National Innovations in Climate Resilient Agriculture (NICRA)

AICRPAM Component

Annual Report 2021

All India Coordinated Research Project on Agrometeorology

National Innovations in Climate Resilient Agriculture

ICAR-Central Research Institute for Dryland Agriculture
Santoshnagar, Hyderabad - 500 059

Citation: Bal, S.K., Subba Rao, A.V.M., Manikandan, N. and Sarath Chandran, M.A. 2022. National Innovations in Climate Resilient Agriculture - AICRPAM Component, Annual Report 2021. ICAR - Central Research Institute for Dryland Agriculture, Hyderabad, Telangana, India. p92.

Copies: 100

Published by
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Printed at:
Sai Maruthi Print Solutions, Almasguda, Hyderabad - 500 058.
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1. Introduction

The principal source of livelihood for nearly 48% of the population in India is agriculture and the allied sector it is contributing 20% to the country's Gross Domestic Product (Economic Survey 2020-21). As per 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 livelihood for 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 have a profound impact on global food production by varying intensity, as any change in climatic variables (eg. temperature, precipitation, CO_2 concentration, solar radiation, etc.) is bound to have a significant impact on crop yield. The recurrent extreme weather events have led to higher variability in agricultural production due to an increase in natural and anthropogenic greenhouse gas emissions.

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. On the other hand, Economic Survey 2017-18 reported that, climate change could reduce farm incomes of the country by 15-18%, and in un-irrigated areas by 20-25%. Extreme shocks have highly divergent effects in un-irrigated and irrigated areas (and consequently in crops that are dependent on rainfall), almost twice as high in the un-irrigated 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 un-irrigated 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 rise in temperature in agricultural crops, imply that in the absence of any adaptation by farmers and any changes in policy (such as irrigation), farm incomes will be lower by around 12% on an average in the coming years, and un-irrigated areas will be the most severely affected, with potential losses amounting to 18% of annual revenue" the survey said.

Realizing the impact of climate change, the Government of India had prioritized the climate change research and a flagship project 'National Innovations in Climate Resilient Agriculture (NICRA)' was initiated in 2010-2011 with the following objectives:

- To enhance the resilience of Indian agriculture (crops, livestock and fisheries) to climatic variability and climate change through the development and application of improved production and risk management technologies

- To demonstrate site-specific technology packages in farmers' fields for adapting to current climate risks
- To enhance the capacity building of scientists and other stakeholders in climate-resilient agricultural research and its application.

In the vulnerable regions, the outcome of the project is expected to bring enhanced resilience of agricultural production systems to climate variability. The project is comprised of four components *viz.,*

- Strategic research on adaptation and mitigation
- Technology demonstration on farmers' fields to cope with current climate variability
- Sponsored and competitive research grants to fill critical research gaps
- Capacity building of different stakeholders

It is a known fact that weather plays a dominant role in year to year fluctuations in crop production, both in rainfed or irrigated agriculture. 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.

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. In order to make the agromet advisory services more successful and continuous process, it should be supported with agrometeorological database, crop conditions, real-time weather, research results on crop-weather relationships, skilled manpower in multi-disciplinary resources and user interface. NICRA-AICRPAM project was thus initiated to address these issues with the following objectives.

- To create weather and crop information acquisition and monitoring system through AWS and Field Information Facilitators' (FIF) network.
- Delineating hotspots for weather anomalies at micro level through benchmark survey and climatic analysis at selected districts/villages/sites for principal cropping/farming systems.
- Quantification of crop responses to weather and its extremes by integrating statistical and dynamic modeling.
- Customizing micro-level agromet advisories and their dissemination through ICTs.
- Development of strategies to combat weather extremes through field research.
- Conduct awareness/training programs on climate change, and workshops for capacity building on agromet advisories.

2. Data Products

2.1 Assessment of climate change impact and development of adaptation strategies for rainfed maize under future climate of India

A study was undertaken to quantify the spatio-temporal changes in maize yield under projected climate and identify the potential adaptation measures to reduce the negative impact. Maize growing districts from 13 states (Andhra Pradesh, Chhattisgarh, Gujarat, Himachal Pradesh, erstwhile Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Telangana, Uttar Pradesh, and Uttarakhand). These districts were selected based on the average crop area ≥ 10000 ha in the five years (2014-18) and availability of continuous yield data for a minimum of 15 years during the *kharif* season. With the above two constraints, 96 districts as part of this analysis, representing approximately 52% of the maize growing region of India were choosen. Out of 96 districts, the results of 38 districts showed that the simulated crop yield was comparatively well in agreement with observed data within acceptable limits of both D-index (≥ 0.50) and MAPE (≤ 50%). The model appears to simulate maize yields reasonably better in 16 districts, out of the calibrated 38 districts, which was corroborated with respect to MAPE and D-Index values. Finally, these 16 districts were used for the simulation. Future climate data derived from 30 general circulation models were used to assess the impact of future climate on yield in 16 major maize growing districts of India. Fig. 2.1 shows the methodological flow chart in calibrating and validating the genetic coefficients and simulating the crop yield.

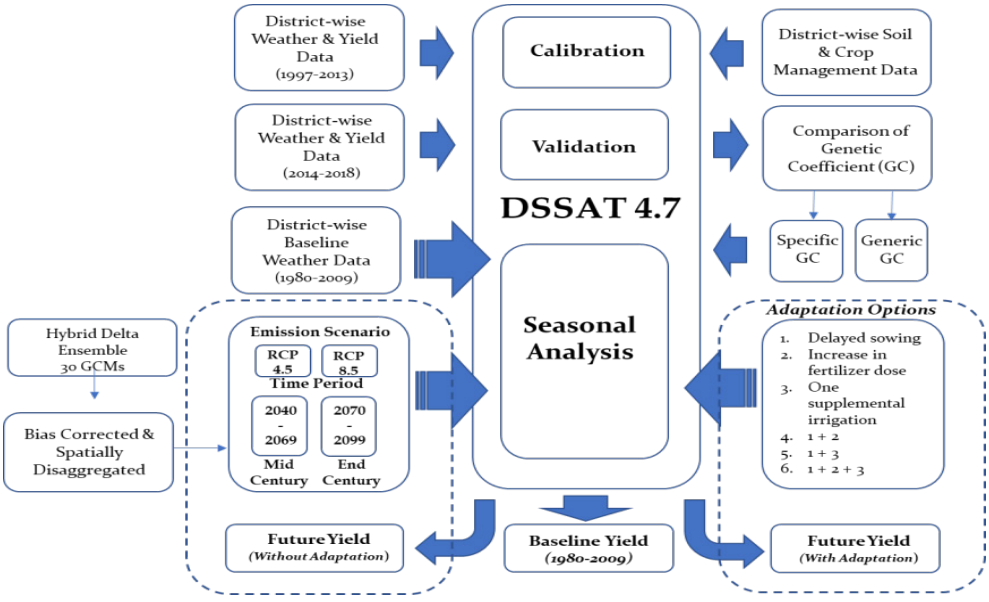
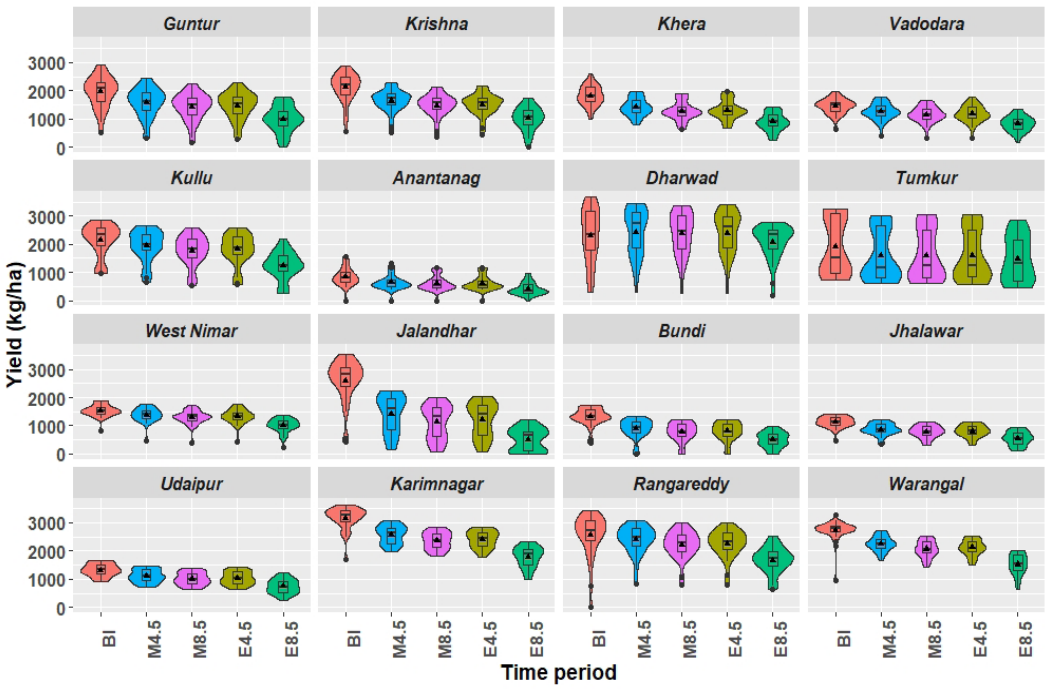


Fig. 2.1. Methodological flowchart for simulating the yield and developing adaptation strategies

DSSAT model was used to simulate maize yield and evaluate adaptation strategies during mid (2040-69) and end-centuries (2070-99) under RCP 4.5 and 8.5. Genetic coefficients were calibrated and validated for each of the study locations. These coefficients are not usually available and therefore they are derived by using Genotype Coefficient Calculator (GenCalc), software embedded in DSSAT. Among the four RCPs, RCP 4.5 and RCP 8.5 were selected for the present study, as they represent intermediate and very high greenhouse gas concentrations, respectively. The seasonal analysis was used as it enables continuous simulation of the CERES-Maize model for multiple years.

The rainfed maize was projected to decrease under all future scenarios across the study regions, except over Dharwad (Fig. 2.2). The magnitude of yield reduction ranged from 46-80% (Jalandhar) to 16-21% (Tumkur) compared to the mean baseline yield. Among the future scenarios, the lowest reduction in yield was recorded under mid-century RCP 4.5 and the highest was under end-century RCP 8.5. The reason for this may be due to the fact that the highest and lowest increase in mean T_{max} and T_{min} was projected under end-century RCP 8.5 and mid-century RCP 4.5, respectively for all the study regions.



(*The black triangle and black line inside each box plot represent the mean and median of 30 years, respectively*) *(BI-Baseline; M4.5-Mid-century @ RCP 4.5; M8.5-Mid-century @ RCP 8.5; E4.5-End-century @ RCP 4.5; E8.5-End-century @ RCP8.5)*

Fig. 2.2. Simulated ensemble model maize yield during mid-century and end-century under RCPs 4.5 and 8.5 relative to baseline yield

Though an increase in mean seasonal rainfall is projected for most of the study regions, the results indicate that it cannot nullify the negative impact of the increase in T_{max} and T_{min} on maize yield. The increase in T_{max} and T_{min} has mainly the following effects *viz.,* (1) it causes faster accumulation of growing degree days and hence, a reduction in total crop duration; (2) leads to higher evaporation and transpiration, which in turn, increases the total crop water requirement; (3) increase in T_{min} leads to a higher rate of night respiration. All of these negatively affect crop yield. In case of Dharwad, the maize yield was projected to increase by 5, 3, and 4% during mid-century RCP 4.5, 8.5, and end-century RCP 4.5, respectively. But, the yield is projected to decrease by 10% during the end-century RCP 8.5. One of the reasons for higher yield at Dharwad may be due to the application of the highest dose of nitrogen at Dharwad (150 kg ha^{-1}) among the study regions. Another observation was that, though the yield is projected to decrease by 10% during end-century RCP 8.5, the inter-annual variability was much lesser compared to that of baseline as indicated by the width of the box plots. Among the study regions, Dharwad, Tumkur, and Jalandhar showed higher inter-annual variability in yield across the future climate.

Table 2.1. Ideal adaptation strategies for different climate periods under different RCPs

District	Adaptation Strategy			
	Mid-Century		End-Century	
	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Guntur	NS+F+I	NS+F+I	NS+F+I	NS+F+I
Krishna	NS+F+I	NS+F+I	NS+F+I	NS+F+I
Kheda	NS+F+I	NS+F+I	NS+F+I	NS+F
Vadodara	NS+F+I	NS+F+I	NS+F+I	NS+I
Kullu	DS+I	DS+I	DS+I	DS+I
Anantnag	DS+I	DS+I	DS+I	DS+I
Dharwad	NA	NA	NA	NS+I
Tumkur	NS+F+I	NS+F+I	NS+F+I	NS+F+I
West Nimar	NS+F+I	NS+F+I	NS+F+I	NS+F+I
Jalandhar	DS+F	DS+I	DS+I	DS+I
Bundi	NS+F+I	NS+F+I	NS+F+I	NS+F+I
Jhalawar	DS+I	NS+F+I	NS+F+I	NS+F
Udaipur	NS+F+I	NS+F+I	NS+F+I	NS+F+I
Karimnagar	NS+F+I	NS+F+I	NS+F+I	NS+F
Rangareddy	NS+F+I	NS+F+I	NS+F+I	NS+F+I
Warangal	NS+F+I	NS+F+I	NS+F+I	NS+F+I

(NS-Normal Sowing; F-Increased Fertilizer Dose; I-One Supplemental Irrigation; DS-Delay Sowing; NA-No Adaptation)

An ideal adaptation strategy for mid and end-century under both RCP scenarios for all the 16 districts are shown in Table 2.1. From the above, adaptation strategies *viz.,* changing the sowing time, increase in the fertilizer dose and supplemental irrigation alone did not improve the crop yield appreciably over the baseline. When increased fertilizer dose with a supplemental irrigation was together applied, the response was distinct in a greater number of districts. In Guntur, Tumkur and Rangareddy districts, the crop yield is expected to increase by 5, 13, and 15% respectively in mid-century under the RCP 4.5 scenario.

2.2. Mobile applications

NICRA-AICRPAM Centre located in Udaipur developed an android mobile application in Hindi language for disseminating agromet advisory services to farming community. This centre developed a new mobile application 'Mewar Ritu' for the benefit of farmers in seven southern Rajasthan districts (Udaipur, Rajsamand, Pratapgarh, Chittorgarh, Bhilwara, Dungarpur, and Banswara) under the jurisdiction of Maharana Pratap University of Agriculture and Technology (MPUAT). This mobile app is very important to farmers for getting information about the weather condition to prevail in the next five days and value-added agro-met advisory which would help them to plan and take agricultural activities in time and reduce the crop/livestock loss due to weather hazards (Fig.2.3). The app is being updated twice a week (every Tuesday and Friday).

NICRA-AICRPAM centre Kanpur also released an android mobile application to disseminate the agromet advisory and weather forecast for the benefit of farmers of Kanpur region of Uttar Pradesh state (Fig.2.4).

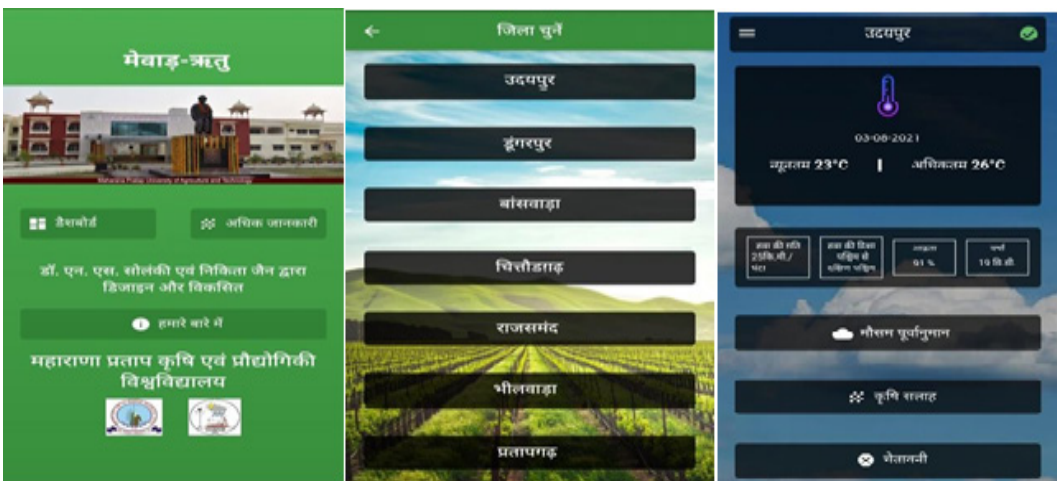


Fig. 2.3. Screenshot of "Mewar Ritu" app

'Mewar Ritu' App is available in the google play store (https://play.google.com/store/apps/details?id=com.mewarritu&hl=en_IN&gl=US).

Fig. 2.4. Screenshot of "CSAU Weather" app

'CSAU Weather' App is available in the following web link (https://apkgk.com/com.exam123livestill.csauweather)

3. Micro-level Agroclimatic Characterization

Akola

Spatial distribution of annual and southwest monsoon rainfall in Akola district

Taluk-wise actual rainfall received during 2020 in Akola district showed variations across different taluks of the district. Monsoon rainfall varied from 527.7 mm in Murtizapur taluka to 915.4 mm in Patur taluka. Annual rainfall varied from 570.1 mm in Murtizapur to 997.0 mm in Patur taluka. At Akola taluka (district headquarter and jurisdiction of NICRA village Kanshivani) received 534.7 mm and 590.1 mm rainfall during monsoon and annually, respectively (Table 3.1). At Barshitakli taluka (jurisdiction of NICRA village Warkhed) monsoon and annual rainfall amount to 533.1 mm and 592.5 mm, respectively.

Table 3.1. Annual and monsoon rainfall in different talukas of Akola district

Taluka	Rainfall (mm)						
	Annual	Monsoon	June	July	August	September	October
Akot	620.3	539.8	119.9	170.2	143.4	106.3	63.8
Telhara	654.2	584.5	144.4	172.1	179.1	88.9	55.7
Balapur	705.5	615.2	119.2	282.0	138.8	75.2	72.8
Patur	997.0	915.4	173.9	337.6	244.5	159.4	56.7
Akola	590.1	534.7	125.8	193.4	167.1	48.4	44.9
Barshitakli	592.5	533.1	125.1	139.4	167.1	101.5	48
Murtijapur	570.1	527.7	99.3	202.2	175.3	50.9	25

Rainfall events in various talukas of Akola district

Analysis of rainfall events was carried out for all seven talukas for different time periods based on the daily rainfall data availability [(Akot, Akola, Balapur – 1971 to 2020); (Telhara – 1973 to 2020); (Patur and Murtijapur – 1981 to 2020) and (Barshitakli – 1984 to 2020)]. The Mann-Kendall test using trend/ change detection software was employed to find the significance of trend of different rainfall events like 10 to 25 mm, 25 to 50 mm, 50 to 75 mm, 75 to 100 mm, >=100 mm, maximum single-day rainfall and also for rainy days on annual and SWM seasonal basis. The taluka-wise Mann Kendall statistic estimate under different rainfall events is presented in Table 3.2. None of the talukas showed a statistically significant increasing or decreasing trend for both annual and SWM rainfall. A non-significant decreasing trend was noticed in the majority of the talukas for annual (except Akot, Balapur and Murtijapur) as well as SWM (except Akot, Balapur and Murtijapur) rainfall. The majority of the talukas showed a significantly increasing trend of annual rainy days in all talukas except Akola as well as during SWM season in all talukas.

Table 3.2. Mann Kendall statistic test for rainfall events in different talukas of Akola district during 1970-2020

Taluka	Rainfall		Rainy day		Rainfall events					
	Annual	SWM	Annual	SWM	10 to 25 mm	25 to 50 mm	50 to 75 mm	75 to 100 mm	>100 mm	One day maximum rainfall
Akot	0.912 (NS)	1.246 (NS)	1.960 (0.05)	2.970 (0.01)	0.937 (NS)	-0.468 (NS)	0.268 (NS)	-1.138 (NS)	-0.234 (NS)	-1.159 (NS)
Telhara	-0.979 (NS)	-0.870 (NS)	2.785 (0.01)	3.154 (0.01)	2.183 (0.05)	-1.397 (NS)	-0.862 (NS)	-2.225 (0.05)	-1.221 (NS)	-1.949 (0.1)
Balapur	0.301 (NS)	0.703 (NS)	2.735 (0.01)	2.652 (0.01)	1.455 (NS)	0.945 (NS)	-1.932 (0.1)	-1.322 (NS)	-0.435 (NS)	-1.957 (0.1)
Patur	-0.629 (NS)	-0.314 (NS)	1.960 (0.05)	2.696 (0.01)	2.479 (0.01)	2.727 (0.01)	0.012 (NS)	1.414 (NS)	0.920 (NS)	2.484 (0.05)
Akola	-0.485 (NS)	-1.167 (NS)	0.928 (NS)	2.066 (0.05)	0.937 (NS)	0.460 (NS)	0.634 (NS)	0.264 (NS)	-0.951 (NS)	-1.083 (NS)
Barshitakli	-0.402 (NS)	-0.377 (NS)	3.130 (0.01)	3.068 (0.01)	5.998 (0.01)	3.195 (0.01)	1.556 (NS)	0.410 (NS)	0.870 (NS)	3.505 (0.01)
Murtijapur	0.338 (NS)	0.035 (NS)	2.377 (0.05)	2.447 (0.05)	2.742 (0.01)	2.141 (0.01)	1.815 (0.1)	1.397 (NS)	0.569 (NS)	2.727 (0.01)

In case of single-day rain event (10 to 25 mm), Telhara, Patur, Barshitakli and Murtijapur taluks showed a significant rising trend, whereas the remaining taluks indicated a non-significant increasing trend. For single-day rain event of 25 to 50 mm, the taluks like Patur, Barshitakali and Murtizapur taluks showed a statistically significant trend (Table 3.2). Akot and Telhara taluks showed a non-significant decreasing trend. Balapur and Akola showed a non-significant increasing trend.

