urea after topping to reduce the growth of suckers. Nitrogen increases the vegetative growth of crops.
01-03-2024	Harvesting stage	Partly cloudy weather conditions and light rainfall on 3 March at isolated places of Anand taluka	Farmers are advised to avoid harvesting tobacco for the next 10 days and safely store harvested tobacco.	Medium rainfall during 03 March and Partly cloudy to clear weather condition	Farmers harvested tobacco after 11 March 2024.	Farmer profit is 1,61,631 and other farmers who don't follow AAS lost 50,000 Rs. ha^{-1} (about 2 farmers).

Bhubaneshwar

Table 5.4 Economic impact assessment of MAAS at village adopted under AICRPAM-NICRA

Name of the Farmer	Date of Issue during 2023-24	Crop	Rainfall Forecast (mm)	Advisory Given	Observed Rainfall (mm)	Action taken by the Farmer	Profit/ Loss
Debaraj Swain	25.06.2023	Rice	30.0	Make provisions for drainage in the Nursery bed.	16.0	Made necessary drainage arrangements	Benefit of Rs. 1,000/- for saving seedlings.
Nirakar Nanda	21.07.2023	Sugarcane	46.0	Make provisions for drainage in the sugarcane field.	18.0	Made necessary drainage arrangements	Saved 3,000/- by preventing crop damage
Giridhari Swain	02.08.2023	Green gram, Black gram	47.0	Make provisions for drainage, where pulses have been sown.	36.0	Avoided Pesticide spraying in Greengram and Black gram.	Saved 2,000/- by preventing crop damage.
Laxmidhar Behera	18.08.2023	Vegetables	24.0	Make arrangements for covering plastic cover or polythene sheets for the vegetable nursery.	36.0	The vegetable nursery was covered with a polythene sheet.	Saved 1,500/- by preventing nursery damage.
Ranjan Ku Bhoi	14.09.2023	Rice	43.0	Withhold application of fertilizer and pesticide until rainwater recedes.	78.0	Withheld spraying of pesticides & application of fertilizer in rice.	Saved pesticides and labour cost of Rs.2500/-.
Sudhansu K. Nayak	20.09.2023	Groundnut	29.0	Make provisions for drainage in the groundnut field.	66.0	Made necessary drainage arrangements.	Benefit of Rs. 2000/- Saved the crop damage.

Chatha

Table 5.5 Economic impact assessment of MAAS at village adopted under AICRPAM-NICRA

Date Issued	Crop and Stage	Forecast (mm)	Advisory given	Observed (mm)	Action taken by farmers in response to AAS	Benefit/Loss
NICRA- adopted villages						
25-28/06/23	Transplanted Rice	110	Bund the rice fields for in situ storage of rainwater. Go for transplanting of rice after the receipt of rain	137	Transplanted the Basmati rice	Saved the two irrigations
04/07/23	Transplanted Rice	45	Go for transplanting of rice after the receipt of rain	50	Transplanted the basmati rice	Saved the irrigation amounting to Rs. 1000-1200 ha^{-1}
04/07/23	Maize (Normal sown)	45	Sow the crop after receipt of rain	50	Timely sown of Maize	Saved up to Rs. 800-1000/ ha
15-19/07/23	Transplanted Rice (Tillering)	31	Bund the rice fields for in situ storage of rainwater	174	Followed the advisory	Saved the irrigation@ Rs.1000-1200 ha^{-1}
15-19/07/23	Maize (Emergence)	31	Withheld the irrigation, and intercultural operations and made proper arrangements to drain out the excess water	174	Postponed all the operations in the wake of anticipated rainfall in the advisory & opened field bunds to drain out excess water	Saved the crop from damage
15-19/07/23	Late sown Pulse crop- Mash (Pre-sowing)	31	Go for sowing of crop under vattar condition after receipt of rain	174	Followed the advisory	Pre-sown irrigation saved @ Rs.1000-1200 ha^{-1} and good germination
26/07/23	Maize (knee-high stage)	10	Withheld the irrigation, intercultural operations	62	Followed the advisory	Saved the irrigation @ Rs. 800-1000 ha^{-1}
04-06/08/23		45		88		

Date Issued	Crop and Stage	Forecast (mm)	Advisory given	Observed (mm)	Action taken by farmers in response to AAS	Benefit/Loss
26/07/23	Normal Transplanted Rice (Tillering stage)	10	Bund the rice fields for in situ storage of rainwater	62	Followed the advisory	Saved the irrigations
04-06/08/23		45		88		
04-06/08/23	Late Transplanted Basmati Rice (Transplanting Stage)	45	Transplant the Basmati rice after the receipt of rain	88	Transplanted the basmati rice and saved irrigations	Saved the irrigation amounting to Rs. 1000-1200 ha^{-1}
13-16/08/23	Maize (6th leaf stage)	19	Postpone the chemical spray to crop suffering from stem borer and make proper arrangements for draining the excess water from crop area	102	Postponed all the operations	Saved the chemical and irrigation charges amounting to Rs. 1000-1200 ha^{-1}
13-16/08/23	Normal Transplanted Rice (Booting stage)	19	Postpone irrigation due to chances of rainfall.	102	Postponed the irrigation	Saved the irrigation amounting to Rs. 1000-1200 ha^{-1}
13-16/08/23	Late sown Pulse crop- Mash (Vegetative stage)	19	Postpone the chemical spray to crops suffering from hairy caterpillars and make proper arrangements for draining the excess water from the crop area	102	Followed the advisory	Saved the irrigation and wastage of chemicals of Rs. 1000-1200 ha^{-1}
11/09/23	Normal Transplanted Rice (Panicle Initiation)	15	Postpone irrigation and application of chemical plant protection measures for blast	85	Postponed all the operations	Saved the irrigation and wastage of chemicals of Rs. 1000-1200 ha^{-1}
11/09/23	Maize (Grain Filling)	4	Postpone irrigation due to chances of rainfall	33	Postponed the irrigation	Saved the irrigation of Rs. 800-900 ha^{-1}

Date Issued	Crop and Stage	Forecast (mm)	Advisory given	Observed (mm)	Action taken by farmers in response to AAS	Benefit/Loss
16-17/10/23	Mustard (Pre-sowing)	15	Sowing of Mustard under vatar condition after receipt of rainfall	85	Followed the advisory	Pre-sown irrigation saved @ Rs.1000-1200 ha^{-1} and good germination of Mustard crop
10/01/23	Normal sown wheat (CRI stage)	26	Postpone the irrigation and fertilizer application	14	Postponed the irrigation and fertilizer application	Saved the irrigation, fertilizer and labour charges of Rs. 800-900 ha^{-1}
31/01/23 & 01/02/23	Normal sown wheat (Jointing)	13	Postpone the irrigation application and chemical spray to crops suffering from yellow rust	22	Postponed the irrigation and chemical spray	Saved the irrigation and wastage of chemicals of Rs. 1000-1200 ha^{-1}
31/01/23 & 01/02/23	Mustard (Siliqua formation)	39	Postpone the chemical spray to crop suffering from Alternaria blight	32	Postponed the spray	Saved the wastage of chemical and labour charges of Rs. 600-700 ha^{-1}
01/03/23	Mustard (Pod Formation)	53	Postpone the irrigation	76	Postponed the irrigation	Farmer saved the irrigation on account of Rs. 800-1000/-
01/03/23	Normal sown wheat (Flowering)	53	Postpone the irrigation and chemical spray to crops suffering from yellow rust	76	Postponed the irrigation and chemical spray	Farmer saved the irrigation and wastage of chemicals and Rs. 900-1100/-

Ludhiana

Table 5.6 Economic impact assessment of MAAS at village adopted under AICRPAM-NICRA (wheat crop)