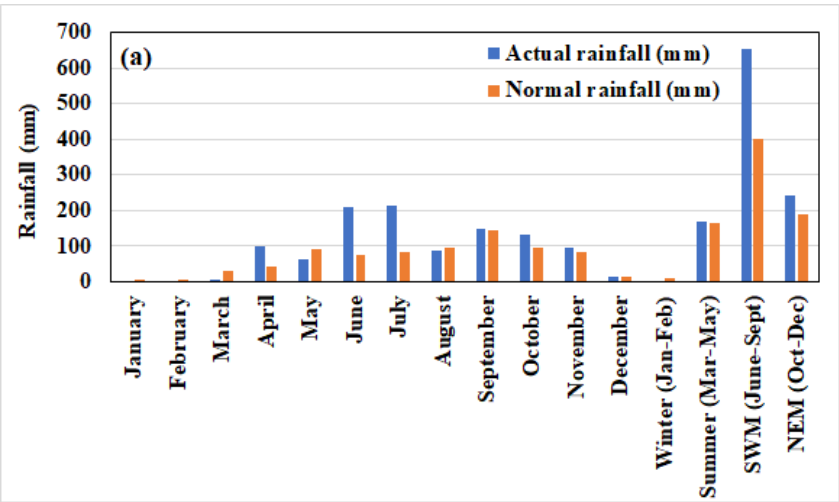
Statistically significant increasing and declining trend was noticed in Murtizapur and Balapur taluks, respectively for one-day rainfall of 50-75 mm. Other taluks except Telhara showed a non-significant increasing trend. A significant rising trend was observed in Telhara taluk in case of 75-100 mm per day while other taluks of the district showed non-significant increasing trend except two taluks (Akot and Balapur) where a non-significant decreasing trend was seen. For the single day rain event of >=100 mm, none of the taluks showed statistically significant trend. It was observed that maximum one-day rainfall in a year was showing significant declining trend Telhara, Balapur while significant increasing trend was noticed in Patur, Barshitakli and Murtizapur taluks.

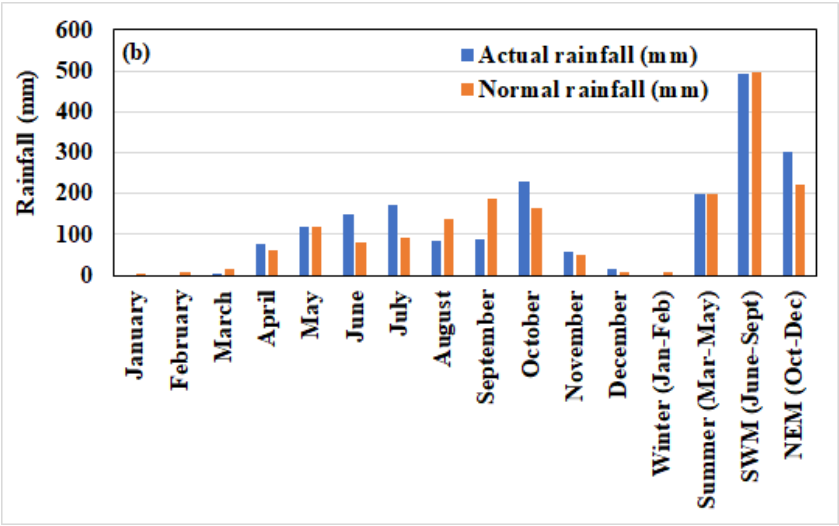
It can be concluded that in spite of increasing trend of rainy days, rainfall trend remains decreasing (though non-significantly) in majority of taluks which could the consequence of increasing trend of 10 to 25 mm rain event and decreasing trend of 50 to 100 mm, >100 mm and maximum rain amount in majority of the taluks.

Bengaluru

Rainfall analysis of study villages

NICRA villages *viz.,* Nayanahalli, Kuthanagere and Durgada Nagenahalli received 1067.6 mm, 996.4 mm and 952.0 mm of annual rainfall, respectively in the year 2020. Runoff causing rains recorded at Nayanahalli, Kuthanagere and Durgada Nagenahalli are 18, 12 and 22 days, respectively during this year. The highest rainfall in a day during 2020 was recorded at Nayanahalli (77.2 mm), Kuthanagere (61.0 mm) and Durgada nagenahalli (59.0 mm) on 26th June, 29th April and 1st September, respectively. Monthly and seasonal normal and actual rainfall recorded at all three villages is depicted in Fig. 3.1(a-c).





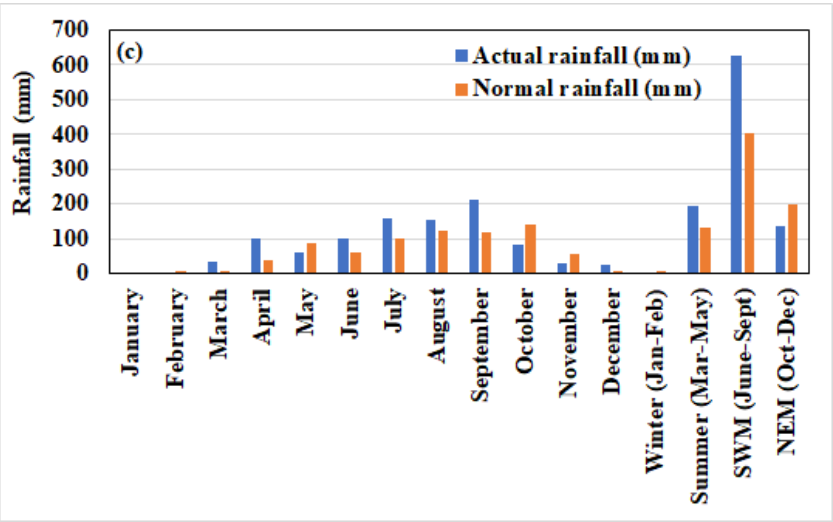


Fig. 3.1. Monthly and seasonal rainfall at (a) Nayanahalli (b) Kuthanagere (c) Durgada Nagenahalli villages

Rainfall during September month was highest in Nayanahalli and Durgada Nagenahalli villages. The rainfall distribution clearly shows bimodal rainfall in all three study villages. Though South West Monsoon of all three villages recorded excess rainfall, it is very clear from monthly rainfall that the excess rains have masked the deficit situation. The Length of the Growing Period (LGP) was calculated using rainfall and PET values. It was found that the lowest LGP is noticed at Durgada Nagenahalli (154 days) and the highest LGP at Kuthanagere (228 days) while Nayanahalli village had 194 days.

Bhubaneshwar

One-day highest rainfall recorded during 1988-2020 and number of days with rainfall more than 60 mm was compiled for all blocks of Ganjam, Kendrapara and Kandamal districts. It is noticed that Buguda block received the highest one-day rainfall of 323 mm in the year 2013 followed by Shergada (287 mm) and Aska (283.1 mm) blocks (Table 3.3). Frequency of days with 60 mm or more was higher (5 days) in Sherguda block followed by Bhanjannagar and Dharakote (4 days) and the lowest was observed in Belaguntha and Sorada (1 day) blocks during 2020.

Table 3.3. One-day highest rainfall during 1988-2020 in different blocks of Ganjam district

Blocks	1988-2020		2020		
	Amount	Date	Amount	Date	No. of rainy days > 60 mm
Bhanjanagar	269.0	03.11.2012	94.0	01.10.2020	4
Belaguntha	265.0	13.10.2013	71.2	10.08.2020	1
Jagannathprasad	210.0	18.06.1992	96.0	25.04.2020	3
Buguda	323.0	13.10.2013	88.0	15.07.2020	2
Aska	283.1	24.10.2013	210.4	14.10.2020	3
Dharakote	276.0	24.10.2013	111.6	14.10.2020	4
Sheragada	287.0	18.10.1999	156.0	14.10.2020	5
Sorada	224.0	04.11.1990	82.0	14.10.2020	1

One-day maximum rainfall recorded during 1988-2020 in different blocks of Kendrapara district showed that all the blocks received exceptionally heavy rainfall (455-495 mm) on the same day i.e. October 29, 1999 due to Odisha Super Cyclone. In the year 2020, the highest one-day rainfall of 234 mm was recorded in Marshaghai block and the lowest (130 mm) in Garadapur block. However, in Kendrapara and Derabis blocks received more than 60 mm rainfall in a day for 10 times followed by Rajnagar block (9 times) in the year 2020 (Table 3.4).

Table 3.4. One-day highest rainfall during 1988-2020 in different blocks of Kendrapara district

Blocks	1988-2020		2020		
	Rainfall (mm)	Date	Rainfall (mm)	Date	No. of rainy days > 60 mm
Kendrapara	480	29.10.1999	193.0	26.08.2020	10
Derabis	482	29.10.1999	178.0	15.08.2020	10
Marshaghai	470	29.10.1999	234.0	26.08.2020	7
Mohakalpara	495	29.10.1999	160.0	26.08.2020	6
Garadapur	487	29.10.1999	130.0	26.08.2020	6
Pattamundai	455	29.10.1999	185.0	26.08.2020	5
Aul	475	29.10.1999	168.0	26.08.2020	6
Rajnagar	480	29.10.1999	180.0	15.08.2020	9
Rajkanika	479	29.10.1999	154.0	26.08.2020, 05.20.2020	7

In Kandhmal district, during the period 1988-2020, the highest one-day rainfall was recorded in Kotagarh block (371 mm) followed by Tumidibandh (355 mm) and G. Udayagiri (351 mm) while the lowest one-day rainfall was observed in Phulbani (259 mm) and Raikia (282 mm). In the year 2020, maximum rainfall that occurred in 24-hours period, was recorded at Phiringia (166.8 mm) followed by Phulbani (148.6 mm) blocks (Table 3.5). In the remaining blocks, it was between 67 mm and 131 mm. It was observed that frequency of days with rainfall more than 60 mm during 2020 was 6 days in five blocks *viz.,* Baliguda, Chakapad, Phiringia, Phulbani and Tikabali.

Table 3.5. One-day highest rainfall during 1988-2020 in different blocks of Kandhamal district

Blocks	1988-2018		2020		
	Amount	Date	Amount	Date	No. of Rainy Days > 60 mm
Baliguda	326.0	06.09.2003	129.0	26.08.2020	6
Chakapad	288.0	13.10.2013	120.0	05.10.2020	6
Daringibadi	316.0	12.10.2018	76.0	11.08.2020	4
G.Udayagiri	351.0	12.10.2018	76.8	05.07.2020	4
Khajuripada	292.2	12.10.2018	131.0	27.08.2020	4
Kotagarh	371.0	29.07.1991	69.8	06.07.2020	1
Nuagaon	327.0	28.08.2003	79.4	27.08.2020	1
Phiringia	331.0	12.08.1991	166.8	27.08.2020	6
Phulbani	259.0	13.08.1991	148.6	27.08.2020	6
Raikia	282.0	12.10.2018	70.0	20.08.2020	3
Tikabali	319.0	30.08.2006	86.0	20.08.2020	6
Tumudibandh	355.0	07.09.2003	67.0	13.06.2020	2

Chatha

Annual rainfall trends

The long-term annual rainfall data (1985-2020) of Kathua district and its deviation from normal rainfall were analyzed to detect any changes in annual rainfall pattern. Analysis showed that there were six deficit rainfall years (< 25% of the normal) and three of excess rainfall years (> 25% of the normal) (Fig. 3.2). The rest of the years were placed under the normal rainfall year's category.

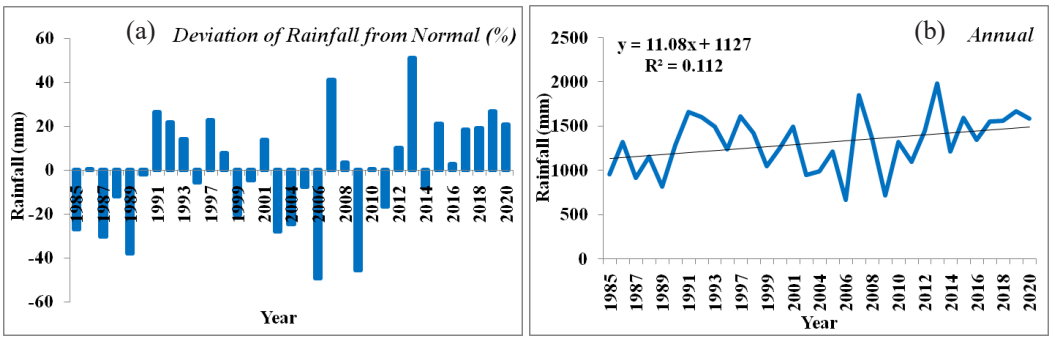


Fig. 3.2. Annual rainfall deviation from normal (a) and its trend (b) in Kathua district

Seasonal rainfall trend

Temporal variation in *kharif* and *rabi* seasonal rainfall during the period from 1985 to 2020 was analyzed using linear trend test. The trend test indicated that there is a non-significant increasing rainfall trend during the *kharif* season and it is increasing at 6.9 mm per year. At the same time, in *rabi* season also non-significant increasing trend was noticed over Kathua at 1.2 mm per year (Fig. 3.3) during the period 1985-2020.

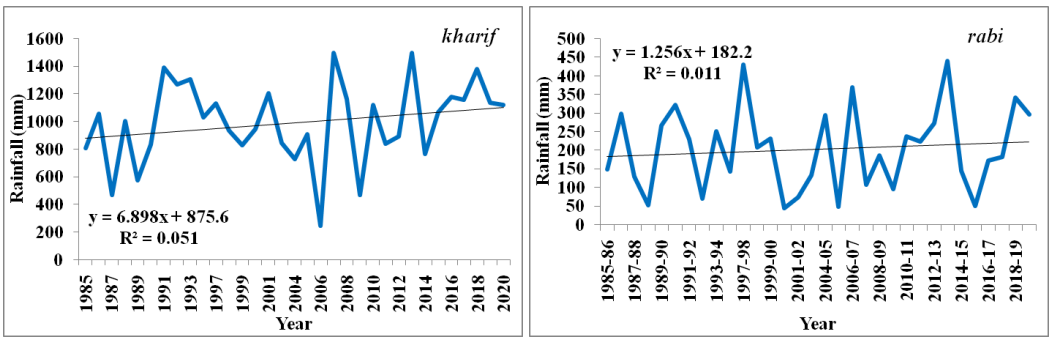


Fig. 3.3. Rainfall trends over Kathua during *kharif* and *rabi* season

Temperature trends

The inter annual variations in maximum and minimum temperature during the period 1985-2020 at Kathua were worked out. The mean annual maximum and minimum temperature was 29.5 and 16.6 ºC, respectively. It was observed that the annual maximum temperature showed non-significant declining trend while minimum temperature showed non-significant increasing trend by 0.001 and 0.024 ºC, respectively (Fig.3.4).

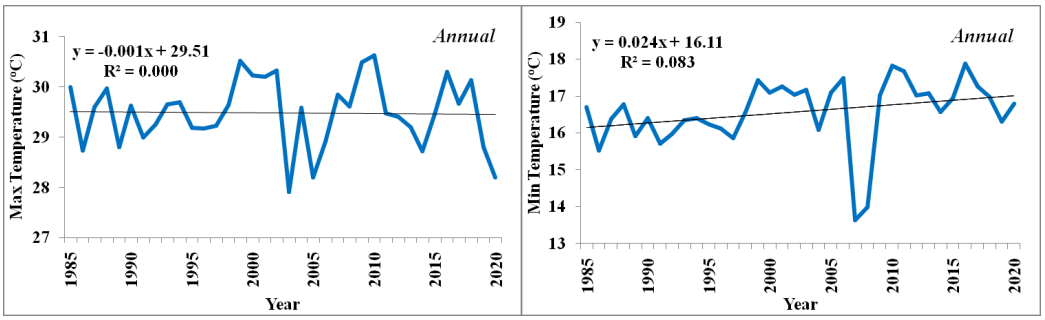


Fig. 3.4. Mean annual maximum and minimum temperature trends over Kathua

Dapoli

One-day rainfall events of different categories in Dapoli, Khed tahsils and Natunagar NICRA village

Rainfall events of different categories (25-50 mm, 50-75 mm, 75-100 mm and >100 mm) and the maximum one-day rainfall recorded each year during 2011-2020 in Dapoli and Khed tahsils and at Natunagar NICRA-AICRPAM village was computed. It is inferred that the frequency of rainfall events of 25-50 mm/day and 50-75 mm/day was almost equally distributed in both the tahsils and at NICRA village. However, number of days with 75-100 mm and >100 mm rainfall was less in Dapoli and Khed tahsil when compared to Natunagar village. For instance, in the year 2019, 25 events were recorded with rainfall above 100 mm per day at NICRA village while only 7 and 12 events were observed in both the tahsils, respectively (Table 3.7).

Table 3.7. One-day rainfall events of different categories in Dapoli and Khed tahsils and Natunagar village during 2011-2020

Year	Number of days with rainfall				Maximum one-day	
	25 – 50 mm	50 – 75 mm	75 – 100 mm	>100 mm	Rainfall (mm)	Date
Dapoli tahsil						
2011	17	13	6	15	219.0	17-07-2011
2012	19	10	10	5	337.0	18-06-2012

Year	Number of days with rainfall				Maximum one-day	
	25 – 50 mm	50 – 75 mm	75 – 100 mm	>100 mm	Rainfall (mm)	Date
2013	21	11	2	18	233.6	16-06-2013
2014	11	6	5	11	172.9	06-09-2014
2015	15	5	2	4	171.0	22-06-2015
2016	18	10	12	11	149.0	24-06-2016
2017	20	7	4	9	153.0	19-09-2017
2018	24	7	5	7	154.3	08-07-2018
2019	30	15	10	7	146.6	28-06-2019
2020	22	13	8	3	126.0	04-08-2020
Khed tahsil						
2011	22	7	9	11	158.0	29-08-2011
2012	25	7	5	7	158.0	18-06-2012
2013	38	8	15	7	156.6	16-06-2013
2014	22	4	5	9	166.4	06-09-2014
2015	20	4	1	4	263.3	22-07-2015
2016	27	16	7	8	131.6	23-09-2016
2017	25	6	3	5	128.1	19-07-2017
2018	24	19	6	1	152.6	08-07-2018
2019	28	25	7	12	182.3	25-09-2019
2020	26	19	8	7	146.6	04-08-2020
Natunagar village						
2011	27	12	12	12	241	17-07-2011
2012	31	12	5	10	218	02-07-2012
2013	26	12	6	15	208	16-06-2013
2014	21	10	5	9	187	05-08-2014
2015	26	2	2	7	214	22-07-2015
2016	34	7	13	11	237	23-09-2016
2017	25	17	1	11	203	19-07-2017
2018	35	4	4	7	260	08-07-2018
2019	40	8	10	25	240	27-07-2019
2020	32	7	15	7	205	05-07-2020

In the case of one-day maximum rainfall, 337 mm in 2012, 263.3 mm in 2015 and 260 mm in 2018 was recorded in Dapoli, Khed and Natunagar, respectively. During the southwest monsoon season of 2020, in Dapoli tahsil, three heavy rainfall events (100 to more than 100 mm/day) were recorded while in Khed tahsil, five such events were noticed. In NICRA-AICRPAM village Natunagar, the rainfall event of 100 to more than 100 mm was recorded

in seven days. The highest rainfall was recorded at Dapoli (126 mm) and Khed (146.6 mm) on 4th August 2020 whereas 205 mm was observed at Natunagar on 5th July, 2020.

Palampur

Rainfall pattern in Bhoranj and Sujanpur Tira blocks of Hamirpur district

The seasonal and annual rainfall data for the period from 1993 to 2020 of Bhoranj block revealed that this block receives an average annual rainfall of 1344 mm with a variation from 843 mm in 1983 to 193.8 mm in 2019. The average annual rainfall in Sujanpur Tira block is 1520 mm during the period 2008-2020 (Table 3.8). Though average annual rainfall is high in Sujanur Tira block, the interannual variability also was at higher side (27%) than Bhoranj block (20%).

Table 3.8. Rainfall (mm) during different seasons at Bhoranj and Sujanpur Tira blocks of NICRA district Hamirpur

Year	Bhoranj					Sujanpur Tira				
	Winter (Jan-Feb)	Summer (Mar-May)	SW monsoon (Jun-Sept)	Post monsoon (Oct-Dec)	Annual	Winter (Jan-Feb)	Summer (Mar-May)	SW monsoon (Jun-Sept)	Post monsoon (Oct-Dec)	Annual
1993	63	84	696	0	843					
1994	172	135	1079	36	1422					
1995	118	72	983	0	1173					
1996	N.A.	N.A.	N.A.	N.A.	N.A.					
1997	93	174	1253	195	1715					
1998	N.A.	N.A.	N.A.	N.A.	N.A.					
1999	N.A.	N.A.	N.A.	N.A.	N.A.					
2000	149	194	1097	0	1440	N.A.	N.A.	N.A.	N.A.	N.A.
2001	82	94	762	54	992					
2002	81	225	868	0	1174					
2003	156	123	989	18	1286					
2004	151	42	922	165	1279					
2005	165	128	962	14	1269					
2006	56	161	1283	13	1513					
2007	144	154	1263	24	158					
2008	111	115	1278	23	1527	0	82	927	33	1042
2009	29	100	811	11	951	53	118	1154	62	1387
2010	81	40	1064	90	1275	67	22	1388	35	1512
2011	169	343	926	16	1453	146	93	1271	15	1525
2012	189	54	903	13	1158	180	35	1739	49	2003
2013	199	87	1276	56	1618	180	85	1904	311	2480
2014	119	156	884	49	1208	148	238	1141	69	1596

Year	Bhoranj					Sujanpur Tira				
	Winter (Jan-Feb)	Summer (Mar-May)	SW monsoon (Jun-Sept)	Post monsoon (Oct-Dec)	Annual	Winter (Jan-Feb)	Summer (Mar-May)	SW monsoon (Jun-Sept)	Post monsoon (Oct-Dec)	Annual
2015	211	275	908	70	1464	138	387	989	39	1552
2016	58	194	966	2	1220	40	198	1430	63	1731
2017	48	139	1326	58	1571	51	76	1121	30	1278
2018	46	178	1376	28	1628	14	78	848	35	975
2019	323	54	1345	191	1914	422	90	1005	90	1607
2020	105	258	565	6	935	117	288	658	6	1069
Mean	125	143	1031	45	1344	120	138	1198	64	1520
Std. Dev. (mm)	67	76	220	58	264	110	108	349	78	410
CV (%)	53	53	21	128	20	92	79	29	120	27

Among the seasons, post-monsoon season was the driest in both the blocks as it receives a meagre rainfall amount of 58 and 78 mm, respectively in Bhoranj and Sujanpur Tira blocks with the almost same coefficient of variation. Season rainfall during the winter (Jan-Feb) generally varied between 29-323 mm whereas during the summer season (March - May) it varied between 40.4 - 342.9 mm in Bhorajpur block. During the southwest monsoon (June-Sept), little higher rainfall is received in Sujanpur Tira (1198 mm) when compared to Bhoranj block (1031 mm).

Maximum one-day rainfall

The highest single-day rainfall events from available records in the Bhoranj and Sujanpur Tira blocks is furnished in Fig. 3.5. It is observed that in Bhoranj block, the highest single-day rainfall of 314.3 mm was received on 11th August, 2007 followed by 208.8 mm on 13th August, 2018. In Sujanpur Tira block, since 2008, the highest rainfall of 160 mm was observed on 30th July, 2012.

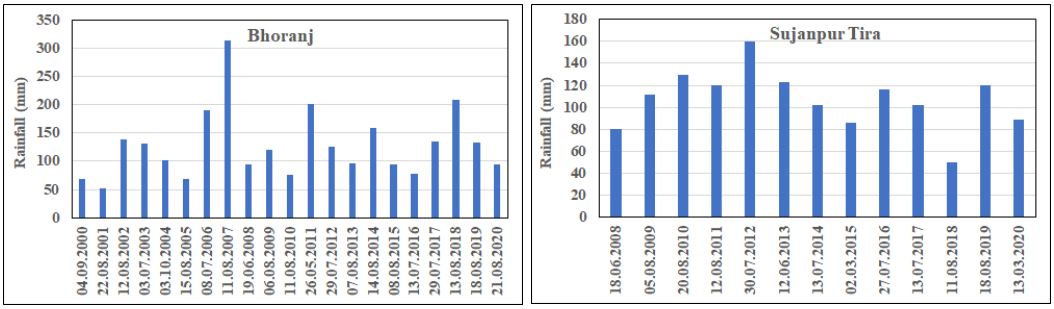


Fig. 3.5. Highest one-day rainfall events in Bhoranj and Sujanpur Tira blocks of NICRA district (Hamirpur)

Thrissur

Variation in annual and southwest monsoon rainfall in NICAR-AICRAPM district (Malappuram)

The interannual variability of annual and seasonal (southwest monsoon, northeast monsoon, winter and summer) rainfall is analyzed to compare the rainfall situation of 2020 with the last thirty-eight years (1983-2020). The annual rainfall was above 2000 mm during 2018 and 2019 in Malappuram district. In 2020, the annual rainfall was 1916.8 mm. The southwest monsoon rainfall and northeast monsoon rainfall during 2020 were less than that in 2019. The highest southwest monsoon rainfall was experienced during 1994 in the last 38 years. But the highest northeast monsoon rainfall was experienced both in the 1994 and 2019.

The daily rainfall data of 18 stations of Malappuram district for the year 2020 was taken from NASA POWER and has been used for mapping the annual and southwest monsoon rainfall using Arc map 10.3.1 version. The spatial distribution of annual and seasonal rainfall of the Malappuram district in the year of 2020 indicated that Kalikavu and Tavanur blocks received an annual rainfall of around 2500 mm (Fig. 3.6). It was observed that in the Kalikavu block located in the eastern region of the district, more rainfall during the southwest monsoon was experienced. At the same time, more rainfall was recorded during the northeast monsoon season than in the southwest region compared to other parts of the district. The observed summer and winter rainfall more in Thavannur block, which is located in the southwest region of the district. The places Angadipuram and Perinthalmanna, which are located in the southeast region of the district also received a higher winter rainfall.

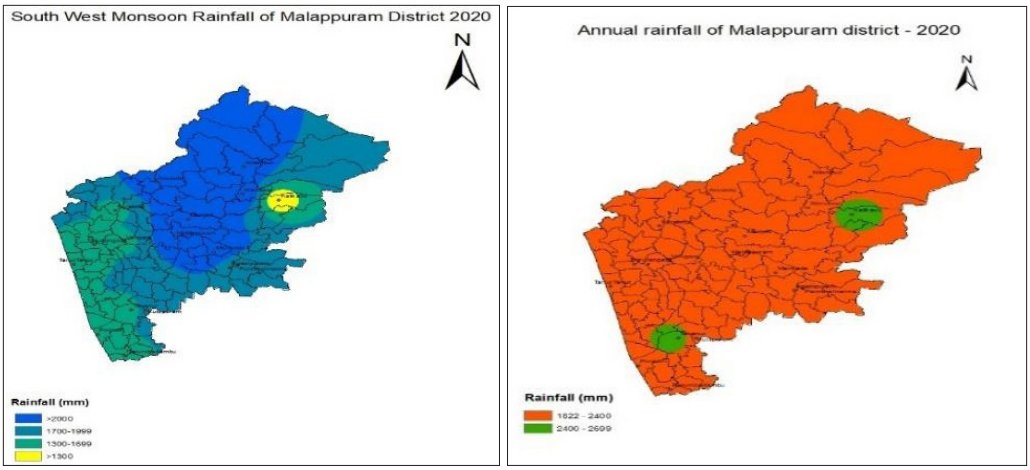


Fig. 3.6. Spatial distribution of annual and southwest monsoon rainfall in Malappuram district

Udaipur

Trend in annual mean maximum and minimum temperature in Rajsamand district

The temperature trend during the period 1970 to 2013 in Rajsamand district was worked out. The mean annual maximum and minimum temperature was 31.8 and 17.8 °C, respectively. It was observed that the annual maximum and minimum temperatures showed increasing trends (Fig. 3.7 & 3.8) by 0.018 and 0.016 °C per year, respectively.

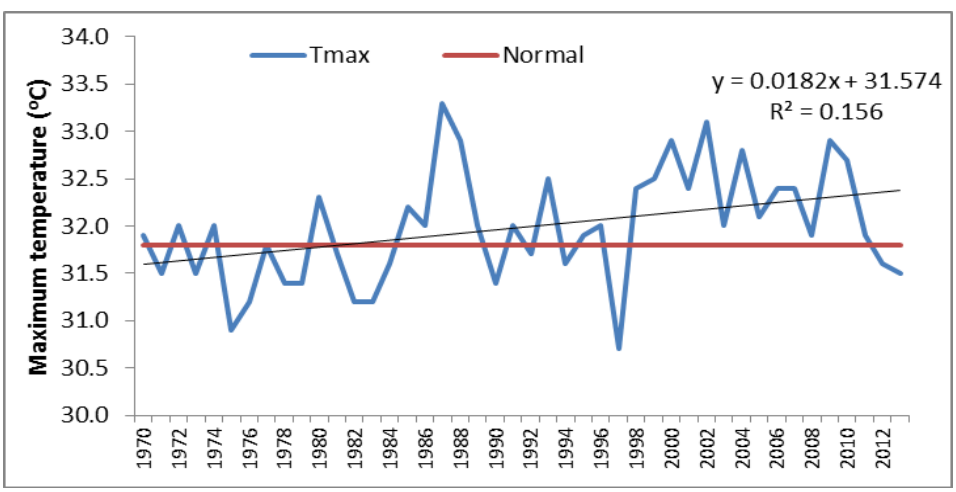


Fig. 3.7. Trend in maximum temperature in Rajsamand (1970-2013)

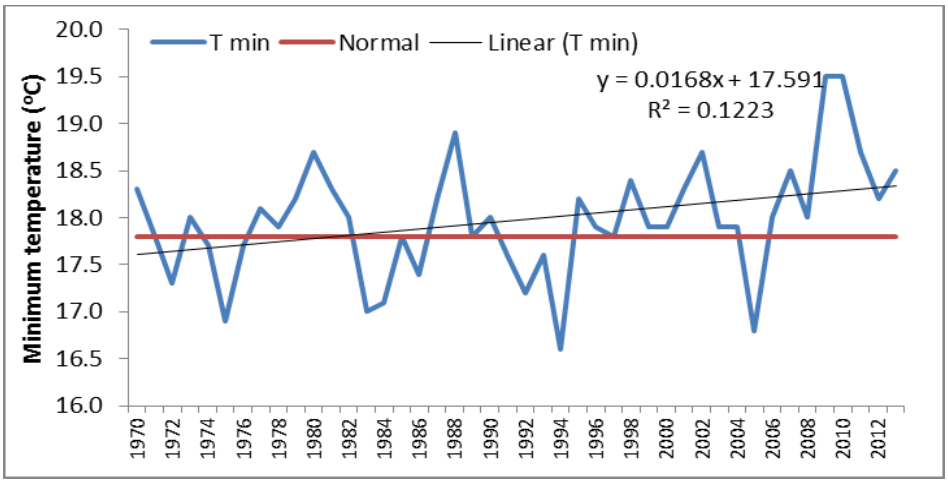


Fig. 3.8. Trend in minimum temperature in Rajsamand (1970-2013)

Seasonal rainfall and rainy days

The seasonal rainfall and rainy days in different tehsils of Rajsamand and Kota district are presented in Table 3.9. Among the tehsils, Kumbhalgarh (635.6 mm in 30.4 rainy days) receives the highest rainfall during southwest monsoon followed by Nathdwara (552.5 mm in 28.6 rainy days). Winter season is the driest and average rainfall during this season varies from 4.8 mm in Nathdwara to 9.1 mm in Bhim (Table 3.9). Rainfall during summer and north east monsoon season is almost same in all the tehsils of the Rajsamand district. In the case of rainy days, Deogarh tehsil had the highest number of rainy days (33) followed by Bhim tehsil (30). The lowest rainy days were recorded in Amit tehsil (23) during southwest monsoon season.

Table 3.9. Seasonal distribution of rainfall in different tehsils of Rajsamand and Kota district (1970-2016)

Tehsils in Rajsamand district	Rainfall (mm)			
	Winter (Jan-Feb)	Summer (Mar-May)	Southwest Monsoon (Jun-Sep)	Northeast Monsoon (Oct-Dec)
Amet	6.0 (0.5)	23.9 (2.1)	482.4 (25.9)	21.9 (1.4)
Bhim	9.1 (0.6)	23.6 (2.0)	469.5 (22.6)	25.3 (1.2)
Deogarh	7.9 (0.8)	21.2 (1.8)	491.7 (24.4)	23.9 (1.6)
Kumbhalgarh	6.3 (0.6)	19.0 (1.5)	635.6 (30.4)	24.8 (1.8)
Nathdwara	4.8 (0.5)	14.9 (1.5)	552.5 (28.6)	24.3 (1.5)

Tehsils in Rajsamand district	Rainfall (mm)			
	Winter (Jan-Feb)	Summer (Mar-May)	Southwest Monsoon (Jun-Sep)	Northeast Monsoon (Oct-Dec)
Railmagra	6.1 (0.6)	15.2 (1.5)	542.4 (26.9)	21.0 (1.5)
Rajsamand	5.0 (0.6)	16.9 (1.6)	513.9 (26.5)	26.7 (1.8)
Tehsils in Kota district				
Kota	7.8 (0.7)	22.2 (1.6)	650.0 (29.6)	37.9 (1.8)
Ladpura	8.3 (0.8)	20.7 (1.6)	682.1 (30.8)	30.6 (1.5)
Piplada	11.8 (1.0)	12.2 (0.9)	693.5 (31.6)	28.8 (1.3)
Ramganj Mandi	9.4 (0.8)	11.6 (1.0)	834.7 (32.4)	48.7 (1.8)
Sangod	8.0 (0.6)	8.8 (0.8)	735.1 (31.7)	36.7 (1.8)

Figures in parenthesis refer to the number of rainy days

The seasonal rainfall and rainy days of different tehsils Kota district was worked out for the period of 47 years (1970-2016). Results revealed that Ramganj Mandi tehsil receives the highest rainfall (834.7 mm) during southwest monsoon season in 32.4 rainy days while the lowest rainfall (650.0 mm in 29.6 rainy days) is noticed in Kota tehsil (Table 3.9). Rainfall during summer and northeast monsoon seasons varied from the lowest of 8.8 mm to the highest of 48.7 mm in different tehsils. Very meager rainfall (7.8-11.8 mm) is received during winter season.

Vijayapura

Seasonal rainfall during 2020 in different talukas of Vijayapura district

The rainfall during *kharif* (June-Aug) and *rabi* (Sept-Dec) for 2020-21 in different talukas of Vijayapura district compared to Long Period Average (LPA) have been computed and results are presented in the graphically in Fig. 3.9. During *kharif* season rainfall was excess in the four talukas of the Vijayapura district namely Bagewadi, Indi, Muddebihal and Sindagi talukas with a percent devition ranging from 28.6% to 63. %, whereas Vijayapura taluka received normal rainfall with a percent deviation of 14.2%. All the talukas received normal rainfall during the *rabi* season with a percent deviation ranging from -7.4% to 14.2% during 2020-21.

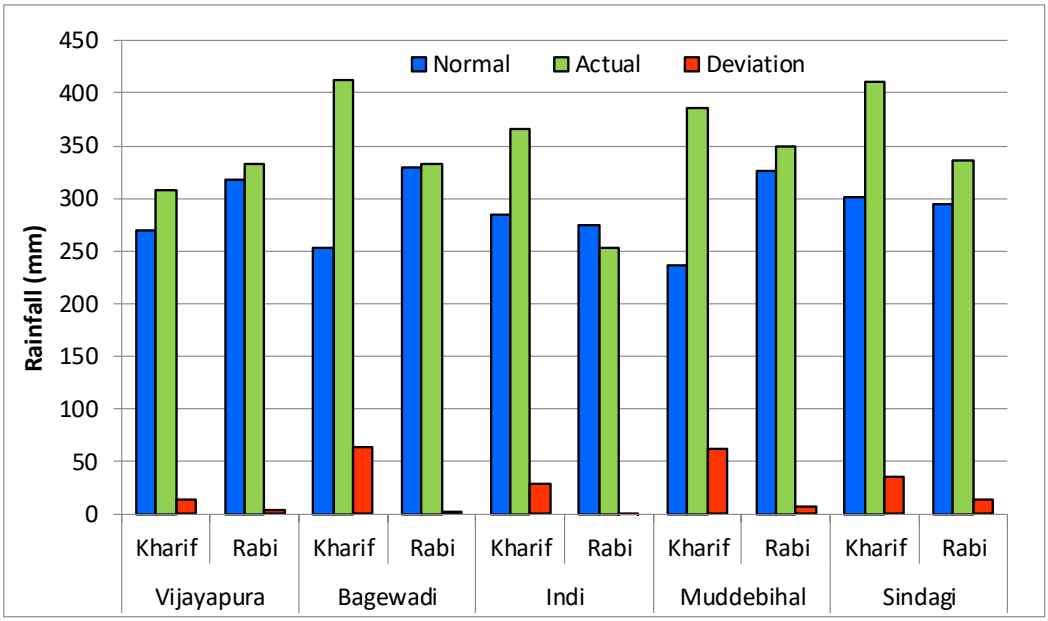


Fig. 3.9. Actual and normal rainfall during 2020 *kharif* and *rabi* seasons in different talukas of Vijayapura disrtict

Monthly rainfall during 2020 in different talukas of Vijayapura district

The monthly rainfall distribution pattern in the different talukas of the Vijayapura district is shown in Table 3.10.

In Vijayapura district, all the talukas received normal to excess annual rainfall during 2020 compared to the long-period average. The rainfall received during June and July months was almost excess in all the talukas, except Vijayapura and Indi talukas where during June normal rainfall has been received. During August Bagewadi and Muddebihal talukas received excess rainfall, Sindagi taluka reeived normal rainfall whereas Vijayapura and Indi received deficit rainfall compared to long-period average. September rainfall was excess in Vijayapura, Muddebihal and Sindagi talukas, normal in Bagewadi taluka and deficit in Indi taluka. During October month all the talukas received normal to excess rainfall followed by scanty rainfall during November and scanty / no rainfall during December. In *kharif* seasons initial conditions were favorable for taking up sowing of crops and also gowth of the crops. But, during *kharif* season the later stages of the crops faced soil moisture deficiency in Vijayapura and Indi talukas due to deficit rainfall received in the month of August. Hence *kharif* crops yield were low. During *rabi* season, except in Indi taluka the initial conditions were favourable for sowing.

Table 3.10. Taluk wise monthly rainfall distribution pattern in Vijayapura district during 2020

Month	Vijayapura			Bagewadi			Indi			Muddwbihal			Sindagi		
	LPA	Actual	Cat.	LPA	Actual	Cat.	LPA	Actual	Cat.	LPA	Actual	Cat.	LPA	Actual	Cat.
Jan	2.6	0.2	D	3.7	2.8	D	3.7	0.1	S	2.1	0.2	S	3.5	0.7	S
Feb	2.6	0.0	NR	3.7	0.1	S	4.6	0.1	S	2.5	0.1	S	2.4	0.5	S
Mar	7.5	9.6	E	7.7	5.4	D	6.9	9.8	E	6.0	6.2	N	3.9	7.9	E
Apr	23.1	20.5	N	22.8	22.3	N	14.4	24.5	E	26.5	20.6	D	16.4	22.3	E
May	47.8	44.4	N	48.7	28.2	D	32.8	29.3	N	52.6	39.9	D	35.0	39.4	N
Jun	102.0	100.5	N	92.4	151.2	E	96.0	109.1	N	83.1	135.3	E	107.1	131.1	E
Jul	76.6	150.0	E	73.6	145.6	E	91.5	193.1	E	68.9	134.0	E	92.9	164.6	E
Aug	91.4	57.9	D	86.8	115.5	E	96.4	63.0	D	84.5	115.7	E	101.8	115.0	N
Sep	158.4	203.0	E	173.4	190.9	N	152.7	121.8	D	156.5	209.4	E	167.1	208.0	E
Oct	123.9	127.2	N	126.2	139.1	N	92.4	129.2	E	137.0	133.6	N	98.4	126.2	E
Nov	27.5	2.3	S	22.2	2.6	S	23.4	2.5	S	22.8	6.1	S	23.3	2.3	S
Dec	7.2	0.1	S	7.3	0.0	NR	5.4	0.0	NR	9.2	0.0	NR	6.0	0.1	S
Annual	**670.6**	**715.7**	**N**	**668.5**	**803.7**	**E**	**620.2**	**682.5**	**N**	**651.7**	**801.1**	**E**	**657.8**	**818.1**	**E**
Rainfall Categories			**Rainfall categorization based on percent departure from normal**												
	E: Excess (=>20%)			**N: Normal (-19 to +19%)**			**D: Deficient (-59 to -20%)**			**S: Scanty (-99 to -60 %)**			**NR: No Rain (-100 %)**		

4. Validation of Block-level Weather Forecast

District-level weather forecast is being used for the preparation of bi-weekly agromet advisory services (AAS) in India, since the last two decades. However, it did not account for the large spatial variation in weather parameters, especially rainfall, which may vary even with in a kilometer. Hence, the validity of AAS prepared based on the district-level weather forecast is an issue and needs to be addressed. India Meteorological Department has started issuing block-level weather forecast since 2014 and AICRPAM is using this block-level forecast for the preparation of micro-level AAS by its 25 cooperating centers. The AICRPAM centres have compared block and district-level rainfall forecasts with the observed rainfall at the NICRA-AICRPAM adopted villages and the results are as follows.

Chatha

Verification of block-level rainfall forecast for NICRA adopted village Sherpur issued by India Meteorological Department was carried out for all the months of 2020 using error structure and statistical indices like, RMSE, Ratio score and HK score.

Table 4.1. Monthly verification of rainfall forecast during the year 2020

Month	Forecast day	No. of days forecast received	Error Structure		RMSE	Ratio score	H.K. score
			Correct + Usable	Not usable			
January	Tuesday	18	100.0	0.0	10.0	55.6	-0.41
	Friday	20	100.0	0.0	15.8	55.0	-0.35
February	Tuesday	21	100.0	0.0	9.9	66.7	-0.26
	Friday	21	93.8	6.3	9.1	76.2	0.29
March	Tuesday	20	83.3	8.3	14.7	60.0	0.25
	Friday	23	90.9	9.1	13.6	47.8	-0.17
April	Tuesday	22	100.0	0.0	10.6	36.4	-0.58
	Friday	21	94.1	0.0	2.1	81.0	0.34
May	Tuesday	23	85.7	14.3	4.6	60.9	0.57
	Friday	22	100.0	0.0	4.7	72.7	-0.24
June	Tuesday	20	100.0	0.0	17.4	45.0	-0.25
	Friday	22	93.3	6.7	4.8	68.2	0.20
July	Tuesday	23	75.0	25.0	12.2	52.2	0.45
	Friday	21	50.0	50.0	26.2	38.1	0.05

Month	Forecast day	No. of days forecast received	Error Structure		RMSE	Ratio score	H.K. score
			Correct + Usable	Not usable			
August	Tuesday	22	33.3	66.7	27.9	54.6	0.20
	Friday	22	30.8	61.5	32.1	59.1	0.23
September	Tuesday	21	100.0	0.0	0.9	90.5	0.02
	Friday	22	100.0	0.0	0.0	86.4	0.06
October	Tuesday	22	100.0	0.0	0.1	100.0	-0.51
	Friday	22	100.0	0.0	0.1	100.0	-0.48
November	Tuesday	21	95.0	5.0	2.2	95.2	0.95
	Friday	21	100.0	0.0	3.2	81.0	-0.06
December	Tuesday	22	95.0	5.0	5.3	90.9	0.90
	Friday	22	100.0	0.0	1.0	90.9	-0.41

From the results, it is found that the error structure (correct +usable) was found more than 80 percent accuracy in all the months except July and August. The H.K. score and RMSE was -0.58 to 0.95 and 0.04 to 32.1, respectively for all the months (Table 4.1). The ratio score was found higher in the months of September, November and December.

Dapoli

Comparison between predicted and actual rainfall on a weekly and monthly basis at Dapoli and Khed tehsils and Natunagar village for the years 2019 and 2020 were carried out. The weekly comparison showed that forecasted values showed higher values as compared to observed rainfall at Dapoli and Khed tehsil and Natunagar village during most of the weeks of 2019 and 2020 (Fig.4.1). It indicates that forecast accuracy need to be improved.

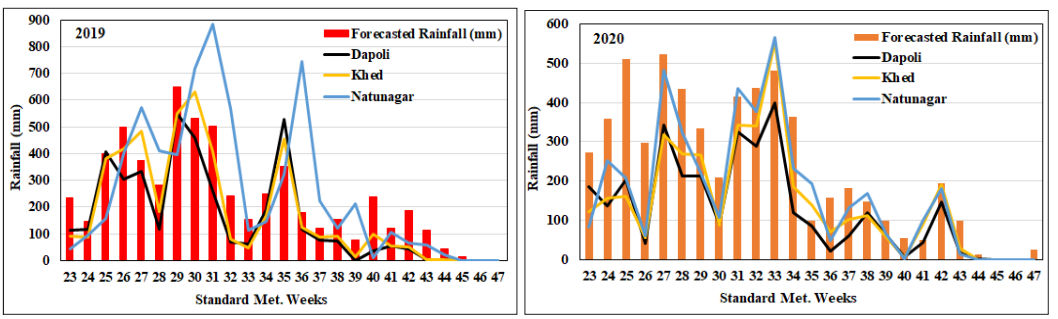


Fig. 4.1. Comparison between predicted rainfall and actual rainfall on week basis at Dapoli and Khed tahsils and NICRA-AICRPAM village-Natunagar during 2019 and 2020

Comparison between forecasted rainfall and actual rainfall in Dapoli, Khed and NICRA village-Natunagar on monthly basis for the year 2020 is depicted in Fig. 4.2. It was observed that the realized south-west monsoon rainfall was comparatively lower than the forecasted rainfall during the months of June to October in both the tahsils. Same situation was noticed for NICRA-AICRPAM village Natunagar also suggesting significant improvement in rainfall forecast skill.