Management Practice	Advisory	Increase in income (Rs. ha^{-1})	Saving on the cost of cultivation (Rs. ha^{-1})
Sowing time	Weather will remain clear and dry (31-10-2023) Wheat must be sown at the optimum time. The first fortnight of November is the optimum sowing time for wheat crops.	Securing the grain yield of wheat leads to a benefit of Rs. 2800 ha^{-1}.	
	Weather will remain clear and dry (22-11-2023) For sowing of wheat crops during the 2nd week to 4th week of November, the suitable variety is Unnat PBW 550 for the entire Punjab.	Increased grain yield of wheat under late sowing leading to a benefit of Rs. 3000 ha^{-1}.	
Irrigation, weedicides, and pesticides	Weather will remain clear and dry (05-12-2023) The first irrigation should be relatively light and given after three weeks to the October-sown crop and after four weeks to the crop sown later.	Increased grain yield of wheat, leading to a benefit of Rs. 2500 ha^{-1}.	
	Weather will remain clear and dry (12-12-2023), (20-12-2023) Post-emergence spray (after first irrigation) can be done at 30-35 days of sowing, using 150 litres of water for control of Phalaris minor (Gulli danda).	Increased grain yield of wheat, leading to a benefit of Rs. 4000 ha^{-1}.	
	Weather will remain clear and dry (27-12-2023) Apply second irrigation of the wheat crop.	Increased grain yield of wheat, leading to a benefit of Rs. 2500 ha^{-1}.	
Heat stress management	Weather will remain clear and dry (06-02-2023), (13-02-2023) Mitigation of effect of high temperature at grain filling and enhancing yield: Apply two sprays of 2% Potassium nitrate (13:0:45) by dissolving 4 kg potassium nitrate in 200 litres of water at boot leaf and anthesis stages or two sprays of salicylic	-	Protect grain yield of wheat crop from terminal heat stress and leading to a benefit of Rs. 2500 ha^{-1}.

Management Practice	Advisory	Increase in income (Rs. ha^{-1})	Saving on the cost of cultivation (Rs. ha^{-1})
	acid by dissolving 15-gram salicylic acid in 450 ml of ethyl alcohol using 200 litres of water per acre at boot leaf and early milk stages to mitigate the effect of high temperature at grain filling and enhance the wheat yield.		
Nutrient management	Weather will remain clear and dry (22-11-2023). Fertilizers for wheat sown with different rice straw management practices broadcast 45 kg urea per acre before first and second irrigation.	Increased grain yield of wheat under late sowing leading to a benefit of Rs. 3000 ha$^{-1.}$	
Insect and disease control	Weather will remain clear and dry (13-02-2023). Spray can be done to control wheat aphids with 20 g Actara/Taiyo 25 WG (thiamethoxam) in 80- 100 litres of water per acre using a knapsack sprayer or in 30 litres of water per acre with a power sprayer	-	Protected the wheat crop from attack of aphids leading to a benefit of Rs. 3500 ha^{-1}.

Table 5.7 Economic impact assessment of MAAS at village adopted under AICRPAM-NICRA (Rice crop)

Management Practice	Advisory	Increase in income (Rs. ha^{-1})	Saving on the cost of cultivation (Rs. ha^{-1})
Sowing time	Weather will remain cloudy and dry (07-06-2023) The first fortnight of June is suitable for sowing direct seeded rice.	Timely sowing of DSR rice helped in getting a higher yield of Rs. 4500 ha$^{-1.}$	
	Weather will remain cloudy and there is a possibility of light rainfall on 15/06/2023 to 18/06/2023 (15-06-2023) Due to the possibility of rain, avoid sowing direct seeded rice in the next days and start transplanting of puddled rice crop.	-	Saved DSR crop from crust formation thus saving the cost of sowing and seed, irrigation and labour amounting to Rs. 5000 ha^{-1}. Timely transplanting of rice crop.

Management Practice	Advisory	Increase in income (Rs. ha^{-1})	Saving on the cost of cultivation (Rs. ha^{-1})
Irrigation, weedicides, and pesticides	Possibility of light rain on 16/07/2023. (11-07-2023) Start transplanting of basmati rice	-	Partial saving of irrigation water and labour in rice leading to saving of diesel cost for irrigation in rice by Rs. 1500 ha^{-1}.
	Possibility of light to moderate rain in many places during the coming 2-3 days; thereafter light rain/ thundershower is likely at isolated places. (18-07-2023) Do not irrigate the crops. Do not apply any pesticides. Drain away the excess water from the maize field.	-	Saving of irrigation and pesticide spray charges. leading to a saving of Rs. 4300 ha^{-1}.
	Possibility of light to moderate rain in many places during the coming 2-3 days; thereafter light rain/ thundershower is likely at isolated places. (26-07-2023), (02-08-2023), (18-08-2023) Do not irrigate the crops. Do not apply any pesticides.	-	Partial saving of irrigation water and labour in rice leading to saving of diesel cost for irrigation in rice by Rs. 1500 ha^{-1}.
	Possibility of light to moderate rain from 11/08/2023 to 14/08/2023, (09-08-2023) Due to the possibility of rain avoid chemical control and prefer mechanical control of the leaf folder can be done only before flowering by passing the 20-30 m long coir/jute rope, forwards and then backward, both ways while touching the crop canopy. While passing the rope, ensure that water must be standing in the crop.	-	Saved pesticide and labour worth Rs. 3300 ha^{-1}
Insect and disease control	Weather will remain cloudy and there is a possibility of rainfall (04-07-2023) (18-07-2023) Do not irrigate the crops. Do not apply any pesticides.	-	Saving of irrigation and pesticide spray charges. saving of Rs. 4300 ha^{-1}.

Mohanpur

Table 5.7 Economic impact assessment of MAAS at village adopted under AICRPAM-NICRA

Date of issue	Forecast given	Crop and Advisory given	Action taken by the farmer	Type of saving/ benefit/ Loss	Benefit/ Loss in terms of cost (Rs. ha^{-1})
2 June, 2023	Almost no rainless period for the next five days.	Not to start nursery bed preparation for Kharif rice	Farmers didn't start nursery preparation with additional irrigation water	The cost of irrigation was saved	Rs. 500 ha^{-1} was saved as the cost of irrigation.
20 June, 2023	Light to Moderate rainfall forecast for next five days (Forecast = 6 to 30 mm, Actual = 2.4 to 38.6 mm)	Nursery bed preparation for Kharif rice	Almost all the farmers started nursery bed preparation	Yield advantage due to timely transplanting = 0.22 t ha^{-1} due to timely sowing and also took complete advantage of the rainfall to meet the water need	Profit for yield advantage and cost of irrigation saving calculated on an average Rs. 2500 ha^{-1}
7 Nov, 2023	Cloudy Sky and High RH forecast (Actual: Accurate)	Chemical application to control downy mildew in cabbage and cauliflower	All farmers adopted control measures	Disease was controlled	Profit of about Rs. 5000 ha^{-1} in treated fields

Palampur

Table 5.8 Economic impact assessment of MAAS

Crop	NICRA district	
	Patlandar (AAS village)	Taryamli (non-AAS village)
Wheat Productivity (q ha^{-1})		
AAS Impact Recommended practices	34	33
Recommended	32	30
Per cent decrease (in Rs.)	9.2	8.0
Wheat Productivity (q ha^{-1})		
AAS Impact Recommended practices	50	45
Recommended	45	44
Per cent increase (in Rs.)	5.5	4.3
Vegetables Productivity (Potato) (q ha^{-1})		
AAS Impact Recommended practices	192	190
Recommended	196	195
Per cent decrease (in Rs.)	0	-1.5

The economic impact on the farmer's field was studied under low external input conditions and fertilizer usage of 30-35 kg ha^{-1}. The results revealed economic benefit in terms of yield gain to the tune of 8.0 to 10.0 % in Wheat, Potato, and Maize crops in the Hamirpur district. The surveyed economic benefit was higher in AAS followed exclusively by recommended packages and practices. The use of weather forecast and real time weather data under research trial on Potato indicated a saving of 120 mm irrigations water to obtained 196 quintals yield of potato crop in Patlandar village.

Animal and Poultry

- Milch animals: The temperature forecast in summers and winters and the shelter management increased milk production in cattle. The survey of farmers revealed that 0.5 to 1.0 kg milk yield is increased during summer and 1.0 kg in winter.
- Sheep and Goat: The advisory through the Department of Animal Sciences to nomads saved the lives of sheep and goat as early snow and rainfall were predicted and accordingly advisory to target nomads.
- Poultry: The feed to 15% of poultry was saved due to the advisory on temperatures above 34 degrees and its protection-based weather forecasts.

Samastipur

Table 5.9 Economic impact assessment of MAAS at village adopted under AICRPAM-NICRA

Crop	Advisory given in bulletin	Impact of specific intervention through NICRA advisory followed by selected farmers
Rice 14 June 2023 5 July 2023	Those farmers who have adequate irrigation facilities and want to cultivate long-duration paddy should try to sow varieties like Rajshree, Rajendra Mansuri, Rajendra Sweta, Kishori, Swarna, Swarna Sub-1 VPT-5204 and Satyam, etc. in the seedbed. Sow seeds in one-tenth of the area in which paddy is to be planted. Before sowing the seeds, treat them at the rate of 1.5 grams of Bavistin per kg seeds. There has been rain in the NICRA villages during the last few days. Taking advantage of rainwater, farmers can transplant seedlings in their fields. Apply 25 kg zinc sulphate or 15 kg chelated zinc per hectare along with 30 kg nitrogen, 60 kg phosphorus, and 30 kg potash.	Farmers transplanted long-duration varieties like Rajshree, Rajendra Mansuri, Rajendra Sweta, and Kishori in the seedbed. Before sowing farmers also treated the seeds with Bavistin 2.0 grams per kg of seeds. With the help of advisory, the farmers prepared seedlings for transplanting. By following the advisory, they transplanted in the main field and saved irrigation costs for puddling.
Maize 4 July 2023	Farmers are advised to sow Suan, Devki, Shaktiman-1, Shaktiman-2, and Rajendra hybrid maize-3 varieties of kharif maize. While plowing the field, apply 10 to 15 tonnes of rotten manure, 30 kg of nitrogen, 60 kg of phosphorus, and 50 kg of potash per hectare. Seed treatment with 2.5 grams Thiram per kg is advised. Keep the seed rate at 20 kg per hectare.	Farmers used our recommended varieties and accordingly followed our management practices and harvested satisfactory maize crop. Earlier, they did not know these varieties of kharif maize.
Pigeon Pea 4 July 2023	Prepare the field for the sowing of pigeon pea. At the time of sowing, apply 20 kg nitrogen, 45 kg phosphorus, 20 kg potash, and 20 kg sulfur per hectare. Varieties like Bahar, Pusa 9, Narendra Arhar 1, Malviya-13, Rajendra Arhar-1, etc. are recommended for sowing.	Like the of maize varieties, they also followed our recommended varieties of peas.

Table 5.10 Economic impact assessment of MAAS at village adopted under AICRPAM-NICRA

Crops: maize, pea, rice and mustard

Date	Crop stage	Weather forecast	Advisory given in NICRA bulletin	Actual weather condition	Action taken by the farmer	Loss/Profit	Remarks
19 May 23	Maturity and harvesting stage of rabi maize	The weather is likely to remain dry for the next 2-3 days. After that, there is a possibility of rain around 23-24 May.	Given the possibility of rainfall around May 23-24, caution should be exercised for harvesting the rabi maize crop.	10 mm of rainfall was recorded on 23 May.	He followed our advisory and saved the harvested maize from rain spoilage	By following the advisory, he saved their maize crops from damage from rain.	Harvested maize cobs were kept safe in storage and they waited for dry weather for sun drying.
	Tasselling and silking (Summer maize)	The weather is likely to remain dry for the next 2-3 days. After that, there is a possibility of rain around 23-24 May.	Farmers who are planning to irrigate should not irrigate at present or should do so in the absence of rainfall. In vegetable crops	Rainfall occurred	The farmer skipped irrigation by following an advisory	Irrigation cost @Rs 3000 per hectare.	
5 Jan 24	Vegetative and Flowering stage, Pea	Cold day conditions are likely to persist in Sarairanjan block (Meyari village) due to which the day temperature is likely to remain much below normal for the next 3 days. Moderate to dense fog may prevail in the morning.	Monitor powdery mildew disease in pea crops. To prevent, disease, spray the crop with a solution of Carathane at the rate of 1.0 ml per liter of water or Sulfex at the rate of 3 grams per liter of water. Regular monitor of pod borer in pea. Apply light irrigation in the cold wave condition.	Cold day and chilly night temperatures were experienced	The farmer sprayed the crop with a solution suggested in the advisory. Farmers irrigated the crop against the negative impact of low temperature.	By following the advisory farmers saved the pea crops	-

Crop: Paddy

Date	Crop stage	Weather forecast	Advisory given in NICRA bulletin	Actual weather condition	Action taken by the farmer	Loss/profit
07 Aug 2023	The tillering stage in early sown rice and the transplanting stage of late rice	Light to moderate rainfall may occur in the NICRA district	Keeping given the possibility of rain during the weather forecast period, farmers should work on strengthening the bunds of the field to collect rainwater. Taking advantage of rainwater, farmers should try to complete the transplanting of short-duration paddy.	On 8 August, about 112 mm of Rainfall occurred	He prepared bunds to collect rainwater for transplanting of late-sown rice	Saved irrigation for both early and late-sown rice

Crop: Mustard

Date	Crop stage	Weather forecast	Advisory given in NICRA bulletin	Actual weather condition	Action taken by the farmer	Loss/Profit
18 Mar 2024	Harvesting stage of mustard	Possibility of light rain in the next 24 to 48 hours.	Take precautions in the harvesting and threshing of mustard in view of the rainfall forecast. Also, postpone irrigation in the standing crop	Rainfall occurred in the NICRA villages	Farmers followed our advisory and stopped irrigation in the crop	Saved mustard crop from spoilage Farmers saved Rs. 3000/- per hectare by avoiding irrigation

6. Case Studies on the Economic Impact of Micro-level AAS

Akola

Case Study- Soybean, Alanda

Shri. Madukar Dhore, who is from Alanda NICRA Village (Barshitakli) under AICRPAM Akola Centre has 4.5 acres of irrigated land under soybean cultivation. JS-335 variety was grown during *kharif* 2023. Crop was sown during 26 MW (29 June). During the crop growing period, a series of AAS bulletins/real-time advisories were issued which were followed as such by the farmer. Details of the AAS issued are given in Table 6.1. The following includes B:C ratio obtained in the case of the soybean farmer Shri. Madukar Dhore, in response to the AAS issued and accordingly, timely action taken by the farmer. The expenditure on different operations and returns received on the sale of produce and other details were collected from farmer's feedback. It also includes the B: C ratio obtained in the case of the four AAS farmers who have followed more or less similar Agro-met advisories as aforementioned for their respective soybean cultivation.

Table 6.1 Analysis of B:C ratio of soybean of AAS farmers in Alanda NICRA village

Input Details	Vivek Pimpalkar	Madukar Dhore	Vishwanath Janorkar	Utam Mohad	Keshav Pimpalkar
Land preparation (Rs. ha^{-1})	4000	4200	4200	4400	4150
Fertilizer cost (Rs. ha^{-1})	4100	4000	4700	4000	3900
Seed cost (Rs. ha^{-1})	4960	3900	4250	3744	4640
Seed Treatment (Rs. ha^{-1})	600	600	550	600	400
Planting cost (Rs. ha^{-1})	1800	2700	1800	2400	2800
Weed Management (Rs. ha^{-1})	1800	1700	2100	3500	3600
Hoeing (Rs. ha^{-1})	1200	1200	1150	1200	1200
Plant protection (Rs. ha^{-1})	3300	3100	3550	3200	2950
Irrigation (Rs. ha^{-1})	500	500	500	0	0
Foliar spray of 2% urea	600	600	600	600	600
Miscellaneous (Rs. ha^{-1})	1100	1600	1100	1000	900
Harvesting cost (Rs. ha^{-1})	3700	3750	3500	3500	3500
Threshing cost (Rs. ha^{-1})	3200	3250	2900	2800	2800
Cost of cultivation (Rs. ha^{-1})	30860	31100	30900	30944	31440
Seed yield (q ha^{-1})	19.2	19.5	18.6	18.4	18.5