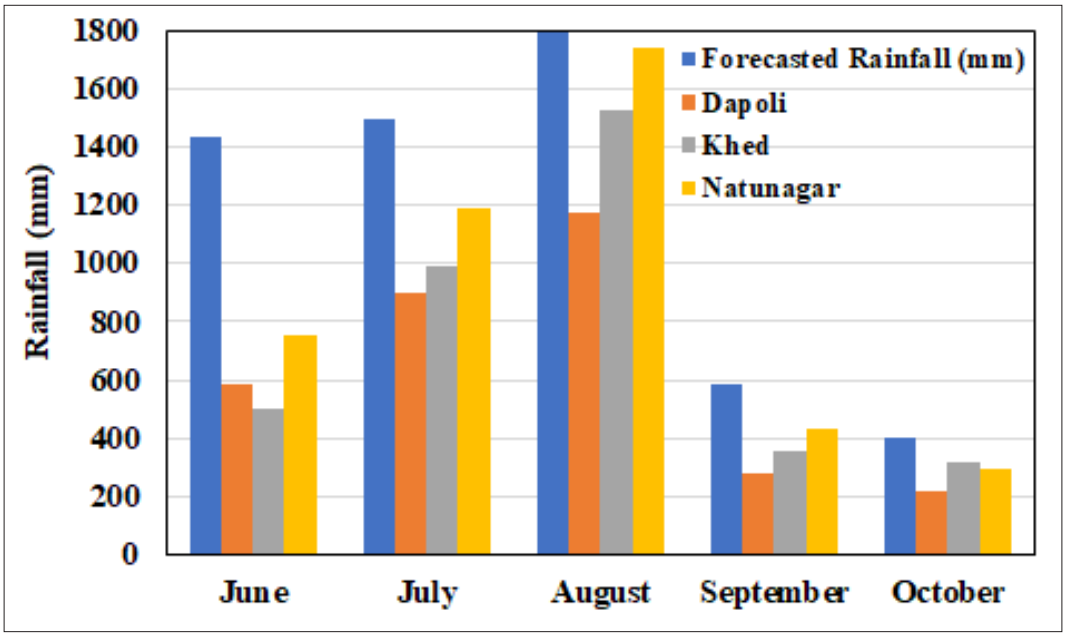


Fig. 4.2. Comparison between predicted rainfall and actual rainfall on monthly basis at Dapoli and Khed tehsils and Natunagar during 2020

Hisar

The season-wise quantitative verification analysis of the forecast for Sirsa during 2020-21 for rainfall, maximum and minimum temperature was carried out using various error structures. It was found that the rainfall forecast was perfect i.e. 100 % correct during the winter season and in the case of post-monsoon it was almost 97.8% perfect and quite good during pre-monsoon (88.7%). The accuracy was comparatively lower during monsoon season (84.4%). In the case of the annual rainfall forecast, the accuracy was 92.6% (Table 4.2).

Table 4.2. Quantitative analysis of predicted rainfall events in Sirsa

Error structure	Season				
	Pre-Monsoon	Monsoon	Post-Monsoon	Winter	Annual
Correct	88.7	84.4	97.8	100.0	92.6
Usable	4.8	2.6	0.0	0.0	1.8
Unusable	6.5	13.0	2.2	0.0	5.6

The quantitative analysis of predicted maximum and minimum temperature was done for pre-monsoon, summer and southwest monsoon seasons and also on annual basis. The results showed that, in the case of maximum temperature, the highest correct forecast events were during monsoon season (55.7%) followed by post-monsoon (51.1%). The pre-monsoon season recorded the least correct events i.e. 41.3%. In the case of annual values, the correct events were 50.0% with 25.2% usable and 24.8% unusable events. The highest unusable events were recorded during the pre-monsoon season (Table 4.3).

Table 4.3. Quantitative analysis of predicted maximum and minimum temperature events in Sirsa

Error structure	Maximum temperature			
	Pre-Monsoon	Monsoon	Post Monsoon	Annual
Correct	41.3	55.7	51.1	50.0
Usable	27.2	26.2	21.7	25.2
Unusable	31.5	18.0	27.2	24.8
	Minimum temperature			
Correct	33.7	62.3	18.5	40.5
Usable	19.6	23.0	12.0	18.6
Unusable	46.7	14.8	69.6	40.9

The season-wise minimum temperature forecast verification results revealed that the highest (62.3%) correct event forecast was observed during monsoon season followed by pre-monsoon (33.7%) and the lowest accuracy was observed during the post-monsoon season (18.5%). Annual forecast verification of minimum temperature events showed that the 40.5% was correct (Table 4.3). The annual usable forecast events were 18.6% and 40.9% were unusable. The unusable percentage was relatively low during the monsoon season (14.8%).

Jorhat

Accuracy of rainfall forecast was carried out using qualitative scores *viz.* Hit score, HK score, HSS score, CSI, POD and FAR during different seasons at Thengalgaon (Golaghat district) and Nagharia (Sonitpur district) villages**.** It was observed that the ratio score during monsoon season was 57.38% (Table 4.4). During post-monsoon and winter seasons, the ratio score was found to be very much accurate i.e., 93.44% and 94.51%, respectively at Thengalgaon village. During these two seasons, the observed as well as forecasted days with no rainfall was maximum which resulted in the higher ratio score values. The HK score were higher (0.75) during post-monsoon season and lowest (-0.02) in the winter season indicating the reliability of forecast was skeptical during winter season. The probability of detection (POD) during pre-monsoon, monsoon and post-monsoon season was 0.43, 0.55 and 0.80, respectively. Very poor POD was observed during the winter season. The false alarm ratio (FAR) was highest during winter (1.00) and lowest in monsoon and post-monsoon season i.e. 0.43. The relative forecast accuracy (CSI) was observed very low during winter (0) and within moderate level during post-monsoon season.

Table 4.4. Season-wise rainfall forecast skills at Thengalgaon and Nagharia villages

Season	Thengalgaon village					
	Ratio score	HK score	HSS score	CSI	POD	FAR
Pre-monsoon	75.00	0.30	0.31	0.30	0.43	0.50
Monsoon	57.38	0.18	0.18	0.39	0.55	0.43
Post-monsoon	93.44	0.75	0.63	0.50	0.80	0.43
Winter	94.51	-0.02	-0.03	0.00	0.00	1.00
	Nagharia village					
Pre-monsoon	72.83	0.56	0.53	0.58	0.85	0.36
Monsoon	63.93	0.00	-0.01	0.71	0.96	0.27
Post-monsoon	78.69	0.26	0.20	0.19	0.43	0.75
Winter	86.81	0.08	0.07	0.08	0.17	0.88

Rainfall forecast skill at Nagharia village showed that the ratio score during pre-monsoon, monsoon, post-monsoon and winter seasons was 72.83%, 63.93%, 78.69% and 86.81%, respectively (Table 4.4). The highest value of the ratio score (86.81%) corresponds to the winter season during the year 2020-21. Seasonal HK score was recorded positive in three

seasons except in monsoon (0.0). However, POD was excellent during the pre-monsoon (0.85) and monsoon season (0.96). The lowest value of POD was recorded during the winter season (0.17) due to the non-occurrence of YY and NN events. Similarly, FAR was highest during the winter season (0.88) and relatively lowest during the monsoon season (0.27). An inverse relationship was observed between POD and FAR values corresponding to the same season. CSI was highest for the monsoon season (0.71) and lowest for winter (0.08). A negative HSS was detected during monsoon season (-0.01) indicates that the chance forecast was better (2020-21).

Ranchi

Accuracy of rainfall forecast during the southwest monsoon at Ghagra and Daltonganj blocks was carried out. The results showed that out of 153 observations, 63 per cent success was observed in Daltonganj block while it was 58 per cent for Ghaghra block. From this result, it is understood that forecast skill can be enhanced for all the seasons especially during monsoon season (Table 4.5).

Table 4.5. Rainfall forecast skill during southwest monsoon season 2020

Block	Percentage (%)		No. of observations
	Success	Failure	
Ghaghra (Gumla)	58.16	41.83	153
Daltonganj (Palamu)	63.39	36.60	153

Thrissur

The block-level (Tanur) and district-level (Malappuram) rainfall forecast during the southwest and northeast monsoon season (2020) was verified with the observed rainfall data as per the guidelines of the India Meteorological Department. The observed rainfall data has been collected from the KAU Agricultural Research Station, Anakkayam located in the Malappuram district. Results revealed that the block-level forecast of rainfall is higher than the district-level forecast most of the time at Tanur. The block-level forecast matches reasonably well with observed rainfall than with the district-level forecast (Table 4.6). During southwest monsoon season, a total number of 122 days of block-level forecast data was verified for the Tanur block. First three days of Tuesday forecast and the first four days of Friday forecast were used by farmers. The same forecasts have been used for verification.

Table 4.6. Verification of block-level forecast of SWM and NEM seasonal rainfall for Valavannur (Tanur Block) village in Malappuram district

Parameter	SWM season	NEM season
Total number of days	122	92
No. of days when rain was forecasted and also observed	77	10
No. of days when rain was not observed but forecasted	35	53
No. of days when rain was observed but not forecasted	0	1
No. of days when rain was not observed and also not forcasted	10	28
No. of matching cases	87	38
Skill Score or Ratio Score of rainfall	71.31	41.3
Probability of detection (POD)	1	0.91
False Alarm Ratio (FAR)	0.31	0.84
Root mean square error (RMSE)	23.56	12.9
Correct forecast	16.39	28.26
Usable	13.93	2.17
Unusable	69.67	67.39
Correlation	0.56	0.23

The number of matching cases (sum of the number of days when rain was forecasted and also observed and the number of days when rain was not forecasted and also not observed) are 87 days out of 122 days during the southwest monsoon season (Table 4.6). The root mean square error (RMSE) between observed and forecasted rainfall was 23.56. The Probability of Detection (POD) was 1. However, False Alarm Ratio (0.31) and correlation (0.56) suggest that there is scope for improving forecast skills. During the northeast monsoon season, a total number 92 days of block-level forecast and observation data have been verified. The number of matching cases were 38 out of 92 days (Table 4.6). So, for the block-level forecast is having a skill score of 41.3 only. Though, a high probability of Detection (0.91) is noticed, a high False Alarm Ratio (0.84) and low correlation (0.23) indicated that block-level rainfall forecast skill can be enhanced.

Udaipur

The qualitative analysis purely on "YES" or "NO" basis for rainfall was done by examining whether the event occurred or not as per the forecast during monsoon season of 2020. It was found that all the three villages, the probability for success is below 50% only. Among the villages, Bagatpura in Relmangra tehsil had higher success (49.2%) when compared to Jorawar Singh Hi Kheda (45.1%) and Chomakot (44.3%) (Table 4.7).

Table 4.7. Probability of success/failure of rainfall forecast

Village/Tehsil	Probability	
	Success	Failure
Jorawar Singh Ji Kheda (Rajsamand)	55/122 (45.1%)	67/122 (54.9%)
Bagatpura (Relmangra)	60/122 (49.2%)	62/122 (50.8%)
Chomakot (Kota)	54/122 (44.3%)	68/122 (55.7%)

The quantitative verification of the forecast of rainfall for the monsoon season was carried out for different categories of rainfall. The per cent success of rainfall forecast for no rainfall, light rainfall and moderate rainfall was 96.3, 14.8 and 7.7% at Jorawar Singh Ji Kheda, 87.8, 2.7 and 11.1% at Bagatpura and 92.5, 7.8 and 8.7% at Chomakot, respectively (Table 4.8). The per cent success forecast for heavy rainfall during the season was 25.0% in Jorawar Singh Ji Kheda, 11.1% in Bagatpuraand 0.0% in Chomakot. The block-level rainfall forecast was quite different from the observed rainfall.

Table 4.8. Success and failure of rainfall forecast during monsoon 2020

Village (Tehsil)	0 mm (No rain)			Trace- 10 mm (Light)			10.1 to 30.0 mm (Moderate)			> 30 mm (Heavy)			Total	
	Observation	Success (%)	Failure (%)	No. of Obs	Success	Failure	No. of Obs	Success	Failure	No. of Obs	Success	Failure	Success	Failure
Jorawar Singh Ji Kheda (Rajsamand)	27	26 (96.3)	1 (3.7)	61	9 (14.8)	52 (85.8)	26	2 (7.7)	24 (92.3)	8	2 (25.0)	6 (75.0)	39 (32.0)	83 (68.0)
Bagatpura (Relmangra)	49	43 (87.8)	6 (12.2)	37	1 (2.7)	36 (97.3)	27	3 (11.1)	24 (88.9)	9	1 (11.1)	8 (88.9)	48 (39.3)	74 (60.7)
Chomakot (Kota)	40	37 (92.5)	3 (7.5)	51	4 (7.8)	47 (92.2)	23	2 (8.7)	21 (91.3)	8	0 (0.0)	8 (100.0)	43 (35.2)	79 (64.8)

Vijayapura

The five-day cumulative rainfall forecast issued by IMD for Vijayapura taluka was compared with the actual rainfall received at RARS, Vijayapura (about 20 kms from the NICRA villages) and the rainfall received at one of the NICRA village Kavalagi (about 8-10 kms from each other).

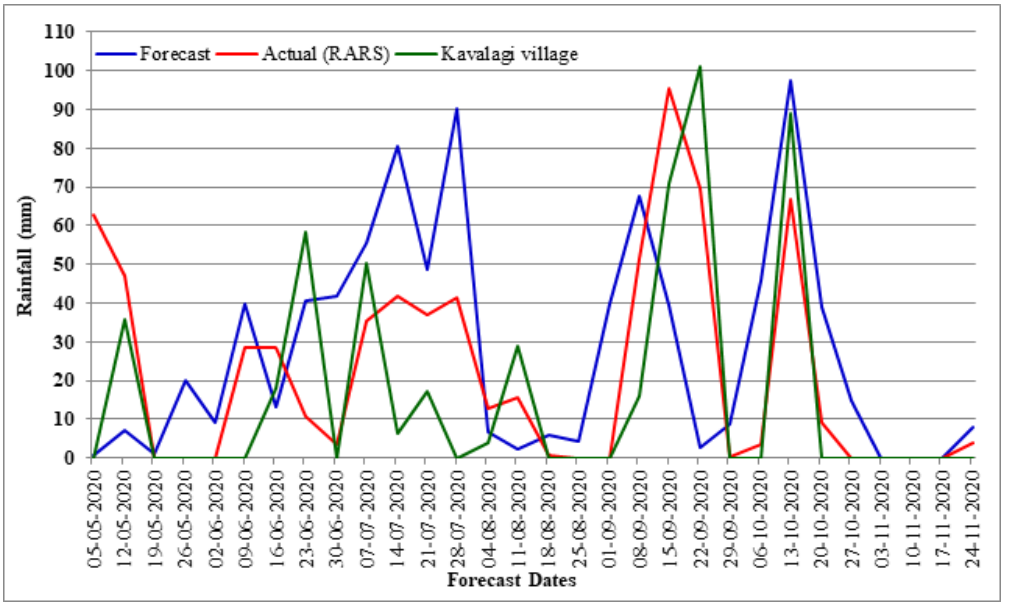


Fig. 4.3. Five-day cumulative rainfall forecast for Vijayapura taluka and actual rainfall at RARS, Vijayapura and Kavalagi village

It is noticed that during the *kharif* season, the rainfall forecast was higher than the actual during the first fortnight of June and the entire July month in the adopted village. On the other hand, the forecast was lower than the actual during the first fortnight of August (Fig. 4.3). During *rabi* season, in the first week of September, there was a forecast of good rainfall but actually, no rainfall has been received and in the subsequent third-and-fourth-weeks, higher rainfall than the forecasted was received, which helped the farmers to take up *rabi* sowing. In the month of October, the second and fourth-week forecasts failed and only the third-week forecast of good rainfall has been realized which helped good growth and development of *rabi* crops.

5. Economic Impact of Micro-level Agromet Advisory Services

A major objective of the NICRA-AICRPAM project is the customization of micro-level agromet advisories and their dissemination through the latest Information Communication Technologies (ICTs). The cooperating centers have started using block-level weather forecast issued by IMD since September 2014. The availability of block-level weather forecast has shown great improvement in 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 forecast from 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 '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 situation at 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 weather forecast and communicate to the FIFs by email who pass on the bulletins to farmers. The micro-level AAS is generated in the name of 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 farming community.

5.1. Selection of NICRA-AICRPAM villages

The selection procedure for district/ villages was defined clearly. A district has been selected under 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 implementation of micro-level AAS under the NICRA-AICRPAM project. A pictorial representation of site selection is given in Fig 5.2.

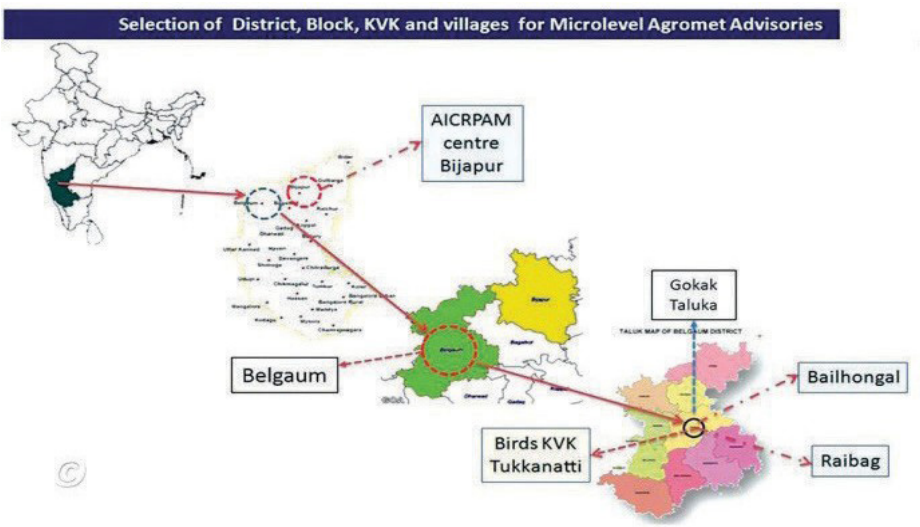


Fig. 5.2: Selection of district, block, KVK and villages for micro-level AAS

5.2. Modes of AAS dissemination

The success of any AAS depends on timely dissemination of them to farmers. In this era of Information Communication Technology, plenty of options are available to ensure dissemination of AAS to farmers on time. Under the NICRA-AICRPAM 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 NICRA-AICRPAM project is given in Fig 5.3.

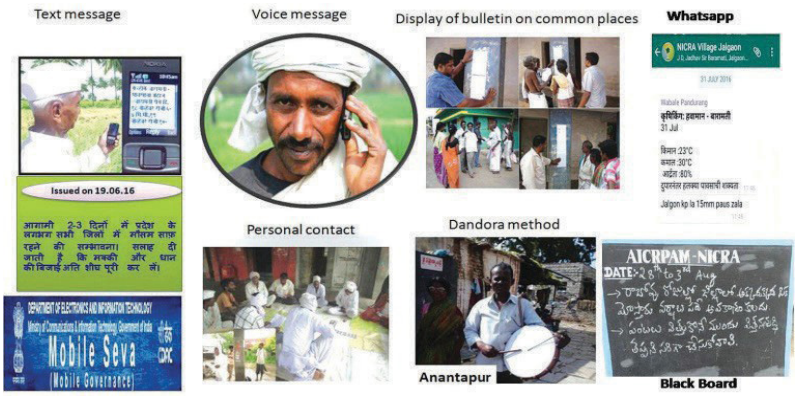


Fig. 5.3: Various methods of micro-level AAS dissemination adopted by AICRPAM cooperating centres

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

- Displaying AAS bulletins on common places like milk booth, PDS shops, Panchayat office etc, where farmers will visit frequently.
- Text SMS: AAS is send 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 forecast of heavy rainfall, hailstorm etc so that livestock, harvest-ready crops can be saved.