Input Details	Vivek Pimpalkar	Madukar Dhore	Vishwanath janorkar	Utam Mohad	Keshav Pimpalkar
Price of soybean (Rs. ha^{-1})	88320	89700	85560	84640	85100
Net Profit (Rs. ha^{-1})	57460	58600	54660	53696	53660
Benefit-cost ratio	2.86	2.88	2.77	2.74	2.71

Table 6.2 Analysis of BC ratio of soybean of Non-AAS farmers in Kanheri village

Input Details	Rajesh Thakare	Nitesh Ingle	Digammbar Damodar	Satish Thakare	Namdev Gawande
Land preparation (Rs. ha^{-1})	3850	3900	4150	2850	4000
Fertilizer cost (Rs. ha^{-1})	4450	4400	4000	3600	4200
Seed cost (Rs. ha^{-1})	4800	4524	5525	4800	4675
Seed Treatment (Rs. ha^{-1})	0	440	0	0	0
Planting cost (Rs. ha^{-1})	1750	2700	2500	1800	1800
Weed Management (Rs. ha^{-1})	2750	2000	3500	3400	2800
Hoeing (Rs. ha^{-1})	1200	1200	1200	1200	1200
Plant protection (Rs. ha^{-1})	3100	3100	3400	3250	3600
Irrigation (Rs. ha^{-1})	500	0	0	0	0
Foliar spray of 2% urea	0	0	0	0	0
Miscellaneous (Rs. ha^{-1})	1400	1200	1400	1500	1400
Harvesting cost (Rs. ha^{-1})	3750	3750	3500	4000	3500
Threshing cost (Rs. ha^{-1})	2592	2400	2175	2700	2265
Cost of cultivation (Rs. ha^{-1})	30142	29614	31350	29100	29440
Seed yield (q ha^{-1})	14.5	15.0	14.5	15.0	15.1
Price of soybean (Rs. q^{-1})	66700	69000	66700	69000	69460
Net Profit (Rs. ha^{-1})	36558	39386	35350	39900	40020
Benefit: cost (B:C) ratio	2.21	2.33	2.13	2.37	2.36

The higher profit obtained by Shri. Madukar Dhore is mainly due to

- Adoption of issued advisories and farm operations accordingly.
- Timely weeding and hoeing
- Postponement of insecticidal/foliar spraying due to rainfall forecast.
- Foliar spray of 2% urea at the pod formation stage
- Timely application of irrigation coinciding with soil moisture stress period.
- Immediate drainage of excess waterlogged areas in crop field
- Timely harvest of the crop during rain-free weather avoiding any delay and its safe drying and storage.

Cotton, Alanda

Shri. Gajanan Mojulkar, who is from Alanda (Barshitakli taluka) NICRA Village of Akola Centre has 3.0 acres of rainfed land under cotton cultivation. Bt cotton Rasi 659 was grown during kharif 2023. The crop was sown on during 26 MW (28 June). During the crop growing period, a series of AAS bulletins/real-time advisories were issued which were followed as such by the farmer. Details of the AAS issued are given in Table 6.3

Table 6.3. Analysis of B:C ratio of Cotton of AAS in Alanda farmers and non AAS farmers in Kanheri NICRA village

Input Details	AAS farmers		Non AAS farmers	
	Gajanan Mojulkar	Tulshiram Mhaise	Sachin Gaigol	Satish Thakare
Land preparation (Rs. ha^{-1})	3900	4050	4450	3900
Fertilizer (Rs. ha^{-1})	4854	5527	5600	5000
Seed cost (Rs. ha^{-1})	5840	5200	5600	5600
Planting (Rs. ha^{-1})	2800	3000	3000	3000
Gap filling (Rs. ha^{-1})	200	400	300	0
Weeding (Rs. ha^{-1})	3400	3100	4100	4100
Hoeing (*with furrow opening) (Rs. ha^{-1})	3600*	3600*	2400	3600
Plant protection (Rs. ha^{-1})	4600	4850	5420	5000
Irrigation (Rs. ha^{-1})	0	0	0	0
Spraying of 2% Urea and 2% DAP (Rs. ha^{-1})	1200	1200	0	0
Miscellaneous (Rs. ha^{-1})	1200	1300	1100	1200
Harvesting cost (Rs. ha^{-1})	11060	10920	9240	8120
Cost of cultivation (Rs. ha^{-1})	42654	43147	41210	39520
Seed cotton yield (q ha^{-1})	15.8	15.6	13.2	11.6
Price (Rs. ha^{-1})	116130	113880	95040	84680
Net Profit (Rs. ha^{-1})	73477	70733	53830	45160
Benefit-cost (B:C ratio)	2.72	2.64	2.31	2.14

Higher profit obtained by Mr. Gajanan Mojulkar is mainly due to

- Adoption of issued advisories and farm operations accordingly.
- Timely weeding and hoeing (with furrow opening)
- Timely plant protection and postponement of spraying due to rainfall forecast.
- Foliar spray of 2% urea and 2% DAP, respectively at flowering and boll development stage.
- Timely supplemental irrigation coinciding with soil moisture stress period.
- Timely drainage of excess water-logged areas in crop fields.

Cotton, Mirzapur

Shri. Ratnakala Jadhav, who is from Mirzapur (Barshitakli taluka) NICRA Village of Akola Centre has 4 acres of rainfed land under cotton cultivation. Bt cotton Ajeet 199 was grown during *kharif* 2023. Crop was sown on during 26 MW (28 June). During the crop growing period, a series of AAS bulletins/real-time advisories were issued which were followed as such by the farmer. Details of the AAS issued are given in Table 6.4.

Table 6.4 Analysis of B:C ratio of Cotton of Mirzapur AAS farmers and non AAS farmers in Kanheri NICRA village

Input Details	AAS farmers		Non AAS farmers	
	Ratnakala Jadhav	Chandra shekar Jadhav	Shyam Nikole	Ambadas sarap
Land preparation (Rs. ha^{-1})	4400	4850	4150	4400
Fertilizer (Rs. ha^{-1})	5373	5244	5500	5600
Seed cost (Rs. ha^{-1})	5600	5600	5840	5600
Planting (Rs. ha^{-1})	3000	3000	3000	3000
Gap filling (Rs. ha^{-1})	300	300	300	300
Weeding (Rs. ha^{-1})	3600	3400	4100	4100
Hoeing (*with furrow opening) (Rs. ha^{-1})	3600*	3600*	2400	2400
Plant protection (Rs. ha^{-1})	4780	4700	6000	5000
Irrigation (Rs. ha^{-1})	0	0	0	0
Spraying of 2% Urea and 2% DAP (Rs. ha^{-1})	1200	1200	0	0
Miscellaneous (Rs. ha^{-1})	1200	1450	1200	1400
Harvesting cost (Rs. ha^{-1})	11200	10990	8400	8680
Cost of cultivation (Rs. ha^{-1})	44253	44334	40890	40480
Seed cotton yield (q ha^{-1})	16.0	15.7	12.0	12.4
Price (Rs. ha^{-1})	118400	116180	86400	89280
Net Profit (Rs. ha^{-1})	74147	71846	45510	48800
Benefit-cost (B:C ratio)	2.68	2.62	2.11	2.21

Higher profit obtained by Mr. Ratnakala Jadhav is mainly due to

- Adoption of issued advisories and farm operations accordingly.
- Timely weeding and hoeing (with furrow opening)
- Timely plant protection and postponement of spraying due to rainfall forecast.
- Foliar spray of 2% urea and 2% DAP respectively at flowering and boll development stage.
- Timely supplemental irrigation coinciding with soil moisture stress period.
- Timely drainage of excess water-logged areas in crop field

Anand

Economic impact of Microlevel Agromet Advisory services

Alpeshbhai Manubhai Patel is farmer of Napad (NICRA village) has 2.56-hectare irrigated land. Crops sown were Brinjal, Tomato, Chilli, Tobacco and Banana. He sown Banana (Mahalaxmi variety) on 13 June, 2022 in 1.2 hectare. During the crop growing period (2022-2023), a series of Agromet advisory bulletins/ real time advisories were issued which were followed by the farmer. MAAS following farmer had additional profit of Rs. 1,43,760 per ha compared to farmer who did not follow MAAS.