5.3. 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 Micro-level agromet advisories and their economic benefits in different crops at various locations during the years 2020-2021

Dapoli

Rice

Advisory No.& Date	Crop	Forecasted Weather/ Reason	Advisory given	Observed weather	Action taken by farmer	No. of farmers adopted out of 50	Benefit or Loss
Adv. No. 62 Date- 4/8/2020	Rice	Heavy rainfall during 5-8 Aug. 2020	Postpone the application of split dose of nitrogenous fertilizer in rice. Make arrangement to drain out excess water from field and maintain optimum water level of 5 cm in rice field.	330.4 mm rainfall was received during 32nd SMW	Postponed the fertilizer application and maintained optimum water level of 5 cm and drained out excess water.	30	Saved the fertilizer and labour cost (Rs. 600/- per acre)
Adv. No.70 Date- 1/9/2020	Rice	Light to medium rainfall, high humidity and cloudy weather condition during 2-6 Sept. 2020	Due to intermittent rainfall and cloudy weather condition, there is possibility of incidence of blast disease in rice crop. If the incidence is noticed spray tricyclazole 75%WP @ 1 gm per liter of water during clear weather (no rainfall).	Weather parameters observed in 36th MW was rainfall- 5.6 mm, RH-I: 80-98% and RH-II: 80-82%.	Applied tricyclazole 75%WP fungicide 1 gm per liter of water during clear weather.	20	Saved the crop and benefitted up to 500/- per acre

Advisory No.& Date	Crop	Forecasted Weather/ Reason	Advisory given	Observed weather	Action taken by farmer	No. of farmers adopted out of 50	Benefit or Loss
Adv. No.74 Date- 15/9/2020	Rice	Light to medium rainfall during 16-20 Sept. 2020	Due to intermittent rainfall, increase in temperature and cloudy weather conditions, there is a possibility of incidence of blue beetle and caseworm on low land rice. If the incidence of blue beetle is noticed on rice crop, spray Lambda cyhalothrin 5%EC @ 5 ml per 10 liters of water. If the incidence of rice case worm on rice crop is noticed and an external source of irrigation is available, then flood the field with water followed by dragging the rope to dislodge the cases and drain out water from the field during no rainfall situation.	Weather parameters observed in 38th MW was rainfall- 33.0 mm, Max. temp.: 29.5- 30.5 °C Min temp.: 20.9-23.7 °C, RH-I: 96-100%, RH-II: 80-82% and Cloud cover: 4-8 octa	Sprayed lambda cyhalothrin 5% EC @ 5 ml per 10 liters of water during clear weather and dragged the rope for dislodging the caseworms and drained out excess water from field	24	Saved the crop from infestation and yield loss and earned 700/- per quintal. Blue beetle infestation was controlled

Hisar

Wheat

Date of issue of advisory	Crop condition/ Crop stage	Forecast	Agromet Advisory issued	Actual weather condition	Action taken by farmers	Remarks (Loss/ Profit/ other)	No. of irrigation saved	Pesticide/ Chemical saved
03/01/2020	Tillering stage	Due to WD, possibility of moderate rainfall along with lightning/ thunderstorms in the coming five days. Chances of fall in day/ night temperature. Shallow to moderate fog is likely to occur at isolated places during morning and late-night hours.	In view of anticipated weather, farmers are advised to withhold irrigation and chemical spray.	About 6.5 mm rainfall was recorded on 7 Jan 2020.	Irrigation was withheld.	Saved Rs 420 per acre.	1	-

Date of issue of advisory	Crop condition/ Crop stage	Forecast	Agromet Advisory issued	Actual weather condition	Action taken by farmers	Remarks (Loss/ Profit/ other)	No. of irrigation saved	Pesticide/ Chemical saved
03/03/2020	Anthesis	Due to WD, possibility of moderate to heavy rainfall along with lightning/ thunderstorm in the coming five days. Chances of fall in day/night temperature.	In view of anticipated weather due to WD, farmers are advised to withhold irrigation and chemical spray.	About 2.2 mm, 14.4 mm and 5.0 mm rainfall was recorded on 5th, 6th and 7th March, 2020.	Irrigation was withheld.	Saved Rs 420 per acre.	1	-
24/03/2020	Dough phase	Due to WD, possibility of moderate rainfall along with lightning/ thunderstorms in the coming five days. Chances of fall in day/night temperature.	In view of anticipated weather due to WD, farmers are advised to withhold irrigation and chemical spray.	About 13.2 mm rainfall was recorded on 27th March, 2020	Irrigation was withheld.	Saved Rs 420 per acre.	1	-

Rice

Date of issue of advisory	Crop condition/ Crop stage	Forecast	Agromet Advisory issued	Actual weather condition	Action taken by farmers	Remarks (Loss/ Profit/ other)	No. of irrigation saved	Pesticide/ Chemical saved
23/06/2020	Seedling establishment	In the coming five days weather will be variable and cloudy. There is a possibility of light rain at isolated places with speedy winds on 25-27 June.	Due to the possibility of anticipated weather, farmers are advised to withhold irrigation and chemical spray application.	About 10.2 mm rain was recorded on 26th June.	Intercultural operation and irrigation were withheld.	Saved Rs 420 per acre	1	-
03/07/2020	Tillering	In the coming five days weather will be variable and cloudy. There is a possibility of rain at isolated places with speedy winds on 5-7 July.	Due to the possibility of anticipated weather, farmers are advised to withhold irrigation and chemical spray application.	Rainfall: 22.0 mm on 5th July	No application of irrigation and chemicals.	Saved Rs 420 per acre	1	-

Date of issue of advisory	Crop condition/ Crop stage	Forecast	Agromet Advisory issued	Actual weather condition	Action taken by farmers	Remarks (Loss/ Profit/ other)	No. of irrigation saved	Pesticide/ Chemical saved
10/07/2020	Tillering/ Vegetative stage	In the coming five days weather will be variable and cloudy. There is a possibility of rain at isolated places with speedy winds on 11-13 July.	Due to the possibility of anticipated weather, farmers are advised to withhold irrigation and chemical spray application.	Rainfall: 43.2 mm.	No irrigation was applied.	Saved Rs 420 per acre	1	-
07/08/2020	Good condition/ anthesis	In the coming five days weather will be variable and cloudy. There is a possibility of rain in isolated places with speedy winds on 9-11 August.	Due to the possibility of anticipated weather, farmers are advised to withhold irrigation and chemical spray application.	Rainfall: 16.2 mm.	Irrigation was not applied.	Rs. 980/ acre saved	1	1

Cotton

Date of issue of advisory	Crop condition/ Crop stage	Forecast, IMD	Agromet Advisory issued	Actual weather condition	Action taken by farmers	Remarks (Loss/ Profit/ other)	No. of irrigation saved	Pesticide/ Chemical saved
10/07/2020	Vegetative stage/ square formation stage	In the coming five days weather will be variable and cloudy. There is a possibility of rain at isolated places with speedy winds on 11-13 July.	Due to the possibility of anticipated weather, farmers are advised to withhold irrigation and chemical spray application. Avoid intercultural operation. Remove excess water after rainfall.	Rainfall: 43.2 mm.	No irrigation was applied.	Saved Rs 420 per acre	1	-
07/08/2020	50% Flowering	In the coming five days weather will be variable and cloudy. There is a possibility of rain at isolated places with speedy winds on 9-11 August.	Due to the possibility of anticipated weather, farmers are advised to withhold irrigation and chemical spray application. Avoid intercultural operation. Remove excess water after rainfall. If insect infestation reached above the ETL, then apply insecticide in the evening hours and keep the weather in mind.	Rainfall: 16.2 mm.	No irrigation and insecticide were sprayed.	Saved Rs 420 per acre	1	-

Chatha

Date	Crop and Stage	Forecast	Advisory given	Observed	Action taken by farmers in response to AAS	Benefit/Loss
NICRA- adopted village – Sherpur						
29/06/2020	Maize (sowing)	20.0 mm rainfall	Postpone the sowing of maize	20.4 mm rainfall	Postponed the sowing of maize.	Saved the wastage of seed and labour charges amounting of Rs 1200-1500/ha
29/06/2020	Normal transplanted rice (Transplanting stage)	20.0 Mm rainfall	Go for transplanting of rice after the receipt of rain	20.4 mm rainfall	Transplanted the rice and saved the irrigation	Farmer saved fuel and labour charges of Rs 800-1000/-/ha at the time of transplanting
26/07/2020 27/07/2020	Normal transplanted rice (Seedling establishment stage)	16.0 mm rainfall	Bund the rice fields for in situ storage of rainwater	130.2 mm rainfall	Followed the advisory	Saved the irrigation and enhanced the efficacy of weedicide amounting of Rs 1400-1500/-/ha
26/07/2020 27/07/2020	Late transplanted basmati rice (Transplanting Stage)	16.0 mm rainfall	Transplant the Basmati rice after the receipt of rain	130.2 mm rainfall	Transplanted the basmati rice and saved at least two irrigations	Saved the irrigation amounting of Rs 1200-1400/ ha

Date	Crop and Stage	Forecast	Advisory given	Observed	Action taken by farmers in response to AAS	Benefit/Loss
26/07/2020 27/07/2020	Maize (6th leaf stage)	16.0 mm rainfall	Withheld the irrigation, intercultural operations and fertilizer application and make proper arrangements for draining the excess water from crop area and store it water harvesting tanks for supplement irrigation	130.2 mm rainfall	Postponed all the operations in the wake of anticipated rainfall as per the advisory and opened field bunds to drain excess water and stored it in water harvesting tanks.	Saved the fertilizer, fuel and labour charges amounting to Rs 900-1100/ha
11/08/2020 12/08/2020	Normal transplanted rice (Tillering Stage)	45.0 mm rainfall	Postpone irrigation, plant protection measures and nitrogenous fertilizer application. Drain out the excess water and do not apply weedicide	113.1 mm rainfall	Followed the advisory and postponed all the operations.	Saved the fuel, chemicals fertilizer, weedicide and labour charges amounting of Rs 1500- 2000/ha
15/08/2020	Early Transplanted Rice (Vegetative stage)	20.0 mm rainfall	Do not irrigate and postpone the plant protection, weedicide & fertilizer application.	70.1 mm rainfall	Postponed all the operations and saved the irrigation.	Saved the chemicals, fertilizer and labour charges

Total number of irrigations saved due to accurate rainfall forecast in the NICRA-AICRPAM adopted village of Sherpur is depicted below:

S. No.	Crop	Dates of forecasting	Phenological Stages	No. of Irrigation saved	Saving per irrigation	Total saving per hectare
1	Rice	20, 27 & 29th July 8, 11, 15, 19, 23, 26 & 29 August.	1. Transplanting 2. Seedling Establishment 3. Tillering Stage 4. Vegetative phase 5. Panicle Initiation	Four	Rs 1000-1200/-	Rs. 4000-4800/-
2	Basmati rice	20, 27 & 29th July 8, 11, 15, 19, 23, 26 & 29 August.	1. Transplanting 2. Seedling Establishment 3. Early Tillering 4. Vegetative stage	Three	Rs. 1000-1200/-	Rs. 3000-3600/-
3	*Kharif* fodder	20, 27 & 29th July 8, 11, 15, 19, 23, 26 & 29 August.	1. Vegetative stage 2. Regeneration (Multiple cut)	Two	Rs. 1000-1200/-	Rs. 2000-2400/-
4	*Kharif* pulses (Moong & Mash)	20, 27 & 29th July 8, 11, 15, 19, 23, 26 & 29 August.	1. Vegetative 2. Flowering 3. Pod formation	Three	Rs. 1000-1200/-	Rs. 3000-3600/-
5	Wheat	28th Feb. 6 & 7th March	1. Soft dough 2. Milking stage	Two	Rs. 800-1000/-	Rs. 1600-2000/-
6	Mustard	28th Feb. 6 & 7th March	1. Flowering 2. Pod formation	Two	Rs. 800-1000/-	Rs. 1600-2000/-

Mohanpur
Rice

Date of issuance of forecast	Forecast given	Crop and Advisory given	Action taken by the farmer	Type of saving/ benefit/ Loss	Benefit/ Loss in term of cost (Rs per ha)
02/06/2020	Moderate to heavy rainfall forecast for the next five days (Forecast = 45 mm on 3.6.20, Actual = 40 mm)	Start nursery bed of *Kharif* rice preparation (Although after Amphan, soil moisture level was very high)	Almost all the farmers started nursery bed preparation	Yield advantage due to timely transplanting = 0.25 t ha^{-1} due to timely sowing.	Profit calculated on an average Rs. 2500 ha^{-1}
28/07/2020	Heavy rainfall forecast on 29 July (Forecast= 110 mm, Actual= 122.5 mm)	Delay spraying of chemicals (Crop: *Kharif* rice)	Near about 85% of farmers delayed the spraying (mainly NSKE spray against BLB & Metominostro-bin against brown spot of rice)	Considerable amount of chemicals was saved.	Profit of Rs. 600-700 ha^{-1} as saving of chemicals and labour.
25/09/2020	No rainfall forecast for 27-29 Sept. (Actual= 0 mm)	Spray 2% urea during flowering (For rice seed production)	80 % of farmers followed spraying activity	Substantial yield increased (about 0.2 t ha^{-1})	Profit in the tune of Rs. 2000 ha^{-1}.

Date of issuance of forecast	Forecast given	Crop and Advisory given	Action taken by the farmer	Type of saving/ benefit/ Loss	Benefit/ Loss in term of cost (Rs per ha)
18/09/2020	Cloudy sky and temperature rise forecast (Actual: Almost Accurate)	Chemical application in Chilli	About 70% of farmers followed the advice	Control of mite and thrips in Chilli.	Profit of Rs. 2000 ha^{-1}
10/11/2020	Cloudy sky and high RH forecast (Actual: Almost Accurate)	Chemical application to control downy mildew in cabbage and cauliflower	All farmers adopted control measures	Disease was controlled.	Profit of about Rs. 4000 ha^{-1} in treated fields.
20/11/2020	Forecast for temperature decrease and high humidity (Actual: Almost Accurate)	Chemical application in Chilli (Imidacloprid or dinotefuran for leaf curl)	Farmers sprayed chemical	Leaf curl disease was not occur.	Saving of Rs.1000 ha^{-1}

Samastipur

Rice

Date	Crop stage	Weather forecast	Advisory given in NICRA bulletin	Actual rainfall happened	Action taken by the farmer	Loss/profit	Remarks
12/07/2020	Nursery sowing	Chances of light rainfall during 13-17 June	Nursery sowing of medium duration paddy crop was advised	About 44.8 mm rainfall occurred	The farmer waited for rain and acted as our advisory	Saved the cost of irrigation @ Rs1200/ha	-
07/07/2020	Transplanting	Due to active monsoon, Chances of rainfall during next 3-4 days	In view of rainfall forecast, transplanting of paddy was advised.	About 100.4 mm rainfall occurred during 8-12 July	With good rainfall, farmers went for transplanting	Saved irrigation cost @ Rs1200/ha	Water logging
07/08/2020	Tillering stage	Chances of rainfall in coming 3-4 days	Looking to rainfall forecast, farmers were advised to postpone irrigation in paddy crop	About 123.2 mm rainfall occurred during 8-12 August	Waited for rain and acted as per the NICRA advisory	Saved irrigation cost @ Rs1200/ha	Flood
01/09/2020	Reproductive stage	Chances of light rainfall in coming 1-2 days	In view of rainfall forecast, postpone irrigation in paddy crop	About 52.2 mm rainfall occurred during 2-6 September	waited for rain and acted as per the advisory	Saved irrigation cost @ Rs1200/ha	-
11/09/2020	Reproductive stage	Chances of rainfall at many places during coming 3-4 days	In view of rainfall forecast, Postponement of irrigation in paddy crop was suggested	About 80.2 mm rainfall occurred during 12-16 September	Waited for rain and acted as advisory	Saved irrigation cost @ Rs1200/ha	-
25/09/2020	Late Reproductive stage	Chances of light rainfall in coming 1-2 days	In view of rainfall forecast, Postponement of irrigation in paddy crop was suggested	About 28.2 mm rainfall occurred during 26-30 September	Acted as the advisory	Saved irrigation cost @ Rs1200/ha	-

Akola

Date	Farmers	Problem/ weather event	Solution recommended	Benefit/loss
21/07/2020	All farmers and mainly farmer of Warkhed and Kanshivni	Cloudy weather and forecast for light to moderate rain for next 5 days. Water logging in low lying areas of crop field due to moderate to heavy rainfall occurred in the past week.	Farmers were advised to drain out excess water from waterlogged areas and also to postpone post-herbicide spray in Chautha village. Opening of conservation furrows is advisable at 30 days stage after every three rows of soybean every two crop rows of cotton at hoeing by tying rope to hoe tine. In areas where infestation of stem fly is reported, for monitoring the incidence of stem fly in soybean erect yellow sticky trap @ 4 to 5 per acre.	Drainage of excess water improved field and crop conditions.
28/07/2020	All farmers and mainly farmer of Kanshivni and Chautha	Cloudy weather and forecast for light to moderate rain for next 5 days. Water logging in low lying areas of crop field due to moderate to heavy rainfall occurred in past week.	Farmers were advised to postpone spraying of imidacloprid for control of sap-sucking pest (Aphid/Jassid) in cotton. Drain out excess water from crop field for Kanshivani and Chuatha farmers.	Rainfall 39 mm (28 July), 5 mm (29 July) 8 mm (30 July) occurred at Warkhed and 20.4 mm (29 July) 27.8 mm (31 July) at Kanshivani and 9.2 mm (29 July) 10.1 mm (30 July) 19.1 mm (31 July) at Chautha occurred. Farmers who followed the advisory avoided the wash off of insecticidal spray and saved approximately Rs.2100/ha towards one plant protection measure. Drainage of excess water improved field and crop conditions.

Date	Farmers	Problem/ weather event	Solution recommended	Benefit/loss
08/09/2020	All farmers	Forecast of scattered light to moderate rainfall.	Suggested opening furrows in cotton and pigeon pea crop to drain out excess water and conserve moisture during the boll formation stage.	Drainage of excess water improved field condition and conserved moisture during boll formation stages of cotton.
15/09/2020	All farmers	Cloudy weather and forecast for light to moderate rain in next 5 days.	Farmers were advised to harvest green gram and black gram crops in view of the rainfall forecast to keep the harvest produce safely to protect against late-season rains.	Farmers harvested green gram and black gram crops.
22/09/2020	All farmers	Cloudy weather condition and forecast of scattered light to moderate rainfall	farmers were advised to Postpone spraying of Chlorantraniliprole 19.5% SC 3 ml or Endoxicarb 15.8 AC 6.6 ml.	Total rainfall at Kanshivni 22 mm occurred during that week. Farmers who adopted the advisory avoided the wash off of insecticidal spray
13/10/2020	All farmers	Dry weather expected	Farmers were advised to undertake harvesting of soybean and keep it 2-3 days in field for sun drying to ensure proper moisture for storage.	Farmers followed the advisory and harvested soybean was kept in the field for sun drying (2-3 days) to maintain proper moisture. This ensured better quality of produce and better market price (Rs.3800-4200/ qt).
20/10/2020	Kanshivani and Warkhed farmers	Dry weather expected. Reddening in cotton	Spraying of 2 kg DAP+ 1 kg magnesium sulphate or 1 kg potassium nitrate per 100 litres water	The condition of the cotton crop improved.

Date	Farmers	Problem/ weather event	Solution recommended	Benefit/loss
27/10/2020	Kanshivani and Warkhed farmers	Dry weather expected. Infestation of pink boll worm in cotton.	Farmers were advised to spray of spinosad 45% SC @ 2.25 ml for control pink boll worm in cotton.	The pest infestation was controlled and cotton boll development improved.
17/11/2020	All farmers	Incidence of pink boll worm in late developing cotton bolls	Advisory to undertake spraying of Quinalphos 25% EC @ 25 ml OR Deltamethrin 2.8% EC @ 9.0 ml /10 litres of water.	Pest infestation reduced, improving the development of bolls.
22/12/2020	All farmers	Dry weather is expected.	Install pheromone traps (hexalure) @ 5/ha for monitoring the incidence of pod borer (*Helicoverpa*).	Farmer installed pheromone traps (hexalure) @ 5/ha for monitoring the incidence of pod borer.
29/12/2020	All farmers	Infestation of pod borer in chickpea. Dry weather expected	Spraying of Emamectin benzoate 5% SG @ 4.5g/10 litres of water	Infestation reduced and benefit awaited.
05/01/2021	All farmers	Infestation of pod borer in chickpea. Dry weather expected	Spraying of Emamectin benzoate 5% SG @ 4.5g/10 litres of water	Infestation reduced and benefit awaited.
12/01/2021	All farmers	Infestation of pod borer in chickpea. Dry weather expected	Spraying of Emamectin benzoate 5% SG @ 4.5g/10 litres of water	Infestation reduced and benefit awaited.

Bhubaneswar

Name of the Farmer	Crop	Action taken by the Farmer	Profit/ Loss
Pratap Nayak	Paddy	Followed the advisory regarding the application of chemical insecticide to control the stem borer as per AAS bulletin (12th SMW).	Saved around Rs. 1000/- per acre by taking proper plant protection measures.
Banabasi Badatya	Paddy	Withheld spraying of pesticide for controlling leaf folder in paddy as there was a possibility of rainfall in 36th SMW.	Saved around Rs. 850/- by avoiding the wastage of pesticide and labour charges.
Maheswar Badatya	Paddy	Information regarding the possible infestation of swarming caterpillars (35th SMW) in paddy fields helped in controlling the disease before it could be widespread.	Saved Rs.870/- by avoiding wastage of pesticide and labour charges.
Rabindra Badatya	Brinjal, Bitter gourd, Tomato, Cabbage	To protect the tomato seedling from cold injury, advisory was given to cover the seedlings with straw, and in some cases paper cap (AAS bulletin, 51st SMW)	Saved Rs. 1750/- by preventing damage to the seedling.
Pana Behera	Paddy	Harvested paddy was shifted from the main field to a safer place due to possible rainfall given AAS (50th SMW)	Saved Rs. 4050/-
Surendra Nayak	Green gram	Withheld operation of fertilizer top dressing due to forecast of heavy rainfall in 34th SMW.	Rs.700-800/- was saved towards labour charge
Santosh Kumar Routa	Paddy	AAS bulletin (35th SMW) helped in taking proper plant protection measures against stem borer infestation	Saved around Rs.1000-1200/- per acre

Ludhiana

Rice

S. No	Forecasted weather	Forecasted advisory(date)	Actual rainfall (mm)	Numberof adopters	Events crop/ Cultural operationsrecommended in Advisory	Economic gain/Loss
1	T_{Max} = 34.0-35.6^{o}C T_{Min} = 20.2-22.8 ^{o}C RH_{Max} = 19-47% RH_{Min} = 9-20% RF RF= 0.0-9.5 mm WS = 7-13 km/h	Weather will be cloudyand there are chances of rainfall (05/05/2020)	-	22	Do not harvest the wheat crop.	Saved the harvested wheatcrop from getting wet due to rains.
2	T_{Max} = 28.8-34.4^{o}C T_{Min} = 21.8-24.7 ^{o}C RH_{Max} = 17-35% RH_{Min} = 10-21% RF = 0.0-4.9 mm WS = 8-13 km/h	Weather will remaincloudy and there is a prediction of rainfall (12/05/2020)	-	21	Do not burn wheat straw.	Saved the environment from air pollution.
3	T_{Max} = 30.2-34.5^{o}C T_{Min} = 22.3-25.7 ^{o}C RH_{Max} = 51-78% RH_{Min} = 27-35% RF = 0.4-10.6 mm WS = 5-16 km/h	Weather will remaincloudy and there is prediction of rainfall (07/07/2020)	-	28	Start transplanting basmati rice varieties like Pb Basmati 5, Pb Basmati 4, Pb Basmati 3, Pb Basmati 2, Pusa Basmati 1637, Pusa Basmati andPusa Basmati 1121. Use rainwater for field preparation. Drain excess water from maize and sugarcanefield.	Timely transplanting of Basmati rice helped in getting good yield. Saved irrigation water. Saved maize and sugarcane crop from stagnant water.