Table 6.5 Cost benefits for banana crop with MAAS

Year	Production kg ha^{-1}	Price (Rs. kg^{-1})	Income (Rs.)	Cost/ ha.	Net profit
2022-23	60,000	9.0	5,40,000	1,18,080	4,21,920

Table 6.6 Cost of cultivation (per hectare) of farmers' who followed MAAS

Sr. No.	Item	Price	Amount	Cost (Rs)
1	Land preparation			
1a	Ploughing, Harrowing, and Planking (3 hrs)	500	3 hrs	1,500
2	Preparation of beds, bunds and irrigation channel (1 hr)	500	1 hr	500
2a	Labour charges	270	10 labour	2,700
3	Planting material	3 Rs. $Seedling^{-1}$	3120 Seedling	9,360
4	FYM	7 Rs. kg^{-1}	7000 kg	49,000
4a	FYM application	270	10 labour	2,700
5	Cost of fertilizer (216-130-270 NPK kg ha^{-1})			
5a	DAP	20 Rs. kg^{-1}	282 kg	5,640
5b	Urea	5 Rs. kg^{-1}	455 kg	2,275
5c	MOP	18 Rs. kg^{-1}	450 kg	8,100
5d	K_2SO_4	60	50	3,000
5e	$ZNSO_4$	225	4.4	990
5d	Fertilizer application charges	270	10 Labour	2,700
6	After care			
6a	Interculturing	270	10 Labour	2,700
6b	Hand weeding	270	10 Labour	2,700
6c	Irrigation	300	45 irrigation	13,500
6d	Irrigation charges	270	10 Labour	2,700
7	Insecticides	400 Rs. L^{-1}	1	400

Sr. No.	Item	Price	Amount	Cost (Rs)
8	Fungicide	135 Rs. kg^{-1}	5 kg	675
8b	Insecticide and fungicide application	270	10 Labour	2,700
9	Streptocyclin	500 Rs. kg^{-1}	1 kg	500
10	Copper oxycloride	500 Rs. kg^{-1}	1 kg	500
11	Harvesting	270	12 labour	3,240
Total				1,18,080

Table 6.7 Cost benefit of banana crop without MAAS

Year	Production (kg ha^{-1})	Price (Rs kg^{-1})	Income (Rs)	Cost ha^{-1}	Net profit
2022-23	48,000	8.5	4,08,800	1,30,640	2,78,160

Table 6.8 Cost of cultivation of banana farmers who did not follow MAAS (Rs. ha^{-1})

S. No.	Item	Price	Amount	Cost (Rs)
1	Land preparation			
1a	Ploughing, Harrowing, and Planking (3 hrs)	500	3 hrs	1,500
2	Preparation of beds, bunds and irrigation channel (1 hr)	500	1 hr	500
2a	Labour charges	270	10 labour	2,700
3	Planting material	5 Rs. Seedling^{-1}	4500 Seedling	22,500
4	FYM	4 Rs. kg^{-1}	9000 kg	36,000
4a	FYM application	270	10 labour	2,700
5	Cost of fertilizer (216-130-270 NPK kg ha-1)			
5a	DAP	30 Rs. kg^{-1}	400 kg	12,000
5b	Urea	10 Rs. kg^{-1}	500 kg	5,000
5c	MOP	25 Rs. kg^{-1}	600 kg	15,000
5d	Fertilizer application charges	270	10 Labour	2,700
6	After care			
6a	Interculturing	270	10 Labour	2,700
6b	Hand weeding	270	20 Labour	2,700
6c	Irrigation	300	50 irrigation	15,000
6d	Irrigation charges	270	10 Labour	2,700
7	Insecticides	400 Rs. L^{-1}	2.5	1000
8	Insecticide and fungicide application	270	15 Labour	2,700
9	Harvesting	270	12 labour	3240
Total				1,30,640

Anantapur

Economic impact of microlevel AAS on Groundnut farmers

NICRA Agromet advisories of Rekulakunta village were provided to a group of 12 farmers growing groundnut in Rekulakunta village. The advisories were given from land preparation till harvest every Tuesday and Friday. farmers used these AAS in timely planning and execution of various agricultural operations.

The AICRPAM-NICRA AAS farmers realized a B: C ratio of 2.75 against 1.73 by non-AAS farmers. Whereas control village Pasuluru farmers realized a B: C ratio of 1.61 in groundnut with Rs. 1,05,000 ha^{-1} cost of cultivation and Rs. 1,74,500 ha^{-1} gross returns. The control village farmers have not followed the forecast and not followed advisories thus had an extra cost of cultivation by spraying just before the rain forecast. The details of the economics for NICRA AAS and non-AAS farmers are given below.

Table 6.9 Details of the cost of cultivation and Economic impact of AAS in Groundnut

Name of the operation	Cost of Cultivation (Rs ha^{-1}) AAS farmers	Reason for higher/ lower cost of unit/field operation	Cost of Cultivation (Rs ha^{-1}) Non-AAS farmers	Reason for higher/ lower cost of unit/field operation
Land preparation and leveling	10500	It was advised to undergo summer ploughing	8500	Not done summer ploughing
Cost of seed	22000	The optimum seed rate was provided in the advisory	26000	Usage of more seed for sowing than the required seed rate
Cost of sowing	6000	-	6000	-
Drainage channel formation	3000	It was advised to prepare drainage channels during heavy rainfall forecast	-	No drainage channel preparation
Irrigation	1500	It was advised to provide lifesaving irrigation during dry spells based on forecast	3000	More irrigations were provided unaware of life-saving irrigations during dry spell
Cost of fertilizers	8000	The optimum fertilizer quantity was suggested	10000	Usage of more fertilizers than required quantity

Name of the operation	Cost of Cultivation (Rs ha^{-1}) AAS farmers	Reason for higher/ lower cost of unit/field operation	Cost of Cultivation (Rs ha^{-1}) Non-AAS farmers	Reason for higher/ lower cost of unit/field operation
Weeding and Inter cultivation	8000	Weed control sprayings were suggested	12000	Did not use weed control chemicals and went for manual weeding
Spraying (including chemical cost)	8000	It was advised not to go for spraying based on the forecast	12500	Wastage on spraying before the forecast
Gypsum cost and application cost	6000	The optimum gypsum quantity was advised	7500	More than the required quantity of gypsum was applied
Harvesting, stripping and transport	15000	-	15000	-
Total Cost of Cultivation	88,000		1,00500	
Yield of groundnut	30 q ha^{-1}		25 q ha^{-1}	
Price of the produce (Rs. kg^{-1})	Rs.110 kg^{-1}		Rs.110 kg^{-1}	
Gross returns	Rs.330000 ha^{-1}		Rs.275000 ha^{-1}	
Net returns	Rs.242000 ha^{-1}		Rs.174500 ha^{-1}	
B:C ratio	2.75		1.73	

Economic impact of microlevel AAS on maize farmers

AICRPAM-NICRA Agromet advisories of Rekulakunta village were provided to a group of 12 farmers growing maize. The advisories were given from land preparation to harvest every Tuesday and Friday. The DEO and YP I working on the project have provided these advisories to farmers and helped the farmers in the timely planning and execution of various agricultural operations. NICRA AAS farmers got a yield advantage of 10 q ha^{-1} over non-NICRA farmers and a benefit of Rs.85,000 ha^{-1} after meeting all the expenses. The NICRA AAS farmers realized a B:C ratio of 2.42 against 1.66 by non-AAS farmers. The details of the economics for NICRA AAS and non-AAS farmers are given below.

Table 6.10 Details of the cost of cultivation and Economic impact of AAS in Maize

Name of the operation	Cost of Cultivation (Rs ha-1) AAS farmers	Reason for higher/ lower cost of unit/ field operation	Cost of Cultivation (Rs ha-1) Non-AAS farmers	Reason for higher/ lower cost of unit/ field operation
Land preparation and levelling	3000	-	3000	-
Sowing and basal application of fertilizers	4000	-	4000	-
Cost of seed	6000	-	6000	-
Cost of fertilizers	3000	Applied recommended quantity of fertilizers	4500	Applied more quantity of fertilizer than required quantity.
Weeding and Inter cultivation	3000	-	3000	-
Spraying	2500	Followed rainfall forecast	4500	Did not follow forecast thus wastage in spraying during rainfall forecast
Irrigation	5500	Provided lifesaving irrigation-based advisory.	3500	Did not provide lifesaving irrigation.
Harvesting, threshing and cleaning	8000	More yield harvested	6000	Less yield obtained
Labor for weeding and spraying	3000	-	3000	-
Total Cost of Cultivation	35000		37500	
Yield of Maize	60 q ha^{-1}		50 q ha^{-1}	
Price of the produce (Rs. kg^{-1})	Rs.20 kg^{-1}		Rs.20 kg^{-1}	
Gross returns	Rs.1,20,000 ha^{-1}		Rs.1,00,000 ha^{-1}	
Net returns	Rs.85,000 ha^{-1}		Rs.62,500 ha^{-1}	
B: C ratio	2.42		1.66	

Bhubaneshwar

Economic impact of microlevel AAS on paddy farmers

A study was conducted among the farmers of NICRA-adopted villages. A series of AAS bulletins/advisories were disseminated among the AAS following farmers, who adopted the Agromet advisories got benefitted, whereas the farmers who did not follow the AAS experienced reduced income. The comparison between AAS farmers of Patapur village and non-AAS farmers of Balabhadrapur village is presented in Table 6.11.

Table 6.11 Comparison of B:C ratio between AAS and Non-AAS paddy farmers

Particulars	Details	
Name of the Farmer	Somanath Swain (AAS Farmer)	Banambar Muduli (Non-AAS Farmer)
		
Address	Village: Patapur, Panchayat: Kakarudrapur Block: Balianta Dist: Khordha	Village: Balabhadrapur Panchayat: Kakarudrapur Block: Balianta Dist: Khordha
Total Agricultural area (in acres)	4	4
Soil Health card (if yes)	NA	NA
Major Crop Grown in Kharif 2023	Paddy	Paddy
Amount (Rs) invested in Kharif 2023		
I. Tractor charges (Rs.)	9500	9500
II. Seed cost (Rs.)	2400	2800
III. Manure cost (Rs.)	8600	8600
III. Fertilizer cost (Rs.)	6300	7500
IV. Pesticides cost (Rs.)	4200	6500
V. Labour cost (Rs.)	58300	65200
VI. Irrigation cost (Rs.)	850	1250
VII.Total cost (Rs.)	90150	101350
Total paddy yield from 4 acres (q)	74.5 q	66 q
Price (q^{-1})	2203	2203
Gross Income (Rs.)	164124	145398
Net Profit (Rs.)	73973.5	44048
B:C Ratio	1.8	1.4

Chatha

Economic impact of microlevel AAS on Basmati rice

Farmers of NICRA-adopted villages are provided farm management information biweekly for Basmati Rice crops in line with weather-sensitive agricultural activities through Agrometeorological Advisory Services (AAS). The benefit-cost ratio for both AAS farmers and non-AAS farmers. It is observed that AAS farmers were able to reduce the cost of irrigation up to 44.8% followed by weeding and manure (29.8 %), plant protection (28.6%) and fertilizer application (14.47%)

Table 6.12 Economic analysis of Basmati rice between Adopted and Non-adopted Farmers

Operations	AAS Farmer	Non AAS Farmers
Nursery raising (500 m^{-2})		
Land Preparation (Two double tillage followed by planking) @ Rs. 300	600	600
Seed cost 20 kg@ Rs. 65 kg^{-1}	1440	1440
Preparation of nursery beds and sowing (2 Man days @ Rs. 400)	800	800
Irrigation (1 Manday @ Rs. 400)	400	400
Source of manures/fertilizers		
FYM (750 kg @ Rs.1.5)	1125	1125
Urea (3 kg @ Rs.5.9)	17.7	17.7
DAP (2.5 kg @ Rs. 29)	72.5	72.5
Application of fertilizers	400	400
Total Cost (A)	4885	4885
Main Field (10,000 m^{-2})		
Land Preparation (Two double tillings followed by planking and puddling) @ Rs. 400/kanal	8000	8000
Uprooting, washing and transplanting of seedlings (32 Mandays @Rs. 400)	12800	12800
Source of fertilizers		
Urea (48.19 kg @ Rs. 5.90)	284	700
DAP (43.48 kg @ Rs. 29)	1261	1300
MOP (16.66 kg @ 19)	317	380
Application of Fertilizers (Basal dose & Top dressing) (3-man days @ Rs. 400)	1200	1200
Herbicide (Nominee Gold) 250 ml @ Rs. 4.50/ml)	1250	-
Application of Herbicide (2 man-days @ Rs. 400)	800	-
Hand Weeding Cost	1600	5200
Spray for attack of blast in paddy	1000	1400
Irrigations	3200	5800
Harvesting, threshing, winnowing and bagging (30 man-days @ Rs. 400)	12000	12000
Miscellaneous (Cost of land, carriage etc)	1600	1600
Total cost (B)	45312	50380
Total cost (A+B)	50167	55235
Grain Yield of Paddy (q ha^{-1})	36.4	33.8
Price of the produce (q ha^{-1})	4500	4500
Gross returns	163800	152100
Net income	113633	96865
B:C ratio	2.27	1.75

Hisar

Economic Impact of MAAS on Cotton growing farmers

An average saving of Rs. 13589 per ha in total cost of cultivation of cotton was reported at Ludas in comparison to Shahpur where no Agromet advisory services were provided while it was Rs. 8320 per ha in Arya Nagar. A higher average B:C of 1.26 and 1.25 was reported from Ludas and Arya Nagar, respectively (Table 6.13), while it was only 1.06 in the case of non-adopters clearly indicating greater benefits to farmers who opted for Agro advisory services.

Table 6.13 Economic impact assessment of MAAS for cotton during Kharif, 2023

Items/Name of operations performed on the field	Non AAS Farmer Shahpur (Rs. ha^{-1})	AAS Farmer Ludas (Rs. ha^{-1})	AAS Farmer Arya Nagar (Rs. ha^{-1})
Preparatory tillage	5500	4350	4863
Pre-sowing irrigation	1175	1175	1175
Sowing	1350	1350	1350
Ridging	0	0	0
Seed (kg)	3400	3400	3400
Seed treatments	0	0	0
FYM (kg)	3725	3725	3725
Fertilizer nutrients	11250	6986	7859
Fertilizer application	625	545	545
Irrigation	4800	1722	3460
Weeding (chemical)	3300	2350	2850
Plant Protection	2300	985	1563
Harvesting	14210	14210	14210
Threshing/winnowing	0	0	0
Miscellaneous	650	650	650
Total	52285	41448	45650
Interest in working capital	2353	1865	2054
Variable cost	54638	43313	47704
Management changes	5464	4331	4770
Risk factor	5464	4331	4770
Transportation	600	600	600
Rental value of land	32800	32800	32800
Total cost	98965	85376	90645
Main product (Rs.)	102415	105526	111489
By product	2200	2200	2200
Gross return	104615	107726	113689
RVC (GR – VC)	49977	64413	65985
Net Return	5650	22350	23044
B:C ratio	1.06	1.26	1.25

#Net benefit of AAS adopted farmers of Ludas and Arya Nagar are Rs. 16700 and Rs. 17494, respectively, higher over non-adopter farmers

Jorhat

Economic impact of microlevel AAS on Potato growing farmer

Mr. Mukuta Thengal of Thengal gaon village, Golaghat district cultivating potato (Kufri Pukhraj) in his 2 bigha (i.e., 0.32 ha) land, has been receiving Agro-met advisory services since 2020 and following scientific procedures as suggested in the advisories from AICRPAM-NICRA, Jorhat center. As informed by him, weather-based advisories enable him to minimize his farm losses to a great extent.