S. No	Forecasted weather	Forecasted advisory(date)	Actual rainfall (mm)	Numberof adopters	Events crop/ Cultural operationsrecommended in Advisory	Economic gain/Loss
4	T_{Max} = 29.2-35.8^{o}C T_{Min} = 22.3-26.8 ^{o}C RH_{Max} = 44-82% RH_{Min} = 21-45% RF = 0.0-20.8 WS = 15-21 km/h	Weather will remaincloudy and there is prediction of rainfall (14/07/2020)	-	35	Start transplanting basmati rice varieties like PbBasmati 5, Pb Basmati 4, Pb Basmati 3, Pb Basmati 2, Pusa Basmati 1637, Pusa Basmati andPusa Basmati 1121. Use rain water for field preparation. Drain excess water from maize and sugarcane field.	Saving of irrigation waterand labour. Saved maize and sugarcane crops from stagnant water.
5	T_{Max} = 28.7-34.1^{o}C T_{Min} = 21.5-24.6 ^{o}C RH_{Max} = 74-89% RH_{Min} = 34-60% RF = 0.0-23.7 mm WS = 13-19 km/h	Weather will remainpartly cloudy and there is prediction of rainfall (28/07/2020)	-	25	Don't excessively irrigate the rice field and applysecond dose of Nitrogen after 21 Days and 3rd dose after 42 days of transplanting. Drain excess water from maize and sugarcanefield.	Saving of irrigation water and labour. Saved maize and sugarcane crop from stagnant water.
6	T_{Max} = 32.4-36.7^{o}C T_{Min} = 26.9-28.6 ^{o}C RH_{Max} = 56-88% RH_{Min} = 29-44% RF = 0.0-17.8 mm WS = 9-16 km/h	Weather will remainpartly cloudy and there is prediction of rainfall (04/08/2020)	-	24	Don't excessively irrigate the rice field and applysecond dose of Nitrogen after 21 Days and 3rd dose after 42 days of transplanting. Drain excess water from maize and sugarcane field. Finish transplanting of Basmati rice varieties like CSR 30, Basmati 370, Basmati 386 and Pusa Basmati 1509.	Saving of irrigation water and labour. Saved maize and sugarcane crop from damage. Timely transplanting of basmati rice helped in getting good yield.

S. No	Forecasted weather	Forecasted advisory(date)	Actual rainfall (mm)	Numberof adopters	Events crop/ Cultural operationsrecommended in Advisory	Economic gain/Loss
7	T_{Max} = 27.5-33.2^{O}C T_{Min} = 24.2-25.9 ^{O}C RH_{Max} = 77-92% RH_{Min} = 50-75% RF = 0.0-20.1 mm WS = 7-18 km/h	Weather will remain partly cloudy and there is prediction of rainfall (11/08/2020)	-	21	Don't excessively irrigate the rice field and apply second dose of Nitrogen after 21 Days and 3rddose after 42 days of transplanting. Drain excess water from maize field. Apply urea to Basmati rice in two equal splits a 3and 6 weeks after transplanting.	Saving of irrigation water and labour. Saved maize and sugarcane crop from damage. Timely transplanting of Basmati rice helped in getting good yield.
8	T_{Max} = 27.6-32.9^{O}C T_{Min} = 23.8-26.0 ^{O}C RH_{Max} = 78-92% RH_{Min} = 55-76% RF = 0.8-22.3 WS = 8-13 km/h	Weather will remainpartly cloudy and there is prediction of rainfall (19/08/2020)	-	20	Apply irrigation to the rice field after 2 days of infiltration of water but before field start showing cranks in it. Apply urea to Basmati rice in two equal splits a 3 and 6 weeks after transplanting. Drain out excessive rain water from maize and sugarcane field.	Saving of irrigation water and labour. Saved maize and sugarcane crop from damage. Timely transplanting of Basmati rice helped in getting good yield.

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

6.1 Akola

6.1.1 Case Study- Soybean, Kanshivani

Shri. Shivanand Kale, who is from Kanshivani NICRA Village (Akola) under AICRPAM Akola Centre has 4 acres of irrigated land under soybean cultivation. JS-335 variety was grown during *kharif* 2020. Crop was sown during 26 MW (27 June). During the crop growing period, a series of AAS bulletins/real time advisories were issued which was followed as such by the farmer.

Higher profit obtained by Shri. Shivanand Kale is mainly due to

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

The following table includes B:C ratio obtained in case of the soybean farmer Shri. Shivanand Kale, in response to the AAS issued and accordingly timely action taken by the farmer (Table 6.1). The expenditure on different operations and returns received on sale of produce and other details were collected from farmer's feedback. It also includes the B:C ratio obtained in case other four AAS farmers also who have followed more or less similar agro-met advisories as aforementioned for their respective soybean cultivation. Similar results from non-adopted farmers are also presented in Table 6.2, which indicated that B:C ratio was less for them compared to farmers who adopted AAS.

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

Input Details	Shivanand Kale	Sharad Waghmare	Sanjay Metkar	Pavan Arekar	Pandurang Waghmare
Land preparation (Rs. ha^{-1})	4075	3000	4000	3300	4250
Fertilizer cost (Rs. ha^{-1})	4600	4552	4850	4600	4800
Seed cost (Rs. ha^{-1})	5070	5440	5200	4680	5280
Seed Treatment (Rs. ha^{-1})	650	650	650	650	650
Planting cost (Rs. ha^{-1})	2050	1975	2050	2150	1800

Input Details	Shivanand Kale	Sharad Waghmare	Sanjay Metkar	Pavan Arekar	Pandurang Waghmare
Weed management (Rs. ha^{-1})	2500	2600	2400	2000	2400
Hoeing (Rs. ha^{-1})	1350	1500	1450	1200	1150
Plant protection (Rs. ha^{-1})	2900	3650	3600	4200	3350
Irrigation (Rs. ha^{-1})	0	0	0	0	0
Foliar spray of 2% urea	400	400	400	400	400
Miscellaneous (Rs. ha^{-1})	1100	1000	1200	1200	1100
Harvesting cost (Rs. ha^{-1})	3000	3375	3250	3000	3250
Threshing cost (Rs.ha^{-1})	2715	2625	2700	2520	2730
Cost of cultivation (Rs. ha^{-1})	30410	30767	31750	29900	31160
Seed yield (q ha^{-1})	18.1	17.5	18.0	16.8	18.2
Price of soybean (Rs. q^{-1})	74210	71750	73800	68880	74620
Net profit (Rs. ha^{-1})	43800	40983	42050	38980	43460
Benefit cost ratio	2.44	2.33	2.32	2.30	2.39

Table 6.2. Analysis of B:C ratio of soybean of non-AAS farmers in Kanshivani NICRA village

Input Details	Kailash Dhore	Gajanan Ganeshpure	Dyaneshwar Kale	Devanand Dhore	Raju Waghmare
Land preparation (Rs. ha^{-1})	2500	3300	4200	2500	3750
Fertilizer cost (Rs. ha^{-1})	5000	4800	5100	4800	4600
Seed cost (Rs. ha^{-1})	5185	5002	5525	5084	4675
Seed treatment (Rs. ha^{-1})	0	650	0	550	650
Planting cost (Rs. ha^{-1})	1675	1925	1900	1800	1900
Weed management (Rs. ha^{-1})	2500	2400	2300	1600	1600
Hoeing (Rs. ha^{-1})	1200	1200	1100	1500	1400
Plant protection (R. ha^{-1})	4400	4050	4450	3640	3090
Irrigation (Rs. ha^{-1})	0	0	0	0	0
Foliar spray of 2% urea	0	0	0	0	0
Miscellaneous (Rs. ha^{-1})	1100	1300	1200	1300	900
Harvesting cost (Rs. ha^{-1})	3250	2750	3375	3375	3250
Threshing cost (Rs. ha^{-1})	2265	2250	2130	2070	2220
Cost of cultivation (Rs. ha^{-1})	29075	29627	31280	28219	28035
Seed yield (q ha^{-1})	15.1	15.0	14.2	13.8	14.8
Price of soybean (Rs. q^{-1})	61910	61500	58220	56580	60680
Net profit (Rs. ha^{-1})	32835	31873	26940	28361	32645
Benefit cost ratio	2.13	2.08	1.86	2.01	2.16

6.1.2. Case Study-Cotton, Warkhed

Shri. Digambar Kondankar, who is from Warkhed (Barshitakali taluka) NICRA Village of Akola Centre has 3 acres of rainfed land under cotton cultivation. Bt cotton Ajeet 155 was grown during *kharif* 2020. Crop was sown on during 25 MW (23 June). During the crop growing period, a series of AAS bulletins/real time advisories were issued which was followed as such by the farmer. A comparison of B:C ratio of farmers who adopted and not adopted AAS is presented in Table 6.3.

Higher profit obtained by Mr. Digambar Kondankar is mainly due to

- Timely adoption of agromet advisories issued
- 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

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

Input Details	AAS farmers			Non - AAS farmers		
	Sachin Kondankar	Gajanan Kondakar	Digambar Kondankar	Sakharam Tople	Prakash Dange	Sitaram Tople
Land preparation (Rs. ha^{-1})	4400	4675	4400	4350	4000	4200
Fertilizer (Rs. ha^{-1})	6200	6100	6000	5700	6800	6200
Seed cost (Rs. ha^{-1})	5110	5250	5250	5320	5180	5760
Planting (Rs. ha^{-1})	2660	2500	2700	2400	2500	2500
Weeding (Rs. ha^{-1})	4800	4800	4000	6000	4200	2900
Hoeing (with furrow opening) (Rs. ha^{-1})	3300	3450	3300	3600	2500	3450
Plant protection (Rs. ha^{-1})	4400	4250	4300	4800	4900	4550
Irrigation (Rs. ha^{-1})	0	0	0	0	0	0
Spraying of 2% Urea and 2% DAP (Rs. ha^{-1})	1250	1300	1200	0	0	0
Miscellaneous (Rs. ha^{-1})	1000	1100	1400	1000	1200	900
Harvesting cost (Rs. ha^{-1})	11200	11060	11060	9870	8960	9100
Cost of cultivation (Rs.ha^{-1})	44320	44485	43610	43040	40240	39560

Input Details	AAS farmers			Non - AAS farmers		
	Sachin Kondankar	Gajanan Kondakar	Digambar Kondankar	Sakharam Tople	Prakash Dange	Sitaram Tople
Seed cotton yield (q ha^{-1})	16	15.8	15.8	14.1	12.8	13
Price (Rs. ha^{-1})	86400	85320	85320	76140	69120	70200
Net profit (Rs. ha^{-1})	42080	40835	41710	33100	28880	30640
Benefit cost (B:C ratio)	1.95	1.92	1.96	1.77	1.72	1.77

6.2 Anantapuramu

6.2.1 Case Study: Maize (*Kharif* 2020)

Village: Yagantipalle

District : Kurnool (Andhra Pradesh)

NICRA agromet advisories of Banaganapalle block were provided to a group of 12 farmers growing maize in Yagantipalle village. The advisories were given from land preparation to harvest on every Tuesday and Friday. The FIF working in the project along with Young Professional have provided these advisories to farmers and helped the farmers in timely planning and execution of various agricultural operations.

All farmers have taken up sowing of maize during 2nd week of July 2020 as per the forecast and advisory given regarding sowing. A rainfall of 38.1 mm was received during the subsequent days helped in crop establishment. During 16-27 July, when the crop is at knee high stage, there was a wet spell and the farmers were advised to immediately drain out the excess water, to avoid water logging and crop damage. Farmers adopted this management practice and provided field drainage facilities and thereby protected the crop. As there was continuous cloudy weather and rainfall forecast, it was also advised to postpone spraying operations during this period. This has saved the cost of chemical and labour charges. After this wet spell, it was suggested to take up control measures for fall army worm control on clear days during the 1st week of October as there was intermittent rainfall forecast. Farmers could take up spraying for pest control as advised. The non-AAS farmers, who have not adopted advisory could not take up spraying in time and hence, resulted in the reduction of yield. The NICRA AAS farmers, who have sown the crop utilizing the forecast rainfall, adopted agromet advisories like draining out of excess water from fields and timely plant protection measures against fall army worm could able to harvest good crop and got an yield advantage of 5.5 t/ha and a benefit of Rs.99,000/ha after meeting all the expenses. The NICRA AAS farmers realized B:C ratio of 3.06 as against 2.51 realized by non adopted famers (Table 6.4). The details of the economics for NICRA AAS and Non AAS farmers is given below.

Table 6.4. Details of cost of cultivation and economic impact of NICRA AAS in Maize

S. No.	Name of the operation	NICRA AAS Cost of Cultivation (Rs/ha)	Non - AAS Cost of Cultivation (Rs/ha)
1	Land preparation and levelling	2,400	2,400
2	Sowing and basal application of fertilizers	4,500	4,500
3	Cost of seed	6,000	6,000
4	Cost of fertilizers	3,000	3,000
5	Weeding and Inter cultivation	4,000	4,500
6	Spraying	3,500	4,500
7	Irrigation	3,000	5,000
8	Harvesting, threshing and cleaning	6,000	6,000
9	Total cost of cultivation	32,400	35,900
10	Yield of maize	5.5 t/ha	5.0 t/ha
11	Price of the produce (Rs./kg)	Rs.18 /kg	Rs.18 /kg
12	Gross returns	Rs.99,000	Rs.90,000
13	Net returns	Rs.66,600	Rs.54,100
14	**B:C ratio**	**3.06**	**2.51**
15	**Benefit from yield advantage due to NICRA AAS**	**Rs.9,000/ha**	

6.2.2 Case Study: Red gram (*Kharif* 2020)

Village: Yagantipalle

District : Kurnool (Andhra Pradesh)

NICRA agromet advisories of Banaganapalle block were provided to a group of 9 redgram growing farmers of Yagantipalle village. The advisories were given from land preparation to harvest on every Tuesday and Friday. The YPI and FIF working in the project have provided these advisories to farmers and helped the farmers in timely planning and execution of various agricultural operations.

The farmers have taken up land preparation utilizing the rainfall received during the first week of June (15.2 mm). They have taken up sowing during 15 June-15 August with the rainfall received during 11-12 June. They were advised to form conservation furrows during the last week of July after crop establishment for conservation of rainwater. Later, there were good rains during the month of August and September and the crop growth was good. They were also advised to drain out excess water from fields to avoid water stagnation.

During the second week of September and October in some cases (pod initiation), it was advised that there was no need to provide protective irrigation to improve the pod development as sufficient amount of rainfall was received during the crop growth period. Farmers did not go for protective irrigation thus saved money on irrigation. Afterwards, it was advised to take up spraying against spotted pod borer as the infestation was above ETL in view of congenial weather conditions for spraying operation. The NICRA AAS farmers followed this advisory and could control the pest effectively at early stages itself with 1-2 sprays. However, non-AAS farmers spent more on pest control due to delayed adoption of spraying that resulted in increased pest damage. Formation of conservation furrows, timely protective irrigation and control of spotted pod borer has helped the NICRA AAS farmers in getting additional yield advantage and returns of Rs.56,000/ha and yields of 800 kg/ha with cost-benefit ratio of 3.66 against 2.30 by Non-NICRA farmers. The details of the economics for AAS and Non-AAS farmers is presented in Table 6.5.

Table 6.5 Details of cost of cultivation and economic impact of NICRA AAS in redgram

S. No.	Name of the operation	NICRA AAS Cost of Cultivation (Rs. ha^{-1})	NON – AAS Cost of Cultivation (Rs. ha^{-1})
1	Land preparation, harrowing and levelling	3,000	3,000
2	Sowing and basal application of fertilizers	2,500	2,500
3	Cost of seed	800	800
4	Cost of fertilizers	2,500	2,500
5	Spraying	1,500	4,500
6	Harvesting, threshing and cleaning	5,000	5,000
7	Total cost of cultivation	15,300	18,300
8	Seed yield	800 kg/ha	600 kg/ha
9	Price of the produce (Rs./kg)	Rs.70/kg	Rs.70/kg
10	Gross returns	Rs.56,000	Rs.42,000
11	Net returns	Rs.40,700	Rs.23,700
12	B:C ratio	3.66	2.30
13	Benefit from yield advantage due to NICRA AAS	Rs. 14,000/ha	

6.2.3. Case Study: Paddy (*Rabi* 2020)

Village: Yagantipalle

District : Kurnool (Andhra Pradesh)

Nine *rabi* paddy growing farmers of Yagantipalle village were selected to study the economic impact of NICRA agromet advisories of Banaganapalle block. The advisories were provided from land preparation to harvest on every Tuesday and Friday. The YPI and FIF working in the project provided the advisories to farmers and helped the farmers in timely planning and execution of various agricultural operations.

The farmers have taken up land preparation utilizing the rainfall received during the first week of September (7.6 mm). They have taken up transplanting during second and third weeks of September month. After sowing, there is medium rainfall forecast during 17-20 September. Hence, advised the farmers to drain out the excess water from the fields immediately. The farmers have adopted this advisory and drained out the excess water due the rainfall (82 mm) received during 17-19 September. This has saved the transplanted rice from uprooting and resulted in better crop establishment. The crop was infested with stem borer due to the congenial weather conditions during second fortnight of October and November. Hence, farmers were advised to take up spraying for control of stem borer on clear days during the month of October. Later, in the month of November, as clear weather is forecasted, they were advised to take up control measures against stem borer, grain mold. NICRA AAS farmers could control the pest effectively with less no. of sprays compared to Non-AAS farmers. Timely advisory on rainfall forecast and removal of excess water from fields has resulted in better plant population and crop establishment. Timely plant protection measures controlled stem borer and grain mold disease. This has helped the NICRA AAS farmers in gaining yield of 6.0 t/ha compared to 5.5 t/ha by Non -AAS farmers and monetary benefit of Rs.96,000/ha against Rs.88,000/ha by Non-NICRA farmers. The details of the economics for NICRA AAS and Non-AAS farmers is given in Table 6.6.

Table 6.6 Details of cost of cultivation and economic impact of NICRA AAS in rice

S. No.	Name of the operation	NICRA AAS Cost of Cultivation (Rs. ha^{-1})	Non - AAS Cost of Cultivation (Rs. ha^{-1})
1	Land preparation and harrowing	9,500	9,500
2	Sowing and basal application of fertilizers	4,000	4,000
3	Cost of seed	4,000	4,000
4	Cost of fertilizers	7,500	7,500

S. No.	Name of the operation	NICRA AAS Cost of Cultivation (Rs. ha^{-1})	Non - AAS Cost of Cultivation (Rs. ha^{-1})
5	Weeding	5,000	7,500
6	Spraying	2,000	4,500
7	Harvesting, threshing and cleaning	7,500	7,500
8	Total cost of cultivation	39,500	44,500
9	Yield of paddy	6.0 t/ha	5.5 t/ha
10	Price of the produce (Rs./kg)	16/kg	16/kg
11	Gross returns	.96,000	88,000
12	Net returns	56,500	43,500
13	**B:C ratio**	**2.43**	**1.98**
14	**Benefit from yield advantage due to NICRA AAS**	**8,000/ha**	

6.3. Bengaluru

6.3.1 Case Study: Grapes (2015-2020)

Location: Chikkaballapura

Partial budgeting of grapes cultivation through AAS was done for 6 years (2015-2020). Nearly 200 farmers were monitored under the project out of which 150 were grape growers in an area of 90 hectares.

- Additional returns due to agromet advisories from sample survey of AAS farmers was Rs.2, 83,000 / ha
- Reduced cost due to savings in irrigation, pesticides spray and timely pruning was to the extent of Rs.25,250/ ha (*Except in 2020 the cost increased due to additional sprays because of incessant rain)
- Total net gain including the total additional return and reduced cost was Rs.3, 08,250/ ha
- Overall benefits from the project due to agromet advisories from grape growers alone was 3.74 **c**rores, including the synergy from line departments, KVKs, Agricultural Research Stations and NGOs in the district

A detailed B:C ratio analysis of AAS adopted and non-adopted farmers is presented in Table 6.7.

Table 6.7. Impact of weather based agro advisories in grapes during 2015-2020 (Average of four years, n=10)

Farmers Groups	Productivity (t/ha)		Cost of Production (Rs /ha)		Gross income (Rs/ha)		% increase in income		Reduced Cost (Rs /ha)		Additional return (Rs /ha)		B:C ratio	
	2020	Mean	2020	Mean	2020	Mean	2020	Mean	2020	Mean	2020	Mean	2020	Mean
Non-AAS farmers	25	28.75	201000	183750	530000	617750		-		-		-	2.64	3.36
AAS farmers	33	36.75	205000	143000	723000	874500	136	142	-4000*	25250	193000	283000	3.52	6.11

6.4 Dapoli

6.4.1. Case Study: Paddy (*kharif* 2020)

Village: Khed

District : Ratnagiri (Maharashtra)

AICRPAM, Dapoli center selected Shri. Suresh Bhikaji Belose, a farmer from Natunagar, a selected NICRA Village (Khed) who has 4 acres of land. He cultivates cereals, pulses and vegetables during *kharif* and rice crop in rabi season. In the year 2020-21, 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 and non-AAS farmer is presented in Table 6.8.

Table 6.8. Comparison of cost cultivation and benefit: cost ratio of AAS and non-AAS rice farmers at Natunagar village of Ratnagiri District Maharashtra (In Rupees)

Name of the operation	Shri. Suresh Bhikaji Belose (AAS farmer)	Shri. Sonu Laxman Tambat (Non-AAS farmer)
1. Land preparation cost	5000	5200
2. Seed cost	1800	1700
3. Fertilizer cost	6500	7000
4. Pesticide cost	2500	2700
5. Labour cost	4000	4000
6. Harvest cost	5000	5000

Name of the operation	Shri. Suresh Bhikaji Belose (AAS farmer)	Shri. Sonu Laxman Tambat (Non-AAS farmer)
Total cost of cultivation	24800/-	25600
Total yield (q) and value (₹)	43,560/- (24 q)	36,300/-(20 q)
Price	1815/-q	1815/-q
Net benefit/loss (₹)	18,760/-	10,700/-
Benefit : cost ratio	1.75	1.41

The AAS farmer obtained higher B:C ratio (1.75) over non-AAS farmer (1.41) due to adoption of agromet-advisories viz., saving fertilizers (avoided application during heavy rainfall period as per advisory), insecticide and pesticide cost (used précised insecticide as per advisory), timely implementation of pest and disease management, perfect nutrient management at right time, advance information regarding sudden change in weather phenomenon like forecasted rainfall during harvesting time and harvestin.

6.5 Faizabad

6.5.1. Case Study: Wheat (*rabi* 2020)

Village: Banpurwa

District : Bahraich (Uttar Pradesh)

Information from farmers on the cost of cultivation of wheat crop by following AAS and the costs of cultivation of the same crop for those farmers who have not followed any AAS provided by the center. A large deviation in the cost of cultivation as well as the B:C ratio was found between the two categories (Tables 6.9 and 6.10).

Table 6.9. Cost of cultivation of wheat (AAS farmers) under Banpurwa village of Dist. Bahraich

Input details (per ha)		Cost (Rs/ha)
i. Ploughing /Harrowing (1) ii. Cultivator with planking (2)	1 hr @ 800/hr 3 hr @ 700/hr	800 2100
Compost (FYM)	5 tones /ha^{-} @ Rs.500/tone	2500
Fertilizer (150:60:40) NPK		
(i) DAP	130 kg/ha^{-} @ Rs.29.0/kg	3770
(ii) N	275kg/ha^{-} @ Rs.6.0/kg	1650
(iii) MOP	66 kg/ha^{-} @ Rs.18.0/kg	1188
(iv) Zn	5.0 kg/ha^{-} @ Rs.50.0/kg	250
Seed Rate	100 kg/ha^{-} @ 35.0/kg	3500

Input details (per ha)		Cost (Rs/ha)
Sowing/Fertilizer/weeding/ Thinning /irrigation	30 labour/ha- @ 174/labour	5220
Plant Protection measures		
(i) Trichoderma virdy (WP)	5.0 kg/ha (soil treatment) @ Rs. 65.00/kg	325
(ii) Weedicide (Sulfosulfuran)	33gm/ha- @ Rs.6.00/gm	198
(iii) 2, 4-D	625 gm/ha- @ 0.35/gm	218
3 Irrigation 8.0 hr/ha / irrigation	Irrigation @ Rs. 150/hr-	3600
Harvesting	15 labour @ 174/labour	2610
2 hr threshing of tractor / winnowing	Tractor Rs.700/hr & 10 labour @174/ labour	3140
Land rent	Rs.6000/ year/ha.	3000
Cost		**31129.00**
Seed yield	42q/ha- @ 1600/q	67200
Straw yield	75q/ha- @ 500/q	37500
Gross Income		**104700.00**
Net Profit		**73571.00**
B:C ratio		**2.36**

Table 6.10. Cost of cultivation of wheat (Non-AAS farmers) under Banpurwa village of dist. Bahraich

Input details (per ha)		Cost (Rs/ha)
(i) Ploughing /Harrowing (1) (ii) Cultivator with planking (2)	1 hr @ 800/hr 3 hr @ 700/hr	800 2100
Compost FYM	5 tones/ha- @ Rs.500/tone	2500
Fertilizer (150:60:40) NPK		
(i) DAP	130 kg/ha- @ Rs.29.0/kg	3770
(ii) N	275 kg/ha- @ Rs.6/kg	1650
(iii) MOP	66 kg/ha- @ Rs.18.0/kg	1188
Seed Rate	125 kg/ha- @ 35/kg	4735
Sowing/Fertilizer/weeding /irrigation	35 labour/ha- @174/ labour	6090
Plant Protection Weeding by		
(i) Weedicide (Sulfosulfuran)	33 gm/ha- @ Rs.6/gm	222
(ii) 2, 4-D	625 gm/ha- @ 0.35/gm	218
4 Irrigation 8 hr/ha/irrigation	Irrigation@150/hr-	3600
Harvesting	15 labour@174/ labour	2610

Input details (per ha)		Cost (Rs/ha)
2 hr threshing of tractor / winnowing	tractor Rs.700/hr & 10 labour @174/Labour	3140
Land Rent	Rs.6000/year/ha.	3000
Cost		**35623.00**
Seed yield	32q/ha-@1600/q	51200
Straw yield	66q/ha-@500/q	32500
Gross Income		**83700.00**
Net Profit		**48077.00**
B:C ratio		**1.34**

Economic impact on wheat:

The economic benefit obtained by the farmers who followed weather based agro-met advisory services were found to be more as compared to non-AAS users. Higher benefit: cost ratio was observed with regards to AAS farmers (2.36) (Table 6.9) as compared to Non-AAS farmer (1.34) (Table 6.10), this is attributed to conservation of moisture in upper layer of the soil and also due to consequent effect on saving the cost of seed, labour, irrigation, insecticide /pesticides which resulted better performance of the crop and reduction in cost of cultivation, as compared to non-adopted farmers.

6.5.2. Case Study: Rice (*Kharif* 2020)

Village: Banpurwa

District : Bahraich (Uttar Pradesh)

The farmers who adopted agro-met advisories (AAS) were able to reduce input cost by utilizing information on seed choice, labour charges, better irrigation scheduling and plant protection measures as compared to farmers who did not follow AAS. Moreover, the adopted farmers gained 607.7 kg/ha higher average rice yield over to non-adopted farmers of village.

Table 6.11. Cost of cultivation of Rice (AAS farmers) under Banpurwa village of dist. Bahraich

Input Details (per ha)	Rate	Cost (Rs. ha^{-1})
(i) Ploughing /Harrowing	2 hr @ Rs.700/hr	1400.0
(ii) Cultivator with planking	2 hr @ Rs.800/hr	1600.0
Compost FYM	10 tones /ha^{-} @ Rs. 500/tone	5000.0

Input Details (per ha)	Rate	Cost (Rs. ha^{-1})
Fertilizer (150:75:75) NPK (i) DAP (ii) N (iii) MOP (iv) Zn	165 kg/ha@ Rs.29.0/kg 265 kg/ha@Rs.6.0/kg 127 kg/ha@Rs.18.0/kg 25 kg/ha@Rs.50.0/kg	4785.0 1590.0 2286.0 1250.0
Seed Rate	15 kg/ha@ Rs.270/kg	4050.0
	PHB-71, Pro-agro-6444 (hybrid)	
Nursery / Planting/Fertilizer/Weeding	50 Labour/ha@ Rs.174/ Labour	8700.0
Plant Protection		
(i) Weedicide (Butachlor)	3.0 lt./ha@Rs.203.0/lt	609.0
(ii) Qunalphas 25%Ec	500 ml@Rs.303.0/lt	151.0
(iii) Insecticide (malathion) 50%	500 ml@Rs.229.0/lt	114.0
Irrigation 8 hr/ha./ irrigation	Irrigation@Rs.150/hr	-
Harvesting	20 Labour@174/Labour	3480.0
Threshing / winnowing	15 Labour@174Labour	2610.0
Land Rent	Rs.6000/year/ha.	3000.0
Cost		**40625.0**
Seed yield	45 q/ha-@1400/q	63000.0
Straw yield	75 q/ha-@200/q	15000.0
Gross Income		**78000.0**
Net Profit		**37375.0**
B:C ratio		**1.92**

It is indicated from the Table 6.11 that comparative per hectare yield of rice under AICRPAM-NICRA AAS farmers showed an average increase of 16.5% over non adopted farming community. Whereas, rice productivity of Non-AAS farmers witnessed a decline in average yield of 607 kg/ha as compared to AAS farmers. It is proved that better quality seed and timely cultural practices based on weather agro-met advisory were responsible for increased rice yields during the year of study in the adopted village.

Economic benefit obtained by the rice grower of village Banpurwa who followed AAS has received higher benefit: cost ratio (1.92) as compared to Non-AAS farmers (1.44) in the village (Tables 6.11 and 6.12). The management practices like conserving moisture in upper layer of the soil and also due to consequent effect on saving the cost of seed, labour, irrigation, insecticide /pesticides which resulted better performance of the crop and reduced the cost of cultivation as compared to Non-AAS farmers of adopted village.

Table 6.12. Cost of cultivation of Rice (Non-AAS farmers) under Banpurwa village of dist. Bahraich

Input Details (per ha)	Rate	Cost (Rs. ha^{-1})
(i) Ploughing /Harrowing	2 hr @700/hr	1400
(ii) Cultivator with planking	2 hr @800/hr	1600
Compost FYM	5 tones /ha^{-} @500/tone	2500
Fertilizer (150:75:75) NPK		
(i) DAP	165kg/ha-@29.0/kg	4785
(ii) N	264 kg/ha-@6.0/kg	1584
(iii) MOP	127kg/ha-@18.0/kg	2286
Seed Rate	20 kg/ha^{-}@ 270/kg	5400
	Pro-agro-6444, PHB-71,	
Nursery / Planting/Fertilizer/Weeding	60 Labour/ha^{-}@174/labour	10440
Plant Protection		
Insecticide (malathion 5% dust)	25kg/ha-@8.0/kg	200.0
3 Irrigation 8 hr/ha./ irrigation	One Irrigation @ Rs.150/hr^{-}	3600
Harvesting	20 Labour @174/Labour	3480
Threshing / winnowing	15 Labour @174/Labour	2610
Land Rent	Rs. 6000/year/ha.	3000
Cost		**42885.0**
Seed yield	35q/ha-@1400/q	49000.0
Straw yield	65q/ha-@200/q	13000.0
Gross Income		**62000.0**
Net Profit		**19115.0**
B:C ratio		**1.44**

6.6. Hisar

6.6.1. Case Study: Wheat (*rabi* 2019-20)

Village: Farwain Kalan

District : Sirsa (Haryana)

The economic impact of micro level agro advisories issued to the farmers' was undertaken at

AICRPAM-NICRA domain village Farwain Kalan (Sirsa) during year 2020-21. Ten farmers were selected for the economic impact study for cotton, rice, wheat and potato crops from the domain village. During the crop growing period, a series of weather based agro advisories in form of AAS bulletins were issued, which were followed as such by the selected farmers.

A comparison was made between AAS adopted farmers and Non-AAS adopted farmers. The weather based agro advisory services are very much popular and appreciated by all the farmers of the domain village. The whole village is weather vigilant due to the continuous activities of AICRPAM-NICRA. For analyses purpose the term Non-AAS adopted farmers refer to the hypothetical farmer who do not follow agro advisories provided under AICRPAM-NICRA and only follow the standard package of practice (varieties, sowing dates, agronomic practices etc.). The MAAS bulletins were disseminated to the target farmers through field information facilitator (FIF) on real time basis through personal approach.

Wheat: For impact assessment of these advisories, the detailed data was collected from the selected farmers in the form of evaluation proforma and Benefit: Cost (B:C) ratio of wheat crop was calculated for Non-AAS adopted and AAS adopted farmers. The economic impact of MAAS was calculated for unit area i.e. 1 hectare (ha) and is presented in Table 6.13. The B:C ratio of AAS adopted farmers was 1.56 as compared to Non-AAS farmers (1.30). The total expenditure of AAS farmers is Rs. 83741ha^{-1}, which is Rs. 8464 lower than the Non-AAS farmers. The net profit of AAS farmers is Rs. 46522ha^{-1}, which is Rs. 18757 more than the Non-AAS farmers as AAS-farmers followed AAS on time. AAS farmers cut down in cost of irrigation by withholding the irrigation keeping in view the anticipated forecasted weather and agromet advisory.

Table 6.13. Economic Impact assessment of MAAS for unit area (1 hectare) for Wheat during 2019-20

S.No.	Items/ Name	Non AAS farmer 1 ha (Rs)	AAS Farmer 1 ha (Rs)
1.	Preparatory tillage	5250	3465
2.	Pre-sowing irrigation	1050	1050
3.	Sowing	1050	1050
4.	Seed (kg)	3000	2940
5.	Seed treatments	325	108
6.	FYM (kg)	10125	8335
7.	Fertilizer nutrients	6668	5826
8.	Fertilizer application	375	460
9.	Irrigation	6300	3255
10.	Weeding (chemical)	2300	1713
11.	Harvesting/Threshing	9250	9250
12.	Miscellaneous	1125	1125

S.No.	Items/ Name	Non AAS farmer 1 ha (Rs)	AAS Farmer 1 ha (Rs)
13.	Total	46818	38576
14.	Interest on working capital	2107	1736
15.	Variable cost	48924	40312
16.	Management changes	4892	4031
17.	Risk factor	4763	4037
18.	Transportation	1125	1125
19.	Rental value of land	32500	32500
20.	Total cost	92204	83741
21.	Production		
21.(a)	Main product	103469	112613
21.(b)	By product	16500	17650
22.	Gross return	119969	130263
23.	Return over variable cost (gross return - variable cost)	71044	89951
24.	Net Return	27765	46522
25.	B:C	1.30	1.56

 # Total saving of adopted farmers is ₹ 8468ha^{-1}.

Potato: The Proforma for evaluation of MAAS and economic impact of MAAS of potato crop was calculated for unit area *i.e.* 1 hectare (ha) and is presented in Table 6.14. The B:C ratio of AAS adopted farmers was 2.26 as compared to Non-AAS farmers (1.95). The total expenditure of AAS farmers is Rs. 175788 ha^{-1}, which is Rs. 4059 lower than the Non-AAS farmers. The net profit of AAS farmers is Rs. 221087 ha^{-1}, which is Rs. 50934 more than the Non-AAS farmers.

Table 6.14. Economic impact assessment of MAAS for unit area (1 hectare) for potato during 2019-20

S.No.	Items/ Name	Non AAS farmer 1 ha (Rs)	AAS Farmer 1 ha (Rs)
1.	Preparatory tillage	5250	4725
2.	Pre-sowing irrigation	1050	1050
3.	Sowing	1050	1050
4.	Ridging	313	250
5.	Seed (kg)	46875	46875

S.No.	Items/ Name	Non AAS farmer 1 ha (Rs)	AAS Farmer 1 ha (Rs)
6.	FYM (kg)	18750	20000
7.	Fertilizer nutrients	13743	12855
8.	Fertilizer application	500	688
9.	Irrigation	4200	2625
10.	Weeding (chemical)	10500	8875
11.	Harvesting/Threshing	13750	13750
12.	Miscellaneous	625	625
13.	Total	116605	113368
14.	Interest on working capital	5247	5102
15.	Variable cost	121852	118469
16.	Management changes	12185	11847
17.	Risk factor	12185	11847
18.	Transportation	1125	1125
19.	Rental value of land	32500	32500
20.	**Total cost**	179847	175788
21.	Production		
21.(a)	Main product	350000	396875
21.(b)	By product	-	-
22.	**Gross return**	350000	396875
23.	Return over variable cost (gross return - variable cost)	228148	278406
24.	Net Return	170153	221087
25.	**B:C**	1.95	2.26

Cotton: The economic impact assessment of MAAS for cotton crop are presented in Table 6.15 which shows that B:C ratio of AAS adopted farmers were higher (1.61) as compared to the non-AAS farmers (1.28). The total expenditure incurred by AAS farmers is Rs. 88322 ha^{-1}, which is Rs. 15508 lower than the Non-AAS farmers (Table 6.15). The net profit of AAS adopted farmers is Rs. 51263 ha^{-1}, which is Rs. 23537 more than the Non-AAS farmers. Higher profit was obtained by AAS farmer due to better management practices in light of forecasted weather. The non-AAS farmers faced losses due to standing of excess water in field by application of irrigation and occurrence of 43.2, 16.2 and 5.5 mm rainfall on 10th July, 7th August and 24th August at vegetative phase, square formation phase and

flowering phases of cotton, respectively. Unlikely, AAS-farmers withhold irrigation during these spans of time by following the advisory given in the AAS bulletin.

Table 6.15. Economic Impact assessment of MAAS for unit area (1 hectare) for cotton during *kharif* 2020

S. No.	Items/ Name	Non-AAS farmer 1 ha (Rs)	AAS Farmer 1 ha (Rs)
1.	Preparatory tillage	4200	3383
2.	Pre-sowing irrigation	1050	350
3.	Sowing	1050	1050
4.	Seed (kg)	3375	3375
5.	FYM (kg)	8100	5789
6.	Fertilizer nutrients	8445	6119
7.	Fertilizer application	600	400
8.	Irrigation	5250	1167
9.	Weeding (chemical)	3400	2711
10.	Plant protection	2950	2167
11.	Harvesting/Threshing	13750	13750
12.	Miscellaneous	625	611
13.	Total	52795	40871
14.	Interest on working capital	2376	1839
15.	Variable cost	55171	42711
16.	Management changes	5517	4271
17.	Risk factor	5518	4271
18.	Transportation	1125	569
19.	Rental value of land	32500	32500
20.	**Total cost**	99830	84322
21.	Production	0	0
22.	Main product	124806	132835
22.(a)	By product	2750	2750
22.(b)	**Gross return**	127556	135585
23.	Return over variable cost (gross return - variable cost)	72385	92874
24.	Net Return	27726	51263
25.	**B:C**	1.28	1.61

 # Total saving of adopted farmers is ₹ 15508 ha^{-1}.

6.7 Samastipur

6.7.1. Case Study: Paddy (*Kharif* 2020)

Village: Bhagwatpur and Ballysaraiya

District : Muzaffarpur (Bihar)

The cost of cultivation and B:C ratio analyzed for adoption of AICRPAM-NICRA Agromet advisory in Bhagwatpur and Ballysaraiya villages of Muzaffarpur district has been worked out and presented in the Tables 6.16 and 6.17, respectively. At Bhagwatpur village, an increased income of Rs 6473 per hectare has been accrued by the farmers who followed AAS over non-adopted farmers. Likewise, an enhanced income of Rs 9000 per hectare has been accrued by AICRPAM NICRA-AAS farmers over non-adopted farmers of Marwan block.

Table 6.16. Cost: Benefit analysis for paddy crop (Bhagwatpur village, Marwan Block, Muzaffarpur)

S. No.	Farmers who did not follow advisory	Cost (Rs/ha)	Farmers who did follow advisory	Cost (Rs/ha)
1	Nursery bed raising	600	Nursery bed raising	600.00
2	Hybrid Seed cost 15kg@325/kg	4875	Hybrid seed cost 12.5kg@Rs 325/kg	4062.00
3	Land preparation	3300	Green manuring and Land preparation	4500.00
4	Water requirements for puddling	1200	Water requirements for puddling	0.0(waited for good rain as per advisory)
4	Transplanting cost (25 Mandays@Rs.350)	8750	Transplanting cost (25 Mandays@Rs.350)	8750.00
5	Weeding cost (10Mandays@ Rs.350)	3550	Weeding cost 1. Spraying cost of herbicides @1600 2. Manual weeding (in later stage of crop) 12 Mandays@ Rs.350 (Rs 4200)	5800.00
6	Fertilizer cost N:P: K (100:40:30 kg /ha)	5500	Fertilizer cost N:P: K (70:40:30 kg / ha)	5050.00
7	Method of fertilizer application 1. basal before puddling 2 Mandays@Rs300 2. Top dressing 2 Mandays@Rs.300	1200	Method of fertilizer application 1. basal before puddling 2 Mandays@Rs 300 2. Top dressing 2 Mandays@Rs.300	1200.00
8	Irrigation (2)	3000	6 irrigations were saved	No input cost applied

S. No.	Farmers who did not follow advisory	Cost (Rs/ha)	Farmers who did follow advisory	Cost (Rs/ha)
9	Plant protection cost (A) Pesticides cost 1. Against Stem borer- Lethal Super 500, 3 litres @Rs 810 2. Against gundhi bug- Folidol dust@20 kg /ha@ Rs 1000 3. Against blight disease -Carbendazime @5 gm Rs 100 (B) Spraying cost 1. 4 Mandays@350@ Rs1400	3310	Plant protection cost (A) Pesticides cost 1. Against Stem borer- Cartap hydrochloride granules (Caldan) @ 25 kg/ha 2. Against gundhi bug- Folidol dust @ 20 kg /ha (B) Spraying cost 1. 4 Mandays @ 350 Rs.1400	3550.00
10	Harvesting and transport to Threshing floor cost (18 Mandays @ Rs.350)	6300	Harvesting and transport to Threshing floor cost	5000.00 (used modern equipment)
11	Threshing (8 hours @ Rs 350)	2800	Threshing (8 hours @Rs 350)	2800.00
12	Total cost cultivation	44385	Total cost cultivation	41312.00
13	Grain yield(q/ha) cost 55 q/ha@Rs.1400.0	77000	Grain yield(q/ha) 57 q/ha @ Rs.1400	79800.00
14	Straw yield (q/ha) cost 58q/ha @ Rs300.00	17400	Straw yield(q/ha) 60q/ha@ Rs 300.00	18000.00
15	Gross income	94400	Gross income	97800.00
16	Net income	50015	Net income	56488.00
	B:C ratio	**1.12**		**1.37**

The major observations from the tables are number of irrigations were saved during puddling and during crop growth stages and also followed the guidelines for spraying of pesticides as suggested in the AAS provided by the AICRPAM-NICRA center at Samastipur.

Table 6.17. Cost: Benefit analysis for paddy crop (Ballysaraiya village, Marwan Block, Muzaffarpur)

S. No.	Farmers who did not follow advisory	Cost (Rs/ha)	Farmers who followed advisory	Cost (Rs/ha)
1	Nursery bed raising	700	Nursery bed raising	700.00
2	Hybrid Seed cost 12 kg @ 320/kg	3840	Hybrid seed cost 12.0 kg @ Rs 320/kg	3840.00
3	Land preparation	3300	Green manuring and Land preparation	4500.00
4	Water requirements for puddling	1200	Water requirements for puddling	0.0 (waited for good rain as per advisory)
4	Transplanting cost (20 Mandays @ Rs.350)	7000	Transplanting cost (20 Mandays @ Rs.350)	7000.00
5	Fertilizer cost N:P: K (100:40:30 kg /ha), DAP-100kg, MOP-50 kg	3500	Fertilizer cost N:P: K (70:40:30 kg /ha)	2900.00
6	Weeding cost (15 Mandays @ Rs.350)	5250	Weeding cost 1. Spraying cost of herbicides @1500 2. Manual weeding (in later stage of crop) 10 Mandays @ Rs.350 (Rs 3500)	5000.00
7	Method of fertilizer application 1. basal before puddling 2 Mandays @ Rs.350 2. Top dressing 2 Mandays@ Rs.350	1400	Method of fertilizer application 1. basal before puddling 2 Mandays@Rs 350 2. Top dressing 2 Mandays@ Rs.350	1400.00
8	Irrigation (2)	2050	4 irrigations were saved	0
9	Plant protection cost (A) Pesticides cost 1. Against Stem borer- Chlorpyriphos, Cypermethrine @ Rs.500 2. Against gundhi bug- Folidol dust @ 25 kg/ha @ Rs.1000 3. Against blight disease -Carbendazime @ Rs 200 (B) Spraying cost 1. 6 Mandays @ 350 @ Rs.2100	3800	Plant protection cost (A) Pesticides cost 1. Against Stem borer- Cartap hydrochloride granules (Caldan)@25 kg/ha 2. Against gundhi bug- Folidol dust@20 kg /ha X Rs 50 =Rs 1000 (B) Spraying cost 4 Mandays@350 Rs 1400	2400.00

S. No.	Farmers who did not follow advisory	Cost (Rs/ha)	Farmers who followed advisory	Cost (Rs/ha)
10	Harvesting and transport to Threshing floor cost (20 Mandays@Rs.350)	7000	Harvesting and transport to Threshing floor cost	5000.00 (used modern equipment)
11	Threshing (7 hours @Rs 400)	2800	Threshing (8hours @Rs 400)	3200.00
12	Total cost cultivation	41840	Total cost cultivation	35940.00
13	Grain yield(q/ha) cost 52 q/ha@Rs.1400.00	72800	Grain yield(q/ha) 54 q/ha@Rs.1400	75600.00
14	Straw yield(q/ha) cost 59q/ha @Rs300.00	17700	Straw yield(q/ha) 60 q/ha@ Rs 300.00	18000.00
15	Gross income	90500	Gross income	93600.00
16	Net income	48660	Net income	57660.00
	B:C ratio	**1.16**		**1.60**

6.8 Thrissur

6.8.1. Case Study: Paddy (*Kharif* 2020)

Village: Thavanur

District : Thrissur (Kerala)

Mr. Jaffer, from Thavanur NICRA Village (Ponnani) has 38 acres of land under paddy cultivation. The variety grown during mundakan 2020 was Ponmani. During this crop growing period, a series of AAS bulletins/real time advisories were issued. The expenditure on different operations and returns received on sale of produce and other details were collected from farmer's feedback. Cost of cultivation and B:C ratio obtained for both the paddy farmers, Mr. Jaffer, who responded to the AAS issued and timely actions taken and the non-AAS adopting farmer Mr. Muhammed is presented in Table 6.18.