Table 6.14. Economic impact assessment of AAS on potato crop in Thengal gaon

Operation	Cost (Rs.)	
Ploughing/Land preparation	1500 x 2 = 3000 (Rs. 1500 bigha^{-1})	
Furrows preparation	800 x 2 times = 1600 (2 labour bigha^{-1}) (2 labour = 400 x 2 = 800)	
Cost of Sowing	800 x 2 = 1600 (2 labour bigha^{-1}) (2 labour cost = 400 x 2 = 800)	
Cost of seed	3 x 1700 = 5100 (Price: 1700 quintal^{-1}) (Req: 1q ha^{-1})	
Earthing up cost	800 x 2 times = 1600 (2 labour bigha^{-1}) (2 labour = 400 x 2 = 800)	
Harvesting cost	1600 x 4 times = 6400 (4 labors /bigha = 400 x 4 = 1600)	
Fertilizer cost	Urea	Rs. 200 (20 kg x Rs. 10)
	SSP	Rs. 100 (10 kg x Rs. 10)
	MOP	350.00 (5kg x Rs. 35)
	TOTAL	655
Chemical cost	280 x 2= 560 (Indofil M-45= Rs. 280 kg^{-1})	
Total Cost (In rupees)	20,515	

Production of potato from 1 bigha of land	:	26.5q bigha^{-1}
Therefore, for 2 bigha	:	26.5 x 2 q = 53 q
Price of 1 quintal	:	Rs. 1500
Total amount received by selling 53 q	:	Rs. 1500 x 53 = Rs. 79500
Net income		
Total cost of cultivation (Total cost)	:	Rs. 20515

Total income after selling the produce
(Gross income) : Rs. 79500
Net Income : (Gross income) - (total cost)
: Rs. 79500 – 20515
: Rs. 58985
B:C ratio : Gross Income / Total cost
: 79500 / 20515 = 3.87

Economic impact of microlevel AAS on rapeseed growing farmer

Mr. Muhikanta Thengal cultivating rapeseed (M-27 (Short duration variety)) in his 5 bigha (i.e., 0.80 ha land), have been receiving weather-based Agro-met advisories since 2020. By applying standard cultivation practices as directed in the advisories he has been able to harness a marginal profit from the rapeseed crop grown during rabi, 2023-24.

Table 6.15 Economic impact assessment of AAS on rapeseed farmer in Thengal gaon

Operation	Cost (Rs.)	
Ploughing/ land preparation	Rs.1400 x 5 = 7000 (Tractor charge=Rs.1400 bigha^{-1})	
Cost of Sowing	Rs. 400 x 2 = Rs. 800 (1 labour cost = Rs. 400)	
Cost of seed	12.5 x Rs. 50 = Rs.625 (2.5 kg bigha^{-1}; total seed = 2.5 x 5 = 12.5 kg)	
Thinning cost	400 x 2= 800 (1 labour cost = 400)	
Harvesting cost	400 x 3 = 1200 (3 labors/ bigha)	
Threshing cost	1000 x 1 = 1000 (Thresher Charge = 1000/day)	
Fertilizer	Urea 50 kg (Rs. 10 kg^{-1})	Rs. 500
	SSP 100 kg (Rs.10 kg^{-1})	Rs. 1000
	DAP 50 kg (Rs. 30 kg^{-1})	Rs. 1500
	Total	Rs. 3000
Chemical cost	Nil	
Total Cost (In rupees)	Rs. 14425	

Production of rapeseed from 1 bigha of land : 1.4 q bigha^{-1}
Therefore, production from 5 bigha land is : 5 x 1.4 = 7 q
Price of 1 quintal harvested produce : Rs. 4050
Total amount received by selling
7 q harvested produce : Rs. 4050 x 7= Rs. 28350

Net income
Total cost of cultivation (Total cost) : Rs. 14425
Total income after selling the produce (Gross income) : Rs. 28350
Net Income (Rs.) : (Gross income)-(Total cost)= Rs.13925
B:C ratio : Gross Income/Total cost
: 28350/13925
: 2.04

Mohanpur

Economic impact of microlevel AAS on potato and Boro paddy growing farmers

The Mohanpur center has issued a forecast and an AAS advisory for the potato and boro rice growing farmers of Mohanpur Village on 1 December 2023. The forecast was Due to Cyclone Michaung, medium rainfall is expected in the region. Farmers are advised to prepare for the forecasted rainfall (Forecasted= 10-20 mm; Actual= 11-56 mm) followed by the advisory. Farmers are advised to stop irrigation in potato fields, create drainage channels to prevent waterlogging and avoid herbicide spraying operations during the expected medium rainfall due to cyclone Michaung. The forecast and the AAS issued to the farmers worked well and Saving the crop from damage due to water stagnation and saving on herbicide spraying and irrigation costs. The benefit cost ratio is mentioned in Table 6.16.

Table 6.16 B:C ratio of Potato and Boro rice for AAS and Non-AAS farmers

Farmers	Boro Paddy		Potato	
	AAS	Non-AAS	AAS	Non-AAS
Farmer 1	1.63	1.22	1.81	1.42
Farmer 2	1.61	1.20	1.76	1.41
Farmer 3	1.56	1.17	1.83	1.37

Parbhani

Economic impact of microlevel AAS on soybean growing farmers

Collection of cost of cultivation information under AICRPAM-NICRA village from AAS & Non-AAS village of 20 farmers grown during Kharif 2023. During the crop growing period, a series of AAS bulletins/real-time advisories were issued for farmers as AAS villages. Table 6.17 describes the B:C ratio obtained in the case of the soybean farmer in response to the AAS issued and, accordingly, timely action taken by the farmer. The expenditure on different operations and returns received on the sale of produce and other details were collected from farmers' feedback. It also includes the cost of cultivation and benefits: the cost ratio of AAS to non-adopted farmers.

Table 6.17 Comparison of cost of cultivation and B:C ratio of AAS adopted and Non-Adopted soybean farmers at Dampuri, Italapur (AAS village) & Thola (Non-AAS village)

Input Details / ha	Soybean Crop		
	AAS Farmer Dampuri	AAS Farmer Italapur	Non AAS Farmer Thola
Field Preparation cost ha^{-1}	6940	7150	7445
Seed cost/ha^{-1}	5688	5310	6915
Seed treatment	316	335	218
Fertilizer cost	3380	3385	4780
Sowing	2500	2500	2500
Weed management	2765	2575	3800
Intercultural operation (Hoeing/Harrowing)	1350	1500	1500
Cost of plant protection ha^{-1}	5200	5405	7025
Harvesting	8763	9000	8900
Threshing	2374	2460	2070
Cost of cultivation	39275	39620	45153
Soybean yield (quintal ha^{-1})	20	21	17
Price of soybean Rs Qt^{-1}	4707	4776	4687
Total Income	95317	97898	80842
Net profit	56042	58278	35690
B:C ratio	2.43	2.47	1.79

Udaipur

Economic impact of microlevel AAS on wheat growing farmer

Name of farmer	:	Mohan Lal Bhil
Address	:	Village- Amloi, Teh. –Rajsamand, Dist. - Rajsamand
Mobile Number	:	8003460208
Aadhar Number	:	670924696917
Name of crop	:	Wheat
Forecast	:	Higher temperature up to 35 °C

AAS given: Temperature will increase and create problems in wheat crops in the form of terminal heat stress.

Action taken: Foliar application of Agrochemicals viz., KCl 0.2 %, and repeating this spray after 10 days again resulted reduce the effect of heat stress and enhance wheat yield.

Particulars	Advisory adopted	Non-adopted
Grain yield	56.94	44.85
Straw yield	83.46	58.64
Cost of cultivation	47570	47570
Economics		
Gross return (Rs ha^{-1})	179330	136994
Net return (Rs ha^{-1})	131759	89423
B:C ratio	2.8	1.9

Economic impact of microlevel AAS on mustard-growing farmer

Name of farmer	:	Nasir Khan
Address	:	Village- Amloi, Teh. - Rajsamand Dist. - Rajsamand
Mobile Number	:	9680534541
Aadhar Number	:	473419973372
Name of crop	:	Mustard
Forecast (10-01-2022)	:	Possibility of frost

Advisory given: Advised given to farmers create smoke around the field at night, if possible light irrigation may be given or foliar spray of agrochemicals viz., Sulphuric acid @ 0.1% in field crops.

Action taken: On 13 January, 2022 at Rajsamand temperature touched 1.8 °C. Nasir Khan Ji followed the advisory guidelines and spray H_2SO_4 in the evening hours to save his crop from frost and produced 15-20 % more yield higher yield.

Particulars	Advisory adopted	Non adopted
Grain yield	24.90	19.96
Straw yield	51.50	42.45
Cost of cultivation	34658	34658
Economics		
Gross return (Rs ha^{-1})	144545	116125
Net return (Rs ha^{-1})	109887	81467
B:C ratio	3.20	2.40

Economic impact of microlevel AAS on Maize growing farmer

Name of farmer	:	Roshan Lal Jat
Address	:	Village- Amloi, Teh. - Rajsamand Dist. - Rajsamand
Mobile Number	:	9928715805
Aadhar Number	:	839941521152
Name of crop	:	Maize
Forecast	:	No chances of rainfall in next five days

Advisory given: Farmers are advised to apply/ spray plant protection measures in standing crops.

Action taken: Farmer Roshan Lal Jat followed the advisory and sprayed Spinetoram 11.7% SC insecticide in maize crops to control fall armyworms resulting in an enhancement in yield.

Particulars	Advisory adopted	Non-adopted
Grain yield	42.50	35.36
Straw yield	79.81	62.46
Cost of cultivation	34830	34830
Economics		
Gross return (Rs ha^{-1})	113566	93265
Net return (Rs ha^{-1})	78736	58435
B:C ratio	2.3	1.7

7. Farmer Awareness Programs on Climate Change

The details of awareness programs on climate change conducted for farmers of the different states under AICRPAM-NICRA project presented as follows.

Centres	Name of the Village	Date	Number of Farmers	Male	Female
Akola	Alanda	06-10-2023	48	36	12
	Swarupkhed	03-11-2023	63	43	20
	Swarupkhed	16-03-2024	60	44	16
Anantapur	Rekulakunta	21-02-2024	85	55	30
Bangalore	Siddaiyanapura	22-12-2023	83	53	30
	I Basapura	04-01-2024	77	64	13
Faizabad	Mitaura	04-12-2023	97	75	22
Hisar	Hisar	16-03-2024	76	63	13
Jorhat	Thengal gaon	28-12-2023	40	28	12
	Thengal gaon	23-01-2024	05	05	00
	Thengal gaon	14-03-2024	30	20	30
Ludhiana	Jalandhar	16-02-2024	70	23	27
	KVK Amritsar	05-02-2024	30	28	02
	Pandrali	19-02-2024	50	31	19
	Shadipur village	21-02-2024	50	40	10
	KVK Bathinda	28-02-2024	45	20	25
	KVK Bahowal	06-03-2024	45	20	25
Mohanpur	Gainpara	13-10-2023	25	18	07
	Kishorinagar	07-02-2024	39	24	15
	Sarati	18-03-2024	38	30	08
Palampur	Bhattu, Kangra	11-01-2024	56	07	49
Parbhani	Italapur	17-10-2023	109	63	46
	Boralae	13-01-2024	100	80	20
	Batala	20-01-2024	90	78	12
	Kolhar	02-02-2024	80	60	20
Raipur	Kutrabod	04-01-2024	20	03	17
	Mudpar	02-02-2024	51	26	25
Samastipur	Meyari	07-03-2024	52	48	04
	Narghoghi	16-03-2024	85	69	16
Udaipur	Nakali	25-01-2024	99	56	43
	Kesar	29-01-2024	95	69	26

Annexure I

AICRPAM-NICRA Activities


ਕ੍ਰਿਸ਼ੀ ਵਿਗਿਆਨ ਕੇਂਦਰ
ਅੰਮ੍ਰਿਤਸਰ
ਪਸ਼ੂ ਪਾਲਣ ਬਾਬਤ
ਕਿਸਾਨ ਜਾਗਰੂਕਤਾ ਕੈਂਪ
FARMER AWARENESS CAMP
ANIMAL HUSBANDRY
PUNJAB AGRICULTURAL UNIVERSITY, LUDHIANA


Kisan Meet
किसान मीलन

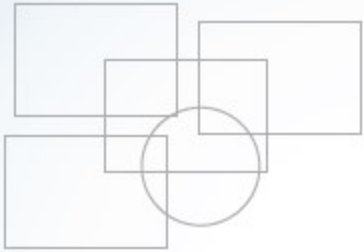

வேளாண்மை ஆராய்ச்சி நிலையம், கோவில்பட்டி
AGRICULTURAL RESEARCH STATION, KOVILPATTI

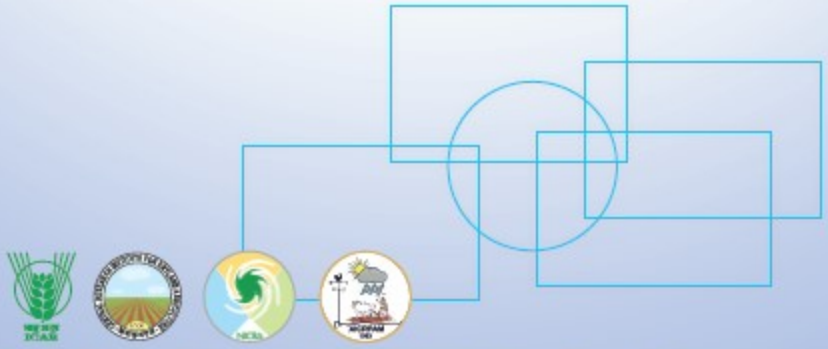
Annexure II

Location of AICRPAM-NICRA villages

S. No.	AICRPAM Centre	District	Block/Tehsil/ Mandal	Name of Village(s)
1.	Akola	Akola	Barshitakli	Alanda
			Barshitakli	Mirzapur
			Barshitakli	Kanheri
2.	Anand	Anand	Anand	Vadod Napapd Kashor
3.	Anantapur	Ananthapur	Buk- karayasa-mudram	Rekulakunta Siddarampuram
			Gooty	Karidikonda Bhachupalli Vannedhoddi
			Singanamala	East Narsapuramu Sodhanapalli Pothurajukaluva
4.	Bengaluru	Bengaluru Rural	Dodda- ballapur	Gulya Dandudasakodi-gehalli Sonnamaranahalli
5.	Bhubaneswar	Khordha	Balianta	Patapur Kakarudrapur Balabhadrapur
6.	Chatha	Jammu	Suchetgarh	Kotli Mirdian
			R S Pura	Fatehpur Slaharian
			Mira Sahib	Makhanpur Gojjran
7.	Faizabad	Ayodhya	Block-Amaniganj	Akma
			Block-Milkipur	Saroorpur
			Tehsil-Milkipur	Dhamthuwa
8.	Hisar	Hisar	Hisar	Ludas Aryanagar Shahpur
9.	Jabalpur	Jabalpur	Panagar	Urdua Khurd
				Keolari
10.	Jorhat	Golaghat	Khumtai	Thengalgaon
			Sirhind	Badoshe Kalan

S. No.	AICRPAM Centre	District	Block/Tehsil/ Mandal	Name of NICRA Village(s)
11.	Ludhiana	Fatehgarh Sahib	Amloh	Bauranga zer Salana
		Rupnagar	Chamkaur sahib	Rampur fasse
12.	Mohanpur	Nadia	Chakdah	Sarati Gainpara
		South 24 Par- ganas	Kultali	Bongheri Gopalganj
13.	Palampur	Hamirpur	Sujanpur	Patlandar Chamian Taryamli
14.	Parbhani	Parbhani	Parbhani	Dampuri Italapur
15.	Raipur	Mahasamund	Mahasamund	Jhalkhamharia Shirgidi
16.	Ranchi	Ranchi	Ormanjhi	Tirla Parsatoli
17.	Samastipur	Samastipur	Sarairanjan	Meyari Narghogi Udaipur
18.	Thrissur	Thrissur	Thrissur	Ollukkara Nadathara adakkathara
19.	Udaipur	Rajsamand	Rajsamand	Amloi Bhatoli Neinpuria
20.	Vijayapura	Vijayapura	Vijayapura	Kaggod Kumatagi Hadagali





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