Table 6.18. Cost of cultivation of paddy at Thavanur village of Thrissur Dist.

Input Details / ha	Mr. Jaffer (AAS Farmer)	Mr. Muhammed (Non-AAS Farmer)
	Total cost /38 acre	Total cost/ 5 acre
A. Total Fixed cost ha^{-1} (Rental value, interest on fixed capital, Depreciation)	251300	23000
1. Field preparation (machine hours/ha)	40000	7500
2. Seed cost/ha	31920	4200
3. Seed treatment/ ha	1125	150

Input Details / ha	Mr. Jaffer (AAS Farmer)	Mr. Muhammed (Non-AAS Farmer)
	Total cost /38 acre	Total cost/ 5 acre
4. Fertilizer (kg/ha)	178188	29950
5. Weed management / ha	24700	4000
6. Cost of plant protection/ ha	60800	15000
7. Hired human labour	285000	37000
8. Harvesting (Machine hours/ ha)	142500	18000
(B) Total variable cost ha^{-1}	967433	115800
(C)Total cost of cultivation ha^{-1} (A+B)	1218733	138800
(D) Paddy yield (kg ha^{-1})	76000	7000
(E) Price of paddy Rs kg^{-1}	27.49	27.49
(F) Total income (D*E)	2089240	192430
Net profit (F-C)	870507	53630
Benefit cost ratio (F/C)	1.71	1.38

Higher profit obtained by Mr. Jaffer is mainly due to

- Timely adoption of agromet advisories issued.
- Transplanted seedlings at 4-5 leaf stage. Soaked seed for 30 minutes in a solution of Pseudomonas culture @ 10g/liter per kg of seeds.
- Postponement of foliar spray due to rainfall forecast.
- Followed the advisory to control thrips in paddy during the dry spell between monsoon period. Applied 3 ml imidachloprid per 10 liters of water to control them.
- Followed the advisory to control leaf folder attack during cloudy weather; controlled by using Trichogramma chilonis cards (2CC per one acre). Sprayed quinalphos @ 2ml per one liter of water during severe attack.
- To control sheath blight disease sprayed 4gram Trifloxystrobin +Tebuconazole in ten liter of water.
- Controlled bacterial leaf blight as per the advisory; Sprayed the cow dung slurry by mixing with 20g of pseudomonas in one liter of water and sprayed 6g of streptomycin in 30 liter of water.
- Followed the advisory to control rice bug attack during milky stage, controlled by sprayed by malathion @ 2ml per one liter of water.

6.8.2. Case Study: Paddy (*Kharif* 2020)

Village: Valavannur

District : Thrissur (Kerala)

Mr. Kunju Hydru a farmer selected under AICRPAM-NICRA Village, Valavannur has 2 acres of land under paddy cultivation. The variety grown during mundakan 2020 was Uma. During the crop growing period, a series of AAS bulletins/real time advisories were issued. The expenditure on different operations and returns received on sale of produce and other details were collected from farmer's feedback. The cost of cultivation and B:C ratio obtained in case of the paddy farmer Mr. Kunju Hydru, who responded well to the AAS issued and Mr. Asainar, who is a non AAS adopting farmer are presented in the Table 6.19 .

Table 6.19 Cost of cultivation of paddy at Valavannur village of Thrissur Dist.

Input Details / ha	Mr. Kunju Hydru (AAS Farmer)	Mr. Asainar (Non-AAS Farmer)
	Total cost /2 acre	Total cost/3 acre
B. Total Fixed cost ha-1 (Rental value, interest on fixed capital, Depreciation)	**200**	**300**
1. Field Preparation (machine hours/ha)	5000	7500
2. Seed cost/ ha	1680	2520
3. Seed treatment/ ha	150	225
4. Fertilizer / ha	12000	17970
5. Weed management / ha	2000	3000
6. Cost of plant protection/ ha	4000	6000
7. Hired human labour (number)	14000	22500
8. Harvesting (machine hours/ ha)	6000	7500
(B) Total Variable Cost ha-1	44830	67215
(C)Total Cost of cultivation ha-1 (A+B)	45030	67515
(D) Paddy yield (kg ha^{-1})	3000	4200
(E) Price of paddy Rs kg^{-1}	27.49	27.49
(F) Total income (D*E)	82470	115458
Net profit (F-C)	37440	47943
Benefit cost ratio (F/C)	**1.83**	**1.71**

Higher profit obtained by Mr. Kunju Hydru may be mainly due to:

- Timely adoption of agromet advisories issued.

- Followed the advisory to control thrips in paddy during the dry spell between monsoon period. Applied 3 ml imidachloprid per 10 liter of water to control them.
- Followed the advisory to control bacterial leaf blight. Sprayed the cow dung slurry by mixing with 20g of pseudomonas in one liter of water and sprayed 6g of streptomycin in 30 liter of water.
- Leaf folder attack in paddy was controlled by applying 2CC *Trichogramma chilonis* card per acre and stem borer in paddy was controlled by applying 2CC *Trichogramma japonicum* card per acre and also sprayed 3 ml chlorantraniliprole per 10 liter of water during severe attack.
- Followed the advisory to control rice bug, sprayed 2 ml malathion per one liter of water. Pesticides application done before 9 am or after 3 pm.

Followed the advisory to control glume discoloration during 50% panicle emergence stage, controlled by spraying 2gram kocide per liter.

6.9 Udaipur

6.9.1. Case Study: Soybean (*Kharif* 2020)

Village: Jorawar Singh Ji Ka Kheda

District : **Udaipur (Rajasthan)**

Shri Narayan Lal Gadri, Selected farmer of Jorawar Singh Ji Ka Kheda NICRA Village (Rajsamand) under AICRPAM Udaipur centre has 3 acres of land under soybean (variety JS-9560) cultivation during kharif. The farmer religiously followed all the AAS bulletins / real time advisories issued throughout the crop growing period. A farmers feedback was collected from the village on the expenditure in executing different operations and returns received on sale of produce and other details. The cost of cultivation and B-C ratio was obtained in case of the 3 soybean farmers including shri Narayan Lal Gadri, Who has taken an immediate action in response to the AAS issued (Table 6.20) and compared the same with the cost of cultivation and B-C ratio of non AAS -adopted farmers (Table 6.21).

Table 6.20. B:C ratio of soybean farmers (AAS adopter) in Jorawar Singh Ji Ka Kheda NICRA village

Inputs	Unit cost (₹)	Narayan Lal Gadri		Shohan Lal Gurjer		Laluram Gadri	
		Total no. of unit acre^{-1}	Total (₹)	Total no. of unit acre^{-1}	Total (₹)	Total no. of unit acre^{-1}	Total (₹)
Land preparation (Rs. hr^{-1})	400	4	1600	4	1600	2	800
Seed (₹ kg^{-1})	50	40	2000	40	2000	40	2000

Inputs	Unit cost (₹)	Narayan Lal Gadri		Shohan Lal Gurjer		Laluram Gadri	
		Total no. of unit acre^{-1}	Total (₹)	Total no. of unit acre^{-1}	Total (₹)	Total no. of unit acre^{-1}	Total (₹)
Seed treatment (₹ g^{-1})	1.5	40	60	40	60		0
Labour (M/F) (₹ manday^{-1})	300	1	300	1	300	1	300
Sowing (₹ hr^{-1})	400	2	800	2	800	2	800
Fertilizing Basal							
DAP (₹ kg^{-1})	23.9	35	837.2	35	837.2	35	837.2
Urea (₹ kg^{-1})	5.96	40	238.4	40	238.4	40	238.4
Labour (M/F) (Rs. manday^{-1})	300	2	600	2	600	2	600
Pest control							
Quinolphos (₹ Litre^{-1})	280	0.5	140		0	0.5	140
Labour (M/F) (₹ manday^{-1})	300	3	900	1	300	3	900
Weeding 1							
Labour (M/F) (₹ manday^{-1})	300	2	600	2	600	2	600
Herbicide (₹ g^{-1})	28.88	0.5	14.44	0.5	14.44	0.5	14.44
Weeding 2							
Labour (M/F) (₹ manday^{-1})	300	2	600	2	600	2	600
Herbicide (₹ Spray^{-1})	160	1	160	1	160	1	160
Weeding 3							
Labour (M/F) (₹ manday^{-1})	300	1	300			1	300
Harvesting & Threshing							
Labour (M/F) (₹ manday^{-1})	300	8	2400	6	1800	6	1800
Tractor (₹ hrs^{-1})	400	2	800	2	800	2	800
Others							
Drainage (₹ manday^{-1})	300	2	600	2	600	2	600
Cost of cultivation			12950		11310		11490
Average Yield	Price (₹)	Yield (kg)	Total (₹)	Yield (kg)	Total (₹)	Yield (kg)	Total (₹)

Inputs	Unit cost (₹)	Narayan Lal Gadri		Shohan Lal Gurjer		Laluram Gadri	
		Total no. of unit acre^{-1}	Total (₹)	Total no. of unit acre^{-1}	Total (₹)	Total no. of unit acre^{-1}	Total (₹)
Grain (₹ kg^{-1})	32	1800	57600	1500	48000	1600	51200
By-product (₹ kg^{-1})	2	1600	3200	1400	2800	1500	3000
Gross income			60800		50800		54200
Net income			47850		39490		42710
B-C ratio			**3.69**		**3.49**		**3.72**

Higher profit obtained by the farmers are attributed to

- Timely responded to all the AAS issued and carried out all farm operations accordingly
- Used high yielding varieties
- Maintained proper drainage system in field
- Carried out proper nutrient and weather based plant protection measures

Table 6.21. B:C ratio of soybean farmers (Non-AAS adopter) in Jorawar Singh Ji Ka Kheda NICRA village

Inputs	Unit cost (₹)	Suresh Chandra Gurjer	
		Total no. of unit per acre	Total (₹)
Land preparation (Rs.hr^{-1})	400	2	800
Seed (₹ kg^{-1})	50	40	2000
Seed treatment (₹ g^{-1})	1.5	40	60
Labour (M/F) (₹ manday^{-1})	300	1	300
Sowing (₹ hrs^{-1})	400	2	800
Fertilizing Basal			
DAP (₹ kg^{-1})	24	35	837
Urea (₹ kg-1)	5.96	40	238
Labour (M/F) (₹ manday^{-1})	300	2	600
Pest control			
Quinolphose (₹ Litre^{-1})	280	0	0
Labour (M/F) (₹ manday^{-1})	300	0	0

Inputs	Unit cost (₹)	Suresh Chandra Gurjer	
		Total no. of unit per acre	Total (₹)
Weeding 1			
Labour (M/F) (Rs. manday^{-1})	300	2	600
Herbicide (Rs.g^{-1})	29	0.5	14
Weeding 2			
Labour (M/F) (₹ manday^{-1})	300	2	600
Herbicide (₹ Spray^{-1})	160	1	160
Weeding 3			
Labour (M/F) (₹ manday^{-1})	300	0	0
Harvesting & Threshing			
Labour (M/F) (₹ manday^{-1})	300	6	1800
Tractor (₹ hrs^{-1})	400	2	800
Others			
Drainage (₹ manday^{-1})	300	0	0
Cost of cultivation			9610
Average yield	Price (₹)	Yield (kg)	
Grain (₹ kg^{-1})	32	600	19200
By-product (₹ kg^{-1})	2	400	800
Gross income			**20000**
Net Income			**10390**
B-C ratio			**1.08**

6.9.2. Case Study: Blackgram (*Kharif* 2020)

Village: Chomakot and Bhagatpura village

District: Udaipur (Rajasthan)

The AAS issued by NICRA-AICRPAM Udaipur center advised the farmers to go for sowing of black gram instead of maize after 15 July based on the prevailing weather conditions. Farmers of chomakot village responded positively and sown black gram whereas farmers of Bhagatpura village continued with maize after 15 July. The B-C ratio was calculated on the basis of average yield and average cost of cultivation for both the crops (Table 6.22). Farmers who sown the black gram after 15th July got higher B-C ratio (2.1) than Maize growing farmers (1.4).

Table 6.22. B:C ratio of black gram and maize sown after 15 July 2020 at Chomakot and Bhagatpura villages

Inputs	Maize			Black gram		
	Unit cost (₹)	Total no. of unit per acre	Total (₹)	Unit cost (₹)	Total no. of unit per acre	Total (₹)
Land preparation (Rs. hr^{-1})	400	4	1600	400	4	1600
Seed (₹ kg^{-1})	18	10	180	50	7	350
Seed treatment (₹ g^{-1})	4	10	40	1.4	7	9.8
Labour (M/F) (₹ manday^{-1})	300	1	300	300	4	1200
Sowing (₹ hrs^{-1})	400	2	800	400	2	800
Fertilizing Basal						
DAP (₹ kg^{-1})	24	52	1244	24	35	837
Urea (₹ kg^{-1})	6	58	346	5.96	5	30
Labour (M/F) (₹ manday^{-1})	300	4	1200	300	2	600
Pest control						
Pesticide (₹ kg^{-1})	150	6	900	250	1	250
Labour (M/F) (₹ manday^{-1})	300	2	600	300	1	300
Weeding						
Labour (M/F) (₹ manday^{-1})	300	5	1500	300	4	1200
Herbicide (₹ kg-1)	360	0.5	180	28.88	20	578
Harvesting & Threshing						
Labour (M/F) (₹ manday^{-1})	300	4	1200	300	10	3000
Tractor (₹ .hrs^{-1})	400	2	800	400	2	800
Cost of cultivation			**10890**			**11554**
Average yield	Price (₹)	Yield (kg)		Price (₹)	Yield (kg)	
Grain (₹ kg^{-1})	17	1370	23290	55	630	34650
By-product (₹ kg^{-1})	2.5	1240	3100	2.5	460	1150
Gross income			**26390**			**35800**
Net income			**15500**			**24246**
B-C ratio			**1.4**			**2.1**

7. Farmer's Awareness Programs on Climate Change

The details of the awareness program on climate change conducted for farmers of different states under the project are presented in the following table.

Table 7.1. Details of farmer's awareness programs conducted at different locations

Center	Name of Village/ Location	Date	Total No. of farmers	Men	Women
Akola	Sakani	22 January 2021	55	35	20
Bengaluru	Huchhahanumegowdana palya (Magadi)	09 July 2020	60	40	20
	Kuthanagere (Magadi)	10 July 2020	45	28	17
	Hirehalli (Kortagere)	13 July 2020	53	32	21
Bhubaneshwar	Katadaganda	15 March 2021	35	21	14
	Penala	16 March 2021	35	25	10
Chatha	Sherpur	14 October 2020	250	194	56
Dapoli	Sadve	21 March 2021	35	23	12
Faizabad	Panti	23 March 2021	85	60	25
Jorhat	Thengalgaon	25 February 2021	32	0	32
		25 October 2021	40	35	5
		01 December 2021	25	22	3
		31 December 2021	20	0	20
	Kochupathar	26 February 2021	53	0	53
Ludhiana	Pathankot	24 September 2020	95	68	27
	Mansa	03 November 2020	21	16	5
	Fatehgarh Sahib	11 November 2020	20	12	8
	Pathankot	25 November 2020	15	11	4
	Beas	12 December 2020	53	36	17

Center	Name of Village/ Location	Date	Total No. of farmers	Men	Women
Mohanpur	Thansara	9 July 2020	30	19	11
	Gainpara	3 December 2020	30	16	14
	Goaplganj	23 December 2020	33	26	7
	Saluka	27 January 2021	30	21	9
Raipur	Albeda	10 September 2020	17	15	02
	Sirgidi	07 October 2020	17	17	0
	Jhal	17 November 2020	22	22	0
	Sirgidi	18 February 2021	53	53	0
Ranchi	Kunda (Navadih)	04 November 2020	23	23	0
	Lawalaung (Bahagada)	04 November 2020	31	27	4
Solapur	Mangalwedha	01 July 2020	45	35	10
	Narotewadi	01 October 2020	11	10	01
	Chickmahud	07 October 2020	17	15	02
	Pokharapur	08 October 2020	16	15	01
	Chickmahud	20 January 2021	13	12	01
	Pokharapur	08 February 2021	22	20	02
Vijayapura	Utnal	29 December 2020	51	32	19
	Honnutagi	04 January 2021	56	32	24
	Tajpur	16 January 2021	58	40	18
		Total	**1602**	**1108**	**494**

ANNEXURE - I

Location of NICRA adopted villages

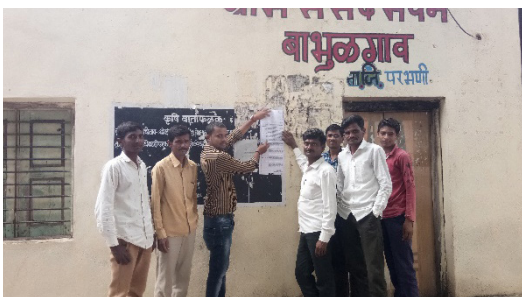
AICRPAM Centre	Name of NICRA-KVK	District	Block/Tehsil/ Mandal	Name of NICRA Village(s)
Akola	AICRPAM village Akola	Akola	Akola	1. Kanshivani
	AICRPDA village Akola	Akola	Akola	2. Warkhed
	KVK, (Dr. PDKV), Buldhana	Buldhana	Buldhana	3. Chautha
Anand	KVK, Mangalbharti	Chhotaudepur	Sankheda	1. Manjrol
	KVK, Targhadia	Rajkot	Rajkot	2. Magharvada
				3. Rafala
				4. Targhadia
Anantapuramu	KVK, Yagantipalle	Kurnool	Banaganapalle	1. Yagantipalle
	KVK, Reddipalli	Ananthapuramu	Singanamala	2. Peravali
	AICRPDA village	Ananthapuramu	Gooty	3. Vannedoddi
Bengaluru	KVK, Chintamani	Chikkaballapur	Chikkaballapur	1. Nayanahalli
	KVK, Magadi	Ramanagara	Magadi	2. Kuthanagere
	KVK, Herehalli	Tumkur	Koratagere	3. Durgada Nagenahalli
Bhubaneswar	Ganjam	Ganjam	Ganjam	1.Ekalpur, Padampur
	Kandhamal	Kandhamal	Kandhamal	2. Budhadani, Phulbani
	Kendrapada	Kendrapada	Kendrapada	3. Krushnadaspur
Chatha	KVK, Kathua	Kathua	Hiranagar	1. Chhapaki Khurd 2. Sherpur Bala
Dapoli	College of Agriculture, Dapoli	Ratnagiri	Dapoli Khed	1. Bandhtivare 2. Natunagar 3. Udhale-Kalambani
Faizabad	KVK, Bahraich	Bahraich	Huzurpur (Kaiserganj)	1. Banpurwa
	KVK, Gonda	Gonda	Paraspur, (Collgan)	2. Bambampurwa
	AICRPDA village	Faizabad	Amaniganj (Milkipur)	3. Amawachhitan
Hisar	KVK, Sirsa	Sirsa Hisar	Sirsa	1. Farwain Kalan
			Sirsa	2. Rupana Khurd
			Hisar	3. Balawas

AICRPAM Centre	Name of NICRA-KVK	District	Block/Tehsil/ Mandal	Name of NICRA Village(s)
Jabalpur	KVK, Rewa	Rewa	Raipur Karchuliyan	1. Padiya 2. Rithi
Jorhat	KVK, Khumtai	Golaghat	Kothalguri	1. Thengalgaon 2. Kochupathar
	KVK, Napam	Sonitpur	Balipara	3. Nagharia
	KVK, Bilasipara	Dhubri	Agomani	4. Udmari III
Kanpur	KVK, Daleepnagar	Kanpur Dehat	Maitha Hamirpur	1. Baghpur 2. Ludhaura 3. Barua
Kovilpatti	KVK, Madurai KVK, Ramanathapuram	Madurai Ramanathapu-ram	Madurai Ramanathapu-ram	1. Allikundam 2. Buchampatti 3. Malangudi
Ludhiana	KVK, Fatehgarh Sahib	Fatehgarh Sahib	Fatehgarh Sahib	1. Badhoshe Kalan 2. Bauranga Zer
Mohanpur	KVK, Ram Krishna Ashram	South 24 Paraganas	Kultoli	1. Bongheri 2. Gopalganj
Palampur	KVK, Bara	Hamirpur	Sujanpur Bhoranj	1. Bagehrah Buhla 2. Palahi 3. Karot Khas 4. Dhamrol
Parbhani	VNMKV, Parbhani	Parbhani	Parbhani	1. Babulgaon 2. Ujalamba 3. Mandakali
Raipur	KVK, Mahasamund KVK, Kanker, KVK , Bemetara	Mahasamund Kanker Koriya	Mahasamund Kanker Bemetara	1. Jhalkhamaria, Lafin khurd 2. Kapsi, Sureli 3. Jhal
Ranchi	ZRS, Chianki, KVK, Bishunpur	Gumla (KVK, Bishunpur) Palamu (ZRS, Chianki)	Gumla Palamu	1. Belagarha (Gumla) TDC 2. Rajderwa (Palamu) 3. Jorkat (Palamu) Dry land
Ranichauri	KVK, Chinyalisaur	Uttarkashi	Dunda	1. Badethi 2. Hitanu 3. Dunda 4. Asthal
			Chinyalisaur	1. Bharkot

AICRPAM Centre	Name of NICRA-KVK	District	Block/Tehsil/ Mandal	Name of NICRA Village(s)
Samastipur	KVK, Saraiya	Muzaffarpur	Saraiya	1. Ballisaraiya
			Marwan	2. Bhagwatpur
		Saran	Dariyapur	3.Darihara
Solapur	Solapur	Solapur	Solapur	1. Narotewadi
			Sangola	2. Chik mahud
Thrissur	KVK, Malappuram	Malappuram	Malappuram	1. Thavanur 2. Valavannur
Udaipur	KVK, Rajsamand	Rajsamand	Rajsamand	1.Bagatpura 2. Jorawar Singh ji Ka Kheda 3. Kundeli
	KVK, Kota	Kota	Kota	4. Chomakot
Vijayapura	ICAR-KVK, Tukkanatti	Belagavi	Gokak	1. Arabhavi
	ICAR-KVK, Hulkoti	Gadag	Gadag	2. Kurthkoti
	AICRPDA village	Vijayapura	Vijayapura	3. Kavalagi

ANNEXURE - II

NICRA-AICRPAM – Field activities



NICRA-AICRPAM – Field activities